THE DETERMINATION OF THE RECYCLER PREFERENCE INDEX (RPI) FOR RECYCLING THE END-OF-LIFE PLASTIC WASTE IN MALAYSIA

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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DECLARATION

I declare that this study entitled “The determination of the Recycler Preference Index (RPI) for recycling the end-of-life plastic waste in Malaysia” results from my research except as cited in the reference. The study has not been accepted for any degree and is not concurrently submitted in any degree's candidature.

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Name : MUHAMMAD ILHAM BIN ABDUL RAHIM

Date : 9th February 2021

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as partial fulfilment of the Bachelor of Manufacturing Engineering requirement.

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ABSTRAK

Produk berasaskan plastik telah mendominasi banyak sektor di peringkat tempatan dan global kesan daripada permintaan yang tinggi dan akses mudah mendapatkannya. Permintaan yang semakin meningkat dan amalan pembuangan yang tidak sihat telah menyebabkan banyak sampah dibuang ke tempat pembuangan sampah dan menimbulkan banyak pencemaran alam sekitar. Di Malaysia, kesedaran mengenai kitar semula plastik masih berada di peringkat permulaan. Perwakilan dan kekurangan penyelidikan yang tepat dalam kitar semula sisa plastik akibat dari kekurangan maklumat telah menjadi cabaran untuk Malaysia memperkasakan alat pengurusan strategik. Objektif penyelidikan ini adalah untuk menentukan faktor-faktor penting untuk pelaksanaan inisiatif kitar semula plastik, untuk mengenal pasti pemilikan akhir sisa plastik, untuk menentukan kerangka rantaian bekalan kitar semula tempatan dalam menguruskan sampah plastik dan memodelkan Preferensi Pengitar Semula Indeks untuk sisa plastik di Malaysia. Dalam penyelidikan ini, borang soal selidik dikhaskan untuk mendapatkan kesimpulan statistik mengenai faktor kritikal dan data penting dari pihak kitar semula di Selangor dan Johor. Dari hasil penemuan, kebanyakan responden menyatakan peraturan dan undang-undang semasa adalah cabaran utama untuk bertahan dalam industri kitar semula dan keuntungan adalah faktor utama yang mendorong responden mengitar semula sampah plastik di Malaysia. Selain itu, permintaan tinggi untuk plastik kitar semula di pasaran adalah pemacu responden untuk bertahan dalam industri kitar semula ini. Dengan menggunakan penemuan tersebut, rantaian bekalan kerangka tempatan dikembangkan dan kemudian dikaji oleh Jabatan Alam Sekitar (JAS) Malaysia. Model pembuatan keputusan untuk mengitar semula keutamaan sampah plastik untuk Malaysia dikembangkan. Kesimpulannya, pengurusan sampah plastik dilihat sebagai cabaran kerajaan. Kajian ini bertujuan untuk meningkatkan kadar kitar semula Malaysia untuk mematuhi visi ekonomi pekeliling. Penemuan ini dapat dijadikan panduan kerajaan untuk meningkatkan aktiviti kitar semula plastik di Malaysia.

ABSTRACT

Plastic based products are dominating many sectors locally and globally due to high demand and easy access to it. The demand is increasing and with the current unhealthy disposal practices, the waste has been simply dumped into the landfill which lead to many environmental issues. In Malaysia, the awareness of the plastics recycling are at the infancy level. The insufficient information to empower strategic management tool has made the plastics recycling needs a proper delegation and investigation. This research objectives were to determine the critical factors for the execution of plastic recycling initiatives, to identify the end-of-life waste ownership for plastic waste, to determine the local-recycling supply chain framework in managing plastic waste and to model the Recycler Preferences Index (RPI) for plastic waste in Malaysia. In this research, a questionnaire was deviced to gain statistical inferences about critical factors and important data from the recycler's in Selangor and Johor. From the findings, most of the respondent stated the current rules and regulation is the main challenges to survive in the recycling industry while profitability is the key factor of the respondent encourage for recycling the plastic waste in Malaysia. Besides, the high demand for recycled plastic in the market is the respondent's current driver can sustain in the recycling industry. Using those findings, the local framework supply chain was developed and later was reviewed by the Department of Environmental (DOE) Malaysia. At the end, a decision making model for recycling plastic waste priorities for Malaysia was developed. In conclusion, plastic waste management is seen as the government's challenges and this study aim to increase Malaysia's recycling rate to comply with the circular economy vision. This finding can be used as the guide for government to enhance current plastic recycling activities in Malaysia.

DEDICATION

To my beloved mom and dad,

My adored siblings,

My supportive academic supervisor, Encik Mohd Shahrizan Bin Othman and Ts. Dr Al Amin Bin Mohamed Sultan,

For all their encouragement, support and understanding.

Thank You So Much & Appreciated Your Kindness

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Praises be to Allah S.W.T for providing me the time, good health, strength and smooth journeys towards completing this study. I am forever grateful for everyone that involves in this study for their encouragement, support and cooperation that helps me completing the study perfectly. I would like to express my deepest appreciation to my beloved parents and siblings for their prayers, emotionally and financially support, encouragement and understanding they showed has ease me to complete the study.

I would like to express my sincere thanks to all the recyclers in Selangor and Johor whom either have accepting me in good manners or rejecting me. In either way, they have taught me the how real-world works. I would also like to this opportunity to express my sincere acknowledgement to my supportive supervisor, for his wisdom, essential supervision, guidance, financial support and encouragement towards this completion of study.

Thank you and appreciated your kindness

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CHAPTER 1

INTRODUCTION

1.1 Background

Plastic is undeniably one of the greatest inventions that have made, where the presence of plastic has continuously contributed to the development of the society to meet their needs. As we can see today, the plastic fact could be seen worldwide and has been a part of social lifestyles. Nowdays, plastic has helped society in many ways, including preserving foods, channelling waters, providing a lightweight and unbreakable material for various sectors, and many more. Food packaging is commonly used in the supermarket to protects and preserve the foods allowing the society to have excess to fresh and nutritious food. Plastics also use the pipe system where the plastics help reduce the water loss.

The ability to resist corrosion and fracture in plastics has made plastics a suitable material for the water supply system. Plastics are also called lightweight material and can be found in the aviation industry. Light properties assist aircraft in increasing aircraft fuel efficiency and emissions of carbon dioxide. Plastics are widely used in the healthcare sector because of its endless application in life-saving. Existing health facilities such as disposable blood bags, tubing, catheters, syringes, protective gloves, and life-saving valves prolong society's health. The versatility, exceptional strength, cheapness and no extensive maintenance requirements have favoured plastics in many industries.

The plastic production and consumption have been gradually increasing in this era of urbanization and economic growth. The annually growing production of plastics could be seen where plastic manufacturers have reported to generate more than 359 million metric tons of total production in 2018 (Garside, 2020), with Malaysia contributed 4.8% until February 2019 (Indeks Pengeluaran Perindustrian Malaysia, 2019). The plastics manufacturing industry is one of the most competitive and growing sectors in Malaysia. According to NSWMD (2011), an average plastics industry growth of 15% has been achieved in the recent 11 years due to the strong Malaysian economy. It is reported that an estimated 2 million tonnes of plastic resin have been produced locally. Nevertheless, this higher rate of plastics produced would simultaneously increase the percentage of plastic waste. It will become a threat to life if they are not adequately managed.

Based on previous study, Klemeš *et al.* (2020) claimed that the price of the virgin plastics is lower than any other material, which, unfortunately, has allowed this material to be single-use in many applications. Current production and management in the plastics industry have become alarming as they keep practising the linear economy concept, the 'take-use-make-dispose' approach. The plastic sector is an important contributor to economic growth, but its current production pattern has led to the deterioration of the environment, and the adverse effects on human health, (Ricardo Barra and Leonard, 2018). This approach of the linear economy will focus on the extraction of virgin material. Then it will be processed into a usable product, and later this useful product would be used by the consumer for a certain period before it is discarded.

The linear economy approach has been argued by Jawahir and Bradley (2016) that highlighted this approach does not consider environmental, economic, and societal impacts, making it an unsustainable solution. This statement is supported by Ricardo Barra and Leonard (2018), where the scholar pointed out that the linear economy approach that is practised in the plastic industry harms the environment and the livings throughout its lifecycle. According to the Geyer *et al.* (2017), a staggering 6,300 million tonnes of plastic waste is generated in 2015. Only 9% is recycled, 12% is incinerated, and the rest is dumped in the landfill or thrown in the ocean. Malaysia generates 1.52 million

tonnes of plastic waste with 22.9 million coastal population in 2010 (Hoegh-Guldberg *et al.* 2015) and has been ranked 8th mismanaged plastic waste country (MESTECC, 2018). 2.9% of the plastic waste was blown from 1,52 million tonnes produced, and 0.14 to 0.37 million tonnes have been thrown in the ocean. It can be seen mostly during the end-of-life (EOL) phase of plastic products where NSWM (2019) points out that plastics pollute 50% of the sea takes 500 years to break down all plastic waste.

Plastic is a huge problem, especially when it gets into the ocean, and humans get exposed through the food chain. Besides, NSWM (2019) points out that animals often deceive plastic waste as food, and approximately 60% of seabirds and almost of the turtles eating plastics. Not only that, many of the animals starve with stomachs full of indigestible trash and which can harm the wildlife (Hoegh-Guldberg *et al.* 2015). The issues have been debated internationally, and one way to provide a sustainable future is to adopt a circular economy. The circular economy is an alternative to the current approach and is supposed to lead a sustainable future. The purpose of the circular economy approach is to reduce the need for new raw resources to be extracted, to retain the resources in use for a more extended period, and to ensure that the goods can be regenerated at the end-of-life phase (Barra *et al.*, 2018).

The circular economy works closed-loop framework in which the value of products, materials, and resources is kept as far as is feasible in the economy (Merli et al., 2018). Jawahir and Bradley (2016) defines that circular economy as an effective plan to decrease the waste resources throughout the product's entire life cycle. The circular economy could be improving resource efficiency by reducing, reuse, and recycle culture by going back to recycling, moving away from virgin resources, and shifting towards reusable resources. With all the benefits offered, MPMA (2019) points out that Malaysia should not hesitate to start implementing the circular economy as the potential seen in this approach are enormous.

1.2 Problem Statement

Plastic has played a definitive role in delivering much of the socio-economic advantages of modern life. Today, plastics have dominated many industries and have replaced many conventional materials. The rapid urbanization, economic development, and a larger population are the primary drivers that lead to the heavy reliance on plastics in livings life. Plastic has benefited the livings in many ways. This kind of material could be seen everywhere closer to the livings, starting from the smallest thing such as paper clips to the most prominent thing such as the spaceship. Owing to the widespread use of plastic, the plastic industry's average growth rate in Malaysia is seen to increase. This is said to grow 15% in the last 11 years (NSWMD, 2011) with Malaysia's market share in the plastic industry rises from 40% in 2008 to 48% in 2015 (KRI, 2019). In 2018, 51% of 360 million tons of plastic produced globally were from Asian countries (Plastics Europe Market Research Group, 2019).

Owing to the widespread use of plastic products in 2018, Malaysia has collected more than 1 million tons of plastic waste. Out of the total waste collected, only 24.6% are recycled (NSWM, 2019). The remaining were either end up in the landfill nor thrown into the ocean causes critical environmental problems. A study of plastic recycling, D'ambrières (2019) points out that plastic is a uniquely incredible material that could benefit humans in several ways. It would be a waste if the end-of-life products were discarded or thrown away because they have an immense value that could help society grow. Besides, this development will enable industries to emerge and recover value from recycled materials that are more sustainable and cost-effective. However, this development could be done with a higher recycling rate.

Malaysia is beginning to move forward towards a sustainable future by preparing to adopt a circular economy in industry practices (MPMA, 2019). However, to do so, the government must take various measures such as identifying ownership of plastic recycling, determining the critical factors for the execution of plastic recycling initiatives, and constructing the official plastic recycling framework for Malaysia which are currently absent. The absence of the ownership of plastic recycling has caused the growth of illegal

plastic recycling plant. Toto (2019) points out the unlawful recycling plant poses a threat to the environment as they often dumped and burned the plastic waste causes pollutions. Not only that, but these companies also do not have a permit from the department of environment, and the pollution control system has never been installed throughout the operating years (Lim, 2019). The absence of official recycling framework, and a lack of critical factor in recycling, the country's mission to achieve a sustainable future is likely to slow down. Therefore, Malaysia is in need of developing more authorized recycling plant that owns the responsibilities to manage the waste sustainably.

1.3 Objectives

1. To determine the critical factors for the execution of plastic recycling initiatives for Malaysia
2. To identify the end-of-life waste ownership for plastic waste in Malaysia
3. To construct the local-recycling supply chain framework in managing plastic waste in Malaysia.
4. To model the recycler preferences index (RPI) for plastic waste in Malaysia

1.4 Scope of Research

This study is based upon a critical factors from recycler's perspectives which measure the driver, challenges and consideration factor for the plastic waste recycling initiatives in Malaysia. Measurement of these critical factors is crucial to enhancing recycling culture among recyclers, as recycling is one of the key Circular Economy (CE) approaches. The output of critical factors to the implementation of plastic waste recycling initiatives are solely based on the perspectives of the recyclers in Selangor and Johor. The measures for plastic waste ownership is crucial to determine the responsibe identities in ensuring waste is managed adequately. The constructed local-recycling supply chain framework for plastic waste and Recycler Preference Index (RPI) developed is primarily based on recyclers in the targeted area and may also be applicable to others with some relevant modification.

1.5 Report Outline

- **Chapter 1: Introduction**

  The chapter forms a general view of determining the research problem statement to find the report's actual objectives.

- **Chapter 2: Literature Review**

  This chapter presents the literature review of the report to deliver an exact point of view of plastic waste in term of its sustainability, circular economy, global plastic scenario, Malaysia plastic scenario and recycling rate of plastic in Malaysia.

- **Chapter 3: Methodology**

  This chapter represents a way or methodology to cater to all the objectives stated in chapter 1. All of the objective methods represent a flow chart to give a clear flow on each objective.

- **Chapter 4: Result and Discussion**

  This chapter presents the findings in chapter 3. All the data collected helps the researcher redesign the plastic waste management framework and constructing recycler preferences index (RPI) of plastic waste in Malaysia to help the government re-establish the recycling rate in Malaysia.

- **Chapter 5: Conclusion**

  This chapter represents the conclusion of the report and the recommendation for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Sustainability

The phrase ‘sustainability’ originated from the Latin, sustinere. ‘Tinere’ means to hold, while ‘Sus’ means up. In the World Commission on Environment and Development (WCED), Brundtland Commission defined sustainable development as a growth that meets current needs without negotiating the future's ability to meet its own needs (Keeble, 1988). Up to 2020, there are some barriers to verifying future requirements as currently, people live in a globalizing world, which is the requirements needed may be different based on country development. Thus, some identification and measurement methods are required to obtain each country's sustainable development targets (Dang and Serajuddin, 2020). The latest report in 2019 had mentioned the inequality of climate change, poverty issue, and other global challenges are linked and act as an indicator to identify the actual sustainability goals (Willis, 2019). In general, sustainability means making the world a better place for all, without destroying opportunities for the next generation (Emas, 2015).

Sustainability is generally linked with the three-pillar model of sustainable development. Social, economic, and environmental are the three-pillars in defining sustainability development (Weinberger, 2015). Typically, it represented three intersecting circles by sustainability at the centre (Purvis *et al.*, 2018). In terms of product development, sustainability can be achieved by designing environmentally, economically, and socially. Figure 2.1 shows the three-pillar relationship between sustainable (Purvis *et al.*, 2018).

Figure 2. 1 : Three key sustainability pillars (Purvis *et al.*, 2018)

Sustainability is currently regarded as a global concept (Klarin, 2018). This can be explained using the three-pillar model. As studied by Reddy and Thomson (2015), the model builds on economic and social environmental considerations that must always be seen as having their place together. First, the environmental pillar includes, among other things, widespread climate protection. Environmental sustainability is designed for protecting resources and biodiversity. For example, increasing environmental complications has prompted global governments to implement strict regulations and sustainable product producers (Benson, 2015). Prashant (2020) highlighted that manufacturers develop or design an environmentally friendly process or product to minimize environmental impact. In general, the environmental aspect of sustainability clearly can be seen through a product or material that contributes to natural eco-system during any phase, such as usage. At the very minimum, it could be considered for an energy recovery option after end-of-life.

Second, economic pillars. According to Haapanen and Tapio (2016), economic growth plays an essential role in implementing sustainability in every nation. Taking plastic to develop sustainability in terms of products as plastic products is among Malaysia's fastest-growing industries (Bernama, 2019). They stated that plastic manufacturing's manufacturing value increased by 3.4% to RM19.76 billion, including exporting plastic to other countries, which rose from 3.6% to RM11.11 billion in 2019. From a manufacturing perspective, plastic can give a big positive vibe in reducing

manufacturing cost as plastic can produce a variety complex shape with a simple process, thus significantly lowering costs related with production and the utilization of man, machine, material and method (Andrady, 2015).

The third social pillar highlighted the development of products or materials capable of providing benefits to society by saving their cost-effectiveness and safety while using it. One more time, they are taking plastic as an example in the automotive industry. According to American Energy Council (2019), almost 50% of the modern vehicle consists of plastic elements. The implementation of plastic, resulting in a weight reduction of the car, can improve its fuel economy. In terms of safety, plastic creates a crumple zone effectively acting as a cushion for life-saving to absorb the energy better than metal before it reaches the occupant when a collision is happened (American Chemical Council, 2006). Plastics play an essential role in the future of vehicles from this innovation.

2.2 A Circular Economy

A circular economy is a well-organized economic development technique designed to benefit businesses, society, and the environment. It is a model of a better solution for environmental protection and economic growth based on the three principles of waste and pollution management, the maintenance of products and materials, and the regeneration of natural systems (Arthur, 2013). Others stated that the Circular Economy (CE) aims to overcome the linear pattern of production and use of take-up and disposal. Jawahir and Bradley (2016) suggest a circular economy as a decrease in waste resources through an effective plan, product execution, and process for improved resource efficiency through circulatory materials streams, including product recovery, recycling, and restoration. This definition would be the most idealistic and detailed, with a comprehensive view of each stage of resources productivity exercises such as recovery, reuse, remanufacture, and recycling.

The present of the circular economy did not dismiss the end-of-life of product and waste stored. Still, it more to arriving at an equalization store network of an item or waste to profit organizations, society, and the earth. This statement is supported by Cavallo and Cencioni (2017) as circular economy gives an advantage for economic growth, enhancing business competitiveness, improving the products and its resources to reduce the impact on the environment. Merli *et al.*, (2018) seeks to keep the value of products, materials, and resources as much as possible in the economy. Therefore, the circular economy cycle can be represented in Figure 2.2 (UNIDO, 2019).

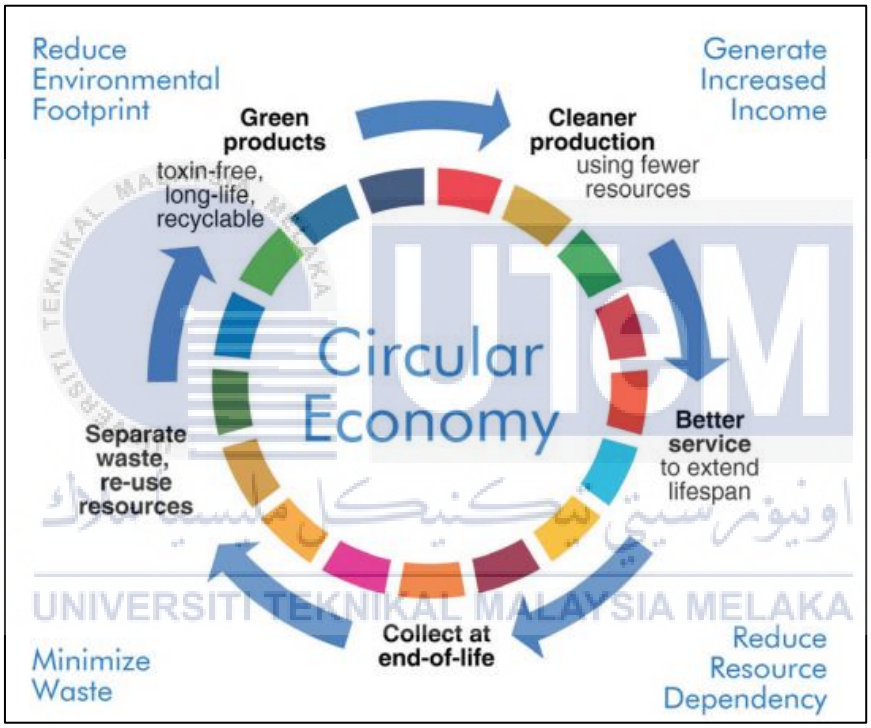

Figure 2. 2 : Cycle of the circular economy (UNIDO, 2019)

However, Iacovidou *et al.*, (2018) highlighted that there are some obstacles and drivers to achieve a sizeable circular economy in a country, especially in the food packaging industry, as the progress towards the implementation of the circular economy requires a significant change that affects the whole association and its partners. Therefore, Kirchherr et al, (2018) reported that the barrier could be avoided and handled to improve the circular economy by specific enabling actions. The obstacles and drivers can be identified through consultation or systematic review of published case studies. The barrier and enabler are divided into two different categories, hard (technically and economically)

and soft (institutionally and socially) (Araujo Galvão *et al.*, 2018). The categorization is useful in recognizing the main element on which progress must be gained to implement a circular economy. Still, the allocation is not always clear cut as it might differ for each country. For instance, some researchers found technological barriers, cultural, regulatory, market barriers, financial, and others. Cultural, regulatory, economic, and sectoral is the main barrier identified by Hart *et al.*, (2019). The circular economy barriers can be shown in table 2.1 by Vermunt *et al.*, (2019).

Table 2. 1 : Barriers of the circular economy

Type of barriers	Description of barriers	Sources
Financial	- Insufficient of financial resources - High up-front investment costs - Unclear financial business case	(Mishra *et al.*, 2018); (de Jesus and Mendonça, 2018); (Ormazabal *et al.*, 2018); (Govindan and Hasanagic, 2018)
Organizational	- Administrative burden - Organization of reverse infrastructures - More complex management and planning processes.	(Rizos *et al*, 2016); (Ritzén & Sandström, 2017); (Ormazabal *et al.*, 2018); (Govindan and Hasanagic, 2018)
Knowledge and technology	- Lack of technical know-how and expertise - Lack of information and data - Design challenges to create durable products	(Yong and Doberstein, 2008); (Preston, 2012); (Rizos *et al.*, 2016); (Jesus and Mendonça, 2018); (Ormazabal *et al.*, 2018); (Ritzén and Sandström, 2017); (Todeschini *et al.*, 2017); (Kirchherr *et al.*, 2018); (Govindan and Hasanagic, 2018)
Supply chain	- Lack of partners and low availability of materials. - Lack of information exchange between supply chain actors. - Conflicting interests between actors in the supply chain. - Lack of consideration of circular design from supply chain actors. - Bad reuse practices/reluctance of third parties.	(Preston, 2012); (Kissling *et al.*, 2013); (Rizos *et al.*, 2016); (Adams *et al.*, 2017); (Ritzén and Sandström, 2017); (Todeschini *et al.*, 2017); (Mishra *et al.*, 2018); (Govindan and Hasanagic, 2018)
Market	- Low virgin material prices	(Yong and Doberstein, 2008); (Preston, 2012); (Kissling *et al.*,

	- Resistance from stakeholders with vested interests in the linear economy - Lack of consumer interest	2013); (Planing, 2014); (Ormazabal *et al.*, 2018); (Jesus and Mendonça, 2018); (Kirchherr *et al.*, 2018); (Todeschini *et al.*, 2017); (Govindan and Hasanagic, 2018); (Mishra *et al.*, 2018)
Institutional	- Ineffective recycling policies - Lack Incentives that promote material consumption above services, such as V.A.T. (value-added tax). - Specific current accounting rules and management systems that are inappropriate for the circular economy. - Lack of standards and guidelines for the quality of refurbishment products. - Lack of awareness and sense of urgency within society	(Yong and Doberstein, 2008); (Preston, 2012); (Kissling *et al.*, 2013); (Rizos *et al.*, 2016); (Ormazabal *et al.*, 2018); (Kirchherr *et al.*, 2018); (Govindan and Hasanagic, 2018); (Ranta *et al.*, 2018); (Jesus and Mendonça, 2018); (Mishra *et al.*, 2018); (Adams *et al.*, 2017)

From table 2.1, (Mishra *et al.*, 2018; Jesus and Mendonça, 2018; Ormazabal *et al.*, 2018; Govindan and Hasanagic, 2018) highlighted in their research of some limitation on the context of the financial that become a barrier for circular economy to be fully implemented. The barrier includes lack of financial resources to fully implementing circular economy in the industry, high up-front investment costs for set up and unclear financial business case. In terms of organizational aspect, (Rizos *et al.*, 2016; Ritzén and Sandström, 2017; Ormazabal *et al.*, 2018; Govindan and Hasanagic, 2018) believes that administrative burden, organization of reverse infrastructures, more complex management and planning processes in the industry are contributing to the drawback for the industry or organization to start implementing circular economy. In terms of knowledge and technology aspect, (Yong and Doberstein, 2008; Preston, 2012; Rizos *et al.*, 2016; Jesus and Mendonça, 2018; Ormazabal *et al.*, 2018; Ritzén and Sandström, 2017; Todeschini *et al.*, 2017; Kirchherr *et al.*, 2018; Govindan and Hasanagic, 2018) highlighted that lack of technical know-how and expertise, lack of information and difficulties in design to create durable products has become a drawback for organization and industry to fully develop circular economy practices.

In terms of supply chain, (Preston, 2012; Kissling *et al.*, 2013; Rizos *et al.*, 2016; Adams *et al.*, 2017; Ritzén and Sandström, 2017; Todeschini *et al.*, 2017; Mishra *et al.*, 2018; Govindan and Hasanagic, 2018) pointed out that the organizations were lack of collaboration, lack of information exchange between supply chain actors, conflicting interests between actors in the supply chain, lack of consideration on the circular design from supply chain actors and wrong reuse practices or reluctance of third parties has become barriers for the organizations to fully practice circular economy. In terms of market in circular economy, (Yong and Doberstein, 2008; Preston, 2012; Kissling *et al.*, 2013; Planing, 2014; Ormazabal *et al.*, 2018; de Jesus and Mendonça, 2018; Kirchherr *et al.*, 2018; Todeschini *et al.*, 2017; Govindan and Hasanagic, 2018; Mishra *et al.*, 2018) addressed that virgin material prices were low, resistance from stakeholders with vested interests in the linear economy and lack of consumer interest has lead the organizations and industry to keep on practicing linear economy.

In terms of institutional, (Yong and Doberstein, 2008; Preston, 2012; Kissling *et al.*, 2013; Rizos *et al.*, 2016; Ormazabal *et al.*, 2018; Kirchherr *et al.*, 2018; Govindan and Hasanagic, 2018; Ranta *et al.*, 2018; de Jesus and Mendonça, 2018; Mishra *et al.*, 2018; Adams *et al.*, 2017) pointed out that ineffective recycling policy, lack of incentives to promote the consumption of materials above services, specific current accounting rules and management systems inappropriate for circular economy purposes, lack of standards and quality guidelines of rehabilitation products, lack of awareness and sense of urgency has become a drawback for most countries to fully implementing circular economy.

2.2.1 Plastic in Circular Economy

Each country is now adapting to take the next step towards sustainability and a circular economy. In a linear economy, virgin resources such as fossil fuels, coal, oil, and others are extracted to develop a new product, utilized, consumed and then thrown out as waste (Sariatli, 2017). It is called linear because it makes a straight line from resource extraction to the landfill. It is also called the “Take, Make, and Waste” economy. In the circular economy, waste becomes a valuable resource, recycled as raw material,

converted into new products and not disposed of. It is an economy that aims to eliminate the expression "waste" by completely recovering the precious materials used in production at the end of product life (European Environment Agency, 2019). Instead of going into a landfill, it biodegrades or returns as feedstock back to the manufacturing process.

Grigore (2017) highlighted that the linear economy's two issues can be solved by developing recyclable plastic. As a plastic mostly produced from fossil fuels, it can minimise natural resource extraction and reduce or prevent waste and plastic pollution. Hence, recycling is the best way to reuse waste as a resource. It reduces production costs by replacing virgin feedstock, reducing one-use plastics to reusable plastics, and creating a cleaner environment. In Figure 2.3 and figure 2.4, the Ellen MacArthur Foundation outlined the objective of circular plastics in the field of funding the reuse and recycling of plastics, preventing the spillage of plastics, especially in pipes and seas, and reducing the development of plastics from non-renewable energies, and fossil fuels (MacArthur *et al.*, 2016).

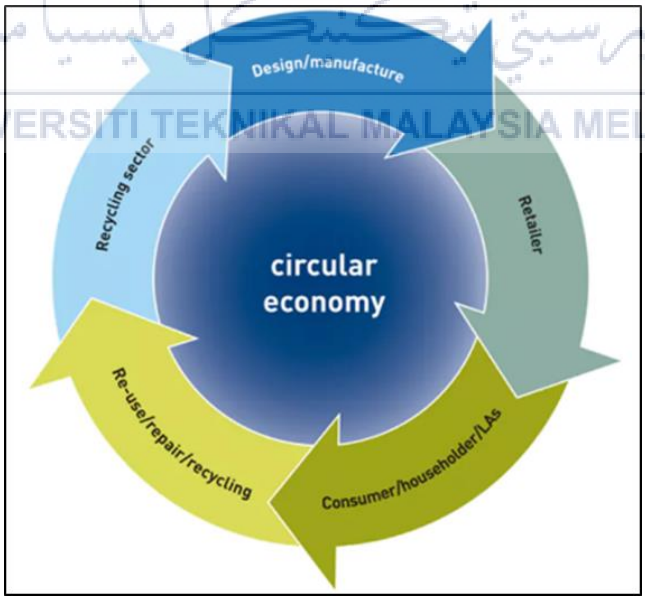

Figure 2. 3 : Circular economy, (MacArthur *et al.*, 2016)

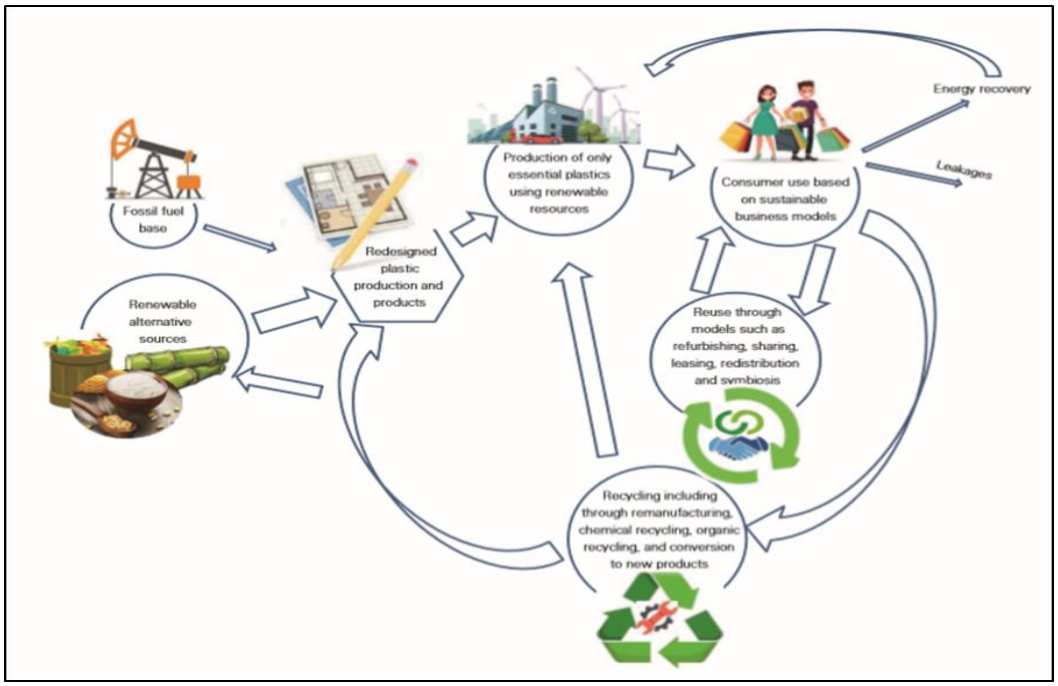

Figure 2. 4 : Circular economy solutions in the plastics sector, (MacArthur *et al.*, 2016)

Several researchers have emphasized some science and innovation drivers to achieve a circular economy in the plastic field where Solaiman et al. (2006) highlighted in his report on plastics production from alternative feedstocks. Greenhouse gases, such as carbon dioxide and methane while bio-based sources such as fats, starch and cellulose, industrial biopolymers, waste slots, and agricultural products, are sources of renewable feedstocks. Some plastic products can be made using soft and biodegradable materials and environmentally safe flame retardants, reducing certain dangerous chemicals in plastic development (Gu et al, 2017). Ricardo (2018) aimed at the service of plastic waste as a resource. Capturing and recycling of plastic waste for re-manufacturing into new consumer goods has been extensively demonstrated, such as the manufacture of bricks in the building and construction sector (Yusof, 2018), road construction (Sasidharan *et al.*, 2019), and garments and footwear (Khan, 2015).

Hollander *et al.* (2017) highlighted that redesigning plastic production systems and products to improve sustainability, reusability, and waste reduction and integrate from the start into design after use, material reuse, waste management, and emissions control. The strategy includes implementing more safe manufacturing, preventing one and other preventable plastics, developing goods for a useful lifetime, extended use and

more comfortable isolation, maintenance, upgrading and recycling, removing dangerous chemicals, and stopping microplastic dispersion atmosphere the redesign of products. For example, recycled water bottles are an alternative to single-use packaging, a returnable bottle program, and refillable packaging that will cut manufacturing costs and minimizing plastic waste in the environment (Godfrey, 2019).

Increase cooperation between businesses and consumers to increase awareness. One example of this is by-products from one company, ultimately resulting in industrial synergy (Van Berkel *et al.,* 2009). Recent studies by Geng *et al.* (2010) have demonstrated the ecosystem and environmental benefits of plastic waste recycling by industrial symbiosis in China and Japan. Embrace innovative market structures that foster goods as commodities and facilitate the recycling and leasing plastic products (Ricardo, 2018). Next, another method shown by Ricardo (2018) is to establish comprehensive information systems that give details on the composition of plastic products. It monitors plastic capital flows on the market, promote a cross-value chain dialogue, share knowledge and draw on expertise from established global institutional networks.

The RECPnet (Resource Efficient and Cleaner Production Network) is an example of a global network that encourages resource-effective, cleaner development. It enables cooperation, including sharing related information, expertise, and technology (RECPnet, 2015). Economic tools, like fiscal and regulatory measures, act to counter the adverse consequences of excessive production and usage of plastics also needed. Without such steps, markets will tend to prefer petroleum feedstocks, mainly when oil prices are low and the obstacles to creating a circular economy will be more challenging to resolve (Ricardo, 2018).

Table 2. 2 : Overview of circular economy solutions and examples of their implementation

Circular economy driver in the plastic sector	Description	Examples	Sources
Alternative feedstocks plastic	The research on developing renewable feedstocks, bio-based products, cane sugar, oils and cellulose, agricultural waste, and other biopolymers.	- Air carbon technology transforms methane (CO_2) into plastics. - Plastics have been produced from sugarcane.	- (Solaiman *et al.*, 2006) - (Palter *et al*., 2006) - (Bharat *et al*., 2016)
Waste plastics as a resource	Use of plastic waste to reproduce new materials or process other useful products.	- Bricks and composites in the building and construction sector. - Roads have been made with plastic waste. - Clothing and footwear.	- (Yusof, 2018) - (Sasidharan *et al.*, 2019) - (Khan, 2015)
Redesign and innovation	It creates plastic items to enhance durability, reusability, recycling and waste avoidance by integrating after-use, material recovery and waste reduction from the outset.	- Recycled water bottles are an alternative to single-use packaging. - Returnable bottle program and refillable packaging.	- (Den *et al.*, 2017) - (Godfrey, 2019)
Business and consumer cooperation	By-products or waste from one industry or consumers become the raw material for producing new products.	- In China and Japan, urban-industrial symbiosis highlights environmental and climatic benefits from plastics recycling.	- (Van *et al*., 2009) - (Geng *et al*., 2010)
Sustainable business modelling	It is implementing market models that support products as commodities and facilitate exchange and leasing of items, maximizing resource use and increasing the number of goods produced.	- Leasing of water and plastic bottles to households and offices	- (Ricardo, 2018)
Strong information platform	Robust information platforms link industry and consumers to ensure data flow and plastics information.	- RECPnet promotes cleaner resource-efficient development and facilitates cooperation, including the sharing of relevant information, expertise and technology	- (RECP, 2015)
Instruments for policy	- Political surcharges, taxes. - Standardized regulation and plastic types ban.	- In 2002, Bangladesh phased out lightweight plastic bags.	- (Rahman, 2017) - (MPMA and MPRA, 2019) - (Logomasini, 2011)

		- Malaysia banned non recycle plastic import in 2019. - Italy banned plastic shopping bags in 2011	

2.3 Plastic History

The word plastic begins with the Greek word "plastikos," meaning it can be shaped or moulded. Plastic was initially mixed and formed and also referred to as polymers. Polymer means many parts, and polymers are made of long molecular chains. Another definition by Eltayef (2003), plastic is a material made up of a long carbon chain formed into various shapes. Plastics are not made with only one material (Van, 2017). Plastic contain hundreds of different materials with a wide variety of properties. They are meant to address every single-use most professionally. Plastics are a synthetic polymer that consists of carbon, oxygen, fluorine, and chlorine. Usually, petroleum and natural gas are raw materials for making plastics (Society and Industry, 1988).

