

DECLARATION

“I hereby declare that the work in this thesis is my own except for summaries and quotations which have been duly acknowledged.”

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SPECIAL THANKS FOR

MA AND ABAH

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ABSTRACT

Emission inventory is a worldwide study of pollution at every country. The study involves more than one source. But for this project, only the area source will be reviewed. The area source will be detailed at the car repairing/refinishing garages that through the process of spraying and painting only. CORINAIR is chosen as the suitable guidebook or manual for emission rate of non-volatile organic compound (NMVOC) in the case study. According to the CORINAIR, the method used is tier 2. Based on the survey that is carried out, the district involves 5 categories, include Cheng, Malim Jaya, Bukit Katil, Bukit Rambai and Duyung. All the district must under the governed of History of Melaka Historic City Council (MBMB). If not, all the data are not valid to use for this case study. The case study uses a software known as Mapinfo 10.0 to identify the polluted region. The data that must have in the software are coordinate and total emission rate of NMVOC to obtain the polluted region. From the mapinfo, the most polluted district is Malim Jaya because the place located near the industrial area. While the least polluted region is found at Bukit Katil due to the location at the rural area.

ABSTRAK

Pelepasan inventori adalah satu kajian mengenai pencemaran yang di lakukan hamper keseluruhan naegara. Kajian ini melibatkan lebih daripada satu sumber. Tetapi untuk projek ini, hanya jenis sumber pada kawasan sahaja yang akan dikaji semula.. Sumber pada satu kawasan akan diperincikan lagi di bengkel pembaikan kereta yang melalui proses penyemburan serta pengeringan cat. CORINAIR telah pilih sebagai buku panduan atau manual yang sesuai untuk kadar pelepasan sebatian organik tidak menentu (NMVOC) dalam bagi kajian kes ini. Berdasarkan, CORINAIR, kaedah yang sesuai digunakan ialah Tahap 2. Kajian yang dijalankan, melibatkan lima daerah sahaja termasuklah Cheng, Malim Jaya, Bukit Katil, Bukit Batu dan Duyung. Daerah-daerah yang terlibat mestilah di bawah pentadbiran Melaka Bandaraya Bersejarah (MBMB). Hal ini demikian kerana skop projek kajian ini melibatkan kawasan MBMB sahaja. Hanya data daripada kawasan ini sahaja yang boleh diguna pakai untuk tujuan pengiraan kadar pencemaran. Kajian kes menggunakan perisian yang dikenali sebagai MapInfo 10.0 untuk mengenal pasti kawasan manakah yang paling banyak dicemari oleh pelepasan gas *NM VOC*. Data yang perlu ada dalam perisian ini termasuklah jumlah kadar pelepasan *NM VOC* dan juga koordinasi tempat. Melalui MapInfo, daerah yang paling tercemar adalah Malim Jaya kerana lokasinya yang terletak berhampiran kawasan perindustrian. Manakala, kawasan yang paling sikit tercemar adalah Bukit Katil, disebabkan kawsannya terletak di luar bandar.

Jika tidak, semua data yang tidak sah untuk digunakan bagi kajian kes ini. Kajian kes menggunakan perisian yang dikenali sebagai MapInfo 10.0 untuk mengenal pasti kawasan tercemar. Data yang perlu ada dalam perisian boleh menyelaraskan dan jumlah kadar pelepasan NMVOC untuk mendapatkan kawasan tercemar. Dari MapInfo, daerah yang paling tercemar adalah Malim Jaya kerana tempat yang terletak berhampiran kawasan perindustrian. Walaupun rantau yang paling tercemar didapati di katil Bukit kerana lokasinya di kawasan luar bandar

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CHAPTER 1

INTRODUCTION

1.0 PROJECT BACKGROUND

Emission inventory can be defined as a database that lists, by source, the amount of air pollutants discharged into the atmosphere of a community during a given time of period. Based on the participant's workbook of "Train for Clean Air of Emission Inventory for Smaller cities" emission inventory usually contains two major groups of pollutants. Firstly, greenhouse gases, which consist of carbon monoxide (CO₂), methane (CH₄), Nitric oxide (N₂O), fluorinated gaseous compound and etc. Also, the other major pollutant is an air pollutant which involves acidifying pollutants (SO₂, NO_x, NH₃), photochemical smog precursors (NMVOC), particulate precursors, toxic pollutants and carbon monoxide (CO).

