

**PLASTIC WASTE INTO RESOURCES :  
ECO-PLASTIC FURNITURE**

**ROHANI BINTI HASANUDDIN**

**FACULTY OF ENGINEERING  
UNIVERSITY MALAYSIA SABAH  
2022**



**UMS**  
UNIVERSITI MALAYSIA SABAH

**PLASTIC WASTE INTO RESOURCES :  
ECO-PLASTIC FURNITURE**

**ROHANI BINTI HASANUDDIN**

**THESIS SUBMITTED IN PARTIAL  
FULFILMENT OF THE REQUIREMENT FOR  
THE DEGREE OF BACHELOR OF CIVIL  
ENGINEERING**

**FACULTY OF ENGINEERING  
UNIVERSITY MALAYSIA SABAH  
2022**



**UMS**  
UNIVERSITI MALAYSIA SABAH

**UNIVERSITI MALAYSIA SABAH****BORANG PENGESAHAN STATUS TESIS****JUDUL** : PLASTIC WASTE INTO RESOURCES : ECO-PLASTIC FURNITURE**IJAZAH**: IJAZAH SARJANA MUDA**BIDANG**: KEJURUTERAAN AWAM

SAYA Rohani Binti Hasanuddin, Sesi 2021/2022, mengaku membenarkan tesis Sarjana Muda ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:

1. Tesis ini adalah hak milik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan ( / ):

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di AKTA RAHSIA RASMI 1972)

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

/ TIDAK TERHAD



**ROHANI BINTI HASANUDDIN**  
**BK18110050**

Disahkan oleh:  
**ANITA BINTI ARSAD**  
PUSTAKAWAN KANAN  
UNIVERSITI MALAYSIA SABAH

(TANDATANGAN PUSTAKAWAN)



(PROF. IR. DR. NURMIN BOLONG)

TARIKH: 01 AUGUST 2022

## Catatan:

\*Potong yang tidak berkenaan.

\*Jika tesis ini SULIT dan TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.

\*Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana Secara Penyelidikan atau disertai bagi pengajian secara kerja kursus dan Laporan Projek Sarjana Muda (LPSM).

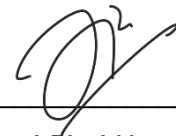


## DECLARATION

I, Rohani Binti Hasanuddin, BK18110050 hereby declare that this thesis entitled "Plastic Waste Into Resources That Focus On Eco-Plastic Furniture" submitted to University Malaysia Sabah as partial fulfillment of the prerequisites for the level of Bachelor of Civil Engineering, has not been acceded to any other university for any level. I also attest that this is a record of an original work executed by me under guidance of Prof. Ir. Dr. Nurmin Binti Bolong, except for quotation and summaries sources of which have been duly acknowledged.

This thesis accessible for consultation within the campus library and may be re-published or lend to other libraries.

30<sup>th</sup> JUNE 2022



---

Rohani Binti Hasanuddin  
BK18110050

## CERTIFIED BY



---

PROF. IR.DR. NURMIN BINTI BOLONG

SUPERVISOR



**UMS**  
UNIVERSITI MALAYSIA SABAH

## CERTIFICATION

NAME : **ROHANI BINTI HASANUDDIN**  
MATRIC NO : **BK18110050**  
TITTLE : **PLASTIC WASTE INTO RESOURCES,  
ECO-PLASTIC FURNITURE**  
DEGREE : **UNDERGRADUATE  
(CIVIL ENGINEERING)**  
DATE : **30<sup>TH</sup> JUNE 2022**

## CERTIFIED BY

**PRINCIPAL SUPERVISOR**

Signature

PROF. IR. DR. NURMIN BINTI BOLONG



**UMS**  
UNIVERSITI MALAYSIA SABAH

## ACKNOWLEDGMENT

First of all, I would like to stretch my gratitude to Professor Ir. Dr. Nurmin Binti Bolong, for his willingness to guide me to conduct a tittle research under his supervisor. As my supervisor she never giving up on me and keep on motivates me during my hard time with my thesis and laboratory work.