2.3.1 Type of Plastics

Plastics can be classified based on the action of heat on it. Generally, there are two types of plastic: thermoplastics and thermosets (Van, 2017). Thermoplastic consists of linear polymer chain linked by using weak forces of attraction, while thermoset is made from polymer chain which forms cross-linkages between one another. Table 2.3 shows the differentiation of thermoplastic and thermoset by (Ahmad *et al.*, 2015). Many plastic types have been developed, but only six plastics types are the most frequently used in local production (NSWM, 2011). Up to 2019, plastics were ranked according to the most commonly produced and used (Clunies-ross, 2019). Table 2.4 indicates the type of plastics is mostly used.

Table 2. 3 : Thermoplastic and thermoset, (Ahmad *et al.*, 2015)

	General properties	Examples
Thermoplastic	Melt when heated Hard when cooled Can be repeatedly melted and moulded Easy to burn Flexible Electricity resistance Inert to most chemicals.	Polypropylene (PP) Polyethylene Terephthalate (PET) Polyvinyl Acetate (PVA) Polyvinyl Chloride (PVC) Polystyrene (PS) Low-density polyethylene (LDPE) High-density polyethylene (HDPE) Etc
Thermoset	Hard Heat resistant Difficult to change the structure once it cooled Not easily flammable Non-electric conductivity	Bakelite Epoxy resins Melamine resins Polyesters Polyurethane Urea – Formaldehyde Alkyd resins Etc

Table 2. 4 : Type of plastic (Clunies-ross, 2019)

Types of plastics	Symbol	Acronym	General properties	Common uses
Polypropylene		PP	Chemical resistant High melting point Translucent Hard but flexible	Bottle caps Margarine tubs Food trays Sweet/snack wrappers Banknotes Combs Bowls Car bumper
Low-Density Polyethylene		LDPE	Tough and flexible Waxy surface Easily scratches Low melting point Good transparency Low density	Fertilizer bags Bubble wraps Irrigation pipes Thick shopping bags
High-Density Polyethylene		HDPE	Chemical resistant Rigid and strong Soft waxy surface Permeable to gas	Water bottles Detergent bottles Shampoo bottles
Polyvinyl Chloride		PVC	Hard and rigid Oily surface High density	Floor/wall coverings Window shutters Plumbing pipes Cables Traffic cones

Polyethylene terephthalate		PET	High heat resistance The high melting point of 245 degree Celsius Toughness Solvent resistant	Mineral water bottle Food trays and jars Medicine jars Polycotton
Polyurethane (thermoset plastic)		PU	High load capability High-stress environments Compression strength Abrasion resistance	Tires Automotive parts Pillows Safety shoes Life jacket Rollers
Polystyrene		PS	Opaque Brittle Affected by fats and solvents High clarity	Fast food trays Video cases Seed trays Coat hangers Cups

2.4 Uses and Global Statistics of Plastic Production

Nowadays, plastic has replaced everything in daily life, such as metal, wood, glass, and others, because they are light, easily moulded into various shapes, and most importantly, they are cheap. Modern types of plastic are known as composites as they are invented by using multiple types of plastics. The main application areas for plastic include automotive, industrial machinery, medical devices, construction and construction, electrical and electronic products, consumer goods, packaging, aviation, optical media, etc. Geyer *et al.* (2017) pointed out that in 2015, the packaging sector dominated all over industries, followed by building and construction, as shown in figure 2.5. Global statistics of plastics production increased from 2017 to 2018 by 348 million tons to 359 tons (Plastics Europe Market Research Group, 2019). Global production of plastic grew fast from 2008 to 2018, and in 2018, almost 360 million tons were recorded in figure 2.6 (Garside, 2020).

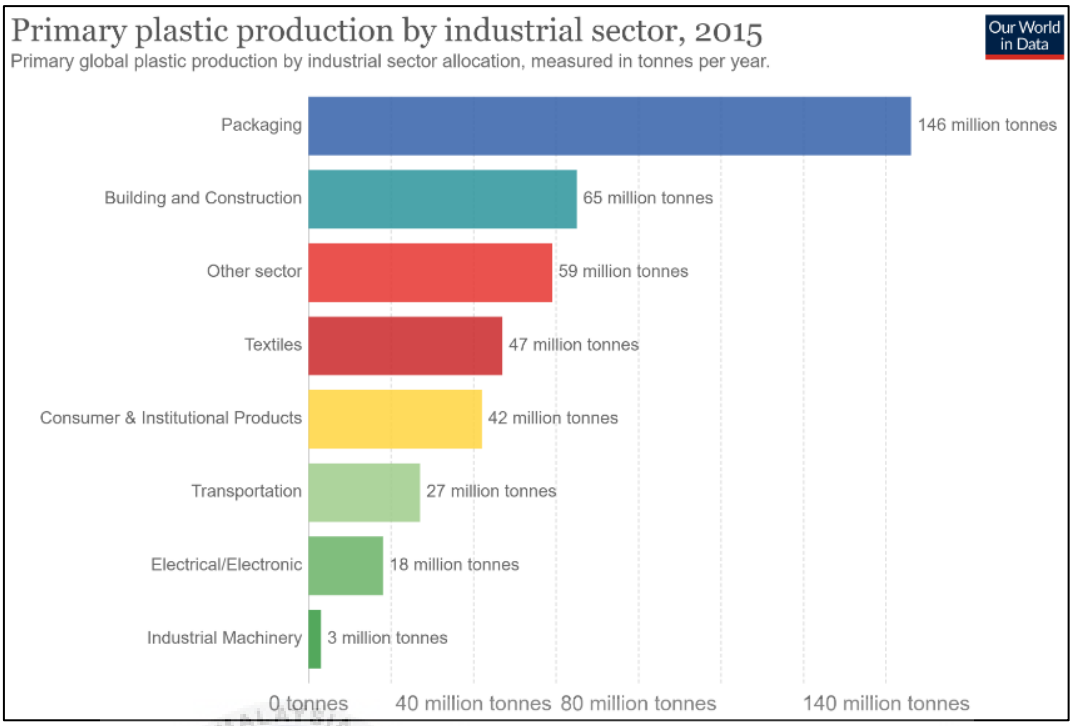

Figure 2. 5 : Primary plastic by the industrial sector in 2015, (Geyer *et al.*, 2017).

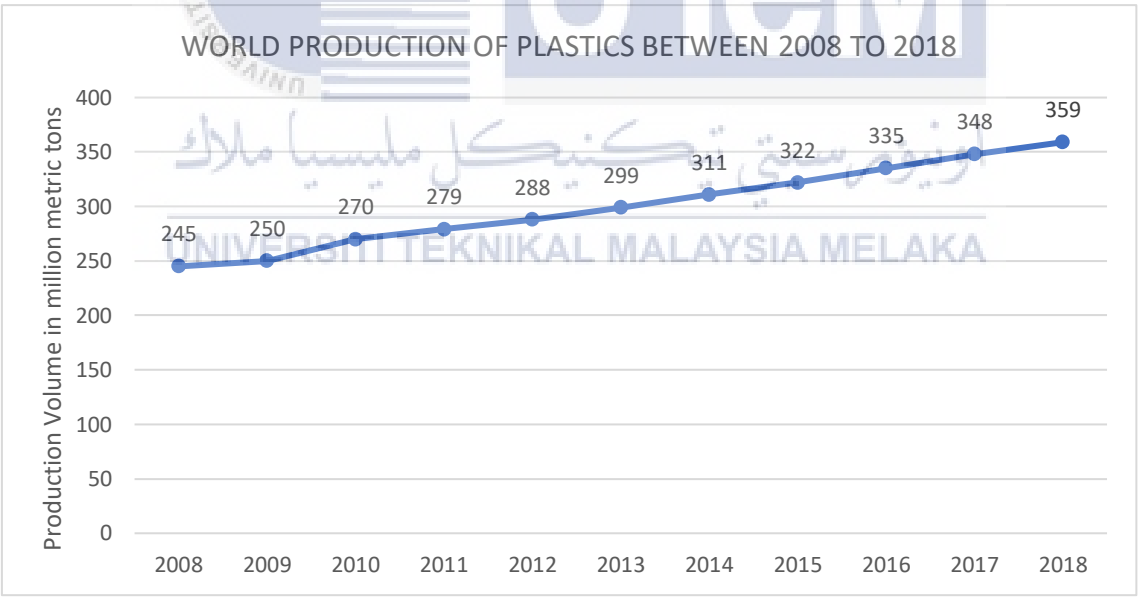

Figure 2. 6 : World production of plastics between 2008 to 2018, (Plastics Europe Market Research Group, 2019)

Nevertheless, asian countries are a significant contributor to global plastic production, followed by North American and Europe in 2018 (Plastics Europe Market Research Group, 2019). More than half of plastic products are manufactured in Asian countries such as China, Japan, India, Indonesia, and others. In 2018, China contributed almost 30% of the world's plastic production.

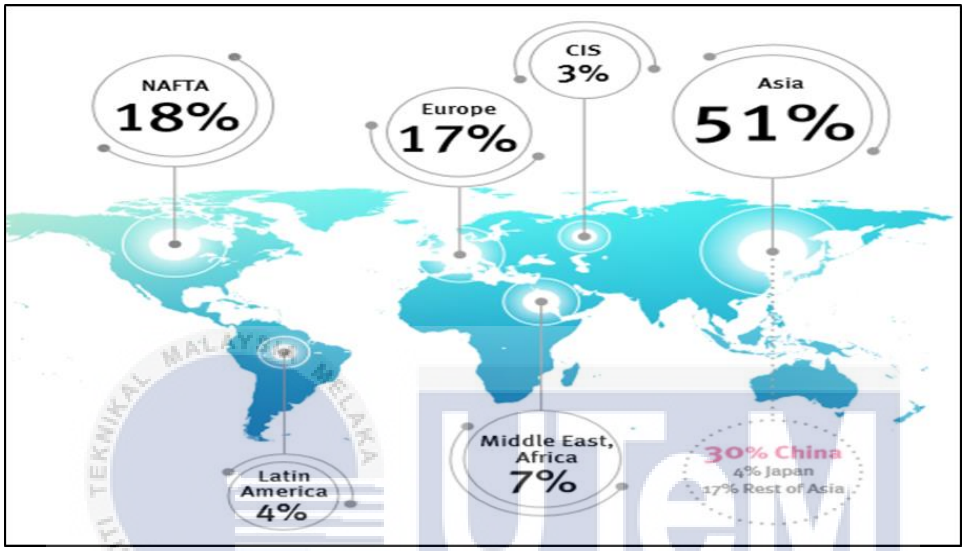

Figure 2. 7 : Global plastics distribution in 2018, (Plastics Europe Market Research Group, 2019)

2.4.1 Global Plastic Waste Scenario

Plastic waste involves the accumulation of plastic objects, such as plastic containers, plastic bags, and much more inland and sea, which affects the natural, animal, and human environment. (Laura, 2018). Plastics waste is sorted into micro-, meso-,or macro waste, based on its size (Jort *et al.*, 2012). According to Van (2017), plastics are economical, durable, and therefore, the manufacturer's plastic production levels are incredibly high. However, plastics are slow to degrade as their molecule chain structure is mostly resistant to the natural degradation process and takes so many years to degrade (Andrady, 2015). Hence, these factors lead to plastic abundant where they are well known as plastic waste and scraps in the environment.

Geyer *et al.* (2017), worldwide production of 407 million tons of plastics and in 2015 only 302 million tons of plastics were discounted as waste. Roughly 9% was recycled, 12% was incinerated, and most accumulated inland and ocean. They estimated around 12000 million tons of plastic waste would be in the landfill or natural environment in 2050 if the current method is implemented to manage plastic waste. Nearly 242 million tons of worldwide plastic waste (Maria and Rucevska, 2020) and plastic waste began primarily in 2016 from three regions of 57 million tons from East and Pacific, 45 million tons Europe and Central Asia, and 35 million tons from North America. An approach to reduce plastic waste of a country is through recycling method and plastic trade among countries for further treatment and disposal because it is cheap, helps meet recycling targets, lacks recycling facilities, and reduces local landfill and another barrier.

As a result, plastic waste is traded globally. Exporting plastic waste from the European Union (EU) to Asia is a way of easing the European Union's lack of recycling ability (European Environment Agency, 2019). According to Brooks *et al.* (2018) pointed out that China has accepted and received almost half of global plastics waste imports, processing much of it into a higher value of the material that could be used by manufacturers over 25 years ago. Wang *et al.* (2020) stated that the overflow of imported plastic waste has seriously damaged the Chinese environment. China introduced a policy for hush remediation in 2017 to safeguard its environment and air quality, which has closed its doors to the reception or accept plastic waste from another country. China's policies have created a significant problem for waste exporters such as Japan, Europe, Germany and others to place their plastic waste, (Brooks *et al.*, 2018). As a result, Southeast Asia is the most impacted region, such as India, Thailand, Vietnam, Indonesia, and Malaysia. Rachel (2019) highlighted that Malaysia may turned into the alternative global throwing ground in 2018. (United Nation Comtrade database, 2018) mentioned the top 10 countries exporting plastic waste worldwide and Japan was the biggest exporters of plastic waste with 925953 tons, followed by the United State, 811420 tons and Germany, and 701539 tons in 2018.

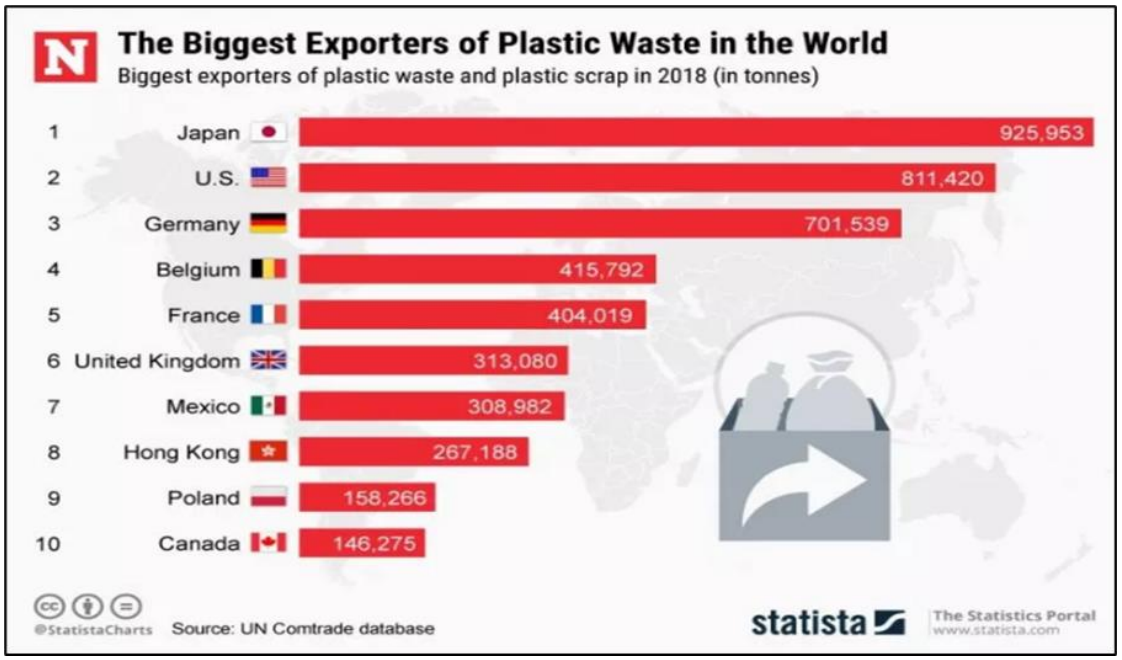

Figure 2. 8 : The world's largest exporter of plastic waste and scrap (United Nation Comtrade database, 2018)

2.5 An Introduction to Malaysia's Plastic Waste Problem

Plastic is one of the finest inventions of the last century. The reality that it has made community life convenient could be a significant understatement. Without even realizing it, plastic is integrated into everyday life in the community. However, concerns about harmful plastic elements were heightened in 2018, when foreign plastic waste was once visibly spread to Malaysia, reported by (United Nations Comtrade database, 2018). The issue arose as China notified the World Trade Organization (WTO) in July 2017 sourced by (World Trade Organization, 2017). They decided to ban imported plastic waste as imports 1 January 2018 in line with its "National Sword Policy" to reduce pollutants in their country.

China banned 24 plastic waste imports, and handiest allowed plastic with a purity price of 99.5% or higher (Parker, 2018). Before 2018, China was the most extensive international importer of plastic waste reported by Brooks *et al.* (2018). However, due to the ban, plastic waste is transported to other countries, especially Southeast Asian

countries, including Malaysia, Indonesia, Vietnam and other countries. Containers of low quality, infected and not recyclable plastic are mostly packed in Malaysian ports. Individual importers managed, without proper documentation, to bring plastic waste into Malaysia using falsifying statement bureaucracy and using one-of-a-kind product code HS3920 which does not now require a permit than the code for plastic waste specified, HS3915 reported by Aladem (2020).

Countries that exported the giant quantities of plastic waste below the commodity code HS3915 to Malaysia were developed nations. Based on Figure 2.9, stated by United Nation Comtrade database (2018), there was a dramatic increase in the import of plastic via Malaysia from developed countries upon China's announcement of the ban, with the USA contributing the maximum in 2018 with approximately 218,000 tonnes, observed by way of Japan (~119,000 tonnes) and the United Kingdom (~112,000 tonnes). Moreover, polyethylene is the most common form of plastic import shown in figure 2.10. It is the reason why most of the rubbish found in Malaysian landfills had been plastic packaging wrappers. While a bulk of the plastic trouble originates from Malaysians, the extension in the inflows of plastic waste from other countries pushed by the ban in China has raised interest on larger problems surrounding Malaysia's plastic waste problem, (United Nations Comtrade database, 2018).

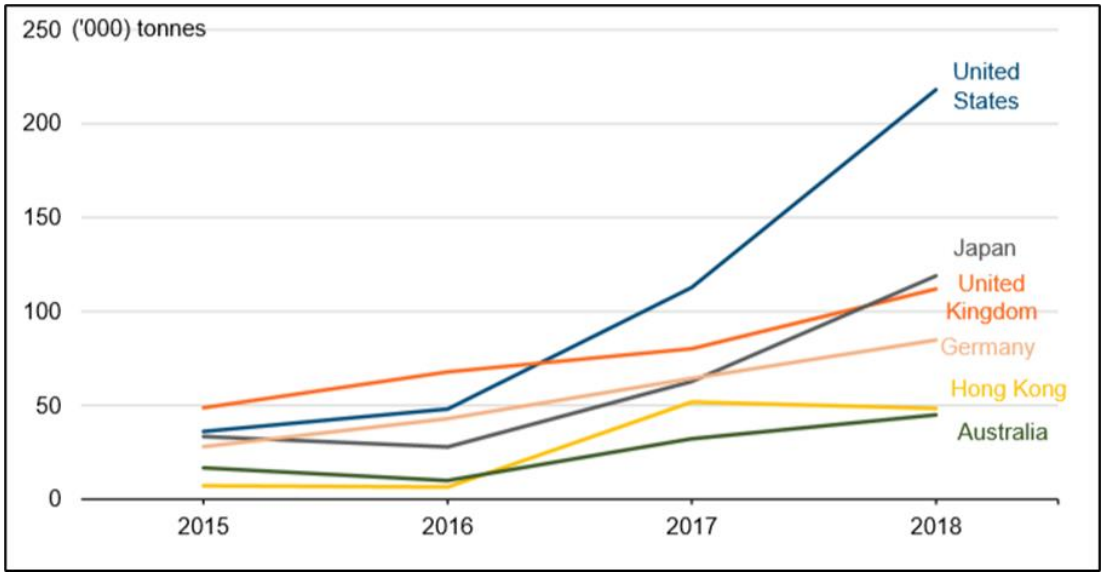

Figure 2. 9 : Malaysia's 2015-2018 imports of plastic waste from the top 6 countries, (United Nation Comtrade database, 2018)

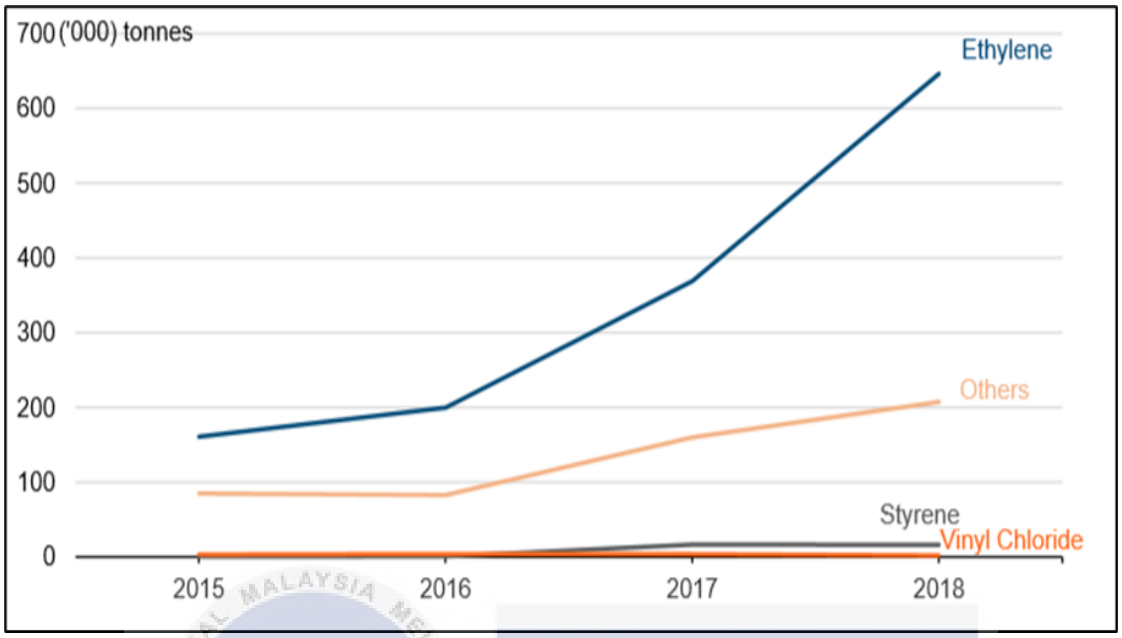

Figure 2. 10 : Breakdown of Malaysia's imports of polymers from 2015 to 2018, (United Nation Comtrade database, 2018)

Thillinadan (2019) highlighted that most global plastic waste is brought in by illegal recycling factories, either for recycling or after receiving a lucrative payment from international agents to dispose of their waste planted or burned in the country. Numerous illegal recycling factories were found in Perak, Kedah and Selangor. As a result, more than 200 containers were found in Malaysia reported by Thillinadan (2019). Forty containers were exporters from France, 42 containers from the United Kingdom, 17 containers from the United States, 11 containers from Canada, and others. Due to this illegal method, people live in Jenjarom polluted by toxic fumes produced by illegal recycling factories by an open-air burning of plastic waste every night. The resident claimed it is tough to sleep and breathe every night as they endured the immediate results of the waste dumping, with their health and prosperity being influenced each day (Bendix, 2019).

2.5.1 Plastic Waste Generation and Recycling Rate in Malaysia

In Malaysia, domestic waste among the country's people registered a 100.75 % increase to 38142 tons per day in 2018, compared to 19,000 tons per day in 2005 (Yusri, 2020). According to figures released by the Solid Waste Management and Public Cleansing Corporation (SWCorp), an average person is expected to produce 1.17 kilograms (kg) of waste a day in 2018, compared to 0.8 kg in 2005. According to Yusri, (2020), the percentage of plastic waste was reported to increase by 20 % in 2018. Up from 44,5% of the total waste, and 13,2% of plastic waste 12,1%. Figure 2.11 shows Malaysia's waste generation from 2012 to 2018 (Khazanah Research Institute, 2019). In 2018 Malaysians generated almost 14.5 million tons of waste, and in 2020, nearly 18.25 million tons of waste are estimated (Solid Waste Malaysia, 2015). Waste generated including from the household, industrial, commercial and institutional sectors in Malaysia.

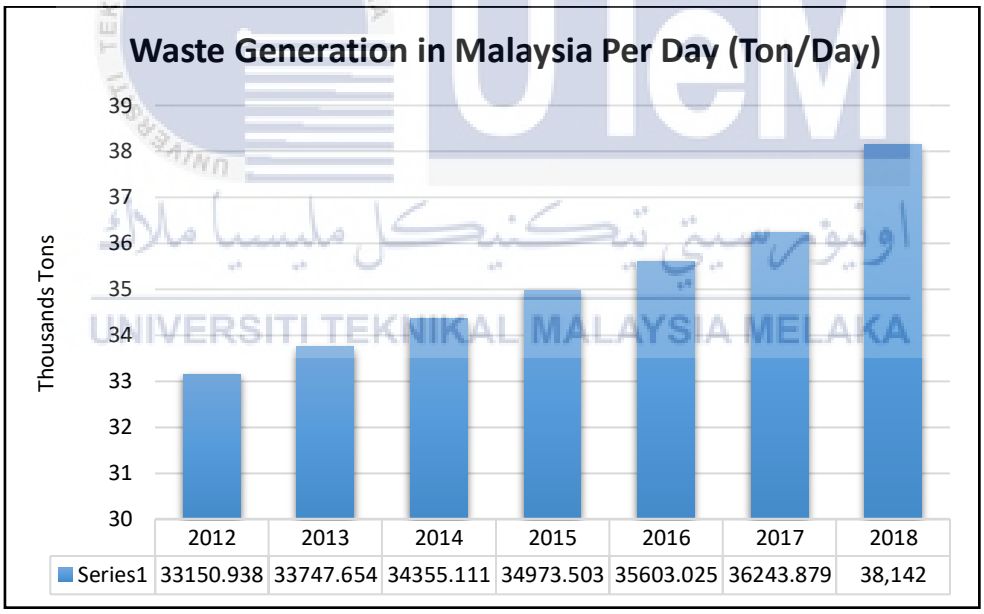

Figure 2. 11 : Total waste generation per day (ton/day) in Malaysia (Khazanah Research Institute, 2019)

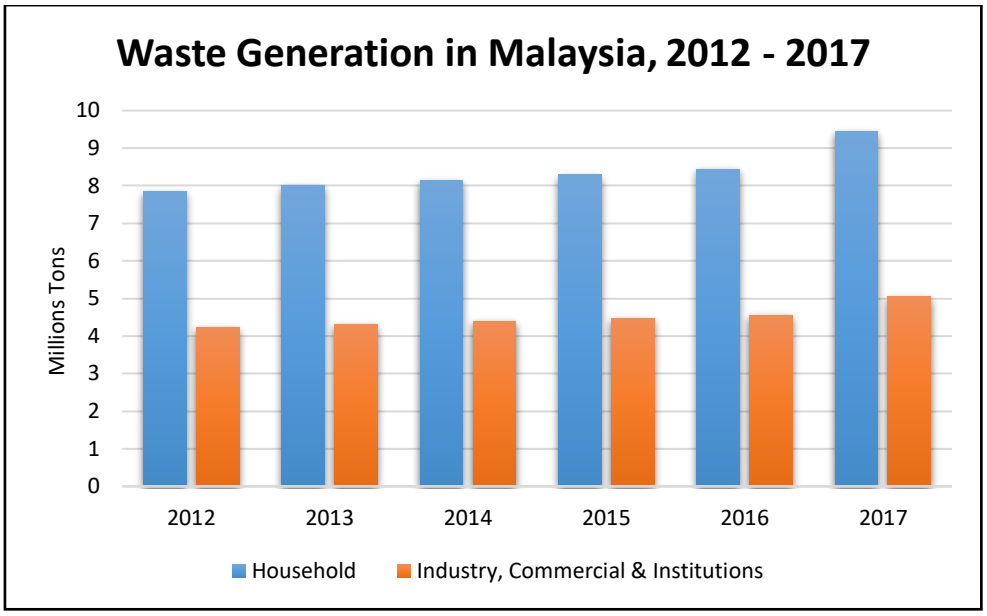

Figure 2. 12 : Waste generation in Malaysia by sector from 2012 to 2017 (Khazanah Research Institute, 2019)

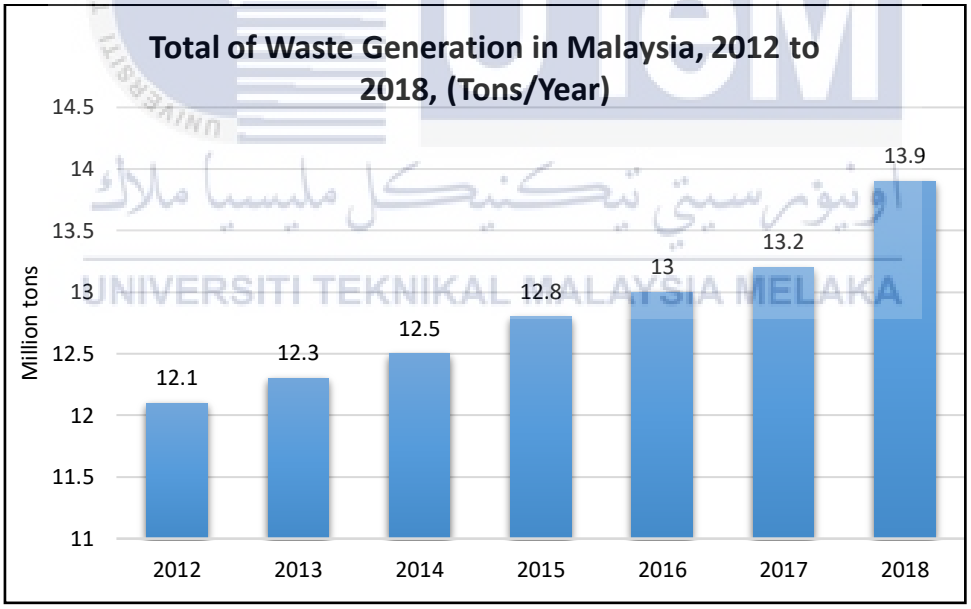

Figure 2. 13 : Total percentages of waste generation in Malaysia from 2012 to 2018 (Khazanah Research Institute, 2019).

In less than 100 years, plastic's international annual production has accelerated from 1950 to 381 million tons in 2015 by almost two million tons. Global statistics of plastics production increased from 2017 to 2018 by 348 million tons to 359 tons by (Plastics Europe Market Research Group, 2019). From 1950 to 2018, global plastic production increased quickly and recorded almost 360 million tons in 2018, compared with 1,5 million tons in 1950 (Garside, 2020). In 2015, the packaging sector dominated all sectors, followed by building and construction. Malaysia's status is comparable as the plastic market share in the packaging segment was perfect in 2008 at 40%, an increase of 8 points at 48% ten years later, as illustrated in figure 2.14. In 2018, major plastic market segments in Malaysia found in packaging, 48%, electrical and electronics, 27%, construction, 8%, and other (Geyer *et al.*, 2017). Packaging sector was the higher demand of plastic usage in Malaysia reported in 2018 by Khazanah Research Institute (2019).

Table 2. 5 : Major market segments for the plastic product in Malaysia, 2008, 2009, 2010 and 2018, (Khazanah Research Institute, 2019)

Sub-Sector	**Share (%)**			
	2008	**2009**	**2010**	**2018**
Packaging	40	42	42	48
Electrical and Electronics	23	25	26	27
Household	15	11	10	4
Automotive	9	10	11	8
Construction	7	7	7	8
Agriculture	3	3	2	4

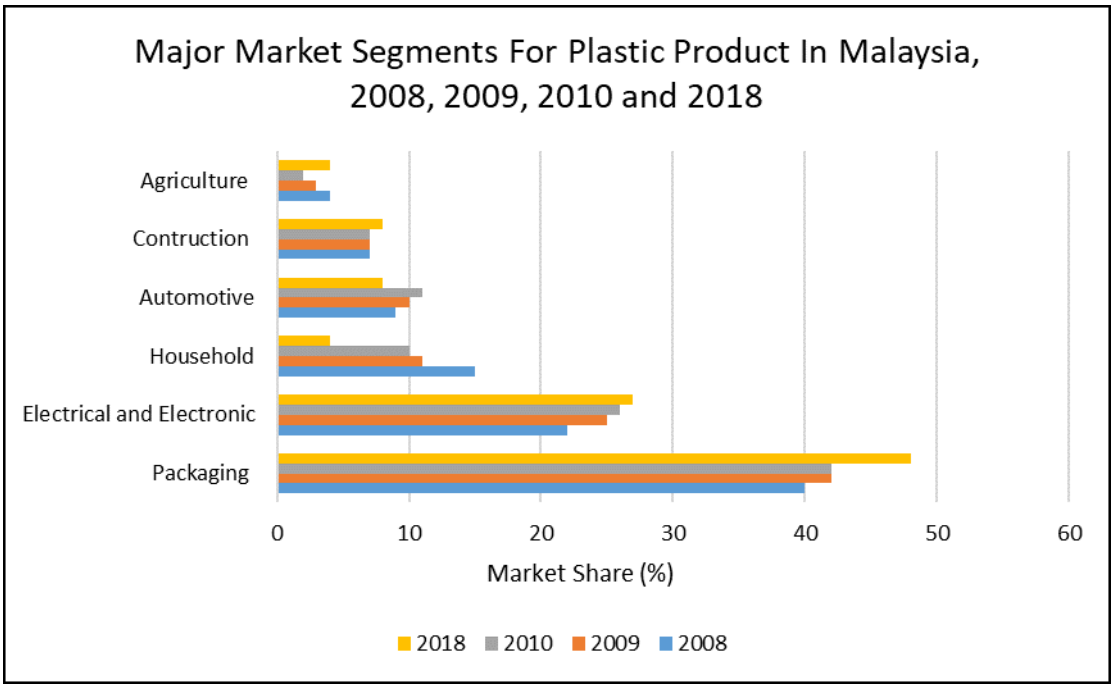

Figure 2. 14 : Major market segments for the plastic product in Malaysia, (Khazanah Research Institute, 2019)

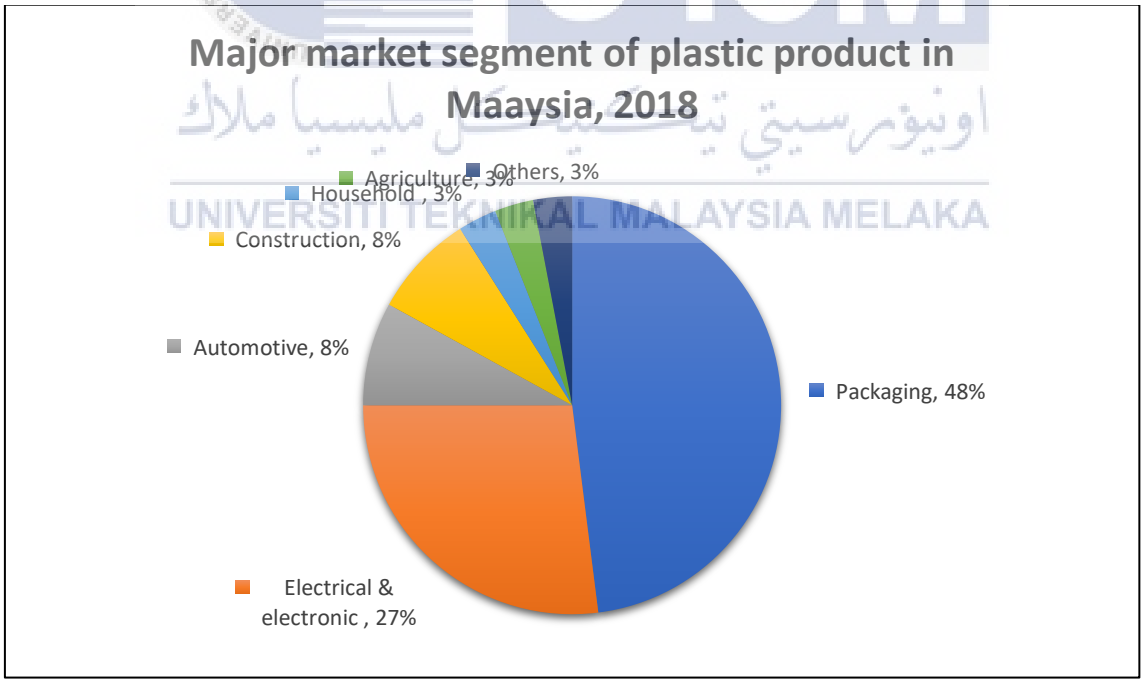

Figure 2. 15 : Major market segment of plastic product in Malaysia, 2018, (Khazanah Research Institute, 2019)

Lim (2018) highlighted that vast amount of such waste, the waste separation and recycling rate is only 28.1 per cent shown in Figure 2.16, while the remaining 76% went to landfill in 2018. This statement has been proved by Khazanah Research Institute (2019), when Malaysia recycling statistics show a minimum increasing recycling rate from 2013 to 2018 compared to other developed countries with averages of 20% rising over the 6 six years in figure 2.17. For plastic recycling in Malaysia shows 3.4% increasing rate from 8% to 11.4% in 2017 shown in figure 2.18 and still in the low level of recycling rates for developed countries (Khazanah Research Institute, 2019).