Emission inventory can be categorized into categories of sources, namely point, area and line or mobile. This separation is important, for instance, since these source

categories are treated differently in dispersion models. The inventories should also contain geographical information so that emissions can be separated on. This project has only covered for area sources. Area sources can be specified as the stationary sources that are too small or else too numerous to be considered as point sources. The area sources that had been chosen to study the emission inventory for this project is in the History of Melaka Historic City Council (MBMB). MBMB is responsible for over area of 11.47 square miles (303 square kilometers). **Figure 1.1** below is the area under administrative of MBMB.

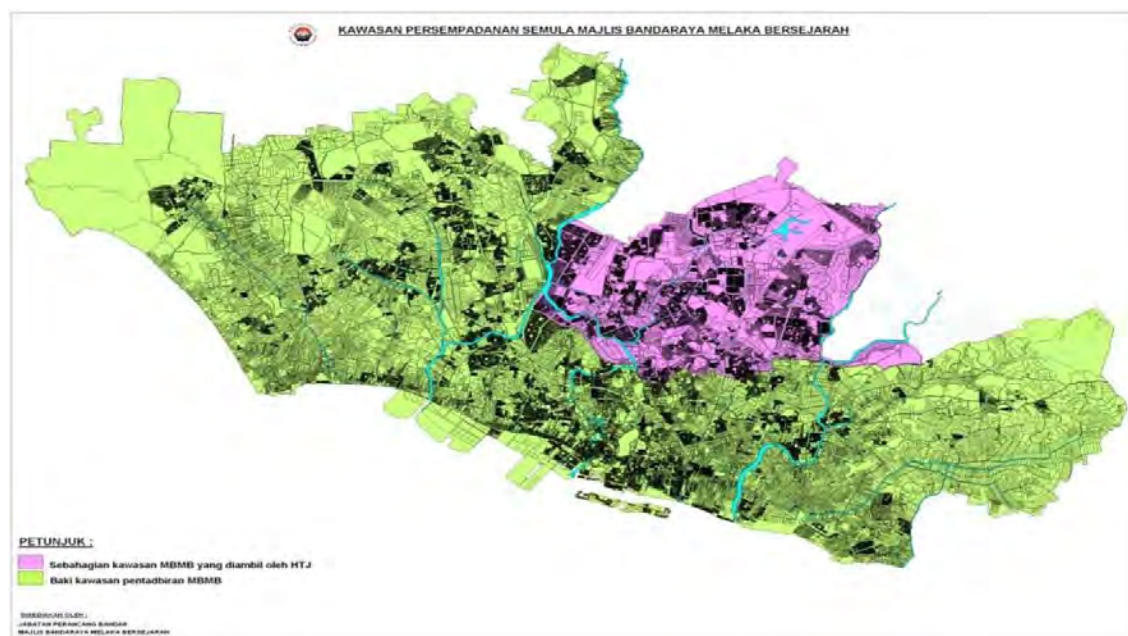


Figure 1.1: The region under administrative of MBMB

(<http://www.mbmb.gov.my/warga-mbmb>)

The study will only specify at certain area whereby the chosen area is at car repairing or refinishing garages that involve painting and coating activities. The activities from car repairing done by workers will produce pollutants that emit into the air and affect the surrounding area and also the people there. The phenomenon occurs due to the solvent of paint.

Garages or workshops is define as a workplace that repair all types of automobiles vehicle. There are many types garages today, but the garages that been chosen in this area source case study is the garages that doing coating, painting and spraying or other else known as car repairing and refinishing workshops.

All the vehicles that want to coat and spray the car surface must go through a few process. Firstly, the vehicle need to do precleaning process to remove the dirt. Then, the scuff and shoot process to repair the texture of surface. After that, the vehicle need to repair the damage body which is most garages use hammer and dollies to further the process. Next, is the primer process whereby the process is to sealling up the surface by applying a primer to the vehicle before applying colour. Then, the process of colouring the vehicle and top coat by any colour of paints based on customers requirement and can be seen in **Figure1.2**. This process can be categorized into many ways like single stag epaints, waterbone paint system and basecoat-clearcoat system. Moreover, the next process is finishing paint and need through the process due to has clearcoat as flat and smooth as possible. After spraying process, the paint need to be drying and then removing dirt and imperfection from waste of paints. (Matt, 2014)



