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SUSTAINABLE HOSPITAL FOR URBAN RESIDENTS

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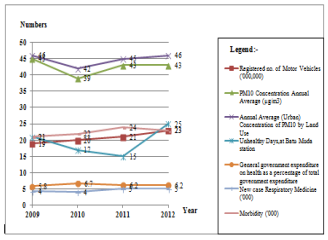
Graphical abstract



Abstract

Malaysia is one of the sustainable countries in the world as it ranked at 51st over 178 countries in Environmental Performance Index (EPI). However, Malaysia as an upper-middle-income country set strong forces in Gross Domestic Production from 2009 until 2014 at 16.18 per cent (%) inclination. The urbanisation activities exposing the urban residents to the concentration of fine and ultrafine particulates matter (PM) include the urban area hospital occupants. The main aim of this research is to investigate the adverse health effects towards the patients in hospital specifically, Kuala Lumpur in general. Significantly, the outcome assist in particulate matter impact control in expenditure by general government and promotes the sustainable hospital ambient towards its occupants. The case study for this pilot study is Kuala Lumpur Hospital (HKL). The approaches used are literature review and data collections. The findings identified the motor vehicles as the main sources of Particulates Matter in Kuala Lumpur urban area. As the sources increases, the PM concentration also increases. Simultaneously, the number of patients facing respiratory related diseases also increased. Contradict to previous researchers' theory, Malaysian results shows that as the number of unhealthy days increase in the year 2012, yet the morbidity case reported decreases. This is for the general government had spent at an increment of 7.46% in the year 2011 during the fall of unhealthy days at 11.76 % in 2011. This shows that the general government spend effectively to mitigate the repeat cases of respiratory patients facing by high risk communities. In conclusion, the sustainable development can be achieved as the economy is being blend well with the environment.

Keywords: Particulate matter, hospital, human health, sustainable development, economy

1.0 INTRODUCTION

The high commitment by Malaysian government in sustaining the environment equitable to the rapid development in Malaysian industry area and urban settlement can be seen as Malaysia is ranked at 51st position from 178 countries in the Environmental Performance Index (EPI) 2014 [1]. Moreover, Malaysia is still preserving and conserving 62.4 per cent (%) of the forested land [2].

However, as an upper-middle-income country, Malaysia set strong forces in Gross Domestic Production that later causes inclination from 2009 until 2014 at 16.18 per cent (%). Urbanization has been spread into small town and villages intensely within the labour market [3]. The development, open burning activities, massive road traffic, industrial processes heat and power generator are being held in today's world [4; 5]. Thus, offering the urban residents great exposure towards the concentration of fine and ultrafine particulates matter.

Particulates matter (PM) is a type of pollutants that currently causing haze in Malaysia. It is defined as a blend of microscopic solids and liquid droplets suspended in the air [6]. It is heterogeneous in sizes, shapes and compositions components that include acids (i.e. nitrates and sulphates), organic chemicals,

metals, soil or dust particles and allergens (such as fragments of pollen or mould spores) [4].

Moreover, PM exist in range of aerodynamic diameter that roles as the main determinant of its behaviour. PM_{10}, or respirable particles refers to particulate matter that are in the form of solid, liquid, aerosol, dust, smoke or pollen with less than 10 µm aerodynamic diameter that may reach the upper part of the airways and lung[4; 7; 8; 9 and 10]. It is believed to be composed by the crustal material [11].

Besides, fine particulates matter or inhalable particles refers to particles with aerodynamic diameters 2.5 µm and smaller that is penetrating deeply into the lung reaching alveolar region [4; 5]. $PM_{2.5}$ concentrations have less important natural component than PM_{10} concentrations. In addition, the combustion is the source of $PM_{2.5}$ [12]. Therefore in monitoring urban anthropogenic activity, $PM_{2.5}$ is a better indicator than PM_{10}.

The smallest particles are acknowledged as the ultrafine particulates that are refers to particles with 1.0 & 0.1 aerodynamic diameters and smaller. $PM_{0.1\&1.0.}$ emits largely from combustion emissions that form through the nucleation and condensation processes. This type of particle are form primarily through mechanical processes likewise wind or abrasion and covers more than half of the particle mass in the air [5;11]. However, the best method to determine the origin of these particle sources is through chemical analysis which will not be discussed in this paper.

