CHARACTERIZATION OF PARTICULATE MATTER AT CONSTRUCTION SITE

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DEDICATION

To my beloved mother and late father
Sopiah Binti Omar, Mohamad bin Ahmad Amin, my sisters and brothers

To my best friend
Zuliana binti Mamat

To my supervisor and Co supervisor
Dr Eeydzah binti Aminudin & Assoc. Prof. Dr. Rozana Zakaria

Support, tolerance, patient, guidance, advice, criticisms and pray will remain in my heart and millions of thanks for the every scarify done for me..

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ABSTRACT

The presence of Particulate Matter (PM) threatens human life especially when it is exposed to unknown air and are frightened if the air inhale will result to death and illness. The PM is known to be invisible, floating in the earth atmosphere and can penetrate respiratory system, blood molecule which later harmful to human life. The emission can existed caused by either the debris from the transport, construction site or even during dry weather. This study reveals the construction site located at Johor Baharu. The Malaysian air pollution standard index (API) will be used as a benchmark for PM pollution. This study aim is to determine the characterization of particulate matter (PM) produced from construction sites with regard to Particulate Matter 10 μm (PM10) and 2.5 μm (PM2.5). The experimental study was conducted at building construction sites over a period of work days for 8 hour. Portable air samplers were used to collect the particulate matter that used sticky pads collected settle dust and the weather condition such as temperature, wind speed and relative humidity was measure to examine the relation in emission of particulate matter. The finding from this study shows that construction site activity produce emission of Particulate Matter to the environment and exceeding the Malaysia Air Pollution Index (API) standard of 150μg/m3. There are 6 days beyond API standard level which 277 μg/m3, 2 days of 208.33 μg/m3 and 173μg/m3 and 243 μg/m3. The concentration of the data beyond than 50 percent from the API standard and it is need for urgency in concern of construction site environment communities. Beside that chemical element of PM at construction sites presences of component K, Na, Ca and Al t which indicate from concreting work site activity. Toward the end, the study also shows that's Pm 2.5 is directly proportion with PM 10. Hence this paper provides a valuable knowledge for various real situations and provides a basis for improving the methodology of collecting PM on construction sites and controlling the production of PM.

ABSTRAK

Kehadiran Particulate Matter (PM) mengancam kehidupan manusia udara yang dihirup akan mengakibatkan kematian dan penyakit. PM diketahui tidak dapat dilihat, terapung di atmosfer bumi dan dapat menembus sistem pernafasan, molekul darah yang kemudiannya menjadi mengamcam kehidupan manusia. Pelepasan boleh wujud disebabkan oleh serpihan dari pengangkutan, tapak pembinaan atau semasa cuaca kering. Kajian ini mendedahkan tapak pembinaan di Johor Baharu. Indeks standard pencemaran udara (API) Malaysia akan digunakan sebagai tanda aras untuk pencemaran PM. Tujuan kajian ini adalah untuk menentukan pencirian bahan partikulat (PM) yang dihasilkan dari tapak pembinaan berkaitan dengan Particulate Matter 10 μm (PM10) dan 2.5 μm (PM2.5). Kajian eksperimen dijalankan di tapak pembinaan bangunan selama satu hari kerja selama 8 jam. Pengelup udara udara mudah alih digunakan untuk mengumpul bahan partikulat yang menggunakan pad melekat yang dikumpul menyelesaikan habuk dan keadaan cuaca seperti suhu, kelajuan angin dan kelembapan relatif adalah ukuran untuk memeriksa hubungan dalam pelepasan bahan zarahan. Dapatan kajian ini menunjukkan bahawa aktiviti tapak pembinaan menghasilkan pelepasan Bahan Partikulat kepada alam sekitar dan melebihi piawaian Indeks Pencemaran Udara Malaysia (API) 150μg / m3. Terdapat 6 hari di luar paras standard API iaitu 277 μg / m3, 2 hari 208.33 μg / m3 dan 173μg / m3 dan 243 μg / m3. Kepekatan data melebihi 50 peratus daripada piawaian API dan ia memerlukan perhatian segera oleh komuniti persekitaran tapak pembinaan. Selain itu unsur kimia PM di tapak pembinaan memperlihatkan komponen K, Na, Ca dan Al t yang menunjukkan dari aktiviti tapak kerja konkrit. Menjelang akhir, kajian itu juga menunjukkan bahawa Pm 2.5 adalah secara langsung dengan PM 10. Oleh itu, makalah ini memberikan pengetahuan berharga untuk pelbagai situasi sebenar dan menyediakan asas untuk memperbaiki metodologi pengumpulan PM di tapak pembinaan dan mengawal pengeluaran PM.

