TECHNICAL AND ECONOMIC ASSESSMENT OF PRODUCING SUSTAINABLE BIO-JET FUEL IN MALAYSIA

By

CHEN JIA TIAN

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Chairman : Professor Luqman Chuah bin Abdullah, PhD
Institute : Tropical Forestry and Forest Products

The aviation industry has implemented targets to reduce their greenhouse gas emissions footprint, in which, some of these measures are known as market-based measures (MBM). This effort to enact decarbonisation of the industry is mainly accounted by certified "drop-in" fuel, also known as alternative sustainable fuel or bio-jet fuel. Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), has placed carbon taxation on airline operators and the industry is at a tipping point to balance increase in air traffic and the cost of carbon emission. Production of enough bio-jet fuel could curb the cost of carbon emission; however adequate sustainable bio-jet fuel needs to be produced to meet a growing demand. Therefore, this study investigates the availability of sustainable biomass in Malaysia, evaluating the best conversion process, and determine the economic feasibility to produce a minimum quantity of bio-jet fuel. For Malaysia, the based quantity to produce is at least 2% of its annual consumption, which is roughly 60,000,000 million litres of bio-jet fuel (40 to 50 million kg of bio-jet fuel). Certified bio-jet fuel is currently only certified through 5 pathways (ASTM D7566), each of which has its set of preferred feedstock, economics, and technology maturity level. Assessment from these 5 technologies was performed from two aspects, (i) technological (maturity, process complexity, etc.) and (ii) economical, using through cost simulation, Discounted Cash Flow Rate of Return (DCFROR), and business potential for the country. It has been identified through analysis that two possible routes are possible for Malaysia as a country to take. For an oil-based route, a mature and cost-effective process known as Hydro-processed Esters and Fatty Acids (HEFA). For carbohydrate route, certified processes known as Fischer-Tropsch can be deployed. The acceptable price ranges from the industry, namely AirAsia and Malaysian Airlines, is to have Kerosene Jet A-1 grade fuel to be not above USD 0.70 per litre of fuel. With feedstock corresponding from 20% to 40% of the cost of production, the cost of production for bio-jet fuel (Jet A-1 grade) is considered higher than conventional jet fuel (fossil fuel based). Through a cost sensitivity analysis, it has been determined that a biorefinery using HEFA

technology will have an investment of USD 122,941,946 (MYR 489,310,789), considering Cost Index and Location Factor to Malaysia. This plant will require a feed-in of 55,556 to 71,429 tonnes of sustainable oil per year. For a FT- plant, an investment cost of USD 304,300,041 is required, or MYR 1,211,118,728, with a feed-in between 238,095 to 384,615 dry tonnes of lignocellulose per year. This study calculates that for FT, a general investment of 6086 USD_{CAPEX}/$tonne_{Jet\ Fuel}$, and 2,460 USD_{CAPEX} /$tonne_{Jet\ Fuel}$ for HEFA, through a DCFROR analysis, backed up by process study and modelling. As for feedstock, HEFA feedstock will require to be lower than 475 USD/$tonne_{Feed(Oil)}$, and for FT feedstock to be lower than 32 USD/$tonne_{Feed(Lignocellulose)}$. Considering feedstock price (HEFA) and plant capital cost (FT), the study shows the potential to meet industrial demand (USD 0.70 per $litre_{Fuel}$), with ideal plant parameters. From the study, HEFA has the highest potential for implementation and meeting industry's requirements.

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

PENILAIAN TEKNIKAL DAN EKONOMI DALAM PENGHASILAN BAHAN BAKAR PESAWAT BIO YANG MAMPAN DI MALAYSIA

Oleh

CHEN JIA TIAN

November 2019

Pengerusi : Profesor Luqman Chuah bin Abdullah, PhD
Institut : Perhutanan Tropika dan Produk Hutan

