UNIVERSITI PUTRA MALAYSIA

INCLUSION OF KENAF AS BIO-MATERIAL COMPONENT IN SUSTAINABLE MANUFACTURING IN MALAYSIAN AUTOMOTIVE INDUSTRY

AMIRA MAS AYU BINTI AMIR MUSTAFA

IPTPH 2019 14

INCLUSION OF KENAF AS BIO-MATERIAL COMPONENT IN SUSTAINABLE MANUFACTURING IN MALAYSIAN AUTOMOTIVE INDUSTRY

By

AMIRA MAS AYU BINTI AMIR MUSTAFA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

March 2019

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

INCLUSION OF KENAF AS BIO-MATERIAL COMPONENT IN SUSTAINABLE MANUFACTURING IN MALAYSIAN AUTOMOTIVE INDUSTRY

By

AMIRA MAS AYU BINTI AMIR MUSTAFA

March 2019

Chair : Professor Mohd Shahwahid Haji Othman, PhD
Faculty : Institute of Tropical Forestry and Forest Product

Increase in societal demand for sustainability has resulted in attention to sustainable manufacturing. Many manufacturers often focus on the economic component sustainability, neglecting the environmental and social aspects. Natural fiber reinforced polymer composites (NFC) provides a practical alternative to synthetic fiber reinforced composites largely in automotive and building product applications. At the laboratory scale, kenaf fibers reinforced polymer composites (KFC) has been proven that it is technically feasible to be developed as part of automotive bio-material components. The purpose of this study is to investigate whether such potential applications could meet the environmental and economic sustainability measurements. As illustration, the supply chain process of spare wheel cover production was used for this purpose. The first objective of the study describes the use of life cycle assessment (LCA) of utilizing kenaf fiber composites for spare wheel cover production. A cradle to gate assessment was performed based on the ISO 14040/14044 guidelines. The aims are to identify the major hotspots and most significant contributions to environmental pollution. The second objective of the study is to conduct an economic valuation of the consumer preferences from the Klang Valley area on using natural fiber composites in certain components of their car. The double bounded dichotomous- choice contingent valuation method (CVM) could be used for this purpose to solicit the interests of consumers to make extra payments towards reducing the impact to the environment. The third objective is to frame out a financial and economic feasibility assessment of using Kenaf fiber composites in the production of the spare wheel cover. The environmental cost and economic value estimates of the intangible environmental and economic impacts obtained from the previous objectives are incorporated into the cashflows to enable the computation of an economic cost-benefit analysis (CBA). Incorporating the three elements of the above study could shed light as

to the environmental and economic sustainable development of Kenaf application into the automotive industry.

From the objective 1, between three phases in spare wheel production, the midstream phase has a higher contribution to the environment pollution with the total environmental cost of RM14,326.30 or 63%, followed by upstream phase and downstream phase with the total contribution 19% and 18% respectively. For objective number 2, all the variables in the double-bounded approach are significant at a different level except for GENDER and LENGTHOFUSE which is insignificant in the double-bounded approach and is therefore, eliminated from the model and the mean additional WTP ranges from RM11.51 to RM16.10 has achieved. For last objective, between three phase, only downstream phase was positive where the project is both financially and economically feasible. The positive result is due to the light-weight impact where the society could benefit with fuel saving and the corresponding reduction of CO_2 emissions and also the total additional WTP. To implement the project successfully, more effort is required to improve the feasibility of Kenaf fiber production. The challenge is in the low quality of local Kenaf fibers that will affect the quality of the production of automotive components. By overcoming these obstacles, the project will have huge positive impacts on both the sector and society

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGGUNAAN KENAF SEBAGAI BAHAN BIO-KOMPONEN DALAM PEMBUATAN MAMPAN DI DALAM INDUSTRI AUTOMOTIF MALAYSIA

Oleh

AMIRA MAS AYU BINTI AMIR MUSTAFA

Mac 2019

Pengerusi : Profesor Mohd Shahwahid Haji Othman, PhD
Fakulti : Institut Perhutanan Tropika dan Produk Hutan

Peningkatan permintaan pengguna untuk kelestarian telah menyumbang kepada pembuatan mampan dalan sector industry. Kebanyakkan industry sering menumpukan kepada kelestarian dari segi ekonomi berbanding kepada aspek alam sekitar dan social. Komposit polimer bertetulang gentian semulajadi (NFC) menyediakan alternatif praktikal kepada komposit bertetulang gentian sintetik terutamanya di dalam aplikasi produk automotive dan bangunan. Pada skala makmal, komposit polimer bertetulang gentian kenaf (KFC) telah membuktikan ia secara teknikal boleh dimajukan sebagai komponen komponen bio-bahan automotif. Tujuan kajian ini adalah untuk mengenal pasti sama ada aplikasi berpotensi itu boleh memenuhi ukuran kemampanan alam sekitar dan ekonomi. Sebagai ilustrasi, proses rantaian bekalan pengeluaran penutup pengganti tayar digunakan untuk tujuan ini. Objektif pertama kajian ini menerangkan penggunaan penilaian kitaran hayat (LCA) untuk menggunakan komposit gentian kenaf dalam pengeluaran penutup roda. Proses “cradle to gate” dijalankan menggunakan garis panduan ISO 14040/14044. Tujuannya adalah untuk mengenal pasti titik-titik panas utama dan sumbangan paling penting kepada pencemaran alam sekitar. Objektif kedua kajian ini adalah untuk melakukan penilaian ekonomi keutamaan pengguna dari kawasan Klang menggunakan komposit serat semulajadi dalam komponen tertentu dari kereta mereka. Kaedah double bounded dichotomous-choice contingent valuation (CVM) boleh digunakan untuk tujuan ini untuk menilai kepentingan pengguna dalam kesanggupan mereka untuk membayar lebih untuk mengurangkan kesan alam sekitar. Objektif ketiga adalah untuk membuat penilaian kemungkinan kewangan dan ekonomi menggunakan komposit serat Kenaf dalam pengeluaran penutup pengganti tayar. Anggaran kos persekitaran dan anggaran ekonomi dari kesan-kesan alam sekitar dan ekonomi yang tidak ketara yang diperolehi dari objektif-objektif terdahulu akan dimasukkan ke dalam aliran tunai untuk membolehkan pengiraan analisis kos-faedah ekonomi (CBA). Dengan menggabungkan ketiga-tiga unsur kajian di atas dapat memberi penjelasan mengenai pembangunan lestari alam sekitar dan ekonomi aplikasi kenaf ke dalam industri automotive.

Dari objektif pertama, di antara tiga fasa, fasa pertengahan mempunyai sumbangan paling tinggi terhadap pencemaran alam sekitar dengan jumlah kos pencemaran sebanyak RM14,326.30 atau 63% dan dikuti dengan fasa hulu dan hiliran dengan jumlah kos pencemaran sebanyak 19% dan 18% masing-masing. Bagi objektif kedua, kesemua pemboleh ubah adalah signifikan kecuali pemboleh ubah Jantina dan Jumlah Penggunaan Kenderaan dan julat purata tambahan kesanggupan membayar adalah dari RM11.51 sehingga RM16.10. Bagi objektif ketiga, di antara ketiga-tiga fasa pengeluaran, fasa hiliran adalah positif dari aspek kewangan dan ekonomi. Ini adalah disebabkan dengan mengurangkan berat kenderaan, kadar penggunaan minyak serta jumlah pelepasan CO_2 dapat dikurangkan. Penambahan kesanggupan membayar dari penggunaan kenderaan mesra alam sekitar juga menyumbang kepada hasil keputusan ini. Untuk keberkesanan projek ini, lebih banyak usaha-usaha yang perlu dilakukan dalam peningkatan kualiti dalam pengeluaran gentian kenaf. Di antara cabaran yang terpaksa dihadapi adalah pengeluaran gentian kenaf yang berkualiti rendah akan menjejaskan kualiti pengeluaran komponen automotive. Dengan mengatasi halangan-halangan ini, projek ini akan memberi impak yang besar kepada industry dan juga masyarakat.

ACKNOWLEDGEMENTS

I wish to express my appreciation to my husband, Mohd Iqbal Bin Mohd Noor, who I will forever be indebted to. His encouragement, understanding, and constant loving support throughout the period of my study have been vital for the completion of this study and for me to attain this degree. I am also very thankful to my beautiful daughter, Nur Irdina Aleesa Binti Mohd Iqbal, and my lovely son, Mohd Adeeb Bin Mohd Iqbal for always be cheerful and supported me. I am also very thankful for my family especially to my father Amir Mustafa Bin Razalli and my mother Junaidah Binti Md Derus, as their advice, encouragement, guidance, constructive criticisms and comments throughout of this year has help me in achieving this degree.