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WHO	-	World Health Organization
PM	-	Particulate Matter
GDP	-	Growth domestic product
RH	-	Relative Humidity
API	-	Air Pollutant Index
DOE	-	Department of Environment
RMG	-	Recommended Malaysia Air Quality Guideline
SO2	-	Sulphur Dioxide
CO	-	Carbon Monoxide
O3	-	Ozone
NO2	-	Nitrogen Dioxide
FRMs	-	Federal Reference Method monitor
EPA		Environmental Protection Agency
NAAQS		National Ambient Air Quality Standard

CHAPTER 1

INTRODUCTION

1.1 Background

The air is a vital requirement for human survival. Healthy air is a requirement for living things. Particulate matter pollutants can cause contamination in the air and harm human health, PM is known to be invisible, floating in the earth atmosphere and can penetrate the respiratory system and blood molecule and will be human killers (Eyu & Alie, 2006; WHO, 2015). This condition is defined as air pollution which inquired to harm to humanity and the universe (Mackenzie, 2016; WHO, 2015).

According to the World Health Organisation (WHO) 3 million premature deaths worldwide per year in 2012 that came from the outdoor air pollution (ambient) in both cities and rural areas. The exposure to the small particulate matter within diameter of 10 microns or less classified (PM10) can become mortality, which can cause to cardiovascular, respiratory disease, and cancers (WHO).

Not long ago the wave of red smoke in Kuantan, Pahang that had made the road, plant, residential, shop, school and almost the entire area including the vehicle wear with the sticky red color jacket. The red air produce by the transportation of material call bauxite and this material is the raw material for aluminium product (Abdullah *et al.*, 2016).

According to (Heo *et al.*, 2017) industrial lead source, construction dust, dust, biomass burning, sea salt, and fuel oil combustion were identified and largely related to local emissions of respective neighborhoods. Meanwhile the construction site activity and material use have been the factor of appreance of particulate matter (de Moraes *et al.*, 2016) .PM 2.5 have related to various adverse health effects, mainly due to their ability to penetrate deeply and to convey harmful chemical components, such as metals inside the body. (Ledoux *et al.*, 2017) . Air pollutants ambient such as PM2.5, PM 10, NO2, SO2 and CO cause the asthma and respiratory patient number increase (Guo *et al.*, 2018).

(Lamichhane *et al.*, 2018) found that the exposure of emission to prenant women in third trimester will give more impact and severe to the baby and mother. Beside that the possibilities in increasing the respiratory system problem and cancer reported by World Health Organization (WHO, 2015) and every year this problem keep increasing and alarming the people. Dust smaller than 10 micrometer in diameter, known as particulate matter PM10 and PM2.5 are of great health concern because it can be inhaled deep into the respiratory system (Abdullah *et al.*, 2016). People that involve directly and indirect are expose to the air and impossible to determine the air contaminate. The air character that untouchable, cannot be seen by the eye and it also silent killer to almost all living thing (Awang *et al.*, 2000).

The uncomfortable condition and classify as nuisance of dust reduces environmental amenity, contaminates clothes, properties, vegetation and water, and has negative effects on personal comfort and health (Abdullah *et al.*, 2016).

Bauxite case at Kuantan, Pahang during the transportation that material to the collection and subsequent transformation to the buyer country cause a lot of physical and financial problem to the state and country. The observation show that the whole stretch of road along the Kuantan Port is tainted to the dark red.color. The tree, vehicles, houses, clothes and food premises along the route of the Lorries transporting bauxite were also contaminated with red dust.