Special thanks also to Pn Zazila as a Director of Ez Plast and the team, that giving me the best guiding and offered the factory to easier me make a sample of Eco-palstic furniture. I'm really appreciate and thank fully for the hard work together with me in making of sample. My grateful appreciation also goes to all the technicians especially En. Azli from Faculty of Forestry and assistant technician Ms. Dayang always give me advice and support throughout the experiments in the laboratory.

Not forgetting my family for their moral support throughout my study and also providing me with all my needs during study in University Malaysia Sabah. Their never ending support from every aspect has lighten my burden. Last but not least to my supportive friends should be recognized especially to Marsylthie who have been helping me throughout my research period. They never forsake me and always giving me moral support and helping hands towards each other.

Finally, thanks to all who are involved directly and indirectly from the beginning of the research until the success of writing this thesis. Their help are much appreciated.

## ABSTRACT

Plastics are a relatively inexpensive, flexible, and durable material that can be easily molded into a number of shapes and sizes for a wide variety of purposes. As a result, plastic production has increased dramatically during the last 60 years. Plastic trash is a problem that affects everyone, whether on a worldwide scale or in Malaysia, with a particular emphasis on Sabah. On those topics, our research aims to assist in resolving the issue of plastic waste reduction. The purpose of this research is to evaluate fabricate HDPE plastic waste into Eco-plastic furniture. Following that, this research will conduct laboratory tests on the Eco-plastic sample to determine its engineering properties such as tensile strength test, flexural test, and water absorption test. Each lab test requires at least five samples to be tested. The final step is to conduct a questionnaire survey to ascertain the respondent user's perspective on the Eco- plastic furniture product. Thus, at the conclusion of the research, it will be possible to determine whether the Eco-plastic furniture met the requirements, particularly in the laboratory test, and how the product was received by the participant user.

## ABSTRAK

*Plastik ialah bahan yang agak murah, fleksibel dan tahan lama yang boleh dibentuk dengan mudah kepada beberapa bentuk dan saiz untuk pelbagai tujuan. Akibatnya, pengeluaran plastik telah meningkat secara mendadak dalam tempoh 60 tahun yang lalu. Sampah plastik adalah masalah yang memberi kesan kepada semua orang, sama ada pada skala dunia atau di Malaysia, dengan penekanan khusus terhadap Sabah. Mengenai topik tersebut, penyelidikan kami bertujuan untuk membantu dalam menyelesaikan isu pengurangan sisa plastik. Tujuan penyelidikan ini adalah untuk menilai fabrikasi sisa plastik HDPE ke dalam perabot Eco-plastik. Selepas itu, penyelidikan ini akan menjalankan ujian makmal ke atas sampel Eco-plastik untuk menentukan sifat kejuruteraannya seperti ujian kekuatan tegangan, ujian lenturan, dan ujian penyerapan air. Setiap ujian makmal memerlukan sekurang-kurangnya lima sampel untuk diuji. Langkah terakhir ialah menjalankan tinjauan soal selidik untuk memastikan perspektif pengguna responden terhadap produk perabot Eco-plastik. Oleh itu, pada akhir penyelidikan, adalah mungkin untuk menentukan sama ada perabot Eco-plastik memenuhi keperluan, terutamanya dalam ujian makmal, dan bagaimana produk itu diterima oleh pengguna peserta.*





# TABLE OF CONTENTS

	<b>Page</b>
<b>DECLARATION</b>	<b>i</b>
<b>CERTIFICATION</b>	<b>ii</b>
<b>ACKNOWLEDMENT</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>iv</b>
<b>ABSTRAK</b>	<b>v</b>
<b>TABLE OF CONTENT</b>	<b>vi - viii</b>
<b>LIST PF TABLES</b>	<b>ix</b>
<b>LIST OF FIGURES</b>	<b>x-xi</b>
<b>LIST OF ABBREVIATION</b>	<b>xii</b>
<b>LIST OF APPENDIX</b>	<b>xiii</b>