A special note of thanks goes to my dedicated supervisor, Prof. Dr Mohd Shahwahid Haji Othman for guiding, support and providing me with extra statistical analysis and in-depth research knowledge which has been very useful for my research. Despite his busy schedules, he always opens to engage in meaningful discussions.

Last, but not least, this study would not have been able to have been completed without the support from UPM. For that, I would like to give my sincere thanks and appreciation for UPM's kindness and input.

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

Mohd Shahwahid Bin Haji Othman, PhD
Professor
Faculty of Economics and Management
Universiti Putra Malaysia
(Chairman)

Paridah Md Tahir, PhD
Professor
Faculty of Forestry
Universiti Putra Malaysia
(Member)

Abdul Rahim bin Abdul Samad @ Iammi, PhD
Associate Professor
Faculty of Economics and Management
Universiti Putra Malaysia
(Member)

_____
ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____ Date: _____

Name and Matric No.: Amira Mas Ayu Binti Amir Mustafa (GS41339)

Declaration by Members of Supervisory Committee

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:	
Name of Chairman of Supervisory Committee:	Professor Dr. Mohd Shahwahid Bin Haji Othman
Signature:	
Name of Member of Supervisory Committee:	Professor Dr. Paridah Md Tahir
Signature:	
Name of Member of Supervisory Committee:	Associate Professor Dr Abdul Rahim bin Abdul Samad @ Iammi

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AFTA	ASEAN Free Trade Area
CBA	Cost-Benefit Analysis
CM	Choice Modelling
CVM	Contingent Valuation Method
DALY	Disability Adjusted Life Years (Years of Disable Living or Years of Life Due to The Impacts)
DBDC	Double Bounded Dichotomous Choice
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory Analysis
LCIA	Life Cycle Impact Assessment
MRKF	Mechanical Retted Kenaf Fibre
NAP	National Automotive Policy
NEAC	National Economic Advisory Council
NFRC	Natural Fiber Reinforced Composites
NKTB	National Kenaf And Tobacco Board
NPV	Net Present Value
PAF	Potential Affected Fraction (Animals Affected by The Impact)
PDF	Potentially Disappeared Fraction (Plant Species Disappeared as Result of The Impacts
SBDC	Single Bounded Dichotomous Choice
SE	Surplus Energy (MJ) (Extra Energy That Future Generations Must Use to Excavate Scarce Resources)
WTA	Willingness to Accept
WTP	Willingness to Pay

CHAPTER 1

INTRODUCTION

1.1 Overview

Sustainability has become an important issue in all spheres of life. Sustainability focuses on safeguarding natural resources against exploitation, in the name of productivity and competitiveness, by manufacturing and service organization. Sustainability has been widely discussed in the context of automotive manufacturing. According to Elkington (1997), this approach mirrors the “triple bottom line” of environmental, economic and social sustainability in community development. It is a major concern in many countries and is leading to strict regulations regarding the impact of products and services during their manufacturing, use and end of life.

The use of renewable resources for industrial materials satisfies many criteria in term of sustainable product life cycle. Companies around the world have shown interest in environmentally friendly manufacturing. Renewable raw materials have an interesting application potential in the automotive sector to replace petroleum-based material (Rieldel et al, 2005). There are two major issues occurred for the current materials for internal car component; 1) high in cost and, 2) high of weight. Thus, by designing a combination of lightweight and strong biomaterials are strategies to develop advanced lightweight composite that can replace the traditional synthetic structures or metals which made as part of automotive component.

1.2 Background of the Study

New trends towards sustainable development have placed greater attention to natural, renewable, and biodegradable raw materials. With the current concern over the environment and greenhouse gas emissions, natural fibers are increasingly being considered as an environmentally friendly and biodegradable composites materials to substitute for synthetic fibers in the reinforced of polymer-based composites. The global natural fiber composites market was worth more than USD 3.36 billion in 2015 and is expected to reach USD 6.50 billion in 2021 (Natural Fiber Composites Market Analysis Report, 2016). The ASEAN region comes out as the most significant growth area for the composites industry and is expected to gain a total market share of about 50% by volume in 2020 (Plastic & Composites Sector Report, 2017).

Natural fibers can be defined as fibers derived from plants or animals. Natural fibers can come from a large variety of fiber sources such as bast fibers, seed fibers, leaf fibers, grass and reed fibers and core fibers. The advantages of using

natural fiber composites are that they are biodegradable, renewable, recyclable, abundant, low cost, density and weight, less polluted during production. These would result in minimal hazards and eco-friendly nature. Natural fiber composites also have a short life when it comes to degradation with limited environmental damage whereas synthetic fibers have a negative impact due to pollution from slow degradation. Besides that, the total CO_2 releases by the natural fibers when they are decomposed or combusted at the end of their life cycle is the same as that absorbed during their growth (Bledzki & Gassan, 1999).

Natural fibers crop are mostly considered as environmentally friendly when compared with synthetic fibers due to many reasons. As example, the plant cultivation sequestrated of much CO_2 from the atmosphere. They also consume less energy than the production of synthetic polymers and fibers. Natural fibers products manufactured from renewable resources which differ from the production of synthetic fibers that lead to depletion of natural resources. The usage of artificial fertilizers and pesticides will result in emission of greenhouse gasses in some processing stages (Carus et al, 2014; and Rana et al, 2014).

In recent years to satisfy the natural fiber demand for the composites, kenaf has grown in importance. This resulted in the establishment of kenaf as a fiber crop around the world (Zheng & Yu (2002), Anandjiwala & Blouw (2007)). Among the many types of natural fibers such as jute, hemp, sisal, and coir, kenaf plants have been widely been used around the world due to its rapid growth over a wide range of climatic conditions and its low indirect cost (Qatu, 2011). Kenaf belongs to the hibiscus family *Malvacea*. Globally, kenaf has been considered as a suitable biological resource and a potential substitute for fossil fuels and wood palm due to its properties of strong resistance, large biomass, great adaptation and rich cellulose.

Due to the excellent mechanical properties and abundant local supply and relatively cheaper cost of kenaf fiber (RM4.00/kg) as compared to glass fibers (RM7.00/kg), it is anticipated to be a perfect choice for composite products primarily for automotive applications (Izran K et al., 2014). There were several research endeavours on the advantages of using kenaf fiber composites in automotive applications. Hassan et al (2017) found that even though glass fiber is more dominant in properties related to strength, modulus (GPa) and elongation at break compared to kenaf fiber, but the latter fiber has some advantages over glass fiber concerning cost, density, renewability, recyclability, abrasiveness, and biodegradability.

1.3 Problem Statement

Currently, policies on vehicle manufacturing are aimed to make the use of any natural fiber in automobile part a must in the legislations, crash-worthiness, safety and light weighting of the vehicle as well as the global green issues for automotive manufacturing (Aminah A, 2003). The mechanical properties, thermal properties, recyclability of the environmental materials must be considered in each product. This is aligned with the European Union (EU) environmental rules and recyclability illustrate that the total body of manufactured vehicle must contains reusable or recoverable part at least 95% of total weight (Bonnia et al, 2010).

As the automotive industry develops, its impact to the environment also increases. Average range of vehicles life is considered between 10 and 15 years, after that they will enter the retired phase. The issues are how to deal with the wastes from retired vehicles and how to get economic and environmental advantage from it. In 2006, Malaysia produced around 1,103,457 metric tons of hazardous waste. The Department of Environment has identified 77 categories of scheduled waste, which is primarily causes by automotive besides the chemical, workshop, petrochemical, metal and pharmaceutical industries (Amelia et al, 2009). Even if the local automotive has not established confident using kenaf as their material in automotive parts, the economic benefits from utilization kenaf fiber composites should motivate the local automotive manufacturer.

Ever since the uprising of the green movement and awareness of the effect of greenhouse gases, consumers all over the world have become conscious about the product they use. Green concept has been spreading especially among the developed nations and is picking up in the developing and less developed countries. Thus, awareness and concern about environment degradation, food safety, animal welfare and sustainable development has created green consumerism among the consuming population in Malaysia as well (Golnaz R. et al, 2013). In 2008, green consumers globally had an estimated annual buying power of US $500 billion (Berry, 2007), and they are willing to pay a price premium for environment-friendly products stemming from the growing global environmental consumerism (Shukri & Muhamad, 2007).

