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**ASSOCIATION BETWEEN MANUFACTURING  
DEVELOPMENT AND GLOBAL WARMING IN  
MALAYSIA THROUGH GEOGRAPHICAL  
VISUALIZATION BY USING R-INLA**

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## APPROVAL

**I/We\* hereby to declare that I have read this thesis paper, and I think this paper is sufficient and acceptable in term of scope and quality for Bachelor Degree in Technopreneurship with Honours.**

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ASSOCIATION BETWEEN MANUFACTURING DEVELOPMENT AND GLOBAL  
WARMING IN MALAYSIA THROUGH GEOGRAPHICAL VISUALIZATION BY  
USING R-INLA

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## **DECLARATION**

I certify that this PROJECT PAPER and the research to which it refers are the product of my own work and that any ideas or quotation from the work of other people, published or otherwise are fully acknowledge in accordance with the standard referring practices of discipline.

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**SAU YING HUI (B061410283)**

## DEDICATION

Thanks and appreciation to Dr. Fam Soo Fen for guiding me as my supervisor so that I can finish this research and wrote my thesis. This study is one of the most important and important experiences in my life along my journey as a student at University Teknikal Malaysia Melaka (UTeM).

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## ABSTRACT

Environmental pollution caused by industrial activities has been increasing over the past four decades (Remoundou and Koundouri, 2009). As science and technology are keep blooming, the activities of manufacturing companies are increase, and lead to climate change, especially the effect of greenhouse gases (GHGs), is one of the new challenges facing countries in the world (Banwo, Du and Onokala, 2017). Hence, the present study examine the relationship between manufacturing development and global warming in Malaysia. The study aims to identify the geographical changes of manufacturing industry and mean temperature in Malaysia to determine their relationship towards global warming. To meet the objective, this study use spatial method to identify the changing of geographical pattern in manufacturing development and mean temperature in Malaysia compared with selected year (2010 and 2015). The data of manufacturing establishment sector and mean temperature in 2010 and 2015 are obtain from Department of Statistics Malaysia (DOSM). Thus, researcher using R-INLA software to analyse the research data and plot out the result in research study. Discussion will be conduct from analysis data and at the end of research, result are able to identify and determine the relationship between manufacturing development and temperature.

*Keywords: Manufacturing, Global Warming, geographical changes, spatial*

## ABSTRAK

Pencemaran alam sekitar semakin meningkat sejak empat dekad yang lalu (Remoundou dan Koundouri, 2009). Memandangkan sains dan teknologi terus berkembang, aktiviti-aktiviti syarikat pembuatan juga meningkat, dan membawa kepada perubahan iklim, terutamanya kesan gas rumah hijau (GHGs), adalah merupakan salah satu cabaran baru yang dihadapi negara-negara di dunia (Banwo, Du dan Onokala, 2017). Oleh itu, kajian ini mengkaji hubungan antara pembangunan pembuatan dan pemanasan global di Malaysia. Industri pembuatan dan suhu purata di Malaysia adalah digunakan untuk menentukan hubungan antara dua factor ini dengan pemanasan global. Untuk mencapai matlamat ini, kajian ini menggunakan kaedah spatial untuk mengenal pasti perubahan geografi dalam pembangunan perkilangan dan suhu purata di Malaysia berbanding dengan tahun 2010 dan 2015. Data dari sektor pembuatan dan suhu purata pada tahun 2010 dan 2015 adalah diperolehi daripada Jabatan Perangkaan Malaysia (DOSM). Selepas itu, penyelidik menggunakan perisian R-INLA untuk menganalisis data penyelidikan dan plot hasil kajian penyelidikan. Perbincangan akan dijalankan melalui data analisis yang telah dikaji dan pada akhir penyelidikan, hasil akan dapat mengenal pasti dan menentukan hubungan antara perkembangan pembuatan dan suhu.

*Keywords: Manufacturing, Global Warming, geographical changes, spatial*



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## CHAPTER 1

### INTRODUCTION

#### *1.1 Topic*

Association between manufacturing development and global warming in Malaysia through geographical visualization by using R-INLA.

#### *1.2 Introduction / background of the study*

Environmental pollution due to industrial activities has been increasing in the last four decades (Remoundou and Koundouri, 2009). With the rapid development of the global economy, climate change, especially the greenhouse gases (GHGs) effect, is one of the new challenges that all countries in the world are facing (Li, Qiao and Shi, 2017). Since the science and technology are getting more and more advanced, manufacturing corporate activity are booming, and maximizing opportunities in different location (Banwo, Du and Onokala, 2017). With the carbon emission that release by manufacturing industries (XIA Chuyu, LI Yan, YE Yanmei, 2017), Therefore, country facing complex problems in a weak environment pollution.

