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Signature   : …………………………………………..

Supervisor's name   : DR. FAM SOO FEN

Date   : …………………………………………..

Signature   : …………………………………………..

Assessor's name   : MISS JOHANNA BINTI ABDULLAH JAAFAR

Date   : …………………………………………..

PROFILING MELAKA ON-ROAD TRANSPORTATION GREENHOUSE GAS (GHG) EMISSIONS

ADIB AKRAM BIN JAAFAR

This report is submitted in fulfilment in the requirement for Bachelor of Technology Management (Innovation Technology) - BTMI

Faculty of Technology Management and Technopreneurship (FPTT)

Universiti Teknikal Malaysia Melaka (UTeM)

JUNE 2017

DECLARATION

'I admitted that this thesis is done by myself except which I have to mention the source such as citation.'

Signature   :

Name   : ADIB AKRAM BIN JAAFAR

Date   :

DEDICATION

This research is dedicated to my mother and my family who have been my constant source of my inspiration. They have given me continuous support in my studies especially during I am completing my thesis. I am so proud to have a family that supporting me from behind since the first day I am producing this thesis. Thank you for giving me a chance to prove myself through my life especially in studies. Not to forget my friends who continue helping me when I need their support in order to complete this study.

ACKNOWLEDGEMENT

I was deeply grateful and wish to express my warm and sincere thanks to my supervisor Dr. Fam Soo Fen for her guidance and encouragement throughout this final year project which is a very long journey. She provided me with a valuable knowledge of doing research in order to enhance my skills of doing research. She also willing to spend some of the times for guiding me to complete this thesis. Her wide knowledge and passion in doing research helped me in completing this thesis.

Furthermore, I would like to acknowledge my panel of presentation, Miss Johanna Binti Abdullah Jaafar for her advices and suggestions during VIVA presentation. Lastly, I also appreciate all my members who involved either directly or indirectly in this final year project.

ABSTRACT

Global warming occurs due to excessive release of the greenhouse gas (GHG) emissions. One of the main contributors to the emissions is from the transportation sector. According to past studies, on-road transportation is the main emitter of the greenhouse gas (GHG) emissions in transportation sector. Hence, it is vital to conduct a study regarding the greenhouse gas (GHG) emissions to provide a clearer picture of the total emissions from the on-road transportation. This study aims to measure the emissions from the on-road transportation in Melaka. Global Protocols for Community-Scale Greenhouse Gas Emission Inventories (GPC), accounting for community emissions, harmonized emission analysis tool plus (HEAT +) and GHG Inventory are the methodologies to produce the on-road transportation energy profile and carbon emission in Melaka. Data was collected from the various states and federal government agencies, as well as the private sectors. Results show that the on-road transportation contributes the largest greenhouse gas (GHG) emissions with 1,167,928.38 (t CO2e) out of 1,172,703.38 (t CO2e) which is around 99.59% from the total of the greenhouse gas (GHG) emissions from the transportation sector in Melaka. In conclusion, Melaka has already embarked on a path towards green city by the year 2020. Melaka has to pursue with low carbon growth through ensuring that the carbon emissions will be reduced by up to 40% by the year 2020.This findings are important to assist the government to led policies and projects, as well as the private sectors and the community initiatives, that seek to enhance liveability in Melaka.

Keywords: Greenhouse Gas (GHG) Emissions, Global Protocols for Community-Scale Greenhouse Gas Emission Inventories (GPC), on-road transportation