As composites edge towards the higher performance applications, designers are faced with a wider range of materials from which to choose. Costs are an important consideration in the effort to produce affordable personal transportation. However, perhaps the primary driver for the use of lighter weight materials today is to lower emissions. It would, therefore, be prudent to also evaluate the environmental performance of a candidate material in addition to its cost. Reductions in environmental burdens from one phase of a vehicle's life cycle may result in increases in other areas which could negate initial benefits. It is precisely these shifts of environmental burdens which need to be understood, thus ensuring materials are selected on their ability to improve

complete environmental performance, rather than focusing on one life cycle phase.

Thus, by highlighting the potential value and demand of the kenaf industry, this could raise awareness and further attract kenaf investors and entrepreneurs to drive the industry forward. For this purpose, an assessment on the environmental and economic sustainability of kenaf fibers is necessary. Does kenaf fiber reinforced composite applied in automobile environmentally less polluting all along its life cycle? Further would using kenaf fiber reinforced composites in automotive add value to the consumers and how much would consumers be willing to pay for a more environmentally automotive component. Incorporating kenaf fiber reinforced composite into applications for the automotive segments could be technically feasible but is this move economically feasible too? These are several practical questions that various stakeholders, be they be researchers, car manufacturers and buyers would like to know.

1.4 Research Question

The main purpose of this study is to assess the environmental and economic sustainability of kenaf fiber as bio-materials in the Malaysian Automotive Industry. To achieve this, the study addresses the following research questions:

1) What are the environmental impact potentials of applying kenaf fiber reinforced composites in automotive components?
2) How much would car consumers value or be willing to pay for the application of kenaf fiber reinforced composite in automotive components?
3) How financially and economically feasible be the application of kenaf fiber reinforced composites in automotive components?

1.5 Research Objective

This study aims to conduct an environmental and economic impact of Kenaf bio-materials into automotive industry in Malaysia, and the objectives are as follow:

1) To assess the environmental impact of applying kenaf fiber reinforced composites in automotive components
2) To identify the economic value of customer preferences on buying a kenaf fiber reinforced composite automotive components.
3) To conduct the financial and economic feasibility on applying kenaf fiber reinforced composites in automotive components.

This thesis addresses this challenge by increasing the understanding of the potential use of kenaf fiber reinforced composite in automotive components for

the car Industry. A positive outcome in terms of environmental and economic feasibility, would go a long way in convincing the investor and potential industry in Malaysia, especially automotive industry to use Kenaf fiber as their material

1.6 Significance of the Study

The significance of the study is to attract more manufacturing industries to invest into kenaf cultivation and value adding processing, especially in the automotive industry. With a greater understanding of the environmental and economic issues and the roles played by relevant stakeholders such planters, fiber processors, automobile manufacturers and car buyers, the possibilities to ensure the kenaf industry develop and be successful would make this investigation an essential instrument to helping the Government in resolving the issues on the way forward for the kenaf industry in Malaysia. Automobile manufacturers need information and have to be convinced that the use of eco-friendly bio-materials is not only environmentally sustainable but also contribute to their income streams. Besides that, understanding consumers preferences for eco-friendly products may play an important role in formulating environmental policy changes to face complex problems as diverse as environmental pollution or global change.

1.7 Scope of the Study

Spare wheel cover has been chosen as an automotive component in this study. The reason why the spare wheel cover has been chosen as an automotive component in this study is because the spare wheel cover has a simple design and material suitability compared with another car component. The production of spare wheel cover will be used as a basis for this study from the upstream into the downstream phase. This included the inclusion of kenaf fiber and kenaf fiber composites in each phase.

1.8 Definition of the Key Terms

There are several main operational definitions used throughout this research. They are defined according to popular definitions used by earlier researchers. The detailed definitions are summarized in Table 1.1.

Table 1.1: Operational Definition

No.	Construct	Operational Definitions
1	Sustainability	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs
2	Sustainable Manufacturing	Defined as a creation of manufactured products which use processes that minimize negative environmental impacts, conserve energy and natural resources, safe for the consumers and are economically sound
3	Environmental Assessment	Defined as identifying, estimating, and evaluating the environmental impacts of existing and proposed projects, by conducting environmental studies, to mitigate the relevant negative effects prior to making decisions and commitments.
4	Bio-composite	Defined as a material formed a combination of resin and natural fiber
5	Green Marketing	to satisfy consumers' wants, needs and desires as well as to preserve the natural environment and benefits to society in a more sustainable way
6	Economic Valuation	a tool to define and measure the value based on the individual preferences and choices.
7	Green Product	one that has less of an environmental impact or is less detrimental to human health than the traditional product equivalent.

Note: Compiled by Author

1.9 Organization of the Thesis

This thesis will be divided into five chapters namely; introduction, literature review, research methodology, result and discussion, conclusion and recommendation for future research.

Chapter One has discussed the background of natural fibers and the potential of utilization Kenaf fibers as automotive components in Malaysia Automotive Industry. It also highlights the problem statement, objective and the justification of this study.

Chapter Two provides a review of the literature on Kenaf industry in Malaysia, especially in cultivation, processing, and manufacturing. It will highlight previous research efforts on the characteristics and potential of Kenaf.

Chapter Three discusses matters about the use of various methodologies such as life cycle analysis, contingent valuation method and cost-benefit analysis as a methodology in the study.

Chapter Four focusses on the research methodology that will be used in this study in line with the primary objectives set in chapter one. This chapter also discusses how and where the data are collected and explains the procedures involved in handling the data for analysis by using appropriate analytical models.

In **Chapter Five**, the result from the life cycle assessment, contingent valuation method and cost-benefit analysis will be analysed in detail.

Chapter Six provide a detailed discussion that obtained from Chapter Five

Finally, **Chapter Seven** provides the summary and conclusions of findings concerning the impacts of utilization kenaf fiber in Malaysian Automotive Industry. Policy implications, limitations of the study and recommendations for future research would also be the highlighted here.

REFERENCES

Abdul Khalil HPS, Yusra AF, Bhat AH, Jawaid M (2010). Cell wall ultrastructure, anatomy, lignin distribution, and chemical composition of Malaysian cultivated kenaf fiber. Ind Crop Prod 31:113–121

Abdelrhman HA, Shahwahid M, Paridah MT, Samad ARA, Habib MAAEI, et al. (2016) Financial and Technical Assessment of Kenaf Cultivation for Producing Fiber Utilized in Automotive Components. Bus Eco J 7: 254. doi: 10.4172/2151-6219.1000254

Abdul, R. H. (2009). Consumers' intention and factors affecting green food consumtion (Unpublished master's thesis). Serdang, Malaysia: University Putra Malaysia.

Ahmad S. (2009) Recreational values of mangrove forest in Larut Matang, Perak Journal of Tropical Forest Science 21(2)

Aini NAS, Hamzah MB, Hazandy AH, Ghizan S, Fadzhel MMN (2009). Growth and phenology of kenaf (Hibiscus cannabinus l.) varieties. Pertanika J. Trop. Agric. Sci. 32:29-33

Akil, H. M., Omar, M. F., Mazuki, A. A. M., Safiee, S., Ishak, Z. A. M., & Abu Bakar, A. (2011). Kenaf fiber reinforced composites: A review. Materials & amp; Design, 32(8–9), 4107–4121. doi.org/10.1016/j.matdes.2011.04.008.

Alirezaei, M., Noori, M., & Tatari, O. (2016a). Getting to net zero energy building: investigating the role of vehicle to home technology. Energy Build 130:465–476.

Alirezaei, M., Noori, M., & Tatari, O. (2016b). BIM-based damage estimation of buildings under earthquake loading condition. Procedia Eng 145:1051–1058.

Albort-Morant, G., Leal-Millán, A., & Cepeda-Carrión, G. (2016). The antecedents of green innovation performance: A model of learning and capabilities. *Journal of Business Research, 69*(11), 4912–4917.

Amelia, L., Wahab, D. A., Haron, C. C., Muhamad, N., & Azhari, C. H. (2009). Initiating automotive component reuse in Malaysia. Journal of Cleaner Production, 17(17), 1572-1579.

Aminah A (2003). Forage and fiber production of selected kenaf introductions on bris. In: Second technical review meeting on the national Kenaf Research project. MARDI. Malaysian Agriculture Institute (MARDI), SERDANG, p. 146.

Aminah A, Wong CC, Hasim I (2006). Production potential of kenaf for forage and fiber on bris under smallholder production system. In: Fourth technical review meeting on the National Kenaf Research Project, MARDI, pp. 15-20.

Amirmohammad Ghandehariun, Y.N., 2016. Sustainable manufacturing and its application in machining processes: a review. Int. J. Glob.Warming 9, 198e228.