Figure 1. 2: The image of the spray painting process of the car at the garage
(<http://www.pandorapigments.com>)

1.1 PROBLEM STATEMENT

The study is about the research of the emission rate from the garages in MBMB region. Emission also can be determined through the data produced from the survey and calculation by referring Corinair guidebook. For this case study, the composition of non-methane volatile organic compound (NMVOC) will be highlighted to obtain due to the fact that only NMVOC is the airborne pollutant inside the solvent of paint. There are few factors that will influence the quantity of NMVOC produced during the process of coating, such as NMVOC solvent content of coatings, volume solid content of coatings, the type of paint used and also the number of vehicle whereby all the factors will influence the data calculation of the study.

1.2 OBJECTIVES

1. To determine the total emission of NMVOC contain in paint when doing car repairing or refinishing activities.
2. To analysis the data produced from the site visit.
3. To identify which area has high result of producing NMVOC.

1.3 SCOPE

The scope for this project is site visit at the garages area MBMB, to do data mining of NMVOC that contain in paint solvent which can be measured through the quantity of paint container used for vehicles coating. Therefore, the calculation can be made based on the data mining to obtain emission rate of NMVOC.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

The project is carried out due to determine the total amount of non-methane volatile organic compound (NMVOC) that contain in paint by painting and spraying activity at garages. The suitable method needs to consider so that the emission inventory around the area of MBMB can be measured. There are lots of methods based on every country that can be used to analyze the result produced

2.1 DUTCH EMISSION INVENTORY

The Dutch Emission Inventory is one of the methods that can be used to measure emission inventory in the Netherlands or else known as Holland. This program was cooperative with other institutes that are responsible towards clean air in the Netherlands, which consist of PBL (Netherlands Environmental Assessment Agency), CBS (Statistics Netherlands), TNO (Netherlands Institute for Applied Scientific Research), Senter Novem, RWS-WD (Water Service, part of the Directorate-General for Public Works and Water Management) and Alterra. (Coenen, 2004)

The purpose of the emission is to create a data set of emission for environment relevant pollutants. The program always developed due to the estimation of emission for all industrial activities and also included non-industrial sectors such as agriculture, consumers, and waste sector. (Coenen, 2004) The Dutch emission inventory is one of the oldest in Europe and contributed to the development of other inventories European countries. Due to that, the current issues of inventories are difficult to adjust to the new quality of requirement.

Although the Netherlands emission inventory has a long history, this did not prove to be a guarantee for optimal use of resources. The Ministry of environment has appointed the Netherlands Environmental Assessment Agency (MNP) as the responsible body for the Dutch Emission register. The data from the emission register are used by the agency to evaluate and predict future levels of environmental contamination. The emission data are also used by other ministries and organizations (such as Statistics Netherlands). By participating in the inventory, these organizations ensure their specific needs are covered by the inventory. (Coenen, 2004)

Based on chapter 5, “Solvent and the Others Product Use (CRF sector 3)” from National Inventory Report 2014 of Greenhouse gas emissions in the Netherlands 1990-2012 on page 97, stated that the element of this case study which is about the paint solvent. Regarding to the sector 3, emissions of greenhouse gases includes indirect emissions of CO₂ related to the release of non-methane volatile organic compounds (NMVOC) through the use of solvents and a wide range of other fossil carbon-containing products such as paints, cosmetics and cleaning agents. Furthermore, this sector also includes N₂O emissions originating from the use of N₂O as anesthesia and as a propelling agent in aerosol cans like cans of cream. But for this program the indirect CO₂ emissions from NMVOC are calculated from the average carbon content of the NMVOC in the solvents (Ministry of Health, 2014). But the paint that had been discuss does not related with paint used for car coating at garages. Based on the table in appendix A, it explained about the pollutants that involve sector 3 and also the emission in 2011 until 2012. (Refer in **Appendix 4**)

2.2 U.S EPA

U.S EPA can be defined as United States Environmental Protection Agency (EPA or sometimes U.S EPA) is an agency of the U.S. federal government which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress. U.S EPA also is one of the programs that used for emission inventory. U.S EPA The U.S. Environmental Protection Agency (EPA) has established a Global Change Research Program (GCRP) in support of the U.S. Global Change Research Program.