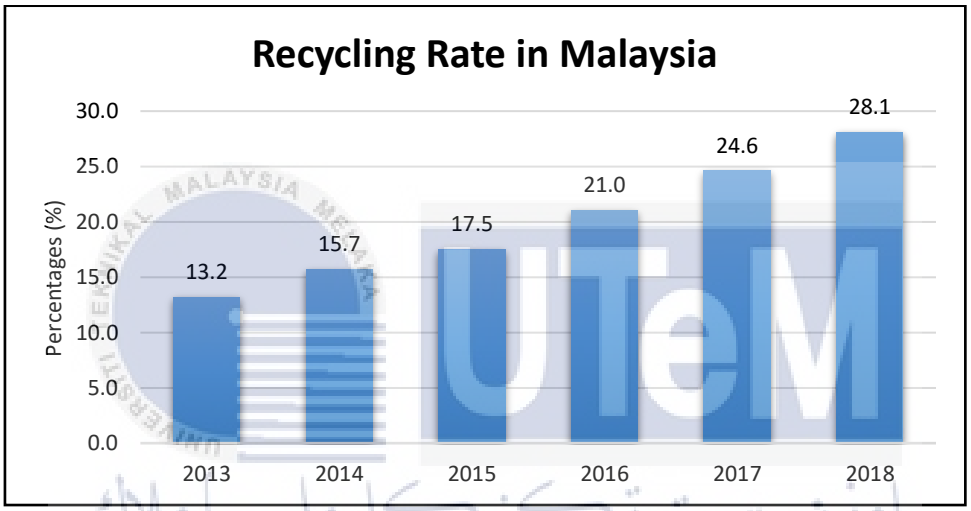

Figure 2. 16 : Recycling Rate in Malaysia (Khazanah Research Institute, 2019).

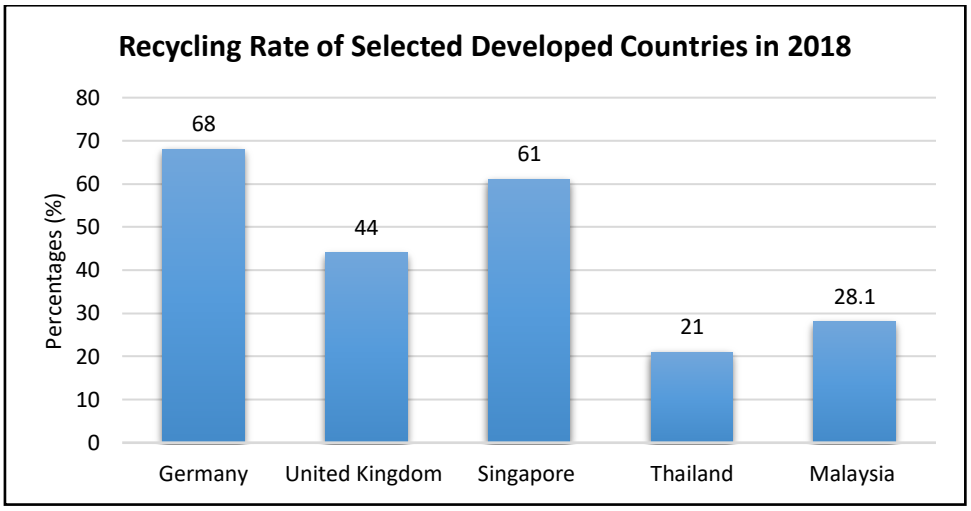

Figure 2. 17 : Recycling Rate of Selected Developed Countries in 2018, (Khazanah Research Institute, 2019)

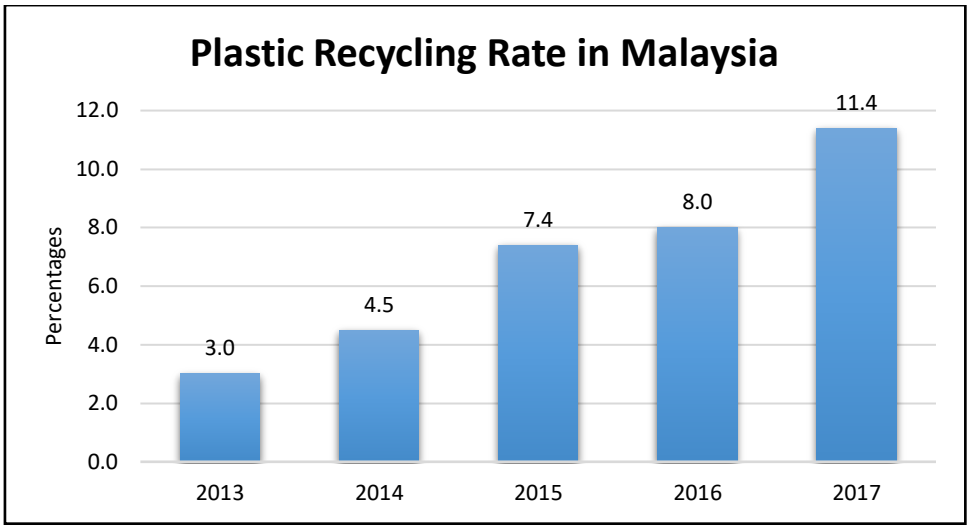

Figure 2. 18 : Plastic Recycling Rate in Malaysia (Khazanah Research Institute, 2019)

2.5.2 Plastic Regulations in Malaysia

Weak regulation and enforcement of plastic waste management appear to contribute to the abundance of plastic waste generated in Malaysia. In order to deal with the current issue, efficient waste management are needed. According to MPMA (2019), recycling industry plays a significant part in ensuring the waste is managed sustainably. It can transform waste into other resources. A lot of benefits could be obtained from recycling practices. For instance, the resources could preserve the next generation, conserve the environment, provide more job opportunities, and increase its economy by being a dynamic export sector. Ensuring the circular economy approach could be implemented, strong regulations and enforcement must be put in place.

Malaysian Plastic Manufacturers Association and Malaysia Plastic Recycle Association (2019) highlighted that the plastic waste in Malaysia is managed by several agencies and the government bodies that includes, Department of Environment (DOE), JPSPN, solid waste corporation (SWCorp) and Local councils. Each agency and government body has an essential role in managing plastic waste in Malaysia, as shown in Figure 2.19 below. The Environmental Quality Act (EQA) 1974 is enforced by the DOE to regulate the emissions and to conserve the ecosystem (The Commissioner Of

Law Revision, 2006). This regulation was implemented in 1974 and entered into force in 1975. Nevertheless, the EQA 1974 has amended several times to meet the international standard. Under EQA 1974, plastic waste is listed under code SW 410 in the first scheduled waste: rags, plastics, papers or filters contaminated with scheduled waste, (Ogboo *et al.*, 2012). According to the Jamin and Mahmood (2015), any waste that is listed as scheduled waste is bound to these regulations:

- Section 34B, Environmental Quality Act, 1974
- Environmental Quality Regulations 1989 (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities)
- Environmental Quality Regulations 2006 (Revised) (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities)
- Environmental Quality Regulations 2005 (Scheduled Wastes)
- Environmental Quality Regulations 2007 (Revised) (Scheduled Wastes)
- Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities) Order 1989
- Environmental Quality (Prescribed Conveyance) (Scheduled Wastes) Order 2005
- Customs (Prohibition of Exports) Order 1998 (Amendment) 2008
- Customs (Prohibition of Imports) Order 1998 (Amendment) 2008

The Department of Environment (DOE) has allowed plastic waste to be imported and recycled into its premises in full compliance with the EQA 1974. Under the Solid Waste and Public Cleansing Act, 2007 of the National Solid Waste Management Department (Act 672), plastic waste management is a controlled waste and implemented by the Solid Waste Corporation. Imports of plastic waste according to HS code 3915 are subject of the Import Prohibition order 2017 as required by the National Solid Waste Management Department with approved permission. Although environmental regulation existed, a robust implementation force must be amended to ensure the law's effectiveness. Khazanah Research Institute (2019) reported that the import permits under HS code 3915 for plastic waste were enacted and enforced in July 2018. However, two months later, the ban was lifted, and many illegal recycling companies continue to rise, resulting in an

abundance of plastic waste (Chan, 2019). Nevertheless, our Department Of Environmental of Malaysia has managed to control the issue and shut down 155 illegal recycling companies in June 2019.

The local authority held responsibilities for the waste collection and ensuring the recycling company has the premises license. Under the EQA 1974, the recycling plant's construction is subjected to the Environmental Quality Act (Prescribed Activities) order 2015. Any individual who intends to carry out the activities needs to be submitted a report to obtain the premises license. As for importing the plastic waste, the import permits and several criteria need to be fulfilled under the Basel Convention on controlling transboundary movements of hazardous wastes and their disposal.

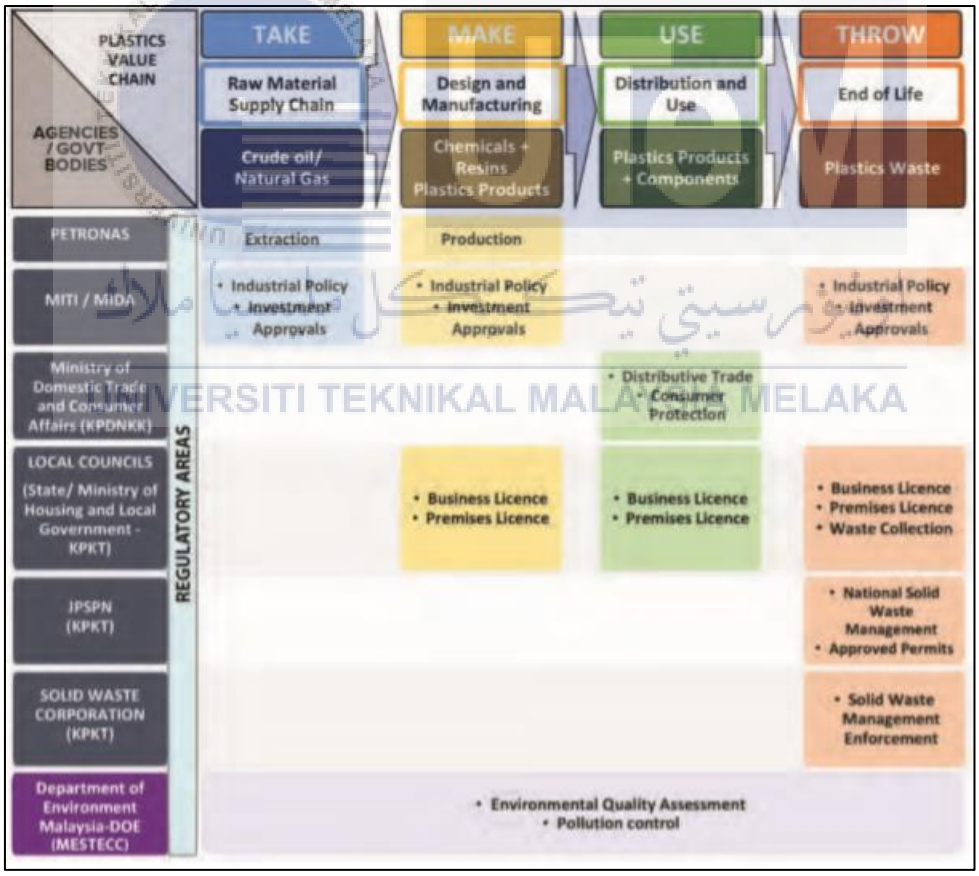

Figure 2. 19 : Map of regulatory areas and agencies (Malaysian Plastic Manufacturers Association & Malaysia Plastic Recycle Association, 2019)

2.5.3 Malaysian Plastic Waste Stream

The current plastic waste flow framework in Malaysia is shown in Figure 2.20 below. Their research on the plastic waste management in Malaysia, National Solid Waste Management Department (2011) has mapped the plastic waste flow, as demonstrated in figure 2.20 below:

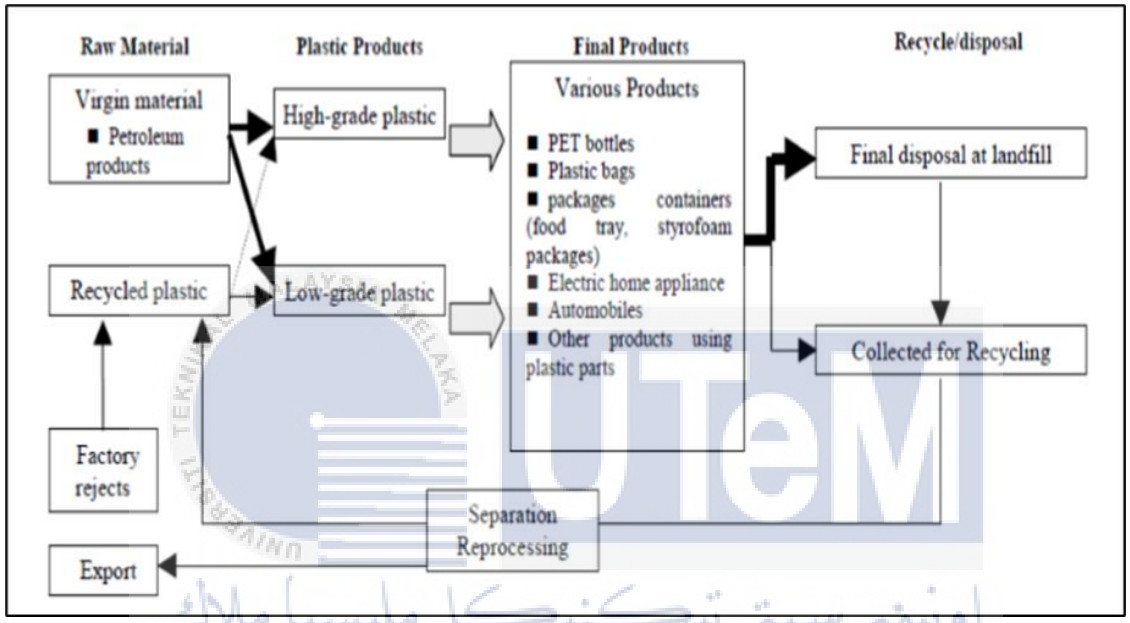

Figure 2. 20 : JICA plastics recycling flow, (National Solid Waste Management Department, 2011)

The raw material extracted is processed to be either high-grade plastic or low-grade plastic. This plastic is sorted out according to its grade than are processed to become a useful product such as bottles, plastic backs, electric home appliance and many more. Nevertheless, every product has its expired date, and when the time has come, these products need to be discarded and disposed of. The end of life of plastic has been collected via the reduce, reuse, recycle programs initiated by the Alam Flora Sdn Bhd. They cover along area at the central and eastern region, covering Kuala Lumpur, Selangor and Pahang. SWM Environment Sdn Bhd (southern region, covering Negeri Sembilan, Melaka and Johor) and Environmental Idaman Sdn Bhd (northern region, covering

Kedah, Perlis and Pulau Pinang). These collected plastic waste will be transported to the recycling facilities for the separation and recovery process.

Plastic recycling concerns the method of waste or recycled plastic reuse and reprocessing plastics into usable and valuable items, as shown in table 2.6, (Thomas, 2019). This practice is known as the plastic recycling cycle. Plastic recycling aims to reduce high levels of plastic pollution while also placing fewer demands on virgin resources to produce new plastic products (Geyer *et al.*, 2017). National Solid Waste Management Department (2011) highlighted that there are 3 primary methods are used for the recovery process: mechanical recycling, feedstock recycling, and energy recovery. Mechanical recycling and feedstock recycling are the standard methods used in recycling plastic waste. Both ways are intended to transform piles of plastic waste into usable resources and put on the market. Nevertheless, these methods have different techniques in handling the waste but have the same purpose of reselling it.

Mechanical recycling techniques are usually collecting plastic from industrial waste and reprocess the waste through some activities like cleaning and sorting. Later, these wastes will be palletizing using an extruder so that the waste will be in a uniform pallet to be put on the market. The feedstock recycling has a different method in handling plastic waste. This method uses the chemical process to break down the plastic structure into its chemical compound (i.e. oils, alkaline, acid solution and other). The chemical compound produced are sold to the industry to become a resource for other plastic-based products. Nevertheless, the methods will be different for non-recyclable plastic waste. These non-recyclable plastics will be burned, and the energy produced during the combustion is channelled to the source of electricity.

The continuous importation of the plastic waste from the developed countries such as Australia, United States, Canada, Saudi Arabia, Japan, and China has caused the increment numbers of plastic waste in Malaysia (Hassan, 2019). Hassan (2019) reported that 50 000 tons of plastic waste equal 1,000 containers exported by a recycling company in the UK to Malaysia. This situation has led to the abundance of plastic waste are dumped

at the landfill. National Solid Waste Management Department,(2019) stated that out of these plastic waste numbers, Malaysia can sustainably manage half of the waste and transform these plastic waste into new resources. The rest is exported back to their country of origin.

Table 2. 6 : Usage and recycled product made from plastic (Alan, 2017)

Types of plastic	Commonly used for	Can be recycled into
Polyethylene Terephthalate (PET or PETE)	Soda bottles Water bottles Beer bottles Salad dressing bottles Peanut butter jars Jelly jars Rope	Carpets Stuffing for pillows, winter jackets, and sleeping bags Bean bags Tennis ball felt Sails for boats
High-Density Polyethylene (HDPE)	Non-carbonated drink bottles Shampoos and conditioner bottles Soap bottles Detergent bottles Motor oil containers	Plastic bottles and jugs Plastic lumber Outdoor furniture Playground equipment Fencing
Polyvinyl Chloride (PVC)	Plumbing pipes Credit cards Carpet backing Floor covering Window and door frames	Flooring Roadside gutters Traffic cones Credit cards Pipes
Low-Density Polyethylene (LDPE)	Plastic wrap Bread bags Squeezable bottles Plastic grocery bags Garbage bags	Plastic lumber Compost bins Trash cans Floor tiles
Polypropylene (PP)	Packing tape Thermal vests Car parts Disposable diapers Sanitary pad liners Car bumper	Shipping pallets Automotive battery cases Brooms Shovels Watering cans
Polystyrene (PS)	Egg cartons Fast-food trays Video cases Seed trays Coat hangers	Picture frames Moldings Home décor products Foam protective packaging

2.5.4 Malaysia's Plastic Recycling Capabilities and Recycling Challenges

Generally, plastic is divided into seven categories, and now not every kind can be recycled in Malaysia. According to table 2.7, Malaysia can recycle categories 1, 2 and 5, (Khazanah Research Institute, 2019). The plastic is reproduced into a new form through this process, but its preliminary chemical composition remains unchanged (Bioplastics, 2019). Khazanah Research Institute (2019) highlighted that the local recycling only focuses on plastic resources that are easy to collect and has a high value, such as PET mineral water bottles. Low-quality plastic used to produce food packaging is seldom recycled.

Table 2. 7 : Recycling ability of plastic in Malaysia (Khazanah Research Institute, 2019)

No	Category	Recyclable in Malaysia
1	Polyethylene Terephthalate (PET/PETE)	Yes
2	High-Density Polyethylene (HDPE)	Yes
3	Polyvinyl Chloride (PVC)	No
4	Low-Density Polyethylene (LDPE)	No
5	Polypropylene (PP)	Yes
6	Polystyrene (PS)	No

The sustainable development goals are the blueprint for achieving a better and more sustainable future for all. The sustainability plan and goals must be fully achieved to achieve a sustainable nation. Therefore, it is challenging for a country to achieve sustainable development's overall objective because each country has its problems, especially in handling and disposing of plastic waste as plastic production increases globally (Babbitt *et al.*, 2018). Malaysia is also no exception to this problem. A drastic measure is needed to decrease plastic waste at our local level. Recycling activity is seen as effective ways of reducing plastic waste in the landfill and the ocean. As mentioned by Khazanah Research Institute (2019), Malaysia's recycling rate is recorded at 28% in 2018 and can be considered low compared to the developed country. Therefore, several actions are needed to enhance the recycling rate by addressing the main challenges in local waste

yard. Therefore, several researchers highlighted the main challenges in their report. Their findings can be summarized in table 2.8 below ;

Table 2. 8 : Current recycling challenges in Malaysia

Challenges	Description	Sources
Regulation	- Poor regulation and enforcement - Too much license is required and hard - Long processing time - Unclear regulation	(Jereme *et al.*, 2016), (Jereme *et al.*, 2015), (Agamuthu and Victor, 2010), (Sin *et al.*, 2016), (MESTECC, 2018), (Moh and Manaf, 2017), (Fatma *et al.*, 2018), (Khazanah Research Institute, 2019), (Beleya *et al.*, 2019), (Bashir, 2019)
Institutional	- Lack of material recovery facilities - lack of sanitary landfill - lack of treatment plant - Inconsistent waste management/campaign - Lack of stakeholder cooperation - low collaboration with the waste dealer	(Jereme *et al.*, 2016), (NSWMD, 2011), (Jereme *et al.*, 2015), (Agamuthu and Victor, 2010), (Moh and Manaf, 2017), (Khazanah Research Institute, 2019), (Rohana *et al.*, 2019), (Beleya *et al.*, 2019), (Bashir, 2019), (Khamis *et al.*, 2019)
Market	- Insufficient waste supply - Low price of scrap material - Lack of recycling awareness among Malaysian	(Jereme *et al.*, 2016), (NSWMD, 2011), (Jereme *et al.*, 2015), (MESTECC, 2018), (Moh and Manaf, 2017), (Rohana *et al.*, 2019), (Beleya *et al.*, 2019), (Bashir, 2019)
Financial	- High up-front investment costs - Lack of internal and external funds	(Jereme *et al.*, 2016), (Agamuthu and Victor, 2010), (Sin *et al.*, 2016), (MESTECC, 2018), (Moh and Manaf, 2017), (Beleya *et al.*, 2019), (Bashir, 2019), (Khamis *et al.*, 2019)
Organizational	- lack of human resources - Bad working environment - Lack of technical know-how and expertise - lack of technology readiness	(Jereme *et al.*, 2016), (NSWMD, 2011), (Jereme *et al.*, 2015), (Sin *et al.*, 2016), (MESTECC, 2018), (Moh and Manaf, 2017), (Khazanah Research Institute, 2019), (Rohana *et al.*, 2019), *(Beleya et al.*, 2019), (Bashir, 2019), (Khamis *et al.*, 2019)

From the table 2.8 above, (Jereme *et al.*, 2016; Agamuthu and Victor, 2010; Sin z*et al.*, 2016; MESTECC, 2018; Moh and Manaf, 2017; Fatma *et al.*, 2018; Khazanah Research Institute, 2019; Beleya *et al.*, 2019; Bashir, 2019) highlighted that the poor regulation and enforcement, many procedure in obtaining license with long processing time has lead to low recycling rate in Malaysia. In terms of institutional, (Jereme *et al.*, 2016; NSWMD, 2011; Jereme *et al.*, 2015; Agamuthu and Victor, 2010; Moh and Manaf, 2017; Khazanah Research Institute, 2019; Rohana *et al.*, 2019; Beleya *et al.*, 2019; Bashir, 2019; Khamis *et al.*, 2019) highlighted that lack of material recovery facilities, lack of sanitary landfill, lack of treatment plant, inconsistent waste management/campaign, lack of stakeholder cooperation and low collaboration with the waste dealer has become challenges for the recycling industry in Malaysia.

In terms of market, (NSWMD, 2011; Jereme *et al.*, 2015; MESTECC, 2018; Moh and Manaf, 2017; Rohana *et al.*, 2019; Beleya *et al.*, 2019; Bashir, 2019) addressed that nsufficient waste supply, low price of scrap material and lack of recycling awareness among Malaysians has become a challenges for the recycling industry to sustain in Malaysia. In terms of financial, (Jereme *et al.*, 2016; Agamuthu and Victor, 2010; Sin *et al.*, 2016; MESTECC, 2018; Moh and Manaf, 2017; Beleya *et al.*, 2019; Bashir, 2019; Khamis *et al.*, 2019) addressed that high up-front investment costs and lack of internal and external funds for the recycling sector has contribute to financial problem in the recycling industry. In terms of organizational, (Jereme *et al.*, 2016; NSWMD, 2011; Jereme *et al.*, 2015; Sin *et al.*, 2016; MESTECC, 2018; Moh and Manaf, 2017; Khazanah Research Institute, 2019; Rohana *et al.*, 2019; Beleya *et al.*, 2019; Bashir, 2019; Khamis *et al.*, 2019) highlighted that lack of human resources, working environment, lack of expertise and technology readiness has been a challenges for the organization to practicing recycling culture.

2.5.5 Malaysia's Plan and Action Towards Zero Single-Use Plastics 2018-2030

Environmental legislation exists in Malaysia, but strong enforcement efforts must support its effectiveness. In 2018, Malaysia Ministry of Energy, Science, Technology of the Environment and Climate Change (MESTECC) has provisional revoked import permits for plastic waste under HS Code 3915 (Khazanah Research Institute, 2019). However, in October 2018, the ban was temporarily removed (Ivan Watson, 2019),. Less than one year later, many illegal recovery plants in the country mushroomed into plastic waste mountains, and the majority were contaminated with plastic which is not recyclable. Import license holders may only store and process plastic scrap on approved premises, and strict guidelines also apply to plastic scrap storage in factories. Only 62 companies in Malaysia are allowed to import plastic by the Minister for Housing and Local Government (Bernama, 2019). In conclusion, the bales of low-quality foreign plastic waste could be attributed to irresponsible, illegal recyclers who take advantage of potentially lax enforcement.

Rajendra (2019) highlighted that the federal government also launched a plastic straw ban in January 2019 for Putrajaya, Kuala Lumpur and Labuan. However, reporters have found little or no reduction in the use of a plastic straw. "No Straw" signs may be placed on counters and tables, but it does not receive much attention. Instead, what was supposed to be a ban looked like a campaign to discourage the use of straws. However, it may take some time for individuals and businesses to be acclimatized to the prohibition. Apart from the straw ban, there seems to be no clear direction for handling plastic waste in Malaysia. Minister Yeo Bee Yin has said that there will be no mercy in the case of illegal plastic recyclers (Naaman, 2019). In comparison, the Minister of Housing and Local Government, Zuraida Kamaruddin, said that the plastic recycling industry is lucrative one worth RM30 billion annually. However, companies are subject to strict regulations, and clean plastic scrap can be imported (Bedi, 2019).

In several states and federal territories, waste segregation was also compulsory on 1 September 2015 (Edward, 2016). Compounds and fines can be issued to lawbreakers. Four years later, there is still little awareness of the separation of waste. According to Jun (2019), this program failed due to waste was laxly deployed and mixed during the disposal stage despite some houses that sort their waste. MESTECC (2018) introduced "Malaysia's Roadmap to Zero Single-Use Plastics 2018-2030" in 2018, and It is a policy guideline to ensure environmental sustainability and eliminate single-use plastics by 2030. It focuses mainly upon introducing biodegradable alternatives to plastic and reducing single-use plastic products such as food bags and straws.

Table 2. 9 : MESTECC Roadmap Summary 2018–2030 Towards Zero Single-Use Plastics, (Ministry of Energy, Science, Technology, Environment and Climate Change Malaysia (MESTECC), 2018)

	Initiatives and Plans
Phase 1 (2018-2021)	• Review existing legislation and develop a legal framework. • National pollution charge for plastic bags at least RM 0.20. • No straws are given by default to customers and only given plastic straws on request. • National Communication, Education and Public Sensitivity (CEPA) Programs.
Phase 2 (2022-2026)	• Biobags to replace plastic bags. • No straw by default continues. • More biodegradable products and compost abilities (food packaging, cutlery). • Research and development (R&D) funding for environmentally friendly alternatives. • Introduction of the single-use plastic legal framework • Levy on plastic bag manufacturers.

Phase 3 (2026-2030)	• Substantially increase the volume of biodegradable and compostable alternatives. • More Research & Development (R&D) • In 2030, an implementation report will be published

2.6 Stakeholder Approach In Waste Management

In general, the stakeholder approach was developed by Freeman,(1984), who described stakeholders as any group or individual who can affect or is affected by accomplishing the organization's objective. Later, they were extended to include the actions, decisions, policies, practices or goals of the organization, (Carroll et al., 2000). The impact criterion identifies which stakeholders can be affected by or may affect business activities. For example, an individual can influence and be affected by a system. (Clarkson, 1995; Carroll *et al.*, 2000; Jensen, 2002) recommended using effect criterion to identify stakeholders.

Manaf *et al.* (2009) highlighted that each stakeholder has a role in the sustainable management of solid waste and waste hierarchy. By integrating different stakeholders into the individual phases of the conventional waste management hierarchy. The top stages and the relevant stakeholder role can, therefore reduce the volume to be disposed of. Therefore, waste generators such as household, industrial, commercial, manufacturer and plastic consumer have a significant role in limiting plastic waste being discarded into the ocean, (Ezeah *et al.*, 2013). Shekdar (2009) stated for an integrated approach to solid waste management, stressing the component of technology, stakeholders' role, and cooperation. However, the primary responsibility lies with stakeholders in sustainable plastic waste management. It is therefore vital to identify their existing practises and interests in the management of plastic waste.

Agamuthu and Victor (2011) highlighted that the Malaysian waste administration framework has set up the idea of Extended Producer Responsibility (EPR) through the Environmental Quality Act 1974 and the Solid Waste and Public Cleansing Management Act 2007. Consequently, the concept of EPR stays on the paper, while Malaysia's current EPR rehearses are limited by willful cooperation. The EPR is an arrangement approach in which makers (producers) are given significant duty regarding the handling or disposal of post-customer products. This statement is supported by Gupt and Sahay (2015), where the authors highlighted that producers and recycler organizations' monetary obligations are interrelated. The blend of the two makes a huge commitment to the accomplishment of expanding producers' duty.

In terms of the local authority, Alam *et al.* (2010) highlighted that the local authority needs to raise public mindfulness (awareness) and support the public's recycling society. This is because the neighbourhood specialists are delegates who are closest to the individuals under their locale. Notwithstanding, to improve the reusing community in the networks, there is a requirement for a scope of guidelines on general people, which are right now deficient. This statement is backed by Kamaruddin and Omar (2015) that highlights that local authority are part of the waste management system and actively participate in community activities, adopting policies that can support the environment. The authorities help foster recycling efforts hoping that public visibility will increase and that public participation in sustainable waste management is possible.

2.7 Modelling The Plastic Recycling Desirability

The fourth objective is determining the priority of recycling plastics. Commonly, plastics themselves consist of various types such as Polyethylene Terephthalate (PET or PETE or Polyester), High-Density Polyethylene (HDPE), and so on with different market value. So those plastic needs to be identified first by material separation. More than one type of material is used to form one complete device, such as a fan consisting of plastic and metal as the primary material. Hence, with the combined use of material, recycler should be known which priority to be taken and recycled. Then, from the material extracted for recycling purposes, they need to undergo several methods using proper technology to be turned into raw material that users can utilize quickly without extracting natural resources.

Hence, the finished product's separating materials' complexity will be calculated to determine how many steps are involved in recovering pure components. (Mtotal) represent the mass of the whole product, and at the same time, the square shape is the separation process to obtain the pure product component or part named by (process 1, process 2, process 3, Process 4, and Process 5). The pure component is the circular shape (M1, M2, M3, M4, and M5). In each separating tree, the evaluation of the mixing material shall be considered. Therefore, it may mean that less separation tree corresponds to lower mixing content, whereas more separation tree corresponds to higher mixing content. Thus, the wording of the complexity measure is determined by equations (2.1) and (2.2) (Mohamed Sultan et al., 2017).

Equation of the complexity measurement:

$$\mathrm{Ci} = \frac{\mathrm{Mi}}{\mathrm{Mtotal}} \qquad \text{Equation 2.1}$$

$$\mathrm{H} = \mathrm{K}(\mathrm{Ci}\log \mathrm{Ci}) \qquad \text{Equation 2.2}$$

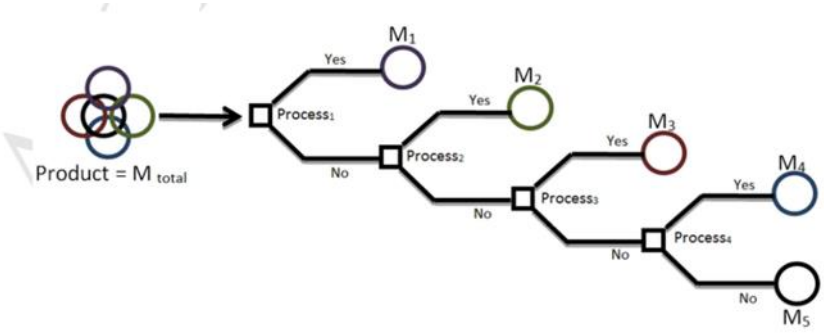

Figure 2. 21 : Material separation tree (Mohamed Sultan et al., 2017)

The simplicity of the material separation simplicity of the product or part is defined in equation (2.3) below, which considers the mass fraction and process stage. H is the complexity index obtainable from equation (2.2), and Htop is the highest level in the materiel complexity index of 3.5. The calculation for the material security index (Dmsi) is then shown in equation (2.4) where n is the maximum number of discrete material type, Mi is the mass material in the product, MT is the total product mass, SI is the material safety index of the pure material of the materials and STOP is the most significant calculus of the material safety index (MSI). The STOP is obtained from the listings of the manufacturer or stakeholder for analysis purposes. Next, the calculation for recycling technology maturity (Dtrl) as illustrated in the equation (2.5), where n represents the maximum number of technology used for the recycling in a product, Mi is the mass of discrete materials in the product, MT is the overall mass of a product, Ri is the readiness technology assessment of the recycling technology of certain materials. Equation (2.3), equation (2.4) and equation (2.5), as shown in the equation (2.6) are the result of recycling desirability (D desirability).

$$D\ simplicity = 1 - \left(\frac{H}{Htop}\right) \quad \text{Equation 2.3}$$

$$Dmsi = \sum_{i=1}^{n} \left(\frac{MiSi}{MTSTOP}\right) \quad \text{Equation 2.4}$$

$$Dtrl = \sum_{i=1}^{n} \left(\frac{MiRi}{MTRtop}\right) \quad \text{Equation 2.5}$$

$$Desirability = Dsimplicity + Dmsi + Dtrl \quad \text{Equation 2.6}$$

CHAPTER 3

METHODOLOGY

This research is based on a rationalist theory that introduces exciting environmental phenomena, in particular recycling. The research aims to understand the current practices and perspectives of recyclers in this field. A proper method is needed to obtain accurate results and to achieve the objective of this study. Therefore, the present study used existing literature to deduce the relationship between constructs and establish a strategy for testing the proposed theory with the ultimate goal of confirming and building on existing knowledge in the area. This chapter set out a road map for the study, which will show the author's direction towards achieving this research objective in several well-defined logical steps.

3.1 Research Plan

Gantt chart is a graphical tool that displays time-based events or activities. It is also defined as a visual presentation of the preparation and scheduling of research in a chart type that makes it easy to understand and interpret. All research preparation is set and planned on an appropriate dateline to avoid duplication and ensure that the research's progress is carried out smoothly. The Gantt chart graph's shaded part in the appendix reflects the time required to complete each activity. The Gantt chart timeline is adjusted under the supervisor's guidance to avoid bottlenecks and waiting time. Hence, the research study's movements are recorded, starting with developing research objectives to the report's submission, as demonstrated in the appendix.

3.2 Identification Of The Problem Statement

The problem statement is a brief explanation of the issue to be resolved or the situation to be improved. Through this phase, the author gained insight into the existing methods of managing plastic waste by studying journals, articles, and newspapers. The findings obtained are then translated into a correctly specified problem.

3.3 Determine The Objective And Scope Of The Research

The authors further explore the factors that contribute to the arising issues and set the direction on research. The research objective is referring as the guideline in ensuring the research to be always on track. The objectives are set up based on the specified problem listed on the problem statement. The objectives of the research include;

- To determine the critical factors for the execution of plastic recycling initiatives for Malaysia
- To identify the end-of-life waste ownership for plastic waste in Malaysia

- To determine the local-recycling supply chain framework in managing plastic waste in Malaysia.
- To model the recycler preferences index (RPI) for plastic waste in Malaysia

The scope outlines the covered research area and specifies the variables to be included in the research. A survey is conducted and distributed to the recycling dealer in Johor and Selangor. For recyclers in a different state, the research results may be different. The built local recycling plastic waste supply chain framework is based exclusively on visited recyclers. The RPI is mainly based on the recyclers in the targeted field, and may not be applicable to others.

3.4 Literature Review Studies

The literature review is taken from an analytical paper that provides a theoretical viewpoint and an approach to those studies. The literature review refers to a compressive summary of the studies in question. It is also a way of evaluating and using others' work in research as the basis for data collection. The data collected is sorted and well written with references to acknowledge scholars. It investigates, first and foremost, the cases of plastic waste management in most developed countries and discusses the value of the recycling of plastic waste. The literature review is also crucial to the author's knowledge of the focus area and is compiled from books, articles, journals, and websites. The question established in the form of a survey could be constructed from the literature review obtained.

3.5 Develop A Research Approach

The research methodology is a method for how research should be carried out. One of the procedures consists of broad assumptions for systematic data collection, analysis, and interpretation methods. Data collection is a systematic method of gathering reliable information depending on the course of the research. In this research, the author uses a quantitative analysis method. The quantitative analysis approach is used for data collection as the author attempts to quantify the attributes, attitudes, behaviours, and other defined variables with the aim of either supporting or opposing the hypothesis of a specific phenomenon by contextualizing the data collected from the literature review.