Anandjiwala, R. D., & Blouw, S. (2007). Composites from bast fibres: prospects and potential in the changing market environment. J Nat Fibres, 4(2):91–109.

Annema, J. A., Mouter, N., & Razaei, J. (2015). Cost-benefit analysis (CBA), or multi-criteria decision-making (MCDM) or both: politicians' perspective in transport policy appraisal. Transportation Research Procedia, 10, 788-797.

Arin, T., & Kramer, R. A. (2002). Divers' willingness to pay to visit marine sanctuaries: An exploratory study. Ocean and Coastal Management, 45(2–3), 171–183. https://doi.org/10.1016/S0964-5691 (02)00049-2.

Ashby MF, Jones DRH. (1980). Engineering materials an introduction to their properties and applications. Oxford, England: Pergamon Press; 1980.

Ashori, A. (2008). Wood–plastic composites as promising green-composites for automotive industries. Bioresource technology, 99(11), 4661-4667.

assessment and cost analysis of hybrid fiber-reinforced engine beauty cover in comparison with glass fiber-reinforced counterpart. Environmental Impact Assessment Review 65. 111-117.

Asumani, O. (2014). Characterization of the mechanical and moisture absorption properties of kenaf reinforced polypropylene composites (Doctoral dissertation).

Azapagic, A. (1999). Life cycle assessment and its application to process selection, design and optimisation. Chemical Engineering Journal, 73(1), 1–21. doi.org/10.1016/S1385-8947 (99)00042-X.

Aziz SH, Ansell MP, Clarke SJ, Panteny SR (2005) Modified polyester resins for natural fiber composites. Compos Sci Technol 65:525–535

Azwa, Z. N., & Yousif, B. F. (2013). Characteristics of kenaf fibre/epoxy composites subjected to thermal degradation. Polymer degradation and stability, 98(12), 2752-2759.

Banerjee, S., & Sarkhel, P. (2012). Biases and reliability of WTP estimates from Contingent Valuation responses: A study bases on Solid Waste Management Services in Bally Municipality, India. Arthaniti-Journal of Economic Theory and Practice, 11(1-2), 77-100.

Barth, M., & Carus, M. (2015). Carbon footprint and sustainability of different natural fibres for biocomposites and insulation material. Bio-based Economy, Services of Nova-Institute www. bio-based. eu/ecology. Accessed, 18, 117.

Basri, M. H. A., Abdu, A., Junejo, N., Hamid, H. A., & Ahmed, K. (2014). Journey of kenaf in Malaysia: A Review. Scientific Research and Essays, 9(11), 458-470.

Basri, M. H. A., Arifin A., Nasima J., Hazandy A. H., & Khalil A. (2014). Journey of kenaf in Malaysia: A review. Academic Journal. 9(11).458-470.

Bein, T., Mayer, D., Hagebeuker, L., Bachinger, A., Bassan, D., Pluymers, B., & Delogu, M. (2016). Enhanced lightweight design e first results of the FP7 project ENLIGHT. In: Proceedings of 6th Transport Research Arena, April 18-21. Warsaw, Poland.

Berry, B. (2007). Going green: The future of the retail food industry. Agri-Food Trade Service. Retrieved from http://www.ats.agr.gc.ca/us/4351_e.htm

Berzi, L., Delogu, M., & Pierini, M. (2016). Development of driving cycles for electric vehicles in the context of the city of Florence. Transportation Research Part D: Transport and Environment, 47, 299–322. https://doi.org/10.1016/j.trd.2016.05.010.

Bismarck, A., Baltazar-Y-Jimenez, A. & Sarikakis, K. Environ Dev Sustain (2006) 8: 445. https://doi.org/10.1007/s10668-005-8506-5

Bledzki, A. K., & Gassan, J. (1999). Composites reinforced with cellulose based fibres. Prog Polym Sci, 24, 221–74.

Boland, C., DeKleine, R., Moorthy, A., Keoleian, G., Kim, H.C., Lee, E., Wallington, T.J., 2014. A life cycle assessment of natural fiber reinforced composites in automotive applications (No. 2014-01-1959). In: SAE Technical Paper.

Bonnia, N. N., Ahmad, S. H., Zainol, I., Mamun, A. A., Beg, M. D. H., & Bledzki, A. K. (2010). Mechanical properties and environmental stress cracking resistance of rubber toughened polyester/kenaf composite. eXPRESS Polymer Letters, 4(2), 55-61.

Breidert, C., Hahsler, M., Reutterer, T., (2006). A review of methods for measuring willingness-to-pay. Innov. Mark. 2 (4), 8–32.

Bruce, C. (2006). Can contingent valuation resolve the “adding-up problem” in environmental impact assessment. Environmental Impact Assessment Review, 26(6), 570-585.

Brundtland, G.H., 1987. Report of the World Commission on Environment and Development: Our Common Future (United Nations).

Calia, P., & Strazzera, E. (2000). Bias and efficiency of single versus double bound models for contingent valuation studies: a Monte Carlo analysis. Applied Economics, 32(10), 1329–1336. https://doi.org/10.1080/000368400404489.

Carson, R. T., Wilks, L., & Imber, D. (1994). Valuing the preservation of australia's kakadu conservation zone. Oxford Economic Papers, 46, 727–749. https://doi.org/10.1093/oep/46.Supplement_1.727.

Carus, M., Eder, A., Dammer, L., Korte, H., Scholz, L., Essel, R., & Breitmayer, E. (2014). Wood-plastic composites (WPC) and natural fibre composites (NFC): European and global Markets 2012 and future trends. WPC/NFC market study, 3, 2014.

Cassettari, L., Bendato, I., Mosca, M., Mosca, R., 2017. Energy Resources Intelligent Management using on line real-time simulation: a decision support tool for sustainable manufacturing. Appl. Energy 190, 841e851. https://doi.org/10.1016/ j. apenergy.2017.01.009.

Champ, P. A., & Bishop, R. C. (2001). Donation payment mechanisms and contingent valuation: an empirical study of hypothetical bias. Environmental and resource economics, 19(4), 383-402.

Chan, K. W., & Ismail, M. (2009). Supercritical carbon dioxide fluid extraction of Hibiscus cannabinus L. seed oil: a potential solvent-free and high antioxidative edible oil. Food Chemistry, 114(3), 970-975.

Chen, Y. S., Chang, T. W., Lin, C. Y., Lai, P. Y., & Wang, K. H. (2016). The influence of proactive green innovation and reactive green innovation on green product devel- opment performance: The mediation role of green creativity. *Sustainability, 8*(10), 966–978.

Chatzinikolaou, S. D., & Ventikos, N. P. (2015). Holistic framework for studying ship air emissions in a life cycle perspective. Ocean Engineering, 110, 113-122.

Chen YD, Huang B, Huang MJ, CaiB Q (2011) On the preparation and characterization of activated carbon from mangosteen shell. J Taiwan Inst Chem Eng 42:837-842

Chen, T. B., & Chai, L. T. (2010). Attitude towards the environment and green products: Consumers' perspective. Management Science and Engineering, 4 (2), 27 – 39

Cichowicz, J., Theotokatos, G., & Vassalos, D. (2015). Dynamic energy modelling for ship life-cycle performance assessment. Ocean Engineering, 110, 49-61.

Clark TF, Nelson GH, Nieschlag HJ, Wolff IA (1962) A search for new fibre crops V. Pulping studies on kenaf. TAPPI 45:780–786

Cordano, M., & Frieze, I. H. (2000). Pollution reduction preferences of U.S. environmental managers: Applying Ajzen's theory of planned behavior.

Academy of Management Journal, 43(4), 627–641. https://doi.org/10.2307/1556358

Dahlke B, Larbig H, Scherzer HD, Poltrock R (1998) Natural fiber reinforced foams based on renewable resources for automotive interior applications. J Cell Plast 34:361–379

Dattilo, C. A., Delogu, M., Berzi, L., & Pierini, M. (2016). A sustainability analysis for electric vehicles batteries including aging phenomena. In: Proceedings of the 17th IEEE International Conference on Environment and Electrical Engineering, June 7-10. Florence, Italy.

Davoodi, M. M., Sapuan, S. M., Ahmad, D., Ali, A., Khalina, A., & Jonoobi, M. (2010). Mechanical properties of hybrid kenaf/glass reinforced epoxy composite for passenger car bumper beam. Materials and Design, 31(10), 4927–4932. https://doi.org/10.1016/j.matdes.2010.05.021.

