INVESTIGATION OF MICROBIOLOGICAL CONCENTRATION IN INDOOR AIR AT SCHOOL CLASSROOMS

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By

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I hereby declare that all corrections and comments made by the supervisor(s) and examiner have been taken into consideration and rectified accordingly.

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Name of Examiner:

Date :

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ABSTRAK

Manusia menghabiskan sebahagian besar kehidupan mereka sama ada rumah, pejabat, sekolah, hospital dan kenderaan. Pencemaran udara dalaman adalah salah satu faktor persekitaran yang paling berbahaya bagi kesihatan manusia. Tujuan kajian ini dijalankan adalah untuk mengkaji tahap kepekatan bakteria dalam empat buah kelas, perbezaan kepekatan bakteria dengan atau tanpa kehadiran pelajar berserta aktiviti dan menentukan hubungan antara kepekatan bakteria dengan suhu dan kelembapan relatif bagi sekolah yang terpilih di Pulau Pinang, Malaysia. Kepekatan bakteria telah ditentukan menggunakan kaedah "settle plate". Agar media yang digunakan adalah agar nutrien yang didedahkan kepada persekitaran selama 15 minit pada titik terpilih bagi setiap bilik darjah. Jumlah purata bacaan bakteria bagi setiap sekolah ialah 322.39 cfu/m^3, 684.89 cfu/m^3, 671 cfu/m^3 dan 387.44 cfu/m^3 bagi SK Bayan Lepas, SK Tasek Gelugor, SMK Mutiara Impian dan SK Machang Bubok. Kajian ini telah menunjukkan bahawa suhu dan kelembapan relatif mempengaruhi kiraan bakteria. Kesimpulannya, aktiviti oleh murid dan guru di dalam bilik darjah mempengaruhi jumlah bakteria yang dikira untuk sekolah terpilih di Pulau Pinang.

ABSTRACT

People spend most of their lifetime indoor whether residences, offices, schools, hospital and vehicles. Indoor air pollution is one of the most harmful environmental factors for human health. This study investigates the level of concentration of bacterial at four different school classrooms and determined the relationship of bacteria with temperature and relative humidity in Penang, Malaysia. The concentration of bacterial was determined using settle plate method. The agar media used was Nutrient Agar that were exposed to the atmosphere for 15 minutes at selected points in each school classrooms. The total of mean bacterial count for each school was 322.39 cfu/m^3, 684.89 cfu/m^3, 671 cfu/m^3 and 387.44 cfu/m^3 for SK Bayan Lepas, SK Tasek Gelugor, SMK Mutiara Impian and SK Machang Bubok, respectively. This study has shown that the temperature and relative humidity affect the bacterial counts. To conclude, activities from occupancy influence the bacterial count in selected schools in Penang.

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LIST OF ABBREVIATIONS

AHPA	**A**merican **P**ublic **H**ealth **A**ssociation
ICOP	**I**ndustry **C**ode **O**f **P**ractice
SK	**S**ekolah **K**ebangsaan
SMK	**S**ekolah **M**enengah **K**ebangsaan
WHO	**W**orld **H**ealth **O**rganization

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Penang is one of the thirteen states in Malaysia that located near the north-western coast of Peninsular Malaysia. It is separated between the State of Kedah in the north and east, the State of Perak in the south and the Straits of Malacca and Sumatra (Indonesia) in the west. Penang State consists of two parts which is Penang Island and mainland, Seberang Perai. The island is connected to Seberang Perai by ferry and by the two bridges that is 13.5 km long Penang Bridge and 24 km long Sultan Abdul Halim Mu'adzam Shah bridges. The island with 285 square metres is situated on the northwest side of the Peninsular Malaysia. The residents in Penang are multiracial communities and each year the population has increase.

As the population grows, all kinds of school are also increasing. The increase of this school is shared by both the government and the private sector. However, there are important aspect that need to be focused which is the learning environment especially the classroom itself and the student's health level (Suroto, 2010). A classroom is one of the important places, where students would stay at classroom for 6 to 8 hours. This is because outside the home, children spend most of their time indoors while at school. The learning environment is related to indoor air quality inside the buildings which can contribute to the development of mind, learning process and the growth of the students. Children are more susceptible to the effects of air pollution than adults because of their immature immune and respiratory system and also their breathing pattern. Asthma and

allergy are two of the most prevalent disease in children (Pearce et al., 2000). Indoor air pollutants can cause or contribute to short-term and long-term health problems (Clausen et al., 2009; Simoni et al., 2010; Annesi-Maesano et al., 2013).

From the previous study, the activities of indoor occupants, such as walking, affect the concentration of ordinary aerosol particles (Batterman, 2001; Ferro et al., 2004; Raunemaa et al., 1989; Qian et al., 2014). Besides, some studies have found that the activities of occupants increase the concentrations of aerosol diameter (> 1 μm) (Batterman, 2001; Raunemaa et al., 1989) in indoor environments. Children's activity and their presence may affect the concentration of biological particles. There have been a few previous studies on the correlation between human activities and bio-aerosols concentration in indoor air environment. It was found that human occupancy increased the bacterial concentration in indoor air environments such as in a classroom (Hospodsky et al., 2012; Qian et al., 2012).

