CHAPTER 1

INTRODUCTION

1.1   Background of Study

In year 2014, only one in ten people can breathe clean air as defined by the WHO Air quality guidelines. Air pollution takes place when contamination of any chemical, physical or biological agent that affects the natural characteristics of the atmosphere (WHO, 2016b). Air pollution has become a major environmental problem in the developing southeast Asian countries such as Malaysia as it grows to be an industrial nation by 2020 (Amalin et al., 2017). Based on the Environment Performance Index Report published in year 2016 stated that vast sources of air pollutant are from motor vehicles emission, biofuel burning and industries emission that causes the accumulation of aerosols in the urban area. Thus, Malaysia is ranked at the 117th worst country in terms of air quality among 180 nations worldwide. Apart from the local sources, Malaysia is also polluted by biomass-burning aerosols resulted from wildfires in Indonesia during the dry season and southwest monsoon.

There are six major air pollutants such as Particulate Matter with the size of less than 10 micron (PM_{10}), Particulate Matter with the size of less than 2.5 micron ($PM_{2.5}$), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ground Level Ozone (O_3), Carbon Monoxide (CO) (Department of Environment, 2013). PM2.5 has become the primary pollutant in urban areas and elevated concern among the community (Zhang et al., 2015). $PM_{2.5}$ continues to get attention in urban areas as it results in adverse health effects (Velali et al., 2016). $PM_{2.5}$ is defined as complex mixture of very small particles and liquid droplets that contains several components including acids such as nitrates, sulphates, organic chemicals, metals and soil or dust particle (US EPA, 2016). $PM_{2.5}$

consist metal particles, acidic oxides, organic pollutants, bacteria, fungi and viruses which are deposited in the airway and enters the lungs during inhalation (Gu et al., 2017). $PM_{2.5}$ consists of toxic organic compounds or metals resulted from vehicle exhaust, industries or urban areas emissions leads to dispersal in the environment. The metals bound to $PM_{2.5}$ come from various combustion sources associated emission are the local heating of households and burning of liquefied fossil fuels in the vehicles combustion engines whereas non-combustion associated emissions comes from vehicular traffic which result in resuspension of dust and emission of industry (Air Quality Expert Group, 2012).

Meteorological conditions are controlling factors for the air pollutants. The weather conditions play vital role in the daily fluctuation of air pollutant concentrations. Several studies have shown the relationship between the concentration of $PM_{2.5}$ and meteorological factors are associated to the spread and dilution of air pollutants. Thus, the change of air pollutant concentration mainly affected by weather conditions. $PM_{2.5}$ concentration distribution is greatly influenced by changes in temperature, relative humidity, wind speed and wind direction (Zhang et al., 2015). Meteorological conditions such as temperature, relative humidity, wind speed and wind direction can easily affect $PM_{2.5}$ (He et al., 2017).

Metals adhered to $PM_{2.5}$ enters the body via direct inhalation, ingestion and dermal contact absorption results in adverse health impacts for humans and causes a long-term burden on environmental quality (Wan et al., 2016). Numerous previous studies had proven that there is an association of metals bound to $PM_{2.5}$ and potential health effects (Chen and Lippmann, 2009). Therefore, the public health is affected especially at city with high air pollutant concentration which result in carcinogenic and non-carcinogenic effects. As a result of exposure to metals in the air, numerous human health effects to public health ranging from cardiovascular, pulmonary inflammation, cancer and damage the vital organs which affects human well-being (Geiger and Cooper, 2010). Niu et al. (2013) reported that metals are the important components that are responsible for the $PM_{2.5}$ induced cardiovascular effects. According to Comparative

Toxicogenomics Database (CTD), air pollutants that are composed of particulate metals are associated with cardiac arrhythmia, myocardial ischemia, myocardial infarction, stroke, and thrombosis (Meng et al., 2013). There are also increasing evidence that associate $PM_{2.5}$ to health impacts such as acute lower respiratory in children under five years old and chronic obstructive pulmonary disease (COPD), ischaemic heart disease (IHD), stroke and lung cancers in adults (WHO, 2016a). The WHO's International Agency for Research on Cancer (IARC) in 2013 had concluded that outdoor air pollution is carcinogenic to humans because the particulate matter composition in our air is associated with increased cancer incidence such as lung cancer and urinary tract or bladder cancer. The findings conclude that metals bound to $PM_{2.5}$ plays a vital role in causing carcinogenic and non-carcinogenic risk and causes adverse health effects to humans.

The WHO had reported that ambient air pollution causes 3,700,000 deaths in 2012. The causes of death comprises of 16% of the lung cancer, 11% of the chronic obstructive pulmonary disease, 29% of the heart disease and stroke and approximately 13% of respiratory infections (Lee, Kim and Lee, 2014). The death attributed by ambient air pollution in Malaysia is 6251 deaths (WHO, 2012). Lilieveld et al. (2013) calculated a global mortality of approximately 773,000/year due to respiratory disease, 186,000/year due to lung cancer and 2,000,000/year due to cardiovascular disease (CVD) due to anthropogenic exposure of $PM_{2.5}$.

1.2   Problem Statement

In Malaysia, the estimated population exposure to $PM_{2.5}$ at annual median concentration is 17 $\mu g/m^3$ in an urban area exceed WHO's Ambient Air quality guidelines which is 10 $\mu g/m^3$ (WHO, 2016a). Thus, this study was carried out to determine the mass concentration of $PM_{2.5}$ in an urban area. The capital city of Pahang, Kuantan was chosen to conduct this study. Kuantan is 2960 km² in area and classified as a commercial centre for the entire east coast of the Peninsula Malaysia with a population of 461,906 which falls under the category of an urban area (Department of Statistics Malaysia, 2016). The Jalan Mahkota which is busiest road in