Industri penerbangan telah melaksanakan sasaran untuk mengurangkan jejak pelepasan gas rumah hijau, di mana beberapa langkah ini dikenali sebagai langkah-langkah berasaskan pasaran (MBM). Usaha ini untuk membubarkan peyahkarbonan industri terutamanya diambil kira oleh bahan api "drop-in" yang disahkan, juga dikenali sebagai bahan bakar lestari alternatif atau bahan api bio-jet. Skim Pengimbangan dan Pengurangan Karbon untuk Penerbangan Antarabangsa, CORSIA, telah meletakkan cukai karbon ke atas pengendali syarikat penerbangan dan industri ini berada pada tahap yang kritikal untuk mengimbangi peningkatan trafik udara dan kos pelepasan karbon. Pengeluaran bahan api bio-jet yang mencukupi dapat membendung kos pelepasan karbon, namun bahan bakar bio-jet yang mampan perlu dihasilkan untuk memenuhi permintaan yang semakin meningkat. Namun demikian, kajian ini meneliti ketersedian bahan api bio yang mampa di Malaysia, penilaian proses laluan bahan mentah yang terbaik, dan menentukan kelayaka ekonomi untuk penghasilan biojet dalam kuantiti yang paling rendah. Bagi Malaysia, keperluan untuk menghasilkan sekurang-kurangnya 2% daripada penggunaan tahunannya, ialah 60,000,000 juta liter bahan bakar bio-jet (40 hingga 50 juta kg bahan bakar bio-jet). Bahan api bio-jet yang disahkan pada masa ini hanya diperakui melalui 5 laluan proses (ASTM D7566), setiap proses laluan mempunyai keperluan bahan mentah, ekonomi, dan kematangan teknologi pilihan masing-masing. Penilaian dari 5 teknologi ini dijalani dari segi dua aspek, (i) teknologi (kematangan teknologi proses laluan dan kompleksiti) dan (ii) ekonomi, menggunakan simulasi kos, dan potensi perniagaan untuk negara. Analisa telah dilaksanakan dan dua proses lalaun telah dikenal pasti untuk pengesahan dalam negara Malaysia, iaitu proses laluan dengan pengunaan bahan mentah karbohidrat dan proses laluan bahan mentah berasaskan minyak. Untuk proses laluan berasaskan minyak, proses yang matang dan kos efektif ialah proses laluan Hydro-processed Esters and Fatty Acids (HEFA). Secara langsung, proses laluan bahan mentah karbohidrat, proses yang berpotensi untuk digunakan ialah proses Fischer- Tropsch (FT). Jumlah harga yang

diterima dari industri, iaitu AirAsia dan Malaysian Airlines, adalah untuk memiliki bahan api gred Kerosene Jet A-1 yang tidak melebihi USD 0.70 seliter. Kos bahan mentah adalah sebagai 20% sampai 40% daripada kos pengeluaran dan kos ini dianggap lebih tinggi daripada bahan bakar jet konvensional (bahan mentah berasaskan bahan bakar fosil). Walau bagaimanapun, melalui hasil analisis kepekaan kos, kos pelaburan bagi kilang penapisan bio yang menggunakan teknologi HEFA adalah sebanyak USD 122,941,946 (MYR 489,310,789), kos ini telah mangambil kira indeks kos dan factor lokasi di Malaysia. Kilang ini memerlukan bekalan bahan mentah berasaskan minyak sebanyak 55,556 kepada 71,429 tan setahun. Untuk kilang yang menggunakan teknologi FT, sebanyak USD 304,300,041 (MYR 1,211,118,728) kos pelaburan telah diperlukan, dengan bekalan bahan mentah kering lignoselulosa antara 238,095 hingga 384,615 tan setahun. Kajian ini didapati bahawa kos pelaburan am bagi teknologi FT dan teknologi HEFA adalah 6086 $USD_{CAPEX}/tonne_{Jet\ Fuel}^{-1}$ dan 2,460 $USD_{CAPEX}/tonne_{Jet\ Fuel}^{-1.}$ Kajian ini telah dilaksanakan melalui Analisis Kadar Pulangan Tunai Diskaun (DCFROR), disokongi oleh kajian proses dan pemodelan. Disamping itu, kos bahan mentah untuk HEFA dihendaki lebih rendah daripada 475 $USD/tonne_{Feed(Oil)}$ dan kos bahan mentah untuk FT adalah lebih rendah daripada 32 $USD/tonne_{Feed(Lignocellulose)}$. Memandangkan harga bahan mentah (HEFA) dan kos modal (FT), kajian ini menunjukan potensi untuk memenuhi keperluan industry (USD 0.70 per liter bahan bakar).