## **CHAPTER 1 : INTRODUCTION**

1.1	Introduction	1-2
1.2	Background of study	2-3
1.3	Problem Statement	3-4
1.4	Objective	5
1.5	Scope of work	5-6

## **CHAPTER 2 : LITERTURE REVIEW**

2.1	Introduction	7
2.2	Plastic Waste Issue In Malaysia	7-8
2.3	Type and Classification of Plastic Waste	8-10
2.4	Plastic Properties	10
	2.4.1 High Density Polyethylene (HDPE)	10-12
	2.4.2 Tensile Strength	12-14
	2.4.3 Flexural Test	15
	2.4.4 Water Absorption	16-17
2.5	Technology	17
	2.5.1 Technology in United State	17-18
	2.5.2 Plasma Pyrolysis Technology	18
	2.5.3 Non-biodegradagable Technology	19
2.6	Other application of Plastic Waste	19



2.6.1	Plastic Waste as Concrete Material	19-20
2.6.2	Wood Plastic Composites	20-21
2.6.3	Plastic Waste as Soil Stabilizer	21-22

### **CHAPTER 3 : METHODOLOGY**

3.1	Introduction	23
3.1.1	Research Design Flow	24
3.2	Waste Generation Data Collection	25
3.2.1	GNC Recycle Centre SDN BHD	25
3.2.2	TZU CHI Recycle Centre	26
3.2.3	Happy Plastic Recycle Centre	26-27
3.3	Preparation of Specimen	27
3.3.1	Sorting and Cleaning	27-28
3.3.2	Cutting and Shredding	28
3.3.3	Moulding	29
3.4	Laboratory Testing	29
3.4.1	Tensile Strength Test (ASTM D638)	30-32
3.4.2	Flexural Test (ASTM D7264)	32-33
3.4.3	Moisture / Water Absorption Test (ASTM D570)	34-35
3.5	Questionnaire	35
3.5.1	Perspective From User	35
3.5.2	Feedback From Active Participant	35-36

### **CHAPTER 4 : RESULT AND DISCUSSION**

4.1	Introduction	37
4.2	HDPE Plastic Waste Data Collection	37-38
4.3	Mechanical and Physical Properties	38
4.3.1	Tensile Strength Test	38-41
4.3.2	Flexural Test	41-44
4.3.3	Water Absorption	44-45
4.4	Questionnaire	45
4.4.1	Perspective from User	45-47
4.4.2	Feedback from Active Participant	47-50



## **CHAPTER 5 : CONCLUSION AND RECOMMENDATION**

5.1	Conclusion	51-52
5.2	Recommendation	52
5.2.1	Machinery	52
5.2.2	Variety of sample thickness	52
5.2.3	Product Finishing	52

<b>References</b>	53-58
-------------------	-------

<b>Appendix</b>	59-77
-----------------	-------



**LIST OF TABLE****Page**

Table 1.5	Objective are related with scope of work and limitation	6
Table 2.3	Plastic Waste and its Sources	10
Table 2.4.1 (a)	Advantage of HDPE Plastic	11
Table 2.4.1 (b)	Physical and Mechanical Properties of HDPE Plastic	12
Table 2.4.2	Summary of Tensile Strength test data from various Sources	14
Table 2.4.3	Summary of water absorption data from various sources	17
Table 3.4.3	Water absorption value for common polymers	14
Table 3.5.1	Questionnaire survey according to plastic waste	33
Table 3.5.2	Questionnaire survey according to Eco-plastic furniture	34
Table 4.2 (a)	Summary of HDPE plastic waste data collection	38
Table 4.2 (b)	Data Processing on produce of one set Eco-Plastic Furniture product	38