The main aim of this paper is to investigate the adverse health effects towards the patients in hospital specifically, and in Kuala Lumpur in general. Its objective is to identify the detrimental health impact that causes by the emission of airborne particulates in and surrounding compound of a hospital. However, this research only focuses on the air quality ambient and specifically on the particulates matter exposure. This paper is significant as the findings can be used to assist the fast recovery among the patient, to provide conducive working area for urban hospital workers and to provide a comfortable and safe ambient for hospital visitor.

Bridging these factors to the hospital in Malaysia urban area that served the urban residents, Statistic shows that 1,670,000 numbers of people in 2010 are the population that lives in Kuala Lumpur metropolitan area [13]. They are served by the Kuala Lumpur Hospital. In Malaysia, Kuala Lumpur is the major conurbation.

2.0 LITERATURE REVIEW

Malaysia urban area is the hub of Malaysia's industries and commerce. There are loggings and processing timber, rubber and oil palm industries, light manufacturing industry, electronics, tin mining and smelting, agriculture processing, petroleum production and refining industry in Malaysia. Among all, the iron and steel industries, nonferrous metal industry, non-metallic (mineral) industry, oil and gas industry, petrochemical industry, pulp and paper, power plants and waste incineration sector are the most affected to the air quality [14].

As the source of particulates matter rising, the number of mortality and warded patient also hiking. Evidence on mortality are obtained from study in USA, Mexico City, Detrot area and Canada [11; 15]. Mortality rates increase by 0.7% per 10 µg/ m^3 increase in PM_{10} concentrations [16]. As per 10 µg/ m^3 increase in PM_{10}, mortality increased by 0-2 % in most of the US cities [11;15;17]. The strongest association is found with $PM_{2.5}$. A 10 µg/m3 in two days mean $PM_{2.5}$ was associated with a 1.5% increase in total daily mortality. Larger increases were found for deaths caused by chronic obstructive pulmonary disease and by ischemic heart diseases [15].

In high temperature, PM_{10} were found more important than $PM_{2.5}$ in Santiago. On the other hand, the $PM_{2.5}$ is found significant on mortality during warm season [4, 11]. He also added that $PM_{2.5}$ combustion-related particles was associated with a 1.5% increase in daily total mortality. The relative risk for death of person age 65 and older was only slightly larger than death of all ages [15].

Furthermore, the chemical compound of the PM_{10} is found sufficient to cause respiratory and cardiovascular morbidity. Study from China, California, Europe, Australiaagrees that high PM_{10} exposure towards respiratory patient is highly associated with morbidity [18; 19; 20; 21; 22; 23 and 24]. They agree that paediatric patient with respiratory disease is more affected area.

Other relevant diseases investigated by the Italian and Darwin studies are the respiratory conditions (43-admissions day-1), acute respiratory infections including pneumonia (18 day-1), chronic obstructive pulmonary disease COPD (13day-1), asthma (4.5 day-1) , ischemic heart diseases (3 day-1) among residents of all ages and among children (0-14 years [25; 26]. Hospital admissions for respiratory causes have been found to be associated with 50 µg/m3 increase in PM_{10}[19]. A 25 µg/m3 increase in PM_{10} was associated with a 2.5% increase in hospital admission for heart disease in a combined analysis of eight cities in the United State [20]. An average congestive heart failure hospital admissions increase by 0.8% per 10 µg/m3 increase in PM10 [24]. A significant association in Spokane between elderly respiratory hospital admission and PM_{10} at the 0-day lags [19]. Hence, concluding that the elderly are the high risk patient that shall be monitored from exposure of particulates matter, for the failure shall lead to high mortality and morbidity impact. These factors are the major issues that support the vital of this study.

3.0 METHODOLOGIES

The research approaches used is case study. This research pilot study uses the case study methodology as it assist researcher to establish full understanding of that case as possible [27]. As referred to the previous journals, the research done through case study [28; 29 and 30]. The hospital buildings chosen are the Respiratory Medical Institute (IPR) of Kuala Lumpur Hospital (HKL). It was established in 1958 and functioning until today. It is consist of 104 no. of beds with 4 high dependency beds and 4 newly built negative pressure isolation rooms.