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Luqman Chuah Abdullah, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

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

Thomas Choong Shean Yaw, PhD
Professor, Ir.
Faculty of Engineering
Universiti Putra Malaysia
(Member)

ZALILAH MOHD SHARIFF, PHD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 12 March 2020

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. Luqman Chuah Abdullah

Signature: ______________________________
Name of Member of Supervisory Committee: Professor Ir. Dr. Thomas Choong Shean Yew

Signature: ______________________________
Name of Member of Supervisory Committee: Professor Dr. Paridah binti Md. Tahir

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LIST OF ABBREVIATIONS

$MM	USD Millions
%	Percent
ºC	degrees Celsius
AEA	All Electric Aircraft
AFR	Air-Fuel Ratio
AGO	Atmospheric Gasoil
AMIC	Aerospace Malaysia Innovation Centre
APU	Auxiliary Power Unit
ARPA-E	Advance Research Projects Agency - Energy
ASTM	American Standard of Testing and Materials
ATAG	Air Transport Action Group
ATC	Air Traffic Control
ATJ	Alcohol to Jet
ATR	Autothermal Reforming
Avgas	Aviation Gasoline
$MM	USD Millions
%	Percent
ºC	degrees Celsius
AEA	All Electric Aircraft
AFR	Air-Fuel Ratio
B.o.P	Balance of Plant
BTL	Biomass to Liquid
CAAM	Civil Aviation Authority of Malaysia

CAGR	Compound Annual Growth Rate
Cap	Capacity
CAPEX	Capital Expenditure
CEPCI	Chemical Engineering Plant Cost Index
CH	Catalytic Hydro-thermolysis
CH_4	Methane
CNG	Carbon Neutral Growth
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CORSIA	Carbon Offsetting and Reduction Scheme
CPO	Crude Palm Oil
CTL	Coal to Liquid
DCFROR	Discounted Cash Flow Rate of Return
Def. Stan	British Defence Standardization
DFBG	Dual Fluidized Bed Gasification
DLR	Deutsches Zentrum Fuer Luft- und Raumfahrt (German Aerospace Centre)
DOE	Department of Energy (United States)
DSHC	Direct Sugar to Hydrocarbon
ECS	Environmental Control System
EEA	European Environment Agency
EFB	Empty Fruit Bunches
EPA	Environmental Protection Agency
EPF	Employee Pension Fund
est.	Estimate

et al.	et alia (latin)
etc.	et cetera (so forth)
EtOH	Ethanol
ETS	Emission Trading Scheme
EU	European Union
EX	Exchange Rate
FAME	Fatty Acid Methyl Esters
FAO	Food and Agriculture Organization
FFB	Fresh Fruit Bunches
FOREX	Foreign Exchange Rate
FRL	Fuel Readiness Level
FT	Fischer-Tropsch
g	grams
gal	Gallon
GBEP	Global Bioenergy Partnership
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMF	Global Market Forecast
GMO	Genetically Modified Organism
GOST	Gosudarstvennyy Standart (Russia Standardization)
GTL	Gas to Liquid
H_2O	Water
ha	hectare
HC	Hydrocarbon

HDCJ	Hydrotreated Depolymerized Cellulosic Jet
HEFA	Hydro-processed Esters and Fatty Acids
HMF	Hydroxymethylfurfural
HRJ	Hydroprocessed Renewable Jet
HTL	Hydrothermal Liquefaction
HVO	Hydrogenated Vegetable Oil
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
ISCC	International Sustainability & Carbon Certification
ISO	International Organization of Standardization
JP	Jet Propellant
kg	kilogram
km	kilometre
kWh	kilowatt hour
L	Litre
LCC	Low Cost Carrier
LF	Location Factor
LHSV	Liquid Hourly Space Velocity
LOSU	Level of Scientific Understanding
m^2	square meter
m^3	cubic metre
MARCS	Modified Accelerated Cost Recovery System

