UNIVERSITI PUTRA MALAYSIA

UTILIZATION OF SCREW-PINE LEAF BIO-COMPOSITE FOR HOME ACCESSORIES

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for degree of Master of Science

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January 2019

Chair : Khairul Aidil Azlin bin Abd Rahman, PhD
Faculty : Design and Architecture

Screw-pine leaf is used in traditional craft product in Malaysia and some part of South East Asia. This traditional material is well-known as *mengkuang* in Malays is an appropriate material to produce the daily necessity products such as cloth storage box, food cover, mat and bag. There are three types of screw-pine leaf used in Malaysia which the usage of each of the screw- pine leaf in the craft product of is variety due to the differences of the leaves strength. The research focus on *Pandanus atrocarpus* locally called *mengkuang minyak* and it is the most durable among the three types of screw-pine leaf. There is an issue about the possibility on the extinction of the *mengkuang* plaiting heritage in Malaysia. The young generation has less concern in continuity of this heritage skill and business. It is the derivation issue of the research problem that shows the underutilization of the screw-pine leaf as material and less application on high value added product such as home accessories. Working together with community from Kampung Bentan , Pahang and Kampung Air Molek, Melaka, the researcher conducted a study on producing a screw-pine leaf bio-composite that will encourage and promote the utilization of the screw-pine leaf in high value product. However, in order to apply the screw-pine leaf on high value added product as bio-composite material, documented data is needed on the properties of this material. Through the early process of producing the screw-pine leaf bio-composite, the researcher identify the needs of treatments on screw-pine leaf. Several experiment included alkali treatment (sodium hydroxide), acid treatment (boric acid) and non-treatment woven is conducted. The sample of the screw-pine leaf bio-composite is produced by using the lamination hand lay–up process of cold press method to introduce the screw-pine leaf bio-composite to the rural business. The testing on tensile and flexural strength is studied to prove the screw-pine leaf can be applied as material as any other natural fiber bio-composite. The testing conducted referring to the ASTM Standard; tensile strength ASTM D638 and flexural strength ASTM D790-07. The test shows the highest tensile

strength is record by acid treated screw-pine leaf bio-composite with 1.878 MPa and 1.877 GPa for the tensile young modulus. While, the flexural strength is 8.57 MPa and 0.538 GPa for the flexural young modulus is recorded by untreated screw-pine leaf bio-composite. Comparison to banana leaf bio-composite with similar fabrication process, the screw-pine leaf bio-composite in this study shows better mechanical properties. The researcher applied the screw-pine leaf bio-composite in various design artefacts consists of furniture, lighting and small decorative products. The artefact is validated through a survey that studying the acceptance of the screw-pine leaf bio-composite material in product design based on the listed attributes. The attributes were collected through brainstorming from a group of designers that experienced in marketing a product. The result of the validation survey shows an acceptance from public and designers especially on the form and the story as traditional material of the proposed product. Also, the survey shows that, there are high-potential marketability for the product with the application of screw-pine leafs. Particularly for the small decorative product and the survey shows that the lighting product is the most suitable to apply the screw-pine leaf bio-composite. The survey also shows the demand that position the screw-pine leaf product in the market. Hence, by proposing an alternative material of screw-pine leaf bio-composite, the range of screw-pine leaf product based can be various. With this kind of approach, there are high possibilities that the rural business of screw-pine leaf heritage can be revitalized and encourage the utilization of the screw-pine leaves.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Master Sains