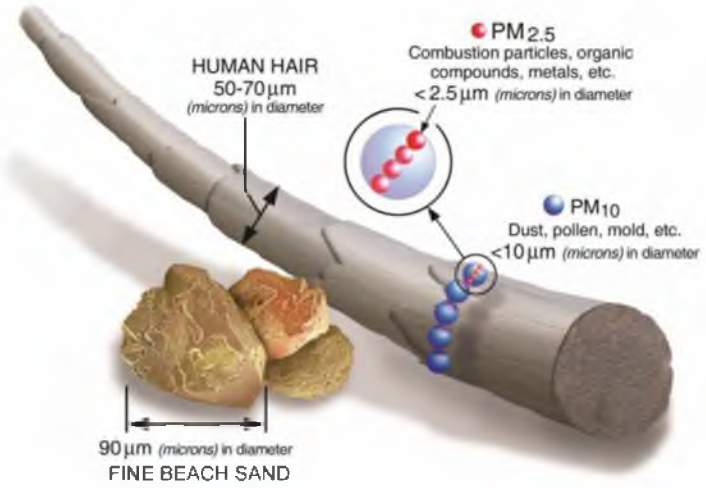
Nuisance dust particles are too large to be inhaled. Apart from causing visual pollution, it has the potential to cause irritation to the eyes, nose and throat (Englert, 2004; Abdullah *et al.*, 2016). It also produces visual impact that can lead to mental health stress especially to those living in proximity to mining sites, particularly when it can be seen from their home (Guo *et al.*, 2018; Abdullah *et al.*, 2016).

Furthermore, the apparent of the dust deposited on premises has the potential to contaminate food sources and clothes because of the lorry pass through the public or local road that included all residential area. This situation of construction site activity related to transportation of material, working methodology, material use and the stages of activity become the source in producing the PM(Mohddin *et al.*, 2014; Araújo *et al.*, 2014; Abualqumboz *et al.*, 2016).

1.2 Problem Statement

Figure 1 show the fine particles illustration of the size difference between human hair and PM. It availability of floating on the earth atmosphere and the most important to keep living thing alive. Fine particles are the cause or an alarm that trigger the occurrence of respiratory and cardiovascular diseases (WHO). According the World Health Organization (WHO, 2015) that there is 'no safe level' of fine particulate

air pollution, PM10 and PM2.5. Through the report have been done by (Zivin & Neidell, 2012) impact on worker productivy and air pollution show the the positif result. Mean while (Xitaodong *et al.*, 2015) carify that constuction dust is the major effect on field worker health at China.



Sources: United States Environmental Protection Agency web page https://www.epa.gov/pm-pollution/particulte -matter-pm-basics#PM

Figure 1.0 PM Size compare to Hair and Fine Beach Size (https://www.epa.gov/pm-pollution/particulte -matter-pm-basics#PM)

Both PM10 and PM2.5 particles which can penetrate deep into the respiratory system and are associated with increased hospital admissions for heart and lung diseases and premature death (Pope III *et al.*, 2002; Pope *et al.*, 2004). It is of great health concern when activity occur in proximity to school area as children is among the most susceptible subpopulations with regards to harmful effects of exposure to particulate matter, PM10 (WHO). As their physiological and immunological systems are still developing, children receive a higher dose of airborne particles relative to the lung size compared to adult.