The research techniques used are literature review and data collections. The literature review is done through two stages that are searched from the primary and secondary literature sources. The first sources, are reviewing the previous research paper from academic journals, papers from conference, related dissertations and government publications. The researcher also uses secondary types of literature sources for instance searching related textbooks, trade journals, magazines and newspaper article. Some internet articles also utilized in order to complement this literature part. This research focuses in literature on the subject of particulates matter, health and economy.

The data collections involved raw data on new case and morbidity of respiratory diseases related patients, obtained from the Kuala Lumpur Hospital officer. The analyses are then aligned with the Air Pollutant Emission by Sources: Motor Vehicles and the Particulates Matter (PM) emissions of Kuala Lumpur area that are obtained from the Malaysia Statistical Department [31] and Department of Environment [32], accordingly. Moreover, it also associated with the general government expenditure on health as a percentage of total government expenditure that is obtained from the World Health Organisation. Thus, aligning the results between the particulates matter sources, concentrations, impact on health and economics of the nations.

4.0 RESULTS AND DISCUSSION

The previous research had been reviewed on the source, impact and method of dissemination of the airborne particulates. For the purpose of this study, the source, impact and meteorological factor that are closely relevant to these two hospitals are being explored. The sources of PM in IPR as found from the observation are the mobile vehicle sources, traffic sources i.e wear breaks and tires, fuels and diesels, the roadway materials. The stationary source of PM in IPR found is the building material itself for it is ages at 55 years already. Building materials sources found are the cement dust, rust of the gate and many more.

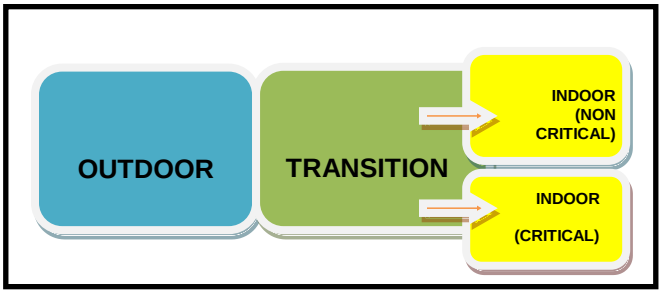


Figure 1 Air movement that disseminate PM into indoor of hospital

The ventilation in IPR is mix. Some area use natural ventilation while some occupied with air-conditioning. The sources of above mentioned from outdoor enter into hospital likewise indicated in the Figure 1. The outdoors air can enter into indoor ambient through three ways that are infiltration, natural ventilation and mechanical ventilation [32]. The infiltration occurs when there are openings, joints, cracks in walls, floor and ceilings and around the windows and doors in a building.

Secondly, the natural ventilation happens as the windows and doors are open and air moves thoroughly, mostly this happen in the transition area in a hospital and at the area with natural ventilation. It goes through the lobby area where the door will open and close. This is also where the transition of PM happens.

Next, the air can get into the indoor ambient from outdoor-vented fans that intermittently remove air from a single room to the air handling systems that use fans and duct to continuously remove indoor air. Thus, the PM is disseminating by the fan or air-conditions to get into the ward (non critical area) and into operation theatre (critical area). However, risk increases as the PM being exposed towards the warded patients with circulatory and respiratory diseases, paediatric, pregnant lady and elderly.

As discussed in the introduction, $PM_{2.5}$ and $PM_{1.0\&0.1}$ are the relevant particle sizes that emitted from combustion processes. Significant effects on mortality by fine particles are found during warm season [4]. Hence, it is believed with the tropical climate in Malaysia supports their discussion.

Furthermore, the impact of PM as reviewed by Ministry of Health Malaysia in 2012 [33], diseases of respiratory system diseases are the number one of principal causes of hospital admission in Malaysia public hospital also [11;18;20;21;22;23]. It is at 10.36 percent (%). Respiratory diseases are then listed number two with 19.48% in the principal cause of death in public hospital. However, the circulatory system related diseases are ranked at number one in the list at 25.64%. Hence, supporting Schwartz *et. al.*,(2012) [15]. From the amount, it is clearly viewed that the diseases that leads by PM dissemination are crucial in affecting the mortality and morbidity in

Malaysia. But is to be acknowledging that genetic factor is also to be included in summarising this data.