The EPA GCRP is an assessment-oriented with four areas of emphasis: human health, air quality, water quality, and ecosystem health. In order to assess the effect of

global climate change on regional air quality, EPA will conduct regional air quality modeling for the year 2050, using the EPA Community Multiscale Air Quality (CMAQ) model, with climate change inputs from regional climate model simulations. (Benjey et al., 2000) Emissions must be projected to the year 2050 in order to capture the direct and indirect effects of changes of biogenic and anthropogenic emissions. (Benjey et al., 2000)

At an early stage of finding, U.S EPA has identified six criteria of pollutants concern which included SO₂, PM, ozone (O₃), CO, NO₂ and lead (Pb). From the criteria, U.S EPA has established primary and secondary for this pollutant. Primary is designed to protect public health and particularly sensitive population, while the secondary is used for public welfare, which includes the environment. (Williams & Kilaru, 2014)

Air pollution is a complex mixture of many different chemical compounds. Many new pollutants that had been discovered by the researchers like volatile organic compound (VOCs) and also mercury (Hg). Under the clean air-act, EPA has been regulated 187 hazardous air pollutants commonly known as “air toxic”. (Williams & Kilaru, 2014). Therefore, EPA has developed an air quality index, where concentration and health concern have been established for a number of common pollutants.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects

Figure 1. 3: The air quality index level that used by U.S EPA (Williams & Kilaru, 2014)

EPA calculates the air quality index for five major air pollutants regulated by the Clean Air Act of EPA, which include ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health. Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country. EPA uses information based on ambient ozone concentrations in the determination of the daily air quality index. On-line formulas incorporate information such as observed 24-hour average concentrations and established minimum and maximum pollutant ranges. (Williams & Kilaru, 2014)

2.3 ARB'S EMISSION INVENTORY (AIR RESOURCES BOARD)

ARB's emission inventory is a technique that used in California to measure the emission under the California environmental protection agency which valid in California only. ARB's mission is to promote and protect public health, welfare and ecological resources through the effective and efficient reduction of air pollutants, while recognizing and considering the effects on the state's economy. The ARB uses the emission inventory to evaluate air quality models and reduce emission in each of 35 local air districts (California's Clean Air Agency, 2011).

There are two major types of inventory approaches used to determine the amount of greenhouse gas emissions from a region which are top-down and bottom up approaches. The California greenhouse gas inventory uses both approaches. The top-down approach, while the bottom-up approach uses facility-specific data to estimate emissions from each source. The total amount of emissions from each source are then summed together to generate an inventory for a particular geographic area (California Environmental Protection Agency, 2014).

At the ARB, the criteria pollutant emission inventory which includes information on the emissions of reactive organic gases (ROG), oxides of nitrogen (NO_x), oxides of sulfur (SO_x), carbon monoxide (CO), and particulate matter (PM₁₀). Data are gathered on an ongoing basis and stored in the California Emission Inventory Development and Reporting System (CEIDARS). These inventories are used to satisfy requirements of the Clean Air Act, to track emissions reductions of air pollutants, and to judge the effectiveness of control technology applications statewide (Smith, Sax, Bode, & Shimp, 2014). The emission inventory can only represent an estimate of what is actually

occurring. Due to the importance of the inventory in air quality planning and management in California, the ARB and local air pollution control agencies are working together to further refine estimation methods to improve the inventory (“California’s Clean Air Agency,” 2011). The example data from California can be seen in appendix A. (Refer appendix 5)

2.4 CORINAIR 2013 (CORE INVENTORY AIR EMISSION

The European Union (EU) emission inventory program (CORINAIR) was set up by the European Council of Ministers in 1985 to assist in the development of consistent, comparable and transparent national inventories for “conventional” air pollutants such as SO_x, NO_x, and NMVOC. CORINAIR had been developed through generation by generation to update with the latest issues of emission especially from the aspects of pollutants produced. The new development had additional pollutants which include NH₃, CO, CO₂ and N₂O, as well as to separate CH₄ from NMVOC. CORINAIR method also had elaborate the source of emission inventory for three types of categorized, include area source, point source, and mobile source. The emission inventory can be measured by three ways; top down approach, bottom up approach and combine.

2.4.1 TOP-DOWN APPROACH

A top-down inventory is characterized by a lack of detailed information about location and emissions from individual sources. When fuel consumption, production, vehicle and other activity statistics are available, a top-down inventory can be constructed, using the statistics and emission factors. Therefore, a top-down emission