De Pelsmacker, P., Driesen, L., Rayp, G., (2005). Do consumers care about ethics? Willingness to pay for fair-trade coffee. J. Consum. Aff. 39 (2), 363–385.

Del Pero, F., Delogu, M., Pierini, M., Bonaffini, D., (2015). Life Cycle Assessment of a heavy metro train. J. Clean. Prod. 87, 787-799.

Delogu, M., Zanchi L., Maltese S., Bonoli A., & Pierini M., (2016). Environmental and economic life cycle assessment of a lightweight solution for an automotive component: A comparison between talc-filled and hollow glass microspheres-reinforced polymer composites. Journal of Cleaner Production 139. 548-560.

Dempsey JM (1975) Fiber crops. The University Presses of Florida, Gainesville

Diamond, P. A., & Hausman, J. A. (1994). Contingent valuation: is some number better than no number. Journal of economic perspectives, 8(4), 45-64.

Duflou JR, De Moor J, Verpoest I, Dewulf W. (2009). Environmental impact analysis of composite use in car manufacturing. Manuf Technol 2009; 58:9–12.

Eberle R, Franze H. (1998). Modeling the use phase of passenger cars in LCI.SAE Technical Paper 982179, SAE Total Life-cycle Conference, Graz Austria; December 1 – 3, 1998.

Edeerozey, A. M., Akil, H. M., Azhar, A. B., & Ariffin, M. Z. (2007). Chemical modification of kenaf fibers. Materials letters, 61(10), 2023-2025.

Elkington, J., 1997. Cannibals with forks. In: Cannibals Forks Triple Bottom Line 21st Century 1e16. https://doi.org/http://doi.wiley.com/10.1002/tqem.3310080106.

Falasca, S. L., Ulberich, A. C., & Pitta-Alvarez, S. (2014). Possibilities for growing kenaf (Hibiscus cannabinus L.) in Argentina as biomass feedstock under dry-

subhumid and semiarid climate conditions. Biomass and Bioenergy,64, 70–80. doi.org/10.1016/j.biombioe.2014.03.031.

Faruk, O., Bledzki, A. K., Fink, H. P., & Sain, M. (2014). Progress report on natural fiber reinforced composites. Macromolecular Materials and Engineering, 299(1), 9-26.

Field, B. C., & Field, M. K. (1997). Environmental economics: an introduction. Sustainable Human Development Review, 105-123.

Final Report Plastic and Composites Sector (2017). Academy of Science Malaysia. Retrieved from http://www.akademisains.gov.my/download/ms3.0/Plastics_Composites_Industry_Sector.pdf

Finkbeiner M, Hoffmann R, Ruhland K, Liebhart D, Stark B. (2006). Application of life cycle assessment for the environmental certificate of the Mercedes-Benzes S class. Int J Life Cycle Assess 2006; 11:240–6.

Finkbeiner, M., & Hoffmann, R. (2006). Application of Life Cycle Assessment for the Environmental Certificate of the Mercedes-Benz S-Class. Int. J. Life Cycle Assess. 11, 240-246.

FlexForm Technologies, (2013). Biofore Concept Car. Retrieved from http://www.flexformtech.com/

Freshley, C. (2009). Green grub: Willingness to pay for green food at university dining facilities. Retrieved from http://green.tulane.edu/PDFs/Freshley_2009.pdf

Ghorbani, M., & Hamraz, S. (2009). A survey on factors affecting on consumer's potential willingness to pay for organic products in Iran (a case study). Trends in Agriculture Economics, 2 (1), 10 – 16. doi: 10.3923/tae.2009.10.16

Global Natural Fiber Composite Market 2015-2020: Trands, Forecast and Opportunity Analysis (2015). Reportlinker. Retrieved from https://www.prnewswire.com/news-releases/global-natural-fiber-composite-market-2015-2020-trends-forecast-and-opportunity-analysis-december-2015-300243712.html.

Goedkoop, M., & Spriensma, R. (2001). The Eco-indicator 99-A damage-oriented method for Life Cycle Impact Assessment-Methodology Annex. Assessment, 144.

Golnaz Rezai, Phuah Kit Teng, Zainalabidin Mohamed & Mad Nasir Shamsudin (2013). Consumer Willingness to Pay for Green Food in Malaysia, Journal of International Food & Agribusiness Marketing, 25:sup1, 1 18, DOI: 10.1080/08974438.2013.798754

Growth Opportunities for the ASEAN Automotive Composites Market (2017). Reportlinker. Retrieved from https://www.reportlinker.com/p05095699/Growth-Opportunities-for-the-ASEAN-Automotive-Composites-Market.html.

Guidelines on the Economic Valuation of the Environmental Impacts for EIA Projects. (2008). Department of Environment, Ministry of Natural Resources and Environment, Putrajaya.

Gurau, C., & Ranchhod, A. (2005). International green marketing: A comparative study of British and Romanian firms. International Marketing Review, 22(5), 547–561.

Hackl, F., & Pruckner, G. J. (2005). Warm glow, free-riding and vehicle neutrality in a health-related contingent valuation study. Health Economics, 14(3), 293-306.

Hakamadan M, Furuta T, Chino Y, Youqing C, Kusuda H, Mabuchi M. (2007). Life cycle inventory study on magnesium alloy substitution in vehicles. Energy 2007; 32:1352–60.

Hall, D. C., Hall, J. V, & Murray, S. N. (2002). Contingent Valuation of Marine Protected Areas: Southern California Rocky Intertidal Ecosystems. Natural Resource Modeling, 15(3), 335–368. doi.org/10.1111/j.1939-7445. 2002.tb00093. x.

Hanemann, M., (1984). Welfare evaluations in contingent valuation experiments with discrete responses. Am. J. Agric. Econ. 66, 332-341.

Hanemann, M., Loomis, J., & Kanninen, B. (1991). Statistical efficiency of double-bounded dichotomous choice contingent valuation. American journal of agricultural economics, 73(4), 1255-1263.

Hanemann, M., Loomis, J., & Kanninen, B., (1994). Statistical efficiency of double-bounded dichotomous choice contingent valuation. Am. J. Agric. Econ. 73, 1255-1263.

Hanley, N., & Spash, C. L. (1993). Cost-Benefit Analysis and Environmental. England: Edward Elger Publishing Lim-ited.

Harrison, G. W., & Kristrom, B. (1996). On the Interpretation of Responses to Contingent Valuation Surveys. Current Issues in Environmental Economics.

Hassan, F., Zulkifli, R., Ghazali, M. J., & Azhari, C. H. (2017). Kenaf fiber composite in automotive industry: An overview. International Journal on Advanced Science, Engineering and Information Technology, 7(1), 315-321.

Hassan, M. M., Karim, A., & Wagner, M. H. (2017). Role of Radiation and Surface Modification on Biofiber for Reinforced Polymer Composites: A Review. Handbook of Composites from Renewable Materials, 541-562.

Hausman, J. A. (Ed.). (1993). Contingent valuation: A critical assessment. Emerald Group Publishing Limited.

Hawkins, T.R., Singh, B., Majeau-Bettez, G., & trømman, A.H., (2013). Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles: LCA of Conventional and Electric Vehicles. J. Ind. Ecol. 17, 53-64.

Hendrickson C, Horvath A, Joshi S, & Lave L (1998). Economic input/output models for environmental life-cycle assessment. Environ Sci Techno 32, 184a–191a

Hendrickson, C. T, Lave, L. B, & Matthews, H. S (2006). Environmental life cycle assessment of goods and services: an input-output approach. RFF Press Book: Washington.

Hicks, J. R. (1943). The four consumer's surpluses. The review of economic studies, 11(1), 31-41.

Hoevenagel, R. (1994). An assessment of the contingent valuation method. In Valuing the environment: methodological and measurement issues (pp. 195-227). Springer, Dordrecht.

Hofstetter, P. (1998). Perspectives in Life Cycle Impact Assessment a Structured Approach to Combine Models of the Technosphere, Ecosphere and Value sphere. Kluwers Academic Publishers. https://Doi.Org/10.1007/978-1-4615-5127-0.

Hokazono, S., Hayashi, K., & Sato, M. (2009). Potentialities of organic and sustainable rice production in Japan from a life cycle perspective. Agronomy Research, 7(I), 257–262. Retrieved from http://agronomy.emu.ee/vol07Spec1/p7sI18.pdf.

Holbery, J., & Houston, D. (2006). Natural-fiber-reinforced polymer composites in automotive applications. Jom, 58(11), 80-86.

Hossain, M. D., Musa, M. H., Nuruddin, A. A., Jol, H., & Hamid, H. A. (2016). Physio-agronomic performance of kenaf as influenced by different carbon levels. Plant Omics, 9(1), 61.