1.2 Problem Statement

Children require good indoor environment since indoor air quality is very important for their growth and wellbeing as they are sensitive groups more compared to adults (Kamaruzzaman & Razak, 2011). Indoor air pollutants such as particulate matter and microbes have been linked to respiratory health effects in children, especially asthma symptoms such as night coughs and wheezing due to early exposure to indoor air contaminants (Khamal et al., 2016). School is one of the most significant environments for children, and there is a proof that the indoor air quality (IAQ) and ventilation in school buildings may affect their health (Daisey et al., 2003). Teachers and students spend most of their times at the school buildings with indoor activities such as in a

classroom. This indoor air quality is very important as it can affect the health of the students, especially the growth and learning process of the students. Moreover, from this research, the effect of concentrations of bacteria on human health can be measured. Respiratory illnesses due to exposure of airborne contaminants are a common problem for humans, particularly to children. Mould allergy was found to be more frequent in children than in adults, although the causes of mould allergies are still uncertain (Aydogdu et al., 2005). According to Bayer et al. (1999), allergic diseases including nasal allergy, asthma and other allergies accounted for 20% loss of school days in both elementary and high schools in US. Furthermore, number of students in each classroom is not similar. Therefore, the presence of occupant in a classroom significantly gave effect on concentration of bacteria. The number of occupants increases the shedding of bacteria and agitation of air increases the bacterial count in indoor environment (Meadow et al., 2014). A study is needed to analyze the concentration of bacteria in each classroom at selected school. Previous study by Kamaruddin (2017) mentioned that the school selected based on microenvironment criteria such as industrial area. The temperature of the classrooms for SK Sungai Kechil (industrial sources) and SK Khir Johari (mobile sources) exceed the ICOP limit (23^{o}C - 26^{o}C). Besides, the values of relative humidity also exceed the limit between 40% - 70%.

1.3 Objectives

The purposes of this study are listed as follow:

1. To determine the concentration of bacteria in school classrooms.
2. To compare the concentration of bacteria in background condition with presence of student and activities.

3. To investigate the relationship between concentration of bacteria in classrooms with relative humidity and temperature.

1.4 Scope of Study

This research was conducted at four selected school around Penang which are SK Bayan Lepas, SK Tasek Gelugor, SK Machang Bubok and SMK Mutiara Impian. Firstly, agar plate was setup at the selected point in the classroom to collect the bacterial contaminants while the formaldemeter used to measure the relative humidity and temperature in the classroom. The sampling time was conducted during the morning session at 07:15 a.m. until 07:30 a.m., 10:40 a.m. until 10:55 a.m. and 12:45 p.m. until 13:00 p.m.

Then, the selection of the school classroom is based on the location of the classrooms at different levels. However, activities of occupant in the classroom affect the bacterial counts. Therefore, the presence and activities of the occupant during sampling period was recorded in order to know the movement of occupant based on learning activities.

There are two categories of indoor air contaminants that are being investigated which are physical and biological contaminants. The physical parameters used in this study were relative humidity and air temperature while the parameters used for biological contaminants was the bacterial concentrations. In addition, the parameters obtained from this study were compared with the guideline of acceptable limits by Industry Code of Practice (ICOP) Malaysia.

1.5 Dissertation Outline

This thesis consists of five chapters. A brief outline of the structure is given below.

Chapter 1 is an introduction to the background of concentration of bacteria and scope of study. The problem statement, objectives and scope of the study are all stated in this chapter.

Chapter 2 include the literature reviews from the previous study about the parameter of indoor air quality and the factors affecting indoor air quality.

Chapter 3 explains an overall methodology that has been applied in this study. A general flowchart is used to simplify the research study.

Chapter 4 discussed in detail the result of the analysis. The result consists of concentration of bacteria, relative humidity and temperature. The relationship of concentration of bacteria with relative humidity and temperature will be described in this chapter.

Chapter 5 conclude the objectives and the results obtained from sampling. The future recommendation is made for future research to expand the scope of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter covers the literature reviews from the previous study about the parameter of indoor air quality, the factors affecting indoor air quality and the guideline of indoor air quality from Industry Code of Practice, 2010.

2.2 Indoor Air

People spend most of their time indoors, especially at home and in school therefore scientists has been focus on indoor air during last decade (Madueira et al., 2015). Indoor environments in workplaces and residential environments have recently caught the attention of scientists and public institutions (Lee and Chang, 2000). People spend 80% - 90 % of their time in indoors environment by breathing on average 14 m^3 of air in a day (Brochu et al., 2006). Millions of children and adults from all over the country spend their days in school buildings, and they need safe, healthy environments to thrive, learn, and succeed (Borgo and Mostafavi, 2007). According to Enitan et al. (2017), by ignored the time of the day, indoor environment allows aerosols build up which could serve as potential risk factors for spread of inspection in the classrooms of schools.

Schools are one of the institutional for communities of learners, including students and teachers (Ramli et al., 2012). According to Torres (2000), children spent only 23% of

their time indoors such as in kindergartens and schools. Moreover, students in Malaysia generally spent between five to ten hours per day at school. The Muslim children spend more time at school as they attending religious school such as Sekolah Rendah Agama (SRA) or Sekolah Menengah Agama (SMA). Obviously, children spend more time in their school environment than in their home environment. Therefore, it is not wrong to conclude that their behavioural growth is affected more by their school environment than their home environment (Ramli et al., 2012).