MBM	Market-Based Measures
MEA	More Electric Aircraft
MEROX	Mercaptan Oxidation
MgO	Magnesium oxide (magnesia)
MIDA	Malaysia Investment Development Authority
MJ	Mega Joules
MJSP	Minimum Jet Fuel Selling Price
MM	Millions
MoT	Ministry of Transport
MoTAC	Ministry of Tourism, Arts and Culture
MPI	Ministry of Primary Industries
MPOB	Malaysian Palm Oil Board
MRO	Maintenance Repair and Overhaul
MRV	Monitoring Reporting Verify
MSW	Municipal Solid Wastes
MtCO2	Metric Tonne of Carbon Dioxide
mW	milli-Watt
MW	Mega Watt
MY	Malaysia
MYR	Malaysian Ringgit
N	Nitrogen
NEO	New Engine Option
Ni	Nickel
NOx	Nitrogen Oxides

NPV	Net Present Value
NREAP	National Renewable Action Plan
O&G	Oil & Gas
OPEX	Operating Expenditures
P&ID	Process and Instrument Diagram
Pd	Palladium
PEMFC	Proton Exchange Membrane Fuel Cell
PFAD	Palm Fatty Acid Distillate
PFD	Process Flow Diagram
PM	Particulate Matters
POME	Palm Oil Mill Effluent
POX	Partial Oxidation
ppm	parts per million
PPP	Purchasing Power Parity
PSA	Pressure Swing Absorption
Pt	Platinum
RAT	Ram Air Turbine
RED	Renewable Energy Directive
REDD+	Reducing emissions from deforestation, forest degradation; the role of conservation, sustainable, management of forests + enhancement of forest carbon stocks in developing countries
RF	Radiative Forcing
RFS	Renewable Fuel Standard
RM	Ringgit Malaysia
RPK	Revenue Passenger Kilometres

RSB	Roundtable on Sustainable Biomaterials
RTK	Revenue Tonnes Kilometre
S	Sulphur
SAGE	Sustainable and Green Engine
SAK	Synthesized Aromatic Kerosene
SDG	Sustainability Development Goals
SIP	Synthesized Iso-Paraffins
SK	Synthesized Kerosene
SO_2	Sulphur Dioxide
SOx	Sulphur Oxides
SPAN	National Water Services Commission
SPK	Synthetic Paraffinic Kerosene
SOx	Sulphur Oxides
SST	Sales and Service Tax
STR	Steam Reforming
synfuel	synthetic fuel
t	Tonne
tCO_2e	Tonne of Carbon Dioxide Equivalent
TNB	Tenaga National Berhad
TRL	Technology Readiness Level
U.S	United States
UN	United Nations
V.O.C	Volatile Organic Compounds
VGO	Vacuum Gas Oil

vol%	Percent Volume
vs.	versus
W	Watt
wt%	Percent Weight
yr	year
η	Efficiency (Conversion)