The main factor of air pollution comes from manufacturing industrial zone (Aaron Huertas, 2015). In order to promote economic development, especially in developing countries, the manufacturing industry produce productivity every day in order to increase its competitive advantage among the market (Banwo, Du and Onokala, 2017). But, the gases that release by the industry has also brought adverse effects leading to temperature rise Zhang *et al.*, (2018) and air pollution (Blaum *et al.*, 2017). This is because the gases produced by the manufacturing industry generate heat are discharged into the air. Moreover, the industry is widely used in oil and gas, petrochemical, chemical, power, mining, steel, metal, environmental protection, pharmaceuticals, pharmaceuticals, biotechnology, food, water, fertilizer, nuclear power, electronics and aerospace industries (APD, 2017). As different industries emit a wide range of gases such as carbon dioxide are contaminated components Thomas et al, (2011), cumulative indirect impact on global warming.

According to Thomas *et al.* (2011), any form of pollution can be traced back to the direct source of industrial practice, known as industrial pollution. Industries that manufacture chemicals, metals, fertilizers, perfumes, pharmaceuticals, plastics, and cement emit hazardous emissions and dangerous dust into the air, which is detrimental to the environment. The level and distribution of air pollutants around the world show that nitrogen dioxide is caused mainly by vehicle emissions A.A. Jaafar et al., (2017) and industrial processes (The Associated Press, 2017). With the intensification of manufacturing industrial pollution, temperature of the air has been steadily increasing. Smoke and greenhouse gases (GHGs) are being released into the air by industry, leading to increased global warming (Rinkesh Kukreja, 2017). In fact, the problem of industrial pollution has become very important for institutions trying to counter the deterioration of the environment.

Air pollution has become a direct constraint on socio-economic development and could cause serious health consequences (Li, Qiao and Shi, 2017). According to Remoundou and Koundouri (2009), the intensification of industrialization and the increase in energy use are the most serious drivers of rising temperature and environmental health problems, which have led to the continuous deterioration of the

environment due to the huge economic growth and population growth. Besides, the interaction between human health and the environment pollution has been extensively studied and environmental risks have been demonstrated either directly by exposing humans to harmful substances or indirectly damaging the life-sustaining ecosystem.

Urban air and water pollution from industry are primarily attribute to environmental risks and lead to occurrences of Asthma and increase in existing diseases such as malaria and cholera, as well as a rising risk of new diseases emerging (Remoundou and Koundouri, 2009). According to Marie Claire (2017), free of chemicals from the manufacturing process that can release volatile organic compounds (VOCs) into the air as they burn. Exposure to VOCs at high levels can lead to skin irritation and allergic skin reactions on human.

Manufacturing are known to have highest pollution (Hassan, Nordin and Ashari, 2016). Increase of manufacturing industry will lead to increase of temperature (Hassan, Nordin and Ashari, 2016). In agriculture industry, temperatures are likely to affect both farmer productivity and have a direct influence on crop yields (Sudarshan, 2015). According to Cynthia Myers (2017), air pollution can lead to different diseases such as cough and other respiratory problems such as respiratory irritation, allergies, asthma or frequent bronchitis. Carbon monoxide and other gases can cause headaches, dizziness, and even death. For humans, it is precisely for these reasons that air pollution has badly affected on us. The harmful effects of air pollution affect not only humans but also flora and fauna. Products such as acid rain and other air pollution caused serious damage to nature. Animal species have disappeared, the forest decayed, global warming and a hole in the ozone layer (Thomas *et al.*, 2011).

Kurane (2010) stated that global warming is one of the components of climate change. Climate change is also a threat to human health and well-being and is therefore becoming a matter of serious concern around the world (Remoundou and Koundouri 2009). IPCC consider new evidence of the impact of global warming on human health (IPCC, 2007). Confalonieri (2017) summarized that the impact of global warming on human health is divided into two categories: direct effects of heat shock, increased mortality in other diseases, infectious diseases, allergies and other diseases

indirectly based on fourth report of the Intergovernmental Panel on Climate Change (IPCC). Furthermore, economic development is also an important part of adaptation, but it does not by itself perpetuate the world's population from diseases and injuries caused by climate change (Kurane, 2010). From the current review, the impact of global warming on infectious diseases is identified, and manufacturing is one of the indirect contributing factors.