Furthermore, the schools were selected based on their surrounding environments such as surrounded by buildings, roadways, and mountains. Children breathe a higher volume of air at very fast rate as they more sensitive when being exposed to unsafe air (Landrigan, 1997; Faustman et al., 2000). During school days, over 30% of a pupil's life was spent at schools, and about 70% of their time inside a classroom (Bako-Biro et al., 2004). In school buildings, the indoor particle concentrations effect the resuspension of particles by students' indoor activities in occupied classrooms (Yang et al., 2009; Mullen at el., 2011).

2.3 Indoor Air Quality (IAQ)

Indoor air quality is determined from a wide range of pollution sources by a combination of various pollutants, all of them relate to the places, the climate and the culture such as the local ambient air, the building features and the indoor activities (Fernandes et al., 2008). Indoor air quality in the residential sector is very important as it takes time to analyse indoor air quality in government schools in indoor air micro-flora (Mohan et al., 2014). Most people spend a great part of their time in the building,

so indoor air quality is very essential as a determinant of healthy life and welfare (Branco et al., 2014).

Most people spend about 87% of their time indoors and only 5% to 6% in the vehicle, hence indoor air quality is an important factor in human exposure to environmental pollutants (Klepeis et al., 2001). School pupils spend more than 70% of life in the classroom and indoor air quality affects the attendance and potential of student learning. Hence, the indoor air quality in primary school buildings is highly important (Peng et al., 2017). Fang et al. (2004) indicated that indoor air temperature has great impact on perceived air quality in office buildings, and high air temperatures can promote the generation of other pollutants, such as volatile organic compounds (VOCs) and formaldehyde.

2.4 Factor of Indoor Air Contaminant

2.4.1 Bacterial Counts

The bacterial concentration was found more in places like classrooms, toilets and canteens and fungal concentration was observed more in libraries, classrooms. Lack of concern in indoor air qualities in the management lead to the growth of bacteria and fungi (Mohan et al., 2014). In all of the tested places a multiple growth of bacteria and significant increase of mould spores were observed in afternoon (Filipiak, 2007). In schools the highest level of bacterial contamination was detected in the corridor and in rooms (Filipiak, 2007). The indoor levels of bacteria and fungi concentrations in schools with occupants were significantly higher than those without occupants due to contamination by the occupants (Hussin et al., 2011).

Moreover, the environmental factors mainly include temperature, humidity, air exchange rate, air movement, building structures and location, poor design, ventilation system as well as interior or redesign which enhance microorganism's growth and multiplication in the indoor atmosphere (Wamedo et al., 2012; Meadow et al., 2014; Graudenz et al., 2005). Mohan et al. (2014) mentioned that the sources of classroom airborne infection or contamination could be traced to a variety of factors. These include the student's own uniforms, bags, sandals; as well as activity of students like sneezing, coughing, talking and yawning. House-keeping activity such as sweeping or using dry dust mops can aerosolize particles that may contain microorganisms. Materials such as cupboards, books and files have been implicated as viable sources (Faustman et al., 2000). Food stuffs, house plants and flower pots, house dust, textiles, carpets, wood material and furniture stuffing, occasionally release various fungal spores into the air (Kalogerakis et al., 2005).

2.4.2 Relative Humidity and Temperature

The average indoor temperature and relative humidity were higher in comparison with those in cold countries due to less variation in the temperature and climate that prevail throughout the year in Malaysia (Hussin et al., 2011). The indoor air temperature in winter is mainly determined by occupants' activities and the adiabatic ability of a building's fabrics (Peng et al., 2017). Kamaruzzaman and Razak (2011) stated that the relative humidity rate is inversely proportional to the temperature and CO_2 concentration. Indoor air quality not only for comfort, which is affected by temperature, relative humidity and odours but also by harmful biological contaminants present in the conditioned space. Temperature, relative humidity, sources of nutrients,

and air movement affect the growth and dissemination of biological contaminants (Seltzer, 1994).

2.4.3 Indoor Sources

The sources of classroom airborne infection or contamination could be traced to a variety of factors. These include the pupil's own normal flora, uniforms, bags, sandals; as well as activity of pupils like sneezing, coughing, talking and yawning (Mohan et al., 2014). The presence of human and their activity may affect the concentration of biological particles. Talking activities, including heavy inhalation and exhalation, decreased the concentration of bacterial bio-aerosols in the confined indoor space (Heo et al., 2017). From the concentration of ordinary aerosol particles affected by the activities of indoor occupants such as walking (Batterman, 2001; Ferro et al., 2004; Raunemaa et al., 1989; Qian et al., 2014). Besides, some studies have found that the activities of occupants increase more than one micrometre of the concentrations of aerosol diameter (Batterman, 2001; Raunemaa et al., 1989) in indoor environments. There have been a few previous studies on the correlation between human activities and bio-aerosols concentration in indoor air environments. An indoor air environment like classroom increased the concentration of bacteria with the human occupancy (Hospodsky et al., 2012; Qian et al., 2012). The concentrations of aero-flora above permissive standard recorded in private primary schools in Nigeria study, underscore the importance of this microenvironment for the high exposure of children to bioaerosols. Immediate interventions are therefore needed to control both human and environmental factors which favour the growth and multiplication of microorganisms (Enitan et al., 2017). Besides, there was a higher concentration of PM indoors, when a classroom was occupied. This was caused by students' activities, such as walking,

running, and cleaning the blackboard, which increased the re-suspension of particulate matter (Peng et al., 2017).