ABSTRAK

Pemanasan global berlaku akibat pelepasan berlebihan gas rumah hijau. Salah satu penyumbang utama kepada pelepasan gas rumah hijau adalah daripada sektor pengangkutan. Menurut kajian lalu, pengangkutan jalan raya adalah pemancar utama pelepasan gas rumah hijau dalam sektor pengangkutan. Jadi, penting untuk menyediakan kajian mengenai pelepasan gas rumah hijau untuk memberikan gambaran yang jelas tentang jumlah pelepasan gas rumah hijau daripada pengangkutan jalan raya. Kajian ini bertujuan untuk mengukur pelepasan gas rumah hijau daripada pengangkutan jalan raya di Melaka. GPC, "accounting for community emissions", HEAT + dan Inventori GHG adalah kaedah untuk menghasilkan profil tenaga dan pelepasan karbon pengangkutan jalan raya di Melaka. Data dikumpulkan daripada pelbagai agensi kerajaan negeri dan persekutuan, dan juga sektor swasta. Keputusan menunjukkan bahawa pengangkutan jalan raya menyumbang pelepasan gas rumah hijau terbesar dengan 1,167,928.38 (t CO2e) daripada 1,172,703.38 iaitu kira-kira 99.59% daripada jumlah pelepasan gas rumah hijau daripada sektor pengangkutan di Melaka. Kesimpulannya, Melaka telah memulakan jalan ke arah bandar hijau menjelang tahun 2020. Melaka perlu mencapai sasaran pertumbuhan karbon rendah dengan memastikan pelepasan karbon dapat dikurangkan sehingga 40% menjelang tahun 2020.Penemuan ini penting untuk membantu kerajaan membuat dasar dan projek, serta inisiatif sektor swasta dan inisiatif komuniti, yang bertujuan untuk meningkatkan tahap keselesaan mendiami di Melaka.

Kata kunci: pelepasan gas rumah hijau, GPC, pengangkutan jalan raya

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LIST OF ABBREVIATIONS

GHG   :   Greenhouse Gas Emissions

CO2   :   Carbon Dioxide

CH4   :   Methane

N20   :   Nitrous Oxide

NEI   :   National Emissions Inventory

UNFCCC   :   United Nations Framework Convention on Climate Change

ICLEI   :   Local Government for Sustainability

CNG   :   Compressed Natural Gas

NGV   :   Natural Gas Vehicle

RON   :   Research Octane Number

NASA   :   National Aeronautics and Space Administration

GISS   :   Goddard Institute for Space Studies

SF6   :   Sulphur Hexafluoride

HFCs   :   Hexafluoride

PFCs	:	Perfluorocarbons
HPF	:	Hot Press Forming
IPCC	:	Intergovernmental Panel on Climate Change
Km	:	Kilometre
GPC	:	Global Protocol for Community Scale Greenhouse Gas Emission
WRI	:	World Resource Institute
C40	:	C40 Cities Climate leadership Group
UN-Habitat	:	United Nations Human Settlements Programme
UNEP	:	United Nations Environment Programme
MGTC	:	Melaka Green Technology Corporation
PTHM	:	Perbadanan Teknologi Hijau Melaka
OilCo	:	Oil Company
HEAT+	:	Harmonized Emission Analysis Tool Plus
GWP	:	Global Warming Potential
CO2e	:	Carbon Dioxide Equivalent
tc	:	Tonnes of Carbon
kg	:	Kilogram
TJ	:	Terajoule
GHGa	:	Greenhouse Gas Emissions resulting from the activity a

EFa	:	Emission Factor of activity a
Da	:	Data for activity a
t CO2e	:	Tonnes of Carbon Dioxide Equivalent
UTeM	:	Universiti Teknikal Malaysia Melaka
BTMI	:	Bachelor of Technology Management (Innovation Technology)
FPTT	:	Fakulti Pengurusan Teknologi dan Teknousahawanan
VIVA	:	Viva Voce (Living Voice)
VKT	:	Vehicle Kilometre Travelled
AR5	:	5th Assessment Report

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The background of the study is vital important to create a clearer view or picture about the study. The aim of the study is to give an overview on how the greenhouse gas (GHG) emissions from the on-road transportation in Melaka were measured and to produce a pioneer results reporting regarding the greenhouse gas (GHG) emissions from the on-road transportation in Melaka.

Melaka has already embarked on a path towards green city by the year 2020. Melaka has to pursue with low carbon growth through ensuring that the carbon emissions will be reduced by up to 40% by the year 2020. So, the researcher found it is vital to conduct a study to measure the greenhouse gas (GHG) emissions in order to determine the amount of the emissions in Melaka. This findings are essentially important to assist the government to led policies and projects, as well as the private sectors and the citizen initiatives, that seek to enhance liveability in Melaka.

In this study, the researcher mainly focused only on the on-road transportation emissions in Melaka. The transportation sector covers emissions of the carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) (Zhao and Li, 2016), so do as the on-road transportation. These gases are the portion of the greenhouse gases (GHG). Greenhouse gases (GHG) are particularly responsible for the global warming (Cervero and Golub, 2007) (Hensher, 2008).