<b>LIST OF FIGURE</b>		<b>Page</b>
Figure 1.3	Annual per capita plastic packaging consumption six countries (kg)	4
Figure 2.4.2 (a)	Stress-Strain curve for HDPE and the lends containing 20, 30, 40% of EVA	13
Figure 2.4.2 (b)	Comparison of tensile strength and Young Modulus for HDPE, EVA blends as a function of EVA content	13
Figure 2.4.2 (c)	Tensile strength of HDPE and fiber HDPE bio composited After surface modification	13
Figure 2.4.2 (d)	Elastic modulus and ultimate tensile strength comparison Due to thickness effect for virgin and regrind HDPE at Room temperature	14
Figure 2.4.3	Flexural stress-strain curve for PP and HDPE	15
Figure 2.5.2	Experimental setup of plastic waste plasma are pyrolyser	16
Figure 2.6.2 (a)	Modulud of Elasticity (MOE)	20
Figure 2.6.2 (b)	Modulus of Rapture (MOR)	21
Figure 3.1.1	Methodology workflow	24
Figure 3.2.1	Company GNC Recycle Centre SDN BHD	25
Figure 3.2.2	Company TZU CHI Recycling	26
Figure 3.3.1	Sorting and cleaning of plastic waste	28
Figure 3.3.2	Cutting and shredding plastic waste	28
Figure 3.3.3	Moulding process and the result of Eco-plastic sample	29
Figure 3.4.1	Tensile Strength test slow chart procedure	31
Figure 3.4.2	Flexural test Procedure Flow chart	33
Figure 3.4.3	Water Absorption Procedure Flow Chart	34
Figure 4.3.1 (a)	Result of Thickness Vs Maximum Load for Eco-Plastic Furniture Product	39
Figure 4.3.2 (b)	Result of Thickness Vs Elastic Modulus for Eco-Plastic Furniture Product	40
Figure 4.3.1 (c)	Result of Thickness Vs Tensile Strength for Eco-Plastic	40



<b>LIST OF FIGURE</b>		<b>Page</b>
Figure 4.3.1 (d)	Condition after Tensile Strength Process	41
Figure 4.3.2 (a)	Result of Thickness Vs Maximum Load for Flexural test	42
Figure 4.3.2 (b)	Result of Thickness Vs Elongation length of the Eco- Plastic Furniture Product	43
Figure 4.3.2 (c)	Result of Thickness Vs Modulus of Elasticity of Eco- Plastic Furniture Product	44
Figure 4.3.2 (d)	Result of Thickness Vs Modulus of Rapture of Eco- Plastic Furniture Product	44
Figure 4.3.3	Water Absorption Result	46
Figure 4.4.1 (a)	Result of aware of the amount of Plastic Waste Produced annually	46
Figure 4.4.1 (b)	Result of recycling own plastic waste at home	45
Figure 4.4.1 (c)	Result of the often collect and recycle own plastic at Home	47
Figure 4.4.1 (d)	Score marks according to Eco-Plastic furniture product Review	47
Figure 4.4.2 (a)	Result of major involvement of active participant	48
Figure 4.4.2 (b)	Result level of difficulty for stage process	49
Figure 4.4.2 (c)	Result of rating marks according to like the joining as a Active participant	49
Figure 4.4.2 (d)	Result on offer if there's some company need to continue The project	49

## LIST OF ABBREVIATION

MYR	Malaysia Ringgit
PE	Polyethylene
PVC	Polyvinyl Chloride
LDPE	Low Density Polyethylene
HDPE	High Density Polyethylene
PET	Polyethylene Teryphthalate
PP	Polypropylene
PS	Polystyrene
MOE	Modulus of Elasticity
MOR	Modulus of Rapture

## LIST OF APPENDIX

Appendix 1	Disposal site in Sabah's District
Appendix 2	Prepared Sample
Appendix 3	Before and After Tensile Strength Test
Appendix 4	Before and After Flexural Test
Appendix 5	Prepared Sample, before and after water absorption test
Appendix 6	Tensile Strength Test Report
Appendix 7	Flexural Test Report
Appendix 8	Standard Deviation Result
Appendix 9	Water Absorption Test Report





# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Plastics are a low-cost, flexible, and durable material that can readily be molded into a range of forms and sizes for a variety of applications. As a result, the production of plastic has expanded significantly during the previous 60 years. However, with the current rates of usage and disposal, a slew of environmental hazards arise. Around 4% of global oil and gas production, a non-renewable resource, is utilized as a feed stock for plastic, with a further 3–4% required to power their creation (Chen, H. L. et al. 2021).