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Global production of aviation fuel, particularly Kerosene Jet A-1, has a market presence of 80 billion gallons per year, or 302.8 billion litre per year. In the United States alone, 83.3 billion litre of aviation fuel per year is refined, as reported by Davidson et al. (2014). Of the 302.8 billion litres, 12% is used for the military while the other 88% is used for commercial flights, with North America having the highest rate of consumption of ca. 102 billion litres. Asia and Russia combined has a fuel consumption of ca. 61.2 billion litres (IATA, 2011). Malaysia consumes roughly 3 billion litres of kerosene jet fuel per year (2010), which only accounts close to 0.01% of global aviation usage, (EIA, 2016). Compared to other countries around the world, Malaysia, with its high biodiversity due to its equatorial climate, boasts a large potential to develop and produce alternative fuel for its transportation industry – whereas other less biodiverse country will lesser options and may rely on bio-fuel imports. While aviation fuel competes with road transportation fuel, especially the source feedstock, road transportation has the luxury of convenient refuel stations and the implementation of alternative power drive trains such as electric motors with batteries. For aviation, however, alternative options to power the aircraft are limited, not to mention any prospective technologies such as batteries, fuel cells, hybrid propulsion, etc. are still rather immature to have short-term impact. The development and roll-out of alternative jet fuel / bio-jet fuel is seen to have the potential to meet the industrial movement towards carbon footprint reduction, able to utilize on current infrastructure, and with quick adoption period (IATA, 2009). Malaysia, as part of IATA and as part of UN, has agreed to reduce the country's carbon footprint. The aviation industry sees an unprecedented unity as an industry compared to many other CO_2 producing industries (automotive, agriculture, maritime, etc.), therefore, any produced bio-jet fuel must meet stringent international standards such as the ASTM D7166. However, wide-scale commercialization and deployment are mainly hampered by the availability of sustainable biomass feedstock, investment costs to enable production of the bio-jet fuel, and the stringent safety requirement.

Asia-Pacific is a region of great interest for the aviation industry, as by 2030, the Asia-Pacific region will see an increase by over 15,000 new aircraft, (GMF, 2018). This increase in air traffic warrants the need to have sustainable fuel to be implemented in this region, to keep its carbon emissions controlled and limited. Malaysia has seen a considerable increase in air traffic recently and is one of the region's larger user of aviation jet fuel. Malaysia is a member of the International Civil Aviation Organization (ICAO), as well as the IATA (International Air Transport Association), and these international organizations have pledged to decrease climate impact from the aviation industry, such as the 4-pillar movement and recently CORSIA. Carbon Offsetting and Reduction

Scheme for International Aviation, or simply CORSIA, is a global initiative by the United Nations (UN) to address and offset aviation emissions through "offset credits" and "allowances" from emissions trading scheme. Malaysia has pledged itself towards CORSIA and the implementation phase is in 2020 (CORSIA States, 2018). While CORSIA's initiative helps account and reduce greenhouse gas emissions from the industry, it also has the adverse effect of curving aviation growth. Therefore, it is imperative that Malaysia has offset credits to address its aviation emissions - one such credit gains could be the utilization of bio-jet fuel. Furthermore, Europe will start to implement regulations to tax incoming flights without carbon neutral fuel / sustainable bio-jet fuel entering its airspace. In order for Malaysia not to be at a disadvantage for such movements, as well as to prevent from falling behind on other countries such as Indonesia, Thailand, Canada, the United States, Europe, China, and Japan on the introduction of bio-jet fuel in flights, Malaysia has to protect, among others, its foreign investment, tourism economy, and aviation expansion, through energy security with sustainable bio-jet fuel production locally.

Bio-jet fuel implementation introduced by the previously mentioned countries are at a level between 2 to 5 vol%. Indonesia, has mandated that a 2% bio-jet fuel (certified blended) implementation in 2018 to its fleet, increasing it to 5% by 2020. For Malaysia to follow this trend, a 2% of bio-jet fuel in Malaysia, equates to roughly 60 million litres (or ca. 40 – 50 million kg, density depending), of bio-jet fuel is required. Assuming a process conversion efficiency of 40% (feedstock to fuel), (Capareda, 2014; Worldwatch Institute, 2016; and Vello et al., 2014), this comes to a rough estimate of 18.4 to 20 million kg of biomass. It is estimated that there are roughly 54 million kg of biomass residue in Malaysia, this indicates that there is enough biomass residue available (Roda et al., 2015). However, asides from securing available sustainable biomass for conversion, which certified conversion pathway still needs to be determined. A robust consideration on the balance of economics (feedstock, production, distribution, product, and social impact) and technological maturity in these processes must be analysed, compared, and modelled to determine the potentiality of which feedstocks and its corresponding processes will enable a viable bio-jet fuel business in Malaysia. To appropriately compare, the processes of the various pathways need to be simulated in chemical process simulation programs such as ASPEN Plus, used in both academic and in the industrial world (Bonomi et al., 2016; Wooley et al., 1996). Through modelling and simulation, energetics of the conversion pathway (feed to fuel) can be identified, compared, and assessed on the efficiency of the process and product formation. Lastly, economics, such as feedstock cost, plant cost, and production cost, will be calculated for the investment cost structure for a bio-refinery plant (using these conversion pathways), operational costs, and cost per litre of bio-jet fuel production needs to be considered (Towler et al., 2015; Aspen Richardson, 2013; Gong et al., 2011). The feedstock cost for oil-based feedstock is USD 700/tonne, whilst carbohydrate-based feedstocks are USD 35/tonne. The current jet-fuel price is approximately USD 324/tonne.