Howlett, D., & Nagu, J. T. (2001). Agricultural project planning in Tanzania. Development and Project Planning Centre, University of Bradford.

Husted, B. W., Russo, M. V., Meza, C. E. B., & Tilleman, S. G. (2014). An exploratory study of environmental attitudes and the willingness to pay for environmental certification in Mexico. Journal of Business Research, 67(5), 891–899. https://doi.org/10.1016/j.jbusres.2013.07.008.

International Organization for Standardization – ISO. Environmental management – life cycle assessment – principals and framework. International Standard ISO 14040, Geneva; 2006.

International Organization for Standardization – ISO. Environmental management – life cycle assessment – requirements and guidelines. International Standard ISO 14044, Geneva; 2006.

Iritani, D. R., Silva, D. A. L., Saavedra, Y. M. B., Grael, P. F. F., & Ometto, A. R. (2015). Sustainable strategies analysis through Life Cycle Assessment: A case study in a furniture industry. Journal of Cleaner Production, 96, 308–318. doi.org/10.1016/j.jclepro.2014.05.029

Ishak, M. R., Leman, Z., Sapuan, S. M., Salleh, M. Y., & Misri, S. (2009). The Effect of Sea Water Treatment on the Impact and Flexural Strength of Sugar Palm Fibre Reinforced Epoxy Composites. International Journal of Mechanical and Materials Engineering, 4(3), 316–320.

Izran, K., M., Zharif, T., Guenter, B., Mohamad, J. S., Noor, A. A. R., & Yanti, A. K (2014). Kenaf for Biocomposite: An Overview. Journal of Science and Technology, 41-66.

JJ, Clark TF (1970) Cultural and harvesting methods for kenaf. An annual crop source of pulp in the Southeast. USDA Agriculture Res Ser Prod Res Report 113. US Government Printing Office, Washington, DC

Joshi SV, Drzal LT, Mohanty AK, and Arora S. (2004). Are natural fiber composites environmentally superior to glass fiber reinforced composites? Composites Part A 2004; 35:371–6.

Joshi, S.., Drzal, L.., Mohanty, A.., & Arora, S. (2004). Are natural fiber composites environmentally superior to glass fiber reinforced composites? Composites Part A: Applied Science and Manufacturing, 35(3), 371–376.

K. Wötzel, R. Wirth, M. Flake, and Ang Makromol (1999). Life cycle studies on hemp fibre reinforced components and ABS for automotive parts. Chemie 272 (1999) 121

Kahneman, D., & Knetsch, J. L. (1992). Valuing public goods: the purchase of moral satisfaction. Journal of environmental economics and management, 22(1), 57-70.

Karaaslan, E., Zhao, Y., & Tatari, O. (2018). Comparative life cycle assessment of sport utility vehicles with different fuel options. The International Journal of Life Cycle Assessment, 23(2), 333-347.

Kassaye, W. W. (2001). Green dilemma. Marketing Intelligence and Planning, 19 (6), 444– 455

Kivimaa, P., & Kautto, P. (2010). Making or breaking environmental innovation? Technological change and innovation markets in the pulp and paper industry. *Management Research Review, 33*(4), 289–305.

Klein, B., and Leffler, K.B., (1981). The role of market forces in assuring contractual perfor- mance. J. Political Econ. 89 (4), 615–641.

Klöpffer, W. (2003). Life-Cycle based methods for sustainable product development. The International Journal of Life Cycle Assessment, 8(3), 157–159. https://doi.org/10.1007/BF02978462

Koffler, C., (2013). Life cycle assessment of automotive lightweighting through polymers under US boundary conditions. Int. J. Life Cycle Assess. 19, 53-85.

Koistinen, L., Pouta, E., Heikkila, J., Forsman-Hugg, S., Kotro, J., Makela, J., Niva, M. (2013). The impact of fat content, production methods and carbon footprint information on consumer preferences for minced meat. Food Qual. Prefer. 29, 126-136.

KPMG (2014). Master Plan for the development of the National Kenaf Industry. National Kenaf and Timber Board.

Kraus, M., Egli, W., Haffner, K., Eliasson, B., Kogelschatz, U., & Wokaun, A. (2002). Investigation of mechanistic aspects of the catalytic CO 2 reforming of methane in a dielectric-barrier discharge using optical emission spectroscopy and kinetic modeling. Physical Chemistry Chemical Physics, 4(4), 668-675.

Leao A, Rowell R, Tavares N (1997) Applications of natural fibres in automotive industry in Brazil-thermoforming process. 4th International Conference. Front

Lee, C. T., Hashim, H., Ho, C. S., Van Fan, Y., & Klemeš, J. J. (2017). Sustaining the low-carbon emission development in Asia and beyond: Sustainable energy, water, transportation and low-carbon emission technology. Journal of Cleaner Production, 146, 1-13.

Lin, B., & Tan, R., (2017). Estimation of the environmental values of electric vehicles in Chinese cities. Energy Policy 104, 221–229.

Lloyd SM, and Lave LB (2003). Life cycle economic and environmental implications of using nano composites in automobiles. J Environ Sci Technol 2003; 37:3458–66.

Lockwood, M., Loomis, J., & Delacy, T. (1993). A contingent valuation survey and benefit-cost analysis of forest preservation in East Gippsland, Australia. Jorurnal of Environmental Management, 38(3), 233–243. https://doi.org/10.1006/jema.1993.1042

M. Laroche, J. Bergeron, G. Barbaro-Forleo, Laroche, M., & Bergeron, J., (2001). Targeting consumers who are willing to pay more for environmentally friendly products. Journal of consumer marketing, 18 (6), 503–520, 18(6), 503–520.

MacLean HL, Lave LB, Lankey R, and Joshi S. (2000). A life-cycle comparison of alternative automobile fuels. J Air Waste Manage Assoc 2000; 50(10):1769–79

Mahdzan, A., Bahrain, S., Amizan, A, & Aznor, S. (2000). Conserving Pulau Payar: Are Visitors Willing to Share the Cost? Proceedings of National Symposium on Pulau Payar Marine Park, 1–15.

Malaysian Industry-Government Group for High Technology (MIGHT), (2010). Business Strategic Implementation Plan in Developing Kenaf Industry in East Coast Economic Region (ECER). ECERDC, Kuala Lumpur.

Marn, M. V., Roegner, E. V., & Zawada, C. C. (2004). The Price Advantage (Vol. 286). John Wiley & Sons.

Masoud Akhshik, Suhara Panthapulakkal, Jimi Tjong, Mohini Sain (2017) Life cycle

Matthews HS, Small MJ (2000). Extending the boundaries of life-cycle assessment through environmental economic input-output models. J Ind Ecol 4, 7–10.

Mayyas, A., Qattawi, A., Omar, M., Shan, D., 2012. Design for sustainability in automotive industry: a comprehensive review. Renew. Sustain. Energy Rev. 16, 1845e1862. https://doi.org/10.1016/j.rser.2012.01.012.

McAuley, J.W., 2003. Global sustainability and key needs in future automotive design. Environ. Sci. Technol. 37, 5414e5416. https://doi.org/10.1021/ es030521x.

Md. Tahir, P., Ahmed, A. B., SaifulAzry, S. O. A., & Ahmed, Z. (2011). Retting process of some bast plant fibres and its effect on fibre quality: A review. BioResources, 6(4), 5260–5281. https://doi.org/10.15376/biores.6.4.5260-5281

Mercedes-Benz, (2013). Environmental Certificate Mercedes-Benz S-class.

Mintu, A.T., Lozada, H.R., 1993. Green marketing education: a call for action. Mark. Educ. Rev. 3 (Fall), 17–23

Mitchell, R. C., & Carson, R. T. (1989). Using surveys to value public goods: The contingent valuation method. Washington, DC: Resources for the Future.

Mohanty, A. K., Misra, M., & Hinrichsen, G. (2000). Biofibres, biodegradable polymers and biocomposites: An overview. Macromolecular Materials and Engineering, 276–277, 1–24. https://doi.org/10.1002/ (SICI) 1439-2054(20000301) 276:1<1: AID-MAME1>3.0.CO; 2-W

Mohanty, A.K., Misra, M., Drzal, L.T., 2002. Sustainable bio-composites from renewable resources: opportunities and challenges in the green materials world. J. Polym. Environ. 10, 19e26.

Monti A, Zatta A (2009) From growing kenaf to its industrial use. 1st Workshop Poznàn. http:// www.crops2industry.eu/images/pdf/poznan/6%20UniBO.pdf.