Plastic is used to create garbage packaging and other one-time-use things that have been destroyed within a day of creation. We can deduce from these two studies in itself that our present rate of plastic consumption is unhealthy. Furthermore, due to the endurance of the polymeric used, a significant amount of wasted later part plastic is collected as waste in landfills and outdoor spaces throughout the world.

Recycling is undoubtedly a waste treatment approach, but it might also be considered an illustration of ecological sustainability, which occurs when a rich biodiversity contains no trash but still only outputs (Frosch and Gallopoulos, 1989). Biodegradable plastics is one technique to aid the ecosystem and conserve natural resources. Essentially, increased amounts of recycling, such as reducing use, reusing, repairing, or reprocessing, can enable a product to perform at a certain standard of support with very little substance than would be necessary elsewhere (Faraca, G. and Astrup, T. 2019)

In contrast, recycling can improve energy efficiency and resources necessary for each unit of production, hence boosting the overall Eco-efficiency of the process (Yang, Te Hsin et al. 2012). Overall system protracted sustainable development will be influenced by the ability to maintain the very same amount of factors of production, forms of energy, and influence of the environment influences on an ecosystem as they were previously.

## **1.2 Background of study**

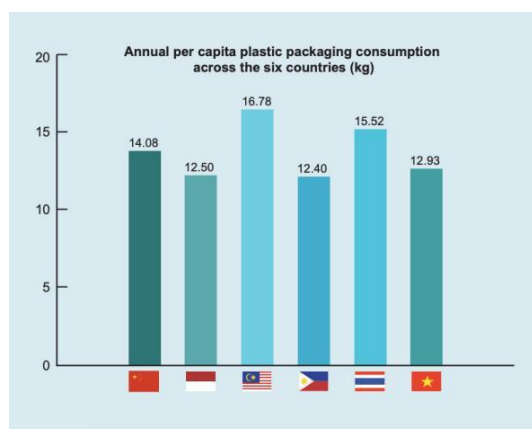
Plastics can be recycled in a variety of methods, and the ease with which they can be recycled varies by polymer type, package design, and product type. Multi-layer and multi-component packages, for example, are more difficult and expensive to recycle than rigid containers made of a single polymer (Kong, S. C. et al. 2017). Thermoplastics, such as PET, PE, and PP, have a high mechanical recycling capability. Thermos setting polymers, such as unsaturated polyester or epoxy resin, cannot be mechanically recycled unless they are size-reduced or pulverized to tiny particles or powders and then re-used as filler materials (Kong, S. C. et al. 2017). But since we are plan to do plastic waste into resources that focus on making furniture that most suitable type of plastic using is HDPE.

The capacity to substitute recycled plastic for virgin polymer is mostly determined by the purity of the recovered plastic feed and the properties required by the plastic product to be manufactured. As a result, existing post-consumer waste recycling programmers focus on the easiest-to-separate products, such as PET soft-drink and water bottles, and HDPE milk bottles, which can be positively identified and sorted out of a mixed waste stream. Multi-layer/multi-component items, on the other hand, are rarely recycled due to contamination between polymer kinds. Collection, sorting, cleaning, size reduction and separation, and/or compatibility to reduce contamination by incompatible polymers are all critical procedures in post-consumer recycling.

Plastic garbage can be collected through 'bring programme or at the curb. Bring-systems tend to achieve poor collection rates in the absence of either highly committed public behaviour or deposit reimbursement schemes that give a direct economic incentive to participate. As a result, recyclables are increasingly being collected at the curb alongside MSW. To enhance the economic effectiveness of these programme, most kerbside collections are of mixed recyclables (paper/board, glass, aluminium, steel, and plastic containers). While kerbside collection systems have been relatively effective in collecting plastic bottle packaging from homes, only 30-40% of post-consumer plastic bottles are recovered in terms of overall consumption, as much of this type of packaging originates from food and beverages eaten away from home.