1.2 Problem Statement

The motivation behind this study is based on the aviation industry's implementation of a set of targets and to reduce its carbon footprint (IATA, 2013), which goals from IATA are:

- From now to year 2020, fuel efficiency to be improved by 1.5% per annum.
- By year 2020, net carbon emissions from aviation will be capped through carbon neutral growth
- By year 2050, 50% reduction in net aviation CO_2 emissions over year 2005 levels.

Thus, the study defines its problem statements in three (3) folds. (i) Does Malaysia have enough sustainable biomass to be converted into bio-jet fuel, to meet the aviation fuel demand within Malaysian airports? (ii) Does it make economic benefits to build and operate a bio-refinery plant? This may provide Malaysia with a new source of revenue, independent from fossil base income. And lastly, (iii) is the bio-refinery plant able to produce price competitive bio-jet fuel for the aviation industry? This is vital to be price competitive to ensure the industry's willingness to adopt and compensate.

1.3 Objectives of Research

The project principally aims to support Malaysia's carbon footprint reduction and to determine the feasibility of producing sustainable bio-jet fuel derived from sustainable biomass or biomass residues for the aviation industry's fuel demand.

The focus of the research is divided into three major areas:

1. To investigate the potential sustainable biomass annual availability and price to match potential demand of bio-jet fuel (annually).
2. To evaluate the Fuel Readiness Level of various conversion processes for Malaysia, and to determine the technical and economic parameters.
3. To determine the quantity of bio-jet fuel able to be produced in Malaysia, given a sustainable roadmap, and provide a brief business case.

1.4 Research Hypothesis

The hypothesis of this research is, “Malaysia has sufficient land and local sustainable biomass (and biomass residue) to replace 2 - 5% of Malaysia’s consumption of aviation turbine jet fuel”. This hypothesis can be achieved through a technical and economical approach, knowing Malaysia’s abundance amount of biomass diversity and marginal lands potential, that ensures certifiable bio-jet fuel. The introducing bio-jet fuel into the local supply will provide an economic boost to the country, such as gross domestic product (GDP), through feedstock value and bio-jet fuel sales. This is also in-line with the aviation industry, specifically Airbus, as it is coherent with their global pledge and the elements within their Sustainable Aviation Action globally. Hence, the hypothesis encompasses synergistic effects with both industry and academia, which from this work, supports an adoption of a bio-jet fuel business in Malaysia.

1.5 Research Significance and Scope of Study

This research has a countrywide to regional impact, providing a platform to enable Malaysia to produce its own bio-jet fuel together with the other major aviation countries in the world, such as the United States, Canada, Europe, Japan, and Indonesia. This will also place Malaysia in a strategic position to fulfil its commitments to the United Nations (UN) in greenhouse gas reduction and decarbonisation of the country, in an initiative called CORSIA (Annex 16, 2018). In the region, Asia Pacific, Malaysia will be one of the pioneers to enable the country to produce its own bio-jet fuel, using sustainable feedstock.

However, the limitation of this research relies on the availability of sustainable biomass in Malaysia. Indirectly, also the technical and technology competence level of Malaysia to adopt conversion technologies needed for certified bio-jet fuel. Malaysia should have enough capacity to localise these technologies and obtain certification stage, however if a learning curve is required, it may increase the adoption cost and thereby decrease cost competitiveness of the bio-jet fuel cost.