2.5 Indoor Air Quality Parameters by Industry Code of Practice

DOSH (2010) have identified the main indoor air parameters. A temperature is the degree or intensity of heat present in a substance or object. The effects of indoor air temperature have caused dehydration but the lower temperature would bring discomfort to students and teachers. Relative humidity is the amount of water vapour present in air expressed as a percentage of the amount needed for saturation at the same temperature. The acceptable range for temperature and relative humidity by ICOP is shown in Table 2.1. Table 2.2 shows the acceptable limits for bacterial contaminants.

Table 2.1: Acceptable range for physical parameters

Parameter	Acceptable Range
Air Temperature	23 – 26 °C
Relative Humidity	40% - 70%

(Source: Industry Code of Practice on Indoor Air Quality, 2010)

Table 2.2: Acceptable limits for bacterial contaminants

Indoor Air Contaminants	Acceptable limits (cfu/m³)
Total bacterial counts	500*

*excess of bacterial counts does not necessarily imply health but serve as an indicator for further investigation.

(Source: Industry Code of Practice on Indoor Air Quality, 2010)

2.6 Effect on health due to poor indoor air quality

Children's immature immune and respiratory system and also their breathing pattern caused them more susceptible to the effects of air pollution than adults. Asthma and allergy are two of the most prevalent disease in children (Pearce et al., 2000). Short-term and long-term health problems can arise from indoor air pollutants (Clausen et al., 2009; Simoni et al., 2010; Annesi-Maesano et al., 2013). Moreover, respiratory illnesses are common problem for humans especially children due to the exposure of air contaminants (Hussin et al., 2011). Although the causes of mould allergies are still uncertain, mould allergy was found to be more frequent in children than in adults (Aydogdu et al., 2005).

Exposure to these indoor air contaminants particularly among school children needs closed attention as children are more susceptible to the infection or respiratory problems and a large portion of their time is spent in school (Hussin et al., 2011). Children are exposed to ultrafine particle mainly at home and school (Buonanno et al., 2012; Mazaheri et al., 2013). Indoor air pollution can increase chances of the development of long and short-term health problems in students and staff in school (Lee and Chang, 2000). High exposure to particulate matters can bring misery problems like asthma, lung cancer, cardiovascular disease, respiratory diseases, birth defects, and premature death (Peng et al., 2017). Sundell et al. (2011) concluded that the incidence of inflammation, respiratory infections, asthma symptoms, and short-term sickness is enhanced as a result of high exposure to air pollutants.

School is one of the most significant environments for children, and there is a proof that the indoor air quality (IAQ) and ventilation in school buildings may affect their

health (Daisey et al., 2003), but a few publications has found on associations between building dampness and measured microbial exposure in schools or about sick building syndrome in school children (Meyer et al., 2004; Saijo et al., 2010). The growth of bacteria and fungi is caused by the lack of concern in indoor air qualities in the management. Indoor microbial contaminants include bacteria, molds, yeast, and various components from these organisms. The most studied bacterial compound is endotoxin (LPS) (Seltzer, 1994).

Furthermore, one of the troubles of indoor air quality is affected by the existence of microorganisms which include bacteria, moulds and viruses (Wamedo et al., 2012). The existence of bacteria in the indoor air pose a serious problem from the point of view of health protection and environmental engineering (Al-Mijalli, 2016). Bacteria and fungi are most commonly microorganisms associated with indoor air quality complaint and most often implicated as indoor bio-contaminants (Wong et al., 2009). Besides, airborne microbe is one of the most contaminant that addressing major issue in defining low indoor air quality. A wide variation of microorganism such as fungi (moulds, yeasts), bacteria, viruses, and amoebae can be found in the indoor environment (Abidin et al., 2013). According to Khamal et al. (2016), the indoor particle concentrations and presence of microbes in indoor room might increase the risk in exposed children for respiratory, particularly asthma, later in life.

Air in the indoor environment can be polluted by a number of pollutants among which airborne microorganism such as bacteria and fungi are one of the most important. It has been estimated that one-third of indoor air quality (IAQ) complaints may be due to microbial contamination (Pope et al., 1993). Lack of cleaning and checking out of the

heating, ventilation and air conditioning systems (HVAC) may allow microbial growth, which causes several diseases in the users. Every few month, the filters of air conditioners should be cleaning. With the cooler months approaching it becomes even more important to make sure that air conditioner is clean (Al-Mijalli, 2016). Specific classroom, cleaning and maintenance characteristics have been identified as having a direct impact on indoor air quality (Fsadni et al., 2017).

2.7 Summary of Literature Review

Previous study indicate that the presence of occupants increase the number of bacterial count in indoor environment. Hayleeyesus and Manaye (2014), revealed that the number of occupants increase the shedding of bacteria count in indoor environment. Besides, another study by Hussin et al. (2011), found that the indoor levels of bacteria and fungi concentrations in schools with occupants were significantly higher than those without occupants due to contamination by the occupants. Furthermore, the activities of occupants in the classroom affect the bacterial counts. Heo et al. (2017) stated that the activities of occupants increase the concentration of bacteria.

On the hand, the literature presented in this chapter evaluated indoor air parameters and the biological contaminants. DOSH (2010) had recommended acceptable guideline limit for indoor air parameters and biological contaminants. However, past investigation was using Duo SAS Super 360 microbiological air sampler. The sampling time was 2 minutes. More than half of bacteria samples had a concentration exceeding WHO recommended level of 500 cfu/m^3 (Hussin et al., 2011). Therefore, in this research, settle plate method using 9cm petri dishes were used to allow bacteria carrying particles to settle on agar media. The sampling time was 15 minutes.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter covers the details explanation of methodology used to complete this research. A systematic process was organized in order to achieve the objective of this study as shown in Figure 3.1.