The effects of climate change may benefit some and harm people. It can affect their livelihoods, health, access to food, water and other facilities and the natural environment (Kolstad et al., 2014). The major mosquito-borne infectious diseases that have been reported to be affected by global warming include malaria, dengue fever, Japanese encephalitis (JE), and tick-borne encephalitis (Chrysostomou *et al.*, 2017). Moreover, impact of global warming on infectious diseases is not yet apparent in East Asia (Kurane, 2010). Studying the impact of global warming on infectious diseases in East Asia and its future prospects should be conducted on a wide range of research topics.

Manufacturing plays an important role in developing countries (Bishop, 2012). Increase of manufacturing sector may bring environmental problem such as global warming, rising temperature of air pollution, the limited supply of sustainable energy, hazardous emissions released into atmosphere and waste (Kokangül, Polat and Dağsuyu, 2017). Xu *et al.*, (2017) stated that rising heat will produce a series of detrimental results such as damage the ozone layer and the frequent of extreme weather events. However, manufacturing industry can also bring benefit to the country economic. Industrial economic manufacturing have increased the demand for global inputs (Lai Wan, 2016).

Manufacturing sector is a key of country growth driver (Fu, Viard and Zhang, 2017). Exporters are able to establish comparative advantages in labour-intensive manufacturing and shift to more capital and technology-intensive industries. Besides, manufacturing establishments have a strong positive average establishment size association between Foreign Direct Investment( FDI) (Biørn and Han, 2017) and Gross Domestic Product (GDP) per capita (Pedro, Bento , Diego, 2016). In China, manufacturing sector contributes to 36 % of GDP and in Thailand is 35 % (The Hindu, 2015). According to Biørn and Han, (2017), FDI significantly improves GDP growth for



the developing Asian countries. It shows that there are positive relationship between manufacturing and economic growth.

Malaysia's growth momentum has been strengthened, where manufacturing output recorded a 7.0% increase in the third quarter of 2017 (UNIDO, 2017). According to (Hashim, Habsah; Shuib, 2012), Penang, Melaka, Selangor, and Johor are top rank in the economic development indicators among 14 states in Malaysia. GDP growth is a positive indicator of median household income. As the economy improves in the state, the salaries of its citizens improve. Population is shown to negatively influence median household income. While the magnitude of the effect is small, larger states are shown to have a negative impact on the income level of its citizens. As indicated by the lagged variables, the household income in one year is a positive indicator of income in future periods.

Referring to Malaysia as Asia's next advanced economy, the IHS report (2016), said that Malaysia's economy is forecast to achieve a per capita GDP of US\$20,000 by 2025, with total GDP exceeding US\$1 trillion by 2030. Finally, the percent of GDP derived from manufacturing is positively correlated with household income. While the relative magnitude is small, manufacturing (relative to other economic sectors) is shown to increase state incomes. For every 1 percentage point increase in manufacturing's contribution to Indiana's economy, yearly median household incomes increase by nearly \$89.

Many studies have used greenhouse gas (GHG) emissions to analyse global, regional and national trends for policy intervention (Brizga, Feng and Hubacek, 2017). The percentage of GDP in manufacturing is positively correlated with household income. The household income in one year is a positive indicator of future income (Brizga, Feng and Hubacek, 2017). Gary Gereffi *et al.* (2014) summarized that increase of GDP, labour force will grow faster, and income will also increase. Therefore, manufacturing production will affect to the household income. However, in spite of the increase in income, the concentration of pollution will exceed the carrying capacity of human welfare (Nora Haenn *et al*, 2016).

In addition, economic growth have a positive impact on carbon dioxide emissions. According to Xu *et al.* (2017), carbon dioxide (CO<sub>2</sub>) emissions from manufacturing account for 55% of the total carbon dioxide emissions. Huge fossil fuel consumption leads to massive carbon dioxide emissions from industry, resulting in a sustained global temperature rise (Rafiq et al., 2016). This means that growth in the manufacturing sector have become the central stage in analysing the growth of developing economies and also CO<sub>2</sub>.

The Emissions Gap Report 2016 from the United Nations Environment Programme (UNEP) shows that even if countries deliver on the commitments of Nationally Determined Contributions (NDCs) the world will still warm by 3.0°C to 3.2°C. To keep global warming to within 2°C and limit the risk of dangerous climate change, the world will need to reduce emissions by 40% to 70% by 2050 and eliminate them together by 2100 (UNEP, 2016).