PENGUNAAN BIOKOMPOSIT MENGKUANG BAGI AKSESORI RUMAH

Oleh

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Daun mengkuang merupakan bahan yang sering digunakan dalan penghasilan barangan kraf di Malaysia dan beberapa tempat di Asia Tenggara. Bahan tradisional ini lebih dikenali sebagai mengkuang dalam Bahasa Melayu adalah bahan yang sesuai bagi menghasilkan produk kegunaan harian seperti kotak penyimpan baju, tudung saji, tikar dan beg. Terdapat tiga jenis daun mengkuang yang sering digunakan oleh ahli kraf Malaysia dimana setiap jenis daun mengkuang mempunyai kegunaan yang berbeza dalam penghasilan kraftangan mengikut kekuatan setiap daun. Dalam kajian ini, pengkaji memberi fokus kepada Pandanus atrocarpus yang dikenali oleh orang tempatan sebagai mengkuang minyak adalah daun yang kuat dan lasak antara ketiga-tiga jenis daun tersebut. Dalam pada itu, terdapat isu di dalam Malaysia yang menyatakan berkemungkinannya seni warisan penghasilan anyaman mengkuang ini akan pupus. Generasi muda semakin kurang berminat dalam mempelajari kemahiran penghasilan mengkuang dan menyambung perniagaan warisan ini. Isu ini membawa kepada permasalahan kajian yang mendapati bahawa daun mengkuang semakin kurang digunakan dan penghasilan produk berimpak tinggi seperti produk hiasan rumah juga kurang. Berkererjasama dengan komuniti dari Kampuang Bentan Pahang dan Kampung Air Molek, Melaka, pengkaji menjalankan kajian dalam menghasilkan biokomposit mengkuang bagi menggalakkan dan mempromosi penggunaan daun mengkuang kepada produk berimpak tinggi. Walau bagaimanapun, bagi mengaplikasikan penggunaan daun mengkuang kepada produk berimpak tinggi dengan menggunakan bahan biokomposit, dokumentasi berkaitan sifat bahan mengkuang diperlukan. Melalui kajian awal dalam menghasilkan biokomposit mengkuang, pengkaji mendapati daun mengkuang perlu menjalani proses rawatan kimia. Beberapa kajian dijalankan ke atas daun mengkuang termasuk rawatan alkali (*sodium hydroxide*), rawatan asid (*boric acid*) dan anyaman mengkuang yang tidak dirawat. Kajian menghasilkan sampel biokomposit mengkuang menggunakan teknik laminasi tekan sejuk bertujuan mudah untuk diperkenalkan kepada komuniti yang menjalankan perniagaan warisan ini. Ujian ketahanan tegangan dan lenturan dijalankan bagi membuktikan bahawa daun mengkuang dapat diaplikasikan sebagai bahan sepertimana bahan biokomposit serat semulajadi yang lain. Ujian dijalankan mengikut standard

ASTM; ketahanan tegangan ASTM D638 dan ketahanan lenturan ASTM D790-07. Ujian ketahanan tegangan memberi bacaan tertinggi oleh sampel biokomposit mengkuang yang dirawat asid dengan 1.878 MPa dan 1.877 GPa bagi tegangan modulus. Manakala, ujian ketahanan kelenturan menunjukkan 8.57 MPa dan 0.538 GPa adalah dari biokomposit mengkuang yang tidak dirawat. Perbandingan antara komposit daun pisang yang menggunakan kaedah penghasilan yang sama menunjukkan biokomposit mengkuang mempunyai ciri mekanikal yang lebih baik. Pengkaji juga menjalankan ujian aplikasi biokomposit mengkuang dalam beberapa reka bentuk artifak produk berbeza terdiri daripada; perabot, lampu dan barangan aksesori yang kecil. Artifak produk yang terhasil divalidasi melalui borang kaji selidik berdasarkan atribut yang disenaraikan. Artibut tersebut dikumpul melalui perbincangan antara pereka yang berpengalaman dalam pemasaran. Keputusan validasi menunjukkan penerimaan daripada pihak awam dan pereka terutamanya dalam bentuk dan penceritaan produk yang menggunakan bahan tradisional. Selain daripada itu, melalui kaji selidik yang dijalankan juga menunjukkan potensi yang tinggi kebolehpasaran produk dengan aplikasi biokomposit mengkuang terutamanya produk dekorasi kecil, manakala produk lampu dinyatakan sesuai dalam menonjolkan keunikan bahan biokomposit mengkuang. Dalam kajian validasi juga menunjukkan terdapat permintaan yang meletakkan produk berasaskan mengkuang masih ada tempat di dalam pasaran. Oleh itu, dengan mencadangkan biokomposit mengkuang, pelbagai produk berasaskan mengkuang dapat dihasilkan. Dengan pendekatan sedemikian, perniagaan luar bandar yang menghasilkan seni warisan mengkuang berpeluang tinggi untuk dipulihkan dan penggunaan daun mengkuang sekali lagi dapat digalakkan.

