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

MUHAMMAD ILHAM BIN ABDUL RAHIM

B051720008

970127-10-5625

FACULTY OF MANUFACTURING ENGINEERING

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Taman Sri Sentosa, Pekan Nenas.
Johor.

Tarikh: 9th February 2021

Cop Rasmi:
MOHD SHAHRIZAN BIN OTHMAN
Lecturer
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka

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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.

Signature :

Name : MUHAMMAD ILHAM BIN ABDUL RAHIM

Date : 9th February 2021

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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.

The member of the supervisory committee is as follow:

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……..

(Principal Supervisor) – Signature & Stamp

MOHD SHAHRIZAN BIN OTHMAN
Lecturer
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka

……

(Co-Supervisor) – Signature & Stamp

TS DR AL AMIN BIN HJ MOHAMED SULTAN
PENSYARAH KANAN/SENIOR LECTURER
FAKULTI KEJURUTERAAN PEMBUATAN
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
HANG TUAH JAYA 76100 MELAKA

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.

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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.

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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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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.

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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.

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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).

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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.

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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

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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.

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