3.2 Study Area

The research is conducted at four selected school around Penang, Malaysia as Penang is one of the developing countries in Malaysia. The selected school of this study are government schools which are SK Bayan Lepas, SK Tasek Gelugor, SK Machang Bubok and SMK Mutiara Impian. The coordinate of each selected schools is stated in Table 3.1. All the selected schools were built more than 15 years ago and constructed of concrete with no air conditioning. All the schools were located near to the residential area. All the schools have only morning session for teaching and learning starts at 07:30 a.m. except SK Tasek Gelugor that has morning and evening session.

Table 3.1: Location of the school

Name of School	Coordinate
SK Bayan Lepas	N 05° 17’ 48’’ E 100° 15’ 38’’
SK Tasek Gelugor	N 05° 29’ 02’’ E 100° 29’ 29’’
SK Machang Bubok	N 05° 19’ 40’’ E 100° 30′ 10′′
SMK Mutiara Impian	N 05° 16’ 28’’ E 100° 28’ 39’’

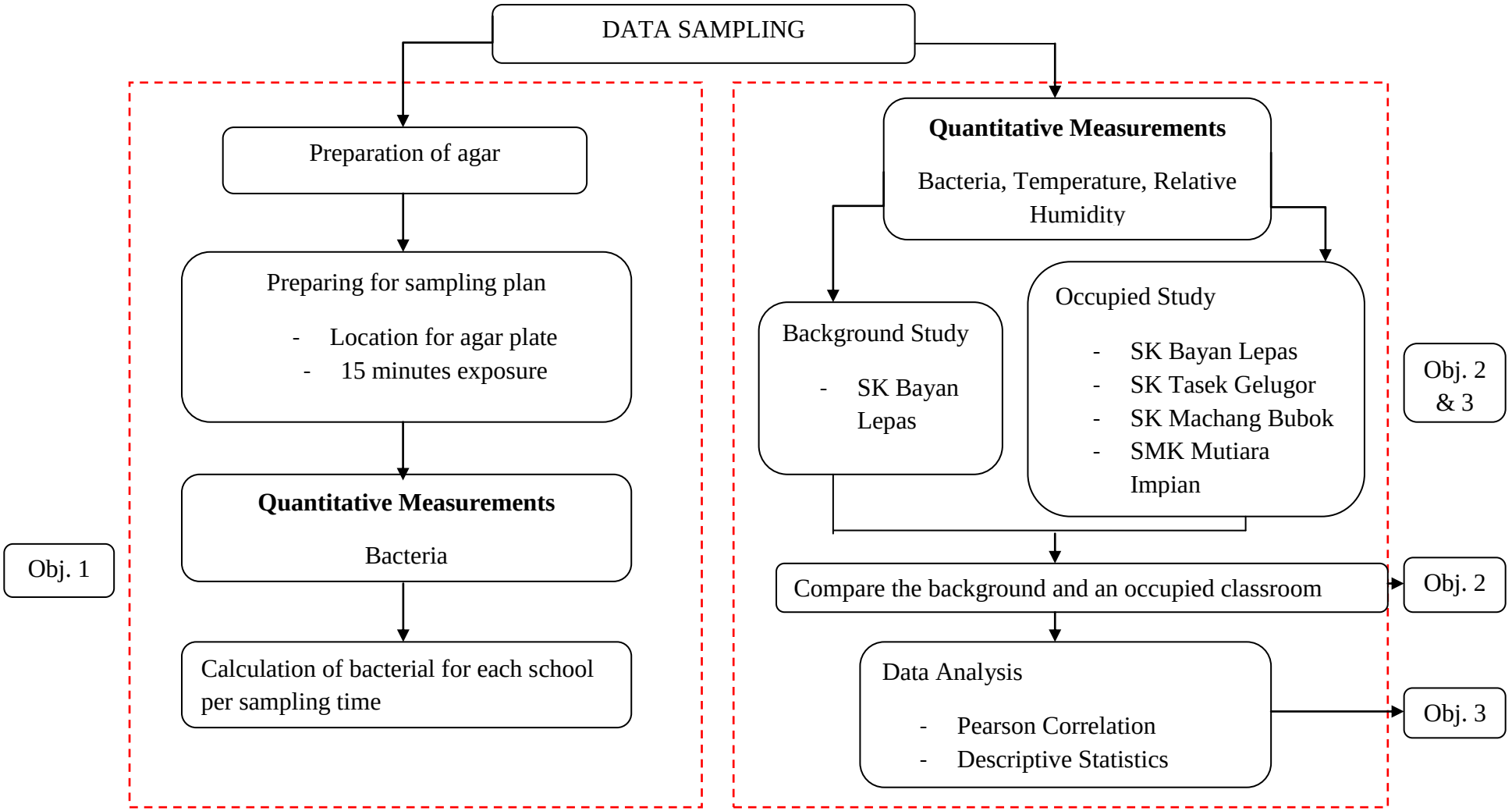

Figure 3.1: Flowchart of methodology

3.2.1 SK Bayan Lepas

SK Bayan Lepas (SKBL) is one of the primary school located at Jalan Dato Ismail Hashim, Bayan Lepas, Penang as shown in Figure 3.2. The coordinate of the school is N 05° 17’ 48’’and E 100° 15’ 38’’.