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I certify that a Thesis Examination Committee has met on 9 January 2019 to conduct the final examination of Izyan Syamimi binti Zainol on her thesis entitled "Utilization of Screw-Pine Leaf Bio-Composite for Home Accessories" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the Master of Sciences. The members of the Supervisory Committee were as follows:

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This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____
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Signature: _____
Name of Member of Supervisory Committee: Saiful Hasley bin Ramli,

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

UPM	Universiti Putra Malaysia
CM	centimeter
NaOH	sodium hydroxide
MPa	megapascals
GPa	gigapascals
HDPE	high density polyethylene
LDPE	low density polyethylene
PP	Polypropylene
NR	Natural Rubber
EVA	ethylene vinyl acetate
FRSB	Faculty of Design and Architecture
MATRADE	Malaysia External Trade Development Corporation
SEED	Sustainable Environmental Exploration Design
KJ	Jiro Kawakita

CHAPTER 1

INTRODUCTION

History shows that this craft has begun in Peninsular of Malaysia since Neolithic era and evolves through the times until now (Ismail, 2011). During the old time, the Malay woman was considered not well prepared for life unless she developed the skill on plaiting screw-pine leaf or *Pandan* ("Malay Weaving", 2012). Haron (2013) mentioned that the consciousness of Malay's elders on developing their daily essential item to assist their life then included plaiting product such as place mat, prayer mat, food cover, and so many others. Nowadays, most of the product have been turned into home decorative item relatively (Bernama, 2013) because of several reasons:

i. The extinguish of the professional screw-pine weaver
ii. The difficulty on processing the screw-pine leaves
iii. Polymer material that is much cheaper and easier to process than screw-pine leaves.

Screw-pine leaf business is recorded as a source for a better income to rural community claimed Sapiah Othman as interviewed by Nor Hatina Shuib (2018). Nor Hanisah Kamaruzaman, Harian Metro (2016) said that the legacy of the screw-pine leaves will be extinct if the heredity is not continued. As mentioned by Nor Hatina Shuib (2018) the number of the professional weaver nowadays is somehow reduced due to several reasons which includes fewer contribution from young generation. The skill is informally passed down through the family and because of that, the number of practitioner is decreasing. The complicated process of the screw-pine leaf that requires specific steps, diligence skills and time consuming efforts affect the young generation interest which results to refusal to learn the plaiting craft by screw-pine and Pandan (Ismail, 2011). Based on the interview with Hajah Rahmah (2017), a professional screw-pine weaver from Melaka who owns Pandan Molek Enterprise, she revealed that there are efforts on making machine to assist the practitioner in processing the screw-pine leaf, yet they still face the problem when the leaves are not equal in size. Other than that, due to the advanced technology that could produce products in a larger scale, less time consuming, and better durability compared to the production of screw-pine leaf products (Ismail, 2011). However, this unique and authentic heritage is not going to cease to exist because of the support and programme by the local authorities that have been working hard on it (Bernama, 2013). More and more studies and programmes were conducted in developing the awareness of the art craft in Malaysia especially the plaiting screw-pine and *Pandan* by the Malaysia Handicraft Development Corporation such as the establishment of Rural Industry Development Authority to encourage the screw-pine leaf practitioner industry able to have a better life (Ismail, et.al., 2013). Under the same attention, this study is conducted to apply the screw-pine as material to be developed in different industry such as home and décor industry.