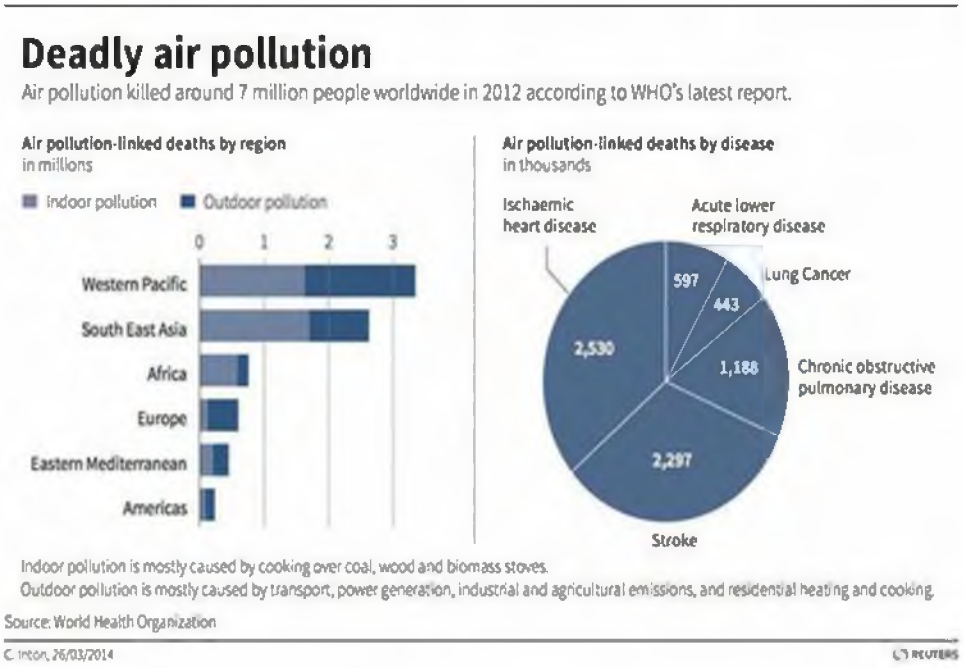


Figure 1.1 Deadly air pollution chart and diseases (Source: World Health Organization web http://www.globalstewards.org/environmental-issues.htm)

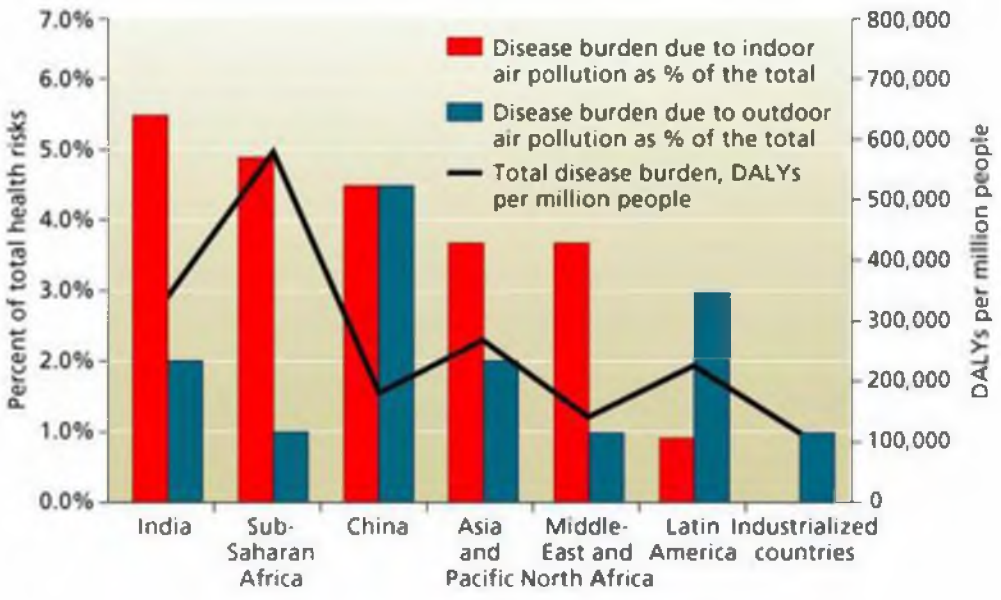


Figure 1 2 Indoors and Outdoor Air Pollution Health Risk Chart (Source web: http://greenplanetethics.com/wordpress/indoor-air-pollutiuon-facts-what-is-indoor-air-pollution-and-how-to-reduce-it)/

Figure 1.1 and figure 1.2 show that the air pollution impact on human health, the numbers of death by diseases and chart of health risk for different region in the world. Particulate Matter is a microscopic particle and affects more people than any other pollutant. The major components of PM are sulphate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. It consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air (WHO, 2015).

The most health-damaging particles are those with a diameter of 10 microns or less, ($\leq PM_{10}$), and it about 1/7 part of the thickness human hair which can penetrate and lodge deep inside the lungs (Kampa, 2008). Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer. Workers at construction industry expose directly to the air pollution. The impact more to the women rather than men (Vidya *et al.*, 2015).

Air quality measurements are typically reported in terms of daily or annual mean concentrations of PM10 particles per cubic meter of air volume (m^3) (WHO, 2012). Routine air quality measurements typically describe such PM concentrations in terms of micrograms per cubic meter ($\mu g/m^3$) (DOE).