3.5.1 Quantitative Method

Quantitative research is a research technique that focuses on the quantification of data collection and analysis. Quantitative analysis approaches are used to measure and interpret variables to obtain information. It includes the use and study of numerical data using particular statistical techniques (Apuke, 2017). Also, the quantitative approach allows reaching a higher sample size in a quick time. In this research, the author uses a statistical survey to draw statistical inferences about the population being studied, the recyclers. As Malaysia moves towards implementing the circular economy, this research seeks to determine the critical factor in executing recycling practice and channelled the recycler's suggestion to the government for improvement.

3.5.1.1 Surveys Development

A survey is an excellent tool for gathering information from a group of people traditionally intended to generalize the broader population results. The survey is structured to ensure that the data collected corresponds to the respondents' actual thoughts, feelings, and preferences to provide a vital source of knowledge and reliable data on specific topics. In this research, the questions were constructed based on the

research objectives and guided by the literature review. The research aims to determine the circular economy's ownership and improve the recycling decision-making tools; therefore, the developed questionnaires are structured and narrowed to achieve the research purpose.

Each of the sections constructed in the questionnaire has its purposes. Section A aims to provide respondents with demographic data to understand the background of the respondent better. It also allows the authors to acknowledge the surveys are distributed to the targeted audience and obtained accurate data from someone in the recycling field. Section A contains a question that focuses more on company background, company nature of the business, the number of employees, and space ownership. In Section B of the surveys, questions are more focused on the execution of recycling initiatives. The information needed from section B is the waste supply chain, collection frequency, source of waste, main waste collected, waste consideration factor, current barriers and drivers to sustain in the recycling industry, waste ownership, and plastic waste framework.

The questions developed in section C is focused on specific waste, mainly plastic waste. In this section, all the questions asked are related to plastic waste management, including types of plastic waste collected, buy and trade price, preferred plastic waste, and the retrieved materials' next destination. Section C's developed question is to obtain the data related mainly on plastic waste and is prepared for the recycling preferences index uses

3.5.1.2 Questionnaire Review

Initially, the questionnaire are reviewed by the academics before being distributed. The validation aims to determine the level to which the reader understands the questions. The questionnaire must be validated for the data's accuracy because the questions that are constructed can sometimes be misleading. The research pilot are taken to improve the research quality and efficiency. The review process is repeatable and enhanced until the question is understandable. The review from the experts are attached on the appendix.

3.5.1.3 Questionnaire Reliability Test

Upon collection of data, the data collected shall be processed and interpreted. The findings presented in the research highlight the recycler's current situation in handling plastic waste in Malaysia. The survey's output is transferred to IBM SPSS statistical software for Cronbach Alpha analysis where the internal accuracy (reliability) of the data is calculated. Cronbach's alpha reliability is among the most frequently used reliability tests in individual and institutional studies (Bonett and Wright, 2015). The Cronbach Alpha output is measured using the rule of thumb, as demonstrated in table 3.1. IBM SPSS software is a powerful statistical software platform capable of understanding large and complex data sets with sophisticated statistical procedures that ensure high accuracy and quality decision-making.

Table 3. 1 : Cronbach's Alpha rule of thumb

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

3.6 Data Collection

The data collection method is a method for the systematic collection and evaluation of information on variables of interest, which helps the author answer questions about research, test hypotheses, and analyse results. The survey is the tool of research for this study. The questionnaire is based on the research goals, particularly on critical recycling factors and the Malaysia supply chain framework for local recycling of plastic waste management. Surveys are sent to all recyclers in Johor and Selangor within four weeks via walk-in.

3.6.1 Research Design

Research design is the structure of research methods as a guide to research. It describes an easy and sensible strategy to respond to a given research question by collecting, presenting, reviewing and discussing data. This study comprises four aims for the determination of the plastic waste recycler index preferences in Malaysia. Figure 3.1 demonstrated the overall research plan for this study. Each of the objective research plans is discussed in each sub-chapter.

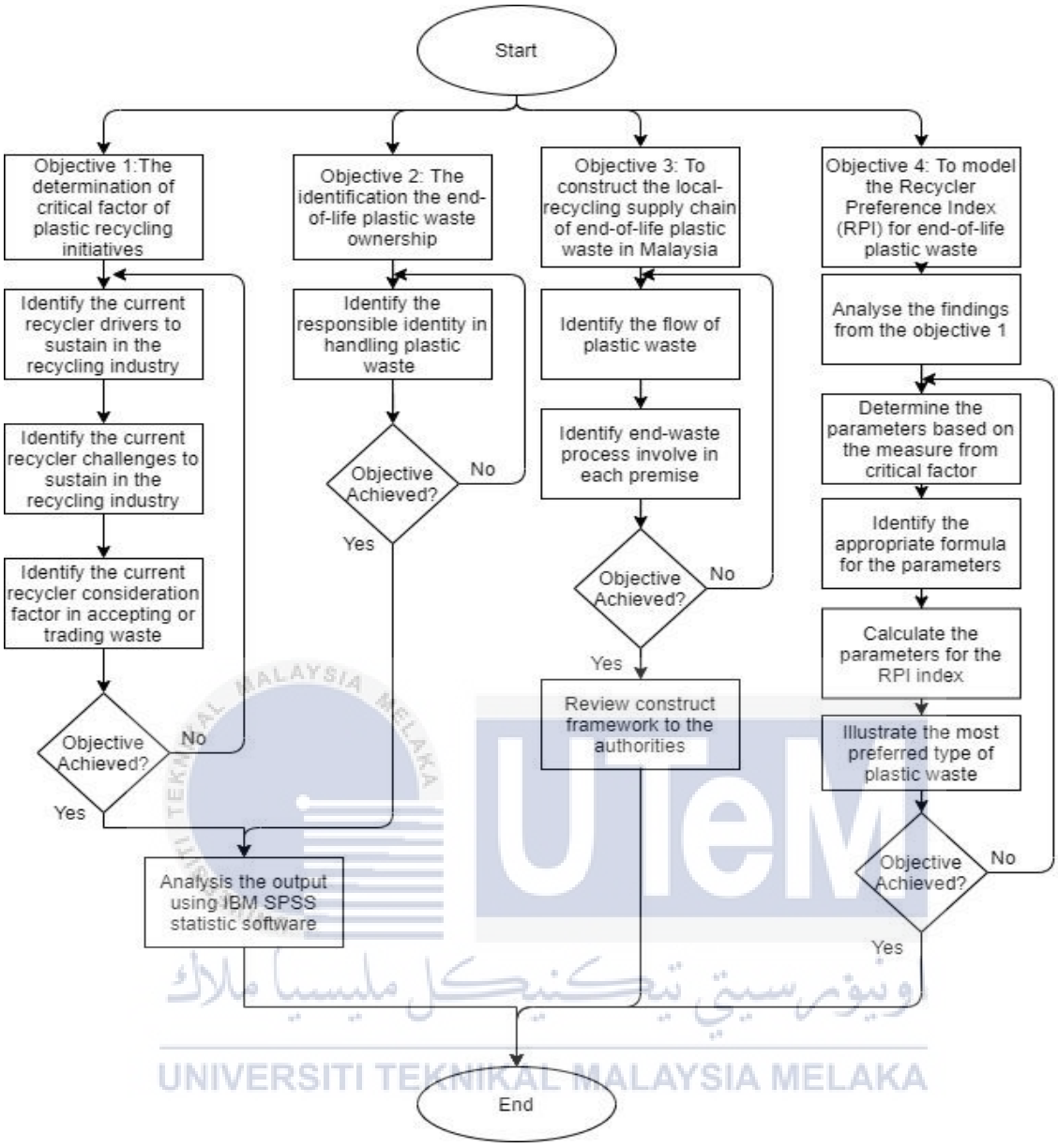

Figure 3. 1 : Overall research plan for this study

3.6.1.1 Descriptive Analysis for Objective 1 and Objective 2

Figure 3.2 below demonstrates the research flow to accomplish objective 1 to determine the critical factors for the execution of plastic recycling initiatives for Malaysia and objective 2 to determine the end-of-life waste ownership for plastic recycling in Malaysia. Both of the objectives are accomplished by using the quantitative method, a questionnaire survey. The 3 factors measure the critical factor for the execution of plastic recycling initiatives in Malaysia: the recycler driver to sustain in the recycling industry, current recycler challenges to sustain in the recycling industry and the recycler consideration factor in accepting or trading the waste. The ownership of end-of-life plastic waste management is measured according to the recycler perspectives. This finding helps the government review the existing plan for recycling activities for plastic in Malaysia because it is impossible to move alone to increase Malaysia's recycling rate. Therefore, it requires more than one party to unite with the government to enhance the recycling rate of plastic in Malaysia.

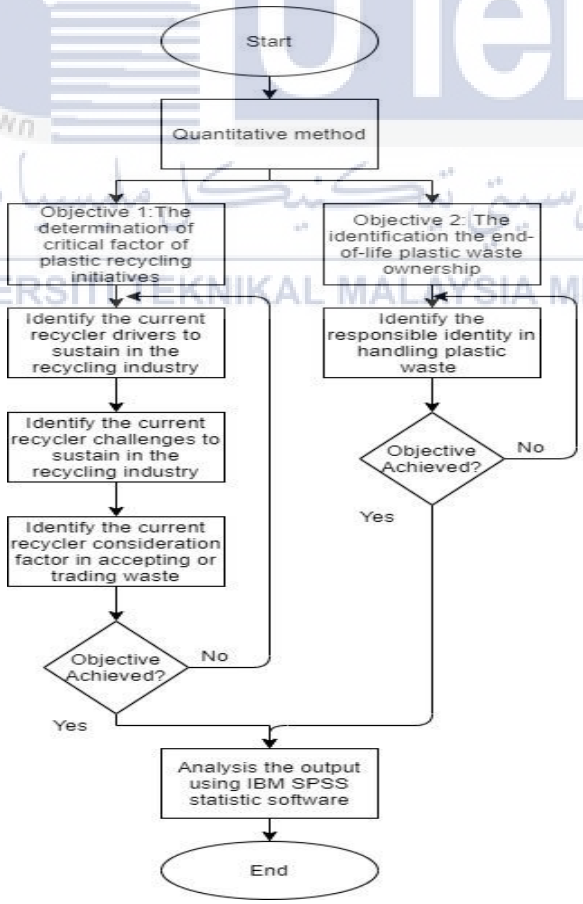

Figure 3. 2 : Research design for Objective 1 and Objective 2

3.6.1.2 Research Plan for Objective 3

Determining the local-recycling supply chain framework in managing plastic waste in Malaysia is the second objectives of this study. The research flow for the third objective of the study is illustrated in figure 3.3. In identifying the plastic waste route and the current process involved in each premises, several questions are constructed in section B of this study's questionnaire survey. The information includes the source of the collected plastic waste, the process in its premises and the next destination for the processed plastic waste either located in the landfill or exported to the local and abroad manufacturer. Since plastic waste comes as used products, many consumers can produce it, whether households, industrial or commercial sectors. A lot of plastic received by the respondent on the premises is not entirely a recyclable plastic. Therefore, this section is vital to determine the non-recyclable and recyclable plastic destination entirely in the premises. The findings' output is translated into the current flow diagram for a local-recycling supply chain of plastic waste. The constructed framework are reviewed by the authority, such as the Department of Environment (DOE). This finding helps the government analyse and upgrade the recycling facilities in Malaysia to enhance the recycling rate. Objective 1, 2 and 3 are conducted simultaneously.

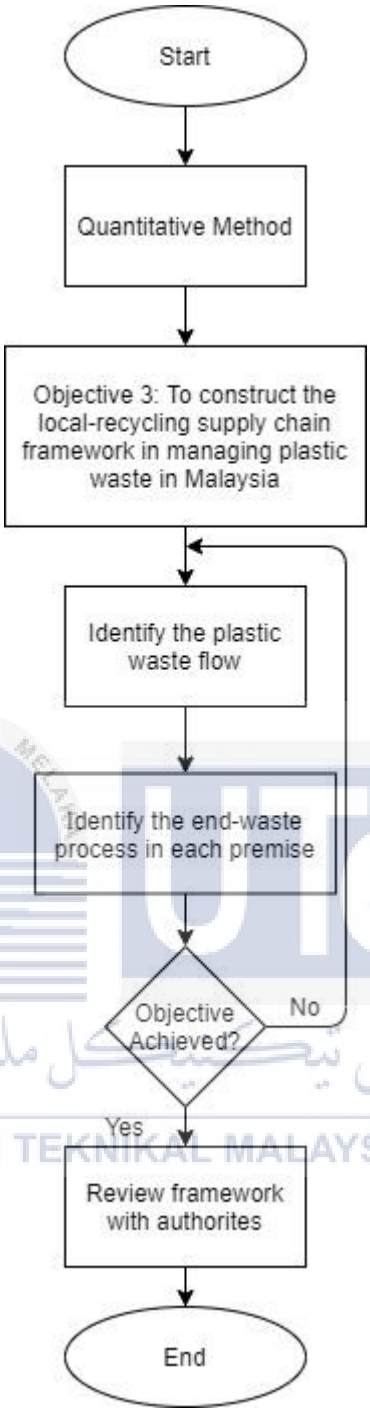

Figure 3. 3 : Research flow for Objective 3

3.6.1.3 Research Plan for Objective 4

Determining the recycler preferences index (RPI) for plastic waste in Malaysia is the fourth objectives of this study. This research's fourth objectives are carried out consecutively after the objective 1 analysis, as demonstrated in the figure below. The parameters of the RPI is developed based on the critical factors' findings. The appropriate equation on the critical factors is calculated to measure the validity of the objective 1 output. The RPI is developed to demonstrate the recycler preference on plastic waste by considering the recyclers consideration factor, drivers and challenges to sustain in the recycling industry. The graph is generated to illustrate the most preferred plastic waste category and its profitability in the recycling industry.

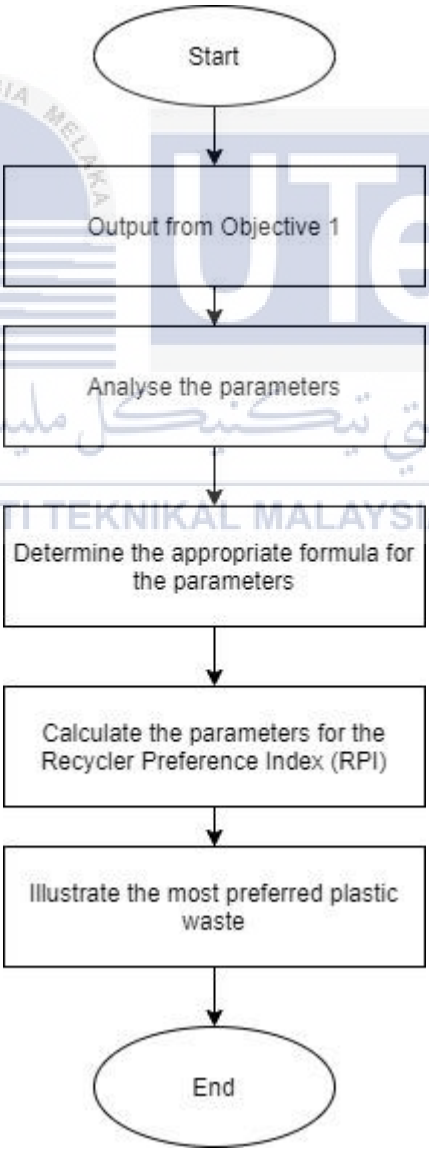

Figure 3. 4 : Research plan for Objective 4

3.7 Data Sampling And Target Populations

The target population is selected based on the objective and the scope of this study. This study's respondent is extracted from the Department of Environment of Malaysia who undergoes collecting and recycling activities licensed from the government. The sample size method is used to obtain the respondent's ideal number for accurate, statistically meaningful results and a successful study from the list obtained. The term ‘sample size' can be found in statistics and market research and is frequently used when surveying a large population of respondents (ANYANWU, 2020). The recyclers list is obtained from the Jabatan Alam Sekitar (JAS) website. Approximately 145 recyclers in Selangor and 138 recyclers in Johor are listed on the DOE websites are used for calculating the research data sampling by using formula below. Based on the calculation, only 163 recyclers is needed for the data sampling. Due to several limitation, the study managed to get 74 respondents with the respond rate of 54.6%.

Table 3. 2 : Sample size formula (ANYANWU, 2020)

$$n = \frac{[\,(N)(P)\,(1-P)\,]}{[\,(N-1)\left(\frac{B}{C}\right)^2 + (P)\,(1-P)\,]}$$	
N	population size
P	proportion population expected to choose, 0.5
B	acceptable sampling error, 0.05
C	Z statistic associated with the confidence level which is 1.96 that corresponds to the 95% level

3.8 Data Analysis

Data analysis using descriptive statistical analysis, where the results are illustrated in a form of graph and table.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter discusses the result of the recycling desirability and a critical factor for plastic waste in Malaysia. The data was collected through the survey by preparing a questionnaire survey to the targeted local recyclers as the respondents. This paper adopts a questionnaire survey technique to determine the recycling desirability and the critical factor for plastic waste in Malaysia. Questionnaire survey is one of the most cost-effective ways to involve many people to achieve better results. The questionnaire survey is first validated with the expert to measure the level of understandable, structure and information needed. The questionnaire survey is distributed to the recycler, particularly in Selangor and Johor. The output from the findings is analyzed using the IBM SPSS statistical software and review by the authorities.

4.1 Finding And Analysis

In this study, Cronbach's Alpha (α) is applied to determine the internal consistency or average correlation of items in a survey instrument to measure its reliability using SPSS Statistics software. Usually, Cronbach's alpha is expressed as a number between 0 and 1 (Cronbach, 1951). The technique was first formulated and published by Lee Cronbach in 1951. The reliability is tested for the survey questionnaire and got 0.790 as the value of Cronbach's alpha from 48 questions, as demonstrated in Table 4.1 below. Cronbach (1951) highlighted that alpha value more than 0.7 means the internal consistency or average correlation of items in a survey instrument is high. This statement is also supported by Taber (2018) which 0.7 value of Cronbach alpha value is acceptable in using Cronbach's alpha during developing and reporting research instruments in science education.

Table 4. 1 : Reliability Statistic of The Study

Reliability Statistics	
Cronbach's Alpha	N of Items
0.790	48

4.2 Demographic Analysis

4.2.1 Demographic Analysis: Nature Of Business

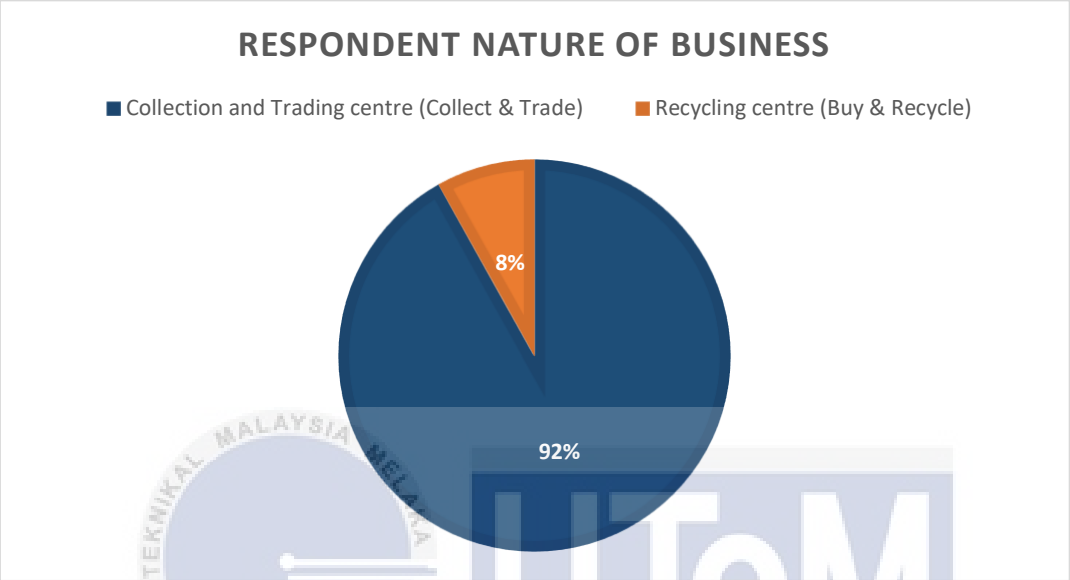

Figure 4. 1 : Pie chart of the respondent nature of business

The pie chart in figure 4.1 shows the results of a survey in which respondents were asked about their business nature. The respondents' nature is needed to determine their premises' activities, whether they collect and trade plastic waste or buy plastic waste and process plastic waste into recycled material. From the pie chart, it is clear that most of the respondents collect plastic waste and trade to the market without processing them into recycled plastic. Around 92% of respondents contributed to collecting and trading plastic waste as their business nature. In comparison, another 8% respondent buy and process the plastic waste into recycled material.

Khazanah Research Institute (2019) highlighted that Malaysia's recycling rate are approximately 30% which are considered low while Singapore recycling rate are 61%, three-time higher than Malaysia in 2017. According to the Department of Statistics Malaysia, Malaysia has approximately 330,803 sq km compared to Singapore's area of approximately 719 square km. This making Malaysia 45,763% larger than Singapore (S.

D. Malaysia, 2010). The government may use Malaysia's land area to set up more processing centres to enhance Malaysia's recycling rate.

4.2.2 Demographic Analysis: Number Of Employees

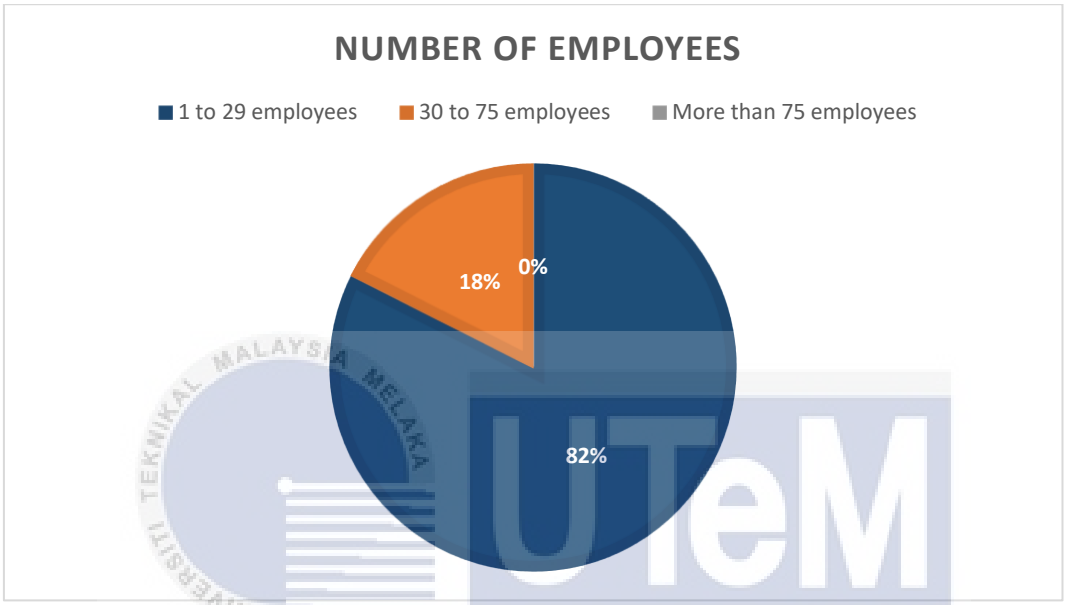

Figure 4. 2 : Number of employees

The pie chart in figure 4.2 shows the picture shows the survey results where the respondents were asked about the number of employees owned on the premises. From the pie chart, it is clear that most of the respondent business category lies in the small business category in the recycling industry. Around 82% of respondents belong to small enterprises outlined according to the government's definition in determining a category of business in Malaysia according to the number of employees available. Only 18% classified as a moderate(medium) business category and no company owned by the respondent has more than 75 employees. The number of employees is required for the study findings to determine a respondent's business category, whether their business belongs to small, medium and mega-business, aligned to SME Corp Malaysia regulation. Small businesses are classified when a premise has 1 to 29 employees, while the medium business category has 30 employees up to 75 employees. The mega business category is classified as more than 75 employees.

4.2.3 Demographic Analysis: Space Ownership

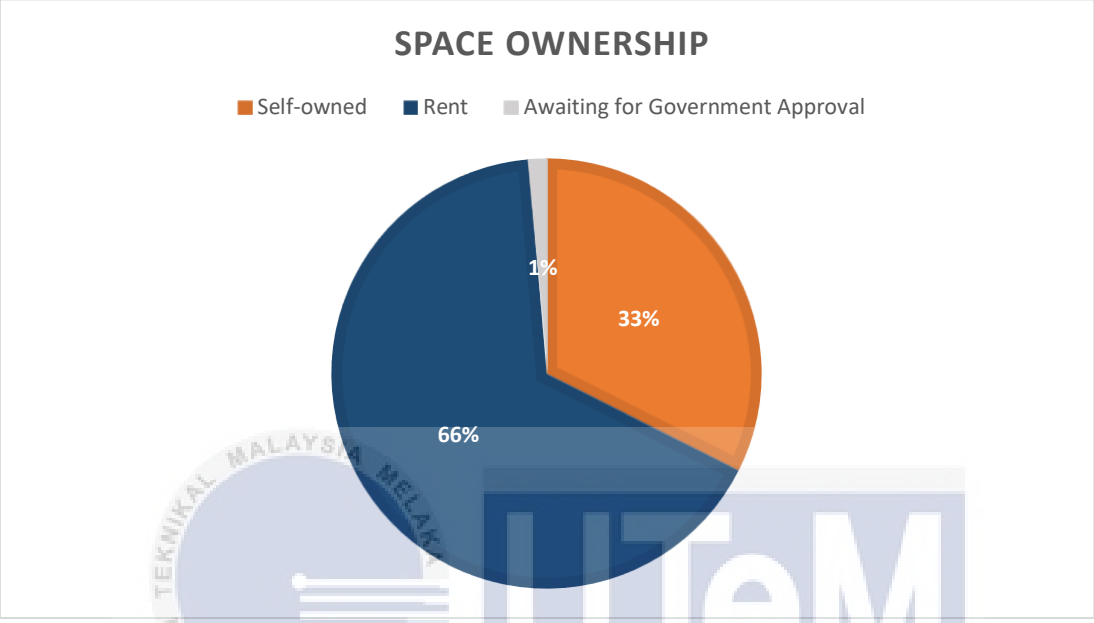

Figure 4. 3 : Space ownership

The pie chart in figure 4.3 shows the survey results in which respondents were asked about their space ownership. The status of space ownership is required in this study's findings to know the premises conducted by the respondent of a tenant, landowner, or waiting for the government decided to apply for business space. It can be clearly seen that most of the respondents rented space to carry out plastic waste collection and recycling activities. Around 66% of respondents rent premises while 33% are permanent owners of premises space. Only 1% of respondents wait for the authorities' approval to occupy the space to carry out activities to collect and process plastic waste.

4.2.4 Demographic Analysis: Premises license status

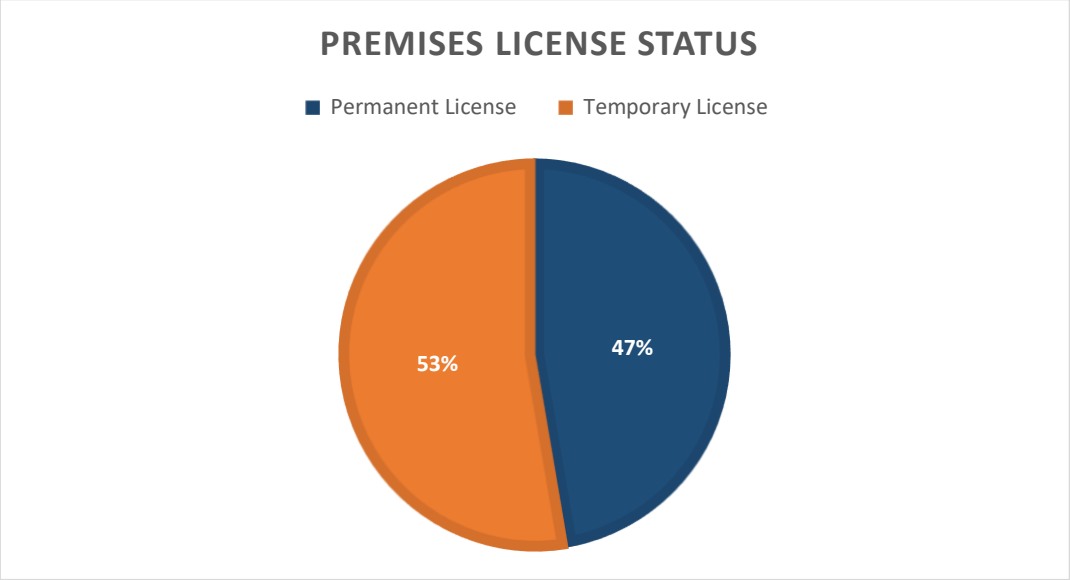

Figure 4. 4 : Premises license status

The pie chart in figure 4.4 shows the survey results in which respondents were asked about their premises license status. From the pie chart, it is clear that most of the respondents are temporary license holders granted by the authority to carry out plastic waste collection and processing activities. Around 53% of respondents are confirmed as temporary license holders. In comparison, 47% are permanent license holders granted by the government under the terms and conditions set in the National Land Code 1965 (NHL) of Malaysia.

The status of premises license is required in this study's findings to determine that the respondent's premises are a temporary or permanent license granted by the authorities under the terms and conditions in developing and carrying out plastic waste collection and processing activities. Jasman (2015) highlighted that Temporary Occupation License (TOL) are referring to temporary licences given to the companies to run a business temporarily. The purpose of the Temporary Occupation License is to allow the holder to occupy state land, mining land and reserved land which are not currently used for mining or for the purposes for which they have been reserved. In contrast, permanent occupancy

license means that the individual or owner of premises is given full permission to conduct business activities as registered to the authorities.

4.3 Section B: Recycling Initiatives

4.3.1 The Supply Chain of Waste

Given Table 4.2 below, the inquiry regarding consideration factors was replied with 74 respondents. No question was left unanswered. The 5 Likert scales changed to 3 Likert scales. The number of respondents that vote 'rarely' and 'sometimes' are combined and characterized as 'Sometimes'. 'Often' and 'Always' are combined and characterized as 'Always'. 'Never' continue as before, as shown in Table 4.3 below.

Table 4. 2 : Frequency statics of overall recycler's supply chain of waste

Statistics						
		Nearby, from the same area, within 1km-2km	From the same district, within 2km-10km	From different district, within 11km-30km	Different State	Different Country
N	Valid	74	74	74	74	74
	Missing	0	0	0	0	0

Table 4. 3 : Scale to analyse Likert scale

Never	Rarely	Sometimes	Often	Always
1	2	3	4	5
Never	Sometimes		Always	

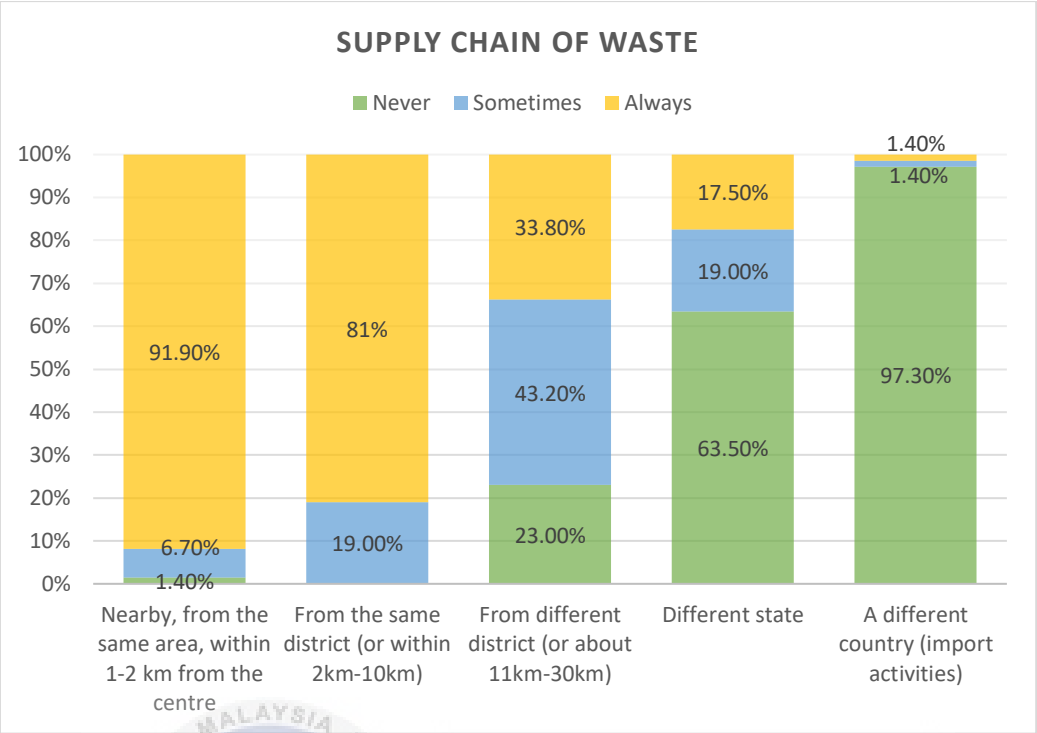

Figure 4. 5 : Supply chain of the waste

The graph presents the results of the survey on the recyclers supply chain of waste. Each of the recyclers receives waste from many sources in a different location. The recyclers usually are received waste from nearby, from the same area that is within 1-2km from the centre, some received waste from in the same district within 2km-10km, some from a different district that are about 11km-30km, some from different state and some from different country. Based on the figure 4.5, most voted supply chain waste were Nearby, from the same area within 1km-2km from the center with 91.90%, followed by the same district within 2km-10km with 81%, different district within 11km-30km with 33.8%, different state with 17.5%, and different country with 1.4%. More details explanation on each category were explained under its own subcategory.

4.3.1.1 The Supply Chain of Waste: Nearby, From The Same Area

The graph presents the results of the survey on the identification of recyclers supply chain of waste. The bar chart illustrates in figure 4.5 shows that the Nearby, from the same area, obtained the highest percentage of always with 91.9% recyclers highlight that they received waste from nearby. The remaining were vote for Never with 1.4% and Sometimes with 6.7% as shown in table 4.4 below. In a more specific word, the majority of the recyclers are always obtained waste from nearby.

Table 4. 4 : Statistic frequency supply chain of waste: Nearby, from the same area (1km-2km)

Nearby, From Same Area (1km-2km)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	1	1.4	1.4	1.4
	Sometimes	5	6.7	6.7	6.7
	Always	68	91.9	91.9	100.0
	Total	74	100.0	100.0	

4.3.1.2 The Supply Chain of Waste: Same District

The graph presents the results of the survey on the identification of recyclers supply chain of waste. The bar chart illustrates in Figure 4.5 shows that the From the Same District obtained the second-highest percentage of always with 81% recyclers highlight that they received waste from the same district. The remaining were vote for Sometimes with 19%, as shown in Table 4.5 below. In more specific words, most recyclers are always obtained waste from the same district.

Table 4. 5 : Statistic frequency supply chain of waste: Same District (2km-10km)

From the Same District (2km-10km)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sometimes	14	19.0	19.0	19.0
	Always	60	81.0	81.0	100.0
	Total	74	100.0	100.0	

4.3.1.3 The Supply Chain of Waste: Different District

The graph presents the results of the survey on the identification of recyclers supply chain of waste. The bar chart illustrates in Figure 4.5 that the from difference district obtained the highest percentage of sometimes with 43.2% recyclers highlight that they sometimes received waste from different districts. The remaining were vote for Never with 23% and Always with 33.8% as shown in table 4.6 below. In more specific word, the majority of the recyclers are sometimes obtained waste from different district.

Table 4. 6 :Statistic frequency supply chain of waste: Different District (11km-30km)

From Different District (11km-30km)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	17	23.0	23.0	23.0
	Sometimes	32	43.2	43.2	66.2
	Always	25	33.8	33.8	100.0
	Total	74	100.0	100.0	

4.3.1.4 The Supply Chain of Waste: Import, Different Country

The graph presents the results of the survey on the identification of recyclers supply chain of waste. The bar chart illustrated in Figure 4.5 shows that the Import obtained the highest percentage of never with 97.3% recyclers highlight that they never received waste from different countries. The remaining were vote for Sometimes with 1.4% and Always with 1.4% as shown in Table 4.7 below. In a more specific word, the majority of the recyclers never obtained waste from a different country.

Table 4. 7 : Statistic frequency supply chain of waste: Import

Import					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	72	97.3	97.3	97.3
	Sometimes	1	1.4	1.4	98.6
	Always	1	1.4	1.4	100.0
	Total	74	100.0	100.0	

4.3.1.5 The Supply Chain of Waste: Different State

The graph presents the results of the survey on the identification of recyclers supply chain of waste. The bar chart illustrates in Figure 4.6 shows the Different State obtained the second-highest percentage of never with 63.5% recyclers highlight that they never received waste from different states. The remaining were vote for Sometimes with 19% and Always with 17.5% as shown in Table 4.8 below. In a more specific word, the majority of the recyclers never obtained waste from a different state.