The school was developed on 1st January 1926. In 1957, Sekolah Umum Bayan Lepas was change to SK Bayan Lepas. SK Bayan Lepas is located about 16 km from Georgetown. Besides, the school only has morning session starting at 07:30 a.m. until 01:30 p.m.

Two classes have been chosen in this school which is 4 Utarid at level 2 with 24 students in the class while 4 Bumi at level 3 with 33 students in the classroom. Figure 3.3 and Figure 3.5 show classroom layout of SK Bayan Lepas for level 2 and level 3, respectively. Figure 3.4 and Figure 3.6 show floor plan for level 2 and level 3, respectively.

Figure 3.2: SK Bayan Lepas from satellite image (Source: Google Map)

Figure 3.3: Classroom's Layout at Level 2 of SK Bayan Lepas

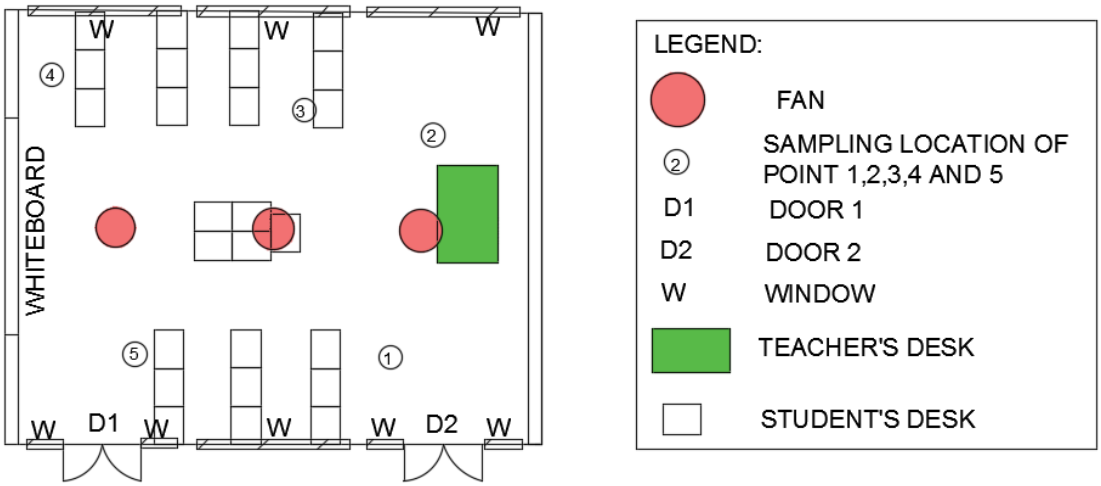

Figure 3.4: Floor plan at Level 2 of SK Bayan Lepas

Figure 3.5: Classroom's Layout at Level 3 of SK Bayan Lepas

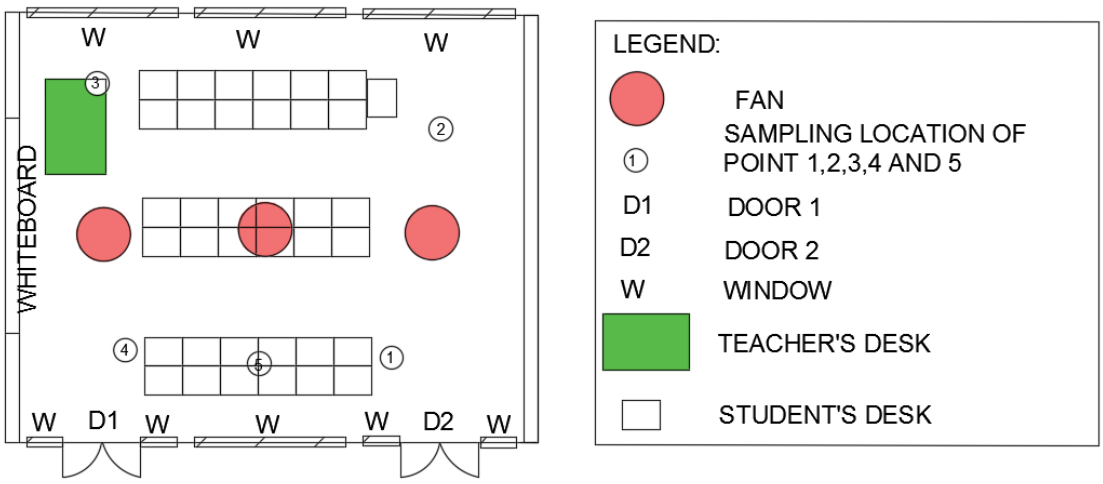

Figure 3.6: Floor plan at Level 3 of SK Bayan Lepas

3.2.2 SK Tasek Gelugor

SK Tasek Gelugor (SKTG) in Figure 3.7 is one of the primary school located at Jalan Hashim Awang, Tasek Gelugor, Penang as shown in Figure 3.8. The coordinate of the school is N 05° 29’ 02’’ and E 100° 29’ 29’’.

The school is developed in 1926. It has 755 students with 65 teachers in 2018. This school have two sessions which are morning session that is for pupils in Year 4, Year 5 and Year 6 while afternoon session is for pupils in Year 1, Year 2 and Year 3. The morning sessions starts on 7.30 a.m. until 1.00 p.m. and afternoon session starts on 1.10 p.m. until 6.30 p.m. However, this study only consider the morning sessions.