The characterization of particulate matter (PM) especially the concentration from construction site activities that related to the characteristic of the particle size, particle composition and the concentration of PM (Araújo et al., 2014). Solid particle floating in the air and sometime a very small liquid form the word that identified as Particulate matter (Zaman *et al.*, 2017). According to the research that have been develop by California Environmental Protection Agency located at western United Stated, the major source of PM10 in both urban and rural area including the motor vehicle, wood burning stove and fireplaces, dust form construction, landfill and agriculture, wildfires and brush/waste burning and also industrial sources and not to forgot the windblown dust form open land.

The mixture of material included smoke, soot, dust, salt, acids and metal produce PM (Winckler & Gisela, 2010). It also forms when gases emitted form motor vehicles and industry undergo chemical reactions in atmosphere and often responsible for much of the haze that we think of as smog. This is a problem in cities, government and worldwide.

The contribution of construction industry no doubt to be the measurement tool of develop country (Khan *et al.*, 2014). But by neglecting of environment impact conclude the change of the world wide climax and the unexpected natural disaster that threaten human race. This paper will identify the characterization of particulate matter PM concentration and composition by using the appropriate measurement tool and mitigation method to implemented and develop with follow the improvement of technology nowadays. But in the same time this study is to develop and build the awareness to the impact of dust that construction site produce.

1.3 Aim and Objectives

The aim of the study is to identity the characteristic of Particulate Matter (PM) that contribute most at construction site and to ensure the understanding the particulate matter contribution by the construction sector among anyone who involve in the industry. The lack of information and exposure will result severe impact to the health and environment. In order to achieve this aim, the following objective have been delineated:

i. To identify the PM concentration at construction site that give the significant with regard to the air pollution.

ii. To measure PM characteristic during construction site activity and clarify the most activity that produce major source of Particulate Matter.

iii. To determine the correlation in between PM concentration at construction site.

1.4 Scope and Limitation

The study was focus to the one selected construction site located at Johor Baharu (Taman Daya) area that related to Telford Signature(M) Sdn Bhd that the researcher working currently. The scope of work will be limited as per listed below:

i. To identify the concentration of particulate matter emission at one construction site.

ii. The measurement tool only will be use the Mini Vol Air Tactical Sampler and Kestrel Weather Pocket Meter.

iii. To use the range of PM10- PM2.5 micrometers that recognize harm the human health.

iv. The site was specific to the diameter of 5 meter in radius, which having the normal ambient air of 27°C to 35°C and air velocity range to $1ms^{-1}$ to $3ms^{-1}$

1.5 Study Outline

By refer to figure 1.3 show the research methodology process to be follow and as the reference. The study covers 6 chapters and focusing to the concentration of particulate matter contributes by construction site. Chapter 1 content will brief the problem statement and also the objective of the study. Beside that the scope of study explained and the limitation of study to formulate the structure of study in order to achieve the objective of the project.

Chapter 2 explained more in theory and the literature review link and related to the research. This chapter also will explain the particulate matter produce by construction site and the characterization that have define by other researcher and the adaption of measurement tool and the development of the study have been introduce by other researcher. The boundary of study will stresses in finding the better understanding of particulate matter. The literature study will go closely and digging more information in determination of characterization of particulate matter in construction site. The factor of location, the weather and the method of work for construction activity that may consider as the factor of characterization of particulate matter that founded less investigated or be the topic to study before.

The methodology of this study will be the pin point of successful of this study. It will discussed and elaborate more detail in chapter 3. The use of measurement tool and the information of equipment will be translated deeper in this chapter.In chapter 4, the collection of data from measurement tool will be explained and discussed. The characterization of particulate matter in selection activity at construction site will determine and the result will be the benchmark to carry out another step in next chapter.

The conclusion from the result given on the chapter 5 will be discussed and analyses. This chapter will prove the identification of characterization particulate matter at construction site is in range on PM2.5- PM10 that harm human health and the action can be taken in order to mitigate and control the sources of particulate matter and finally to recommendation for further study in this subject.

Finally the recommendation concluding the overall chapter and the closing of the research. The purpose of the chapter is to recommend and enhancer the research have been done in order to improve and develop the finding data or result.