1.1 Background of the Research

In Malaysia, the practitioner used two types of screw-pine leaf commonly used in screw-pine plaiting products which is screw-pine leaf; or also known as mengkuang minyak, *Pandanus atrocarpus* (Ismail, 2013) and mengkuang laut, *Pandanus tectorius* ("Pandan and Screw-pine", 2014) While, another type of screw-pine leaf is called *pandan*; *Pandanus odoratissimus* (Plant use, 2015). Figure 1.1 shows there are not much differences between two leafs of *mengkuang* and *pandan*. However, the screw-pine leaf is much more durable and longer than *pandan* ("Malay Weaving", 2012). The professional screw-pine weaver said that the *pandan* leafs are shinier after the colouring process, does not have thorn, and easier to handle. The use of pandan leafs are more to the making of small products while, the screw-pine leaf are more suitable for larger product (Awang, 2017).

Figure 1.1: *Mengkuang Minyak* (Left), *Mengkuang Laut* (Middle), *Mengkuang Pandan* (Right)

Figure 1.2: Detail of the leaf's features between *Mengkuang Minyak, Mengkuang Laut* (Right) and *Mengkuang Pandan* (Left)

Under the family of Pandanaceae (Plant use, 2016), as shown in figure 1.2 above, the researcher has also noticed the differences between the screw-pine leafs. *Mengkuang Minyak* (*Pandanus atrocarpus*) and *Mengkuang Laut* (*Pandanus tectorius*) that have the thorn on each edges of the leaf while *Mengkaung Pandan* does not have it. The comparison that was identified by expert (Awang, 2017 & Ismail, 2016) mentioned that among the three leafs, *Mengkuang Minyak* which is *Pandanus atrocarpus* has the most high-durability in making a larger scale product. Furthermore, there is the mention in Plant use (2016) that the *Pandanus atrocarpus* is very large and tough. Thus, it has been used extensively in Malaysia and Indonesia for durable and waterproof mats to cover carts and boats. Plant use (2016) also mentioned that the older and longer *Pandanus atrocarpus* leafs are flexible and strong material. *Pandanus atrocarpus* also can be served as sails and thatching (Plant use, 2016). Based on those comparisons above, the researchers choose to only use *Pandanus atrocarpus* as the main subject in this study.

Mentioned by Encyclopaedia Britannica (2015), screw-pine tree is a plant that can be found in various place in Asia mainly Malaysia, Thailand, Indonesia and Philipine. Screw-pine tree can be found in certain areas in Africa and Oceania. It is an evergreen plant that has the green leafs throughout the years (Plant use, 2016). The most growth in Malaysia's salty area of mangrove swamp has various name such as *Mengkuang Minyak* and *Mengkuang India* called by the local in which their specific name apparently is *Pandanus atrocarpus* (Shafiee & Sulaiman, 1992). In Malaysia, there are several states that well known for their screw-pine leaf plaiting product such as Kelantan, Terengganu, Perak, and Melaka since these states have plenty of screw-pine leaf sources (Azahana, 2015).

Figure 1.3: Identifies location of screw-pine leaf in Peninsular Malaysia

The figure above illustrates the location of screw-pine leaf occurrence in Peninsular of Malaysia. The grey round dots were recorded by Azahana (2015). While, the red squares dots are the new locations found by researcher while searching for screw-pine leaf sources. As also shown in diagram, the location of Kampung Bentan, Pekan, Pahang; where the community from this village collaborated in T.I.K.A.R. programme in 2014 till 2016. While the sources of the screw-pine for the experiment are taken from a village name Kampung Air Molek, Kuala Sungai Baru in Melaka which is widely popular among screw-pine leafs business in Malaysia (Pandan Molek Enterprise).

1.1.1 Traditional Method of Processing Screw-pine Leaf.

In order to get better understanding regarding the screw-pine leaf, the researcher visited the village; Kampung Bentan, Kuala Pahang, Pahang, where the screw-pine leaf can be obtained until the craft product being produced. From the visit, the researcher identifies the process steps of the raw material before it can be used to plait. Hence, the researcher is in agreement with Ismail (2011) that processing and plaiting the screw-pine leaf is complicated and need skill, diligence, creativity, and patience.
Through the experience gained from the visit, the researcher classified 12 stages on processing the raw material. Researcher also found that the process is a natural process that requires treatment of water. The only process that involves chemical is during the colouring stage. However, the colouring process is an option.