At this school, the chosen class are 5 Ibnu Abbas and 5 Ibnu Majah. 5 Ibnu Abbas is at ground floor with 38 students in classroom while 5 Ibnu Majah is at level 3 with 29 students. Figure 3.9 and Figure 3.11 show classroom layout of SK Tasek Gelugor for level 1 and level 3, respectively. Figure 3.10 and Figure 3.12 show floor plan for level 1 and level 3, respectively.

Figure 3.7: SK Tasek Gelugor

Figure 3.8: SK Tasek Gelugor from satellite image (Source: Google Map)

Figure 3.9: Classroom's Layout at Level 1 of SK Tasek Gelugor

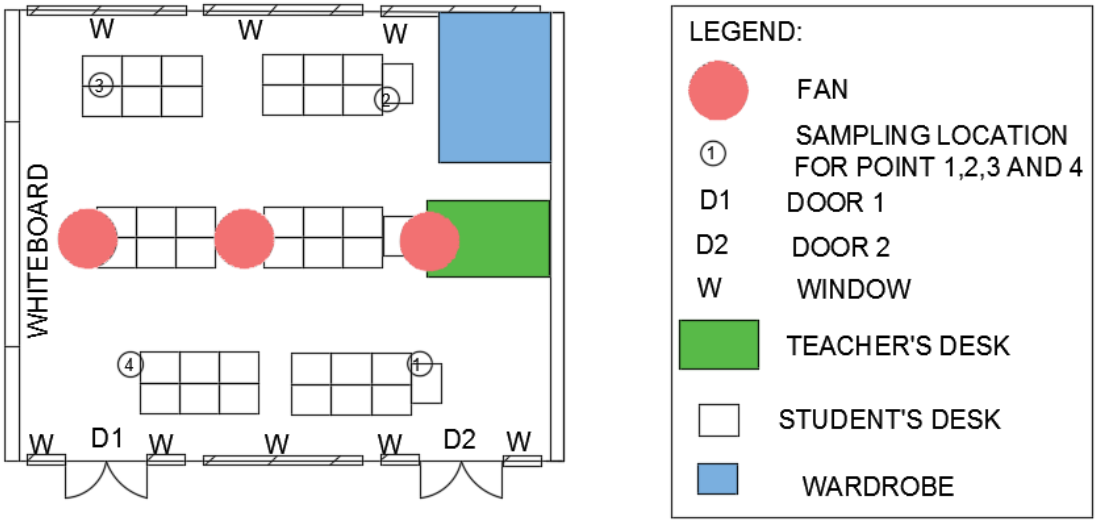

Figure 3.10: Floor plan at Level 1 of SK Tasek Gelugor

Figure 3.11: Classroom's Layout at Level 3 of SK Tasek Gelugor

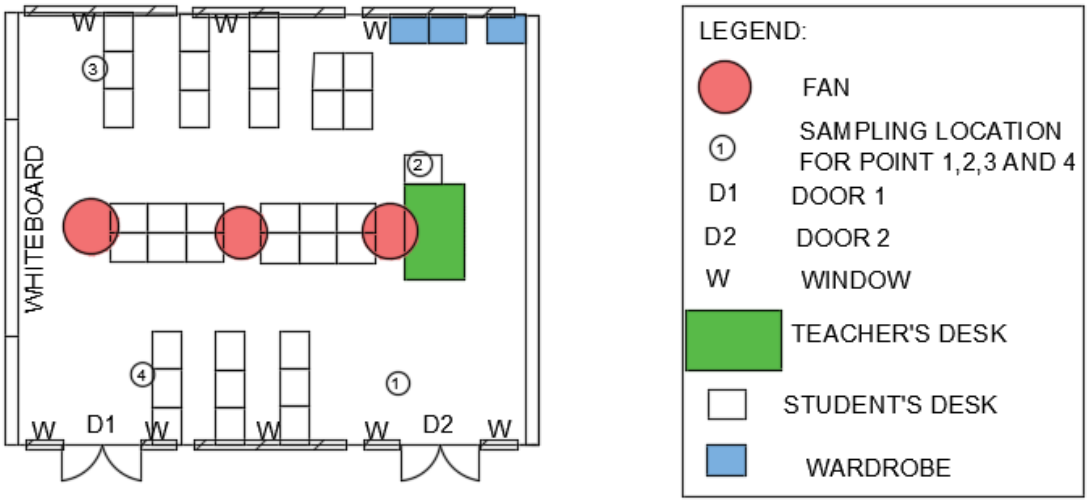

Figure 3.12: Floor plan at Level 3 of SK Tasek Gelugor

3.2.3 SK Machang Bubok

SK Machang Bubok is a primary school located at Jalan Gajah Mati, Penang as shown in Figure 3.13. The coordinate of the school is N 05° 19’ 40’’ and E 100° 30’ 10’’. This school only has one session which is morning session. This school was founded in 1921.

The chosen classes at this school are 5 Bijak and 4 Bijak. 5 Bijak is located at level 2 with 25 students in class while 4 Bijak at level 3 with 24 students in the classroom. Figure 3.14 and Figure 3.16 show classroom layout of SK Machang Bubok for level 2 and level 3, respectively. Figure 3.15 and Figure 3.17 show floor plan for level 2 and level 3, respectively.