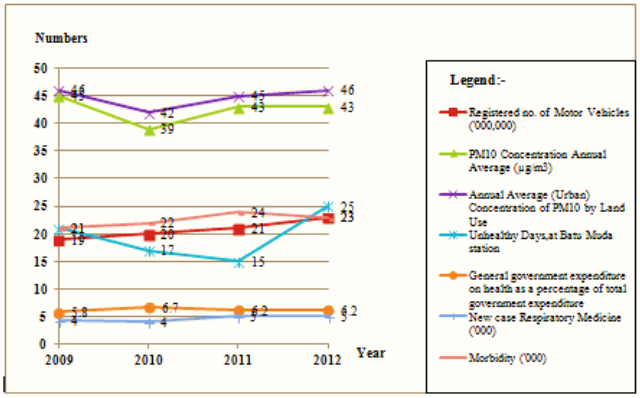


Figure 2 Associations between Particulates Matter, Health and Government Expenditure in Malaysia, 2009 until 2012

Sources: Amended from the Department of Statistics Malaysia [a](2013), Department of Statistics Malaysia [b](2013)World Health Organisation (2014), Kuala Lumpur Hospital (2014), MohdEzzani,(2013).

The unhealthy days of air pollutant index by Malaysia as mentioned in the Figure 2 above ranges between 101 until 200. This mean it worsen the health condition of high risk people who is the people with heart and lung complications. It means the high risk people shall limit their outdoor activities at this stage while the public shall reduce their extreme outdoor activities. For this paper case study is in Kuala Lumpur urban area, thus data from Batu Muda station had been chosen.

The registered no. of motor vehicles which is the main sources of Kuala Lumpur particulates matter is increasing each year from 2009 until 2012. The increment is averagely at 6 percent (%) each year. In the increment from 2009 to 2010 is 6.16%, while 2010 to 2011 at 6.01% and 2011 to 2012 is 6.08 %. Moreover, data on particulates matter generally shows by the annual average PM10 concentration and specifically in urban area line graph. It can be seen that the decrement of PM no. from 2009 to 2010 but the increment occurs from 2010 to 2011 and 2011 to 2012 at 10.26% and 7.46%, accordingly. However, the unhealthy day number captured by DOE in Kuala Lumpur station nearest to the Kuala Lumpur Hospital sees the decrement at two years from 2009 until 2011 and 2010 until 2011.Yet hiking rapidly at 66.6% in the year 2012. This is aligned with the sources, as the motor vehicles increases in 2012, the number of unhealthy days also increase.

The result of PM aligned with the new case reported relevant to the respiratory diseases which the decrement at 2010 but increase in 2011 and 2012 at 10.24% and 2.74%, accordingly. This supports the literature review found from the previous researchers. In Malaysia, the morbidity number however contradicts with the PM results. As PM is increasing and number of unhealthy days is increasing from 2011 to 2012, yet the morbidity number is decreasing at 2.67%.

Economically, the general government had spend on health at increase percentage from 2009 to 2010, while decrement at 2010 to 2011 that is similar to the number of unhealthy days, while the increment at 6.2 % after 2010 to 2011 and maintain at 6.2% from 2011 until 2012. This supports that as the government expend more especially on health medication or pharmaceutical [33]. Thus, the morbidity number is decreasing. This mean the Malaysian government is playing its role in assisting the high risk people from facing or repeat treatment. This indirectly saving their money and simultaneously allow the budget to be spent by the new respiratory diseases patients.

5.0 CONCLUSION

The nature and characteristics of particulates matter in IPR, HKL are described through its sources, way of movement and impact by linking the pass researchers outcomes and observation on site. Fine and ultrafine particulates matter are believed to be disseminated in the hospital compounds through the exposure towards motor vehicles as the main sources of Particulates Matter in Kuala Lumpur urban area. As the sources increases, the PM concentration also increases. Simultaneously, the number of patients facing respiratory related diseases also increased. Contradict to previous researchers' theory, Malaysian results shows that as the no. of unhealthy days increase in the year 2012, yet the morbidity case reported decreases. This is for the general government had spent at an increment of 7.46% in the year 2011 during the fall of unhealthy days at 11.76 % in 2011. This shows that the general government spend effectively to mitigate the repeat cases of respiratory patients facing by high risk communities.

In conclusion, the sustainable hospital with clean ambient from the particulates exposure are the key towards the good environmental management that leads to the quality life of urban resident especially the elderly and the children. Therefore, the sustainable development can be achieved as the economy is being blend well with the environment.

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