### 1.3 Problem Statement

The increased of population in Malaysia had make the solid waste generation increased. More than 75% of the material value of plastics worth US\$6 billion (RM24.7 billion) is lost every year across Malaysia, the Philippines and Thailand, according to a recent study by World Bank (WWI Malaysia 2021). In Malaysia alone, 1.07 Million tones per year of plastics are disposed of and 81% of the material value of plastic is lost. Refer to the graph below show Annual per capita plastic packaging consumption of 16.78 kg. It is show Malaysia has the highest per capita plastic packaging consumption compared to neighbouring countries (Chukwuma, E. C. et al. 2019).



### **Figure 1.3 Annual per capita plastic packaging consumption across the six countries (kg)**

Source : WWI Malaysia, 2021

In 2021 solid waste generation in Sabah was 2,062,3900 and the value keep increasing year by year where the waste generation rate in Sabah is 0.7kg/capita. In 2010 the plastic waste is 17 % (tons/days) from the total solid waste in Sabah (Kota Kinabalu City Hall, 2013). The increase of solid waste in Malaysia especially Sabah can't be cover by solid solid disposal site or incineration anymore and caused pollution rate increasing.

In Sabah, there are 23 solid waste disposal site and out of 23, 14 disposal site located in a unsuitable place such as swamp, valleys and side slope. The other 7 disposal site were fairly suitable. From 23 disposal only one can be categorized as sanitary land fill operated at level IV located at Kayu Madang, Telipok Sabah. There also some privatized disposal site at Sandakan, Lahad Datu and Tawau that well operated and maintained (Fatma Sabariah et al, 2013). Until today there's only 19 disposal site that still operating (Ministry of Housing and Local Government, 2013). **Appendix 1** shows the disposal in Sabah and the sanitary level of the site. Out of 18 sites only one is sanitary.

Land filling of the solid waste disposal site is a process where waste material is buried in a specific area with specific method. This process may result in affecting the ground water resources, disturbing the characteristics of soil and will make the surrounding area not suitable for any human activities (Chukwuma, E. C. et al. 2019). The availability of land filling site also very low nowadays. Incineration of plastic waste also will produce CO and CO<sub>2</sub> and this gases will contribute in the cause of global warming and air pollution (Chen, H. L. et al. 2021).

To overcome this problem, plastic waste is used to become eco-plastic furniture. The availability plastic waste are very high and the price is also very cheaper.

## 1.4 Objective

The objectives of this research are:

- i. To evaluate data collection of HDPE plastic waste generation in Kota Kinabalu area
- ii. To evaluate the engineering characteristic for material of Eco-Plastic Furniture in terms of Tensile Strength test, Flexural test and Water absorption test
- iii. To evaluate respondent user and active participant of Eco-Plastic Furniture product

## 1.5 Scope of work

For the first objective, mostly just focus on HDPE plastic that need process until its become Eco-plastic furniture. In term become Eco-plastic furniture there are many process must to start with collection of plastic, then cleaning such as remove the stickers, sorting that means only HDPE plastic are required then continue to cutting to small pieces to make sure the shredder's machine can operation the plastic and cut into a more small. The processing on making sample and product are making at Happy Plastic Recycle Center at Kepayan. All the machine are provided at the factory. After that, the process go to moulding process that finally become a Eco-plastic sample. For the collection of plastic waste only focused at UMS and One Borneo area.

To overcome the second objective, the Eco-plastic furniture sample need to know of their engineering characteristic. So that the sample need to do Tensile strength, flexural test and water absorption test. The result of all the test will be compare with other of construction material. The test are conducting in Laboratory Faculty of Forestry and environmental lab at Faculty of Engineering

To accomplish the third objective, evaluation of respondent user for Eco-plastic furniture must be done. Since the product already become a furniture, the evaluation from respondent can know what their perspective about the product.

From the respondent can show either the product can be accepted from their sight and additional part are include of the perspective from the active participant in joining the whole process on making the Eco-Plastic furniture product. The product are place at entrance of foyer at Faculty of Engineering. So, the feedback received from the student, staff and lecture who are passing through the product.