The process is begin with the selection of leaf, and using a machete, cut down leafs from the tree. Next step is called '*mengeram'* by practitioner which cut the leaf into same length. The third step is remove the middle torn using a small knife. Then, heat the leafs on the heat of ember until the leaf turns color to slightly brownish. This step is called 'layur'. When the leaf is a bit cool after the 'layur' step, cut the leaf into strip size using 'alat jangka'. The size of the strips is various from 3 mm to 1 inch size. The strips of leafs then undergo 'lurut' process to soften the leaf. Process of 'lurut' is using a metal plate. The soft leafs is to ease to tie up. It is tie up for soaking process that took 2 to 3 days to get rid the chlorophyll in the leaves. The drying process only took half day time under a bright sunlight. Then the screw-pine leafs is ready to used. If needed, color the screw-pine leafs using a chemical pigment with a boiling water to soak the dried leafs for about 30 minutes and dry it up by hanging.

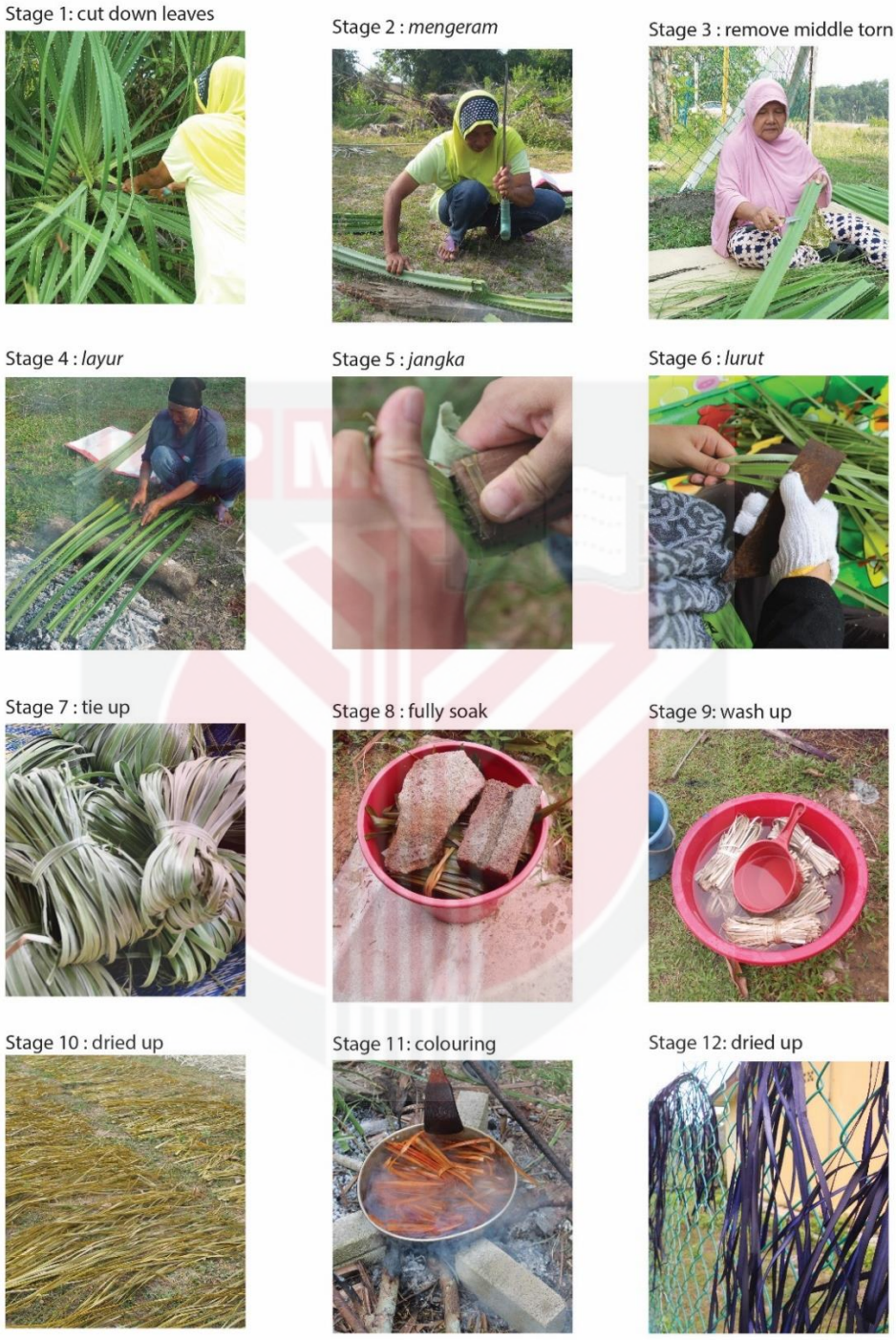

Figure 1.4: Traditional process of screw-pine leaf, stage 1 to 12

Figure 1.4 shows the process in sequences of images which does not include the plaiting process. All the processes are done by the professional screw-pine weaver, who finds the process is easier by doing it manually then having any involvement of high technology machine (Rosul, 2016). All the processes require special tools such as machete to cut down the leaf from the tree and knife to remove the thorn. Also, '*alat lurut*' in figure 1.5 which is made of metal or wood used to smoothen the leaf stiffness. 'A*lat jangka*' as shown in figure 1.6 has several size which is another ancient tools that is used to turn the leaf into several strips depending on the demanded size.

Figure 1.5: Tools; '*Alat lurut*'

Figure 1.6: Tools ;*Alat jangka'*

1.2 Problem Statement

The researcher identifies three problem which is;

1. The screw-pine leaf is an underutilized material for high value-added product.