So, the researcher found it is important for Melaka to encounter this problem in order to achieve sustainable city status in the future by having its own method of measuring the greenhouse gas (GHG) emissions for the on-road transportation. By having the suitable method to measure the greenhouse gas (GHG) emissions from the on-road transportation in Melaka, it will help in providing the right result regarding the emissions that are coming from the on-road transportation in Melaka, at once giving a clarity picture on the emissions in Melaka which can be used by the policy makers and the local government to provide the right policies and mitigation options to encounter this problem.

In this study, the researcher provides the insight on which method is to be chosen for Melaka in measuring the greenhouse gas (GHG) emission emissions from the on-road transportation according to suitability level, types of the fuel consumption that have the biggest contribution to the greenhouse gas (GHG) emissions from the on-road transportation in Melaka and the total amount of the greenhouse gas (GHG) emissions by the on-road transportation in Melaka. It is important to answer all these three questions in order to make this research achieve its primary objective which is providing a comprehensive profiling for Melaka on the on-road transportation greenhouse gas (GHG) emissions in proper manner and to ease the understanding by the readers or researchers for future reference.

1.2   Problem Statement

Climate change resulting from the global warming causing extreme weather events and have been reported frequently by the few countries (Santovito et al., 2015). Intensification of the greenhouse effect due to the rising concentration of the particular type of the gases in the atmosphere causing the global warming which is later resulting in climate change. Greenhouse gases (GHG) are particularly responsible for the global warming (Cervero and Golub, 2007) which is also supported by Hensher (2008). In this study, the researcher focused based on the on-road transportation greenhouse gas (GHG) emissions. There are three main emissions from the on-road transportation: carbon dioxide (CO_2), methane (CH_4) and nitrogen oxide (N_2O).

Greenhouse gas (GHG) emissions accounting is a method of calculating the amount of the greenhouse gases (GHG) emitted by a region in a given time-scale. A National Emissions inventory (NEI) measuring country's greenhouse gas (GHG) emissions 1 year required by UNFCCC (United Nations Framework Convention on Climate Change). The main purpose is to provide a benchmark for the country's emissions reduction in order to control the global warming issues. A standard for measuring the greenhouse gas (GHG) emissions in the city level is needed for the city-scale greenhouse gas (GHG) emissions measurement in order to understand the challenges and opportunities for the city-scale inventories due to the cities have different needs and abilities in combining the inventories than the national level such as nations (ICLEI, 2009) (Richter, 2012). It is crucial to choose the right method for a city to measure the greenhouse gas (GHG) emissions based on the several criteria which are the availability of the data, the quality of the data and the reliability of the data.

So, the researcher found that choosing the right method for measuring the greenhouse gas (GHG) emissions from the on-road transportation in Melaka as a city state is vital in order to enhance further understanding on the greenhouse gas (GHG) emissions from the on-road transportation in Melaka.

1.3   Research Questions

This study explored the following key questions:

1.   What is the method used to measure the greenhouse gas (GHG) emissions from the on-road transportation in Melaka?

2.   Which type of the fuel consumption have the largest contribution towards the greenhouse gas (GHG) emissions from the on-road transportation in Melaka?

3.   What is the total amount of the greenhouse gas (GHG) emissions from the on-road transportation in Melaka?

1.4   Research Objectives

The main objective of this study is to determine the amount of the greenhouse gas (GHG) emissions that came from the on-road transportation in Melaka. To ensure this study is reliable, these objectives must be achieved during this study. Below are the listed objectives that need to be achieved:

1.   To determine the suitable method used to measure the greenhouse gas (GHG) emissions from the on-road transportation in Melaka.

2.   To determine the type of the fuel consumptions have the largest contribution towards greenhouse gas (GHG) emissions from the on-road transportation in Melaka.

3.   To determine the total amount of the greenhouse gas (GHG) emissions from the on-road transportation in Melaka.

1.5   Scope, Limitation and Key Assumption

The scope of this study is focused on the greenhouse gas (GHG) emissions from the on-road transportation only. The area that is needed to be focused only in Melaka geographical boundary covering all the districts in Melaka which are Jasin District (Melaka-Jasin), Central Melaka (Melaka-Tengah) and Alor Gajah District (Melaka-Alor Gajah).