Mostafa M. M. (2016). Egyptian consumers' willingness to pay for carbon-labelled products: A contingent valuation analysis of socio-economic factors. Journal of Cleaner Production 135 (2016) 821-828

Muñoz, I., Rieradevall, J., Domènech, X., & Gazulla, C. (2006). Using LCA to Assess Eco-design in the Automotive Sector: Case Study of a Polyolefinic Door Panel (12 pp). The International Journal of Life Cycle Assessment, 11(5), 323-334.

Murray, C. J. L., & Lopez, A. D. (1994). Quantifying disability: Data, methods and results. Bulletin of the World Health Organization, 72(3), 481–494.

N. Saba, M.T. Paridah, M. Jawaid, K. Abdan and N.A. Ibrahim (2015) Chapter 1:

National Commodity Policy, 2011-2020

Natural Fiber Composites (NFC) Market Size, Share & Trend Analysis Report By Raw Material, By Matrix, by technology (Injection Molding, Compression Molding, Pultrusion), By Application, and By Segment Forecast, 2018-2024 (April 2018). Grand View Research. http://www.grandviewresearch.com/industry-analysis/natural-fiber-composites-market

Nemecek, T., Weiler, K., Plassmann, K., Schnetzer, J., Gaillard, G., Jefferies, D., Milà I Canals, L. (2012). Estimation of the variability in global warming potential of worldwide crop production using a modular extrapolation approach. Journal of Cleaner Production, 31, 106–117. https://doi.org/10.1016/j.jclepro.2012.03.005

Netravali, A. N., & Chabba, S. (2003). Composites get greener. Materials today, 6(4), 22-29.

Nishino, T., Hirao, K., Kotera, M., Nakamae, K., & Inagaki, H. (2003). Kenaf reinforced biodegradable composite. Composites Science and Technology, 63(9), 1281–1286. https://doi.org/10.1016/S0266-3538 (03) 00099-X

Ochi M. (2016). Kenaf (Hibiscus cannabinus L.) fibre-based bio-materials: A review on processing and properties, Progress in Materials Science, 78–79.

Ochi, S. (2008). Mechanical properties of kenaf fibers and kenaf/PLA composites. Mechanics of Materials, 40(4–5), 446–452. doi.org/10.1016/j.mechmat.2007.10.006

Ong, C. L., Othman, M. S. H., Tahir, P. M., & Elhag, E. A. I. (2015). Feasibility of kenaf as bio-material for automotive components: the case of Malaysia. International Journal of Green Economics, 9(3-4), 273-290.

Pandey, N., Mehta, N., Roy, S.B., (2016). Semiconductor pricing strategy in USB market: a market leader's dilemma. Bus. Perspect. Res. 5 (1), 1–10.

Paridah, M. T., Basher, A. B., SaifulAzry, S., & Ahmed, Z. (2011). Retting process of some bast plant fibres and its effect on fibre quality: A review. BioResources, 6(4), 5260-5281.

Phillips WA, Rao SR, Tungeln DLV, Fitch GQ (1996) Digestibility of freshly harvested, ensiled, and mature kenaf by sheep. Prog Animal Sci 12:99–104

Pishgar-Komleh S, Ghahderijani M, Sefeedpari P (2012) Energy consumption and CO_2 emissions analysis of potato production based on different farm size levels in Iran. J Clean Prod 33:183–191

Polym Adv Mater Conference Proceeding, pp 755–760

Potential Utilization of Kenaf Biomass in Different Applications. Agricultural biomass based potential materials. Springer-Verlag, Switzerland.

Qatu, M. S. (2011). Application of kenaf based natural fibre composites in the automotive industry. In: Proceedings of SAE 2011 world congress and exhibition, Detroit; April 2011.

Rajesh D. A., & Sunshine, B. (2007). Composites from bast fibres: prospects and potential in the changing market environment. J Nat Fibres 4(2):91–109.

Ramesh M., Palanikumar K., & Hemachandra K.R. (2013). Mechanical property evaluation of sisal-jute-glass fiber reinforced polyster composites. Composites, 48:1-9.

Rana, S., Pichandi, S., Parveen, S., & Fangueiro, R. (2014). Natural plant fibers: production, processing, properties and their sustainability parameters. In Roadmap to Sustainable Textiles and Clothing (pp. 1-35). Springer, Singapore.

Rao, A.R., Bergen, M.E., (1992). Price premium variations as a consequence of buyers' lack of information. J. Consum. Res. 19 (3), 412–423.

Reap, J., Roman, F., Duncan, S., & Bras, B. (2008). A survey of unresolved problems in life cycle assessment. The International Journal of Life Cycle Assessment, 13(5), 374. 45849094854&partnerID=40&md5=85dac79cbe54001d1eb39c6ffc21aaf8

Reinhardt, F. L. (1998). Environmental product differentiation: implications for corporate strategy. California Management Review, 40(4), 43–73. https://doi.org/10.2307/41165964.

Release, Press (2016). The Perodua Myvi Receives the F & S Value-For-Money Car of The Year.

Renault, (2011). Fluence and Fluence Z.E. Life Cycle Assessment.

Ribeiro, C., Ferreira, J. V., Partidário, P. (2007). Life Cycle Assessment of a Multi-Material Car Component. Int J Life Cycle Assess 12(5) 336-345

Riedel U, Gassan J, Karrus M, Mu¨ssig J, Pro¨mper E, Scho¨nberger D, Sperber V (2005) Technical and economic framework for parts based on natural fiber composites. In: Arbeitsgemeinschaft Versta¨rkte Kunststoffe – Technische Vereinigung e.V. (AVK- TV) (ed) 8. Internationale AVK-TV Tagung fu¨ r versta¨ rkte Kunststoffe und duroplastische Formmassen 2005-09-27/28. Baden-Baden, Germany, pp A3-8–A3-11

Roes AL, Marsill E, Nieuwlaar E, Patel MK. (2007). Environmental and cost assessment of a polypropylene nanocomposite. J Polym Environ 2007; 15:212–26.

Salit, M. S. (2014). Tropical natural fibre composites. Tropical Natural fibers and their properties, 15.

Salman, S. D., Sharba, M. J., Leman, Z., Sultan, M. T. H., Ishak, M. R., & Cardona, F. (2015). Physical, mechanical, and morphological properties of woven kenaf/polymer composites produced using a vacuum infusion technique. International Journal of Polymer Science, 2015.

Salvadó, J. A., de Castro, G. M., Verde, M. D., & López, J. E. N. (2012). Environmental innovation and firm performance: A natural resource-based view. Palgrave Macmillan

Schmidt WP, Beyer HM. (1998). Life cycle study on a natural fiber reinforced component. SAE Technical paper 982195. SAE Total Life-cycle Conf. Graz, Austria; December 1 – 3, 1998

Sharaai, A. H., Mahmood, N. Z., & Sulaiman, A. H. (2010). Life Cycle Impact Assessment (LCIA) Using the Ecological Scarcity (Eco points) Method: A Potential Impact Analysis to Potable Water Production. World Applied Science Journal, 11(9), 1077–1088. https://doi.org/10.5897/AJB11.428.

Shukri, M., & Muhamad, L. I. (2007). Preliminary study on willingness to pay for environmentally certified wood products among consumers in Malaysia. Journal of Applied Sciences, 7 (9), 1339 – 1342. doi: 10.3923/jas.2007.1339.1342

Singh, G., & Pandey, N. (2015). Leveraging return policy for price premium. Journal of Revenue and Pricing Management, 14(4), 276-292.

Song YS, Youn JR, Gutowski TG. (2009). Life cycle energy analysis of fiber-reinforced composites. Composites Part a 2009; 40:1257–65

Spielmann, M., Scholz, R. (2004). Life Cycle Inventories of Transport Services: Background Data for Freight Transport. Int. J. Life Cycle Assess. 10, 85-94.

Stans, J., Bos, H., (2007). CO2 reductions from passenger cars. In: The European Parliament's Committee on the Environment. Public Health and Food Safety, (IP/A/ENVI/FWC/2006-172/Lot 1/C2/SC1).

Stoycheva S, Marchese D, Paul C., Padoan S., Juhmani A.S, Linkov I (2018). Multi-Criteria Decision Analysis Framework for Sustainable Manufacturing in Automotive Industry. Journal of Cleaner Production. 257-271

Straughan, R. D., & Roberts, J. A. (1993). Environmental segmentation alternatives: a look at green consumer behavior in the new millennium. Journal of Consumer Marketing, 16(3), 558–575. https://doi.org/10.1108/07363769910297506.