Figure 3.13: SK Machang Bubok from satellite image (Source: Google Map)

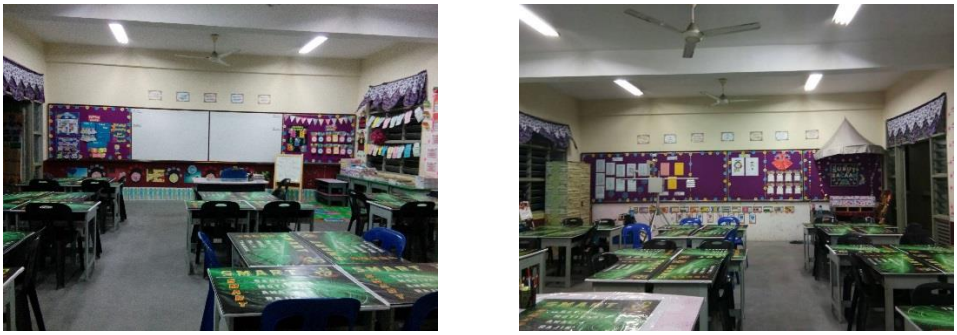
Figure 3.14: Classroom’s Layout at Level 2 of SK Machang Bubok

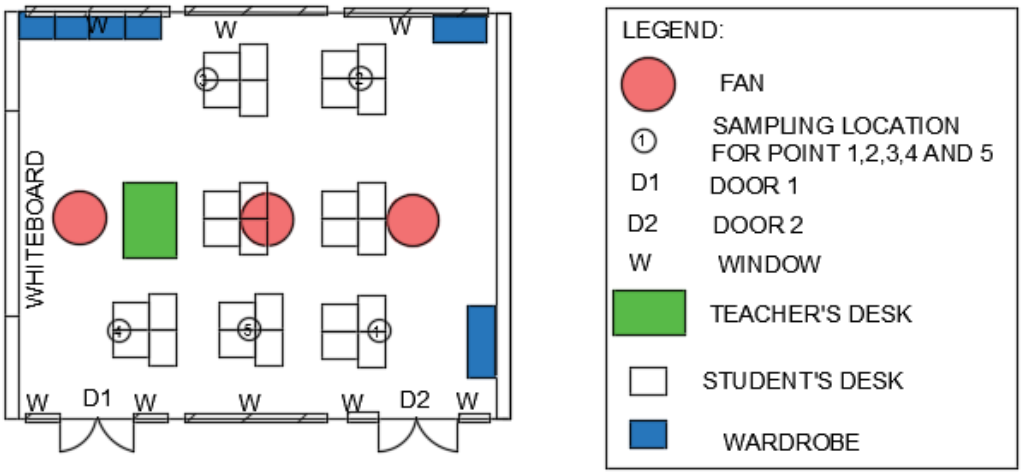

Figure 3.15: Floor plan at Level 2 of SK Machang Bubok

Figure 3.16: Classroom's Layout at Level 3 of SK Machang Bubok

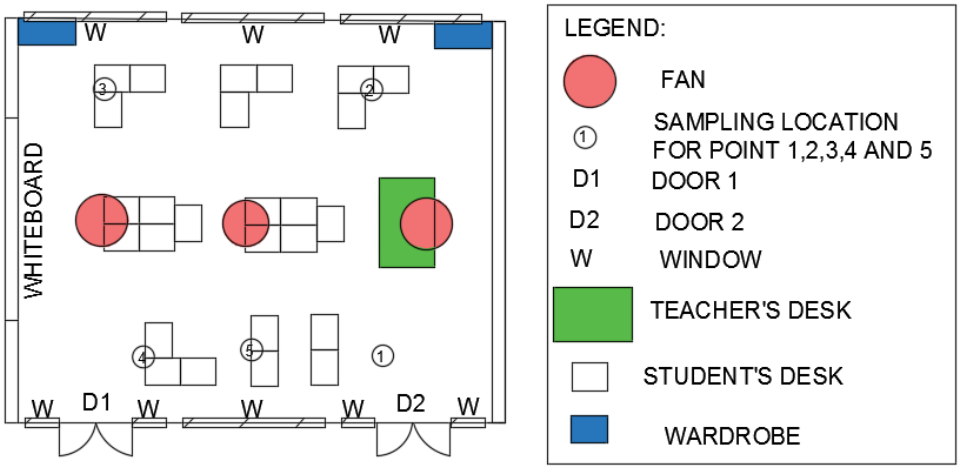

Figure 3.17: Floor plan at Level 3 of SK Machang Bubok

3.2.4 SMK Mutiara Impian

SMK Mutiara Impian is a secondary school located at Simpang Ampat, Pulau Pinang as shown in Figure 3.18. This is a government sports school and the only secondary school chosen for this study. The coordinate of the school is N 05° 16’ 28’’ and E 100° 28’ 39’’. SMK Mutiara Impian started operating on 24 July 2001 after the school building completed.

At this school, 1 Olimpik and 2 Olimpik were selected for the sampling. 1 Olimpik located at level 2 with 18 students while 2 Olimpik located at level 3 with 19 students in the classroom. Figure 3.19 and Figure 3.21 show classroom layout of SMK Mutiara Impian for level 2 and level 3, respectively. Figure 3.20 and Figure 3.22 show floor plan for level 2 and level 3, respectively.

Figure 3.18: Study location from satellite image (Sources: Google Map)


Figure 3.19: Classroom’s Layout at Level 2 of SMK Mutiara Impian