Table 4. 8 : Statistic frequency supply chain of waste: Different state

Different State					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	47	63.5	63.5	63.5
	Sometimes	14	19.0	19.0	82.5
	Always	13	17.5	17.5	100.0
	Total	74	100.0	100.0	

4.3.2 Source of Waste

In view of Table 4.9 below, the question concerning consideration factors was replied with 74 respondents. No question was left unanswered. The 5 Likert scales changed to 3 Likert scales where the number of respondents who vote 'rarely' and 'sometimes' are combined and characterized as 'Sometimes', 'Often' and 'Always' are combined and described as 'Always'. While 'Never' continue as before, as shown in Table 4.10.

Table 4. 9 : Frequency statics of overall recycler's supply chain of waste

Statistics							
		Waste Bin	Household	Small Collector (Lorry, Bicycle, etc.)	Offices / Universities	Manufacturers	Waste Companies (Alam Flora, Majlis Bandaran, etc.)
N	Valid	74	74	74	74	74	74
	Missing	0	0	0	0	0	0

Table 4. 10 : Scale to analyse Likert scale

Never	Rarely	Sometimes	Often	Always
1	2	3	4	5
Never	Sometimes		Always	

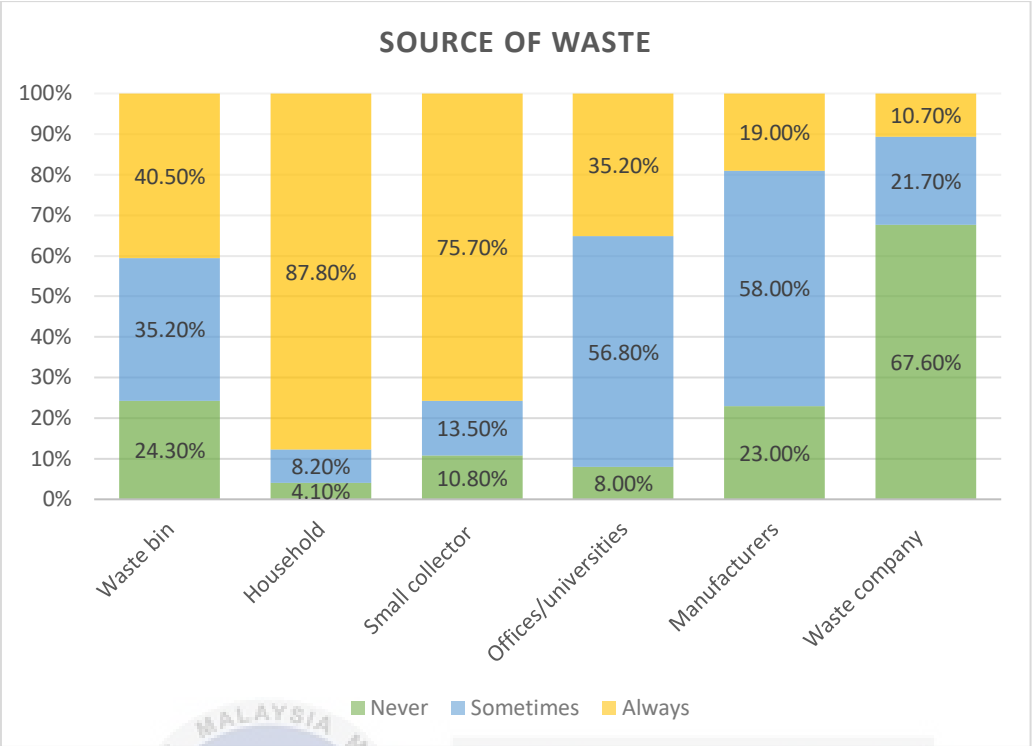

Figure 4. 6 : Recyclers Source of Waste

The graph in figure 4.6 presents the results of the survey on recyclers source of waste. Each of the recyclers receives waste from many sources. The recyclers waste typically from waste bin, household, small collectors by lorry or bicycle, offices or universities, manufacturers, and waste companies. Based on figure 4.6, most voted source of waste was the household with 87.8%, followed by small collectors with 75.7%, waste bin with 40.50%, offices or universities with 35.20%, manufacturers with 19% and waste company with 10.7%. More details explanation on each category were explained under its subcategory.

4.3.2.1 The Source of Waste: Household

The graph presents the results of the survey on the identification of recyclers source of waste. The bar chart illustrates in Figure 4.6 shows that the Household obtained the highest percentage of always with 87.7% recyclers highlight that they received waste from the household. The remaining were vote for Never with 4.1% and Sometimes with 8.2% as shown in the Table 4.11 below. In a more specific word, the majority of the recyclers are obtained waste from the household.

Table 4. 11 : Statistic frequency source of waste: Household

Household					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	3	4.1	4.1	4.1
	Sometimes	6	8.2	8.2	12.3
	Always	65	87.7	87.7	100.0
	Total	74	100.0	100.0	

4.3.2.2 The Source of Waste: Small Collector

The graph presents the results of the survey on the frequency of waste generator collection. The bar chart illustrates in Figure 4.6 shows that the Small Collectors obtained the second-highest percentage of always with 75.7 % recyclers highlight that they received waste from small collectors. The remaining were vote for Never with 10.8% and Sometimes with 13.5% as shown in Table 4.12 below. In a more specific word, most recyclers are also obtained waste from the small collector.

Table 4. 12 : Statistic frequency source of waste: Small Collector

Small Collector (By lorry, bicycle, etc.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	8	10.8	10.8	10.8
	Sometimes	10	13.5	13.5	24.3
	Always	56	75.7	75.7	100.0
	Total	74	100.0	100.0	

4.3.2.3 The Source of Waste: Waste Bin

The graph presents the results of the survey on the frequency of waste generator collection. The bar chart illustrates in Figure 4.6 shows the Waste Bin obtained the third-highest percentage of always with 40.5% recyclers highlight that they received waste from the waste bin. The remaining were vote for Never with 24.3% and Sometimes with 35.2% as shown in Table 4.13 below. In a more specific word, most of the recyclers are obtained waste from the waste bin.

Table 4. 13 : Statistic frequency source of waste: Waste Bin

Waste Bin					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	18	24.3	24.3	24.3
	Sometimes	26	35.2	35.2	59.5
	Always	30	40.5	40.5	100.0
	Total	74	100.0	100.0	

4.3.2.4 The Source of Waste: Manufacturers

The graph presents the results of the survey on the frequency of waste generator collection. The bar chart illustrates in Figure 4.6 shows that the Manufacturers obtained the highest percentage of sometimes with 58% recyclers highlight that they received waste from manufacturers. The remaining were vote for Never with 23% and Sometimes with 58% as shown in Table 4.14 below. In a more specific word, most of the recyclers are sometimes obtained waste from manufacturers.

Table 4. 14 : Statistic frequency source of waste: Manufacturers

Manufacturers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	17	23.0	23.0	23.0
	Sometimes	43	58.0	58.0	81.0
	Always	14	19.0	19.0	100.0
	Total	74	100.0	100.0	

4.3.2.5 The Source of Waste: Offices or Universities

The graph presents the results of the survey on the frequency of waste generator collection. The bar chart illustrates in Figure 4.6 shows that the Offices or Universities obtained the second-highest percentage of sometimes with 56.8% recyclers highlight that they received waste from offices or universities. The remaining were vote for Never with 8% and always with 35.2%, as shown in Table 4.15 below. In a more specific word, most of the recyclers are sometimes obtained waste from offices or universities.

Table 4. 15 : Statistic frequency source of waste: Offices or Universities

Offices or Universities					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	6	8.0	8.0	8.0
	Sometimes	42	56.8	56.8	64.8
	Always	26	35.2	35.2	100.0
	Total	74	100.0	100.0	

4.3.2.6 The Source of Waste: Waste Companies

The graph presents the results of the survey on the frequency of waste generator collection. The bar chart illustrates in Figure 4.6 shows that the Waste Companies obtained the highest percentage of never with 67.6% recyclers highlight that they never received waste from waste companies. The remaining were vote for sometimes with 21.7% and always with 10.7%, as shown in Table 4.16 below. In a more specific word, most of the recyclers never obtained waste from waste companies.

Table 4. 16 : Statistic frequency source of waste: Waste Companies

Waste Company (Alam Flora, Majlis Bandaran, etc.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	50	67.6	67.6	67.6
	Sometimes	16	21.7	21.7	89.3
	Always	8	10.7	10.7	100.0
	Total	74	100.0	100.0	

4.3.3 Frequency of Waste Collection

In view of Table 4.17 below, the inquiry regarding consideration factors was replied with 74 respondents. No question was left unanswered. The 5 Likert scales remain the same where the respondent will vote never, yearly, monthly, weekly or daily, as shown in Table 4.18 below as it is the frequency and no combination is needed.

Table 4. 17 : Frequency statics of overall recycler's frequency of waste collection

Statistics							
		Waste Bin	Household	Small Collector (Lorry, Bicycle, etc.)	Offices / Universities	Manufacturers	Waste Companies (Alam Flora, Majlis Bandaran, etc.)
N	Valid	74	74	74	74	74	74
	Missing	0	0	0	0	0	0

Table 4. 18 : Scale to analyse Likert scale

Never	Yearly	Monthly	Weekly	Daily
1	2	3	4	5

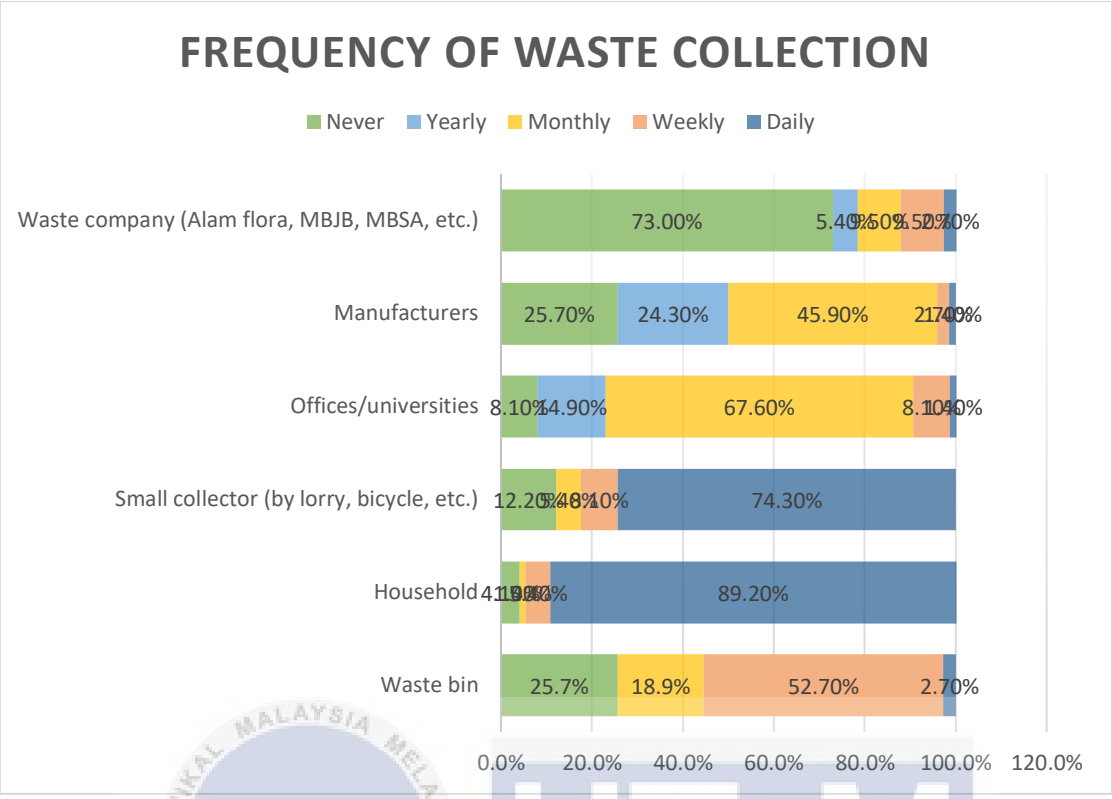

Figure 4. 7 : Frequency of Waste Collection

Figure 4.7 represents the results of the survey on recyclers frequency of waste collection. Each of the recyclers receives waste from many sources. The recyclers received waste daily typically from the household with 89.2%, small collectors with 74.3%. The recyclers received waste on weekly is usually from the waste bin with 52.7%. The recyclers received waste on monthly is usually from offices or universities with 67.6% and manufacturers with 45.9%. The recyclers are mostly never received waste from waste companies with 73%. More details explanation on each category were explained under its own subcategory.

4.3.3.1 Frequency of Waste Collection: Household

The graph presents the results of the survey on frequency of waste generator collection. The bar chart illustrate in the Figure 4.7 shows that the Household obtained the highest percentage of Daily with 89.2 % recyclers highlight that they received waste from household daily. The remaining were vote for Never with 4.1%, Monthly with 1.4% and Weekly with 5.4% as shown in the Table 4.19 below. In simpler word, majority of the recyclers are obtained waste from household daily.

Table 4. 19 : Statistic frequency of waste collection: Household

Frequency: Household					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	3	4.1	4.1	4.1
	Monthly	1	1.4	1.4	5.4
	Weekly	4	5.4	5.4	10.8
	Daily	66	89.2	89.2	100.0
	Total	74	100.0	100.0	

4.3.3.2 Frequency of Waste Collection: Small Collectors

The graph presents the results of the survey on frequency of waste generator collection. The bar chart illustrate in the Figure 4.7 shows that the Small Collectors obtained the second highest percentage of Daily with 74.3 % recyclers highlight that they received waste from small collector daily. The remaining were vote for Never with 12.2%, Monthly with 5.4% and Weekly with 8.1% as shown in the Table 4.20 below. In simpler word, majority of the recyclers are as well obtained waste from small collector daily.

Table 4. 20 : Statistic frequency of waste collection: Small Collectors (by Lorry, Bicycle, etc.)

Frequency: Small Collectors (Lorry, Bicycle, etc.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	9	12.2	12.2	12.2
	Monthly	4	5.4	5.4	17.6
	Weekly	6	8.1	8.1	25.7
	Daily	55	74.3	74.3	100.0
	Total	74	100.0	100.0	

4.3.3.3 Frequency Of Waste Collection: Offices Or Universities

The graph presents the results of the survey on frequency of waste generator collection. The bar chart illustrate in the Figure 4.7 shows that the Offices or Universities obtained the highest percentage of Monthly with 67.6 % recyclers highlight that they received waste from office or universities monthly. The remaining were vote for Never with 8.1%, Yearly with 14.9%, Weekly with 8.1% and Daily with 1.4% as shown in the Table 4.21 below. In simpler word, majority of the recyclers are obtained waste from office or universities monthly.

Table 4. 21 : Statistic frequency of waste collection: Small Collectors (by Lorry, Bicycle, etc.)

Frequency: Offices or Universities					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	6	8.1	8.1	8.1
	Yearly	11	14.9	14.9	23.0
	Monthly	50	67.6	67.6	90.5
	Weekly	6	8.1	8.1	98.6
	Daily	1	1.4	1.4	100.0
	Total	74	100.0	100.0	

4.3.3.4 Frequency of Waste Collection: Manufacturers

The graph presents the results of the survey on frequency of waste generator collection. The bar chart illustrate in the Figure 4.7 shows that the Manufacturers obtained the highest percentage of Monthly with 45.9 % recyclers highlight that they received waste from manufacturers monthly. The remaining were vote for Never with 25.7%, Yearly with 24.3%, Weekly with 2.7% and Daily with 1.4% as shown in the Table 4.22 below. In simpler word, most of the recyclers are obtained waste from manufacturers monthly.

Table 4. 22 : Statistic frequency of waste collection: Manufacturers

Frequency: Manufacturers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	19	25.7	25.7	25.7
	Yearly	18	24.3	24.3	50.0
	Monthly	34	45.9	45.9	95.9
	Weekly	2	2.7	2.7	98.6
	Daily	1	1.4	1.4	100.0
	Total	74	100.0	100.0	

4.3.3.5 Frequency Of Waste Collection: Waste Bin

The graph presents the results of the survey on frequency of waste generator collection. The bar chart illustrate in the Figure 4.7 shows that the Waste Bin obtained the highest percentage of Weekly with 52.7% recyclers highlight that they received waste from waste bin weekly. The remaining were vote for Never with 25.7%, Monthly with 18.9% and Daily with 2.7% as shown in the Table 4.23 below. In simpler word, majority of the recyclers are obtained waste from waste bin weekly.

Table 4. 23 : Statistic frequency of waste collection: Waste Bin

Frequency: Waste Bin					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	19	25.7	25.7	25.7
	Monthly	14	18.9	18.9	44.6
	Weekly	39	52.7	52.7	97.3
	Daily	2	2.7	2.7	100.0
	Total	74	100.0	100.0	

4.3.3.6 Frequency Of Waste Collection: Waste Companies

The graph presents the results of the survey on frequency of waste generator collection. The bar chart illustrate in the Figure 4.7 shows that the waste company obtained the highest percentage of Never with 73% recyclers highlight that they never received waste from waste companies. The remaining were vote for Yearly with 5.4%, Monthly with 9.5%, Weekly with 9.5% and Daily with 2.7% as shown in the Table 4.24 below. In simpler word, majority of the recyclers are never obtained waste from waste companies unless they have tender or contract with them.

Table 4. 24 : Statistic frequency of waste collection: Waste Companies

Frequency: Waste Company (Alam Flora, Majlis Bandaran, etc.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	54	73.0	73.0	73.0
	Yearly	4	5.4	5.4	78.4
	Monthly	7	9.5	9.5	87.8
	Weekly	7	9.5	9.5	97.3
	Daily	2	2.7	2.7	100.0
	Total	74	100.0	100.0	

4.3.4 Main Product Or Material Collected

In view of the Table 4.25 below, the inquiry with respect to consideration factors were totally replied with 74 respondents. No inquiry was left unanswered. The 5 Likert scale were change to 3 Likert scale where the quantity of respondent that vote rarely and sometimes are combine, and characterized as Sometimes, Often and Always are combined and characterized as Always and neither Never continue as before as shown in Table 4.26 below.

Table 4. 25 : Frequency statics of overall recycler's supply chain of waste

Statistics							
		Metal	Plastic	Glass	Wood	Paper / Cardboard	Electric and Electronic Appliance
N	Valid	74	74	74	74	74	74
	Missing	0	0	0	0	0	0

Table 4. 26 : Scale to analyse Likert scale

Never	Rarely	Sometimes	Often	Always
1	2	3	4	5
Never	Sometimes		Always	

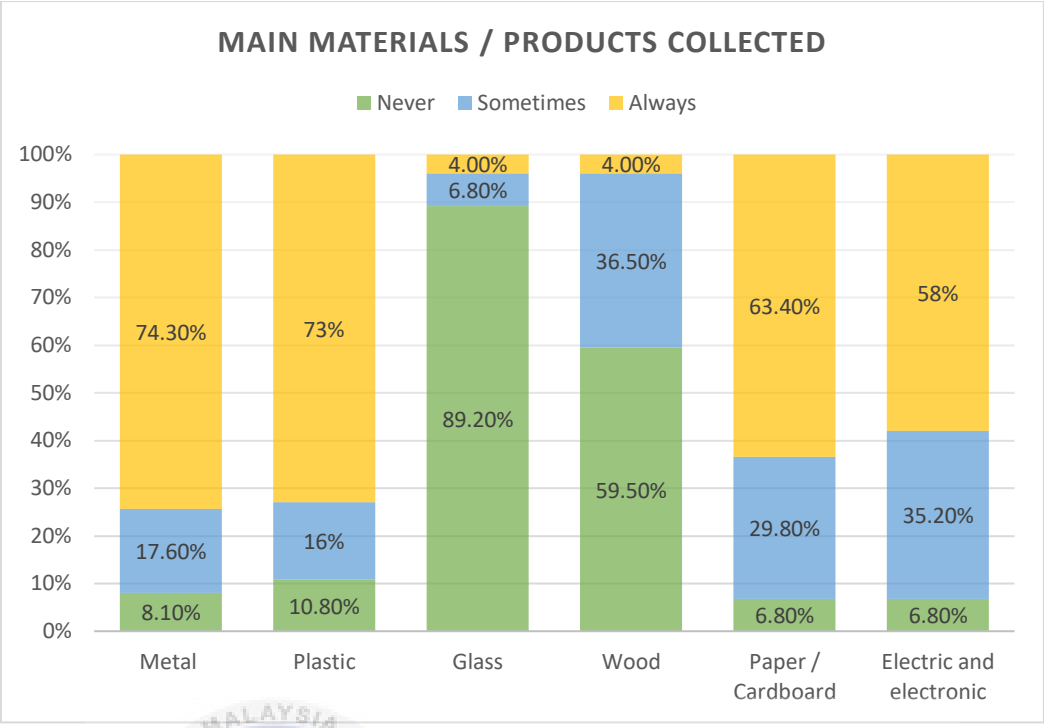

Figure 4. 8 : Main Product or Material Collected

The graph in figure 4.8 presents the results of the survey on recyclers most preferred materials or product waste to be collected and recycled. The recyclers most preferred waste may be varied from one recycler to another. The list of normally preferred waste are as follows; Metal, plastic glass, wood, paper or cardboard and electric and electronic appliance (e-waste). Based on the Figure 4.8, we can clearly see that most preferred waste were metal with 74.3%, followed by plastic with 73%, paper or cardboard with 63.4%, electric and electronic appliances with 58%, glass and wood with 1.4%. More details explanation on each category were explained under its own subcategory.

4.3.4.1 Main Product Or Material Collected: Metal

The graph presents the results of the survey on main materials recyclers collected and recycled. The bar chart illustrate in the Figure 4.8 shows that the Metal obtained the highest percentage of always with 74.3 % recyclers highlight that metal is their main materials collected. The remaining were vote for Never and Sometimes with 8.1% and 17.6% as shown in the Table 4.27 below. In simpler word, majority of the recyclers are accepting metal in their premise.

Table 4. 27 : Statistic frequency of main materials collected: Metal

Metal					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	6	8.1	8.1	8.1
	Sometimes	13	17.6	17.6	25.7
	Always	55	74.3	74.3	100.0
	Total	74	100.0	100.0	

4.3.4.2 Main Product Or Material Collected: Plastic

The graph presents the results of the survey on main materials recyclers collected. The bar chart illustrate in the Figure 4.8 shows that the Plastic obtained the second highest percentage of always with 73 % recyclers highlight that plastic is their main materials collected. The remaining were vote for Never and Sometimes with 10.8% and 16.2% as shown in the Table 4.28 below. In simpler word, majority of the recyclers are accepting plastic as well in their premise.

Table 4. 28 : Statistic frequency of main materials collected: Plastic

Plastic					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	8	10.8	10.8	10.8
	Sometimes	12	16.2	16.2	27.0
	Always	54	73.0	73.0	100.0
	Total	74	100.0	100.0	

4.3.4.3 Main Product or Material Collected: Paper and Cardboard

The graph presents the results of the survey on main materials recyclers collected. The bar chart illustrate in the Figure 4.8 shows that the Paper and Carboard obtained the third highest percentage of always with 63.4 % recyclers highlight that metal is their main materials collected. The remaining were vote for Never and Sometimes with 6.8% and 29.8% as shown in the Table 4.29 below. In simpler word, most of the recyclers are accepting paper and cardboard in their premise.

Table 4. 29 : Statistic frequency of main materials collected: Paper and Cardboard

Paper & Cardboard					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	5	6.8	6.8	6.8
	Sometimes	22	29.8	29.8	36.6
	Always	47	63.4	63.4	100.0
	Total	74	100.0	100.0	

4.3.4.4 Main Product Or Material Collected: Electrical And Electronic Appliances

The graph presents the results of the survey on main materials recyclers collected. The bar chart illustrate in the Figure 4.8 shows that the Electrical and Electronic Appliances obtained the fourth highest percentage of always with 58% recyclers highlight that electrical and electronic appliances is their main materials collected. The remaining were vote for Never and Sometimes with 6.8% and 35.2% as shown in the Table 4.30 below. In simpler word, most of the recyclers are accepting electrical and electronic appliances in their premise.

Table 4. 30 : Statistic frequency of main materials collected: Electrical and Electronic Appliances

Electrical & Electronic Appliances					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	5	6.8	6.8	6.8
	Sometimes	26	35.2	35.2	42.0
	Always	43	58.0	58.0	100.0
	Total	74	100.0	100.0	

4.3.4.5 Main Product or Material Collected: Glass

The graph presents the results of the survey on main materials recyclers collected. The bar chart illustrate in the Figure 4.8 shows that the Glass obtained the highest percentage of Never with 89.2 % recyclers highlight that glass is their minor materials collected. The remaining were vote for Sometimes and Always with 6.8% and 4.0% as shown in the Table 4.31 below. In simpler word, majority of the recyclers are not preferred glass in their premise.

Table 4. 31 : Statistic frequency of main materials collected: Glass

Glass					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	66	89.2	89.2	89.2
	Sometimes	5	6.8	6.8	96.0
	Always	3	4.0	4.0	100.0
	Total	74	100.0	100.0	

4.3.4.6 Main Product Or Material Collected: Wood

The graph presents the results of the survey on main materials recyclers collected. The bar chart illustrate in the Figure 4.8 shows that the Wood obtained the second highest percentage of Never with 59.5 % recyclers highlight that wood is their minor materials collected. The remaining were vote for Sometimes and Always with 36.5% and 4.0% as shown in the Table 4.32 below. In simpler word, majority of the recyclers are not preferred wood in their premise.

Table 4. 32 : Statistic frequency of main materials collected: Wood

Wood					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	44	59.5	59.5	59.5
	Sometimes	27	36.5	36.5	96.0
	Always	3	4.0	4.0	100.0
	Total	74	100.0	100.0	

Objective 1: To Determine The Critical Factors For The Execution Plastic Recycling Initiatives

4.3.5 The Consideration Factors That Encourage For Collecting And Recycling The Plastic Waste

In view of the Table 4.33 below, the inquiry with respect to consideration factors were totally replied with 74 respondents. No inquiry was left unanswered. The 5 Likert scale were change to 3 Likert scale where the quantity of respondent of firmly Strongly Agree and Agree are combined and characterized as Agree, Strongly Disagree and Disagree are combined and characterized as Disagree, and neither Disagree nor Agree continue as before as shown in Table 4.34 below

Table 4. 33 : Frequency statistic for overall consideration factors that encourage for collecting and recycling the plastic waste

Overall Consideration Factor Statistic							
		Large Quantity	High Demand	Profitable	Technology Readiness	Cleanliness	Sorted Waste
N	Valid	74	74	74	74	74	74
	Missing	0	0	0	0	0	0

Table 4. 34 : Scale to analyse Likert scale

Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree
1	2	3	4	5
Disagree		Neither Disagree nor Agree	Agree	

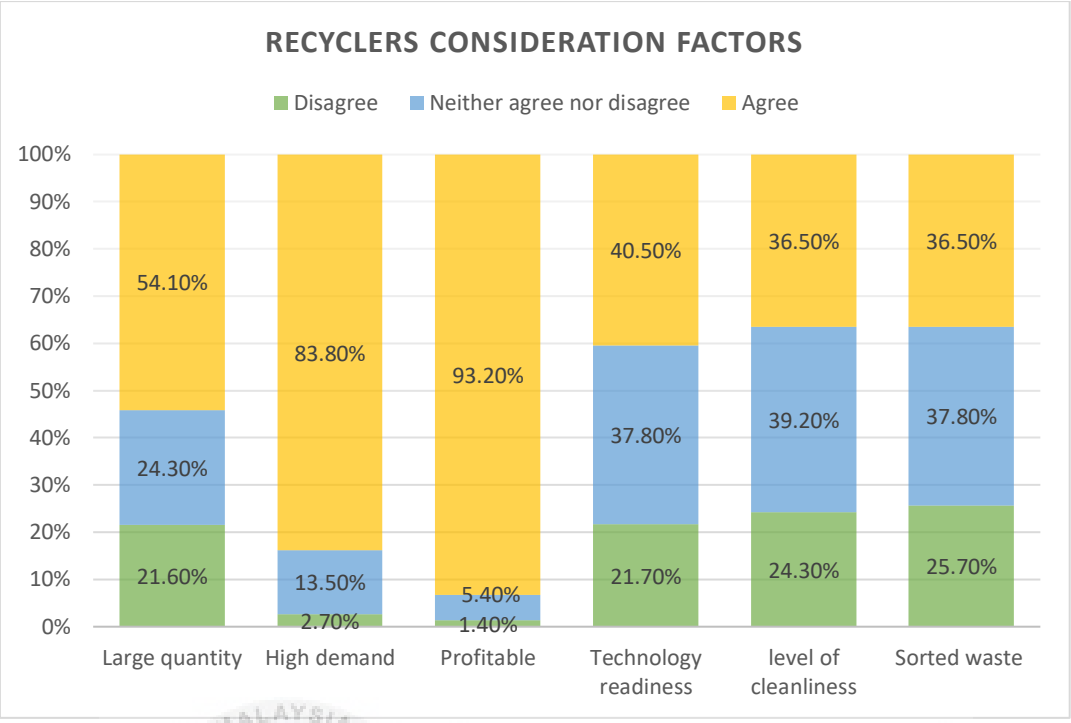

Figure 4. 9 : Recyclers overall consideration factors

The graph in figure 4.9 presents the results of the survey on recyclers consideration factors when accepting or trading waste. The consideration factors include large quantity, high demand, profitable, technology readiness, level of cleanliness and sorted waste. Based on the graph, most voted factors were profitable with 93.20%, followed by the high demand with 83.80%, large quantity with 54.10%, technology readiness with 40.50%, and both level of cleanliness and sorted waste obtained 36.50%. More details explanation on each category were explained under its own subcategory.

4.3.5.1 Consideration Factor In Accepting Or Trading The Waste: Profitability

The graph presents the results of the survey on recyclers concern when collecting and recycling the waste. The bar chart illustrate in the Figure 4.9 shows that the profitable obtained the highest percentage with 93.2 % recyclers agrees that the profitable is their main consideration when accepting the waste. The remaining were vote for disagree and neither disagree nor agree with the percentage of 1.4% and 5.4% as shown in the Table 4.35 below. In simpler word, majority of the recyclers are accepting any of the waste form regardless of their materials as long they obtain a profit in return.

Table 4. 35 : Statistic frequency of profitability

Profitability					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.4	1.4	1.4
	Neither Disagree nor Agree	4	5.4	5.4	6.8
	Agree	69	93.2	93.2	100.0
	Total	74	100.0	100.0	

MPMA (2019) highlighted that approximately 1.49 million tonnes of recycled resins are produced annually; this is worth RM4.49 billion in revenue. The export of recycled plastic is projected to be approximately 70% of Malaysia's Gross Domestic Product (GDP), in turn driving Malaysia's economic growth. Brooks (2020) foresees global growth in recycled plastics, with PET leading the way and also with HDPE and PP showing strong growth. Plastic demand is expected to grow globally as recycled materials are now meeting 8% of overall plastic demand. Malaysia most common method in handling plastic waste is by mechanical recycling where KRI (2019) highlighted that Malaysia are capable of recycling 3 out 7 plastic waste categories, mainly PET,HDPE and PP. Thus, with Malaysia capability to process 3 most demanded category, it surely could boost the economy. Based on the findings, most of the recyclers that have been visited, accept plastic waste, thus it explains on highest voted.

4.3.5.2 Consideration Factor In Accepting Or Trading The Waste: High Demand

The second highest percentage with 83.8 % recyclers agrees that high demand is as well their priorities in accepting the waste. For instance, most of the recyclers we visited collect the general waste such as plastic, paper, metal, electric and electronic appliances. Nevertheless, we can clearly see that most of the recyclers are not accepting glass due to the fact that glass has less demand from the market industry, thus the recycler mostly will reject this type of waste to prevent any losses and curb the increment of non-profit waste in the premise. The remaining were vote for disagree and neither disagree nor agree with the percentage of 2.7% and 13.5% as shown in the Table 4.36 below.

Table 4. 36 : Statistic frequency of high demand

High Demand					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	2.7	2.7	2.7
	Neither Disagree nor Agree	10	13.5	13.5	16.2
	Agree	62	83.8	83.8	100.0
	Total	74	100.0	100.0	

In focusing on plastic waste, MPMA (2019) highlighted that the plastics recycling industry finances over RM30.99 billion in local supply linkages to major manufacturing sectors like the electrical and electronics and automotive industries. The global plastic market size was USD 450.88 billion in 2019 and is projected to reach USD 579.19 billion by 2027, exhibiting a Compound Annual Growth Rate (CAGR) of 4.2% during the forecasted period.

4.3.5.3 Consideration Factor In Accepting Or Trading The Waste: Large Quantity

The third highest percentage with 54.05 % recyclers agrees that the large quantity is as well their priorities in accepting the waste. Most of the recyclers would appreciate if the waste received is in large quantity, but if the waste received in a smaller quantity, they will still accept. The remaining were vote for disagree and neither disagree nor agree with the percentage of 21.6% and 24.3% as shown in the Table 4.37 below.

Table 4. 37 : Statistic frequency of large quantity

Large Quantity					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	16	21.6	21.6	21.6
	Neither Disagree nor Agree	18	24.3	24.3	45.9
	Agree	40	54.1	54.1	100.0
	Total	74	100.0	100.0	

MPMA (2019) estimate the overall value of plastics products to be approximately RM320 billion annually. The electronics and electrical industry contribute RM290 billion, automotive industry contributes RM25 billion and Food and Beverages (F&B) contributes RM3 billion of the overall value of end-products containing plastics. Thus, it shows on the reasons why the recyclers voted high demand on recycled waste. Therefore, the large quantity of waste is preferred by the recyclers in order to address the following demands.

4.3.5.4 Consideration Factor in accepting or trading the waste: Technology Readiness

The fourth highest percentage with 40.54% recyclers agrees that the technology readiness is their priorities in accepting the waste. Based on the findings, the technology readiness is less important factors in Malaysia as the recyclers were found comfortable with the current process in their premise. This is due to the more process used in the premise will causes more declaration need to be updated in the license that lead to more fees to be paid. Hence, they are comfortable with the current process that involves the physical processes such as sorting, dismantling and metal extraction. The remaining were vote for disagree and neither disagree nor agree with the percentage of 21.7% and 37.8% as shown in the Table 4.38 below.

Table 4. 38 : Statistic frequency of Technology Readiness

Technology readiness					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	16	21.7	21.7	21.7
	Neither Disagree nor Agree	28	37.8	37.8	59.5
	Agree	30	40.5	40.5	100.0
	Total	74	100.0	100.0	

MPMA (2019) highlighted that plastic are an essential asset that can be turned into a new feedstock or an energy source. The plastic recycling industry in Malaysia currently uses mechanical recycling for processing resin pellets. Though, higher-value recycled feedstock can as well be generated with better technology investment that could potentially increase their contributions to the Malaysian economy.

4.3.5.5 Consideration Factor in accepting or trading the waste: Level of Cleanliness, and Sorted Waste

The Table 4.39 and Table 4.40 demonstrate percentage of respondents in the consideration factor of level of cleanliness and sorted waste. Most of the recyclers voted Neither Disagree nor Agree in level of cleanliness with 39.2%, followed by Agree with 36.5% and Disagree 24.3% for level of cleanliness in their consideration factors. Most of the recyclers voted Neither Disagree nor Agree in sorted waste with 37.8%, followed by Agree with 36.5% and Disagree 25.7%. Both of the level of cleanliness and sorted waste is considered as least important factors due to the recyclers are not putting high expectation on the end-consumer to sort out or clean their waste before sending to them.

Table 4. 39 : Statistic frequency of cleanliness

Level of Cleanliness					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	18	24.3	24.3	24.3
	Neither Disagree nor Agree	29	39.2	39.2	63.5
	Agree	27	36.5	36.5	100.0
	Total	74	100.0	100.0	

Table 4. 40 : Statistic frequency of sorted waste

Sorted Waste					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	19	25.7	25.7	25.7
	Neither Disagree nor Agree	28	37.8	37.8	63.5
	Agree	27	36.5	36.5	100.0
	Total	74	100.0	100.0	

However, in view of plastic waste that mix along with the solid waste, MPMA (2019) highlighted that the separation of recyclables at source and the social behaviour of going through the steps to recycle are problems that lead to low recovery rates. This, in essence, affects the aggregation and further separation of clean sources of recyclables, including plastics, by non-existent Material Recovery Facilities (MRFs). The consistency of quality and contamination of recyclables with dirt, food and a wide range of other materials is a related concern. Collected and sorted recyclables, which are soiled, do not meet the recycling grade and are instead sent to landfills for disposal. Hence, it can be conclude that the plastic waste shall be segregated and must not mixed along with other solid waste to retain their recovery rate and quality.

4.3.6 Current Challenges Faced By The Recycling Industry

In view of the Table 4.41 below, the inquiry with respect to consideration factors were totally replied. No inquiry was left unanswered. The 5 Likert scale were change to 3 Likert scale where the quantity of respondent of firmly Strongly Agree and Agree are combined and characterized as Agree, Strongly Disagree and Disagree are combined and characterized as Disagree, and neither Disagree nor Agree continue as before as shown in Table 4.42 below.