**Table 1.5. Objective are related with scope of work and limitation.**

Objective	Limitation
1. To evaluate data collection of HDPE plastic waste generation at Kota Kinabalu area.	<ul style="list-style-type: none"> <li>- Plastic waste collection only in UMS and One Borneo Area</li> <li>- Data also are collected at three different recycle centre at Kota Kinabalu area.</li> </ul>
2. To evaluate the engineering characteristic for material of Eco-Plastic Furniture in terms of Tensile Strength test, Frexural test and Water absorption test	<ul style="list-style-type: none"> <li>- Laboratory Testing for Tensile and Flexural test are conducted at Lab of Faculty of Forestry</li> <li>- Water Absorption test are conducted at Environmental Lab at Faculty of Engineering</li> </ul>
3. To evaluate respondent user and active participant of Eco-Plastic Furniture product	<ul style="list-style-type: none"> <li>- Respondent user only focused at Faculty of Engineering area</li> <li>- Active participant only focus on the team member are participant throughout the product processing.</li> </ul>

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter will discuss any past study of research that linked with the plastic waste into Eco-plastic furniture. The problem statement and any kind of engineering characteristic that provide in this research also reveal as a addition information for the comparison and reference soon in other chapter. The characteristics of plastic waste is shown based on the past laboratory experiment that conducted various researchers. Past and recent application of plastic waste into any plastic waste design in real construction are also discusses in this chapter. Also other application of plastic waste are discusses in this chapter that show the variability of usage of plastic waste as construction material.

#### **2.2 Plastic Waste Issue in Malaysia**

Since 2004, the manufacture of plastics has seen one of the fastest growth rates of any sector (GESB 2011). Malaysia has one of the greatest manufacturing sectors in the world with more than 1,300 plastic producers (MESTECC 2018). and in 2016, resins worth 30 billion Malaysian Ringgits (MYR) were shipped to companies that make plastic all around the world (MESTECC 2018). The Malaysian plastic industry has been divided into seven primary sectors, including plastic furniture and medical devices as well as the subsectors of construction, electronics, automotive, agricultural, housing, packaging, and household goods (GESB 2011). According to worldwide trends, Malaysia's top use for plastic production is packaging (NSWMD 2015).

According to Moh and Manaf (2017), one of the major environmental issues in Malaysia is solid waste management, which is exacerbated by the country's population increase and the construction of landfill sites. These issues include contamination of the air, water, and land, as well as climate change caused by the emission of greenhouse gases into the environment during industrial operations. Many of the issues originate from the environmental resilience and hence lifespan of plastics.

The accumulation of pervasive and persistent waste plastic has concomitantly increased in landfills and the environment. Thinounn and smith (2020) has found that the societal , ecological, and economic problem plastic waste or pollution demand immediate and decisive action. In 2015, only 9% of plastic waste was successfully recycled in the United States. The major current recycling processes focus on the mechanical recycling of plastic waste. Chen et al (2021) also has found that Malaysia is tracking global trends in both the overall generation of plastic waste and the consumption of single-use plastics and since 2017 has been the world's largest importer of plastic waste/ these elements create a number of major challenges for the country's waste management systems.

### **2.3 Type and Classification of Plastic Waste**

Plastics are incredibly durable and degrade at a snail's pace, making them ideal for outdoor use. Plastic's chemical links, which make it so durable, also make it resistant to the natural degrading processes that occur in the environment (Grellmann, W. 2014). Approximately one billion tonnes of plastic have been dumped since the 1950s, and it is feasible that they will continue to exist for hundreds, if not thousands, of years in the environment (Ilyas, M. et al. 2018). Curdles, the raw material utilized in the production of all plastics, are perhaps the most significant environmental threat posed by the material. Taifor Azeez, A. (2017) has been researching minuscule pre-plastic pellets that are mistaken for food by a large number of fish and birds, resulting in their death. Save for life-critical fire suppression systems, polystyrene manufacture contributed to the depletion of the