Tahery Y, Shukor NAA, Abdul-Hamid H, Norlia B (2011) Growth characteristics and biomass production of kenaf. Afr J Biotechnol 10:13756–13761

Tan, R. R., Culaba, A. B., & Purvis, M. R. I. (2004). POLCAGE 1.0 - A possibilistic life-cycle assessment model for evaluating alternative transportation fuels. Environmental Modelling and Software, 19(10). https://doi.org/10.1016/j.envsoft.2003.10.004

Ungureanu CA, Das S, and Jawahir IS (2007). Life-cycle cost analysis: aluminums versus steel in passenger cars. Miner Met Soc 2007:11–24.

United Nations (1987, December 11). Report of the World Commission on Environment and Development. General Assembly Resolution 42/187.

US Commerce, D. of, 2011. Sustainable manufacturing initiative (SMI): a true public-private dialogue. International Trade Administration 1e16.

Van den Brink, R.M., Van Wee, B., (2001). Why has car-fleet specific fuel consumption not shown any decrease since 1990? Quantitative analysis of Dutch passenger car-fleetspecific fuel consumption. Transp. Res. Part D: Transp. Environ. 6 (2), 75–93.

Veleva, V., Ellenbecker, M., 2001. Indicators of sustainable production: framework and methodology. J. Clean. Prod. 9, 519e549.

Veshagh, A., & Obagun, A. (2007). Survey of Sustainable Life Cycle Design and Management. 14th CIRP Conference on Life Cycle Engineering, 237–242. https://doi.org/10.1007/978-1-84628-935-4

Volkswagen, A. G. (2012). The Golf. Environmental Commendation e Background Report.

Wang, H.J., 2017. Determinants of consumers' purchase behaviour towards green brands. Serv. Ind. J. 37 (13-14), 896–918.

Welford, R. (2011). Corporate social responsibility in Asia: An introduction to introduction to sustainable consumption. Presented at the 19th CI World Congress, Hong Kong.

White GA, Cummings DG, Whiteley EJ, Fike WT, Grieg FK, Marti FA, Killinger GB, Higgins

Wotzel K, Wirth R, Flake R. (1999). Life cycle studies on hemp fiber reinforced components and ABS for automotive parts. Angew Makromol Chem 1999; 272(4673):121–7.

Xie, B. C., & Zhao W. (2018). Willingness to pay for green electricity in Tianjin, China: Based on the contingent valuation method. Energy Policy 114, 98-107.

Xue, Y., Du, Y., Elder, S., Wang, K., & Zhang, J. (2009). Temperature and loading rate effects on tensile properties of kenaf bast fiber bundles and composites. Composites Part B: Engineering, 40(3), 189–196. https://doi.org/10.1016/j.compositesb.2008.11.009

Zheng, L. J. & Yu, C. W. (2002). Study on chemical modification of kenaf fibre and mixed blending with cotton. J Dalian Inst Light Ind, 21, 145–158.

Zhuang, J., Liang, Z., Lin, T., & De Guzman, F. (2007). Theory and practice in the choice of social discount rate for cost-benefit analysis: a survey (No. 94). ERD working paper series.

BIODATA OF STUDENT

Amira Mas Ayu Binti Amir Mustafa holds a bachelor's degree of Economic (International trade and finance) from Universiti Putra Malaysia and a Master of Science in Economics from Universiti Putra Malaysia. She has a wide experience in consulting and professional training services in the area of: (i) Natural Resources. (ii) Environmental Economics, (iii) Economic Valuation and (iv) Social Impact Assessment.

She has vast experiences in conducting consultancy services on issues of natural resources and environmental economics, impact of economic development in rural and urban regions to both national and international institutions. Among agencies she has done consultancy with are INSPEN, Department of Irrigation and Drainage, Department of Environment, Forest Research Institute Malaysia and Department of Forestry. Among the private consulting institutions, she has working experiences with AECOM Consultant, RBM Engineering Consultant, and Dr Nik & Associates.

LIST OF PUBLICATIONS

Mohd Shahwahid H.O., Amira Mas Ayu A.M., Paridah M.T., Ahmad Ainuddin N., Farah M.S., Norfaryanti K., Abdul Rahim A.S. (2017). Sustainability of Kenaf Development: Moving Forward. Publish by MEEA (Malaysian Economy and Environment Association.

Mohd Shahwahid H.O., Mohd Iqbal M.N., Amira Mas Ayu A.M., Farah M.S., Yuhanis A.A., Zaiton S. (2017). Trigon asp (Kelulut) Farming and Eco-Tourism Expedition of Apis Dorsata (Lebah Tualang) Honey Hunting: A Knowledge Transfer Programme. Publish by MEEA (Malaysian Economy and Environment Association)

Amira Mas Ayu A.M., Mohd Shahwahid H.O., Mohd Iqbal M.N., Zainal Ariffin M.I (2017), Cost and Earning Structure of Spare Wheel Cover Production, Chapter in Book. Editor: Mohd Shahwahid et.al. Publish by MEEA (Malaysian Economy and Environment Association)

Mohd Shahwahid H.O., Mohd Iqbal M.N., Amira Mas Ayu A.M., Rahinah I. & Mohd Ihsan M.S (2016). Social Network Analysis of Kampung Kuantan Fireflies Park, Selangor and the Implications Upon its Governance. Journal of Tropical Forest Science 28(4). (Scopus Indexed Journal) (Q2)

Amira Mas Ayu A.M., Mohd Shahwahid H.O., Mohd Iqbal M.N. and Rahinah I. (2014). Factors Determining the Stakeholders Perception of Kenaf Cultivation in Kelantan. International Journal of Green Economics (Scopus Indexed Journal) (Q3)

Mohd Shahwahid H.O., Amira Mas Ayu A.M. & Norfaryanti K. (2012). Critical Factors of farmers's participation in kenaf cultivation: Malaysian Context. African Journal of Agricultural Research. Vol. 7(23), pp. 3485-3489

Mohd Iqbal Mohd Noor, Mohd Shahwahid Hj Othman, Amira Mas Ayu Amir Mustafa and Rahinah Ibrahim (2016). Assessing the Governance of Ecotourism in Natural Forests Using Social Network Analysis: Kampung Kuantan Fire Flies Park Chapter in Book. In Amir Etal. UPM Press

Mohd Iqbal M.N., Mohd Shahwahid H.O., Amira Mas Ayu A.M. (2017) Analyzing Social Network Relationship Between Important Stakeholder in Malaysia Kenaf Industry Using Social Network Relationship, Chapter in Book. Editor: Mohd Shahwahid et.al. Publish by MEEA (Malaysian Economy and Environment Association)

Mohd Hafiz G., Mohd Shahwahid H.O., Amira Mas Ayu A.M. (2017) Theory of Behavioural Change: Structural Equation Modelling (SEM) Approach. Chapter in Book. Editor: Mohd Shahwahid et.al. Publish by MEEA (Malaysian Economy and Environment Association)

UNIVERSITI PUTRA MALAYSIA

STATUS CONFIRMATION FOR THESIS / PROJECT REPORT AND COPYRIGHT

ACADEMIC SESSION : First Semester 2019/2020

TITLE OF THESIS / PROJECT REPORT :

INCLUSION OF KENAF AS BIO-MATERIAL COMPONENT IN SUSTAINABLE MANUFACTURING IN MALAYSIAN AUTOMOTIVE INDUSTRY

NAME OF STUDENT: AMIRA MAS AYU BINTI AMIR MUSTAFA

I acknowledge that the copyright and other intellectual property in the thesis/project report belonged to Universiti Putra Malaysia and I agree to allow this thesis/project report to be placed at the library under the following terms:

1. This thesis/project report is the property of Universiti Putra Malaysia.
2. The library of Universiti Putra Malaysia has the right to make copies for educational purposes only.
3. The library of Universiti Putra Malaysia is allowed to make copies of this thesis for academic exchange.

I declare that this thesis is classified as :

*Please tick (√)

☐	**CONFIDENTIAL**	(Contain confidential information under Official Secret Act 1972).
☐	**RESTRICTED**	(Contains restricted information as specified by the organization/institution where research was done).
☐	**OPEN ACCESS**	I agree that my thesis/project report to be published as hard copy or online open access.

This thesis is submitted for :

☐ **PATENT** Embargo from _____ (date) until _____ (date)

Approved by:

_____
(Signature of Student)
New IC No/ Passport No.:

Date :

_____
(Signature of Chairman of Supervisory Committee)
Name:

Date :

[Note : If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization/institution with period and reasons for confidentially or restricted.]