The issue on less interest among the young generation has been repeatedly highlighted in several local newspapers such as *Harian Metro* (2016), *Sinar Harian* (2017) and *Berita Harian* (2018). This will eventually lead to the disappearance or reduced number of the screw-pine leaf heritage business. Consequently, it is initiating the underutilized material of the screw-pine leaf. The use of screw-pine leaf as main material is rarely being proposed in the production of high value-added product such as home accessories product.

2. Lack of data of screw-pine leaf related to produce high value-added product such as home accessories product.

Lack on specific data of the screw-pine leaf characteristic which leads to no action of further production. Even though screw-pine leaf is widely used as craft product in Asia, there are no studies of the production, composition or properties of screw-pine leaf have been conducted to date (R.M. Sheltami et al, 2012). As mentioned in website inaturalist.org, under pandanus atrocarpus genus, there are no establishing data for the pandanus atrocarpus (2017). The researcher also identifies there is a need of support data in order to propose and apply the screw-pine leaf as a material to be applied to high value-added product. Therefore, the material could be developed into bio-composite materials that reach the suitable characteristic as a material for home accessories product. Thus, the bio-composite material may be utilize as a high value added product and promote the screw-pine leaf business back on track.

1.3 Research Question

The research question below is composed based from the research problem.

1. What are the issue in the screw-pine leaf industry?
2. How to produce screw-pine leaf bio-composite?
3. How to apply screw-pine leaf bio-composite for value added the home accessories products?

1.4 Scope of Research

This research will focus on developing new approach which consist from two main issues to be cover; the social and the technology. Meanwhile, bio-composites is an alternative that benefits the utilization natural fibre in different perspective that brought a better look and well received by customer (Nova Institute, 2017). Referring to the second research problem, this study also included on how to produce the screw-pine leaf bio-composite and the application of the material on high value-added product such as home accessories. By having the screw-pine leaf been utilize, transfer technology is happen to improve the quality and product line to enter a bigger market.