There are total of 24 types of global greenhouse gases which considered harmful to the ozone layer, responsible for the phenomenon of global warming. Carbon Dioxide is one of those greenhouse gases (UNFCCC, 2017). The substantial increase in greenhouse gases (GHGs) is mainly due to carbon dioxide (CO<sub>2</sub>) as the principal gas leading for global warming and climate change (The World Bank, 2007).

The concentration of carbon dioxide (CO<sub>2</sub>) in the atmosphere is about 0.04%, effectively disqualifying the atmosphere as a resource for CO<sub>2</sub> collection. Instead, carbon dioxide is produced as a by-product of industrial ammonia and hydrogen production (Matheson, 2017). Moreover, the level of carbon dioxide (CO<sub>2</sub>) in the atmosphere has been rising since tracking began in 1958. Data show that the combustion of fossil fuels accounts for about 67% of the total worldwide of CO<sub>2</sub> emissions into the atmosphere today. Carbon dioxide is absorbed by the world's oceans, but as the emissions increase, so does the acidification of the same oceans more and more leading to ecological and biological changes, while rising atmospheric concentrations lead to global warming and climate change (Cubasch et al., 2013).

Thermal discomfort is one of the causes of work dissatisfaction, leading to changes in personal behaviour changes and work-related accidents. The thermal environment in the interior of manufacturing industries increases the thermal sensation of workers. This is because workers spend most of their time in in the working environment (Morgado, Talaia and Teixeira, 2017). According to Xia *et al.*, (2018), extremes of heat not only lead to health consequences of excess mortality and morbidity, but also loss of productivity and loss of outdoor staff capacity due to occupational safety requirements. Therefore, rapid manufacturing growth will not only increase external air pollution but also enhance the heat of the internal environment.

Besides, air pollution will effects on labour productivity. Contamination of particulate matter less than 2.5 microns in diameter (PM<sub>2.5</sub>) is -0.58 and sulphur dioxide (SO<sub>2</sub>) is -0.54 of labour productivity (Fu, Viard and Zhang, 2017). Productivity as a source of growth has become a central stage for analysing the growth of developing economies. (Brizga, Feng and Hubacek, 2017). The work environment allows people to work optimally in comfortable conditions. Thermal comfort, also known as thermal stress, when exposed to a very hot or cold thermal environment, is not satisfactory in terms of human thermal sensation (Lobell *et al.*, 2013). All these will have negative impact on environmental security and even threaten on human survival.

Heat affects to human bodies as well as their minds. This is because temperatures rise will lead to human die. In India, a rise of 1.8 degrees Fahrenheit in average daily temperatures leads to a 10 percent increase in the annual mortality rate. Even a single extra hot day leads to a noticeable jump in mortality. In US is heat kills. A single day above 90 degrees increases the monthly mortality rate by more than 1 percent, according to research by Olivier Deschenes and other economists (Malaymail, 2017).

Recently, researchers at the University of California, Santa Barbara have shown that climate change will dramatically reduce the manufacturing output in China. The researchers found that by the middle of the 21st century, if not able to successfully slow or stop global warming, climate change will reduce China's manufacturing output by 12% a year, which is equivalent to a loss of 39.5 billion U.S. loss of \$39.5 billion in 2007 dollars (Stephanie Pernet, 2017). GDP growth rate in the coming decades will be

challenging (Lee, 2017). This statement show that global warming will also have significant impact on manufacturing industry and indirectly effect to global economic.

In this paper, studying the relationship of manufacturing industry and global warming was the main concern. It was recommended by Yacout et al. (2016) to improve the environmental protection alert and capabilities. This study primary focus on manufacturing sector in Malaysia. Moreover, it moves beyond to understand the impact of manufacturing sector that affect to the temperature.

To identify the growth of manufacturing industries, this paper refer to the establishment of manufacturing industries across states and aim for the impact that developing of manufacturing industries for the environment. Although land in developed countries usually accounts for only a small portion of the region, but it is a catalyst for social and environmental change (Chuangchang and Tongkumchum, 2014). As a result, the change of land use can provide valuable information to developed countries and gives information to planners, developers and decision makers.

The aim of the current study was to analyse the impacts of manufacturing industry on environment to obtain information for assisting decision makers in improving relevant environmental protection measures for green field investments in developing countries especially in Malaysia. Limitation of this paper includes: (i) Heat that causes global warming can come from different gases; (ii) Increase of temperature can cause by other reasons like transportation and other economic sector not only from manufacturing sector.