Table 4. 41 : Frequency statistic for current challenges faced by recyclers to sustain in the industry

Factors: Current Challenges								
		Government policy	Taxes or Fees	Complaint from Neighborhood	Insufficient Supply	Difficult to identify stolen item	Expensive technology	Capital
N	Valid	74	74	74	74	74	74	74
	Missing	0	0	0	0	0	0	0

Table 4. 42 : Scale to analyse likert scale

Strongly Disagree	**Disagree**	**Neither Disagree nor Agree**	**Agree**	**Strongly Agree**
1	2	3	4	5
Disagree		Neither Disagree nor Agree	Agree	

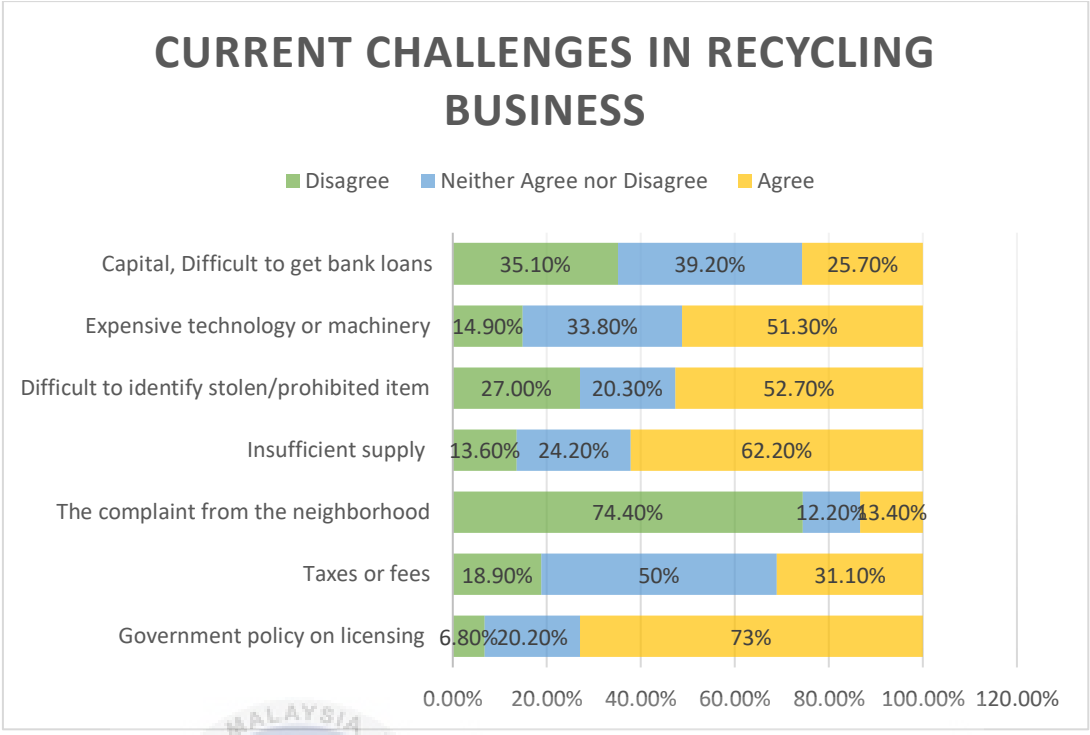

Figure 4. 10 : Current challenges in recycling business

The graph in figure 4.10 presents the results of the survey on recyclers current challenges. The current challenges include government policy and licensing, taxes or fees, the complaint from neighborhood, insufficient supply, difficulties in identifying stolen item, expensive machinery and technology, and capital. Based on the Figure 4.10, most voted factors were government policy and licensing with 73%, followed by the insufficient supply with 62.2%, difficult to identify stolen item with 52.7%, expensive technology and machinery with 51.3%, taxes or fees with 31.10%, capital with 25.70% and complaint from neighborhood with 13.4%. More details explanation on each category were explained under its own subcategory.

4.3.6.1 Current Challenges To Sustain In The Recycling Business: Government Policy And Licensing

The graph presents the results of the survey on current challenges that faced by recyclers in sustain in the industry. The bar chart illustrate in the figure 4.10 shows that the government policy in licensing obtained the highest percentage with 73% recyclers agrees that licensing is their main challenges to sustain in the industry. The remaining were vote for disagree and neither disagree nor agree with the percentage of 6.8% and 20.2% as shown in the Table 4.43 below. The recyclers mainly need a license before they can start operating. The license is from the local authority; Police is for the business operation and Majlis Bandaran is for premise.

Table 4. 43 : Statistic frequency of Government policy in licensing

Government policy in licensing					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	6.8	6.8	6.8
	Neither Disagree nor Agree	15	20.2	20.2	27.0
	Agree	54	73	73	100.0
	Total	74	100.0	100.0	

Plastics recycling industry plays a crucial role in any country's waste management system. Recycling decreases the volume of waste that would otherwise be buried in landfills. MPMA (2019) highlighted Malaysia needed to go hi-tech to support a profitable plastics recycling industry in which policies and practises are needed to support sustainable recycling industries. Stricter policy in licensing is to curb the growth of the informal sector rising in Malaysia, for instance, 60 percent of illegal plastic factories near Port Klang are forced to shut down (Chan, 2019). Malaysia have been a second hub for plastic waste as the China has stop on import HS code 3915 plastic waste activities from developed countries. With stricter policies, the growth of illegal plastic recyclers can be curbed as their recycling activities have not been monitored by local authorities, unlike licenced plastic recyclers. It therefore concludes that, in order to be a sustainable country,

a stricter policy needs to be adopted, suggesting that more protocols and standards need to be followed. Hence, it explains on why the higher voters on licencing.

4.3.6.2 Current Challenges To Sustain In The Recycling Business: Insufficient Supply

The second highest percentage with 62.2% recyclers agrees that insufficient supply is their main challenges to sustain in the industry. The remaining were vote for disagree and neither disagree nor agree with the percentage of 13.6% and 24.2% as shown in the Table 4.44 below.

Table 4. 44 : Statistic frequency of Insufficient Supply

Insufficient Supply					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	10	13.6	13.6	13.6
	Neither Disagree nor Agree	18	24.2	24.2	37.8
	Agree	46	62.2	62.2	100.0
	Total	74	100.0	100.0	

As the global epidemic of COVID-19 grows on a regular basis, companies are struggling to continue serving their consumers and communities around the world. COVID-19 has been a great challenge for the industries that are dependent profoundly on in-person interaction such as industrial services (Guzman, 2020). The recycling industry is categorized as industrial service that has faced challenges in obtaining supplies, especially during the Movement Control Order (MCO), where the case is currently on the rise. In order to effectively control the current situation of COVID-19, the Malaysian Government has introduced different levels of MCO in areas with COVID-19 cases, depending on the number of active cases in the region. The Movement Control Order is imposed under the Prevention and Control of Infectious Diseases Act 1988 and well as the Police Act 1967, which cover a range of activities (NST, 2020a). Our prime minister,

Tan Sri Muhyiddin Yassin has announced the closure of most the business except essential services to curb the virus from spreading (NST, 2020a). During the MCO, most recyclers are found to suspend their operations and only resume when the government requires them to do so. Not just the recycler, but even the public should not be seen walking around or be in a crowded area. Hence, it explains why the recyclers agrees that they are inadequate supply of waste in the moment.

4.3.6.3 Current Challenges To Sustain In The Recycling Business: Difficulties To Identify Stolen Items

The third highest percentage with 52.7% recyclers agrees that they are difficult to identify the stolen item during trading process. The remaining were vote for disagree and neither disagree nor agree with the percentage of 27% and 20.3% as shown in the Table 4.45 below.

Table 4. 45 :Statistic frequency of difficult to identify stolen items

Difficult to identify stolen items					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	20	27.0	27.0	27.0
	Neither Disagree nor Agree	15	20.3	20.3	47.3
	Agree	39	52.7	52.7	100.0
	Total	74	100.0	100.0	

Harakah (2018) highlighted that the recycling centre was a place to sell stolen goods. There are a range of records of theft incidents involving iron goods such as drain covers, fence posts and roadblocks. The recycling centre must also be more vigilant for not purchasing items suspected of being stolen and report to the police immediately if a suspicious transaction is attempted. Nevertheless, plastic waste is not tarnished with the issue due to plastic are available anywhere, often considered not useful and are thrown in the environment. Thus, the volunteers of collecting plastic waste is considered as the saviour in keeping the environment clean. In Malaysia, there is a group, namely Trash Hero volunteered to collect plastic waste, and until 2019 Trash Hero Malaysia organized

750 clean-ups, resulting in 111,029 KG of trash removed from beaches, community parks, and city centres (Chung, 2019).

4.3.6.4 Current Challenges To Sustain In The Recycling Business: Expensive Machinery And Technology

The fourth highest percentage with 51.3% recyclers agrees that expensive technology and machinery were their challenges to sustain in the industry. The remaining were vote for disagree and neither disagree nor agree with the percentage of 14.9% and 33.8% as shown in the Table 4.46 below. Based on the findings, most of the common method to recycle plastic is through mechanical recycling. Local recycling industry were often concentrating on recycling easy retrieve plastic from PET, HDPE and PP (KRI, 2019).

Table 4. 46 : Statistic frequency on Expensive Machinery and Technology

Expensive Machinery and Technology					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	11	14.9	14.9	14.9
	Neither Disagree nor Agree	25	33.8	33.8	48.6
	Agree	38	51.3	51.3	100.0
	Total	74	100.0	100.0	

MPMA (2019) highlighted that Malaysia is now preparing to take a further step towards sustainability and the implementation of a circular economy. Without improved recycling technologies, Malaysia's recycling system remains ad hoc and scattered, and will be hard to handle in the long term where Malaysia will eventually find itself with the same situation as countries that exported their plastic waste, which would eventually happen. Malaysia must provide the right economic incentives and promote an effective and productive waste management system that is the core of the circular economy.

With better technology, progressive policies and investment frameworks, a higher value of recycled feedstock and better opportunities can be developed. Plastics are valuable resources that can be transformed into new feedstock or into energy instead of being buried in landfills. To advance up the value chain, it is not just the plastics recyclers who need to upgrade their equipment and technology to produce higher value recycled feedstock. Malaysia as a country must encourage higher quality investments in the recycling of all materials, from plastics to construction waste.

4.3.6.5 Current Challenges To Sustain In The Recycling Business: Taxes Or Fees

The Table 4.47 below demonstrate percentage of current challenges of Taxes or Fees. Most of the recyclers voted Neither Disagree nor Agree in Taxes or Fees with 50%, followed by Agree with 31.1% and Disagree with 18.9%. Based on the findings, the taxes or fees are were not their main challenges to sustain in the recycling business.

Table 4. 47 : Statistic frequency of Taxes or Fees

Taxes or Fees					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	14	18.9	18.9	18.9
	Neither Disagree nor Agree	37	50.0	50.0	68.9
	Agree	23	31.1	31.1	100.0
	Total	74	100.0	100.0	

Most recyclers have to pay taxes like other business sectors, including income tax, land tax, etc. The implementation of the goods and services tax (GST) in Malaysia on 1 April 2015 was part of the Malaysian government's taxation reforms to improve the collection of revenue and reduce the country's budget deficit. Santhariah et al. (2018) highlighted that whilst larger businesses confirmed that they were well prepared for GST, smaller companies experienced tremendous stress in their preparation.

4.3.6.6 Current Challenges To Sustain In The Recycling Business: Capital

The Table 4.48 below demonstrate percentage of current challenges of Capital Investment. Most of the recyclers voted Neither Disagree nor Agree in Taxes or Fees with 39.2%, followed by Agree with 25.7% and Disagree with 35.1%. The findings show that proper documentation is needed to ease the process of loan banks. Hence, having a good system will encounter difficulty getting a loan bank for the recyclers that are illegal or not.

Table 4. 48 :Statistic frequency of capital

Capital					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	26	35.1	35.1	35.1
	Neither Disagree nor Agree	29	39.2	39.2	74.3
	Agree	19	25.7	25.7	100.0
	Total	74	100.0	100.0	

4.3.6.7 Current Challenges to Sustain in the Recycling Business: Complaint from Neighborhood

Table 4.49 below demonstrate highest percentage disagree on the complaint from neighbourhood. Most of the recyclers voted disagree with 74.4%, followed by Agree 13.4% and Neither Disagree nor Agree 12.2%. The complaint from neighbourhood factor were not a recyclers challenges as most of the recycler's premise is on the industrial area and business lot who had the permission from the authority. Hence, it rarely seen the recycling business on the housing area.

Table 4. 49 :Statistic frequency of Complaint from neighbourhood

Complaint from neighborhood					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	55	74.4	74.4	74.4
	Neither Disagree nor Agree	9	12.2	12.2	86.5
	Agree	10	13.4	13.4	100.0
	Total	74	100.0	100.0	

4.3.7 Drivers to Sustain in the Recycling Business

In view of the Table 4.50 below, the inquiry with respect to consideration factors were totally replied. No inquiry was left unanswered. The 5 Likert scale were change to 3 Likert scale where the quantity of respondent of firmly Strongly Agree and Agree are combined and characterized as Agree, Strongly Disagree and Disagree are combined and characterized as Disagree, and neither Disagree nor Agree continue as before as shown in Table 4.51 below.

Table 4. 50 :Frequency statistic for recyclers driver to sustain in the industry

Factors: Drivers to Sustain in the Recycling Business									
		Wide Collaboration	Consumer Awareness	Legislation	Demand for recycled material	Government Funding	Standardized Market value	Guaranteed volume supply	Material Scarcity
N	Valid	74	74	74	74	74	74	74	74
	Missing	0	0	0	0	0	0	0	0

Table 4. 51 :Scale to analyse likert scale

Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree
1	2	3	4	5
Disagree		Neither Disagree nor Agree	Agree	

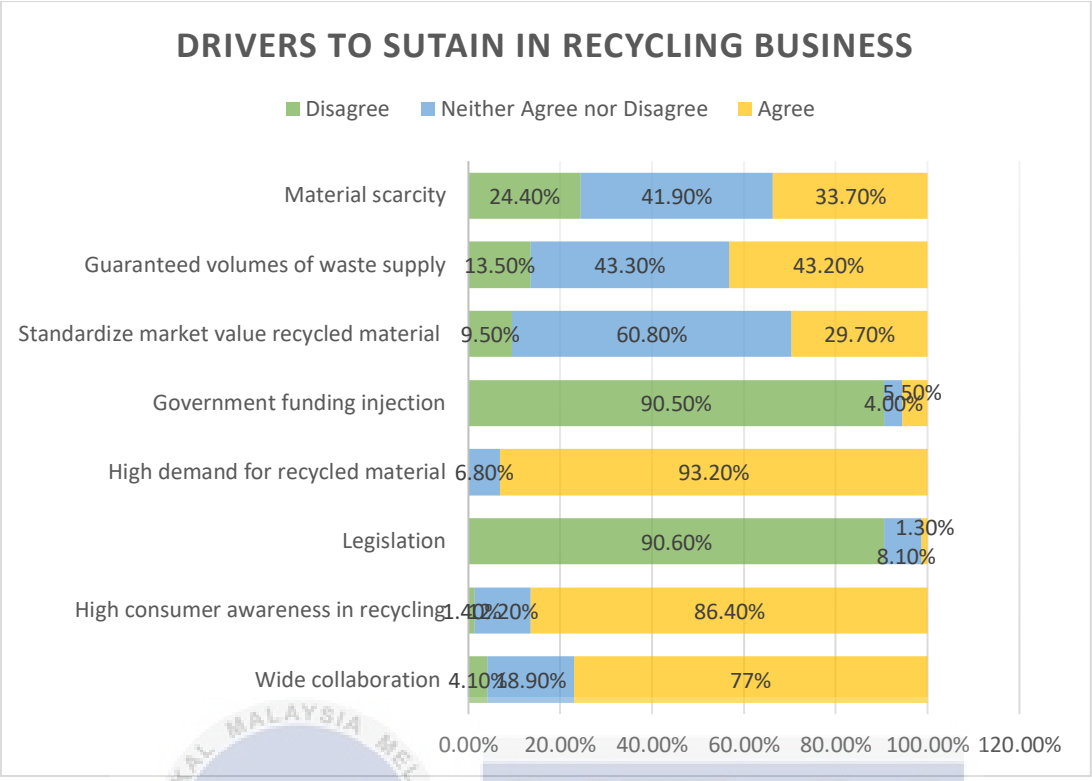

Figure 4. 11 : Drivers to sustain in recycling business

The graph presents the results of the survey on drivers to sustain in the recycling business. Numbers of drivers has been listed as in the Figure 4.11. The drivers include wide collaboration, high consumer awareness, legislation, high demand for recycled material, government funding injection, standardized market value, the guaranteed volume of waste supply and material scarcity. Based on the graph, most voted drivers were high demand for recycled material with 93.2%, followed by high consumer awareness with 86.40%, wide collaboration with 77%, guaranteed volume of waste supply with 43.2%, material scarcity with 33.7%, standardized market value with 29.7%, government funding injection with 5.5%, and legislation with 1.3%. More details explanation on each category were explained under its own subcategory.

4.3.7.1 Drivers To Sustain In The Recycling Business: High Demand For Recycled Materials

The graph in figure 4.11 presents the results of the survey on drivers that keep recyclers to sustain in the industry. The bar chart illustrates in the figure 4.11 shows that the highest percentage with 93.2% recyclers agrees that high demand for recycled materials is their main Drivers to Sustain in the Recycling Business. The remaining were vote for neither disagree nor agree with the percentage of 6.8%, as shown in ta**bl**e 4.52 below.

Table 4. 52 : Statistic frequency of High demand for recycled material

High Demand for recycled material					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neither Disagree nor Agree	5	6.8	6.8	6.8
	Agree	69	93.2	93.2	100
	Total	74	100.0	100.0	

Wahab et al. (2007), 80% of local manufacturing companies used recycled plastic in their production and heavily depended on local recycling companies' supplies. These companies carry out in-house recycling due to cost savings. MPMA (2019) estimates that the plastics recycling industry supports the RM31 billion local plastics industry, which is a crucial supply chain for the local electrical and electronics and automotive industries. The electrical and electronic sector uses 39% of plastic, followed by automotive 26% , domestic 19% and packaging 10% (Wahab et al., 2007). Some companies do not use recycled materials at all due to the need for a high-precision product as defined by customers. The rest uses more than 50 per cent of mixed recycled materials for local production, which do not demand significant quality or precision (Wahab et al., 2007). Hence, it can be concluded why most of the recyclers agree that recycled materials are on demand.

4.3.7.2 Drivers to Sustain in the Recycling Business: High Consumer Awareness

The Second highest percentage with 86.4% recyclers agrees that high consumer awareness is their main Drivers to Sustain in the Recycling Business. The remaining were vote for disagree and neither disagree nor agree with the percentage of 1.4% and 12.2% as shown in table 4.53 below.

Table 4. 53 : Statistic frequency of High Consumer Awareness

Drivers: High Consumer Awareness					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	1.4	1.4	1.4
	Neither Disagree nor Agree	9	12.2	12.2	13.6
	Agree	64	86.4	86.4	100.0
	Total	74	100.0	100.0	

Plastic pollution is known to be one of the world's most serious issues. Huge quantities of plastic are induced by consumerism (Rhein and Schmid, 2020). Nevertheless, as time goes by, consumers are becoming mindful of the risks of plastic use. In Malaysia, the recycling rate is about 30% which shows the increment from the previous years. The total collection of recycled items in May 2020 was 307.63 tonnes compared to 163.15 tonnes during the corresponding month in 2019 (TheStar, 2020). It demonstrates that people are more enlightened on the risk of plastic, which affects the environment and themselves as well. Higher consumer awareness drives improved profitability as the consumer get paid in cash for any waste they sell. Recycling was one way to develop a circular economy, plus it enables the reduction of the amount of plastic that we generate domestically (Ibrahim, 2020).

4.3.7.3 Drivers To Sustain In The Recycling Business: Wide Collaboration

The third-highest percentage with 77% recyclers agrees that wide collaboration is their main Drivers to Sustain in the Recycling Business. The remaining were vote for disagree, and neither disagree nor agree with the percentage of 4.1% and 18.9% as shown in table 4.54 below.

Table 4. 54 : Statistic frequency of Wide Collaboration

Drivers: Wide Collaboration					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	4.1	4.1	4.1
	Neither Disagree nor Agree	14	18.9	18.9	23.0
	Agree	57	77	77	100.0
	Total	74	100.0	100.0	

Brown (2018) highlighted that plastics problem is a collective challenge that could not be addressed by one organisation alone. Hence, broad collaboration is needed to ensure materials flow in circularity. However, Malaysia is a global player in the plastic industry with currently about 1,300 plastic manufacturers. As of 2016, our exports amounted to RM30 billion, which saw a 2.26 million metric tonnes of resin utilised to produce plastics. MPMA (2019) highlighted that Malaysia is in desperate need of broader cooperation, as the management of plastic flow from the cradle to the grave is a multi-stakeholder endeavour. Although most recyclers agree wide collaboration was their main drivers to sustain in the recycling business, wider collaboration from current situation is needed to ensure the plastic is managed in a sustainable manner throughout its lifecycle. This effort is to reduce environmental impacts and promote renewable energy resources in order to reduce the rate of climate change. This initiative aims to reduce the environmental effects and encourage renewable energy

4.3.7.4 Drivers to Sustain in the Recycling Business: Guaranteed Volumes of Waste Supply

The highest percentage with 43.3% recyclers is neutral that guaranteed waste volumes are their less important Drivers to Sustain in the Recycling Business. The remaining were vote for agree and disagree with the percentage of 43.2% and 13.5% as shown in table 4.55 below. The findings show that the number of wastes received was unpredictable in which someday may be more or less. This, however, varies they got a tender from either government, universities, offices or manufacturers. In days of not receiving any waste, they will continue sorting or dismantling the current waste exist in the premise.

Table 4. 55 : Statistic frequency of Guaranteed volumes of supply

Drivers: Guaranteed volumes of supply					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	10	13.5	13.5	13.5
	Neither Disagree nor Agree	33	43.3	43.3	56.8
	Agree	31	43.2	43.2	100.0
	Total	74	100.0	100.0	

In cases of plastic waste, Malaysia is reported to be the biggest plastic consumers. NST (2020b) highlighted that Malaysians have been one of the main users of plastic packaging that involves a single-use plastic. The rapid economic growth in Malaysia has led to a dramatic increase in plastics, particularly for the packaging of consumer goods. The manufacture of plastic has surpassed that of almost any other material due to its flexibility and compatibility. Many of these plastics are constructed to be disposed of when used just once (single-use) resulting in single-use disposable plastic waste generation. Therefore, Malaysia has been ranked in the 8th country who mismanaged the plastic waste in which MESTECC (2018) estimated Malaysia had produced 0.94 millions tons of mismanaged plastic waste. Thus, to curb the widespread use of single-use plastic, the government need to be more stricter on single-use plastic policy or provide more alternative by partnering with recycling business creating a closed-loop supply chain.

Brooks, (2020) highlighted that recycled plastic will take around 8% of virgin polymer in 2020, showing an increase from 7% in the previous year.

4.3.7.5 Drivers to Sustain in the Recycling Business: Standardized Market Value

The highest percentage with 60.8% recyclers is neutral that standardized market value is their less important Drivers to Sustain in the Recycling Business. The remaining were vote for agree and disagree with the percentage of 29.7% and 9.5% as shown in table 4.56 below. Based on the findings, there is an absence of market standardization for the recycled material in Malaysia.

Table 4. 56 : Statistic frequency of Standardized Market Value

Drivers: Standardized Market Value					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	7	9.5	9.5	9.5
	Neither Disagree nor Agree	45	60.8	60.8	70.3
	Agree	22	29.7	29.7	100.0
	Total	74	100.0	100.0	

The upper traders are the one who determines the market value, and the price was intolerance of 20 cents between the upper traders. The absence of the price-control is absurd as the small trader tend to get bullied when the upper traders can set their buy price. The price-control are government-mandated legal minimum or maximum prices set for specified goods. The law on price regulation and anti-profit making was passed by the Malaysian Parliament in 2011, allowing the federal government to control the goods' price rate. This act was due to expire on 31 December 2016. however, the government has, revived price regulation and anti-profit making Act 2017 without sunset clause (Shams, 2017). Price controls that set maximum prices are price ceilings, while price controls that set minimum prices are price floors. The purpose of the price control is to set the boundary between the traders so that the supply and demand for the recycled material could be circulated in the right manner.

4.3.7.6 Drivers To Sustain In The Recycling Business: Material Scarcity

The highest percentage with 41.9% recyclers is neutral that material scarcity is their less important Drivers to Sustain in the Recycling Business. The remaining were vote for agree and disagree with the percentage of 33.7% and 24.4% as shown in Table 4.57 below. The material scarcity was the least important driver due to the research was focusing on recycler's perspectives.

Table 4. 57 : Statistic frequency of Material Scarcity

Drivers: Material Scarcity					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	18	24.4	24.4	24.4
	Neither Disagree nor Agree	31	41.9	41.9	66.3
	Agree	25	33.7	33.7	100.0
	Total	74	100.0	100.0	

However, the result may vary if the research is focusing on end-consumer. The material shortage is the lack of metal and mineral resources predicted in the coming decades. With a rising global population that is also becoming more industrialized, the demand for goods is increasing. Hence, the closed loop supply chain needs to be enforced to curb the excessive use of raw natural resources that need to be preserved for future generations. The economic development and industrial revolution have led to an improved standard of life; however, it has resulted in more natural resources being depleted, which placed pressure on Earth's life support system. (Hák et al., 2016; Mensah, 2019) stressed that adopting a sustainable development approach is necessary to ensure that the supply of natural resources and population growth is adequate. Thus, the calls for other alternatives. The economic model, also known as the Circular Economic, is a pragmatic response to the emerging global resource crisis where this model has been an incentive to overcome the constraint of a linear economy by addressing economic growth, environment conservation, and social well-being.

In the circular economy, the products' life cycle circulates in holding the services in operation for as long as possible, extracting the full benefit while in use, recycling and regenerating the products and materials at the end of each service period. According to Jawahir and Bradley (2016b), CE strategies are efficient in increasing resource efficiency and eliminating the waste of useful resources in the products that are normally disposed of in the landfill.

4.3.7.7 Drivers to Sustain in the Recycling Business: Legislation

The highest percentage with 90.5% recyclers is disagreed that government funding is their main Drivers to Sustain in the Recycling Business. The remaining were vote for Neither Disagree nor Agree and Agree with the percentage of 4% and 5.5% as shown in Table 4.58 below. Based on the findings, legislation is absent in enforcing the growth of recycling business. Towards the transition of the circular economy, the recycling business's growth is important as this transition is a multi-stakeholder endeavour. However, the circular economy practices may need legislation to hold the waste generation and energy usage within reasonable limits.

Table 4. 58 : Statistic frequency of Legislation

Drivers: Legislation					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	67	90.6	90.6	90.6
	Neither Disagree nor Agree	6	8.1	8.1	98.7
	Agree	1	1.3	1.3	100.0
	Total	74	100.0	100.0	

Mohamed (2010) highlighted that key drivers and factors for setting and maintaining standards in the waste recycling industry are important. Involved parties and institutional support are needed. Standards should be established in line with technological advances, requiring human resources for a number of important activities, particularly for enforcement and technology growth, in order to improve standards. The technology advancement should be revised to ensure that quality standards are not

affected by a lack of standards. Compliance with standards must be endorsed not only by the government, but also by industry. The involvement of the industry helps to ensure trade and market suitability in applying the standards.

4.3.7.8 Drivers To Sustain In The Recycling Business: Government Funding Injection

The highest percentage with 90.5% recyclers is disagree that government funding is their main Drivers to Sustain in the Recycling Business. The remaining were vote for Neither Disagree nor Agree and Agree with the percentage of 4% and 5.5% as shown in the Table 4.59 below. Based on the findings, the recycling industry were not getting any incentive from the government.

Table 4. 59 : Statistic frequency of Government Funding Injection

Drivers: Government Funding Injection					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	67	90.5	90.5	90.5
	Neither Disagree nor Agree	3	4.0	4.0	94.5
	Agree	4	5.5	5.5	100.0
	Total	74	100.0	100.0	

Mohamed (2010) highlighted that financing and insurance scheme should be established, along with adequate standards, to incentivise compliance by industry and company. Those influences or considerations must be incorporated to assure that standards for the waste recycling industry are ready to accommodate demand for recycled materials for industry in many parts of the world.

Objectives 2 : Developing Local-Recycling Supply Chain Framework In Managing Plastic Waste In Malaysia

4.3.8 : Local-Recycling Supply Chain Framework In Managing Plastic Waste In Malaysia

The disposal of plastic waste is an environmental concern as plastic polymers in consumer goods, and packaging has increased dramatically (Clunies-ross, 2019). Therefore, the government needs to keep the plastic in the circular economy in various ways to reduce plastic pollutants on the environment. As shown in figure 4.12, plastic waste input is recognized from the household, industrial and commercial sector. Plastic waste generated by them will be collected by the formal and informal waste management sector in Malaysia. The first step in the recycling process is always collecting the plastic material that is to be recycled. This step is entirely up to the waste generator to dispose of its plastic waste properly at the correct place. If the plastic waste is disposed of in the existing trash bins, it will not be recycled, so it is crucial to separate common waste and plastic waste. The separated plastic waste from the sources can be sold to the informal sector for profitability. Next, the informal collector will trade the plastic to the government's material recovery facilities to recycle plastic waste. At these facilities, plastic waste will undergo a dismantling process to separate them into their categories as most of the plastic also is being used by an electric and electrical appliance (European Environment Agency, 2019).

Second, the pre-sorting process of plastic waste to clarify whether it can be recycled or not. If the plastic can be recycled, it will be sorted in a few common ways, such as the type of plastic, colour of the plastic, and the plastic's thickness followed by the washing process. Washing the sorted plastic waste is to eliminates impurities, and others that are not made by the plastic as most plastic containers and packages have their label and sticker, adhesive, oil or even food residue that must be removed as the third process in the facilities. Forth, resizing the plastic waste. Resizing consists of shredding or granulating the plastic waste into small particles with the help of a machine. The plastic is cut into small flakes and melted at high temperature to be molded, pelletized and packed in amounts according to market requirement. As a result, recycled plastic is sold to the

local manufacturer and exported to ensure that the plastic is converted into a fresh product as required by the consumer. Lastly, plastic is not recycled by the facilities will be discarded in the landfill or incinerated as final disposal and turned into energy.

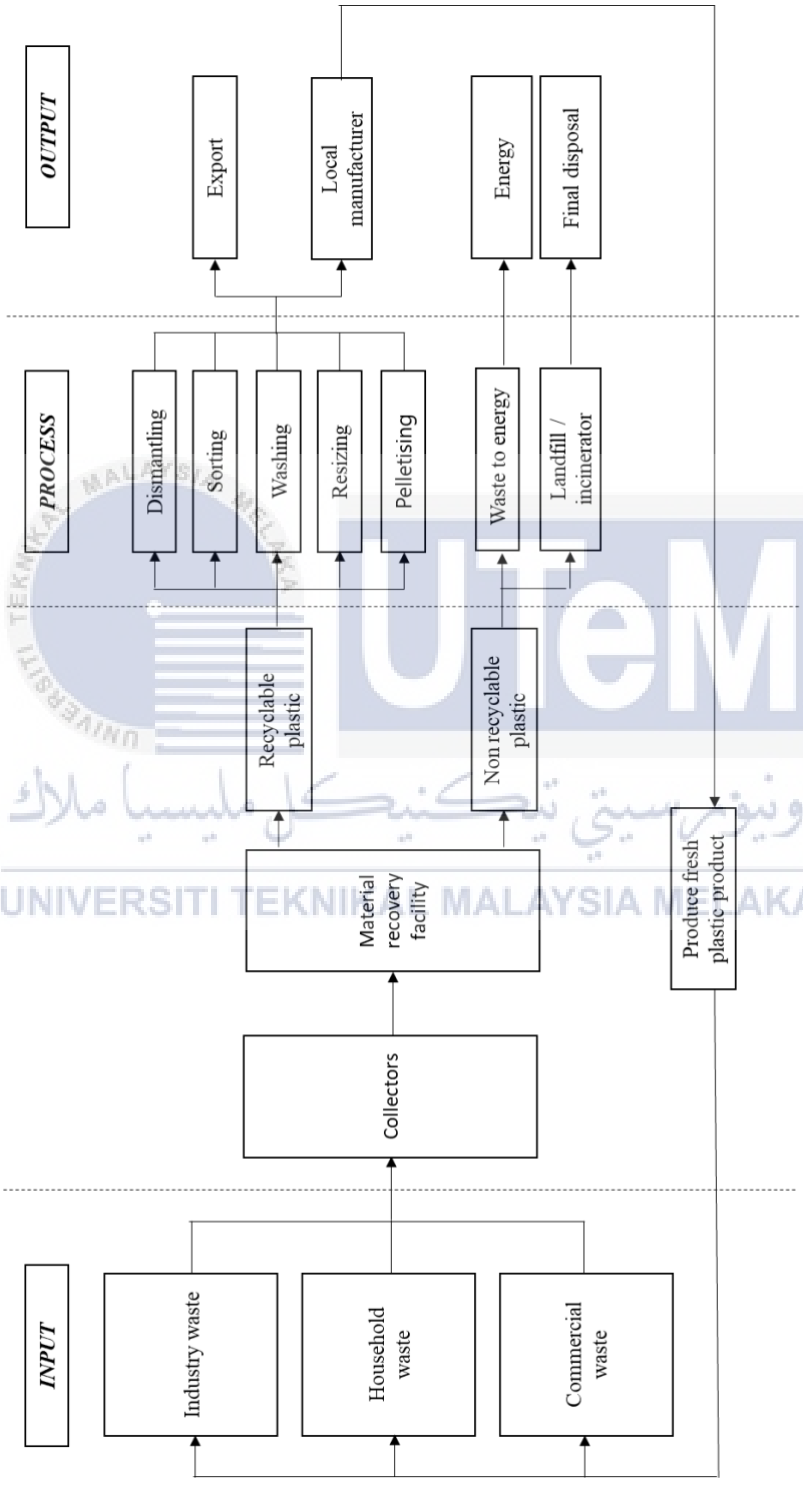

Figure 4. 12 : Local-Recycling Supply Chain Framework In Managing Plastic Waste In Malaysia

4.3.8.1 Framework review by authority

The framework has been reviewed with the Department Of Environment of Malaysia's officer known as Puan Hasnita Binti Mansor, environmental control officer (C44) to ensure the finding's framework is parallel to the current framework managing plastic waste in Malaysia. The recyclers who process the plastic waste into new resources shall have license and must be recycled and recovered in prescribed or licenced premises and carried out in an environmentally sound manner. Therefore, the constructed framework is intended to demonstrate the current local-recycling supply chain framework in managing plastic waste in Malaysia.

Objective 3: Responsible Identities In Plastic Waste Ownership In Malaysia

4.3.9 Responsible Identities In Plastic Waste Ownership

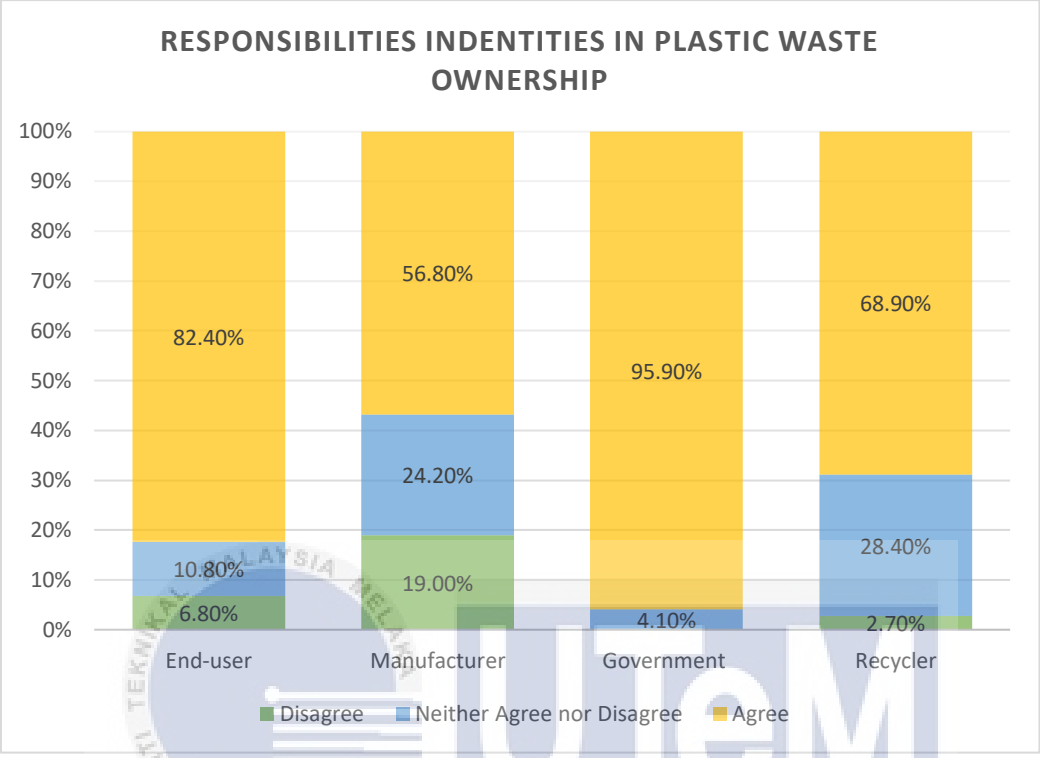

Figure 4. 13 : Responsibilities identities in plastic waste ownership

The graph in figure 4.13 presents the results of the survey on plastic waste ownership. Percentage of result on plastic waste management responsibility in each category has been listed in Figure 4.13. The responsibilities of plastic waste ownership are divided into several parties such as end-user, manufacturers, government and recyclers. Based on the graph, most voted factors were government with 95.9%, followed by the end-user with 82.4%, recyclers with 68.9%, and manufacturers with 56.8%. More details explanation on each party were explained under its subcategory. The worldwide rise in plastic waste over recent decades and its degradation of the environment is well known. Unlike organic materials, plastics do not decompose in nature within years. Plastic waste pollutes the environment by clogging drains, causing respiratory problems, lowering animal lifespans when ingested, and polluting lakes and rivers when pumped into canals and oceans. Therefore, to be fully developed circular economy in Malaysia, multi-stakeholders need to have participated.