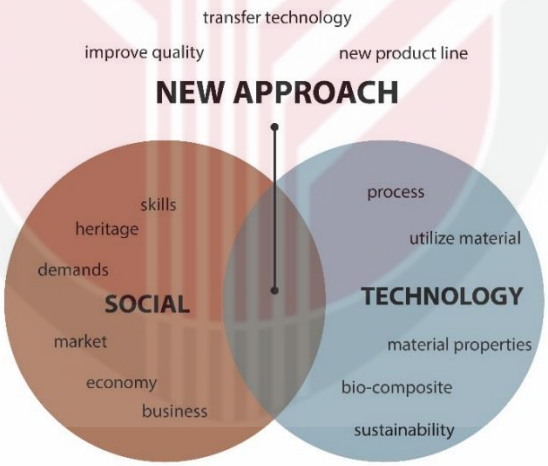

Figure 1.7: New Approach as the research aim.

1.5 Research Objective

Referring to the research question, there are the new approach that act as the aim of the study also leads the objective of this research. Therefore, the objective in this study are;

1. To identify the issue that related to the screw-pine leaf industry.

2. To formalize the process on producing the screw-pine leaf bio-composite material.

3. To fabricate and validate the product design that apply screw-pine leaf bio-composite for home accessories product.

1.6 Research Significant

This study will contribute to expand on the utilization of screw-pine leaf material and promote the traditional material. The production of new material tested, may create the demands in market. This will promote not only the material usage, but also increase the market growth to the rural business. Furthermore, the projection of the new appearance of home accessories product is more sustainable using the screw-pine leaf bio-composite. In this research point of view, the study also upsurge the data related to the screw-pine leaf. Thus, this study uncover parts of the processing new bio-composite material by using screw-pine leaf.

1.7 Chapter Structure

This dissertation consists of six chapters as follows;

1. **Chapter 1**; the introduction chapter that shows the issue, problem statement, research objective and significant of the research.
2. **Chapter 2**; the literature review is a part of research methods by collecting all the data related to this study. The data collected through various media such as journal, article, newspaper and others.
3. **Chapter 3**; in this chapter, the preliminary study and the result is revealed. The research methodology of the research involves experiment of the treatments, the testing and data analysis method, product development and the validation survey of the research.
4. **Chapter 4**; data analysis of the tested sample.
5. **Chapter 5**; the application of the screw-pine leaf bio-composite into high value added product and the validation analysis.
6. **Chapter 6**; conclude the research with answering the research question, contribution of the knowledge, limitation of the study and some recommendations.

1.8 Summary

In conclusion, this chapter discusses the introduction of the research, which includes the research background that covers the visit experiences. Based on the background of the study, the researcher identifies the problem of the research which is mainly divided into two compounds which are social and technological issues that initiated the new approach. In order to achieve those objectives and answer the research questions, more literature is in need in order to compose the research methodology. The researcher concluded that the endangered issue on no continuity of the screw-pine leaf business makes the screw-pine leaf an underutilized material which also lack in related data to propose the usage of the material for high value-added product. Therefore, the researcher initiates the new approach as the alternative methods of producing the screw-pine leaf bio-composite at the same time collecting the required data. The keywords found from the research question is screw-pine leaf or *mengkuang* leaves, bio-composite, and material application for high value-added home accessories product.

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In March 2016, she received second place at Malaysian International Furniture Fair Furniture Design Competition. While in 2017, she won first place in MOBILI Furniture Design Competition, professional category. Aggressively under furniture design field, she decided to own a design studio and a furniture brand. July 2017, she open a design studio. In September 2018, she and her partner launched a furniture brand in South Korea, called BASICOLOGY. She also actively performs as TANGGAM Designer which is a designer label under Malaysia Timber Industry Board since 2018. In October 2018, she also joined the Persatuan Reka Bentuk Perindustrian Malaysia as the Melaka's representative.

LIST OF PUBLICATION

Zainol I. S., Rahman K.A.A.A, Ramli S.H. (2016) *Conceptual Framework of Screwpine Leaves Bio-composites for Furniture Component*. Conference Proceeding: 2nd INTERNATIONAL CONFERENCE ON CREATIVE MEDIA, DESIGN & TECHNOLOGY, p 282-287.

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