Therefore, researcher may further research in-depth investigation of the existing of manufacturing industry and spill over effects of air pollution control on gasses reduction is of great importance in actively exploring past experiences and build the lesson learnt in the experience and came out with new solution to prevent it.

### **1.3 Problem Statement**

According to World Economic Forum, (2017), the industrial revolution has transform interaction between societies with the environment. Malaysia's temperature readings had almost reached to 40 degree Celsius (°C). It will causing heatstroke if the temperature keep increase until 40°C because reach to the danger level (Malaymail, 2016). Compared with past, the average temperature in Malaysia is typically 27°C, but in then, temperatures have soared into average of 30°C (Channel News Asia, 2016). However, manufacturing is a major contributor to temperature rise (WMO, 2014). According to the forum's 12th edition of the Global Risk Report, global greenhouse gas (GHG) emissions are growing, currently by about 52 billion tons of CO<sub>2</sub> equivalent per year (WEF, 2017).

Cities in the world account for 70% of the total carbon dioxide emissions. This poor environmental records show that air pollution has led to high medical costs, reduced labor productivity and higher labor costs, which kill more than 3 million people each year. Scientists also cautioned that if greenhouse gas emissions continue to rise, people will surpass this threshold when global warming becomes catastrophic and irreversible (Malaymail, 2017). Based on economic census Malaysia (2016), 662,939 establishments operating in 2011 and now become 903,818 establishments in 2016 with the annual growth rate of 6.4%. Manufacturing sector was the second large contribution to the percentage of establishments, which is 5.43% (DOSM, 2017). This show that establishments sector in Malaysia are keep growing and blooming. According to Kokangül, Polat and Dağsuyu (2017), manufacturing processes such as produce productivity and release emission gas to air will increase the environmental risk.

The industrial revolution has transform interaction between societies with the environment. The demand for fostering new products by using natural resources has risen sharply and the environment has deteriorated. Climate change and depletion of resources have risen to the top of the agenda. The rise in greenhouse gas emissions is the third highest in the world with manufacturing accounting for more than one-third of global carbon dioxide emissions (WEF, 2012). Therefore, understanding the relationship between manufacturing and global warming is the main research issue in this paper.

### ***1.4 Purpose of the Study***

The main purpose of this study is to understand the relationship between the establishments of manufacturing sector and mean temperature in Malaysia to find out the possibility of manufacturing affect to global warming. Outcome of the research may allow people increase their awareness to protect their environment. Besides, government and developers' may also alert on gas emission and pollution problem and develop manufacturing industries in an environmentally friendly way. Therefore, the purpose of this study is to identify the geographical pattern of manufacturing establishments and mean temperature and make comparison.

### ***1.5 Research Questions***

There are three research question to be study in this paper which are;

1. What are the geographical pattern for manufacturing by state in Malaysia comparing year 2010 and 2015?
2. What are the geographical pattern for mean temperature in Malaysia changed compared to year 2010 and 2015?
3. What are the relationship between manufacturing towards mean temperature?

### ***1.6 Research Objective***

Global warming can be being affected by temperature and manufacturing land use. Therefore, the research objectives are as below;

1. To visualize the geographical changes of manufacturing growth by state in Malaysia in year 2010 and 2015.
2. To visualize mean temperature in Malaysia at year 2010 and 2015.
3. To investigate the relationship between manufacturing and mean temperature.

### ***1.7 Scope of Research***

This research study is carried out to study the relationship between manufacturing with global warming. The research was focus on area Malaysia, manufacturing sector field. Since manufacturing development is a potential of activating the economic growth of a country, many developers are taking steps to entry and studies on manufacturing environments, opportunities, and growths (Li X., 2016).

### ***1.8 Limitation of Research***

This analysis has limited to heat on global warming. However increase of temperature can cause by other reasons like mobile units (A.A. Jaafar *et al.*, 2017) and other economic sector for example service, mining and quarrying sector (Fugiel *et al.*, 2017). The increase of temperature can come from different gases not only from Carbon Monoxide (CO), Nitrogen Dioxide (NO<sub>2</sub>), Particulate Matter (PM) and Sulphur Dioxide (SO<sub>2</sub>).

### ***1.9 Summary***

The main purpose of this study is to understand the relationship between manufacturing and global warming. In this research, Outcome of the research may allow planners and developers' to alert on gas emission and pollution problem, and required skill to prevent and knowledge to develop manufacturing industries.