1.6 Significant of Study

Particulate matter is the dust smaller than 10 micron meters in diameter and it harm human health. The characteristic of dust must be understood and to identify the source that contribute to the air pollution will be the bench mark and as a guide to develop more methodology to mitigate and as the code to practice in order for future survival and sustainability.The construction site have been familiar as the contributor of the particulate matter and it uncontrolled, predicted and never finding the ending of it, even though all the guideline and the law have been introduced and enforced by government and association. However the study is to investigate the critical activity contributor to the air pollution and that will be a report or base for the improvement of material use, the method of work, the site condition and the safety equipment to be provided during performing the activity.

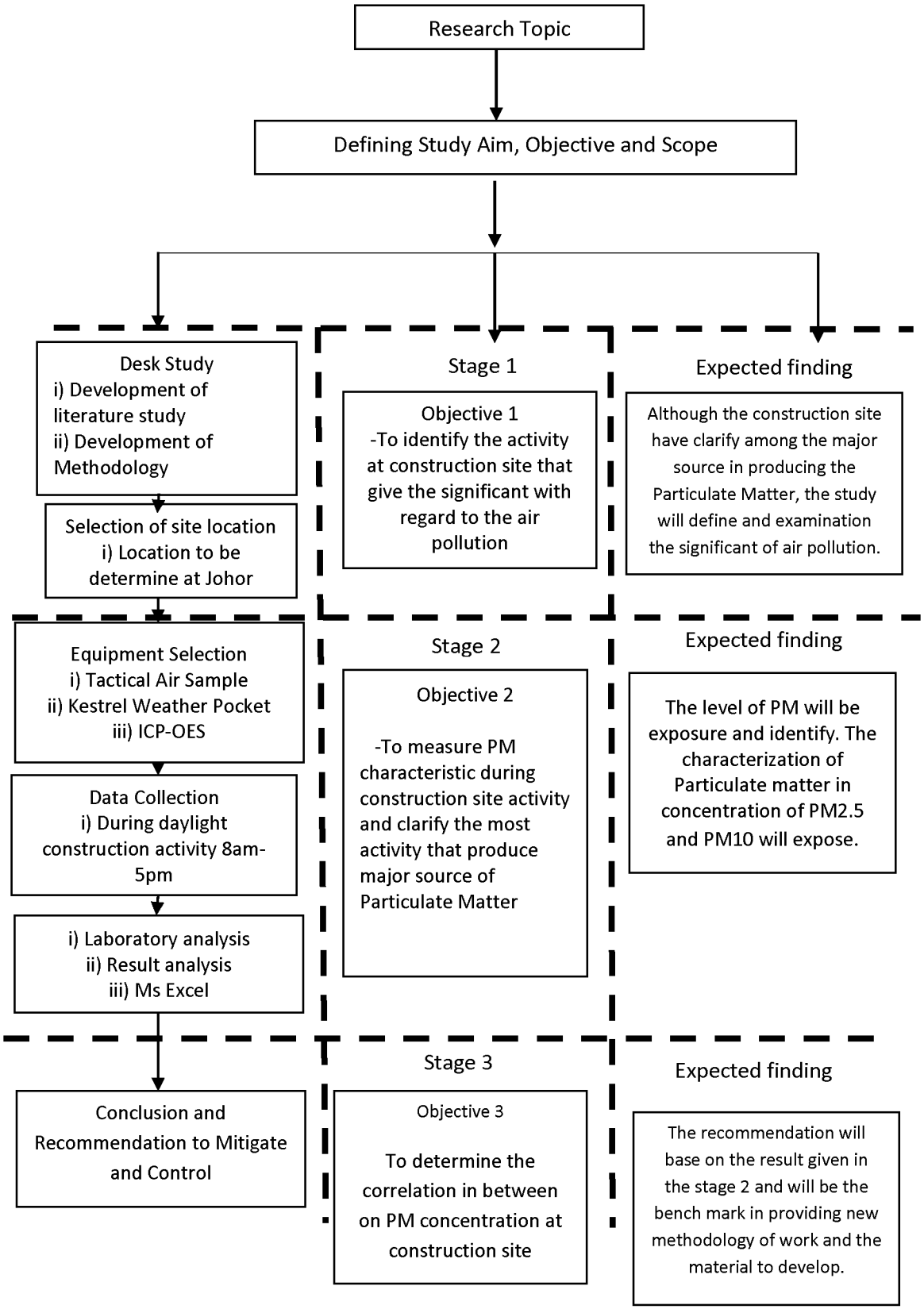


Figure 1.3 : Research Methodology Process

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