1.6 Significance of Study

The significance of this study is to support the Malaysian government is determining the investment and collaboration (industrial, governmental and academics) required to have Malaysia produce its own bio-jet fuel, rather than rely on imports other countries. This study is the first to compare the various conversion pathways, focus on determining the potential to reach a minimum jet fuel selling price which the industry can accept (offtake). The field of study is highly relevant and impactful to the Institute of Forestry and Forest Product (INTROP), in particular bioresource management, as the jet fuel selling price will determine which process and feedstock (biomass/bioresource) is best suited to achieve commercial potential (fuel sales to the airlines), and therefore how UPM and INTROP is best able further investigate this new stream of supply chain and bio-jet fuel product.

1.7 Thesis Outline

The thesis introduces the overall stance of the current aviation industry, and how steps the industry has taken to be responsible and accountable for its carbon footprint, this is highlighted in detail in Chapter 2. Chapter 3 provides the technical assessment and literature review of the various certified pathways for bio-jet fuel conversion (technical), and economical assessment required for parameters input to Chapter 4. Chapter 4 is process modelling and parameters calculations for inputs into the economic modelling. Chapter 5, using the discounted cash flow rate of return method to determine the best bio-refinery cost possible, given industrial price point demands, and utilizing Monte Carlo simulation to determine the confidence level of the data. Chapter 6 summaries this study and draws the conclusion of the ideal bio-refinery plant, feedstock, and possible ways forward for implementation.

1.8 Research Methodology

This study's research methodology can be represented in the following diagram:

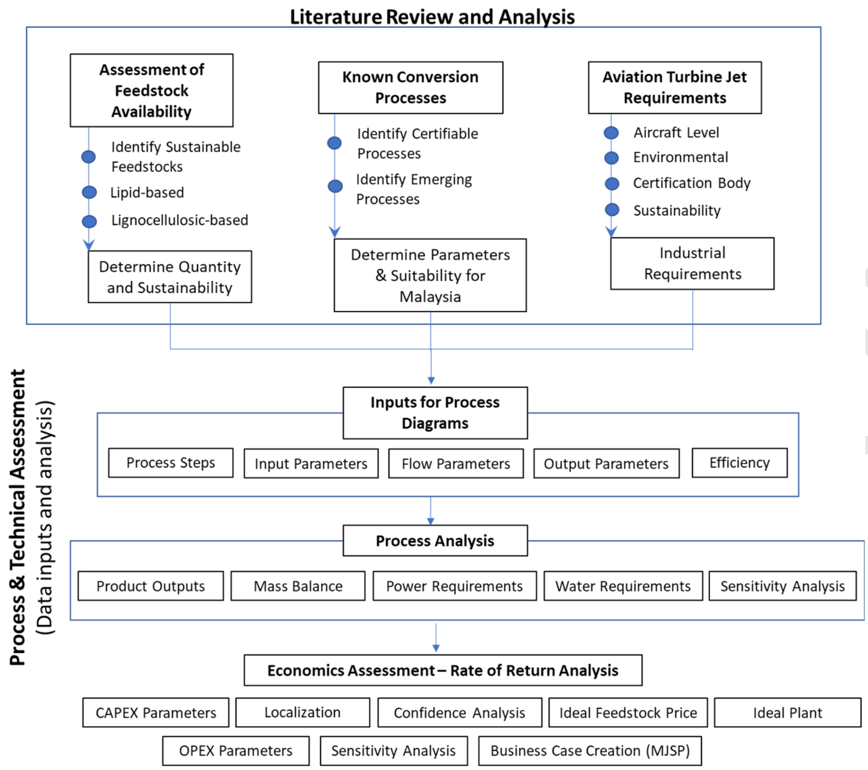

Figure 1.1: Research Methodology of this study

This research follows the Type I quantitative research method, which is industry driven through the undertaking of research and investigation. The hypotheses are a positivistic approach, which is data centric through model and process analysis. This study takes research and industrial inputs and correlate the data based on the deduction method and analysis. The sources within this study is a mixture of primary and secondary data.

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