The limitations of this study were this to determine the on-road transportation greenhouse gas (GHG) emissions on the common mode of transportation which are the emissions in general from the personal vehicle such as cars and motorcycles and also public transport such as buses. Unfortunately, this study cannot determine specifically which the on-road transportation mode contributes to the largest greenhouse gas (GHG) emissions due to it only focused on the fuel sold by the oil companies in order to determine the amount of the greenhouse gas (GHG) emissions. The fuel sold are based on 3 types of fuel sold in Malaysia which are petrol, diesel and natural gas or also known as CNG or NGV.

Another limitation in this study is it is based on the top-down approaches in order to measure the greenhouse gas (GHG) emissions from the on-road transportation which is based on the total fuel sold by the oil companies and in order to calculate the emissions, the top-down approach using the basic formula by multiplying the emission factor with the activity data to get the total amount of the emissions from the on-road transportation. For example, the emission factor of petrol multiply with the activity data which is the petrol fuel sold so the researcher can get the total amount of the on-road transportation emissions. Different types of the fuel such as petrol, diesel and natural gas will give different value of the emission factor. So, due to this kind of measuring method nature, it can't calculate the emissions based on the specific measures such as emission factor that coming from various engines technology, engines capacity, driving style, traffic patterns and fuel characteristics in terms of mixing of the fuel content due to the different formula. For example, Petronas has different fuel formula compared to Shell, Petron, BHP and Caltex or also known as

Chevron. This study only provide the readers about the general emissions that are coming from the on-road transportation based on the fuel sold method.

Another limitation in this study is it does not included the emission factor based on the different level of the petrol fuel which refers to the fuel quality and performance rating. In Malaysia there are three different level of the petrol fuel which are RON 95, RON 97 and RON 100. RON actually stands for Research Octane Number that determine the fuel quality and the performance rating of the petrol fuel itself. So, different RON number basically has different emission factor due to the different in terms of the fuel quality and performance rating. But, for this study the researcher only focus on the common petrol fuel sold which include all the RON 95, RON 97 and RON 100 into the same category of the petrol fuel sold due to the amount of the emission factor between the different RON number are negligible but in order to get a better emissions results from the on-road transportation in the future, the RON number emission factor should be include in the study in order to compare the results and at the same time to see is there any minor or major differences between the amount of the emissions from the on-road transportation using the common petrol fuel sold which include all the RON 95, RON 97 and RON 100 into the same category with the petrol fuel sold that are segregated all RON into different fuel level individually which are RON 95, RON 97 and RON 100 in order to provide a clearer picture on whether the emission factor of the petrol fuel sold that are segregated all RON into different fuel level individually should be include in the future study or should be ignored in order to reduce the complexity of the study.

The key assumptions that can be made from this study is personal vehicle could be the largest greenhouse gas (GHG) emissions contributor compared to the public transport. This is due to the tendency of the Melaka communities owning more than one car or motorcycle at a time and the public transportation in Melaka is not covering every route especially in the rural areas and also the inefficiency of the public transportation systems itself such as delay in schedule that cause longer waiting time, not having enough bus to cover every route in Melaka, not having enough workers,

small demand from the local communities in the certain areas and breakdown of the bus due to bad service maintenance which cause delay in time to reach destination.

Next key assumption that can be made in this study is the petrol fuel could become the main contributor to the greenhouse gas (GHG) emissions from the on-road transportation in Melaka due to the people tendency to use private transportation rather than public transportation which is due to the convenience of the private transportation that can be used directly from home to desire destination for example going to work place such as office. This statement also supported by Soylu (2007) which stated that fuel consumptions and emissions per km travelled are higher for the on-road transportation mode compare to the other transportation mode due to its characteristics as a convenient transportation mode for our daily life due to its ability to become a direct transportation that can be easily use from home to desire place. Most of the on-road transportation in Melaka use petrol fuel rather than diesel fuel due to the domination of the car and motorcycle on road in Melaka compare to the lorries and buses that use diesel fuel and only a few of the taxies and rental car use natural gas or also known as CNG or NGV based fuel.

Another key assumption in this study is the on-road transportation could be the largest contributor of the greenhouse gas (GHG) emissions compared to the other transportation mode such as railway, aviation, water-borne and off-road transportation mode due to its popularity and its convenient to be used as a direct transportation from our home and becoming our daily transportation, make it valuable to study the emissions came from this mode of transportation.