4.3.9.1 Responsible Party of Plastic Ownership: Government

The graph in figure 4.13 presents the results of the survey on plastic waste ownership to ensure the circular economy is ready to be implemented in Malaysia. The bar chart illustrated in Table 4.60 below shows that the highest percentage with 95.9% recyclers agrees that the government shall take full responsibilities to ensure a circular economy could be implemented. The remaining were vote for neither disagree nor agree with the percentage of 4.1%.

Table 4. 60 : Statistic frequency of ownership from Government perspectives

Government					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neither Disagree nor Agree	3	4.1	4.1	4.1
	Agree	71	95.9	95.9	100.0
	Total	74	100.0	100.0	

In anticipation of addressing plastics management problems, policymakers can first resolve all waste-related issues. Cities need consistent recycling services, secure and acceptable disposal practises, and consistent compliance mechanisms before plastic can be effectively handled. Without specific rules for waste management, plastic will remain discarded and uncollected. Regulations on the disposal practices, on the other hand, have the indirect effect of increasing recycling culture. Measures to restrict the amount of plastic waste sent to landfills, such as taxes on the landfill or outright bans on landfill disposal of some forms of plastic waste categories, are the most efficient ways to minimise the amount of plastic waste sent to landfill. Woldemar (2019) highlighted that the European Union has set a target of handing over just 10% of plastic waste to landfill by 2030, compared to about 30% of plastic waste being discharged into landfill currently. Taxes on incineration are often used as a punishment for air pollution violations.

However, recycling could only be established where adequate facilities and collection rules are in place. Until seeking dedicated strategies for plastics disposal, policymakers must first concentrate on comprehensive waste management. Cities need consistent recycling services, safe and environmentally friendly disposal and consistent policy implementation before targeted plastic measures can be completely successful. On the other hand, Malaysia is ranked 8th country of mismanaged plastic waste in the world (NST, 2020) after China started banning the import of most plastic waste in 2018, Malaysia became an alternative market for polluted and mixed plastic waste. Based on the statement, the government shall enact stricter regulation enforcement to enhance the current plastic waste management. Although Malaysia has demonstrated a good action by sending back 150 containers of plastic waste to its origin country, the remaining plastic waste in this country alone is still in millions of tonnes. The crisis of plastic waste pollution in Malaysia appears to be snowballing at an unmatched rate.

Besides stopping illegal plastic waste imports, our Environment and Water Ministry has unveiled a Roadmap to Zero Single-use Plastic by 2030. Malaysia Sustainable Plastic Alliance is shutting down illegal plastic recycling factories and promoting the Expanded Producer Responsibility (EPR) Policy. Toloken (2019) highlighted that the plastics recycling sector scale can be increased with government funding through the EPR scheme for the plastics packaging sector. The idea for an EPR scheme came in the October Malaysian Plastics Manufacturers Association report that proposed that industry would essentially make the industry responsible for much of the plastic packaging recycling in Malaysia. The EPR scheme is seen as one way to ensure the industries are moving towards recycling culture by requiring recycled plastic in goods manufactured from plastic. Hence, plastic is likely to persist in being discarded without effective waste management systems when mismanaged. Residents and companies are less willing to adhere with limits on products for use or production, and cost recovery for waste management systems will continue to be a challenge.

Thus, plastic management problems can only be addressed through Malaysia's concrete waste management framework and plenty of government incentives. In enhancing plastic waste management and moving towards a sustainable country, the

government plays a big role as the government obtains the highest percentage for the responsible identities for plastic waste ownership. Besides work towards environmental perspectives, this plastic waste management could as well boost country's economy where Toloken (2019) reported that Malaysia's plastics recycling industry could grow from 4.5 billion Malaysian ringgits ($1.08 billion) to 20 billion ringgits ($4.8 billion) within 10 years. Hence, a better opportunity for us all.

4.3.9.2 Responsible Party of Plastic Ownership: End-user

The graph in figure 4.13 presents the survey results on plastic waste ownership to ensure the circular economy is ready to be implemented in Malaysia. Table 4.61 shows that the highest percentage with 82.4% recyclers agrees that end-user plays an important role in ensuring the circular economy could be implemented. The remaining were vote for neither disagree nor agree with the percentage of 10.8% and disagree with 6.8%.

Table 4. 61 : Statistic frequency of ownership from End-user perspectives

End-User					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	6.8	6.8	6.8
	Neither Disagree nor Agree	8	10.8	10.8	17.6
	Agree	61	82.4	82.4	100.0
	Total	74	100.0	100.0	

Teh et al. (2019) highlighted that 56% of respondents were concerned about the plastic and its sustainability issues and thus in need to see an effort made to encounter it. Based on the findings, high consumer awareness was one of the recyclers drivers to sustain in this recycling business. It shows that Malaysians are aware of single-use plastics' harmful effects, thus supporting this research finding where the recyclers believed that end-users should take responsibility for its plastic waste.

Consumer are increasingly concerned about the environmental impact of packaging, and many retailers are looking at recycled content in packaging as part of the solution. One major issue in the current recycling process is the need to limit contamination in the initial material stream used for recycling (WRAP, 2017). Reducing contaminants in plastic waste will significantly impact the waste's quality or potential to be sold or recycled. Waste Management (2018) highlighted that in Waste Management Sustainability Report 2018, there are an increasing mix of materials in the waste stream, and the move to cart-based, single-stream recycling has led to a rise in the average contamination rate for materials collected in curbside program, indicating only 50% of the volume of collected waste gets recycled. The recyclable waste that is contaminated will be lost its true value. However, the recycling became difficult for the end-user to keep up with what should and should not be in the bin, while at the same time living a fast-paced everyday life (Waste Management, 2018).

Teh et al. (2019) stated that 80% of Malaysians prefer to recycle and will minimise plastic usage if recycling bins are given in the community, meanwhile, 73% of Malaysians are eager to engage in 'No Plastic Waste' projects, 59% of Malaysians agree to substitute plastics with biodegradable goods, and 42% of Malaysians who believed in banning plastics for everyday use. It is heartening to see that many Malaysians can phase out single-use plastic bags, so long as they do not have to pay more. This positive feedback on plastic waste management is fascinating, showing that the end-user is well aware of plastic waste's environmental threat caused by plastic waste. Thus, the government shall provide what the public needs to ensure the smooth transition towards the circular economy.

4.3.9.3 Responsible Party of Plastic Ownership: Recyclers

The graph in figure 4.13 presents the survey results on plastic waste ownership to ensure the circular economy is ready to be implemented in Malaysia. Table 4.62 shows that the highest percentage with 68.9% recyclers agrees that end-user plays an important role in ensuring a circular economy could be implemented. The remaining were vote for neither disagree nor agree with the percentage of 28.4% and disagree with 2.7%.

Table 4. 62 : Statistic frequency of ownership from Recyclers perspectives

Recyclers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	2.7	2.7	2.7
	Neither Disagree nor Agree	21	28.4	28.4	31.1
	Agree	51	68.9	68.9	100.0
	Total	74	100.0	100.0	

More than 50% of plastic waste is caused by humans (Rhein and Schmid, 2020). Although the end-user became a main consumer of plastic, they knew the plastic waste hold's disadvantages. This understanding drove the findings, where most recyclers agree that driver of their recycling business was high consumer awareness. Thus, they believed that the end-user should take responsibilities in managing their plastic waste. Plastic recyclers can accelerate their growth to a projected RM15-20 billion annually, with enhanced infrastructure, technology and capacity upgrades (Bernama, 2019). MPMA (2019) highlighted that Malaysia's plastic recycling industry must strengthen its activities to establish a more holistic approach to handling plastic waste flows. Managing plastics waste and waste management infrastructure are critical for a viable and successful circular economy. Besides that, the plastic recycling industry can contribute to Malaysia's economy, which can be seen in these research findings. The high demand for recycled material was one of the recycler drivers to sustain in the recycling business.

4.3.9.4 Responsible Party Of Plastic Ownership: Manufacturers

The graph in figure 4.13 presents the survey results on plastic waste ownership to ensure the circular economy is ready to be implemented in Malaysia. Table 4.63 shows the highest percentage with 82.4% recyclers agrees that end-user plays an important role in ensuring the circular economy could be implemented. The remaining were vote for neither disagree nor agree with the percentage of 10.8% and disagree with 6.8%.

Table 4. 63 : Statistic frequency of ownership from Manufacturers perspectives

Manufacturers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	14	19	19	19
	Neither Disagree nor Agree	18	24.2	24.2	43.2
	Agree	42	56.8	56.8	100.0
	Total	74	100.0	100.0	

Market demand and behaviour changes could also lead manufacturers to use more recycled plastic in their products (Woldemar, 2019). Using recycled material in the product will significantly demonstrate the manufacturers are committed to corporate social responsibility and the environment (WRAP, 2017). Research by WRAP (2017) shows that consumer preferred the brands or retailers that use recycled content in their packaging. The recycling content shall help the manufacturers or retailers build brand loyalty, leading to change in public perspectives. The EPR policy in Malaysia may be one of the alternative solutions in embarking the recycling culture. WWF (2020) highlighted that Extended Producer Responsibility (EPR) strategy as a key policy instrument in keeping manufacturers responsible for the end-of-life impacts of their plastic goods and packaging. EPR promotes the incorporation of holistic eco-design initiatives in the business sector. In addition, cooperation between stakeholders in the plastics industry may lead to the development of an advanced plastics recycling industry to address plastic waste issues that are currently on the rise.

Objective 4: To Develop Recycler Preference Index (RPI) For End-Of-Life Plastic Waste Management In Malaysia

4.4. Recycler Preference Index

The recycling desirability model was a new approach proposed by Mohamed et al. (2017) that focuses on evaluating recycling desirability on many products. There are 3 critical parameters of end-of-life product that has been assessed primely based on their findings in the United Kingdom (UK); Material separation, the criticality of the materials and technology readiness. The recycling desirability index was developed as a measure to end-of-life recycling desirability and the product recycling priorities. In these research findings, the output was different. The author also obtained 3 parameters in different categories, which is profitable as the main consideration factor. High recycled demand is the main drivers to sustain recycling business and government policy and licensing as the main challenge to sustain the recycling business. These parameters are demonstrated, as shown in Figure 4.14 below. The parameters will turn into the score and are calculated to obtain the overall score. The score obtained demonstrate the likeliness or preference of plastic waste category. All data provided were based on the research findings. However, not many companies willing to share as the data are confidential to them.

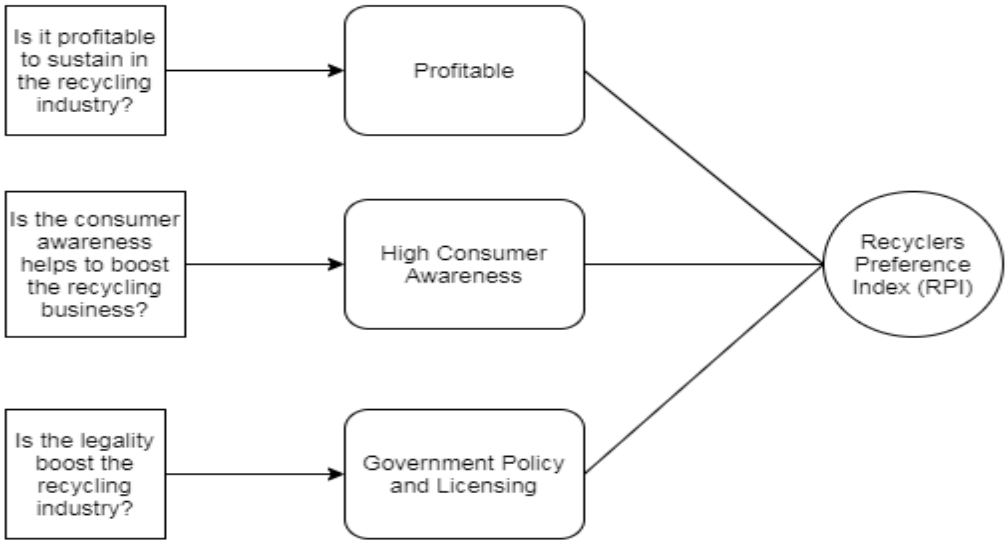

Figure 4. 14 : Recyclers Preference Index

4.4.1 Recycler Preference Index: Parameter 1 (Profit)

Figure 4.15 below demonstrates the profitable obtained from trading plastic waste in three companies. The Nadim Metal is illustrated in the green line, Zain Paper Enterprise in blue line and Nithia Sree Enterprise. The Nadim metal obtains the highest profit compared than the other two companies. Zain Paper Enterprise obtained moderate profit, and Nithia Sree enterprise obtained the lowest profit compared to the other two companies.

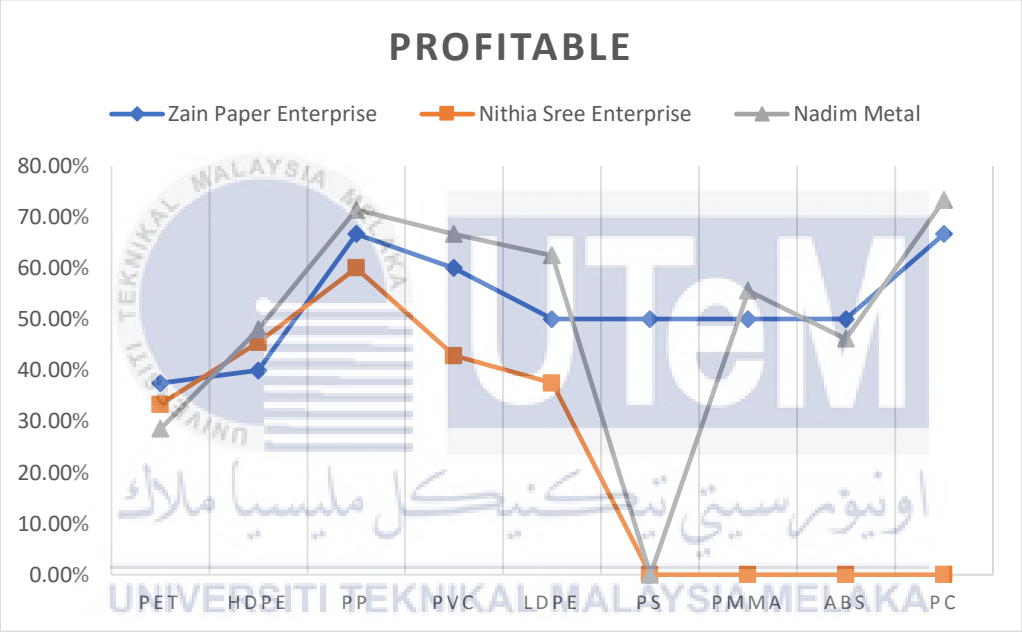

Figure 4. 15 : Company profit from plastic waste

Table 4.64 below shows the profitable in collecting and trading the plastic waste. Numbers of plastic waste category such as Polyethene Terephthalate (PETE), High-Density Polyethylene (HDPE), Vinyl Polyvinyl Chloride (PVC), Low-Density Polyethylene (LDPE), Polypropylene (PP), Polystyrene (PS), Polymethyl Methacrylate (PMMA), Acrylonitrile Butadiene Styrene (ABS) and Polycarbonate (PC) along with its cost and price. The provided data is used to compare plastic waste buy and sell price, and the number of plastic waste collected between Zain Paper Enterprise, Nithia Sree Enterprise, and Nadim Metal as demonstrated in Figure 4.16.

Table 4. 64 : Profit from recycled materials

Zain Paper Enterprise				Nithia Sree Enterprise			Nadim Metal		
Plastic Category	Recyclers Accepted Price /Kg	Recyclers Trade price	Numbers of material collected in tonnes (2019)	Recyclers Accepted Price /Kg	Recyclers Trade price	Numbers of material collected in tonnes (2019)	Recyclers Accepted Price /Kg	Recyclers Trade price	Numbers of material collected in tonnes (2019)
PETE	RM 0.50 /kg	RM 0.80/Kg	360 tonnes	RM0.60 /kg	RM 0.90 /kg	100 tonnes	RM 0.50/kg	RM 0.70/kg	200 tonnes
HDPE	RM 1.50 / kg	RM 2.50 /kg	300 tonnes	RM0.60 /kg	RM1.10 /kg	250 tonnes	RM1.30 /kg	RM2.50 /kg	400 tonnes
PP	RM 0.50/kg	RM 1.50/kg	150 tonnes	RM0.60 /kg	RM1.50 /kg	200 tonnes	RM0.40 /kg	RM1.40 /kg	280 tonnes
PVC	RM0.20 /kg	RM0.50 /kg	400 tonnes	RM0.40 /kg	RM0.70 /kg	60 tonnes	RM0.20 /kg	RM0.60 /kg	100 tonnes
LDPE	RM0.50 /kg	RM1.00 /kg	100 tonnes	RM0.50 /kg	RM0.80 /kg	150 tonnes	RM0.15 /kg	RM0.40 /kg	150 tonnes
PS	RM0.50 /kg	RM1.00 /kg	100 tonnes	Not Accepting this category			Not Accepting this category		
PMMA	RM0.50 /kg	RM1/kg	150 tonnes	Not Accepting this category			RM0.40 /kg	RM0.90 /kg	200 tonnes
ABS	RM1/kg	RM2/kg	80 tonnes	Not Accepting this category			RM0.70 /kg	RM1.30 /kg	50 tonnes
PC	RM0.50 /kg	RM1.50 /kg	50 tonnes	Not Accepting this category			RM0.40 /kg	RM1.50 /kg	60 tonnes

Zain Paper Enterprise buy price on the PET is RM 0.50 per Kg and sell price are RM 0.80 per Kg. Zain Paper Enterprise makes out the profit of RM 0.30 per Kg. Nithia Sree Enterprise buy price on the PET is RM 0.60 per Kg and sell price are RM 0.90 per Kg. Nithia Sree Enterprise is as well makes out the profit of RM 0.30 per Kg. Nadim Metal buy price on the PET is RM 0.50 per Kg and sell price is RM 0.70 per Kg. Nadim Metal makes out the profit of RM 0.20 per Kg.

Zain Paper Enterprise buy price on the HDPE is RM 1.50 per Kg and sell price is RM 2.50 per Kg. Zain Paper Enterprise makes out the profit of RM 1.00 per Kg. Nithia Sree Enterprise buy price on the HDPE is RM 0.60 per Kg and sell price is RM 1.10 per Kg. Nithia Sree Enterprise is as well makes out the profit of RM 0.50 per Kg. Nadim

Metal buy price on the HDPE is RM 1.30 per Kg and sell price is RM 2.50 per Kg. Nadim Metal makes out the profit of RM 1.20 per Kg.

Zain Paper Enterprise buy price on the PP is RM 0.50 per Kg and sell price is RM 1.50 per Kg. Zain Paper Enterprise makes out the profit of RM 1.00 per Kg. Nithia Sree Enterprise buy price on the PP is RM 0.60 per Kg and sell price are RM 1.50 per Kg. Nithia Sree Enterprise makes out the profit of RM 0.90 per Kg. Nadim Metal buy price on the PP is RM 0.40 per Kg and sell price are RM 1.40 per Kg. Nadim Metal makes out the profit of RM 1.00 per Kg.

Zain Paper Enterprise buy price on the PVC is RM 0.20 per Kg and the sell price is RM 0.50 per Kg. Zain Paper Enterprise makes out the profit of RM 0.30 per Kg. Nithia Sree Enterprise buy price on the PVC is RM 0.40 per Kg and sell price is RM 0.70 per Kg. Nithia Sree Enterprise is as well makes out the profit of RM 0.30 per Kg. Nadim Metal buy price on the PVC is RM 0.20 per Kg and sell price is RM 0.60 per Kg. Nadim Metal makes out the profit of RM 0.40 per Kg.

Zain Paper Enterprise buy price on the LDPE is RM 0.50 per Kg and the selling price is RM 1.00 per Kg. Zain Paper Enterprise makes out the profit of RM 0.50 per Kg. Nithia Sree Enterprise buy price on the LDPE is RM 0.50 per Kg and sell price is RM 0.80 per Kg. Nithia Sree Enterprise is as well makes out the profit of RM 0.30 per Kg. Nadim Metal buy price on the LDPE is RM 0.15 per Kg and sell price is RM 0.40 per Kg. Nadim Metal makes out the profit of RM 0.25 per Kg.

Zain Paper Enterprise buy price on the PS is RM 0.50 per Kg and the selling price is RM 1.00 per Kg. Zain Paper Enterprise makes out the profit of RM 0.50 per Kg. Nithia Sree Enterprise and Nadim Metal are both not accepting this category of plastic waste. Zain Paper Enterprise buy price on the PMMA is RM 1.00 per Kg and the selling price is RM 1.50 per Kg. Zain Paper Enterprise makes out the profit of RM 0.50 per Kg. Nadim Metal buy price on the PMMA is RM 0.40 per Kg and sell price is RM 0.90 per Kg.

Nadim Metal makes out the profit of RM 0.50 per Kg. Nithia Sree Enterprise is not accepting this category of plastic waste.

Zain Paper Enterprise buy price on the ABS is RM 1.00 per Kg and sell price is RM 2.00 per Kg. Zain Paper Enterprise makes out the profit of RM 1.00 per Kg. Nadim Metal buy price on the ABS is RM 0.70 per Kg and sell price is RM 1.30 per Kg. Nadim Metal makes out the profit of RM 0.60 per Kg. Nithia Sree Enterprise is not accepting this category of plastic waste.

Zain Paper Enterprise buy price on the PC is RM 0.50 per Kg and the selling price is RM 1.50 per Kg. Zain Paper Enterprise makes out the profit of RM 1.00 per Kg. Nadim Metal buy price on the PC is RM 0.40 per Kg and sell price is RM 1.50 per Kg. Nadim Metal makes out the profit of RM 1.10 per Kg. Nithia Sree Enterprise is not accepting this category of plastic waste.

However, a certain plastic category such as PS, PMMA, ABS and PC are not accepted in some premise due to many factors; lack of tools and machinery, low market demand and insufficient supply. Each plastic waste category is calculated using the formula in the equation (4.1) to obtain the net profit margin. The net profit margin is equal to the number of net profits generated as a percentage of revenue. Net profit margin lets recyclers determine whether the business earns enough profit from its revenue.

$$\text{Net profit margin} = \frac{(\text{Revenue} - \text{cost})}{\text{Revenue}} \text{ x } 100\% \qquad \text{Equation 4.1}$$

4.4.1.1 Parameter 1: Net Profit Margin

The table 4.65 below demonstrate the calculated net profit margin on each plastic category. Each of the plastic category are scored according to their classification in Table below. The scoring system are as demonstrate in Table 4.67below. The PET in Zain Paper Enterprise makes 37.50% of profit, followed by Nithia Sree Enterprise with 33.33% and Nadim Metal with 28.57% contributing to the company's profit. The average net profit margin in PETE based on these 3 companies are 33.13%. The PETE obtained score 1 which indicate the profit obtained of this plastic waste category are below 50%.

Table 4. 65 : Profit Scoring Level

Score	Explanation
1	The profit obtained below 49%
2	The profit obtained is in the range of 50% to 59%
3	The profit obtained above 60%

The PS in Zain Paper Enterprise makes 50% of profit, while Nithia Sree Enterprise and Nadim Metal did not take this thype of companies. Hence the average profit for theses 3 companies are 16.67%. The PS obtained score 1 which indicate the profit obtained of this plastic waste category are below 50%.

The PETE in Zain Paper Enterprise makes 37.5% of profit, followed by Nithia Sree Enterprise with 33.33% and Nadim Metal with 28.57% contributing to the company's profit. The average net profit margin in PETE based on these 3 companies are 33.13%. The PETE obtained score 1 which indicate the profit obtained of this plastic waste category are below 50%.

The HDPE in Zain Paper Enterprise makes 40% of profit, followed by Nithia Sree Enterprise with 45.45% and Nadim Metal with 48% contributing to the company's profit. The average net profit margin in HDPE based on these 3 companies are 44.48%. The HDPE obtained score 1 which indicate the profit obtained of this plastic waste category are below 50%.

The PP in Zain Paper Enterprise makes 66.67% of profit, followed by Nithia Sree Enterprise with 60% and Nadim Metal with 71.43% contributing to the company's profit. The average net profit margin in PP based on these 3 companies are 66.03%. The PP obtained score 3 which indicate the profit obtained of this plastic waste category are above 50%.

The PVC in Zain Paper Enterprise makes 60% of profit, followed by Nithia Sree Enterprise with 42.86% and Nadim Metal with 66.67% contributing to the company's profit. The average net profit margin in PVC based on these 3 companies are 56.51%. The PVC obtained score 2 which indicate the profit obtained of this plastic waste category are in the range of 50% to 59%.

The LDPE in Zain Paper Enterprise makes 50% of profit, followed by Nithia Sree Enterprise with 37.5% and Nadim Metal with 62.5% contributing to the company's profit. The average net profit margin in LDPE based on these 3 companies are 50%. The PS in Zain Paper Enterprise makes 50% of profit. The average net profit margin in PS are 50%. The PS obtained score 2 which indicate the profit obtained of this plastic waste category are in the range of 50% to 59%.

The PMMA in Zain Paper Enterprise makes 50% of profit, followed by Nadim Metal with 55.56% contributing to the company's profit. The average net profit margin in PMMA based on these companies are 35.19%. The PMMA obtained score 1 which indicate the profit obtained of this plastic waste category are below 49%.

The ABS in Zain Paper Enterprise makes 50% of profit, followed by Nadim Metal with 46.15% contributing to the company's profit. The average net profit margin in ABS based on these companies are 32.05%. The PP obtained score 1 which indicate the profit obtained of this plastic waste category are below 49%.

The PC in Zain Paper Enterprise makes 66.67% of profit, followed by Nadim Metal with 73.33% contributing to the company's profit. The average net profit margin in PC based on these companies are 46.67%. The PP obtained score 1 which indicate the profit obtained of this plastic waste category are above below 49%.

Table 4. 66 : Net profit margin

Material	**Zain Paper Enterprise**		**Nithia Sree Enterprise**		**Nadim Metal**		**Average Net Profit Margin**	**Score**	**Rank of Profitability**
PET	Net Profit Margin	37.50 %	Net Profit Margin	33.33 %	Net Profit Margin	28.57 %	33.13%	1	7
HDPE	Net Profit Margin	40.0%	Net Profit Margin	45.45 %	Net Profit Margin	48.0%	44.48%	1	5
PP	Net Profit Margin	66.67 %	Net Proft Margin	60.0%	Net Profit Margin	71.43 %	66.03%	3	1
PVC	Net Profit Margin	60.00 %	Net Proft Margin	42.86 %	Net Proft Margin	66.67 %	56.51%	2	2
LDPE	Net Profit Margin	50.00 %	Net Proft Margin	37.50 %	Net Proft Margin	62.50 %	50%	2	3
PS	Net Profit Margin	50.00 %	Net Proft Margin	0	Net Proft Margin	0	16.67	1	9
PMMA	Net Profit Margin	50.00 %	Net Proft Margin	0	Net Proft Margin	55.56 %	35.19%	1	6
ABS	Net Profit Margin	50.00 %	Net Proft Margin	0	Net Proft Margin	46.15 %	32.05%	1	8
PC	Net Profit Margin	66.67 %	Net Proft Margin	0	Net Proft Margin	73.33 %	46.67%	1	4

4.4.2 Recycler Preference Index: Parameter 2 (Consumer Awareness for recycled materials)

Table 4.67 below demonstrates the level of consumer awareness in handling end-of-life plastic waste. The calculation of this parameter is demonstrated in formula at equation (4.2) below. The output of this calculation is to measure the tonnage of waste collected per household. Zain Paper Enterprise manage to collect an overall of 1690 tonnes of plastic waste in 2019. As the Zain Paper Enterprise is located near Ampang, Selangor, the total plastic waste obtained are divide by the total population in Ampang. Zain Paper Enterprise obtained score 1 which indicate below than 0.49% of plastic waste are collected per household. Nithia Sree Enterprise is located near Damansara, Selangor. Therefore, the total plastic waste obtained are divide by the total population in Damansara. Nithia Sree Enterprise are as well obtained score 1 which indicate below than 0.49% of plastic waste are collected per household. Nadim Metal is located at Pontian, Johor. Therefore, the total plastic waste obtained are divide by the total population in Pontian. Nadim Metal obtained score 3 which indicate more than 0.60% of plastic waste are collected per household. Each of the score are described as in Table 4.68 below.

Table 4. 67 : Consumer Awareness on recycled materials

Material	**Zain Paper Enterprise** **Numbers of Waste Collected 2019**	**No of Population in Ampang, Selangor**	**Nithia Sree Enterprise** **Numbers of Waste collected in 2019**	**No of Population in Damansara, Selangor**	**Nadim Metal Enterprise** **Numbers of Waste Collected in 2019**	**No of population in Pontian, Johor**
PET	360 tonnes	800 000	100 tonnes	500,000	200 tonnes	155,541
HDPE	300 tonnes		250 tonnes		400 tonnes	
PP	150 tonnes		200 tonnes		280 tonnes	
PVC	400 tonnes		60 tonnes		100 tonnes	
LDPE	100 tonnes		150 tonnes		150 tonnes	
PS	100 tonnes		-		-	
PMMA	150 tonnes		-		200 tonnes	
ABS	80 tonnes		-		50 tonnes	
PC	50 tonnes		-		60 tonnes	
Total of plastic waste collected	1690 tonnes		760 tonnes		1380 tonnes	

Tons of waste collected per household	0.00211		0.00152		0.0089	

$$\text{Consumer Awareness} = \frac{(\text{Total Waste Collected})}{\text{No.of state population}} \qquad \text{Equation 4.2}$$

Table 4. 68 : Consumer awareness score

Score	Explanation
1	Below than 0.49% of plastic waste collected per household
2	In the range of 0.50% to 0.59% of plastic waste collected per household
3	More than 0.60% of plastic waste collected per household

4.4.3 Recycler Preference Index: Parameter 3 (Government policy and licensing)

The federal laws enacted by the federal assembly or better known as the Parliament of Malaysia applies throughout the country. Malaysia is a federal constitutional monarchy. It has a parliamentary system of government headed by a prime minister selected through periodic, multiparty elections. Hence, the score for the critical factor of policy is constant with a score 2 for all waste category. The regulation for the score are described as in Table 4.69 below.

Table 4. 69 : Regulation Score

Score	Explanation
Score 1	The regulation is according to state level
Score 2	The regulation is according to federal level
Score 3	The regulation is according to international level

To seek the further declaration, the finding for current recycler challenges mainly on the government policy and licensing are reviewed with the authorities representatives from Jabatan Alam Sekitar, police and Majlis Bandaran. To start up the recycling business, the recyclers need to seek approval from these authorities. The recyclers are bound under Undang-Undang Pelesenan Tred, Perniagaan dan Perindustrian 1986 where no person shall carry on any trading, business and industrial activities or use any place premises within the council area without a license issued by the authority. The recyclers shall pay process fees to the Majlis Bandaran, and these fees are not refundable regardless of the status of an application. The license shall be renewed every 31st December and fail to do so; Majlis Bandaran has the right to enforce the recyclers to stop the business immediately unless they have documentation on license renew (in progress). To apply for the license from Majlis Bandaran, the recyclers need to seek approval from a local authority such as police, BOMBA, JKR, Kesihatan, etc.

From the police perspectives, the recyclers need to apply for the license under Act 189 – Secondhand dealers Act 1946. In this act, the recyclers shall only trade secondhand goods except in accordance with the terms of the license issued under this act in the interests in the first schedule, and at the place specified in the license. Each licensee shall bring his license with him and submit the license for inspection at any time upon request by any police officer. The act has also highlighted that the recycling premise shall only accept or trade any waste within 7 in the morning until 7 in the evening, or else, they will be penalties. There are three categories of licenses that traders need to apply for based on the type of business, License A, License B and License C. License A can only be applied for by traders who have premises, License B can be applied for by mobile hawkers and can only buy permitted items while License C is in addition to the License A in which License C is for waste transportation.

From the Jabatan Alam Sekitar perspective, only recyclers involve in processing plastic waste shall apply while the collectors does not need to apply this license. The recyclers of plastic waste are bound to the license is due to they are processing hazardous materials into resources, thus, the Jabatan Alam Sekitar need to supervised the premise to avoid any pollutant. In order to obtain the license from Jabatan Alam Sekitrar, the

recyclers need to get support letters from several government agencies' for recyclers to apply written permission under section 19 (KB 19). The KB 19 is an approval for the recyclers to set up off-site recovery facilities. The recyclers that obtained KB 19 is under supervision of Jabatan Alam Sekitar and as trial for the recycler. The KB-19 is not a assurance for the recyclers to obtained the license from Jabatan Alam Sekitar, thus, the recyclers need to strictly follow the regulation. The process fee for the KB 19 is estimated to be RM 1000 per process. Many government agencies' involvement and stricter regulation in getting a license are among the causes of the rising numbers of illegal recyclers due to many procedures and fees. Despite so, this has seen as a good initiative from the government to ensure the plastic waste is processed sustainably.

4.4.4 Recycler Preference Model: The Products Distribution

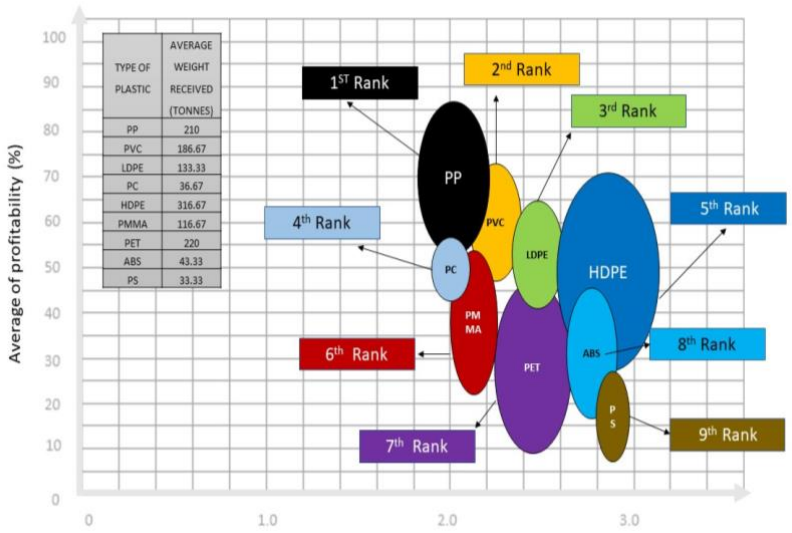

Figure 4. 16 : RPI index for type of plastic waste

Figure 4.16 demonstrate the Recyclers Preference Index (RPI) for the plastic waste. The RPI were based on the net profit margin calculation for 2 company that are located in Selangor and Johor. The output of the calculation are demonstrated on the graph shown in figure 4.16 where PP is the most preferred plastic waste in both company followed by PVC, LDPE, PC, HDPE, PMMA, PET, ABS and PS. The PP obtained 66.03% of the average of profitabilitity with an average of both company collect 210 tonnes of PP waste in 2019. The PVC obtained 56.51% of the average of profitability with an average of both company collect 186.67 tonnes of PVC waste in 2019. The LDPE obtained 50% of the average of profitabilitity with an average of both company collect 133.33 tonnes of LDPE waste in 2019. The PC obtained 46.67% of the average of profitabilitity with an average of both company collect 36.67 tonnes of PC waste in 2019. The HDPE obtained 44.48% of the average of profitabilitity with an average of both company collect 316.67 tonnes of HDPE waste in 2019. The PMMA obtained 35.19% of the average of profitabilitity with an average of both company collect 156.67 tonnes of PMMA waste in 2019. The PET obtained 33.13% of the average of profitabilitity with an average of both company collect 128 tonnes of PET waste in 2019. The ABS obtained 32.05% of the average of profitabilitity with an average of both company collect 48.38 tonnes of ABS waste in 2019. The PS obtained 16.67% of the average of profitabilitity with an average of both company collect 38.18 tonnes of PMMA waste in 2019.

CHAPTER 5

CONCLUSION

5.1 Conclusion Of The Study

Plastic is undeniably one of the greatest inventions that have made, where the presence of plastic has continuously contributed to the development of the society to meet their needs. As we can see today, the plastic fact could be seen worldwide and has been a part of social lifestyles. The price of the virgin plastics is lower than any other material, which, unfortunately, has allowed this material to be single-use in many applications. Current production and management in the plastics industry have become alarming as they keep practising the linear economy concept, the 'take-use-make-dispose' approach. The plastic sector is an essential contributor to economic growth. Still, its current production pattern has led to the deterioration of the environment, the adverse effects on human health in which simultaneously increased the plastic waste generated.

Making the best choice to tackle end-of-life waste was one of the most difficult challenges. The absence of critical factors in measuring the level of recyclers readiness towards the circular economy has become a drawback for Malaysia. To fully implement a circular economy like other developed countries, the recycling industry must be strengthening its foundation. With the unclear roles of plastic waste ownership, limited analysis of the current state of the recycling practice in Malaysia, the absence of the related plastic recycling framework has led to the difficulties of adequately addressing plastic waste. Thus, the current issue can be concluded on why Malaysia is still at infancy stage towards recycling practice compared to other developed countries.

Hence, this study aims to measure the level of recycling readiness towards a circular economy's full implementation by determining the critical factors that affected the recycling business. Based on the findings, the critical factors currently affecting recyclers are government policy and licensing, profitability and demand for recycled materials. These critical factors are measured by using an appropriate formula to ensure the validity of the findings. The recycler preference index is developed to demonstrate the current preference from the recycler's perspectives. The local-recycling supply chain of the end-of-life plastic waste management in Malaysia is well-constructed and reviewed by the authorities to demonstrate the current plastic waste flow in Malaysia. The study was prepared for future work analysis and as government guidelines to improve in this sector.

Approximately 80% of local manufacturing companies used recycled plastic in their production and heavily depended on local recycling companies' supplies. These companies carry out in-house recycling due to cost savings. The plastics recycling industry supports the RM31 billion local plastics industry, a crucial supply chain for the local electrical and electronics and automotive industries. However, plastic is likely to persist in being discarded without effective waste management systems when uncollected, residents and companies are less willing to adhere with limits on products for use or production, and cost recovery for waste management systems will continue to be a challenge.

Thus, plastic management problems can only be addressed through the concrete waste management framework in Malaysia, and plenty of government incentives. In enhancing plastic waste management and moving towards a sustainable country, the government plays a significant role as the government obtains the highest percentage for the responsible identities for plastic waste ownership. Besides working towards environmental perspectives, this plastic waste management could boost the country's economy where Malaysia's plastics recycling industry could grow from RM4.5 billion to RM 20 billion within 10 years. Hence, a better opportunity for us all.

5.2 Recommendation

The study is focusing on the current critical factors of the plastic waste recycling initiatives in Malaysia. The findings show that several steps and strategies is needed for Malaysia could fully implemented the circular economy simultaneously ensuring plastic waste is well taken care of and processed in safely manner. Among the steps and strategies that may be taken by government are:

1. Companies and consumers are key players in the transition to a plastic circular economy. In short, the upstream and downstream actions of the supply chain should be more interrelated and consistent. This involves establishing incentives to connect different stakeholders, suppliers, inventors, consumers, and recyclers in the value chain in a coherent manner by ensuring that all costs and benefits are fairly distributed.
2. Need to develop a well-functioning plastic secondary market. Special attention needs to be paid to the mechanisms that enable entrepreneurs to take advantage of the potential new markets associated with the plastic circular economy.
3. The official framework and methods for the recycling business need to be properly constructed to ensure that only high-quality plastic waste recycling is carried out and to help develop a market for high-quality secondary raw materials.
4. Policies and measures must be formulated to promote the improvement of waste management. Measures can be formulated through landfill taxes, pay-as-you-go and extended producer responsibility (EPR) programs, or measures to encourage local authorities to promote a 3R (reduction, reuse, and recycling) culture.
5. It is necessary to encourage innovation by funding plastic recycling research and development (R&D) to improve the resource utilization efficiency of plastics in the entire value chain.
6. Government shall better educate consumer to make informed decisions through a better understanding of green products. Futhermore, the government shall educate publics more on the the disposal process concern on the specific type of plastic. This segregration of plastic waste must be done at home to ease the recyclers in processing the waste.

5.3 Sustainable design and development

The study deals with sustainable growth, where these services we provide today are the ones we look forward to in the future if we do not use them carefully within a given time frame. The author has learnt through the results the importance of recycling in which the waste is a threat to the environment and also to humans. The waste piles in the waste site can be a source of income for Malaysians because the waste can be recycled into new products. To ensure that the recycling industry in Malaysia are equal other developed countries, a continual supply chains are required. A potential product shall be designed for recycling and disassembly. The engineers shall addresses specifically the collection and recycling of materials. Engineers must ensure that the design result is for recovery, value retention and use afterwards. Only then will Malaysia be ready and will be able to work towards a fully integrated circular economy and sustainable countries

5.4 Complexity of the research

In order to achieve the specific objective of this study, the knowledge from the literature review must be taken as an early picture. In this study there is a level of interaction where the author must be resourceful in order to tackle the involvement of the respondent. Since most recycling business are family-own and absence of proper management, has become challenges for the author to obtain information needed. The feedback received from recyclers therefore depends heavily on recycler behavior and the author must be creative to attract the recycler's interest. The findings are vital in order to provide government guidance on various aspects of future plans in recycling industry. Futhermore this study as well applied, the recycling approach employed by the other scholar and revised according to Malaysia's current situation. Any recommendations for a better system and improvisation obtained will be chanelled to the government for further action.

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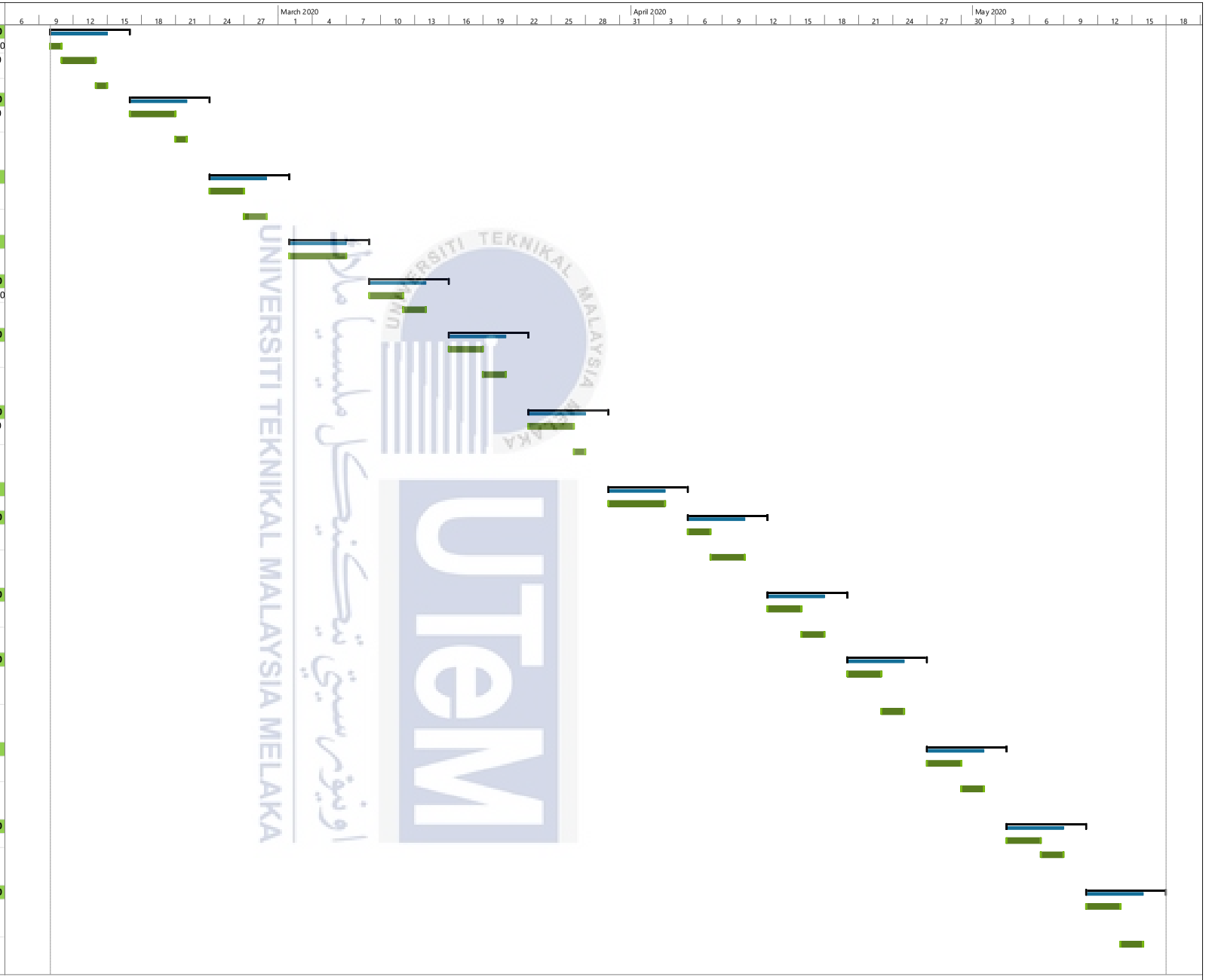
APPENDIX

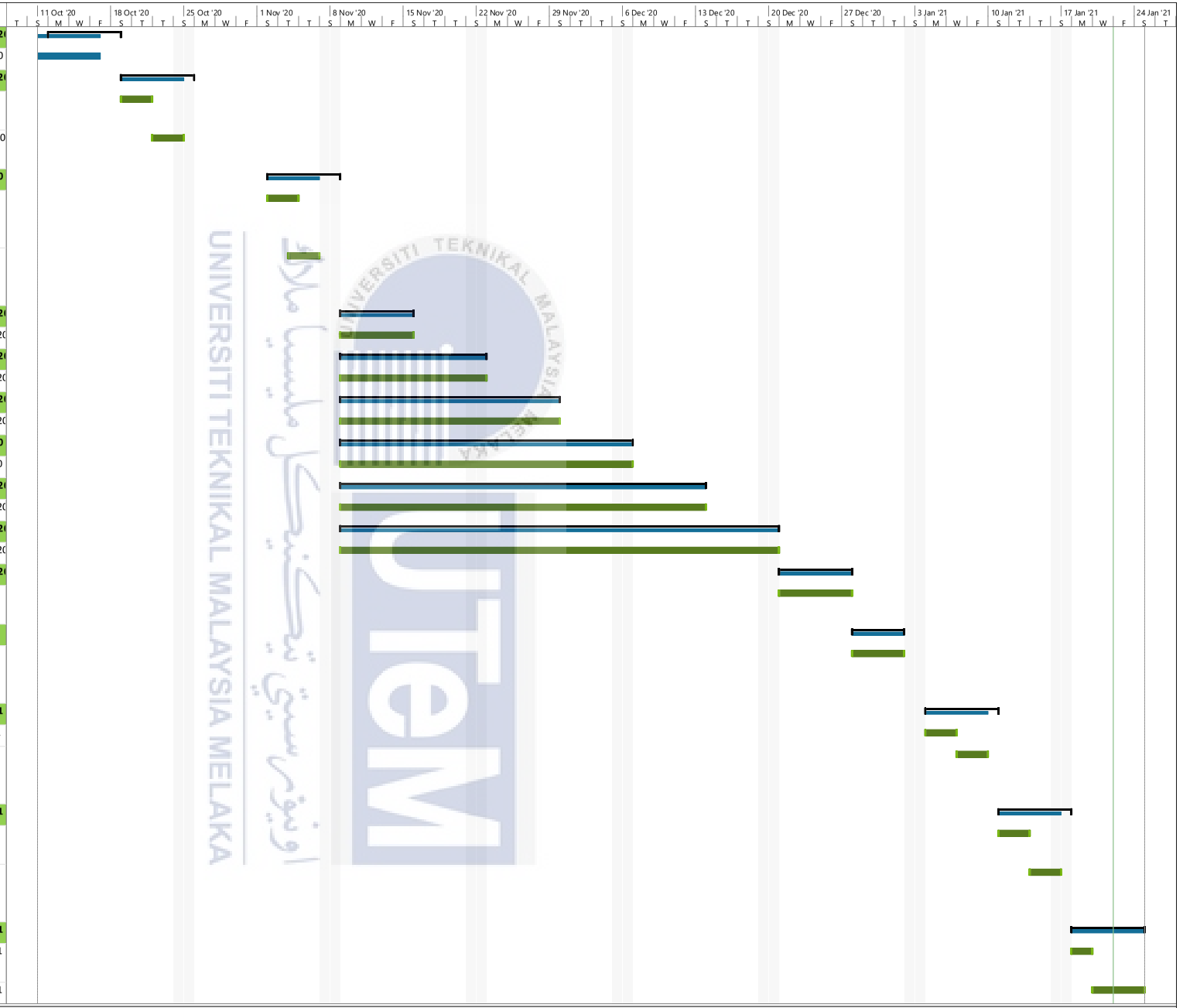
ID	Task Mode	Task Name	Duration	Start	Finish
1		**Week 1**	**6 days**	**Mon 10/2/20**	**Sun 16/2/20**
2		PSM briefing	1 day	Mon 10/2/20	Mon 10/2/20
3		Selection of supervisor	3 days	Tue 11/2/20	Thu 13/2/20
4		Selection of title	1 day	Fri 14/2/20	Fri 14/2/20
5		**Week 2**	**6 days?**	**Mon 17/2/20**	**Sun 23/2/20**
6		Research journal related to recycling	4 days	Mon 17/2/20	Thu 20/2/20
7		Selection of recycling material/product	1 day	Fri 21/2/20	Fri 21/2/20
8		**Week 3**	**6 days**	**Mon 24/2/20**	**Sun 1/3/20**
9		Determining objective	3 days	Mon 24/2/20	Wed 26/2/20
10		Determining problem statement	2 days	Thu 27/2/20	Fri 28/2/20
11		**Week 4**	**6 days**	**Mon 2/3/20**	**Sun 8/3/20**
12		Completing chapter 1	5 days	Mon 2/3/20	Fri 6/3/20
13		**Week 5**	**6 days**	**Mon 9/3/20**	**Sun 15/3/20**
14		Repairing chapter 1	3 days	Mon 9/3/20	Wed 11/3/20
15		Constructing literature review	2 days	Thu 12/3/20	Fri 13/3/20
16		**Week 6**	**6 days**	**Mon 16/3/20**	**Sun 22/3/20**
17		Completing chapter 2	3 days	Mon 16/3/20	Wed 18/3/20
18		Supervisor checking and repairing chapter 1 and 2	2 days	Thu 19/3/20	Fri 20/3/20
19		**Week 7**	**6 days**	**Mon 23/3/20**	**Sun 29/3/20**
20		Researching on the methodology	4 days	Mon 23/3/20	Thu 26/3/20
21		Presenting the methodology to Supervisor	1 day	Fri 27/3/20	Fri 27/3/20
22		**Week 8**	**6 days**	**Mon 30/3/20**	**Sun 5/4/20**
23		Midsem break	5 days	Mon 30/3/20	Fri 3/4/20
24		**Week 9**	**6 days**	**Mon 6/4/20**	**Sun 12/4/20**
25		Drafting survey questionaire	2 days	Mon 6/4/20	Tue 7/4/20
26		Supervisor review on the survey questionaire	3 days	Wed 8/4/20	Fri 10/4/20
27		**Week 10**	**6 days**	**Mon 13/4/20**	**Sun 19/4/20**
28		Improving survey questionaire	3 days	Mon 13/4/20	Wed 15/4/20
29		Completing survey questionaire	2 days	Thu 16/4/20	Fri 17/4/20
30		**Week 11**	**6 days**	**Mon 20/4/20**	**Sun 26/4/20**
31		Sending survey questionaire to the expert to be review	3 days	Mon 20/4/20	Wed 22/4/20
32		Improving the questionaire survey based on comment	2 days	Thu 23/4/20	Fri 24/4/20
33		**Week 12**	**6 days**	**Mon 27/4/20**	**Sun 3/5/20**
34		Preparing for PSM 1 presentation	3 days	Mon 27/4/20	Wed 29/4/20
35		Developing slide presentation and video	2 days	Thu 30/4/20	Fri 1/5/20
36		**Week 13**	**6 days**	**Mon 4/5/20**	**Sun 10/5/20**
37		PSM 1 Presentation	3 days	Mon 4/5/20	Wed 6/5/20
38		Subbmission of report from chapter 1 to 3	2 days	Thu 7/5/20	Fri 8/5/20
39		**Week 14**	**6 days**	**Mon 11/5/20**	**Sun 17/5/20**
40		Waiting the feedback of report from supervisor	3 days	Mon 11/5/20	Wed 13/5/20
41		Repairing and completing the report	2 days	Thu 14/5/20	Fri 15/5/20



Project: Simple Project Plan
Date: Fri 22/1/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress | Slippage

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Week 1**	**6 days**	**Mon 12/10/2**	**Sun 18/10/2**
2		PSM 2 briefing	6 days	Sun 11/10/2(	Fri 16/10/20
3		**Week 2**	**6 days?**	**Mon 19/10/2**	**Sun 25/10/2**
4		Identifying target population	3 days	Mon 19/10/20	Wed 21/10/20
5		Calculating sample size of respondent	3 days	Thu 22/10/20	Sat 24/10/20
6		**Week 3**	**6 days**	**Mon 2/11/2(	Sun 8/11/20**
7		Rechecking and presenting sample size to surpervisor	3 days	Mon 2/11/20	Wed 4/11/20
8		Waiting for supervisor comment	3 days	Wed 4/11/20	Fri 6/11/20
9		**Week 4**	**6 days**	**Mon 9/11/2(	Sun 15/11/2**
10		Collecting data	6 days	Mon 9/11/20	Sun 15/11/20
11		**Week 5**	**11 days**	**Mon 9/11/2(	Sun 22/11/2**
12		Collecting data	11 days	Mon 9/11/20	Sun 22/11/20
13		**Week 6**	**16 days**	**Mon 9/11/2(	Sun 29/11/2**
14		Collecting data	16 days	Mon 9/11/20	Sun 29/11/20
15		**Week 7**	**21 days**	**Mon 9/11/2(	Sun 6/12/20**
16		Collecting data	21 days	Mon 9/11/20	Sun 6/12/20
17		**Week 8**	**26 days**	**Mon 9/11/2(	Sun 13/12/2**
18		Collecting data	26 days	Mon 9/11/20	Sun 13/12/20
19		**Week 9**	**31 days**	**Mon 9/11/2(	Sun 20/12/2**
20		Collecting data	31 days	Mon 9/11/20	Sun 20/12/20
21		**Week 10**	**6 days**	**Mon 21/12/2**	**Sun 27/12/2**
22		Extracting data collection	6 days	Mon 21/12/20	Sun 27/12/20
23		**Week 11**	**5 days**	**Mon 28/12/2**	**Fri 1/1/21**
24		Reviewing framework with DOE officer	5 days	Mon 28/12/20	Fri 1/1/21
25		**Week 12**	**6 days?**	**Mon 4/1/21**	**Sun 10/1/21**
26		Writing the report	3 days	Mon 4/1/21	Wed 6/1/21
27		Discussing the finding with supervisor	3 days	Thu 7/1/21	Sat 9/1/21
28		**Week 13**	**6 days**	**Mon 11/1/2**	**Sun 17/1/21**
29		Preparing slide for presentation	3 days	Mon 11/1/21	Wed 13/1/21
30		Checking the slide presentation with supervisor	3 days	Thu 14/1/21	Sat 16/1/21
31		**Week 14**	**6 days**	**Mon 18/1/2**	**Sun 24/1/21**
32		Report presentation	2 days	Mon 18/1/21	Tue 19/1/21
33		Report submission	4 days	Wed 20/1/21	Sun 24/1/21



Project: Simple Project Plan
Date: Fri 22/1/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

SURVEY EXPERT REVIEW FORM

This is a form for the expert to review the developed questionnaire survey. The review on overall questionnaire including the suitability of the questions, structure and language.

Title of the research: The determination of the recycler preference index (RPI) for recycling the end-of-life plastic waste in Malaysia

	Items and Agreement Statements'	Level of agreement on the quality of the developed items in the questionnaire (1 is the lowest score – 5 is the highest score) Please circle one				
1	The questions are few, short, clearly worded, simple and easy to reply.	**1**	**2**	**3**	**4**	**5**
2	The questions are within the information scope of the respondents.	**1**	**2**	**3**	**4**	**5**
3	The questions have direct relation to subject of the investigation.	**1**	**2**	**3**	**4**	**5**
4	The opening questions are not be such as to abuse human interest.	**1**	**2**	**3**	**4**	**5**
5	Units and technical terms are correctly used in question as far as possible.	**1**	**2**	**3**	**4**	**5**
6	The questions are be inter-related with each other.	**1**	**2**	**3**	**4**	**5**
7	The questions are proceed in logical sequence moving from basic to more intense questions.	**1**	**2**	**3**	**4**	**5**
8	Personal and intimate questions are not included unnecessary	**1**	**2**	**3**	**4**	**5**
9	Emotional questions are avoided.	**1**	**2**	**3**	**4**	**5**
10	The questions are framed that there is a minimum of writing works. Questions may be dichotomous or multiple choice. Open-ended questions are limited to important questions.	**1**	**2**	**3**	**4**	**5**
11	The questions are free from ambiguity. Vague expressions capable of different interpretations are avoided in a questionnaire.	**1**	**2**	**3**	**4**	**5**
12	Answer to a question are be objective and have a capacity of easily classified, tabulated and analyzed.	**1**	**2**	**3**	**4**	**5**

SURVEY EXPERT REVIEW FORM

13	There are be some control questions in the questionnaire which indicate the reliability of the respondent.	**1**	**2**	**3**	**4**	**5**
14	Adequate space for answers are be provided in the questionnaire.	**1**	**2**	**3**	**4**	**5**
15	There are always be provision for indications of uncertainty, e.g. "low score indication"	**1**	**2**	**3**	**4**	**5**
16	Questions are be so worded that ego of the respondents is not injured in any way.	**1**	**2**	**3**	**4**	**5**
17	If there is more than one page of questionnaires, each page of questionnaires are be numbered serially.	**1**	**2**	**3**	**4**	**5**
18	A place in the questionnaire are be provided for the signature of the respondent.	**1**	**2**	**3**	**4**	**5**
19	Brief directions with regard to filling up the questionnaire are be given.	**1**	**2**	**3**	**4**	**5**
20	The physical appearance of the questionnaire are be good. The quality of the paper, along with its colour must be good.	**1**	**2**	**3**	**4**	**5**

REVIEWER OVERALL COMMENTS	

REVIEWER NAME, POSITION SIGNATURE AND STAMP	Mohd Shamsuri Md Saad Coordinator Centre for Technopreneurship Development
DATE	25/11/2020

SURVEY EXPERT REVIEW FORM

This is a form for the expert to review the developed questionnaire survey. The review on overall questionnaire including the suitability of the questions, structure and language.

Title of the research: The determination of the recycler preference index (RPI) for recycling the end-of-life plastic waste in Malaysia

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SURVEY EXPERT REVIEW FORM

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REVIEWER OVERALL COMMENTS	Overall, all questions are easily to understand and most of them are related to the current study. However, in pdf format, some of wording arrangement especially for table header are not properly arranged. On the other hand, I would suggest to add a glossary to ensure that the respondent has same understanding for each of question or terminologies in the survey.

REVIEWER NAME, POSITION SIGNATURE AND STAMP	ASSOC PROF TS DR WAN HASRULNIZZAM BIN WAN MAH MOOD Faculty of Mechnical and Manufacturing Engineering Technology Universiti Teknikal Malaysia Melaka
DATE	12 Nov 2020

SURVEY EXPERT REVIEW FORM

This is a form for the expert to review the developed questionnaire survey. The review on overall questionnaire including the suitability of the questions, structure and language.

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SURVEY EXPERT REVIEW FORM

13	There are be some control questions in the questionnaire which indicate the reliability of the respondent.	**1**	**2**	**3**	●	**5**
14	Adequate space for answers are be provided in the questionnaire.	**1**	**2**	**3**	**4**	**5**
15	There are always be provision for indications of uncertainty, e.g. "low score indication"	**1**	**2**	**3**	**4**	**5**
16	Questions are be so worded that ego of the respondents is not injured in any way.	**1**	**2**	**3**	**4**	**5**
17	If there is more than one page of questionnaires, each page of questionnaires are be numbered serially.	**1**	**2**	**3**	**4**	●
18	A place in the questionnaire are be provided for the signature of the respondent.	**1**	**2**	**3**	**4**	**5**
19	Brief directions with regard to filling up the questionnaire are be given.	**1**	**2**	**3**	●	**5**
20	The physical appearance of the questionnaire are be good. The quality of the paper, along with its colour must be good.	**1**	**2**	**3**	●	**5**

REVIEWER OVERALL COMMENTS	1. Overall is good. 2. For Question A2, if you want to calculate mean in your analysis, you need to ma ke the class size equals. 3. For Questions C1 and D1, the questions are fine. However, respondents need to fill up in details. Could be challenging to get responses from them.

REVIEWER NAME, POSITION SIGNATURE AND STAMP	SAYED KUSHAIRI BIN SAYED NORDIN
DATE	13/11/2020

UTeM UNIVERSITI TEKNIKAL MALAYSIA MELAKA	**SURVEY ON THE RECYCLING DESIRABILITY CRITICAL FACTORS FOR PLASTIC WASTE IN MALAYSIA**

Title of the research: The determination of the recycler preference index (RPI) for recycling the end-of-life plastic waste in malaysia

This survey aims to analyze the ownership of the circular economy and improve decision-making tools for recycling. The following objectives should discuss the goal:

1. To determine the critical factors for the execution of plastic recycling initiatives for Malaysia
2. To identify the end-of-life waste ownership for plastic waste in Malaysia
3. To determine the local-recycling supply chain framework in managing plastic waste in Malaysia.
4. To model the recycler preferences index (RPI) for plastic waste in Malaysia

Conducted by:

Name	Institution	Email	Phone No
Muhammad Ilham B. Abdul Rahim	Universiti Teknikal Malaysia Melaka (UTeM)	b051720008@student.utem.edu.my	+6016-6230456

Students from:

University's Name & Address	**Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka (UTeM), 76100, Hang Tuah Jaya, Melaka, Malaysia.**
University's Logo	UTeM UNIVERSITI TEKNIKAL MALAYSIA MELAKA
Confirmation by	TS DR AL AMIN BIN HJ MOHAMED SULTAN *PENSYARAH KANAN/SENIOR LECTURER* FAKULTI KEJURUTERAAN PEMBUATAN UNIVERSITI TEKNIKAL MALAYSIA MELAKA HANG TUAH JAYA 76100 MELAKA

Notes: Your response will be treated as highly confidential and will only be used for academic and research purposes. Thank you in advance for your willingness to participate in the survey.

UTeM UNIVERSITI TEKNIKAL MALAYSIA MELAKA	**SURVEY ON THE RECYCLING DESIRABILITY CRITICAL FACTORS FOR PLASTIC WASTE IN MALAYSIA**

Section A: General information on your company

Name of company	
Address	
Company stamp	
Number of working days per week	
Operational hours	
Phone no. and Email	

1. What is your nature of business?

Collection and trading centre (collect and trade) ☐

Recycling centre (buy and recycle) ☐

2. How many employees are there in your company?

1 to 29 employees ☐

30 to 75 employees ☐

More than 75 employees ☐

3.Space ownership (Please (/) where applicable)

Self-owned ☐

Rent ☐

Waiting for government approval ☐

4. What is your premise's status?

Status	Description	Tick (/) where Applicable
Temporary license	license or permission to occupy the land for a temporary period. It is not a property or lease. It is limited in terms of time, which is only valid in the year it is issued and will expire on 31 December every year, unless it is terminated earlier by the State Authority	
Permanent license	License or permission to occupy the land permanently. The tenant does not require the conversion of land status and premises relocation.	

Section B: Recycling initiatives

1. The supply chain of the waste

Where is your customer coming from?	Never	Rarely	Sometimes	Often	Always
Nearby, from the same area, within 1-2 km from the centre					
From the same district (or within 2km-10km)					
From different district (or about 11km-30km)					
Different state					
A different country (import activities)					

2. Source of the waste

Type of customer	Never	Rarely	Sometimes	Often	Always	% of the waste
Waste bin						
Household						
Small collector (by lorry, bicycle, etc.)						
Offices/universities						
Manufacturers						
Waste company (Alam flora, MBJB, MBSA, etc.)						
Other (please specify) 1.						

2.						

3. Frequency of waste collection and the collection method

Method	Frequency of collection					Collection method (DTD/WI)
	Daily	Weekly	Monthly	Yearly	Never	
Waste bin						
Household						
Small collector (by lorry, bicycle, etc.)						
Offices/universities						
Manufacturers						
Waste company (Alam flora, MBJB, MBSA, etc.)						
Other (please specify) 1. 2.						

* Door-To-Door (DTD) // Walk In (WI)

4. What is the main product do you collect/recycle/trade?

Product	Never	Rarely	Sometimes	Often	Very frequent	Rank the material you preferred 1-5 (5 is most preferred)	Price sold per kg (RM)
Metal							
Plastic							
Glass							
Wood							
Paper / Cardboard							
Electric and electronic							
Other							

(please specify) 1. 2.							

5. The consideration factors that encourage for collecting/recycling/trading the waste?

Reason	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Large quantity					
High demand					
Profitable					
Technology readiness					
level of cleanliness					
Sorted waste					
Other (please specify) 1. 2.					

6. What are the current challenges for your premise to survive in this industry?

Business challenges	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Explanation
Government policy on licensing						
Taxes or fees						
The complaint from the neighborhood						
Insufficient supply						
Difficult to identify stolen/prohibited item						
Expensive technology or machinery						

Capital, Difficult to get bank loans						
Other (please specify) 1. 2.						

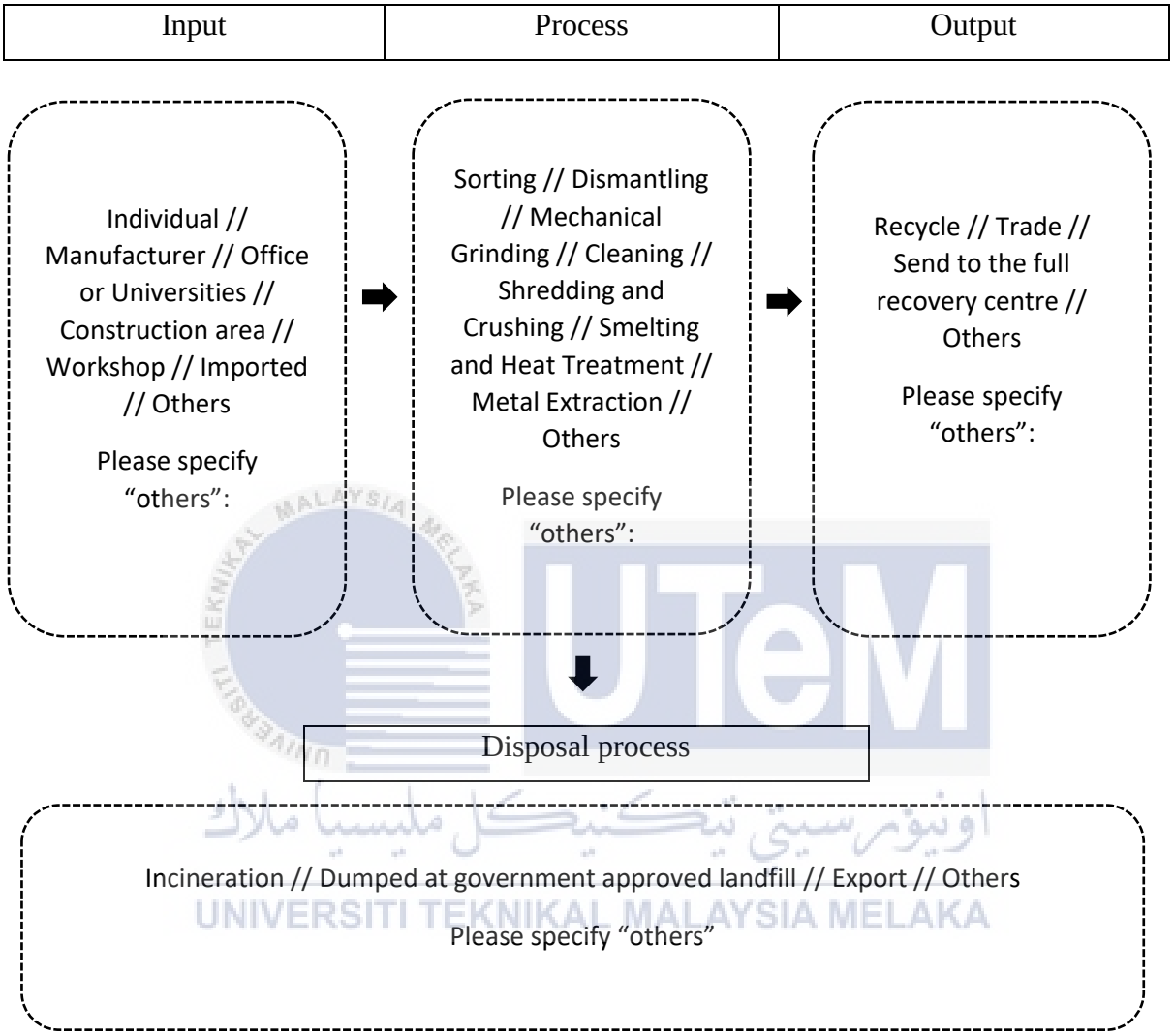
7. What are the drivers for your premises to sustain in this business?

Example	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Wide collaboration					
High consumer awareness in recycling					
Legislation					
High demand for recycled material					
Government funding injection					
Standardize market value recycled material					
Guaranteed volumes of waste supply					
Material scarcity					
Other (please specify) 1. 2.					

8. Who should be responsible for the end-of-life product waste?

Parties	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
End-user					
Manufacturer					
Government / recycler					
Other (please specify) 1. 2.					

9. The direction of the collected waste. (You can circle more than one)



10. Do you receive imported waste?

Yes ☐

No ☐

11. If yes, what kind of imported waste did you received?

Recyclable ☐

Non-recyclable ☐

Mixed ☐

12. Where did you get imported waste from?

SURVEY ON THE RECYCLING DESIRABILITY CRITICAL FACTORS FOR PLASTIC WASTE IN MALAYSIA

Section C: Plastic waste

1. What is the amount of plastic waste received by your premise?

Plastic Category	Code	Abbv.	Numbers of product collected in tons		Recycler accepted price per kg (RM)	Price sold per kg (RM)	Where does the non-recyclable plastics ended up?	Where does recyclable plastic will end up?
			2018	2019				
Polyethene Terephthalate	1	PET, PETE						
High-Density Polyethylene	2	HDPE						
Vinyl (Polyvinyl Chloride)	3	PVC						
Low-Density Polyethylene	4	LDPE						
Polypropylene	5	PP						
Polystyrene	6	PS						
Polymethyl Methacrylate (Cod	7	PMMA						
Acrylonitrile Butadiene Styrene (Code 8)	8	ABS						
Polycarbonate (Code 9)	9	PC						
Other (please specify) 1. 2. 3.								

2. What is the preferable plastic you would like to recycle?

Plastic category	Code	Not at all importance	Slightly important	Moderately important	Very important	Extremely important
Polyethene Terephthalate	1					
High-Density Polyethylene	2					
Vinyl (Polyvinyl Chloride)	3					
Low-Density Polyethylene	4					
Polypropylene	5					
Polystyrene	6					
Polymethyl Methacrylate	7					
Acrylonitrile Butadiene Styrene	8					
Polycarbonate	9					
Other (please specify) 1. 2. 3.						

UTeM UNIVERSITI TEKNIKAL MALAYSIA MELAKA	**SURVEY ON THE RECYCLING DESIRABILITY CRITICAL FACTORS FOR PLASTIC WASTE IN MALAYSIA**

3. Tick the process available in your premise and tick the process you need according to your premise priority

Process	**Tick where applicable**	**Which is the process that you prefer to do/have?**				
		Strongly disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**
Incineration						
Sorting						
Dismantling						
Mechanical grinding						
Shredding and crushing						
Smelting or heat treatment						
Metal extraction						
Other;(please specify) 1. 2.						

4. If the university research team wants to send the 'Recycling Business Needs in Malaysia,' what would you like to convey to the government to empower your recycling business activities?

1.
2.
3.
4.
5.
6.

5. Would you like to receive a summary of the result of the survey?

Yes ☐

No ☐

Thank you very much for your time and kind co-operation

FRAMEWORK EXPERT REVIEW FORM

Title of the research: Determination of the recycling desirability critical factors for plastic in Malaysia.

This is a form for the expert to review the constructed framework based on the student scope of research. The objective of the research to develop local-recycling supply chain for plastic management.

	Items and Agreement Statement	Level of agreement on the quality of the developed items in the questionnaire (1 is the lowest score – 5 is the highest score) Please circle one				
1	The process flow is inter-related from one source to another.	1	2	3	(4)	5
2	The constructed framework is within the current framework	1	2	3	(4)	5
3	The technical terms are correctly used in a framework as far as possible.	1	2	3	(4)	5
4	The constructed framework flow in logical sequence moving from basic to the manufacturer	1	2	3	(4)	5

REVIEWER OVERALL COMMENTS	The diagram must be given a spesific title.
REVIEWER NAME, POSITION, SIGNATURE AND STAMP	HASNITA BINTI MANSOR Pegawai Kawalan Alam Sekitar C44 Jabatan Alam Sekitar W.P Kuala Lumpur
DATE	23 / 12 / 2020

Recycling centre premises









Local authorities

Police	Majlis bandaran	DOE