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ASSOCIATION BETWEEN SOCIO-DEMOGRAPHIC, BIOLOGICAL HAZARD & PSYCHOSOCIAL FACTORS WITH RESPIRATORY SYMPTOMS AMONG MANUFACTURING WORKERS IN SELANGOR

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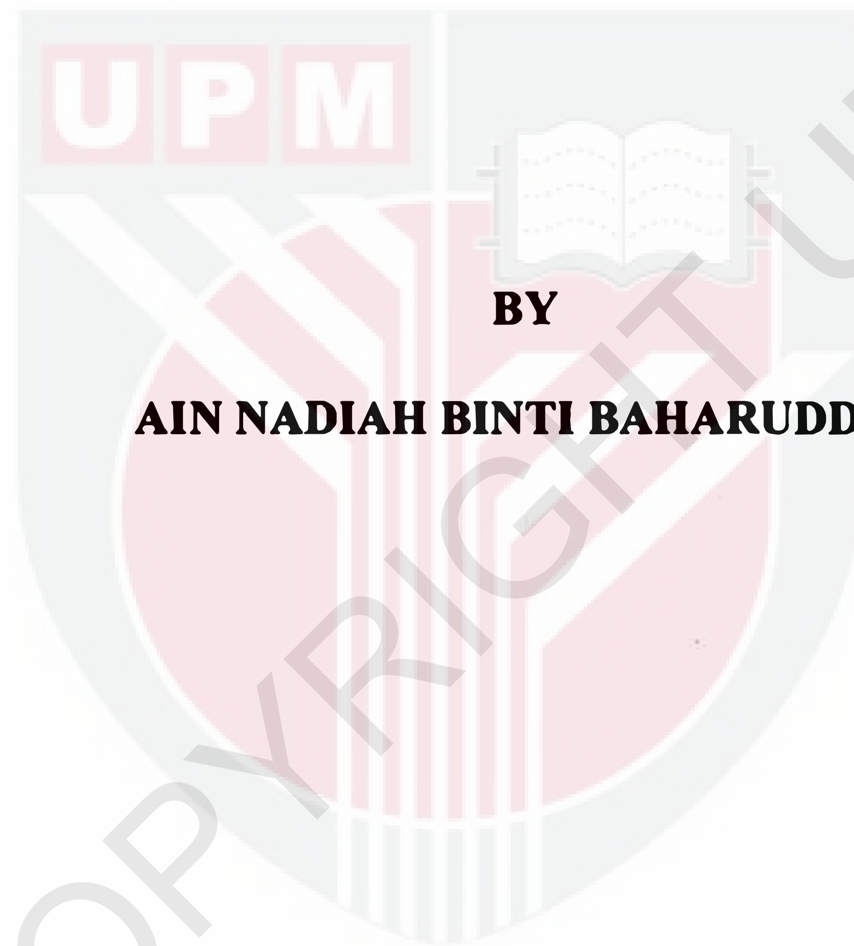
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AIN NADIAH BINTI BAHARUDDIN

Thesis submitted in fulfillment of the requirement for the degree of Bachelor Science (Environmental and Occupational Health) from the Faculty of Medicine and Health Science, Universiti Putra Malaysia

ACKNOWLEDGEMENT

First of all, I praise to Allah , the Almighty for providing me this opportunity and granting me the capacity to proceed successfully. I was supported and supervised by many people during completion of this thesis. I would like to express my highest gratitude and appreciation to Dr Emilia Zainal Abidin as my supervisor and Dr Irniza Rasdi as my co-supervisor. They had been supervised and encouraged me throughout my thesis process and giving me chance to learn much knowledge from their expertise and experience. They gave me a lot of guidance, advice and support that really encourage me to complete this thesis. They also had provided me a great supervision and constructive feedback.

I also would like to express my gratitude to support staff from Department of Environmental and Occupational Health as empower me through their faith and wisdom. My special gratitude also dedicated to all respondents that have been involved in this study. Without them, this study will not be completed.

Acknowledgements are also extended to my parents and friends who also encouraged me to finish this study. Lastly, an infinite gratitude I wish to all those had been involved either directly or indirectly in this study.

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ABSTRACT

ASSOCIATION BETWEEN SOCIO-DEMOGRAPHIC, BIOLOGICAL HAZARD & PSYCHOSOCIAL FACTORS WITH RESPIRATORY SYMPTOMS AMONG MANUFACTURING WORKERS IN SELANGOR

AIN NADIAH BINTI BAHARUDDIN

Introduction: People spend a large part of their time each day indoors. The quality of the air they breathe indoors is an important determinant of their health and well-being. Biological parameter become a concern in this study as the activity of people and equipment within the indoor environments is thought to be the principal factor contributing to the build-up and spread of airborne microbial contamination. Other than that, particular activities like talking, sneezing, coughing, walking and washing can generate airborne biological particulate matter. Based on WHO (2004) respiratory infection is the fourth cause of deaths and respiratory disease is a fifth cause of death in the world. Then, the improperly maintained air conditioning systems and exposure to these microbial fragments and metabolites can be a source of wide variety of illnesses (Almoffarreh et. al,2016). Other than that, there is no a NOAEL or a LOAEL (Lowest-Observed-Adverse-Effect Level) has not been identified for bioaerosol exposures. **Objectives:** To determine the association between concentration of indoor airborne bacteria and fungi and respiratory symptoms among manufacturing workers. To measure the association between concentration of indoor airborne bacteria and fungi , psychosocial risk factors and socio-demographic factors with respiratory symptoms among study respondents. **Methodology:** 108 workers at one manufacturing factory at Bandar Baru Bangi was selected in this study. Self constructed questionnaire and questionnaire adopted from Job Content Questionnaire (JCQ) and International Union against Tuberculosis and Lung Disease (IUATLD) was used in this study. Generally, the questionnaire used was asked the socio-demographic information, working information, psychosocial work factors and respiratory symptoms. Then, data collection on bacterial and fungal concentration was collected using Duo Sas Super 360 with Trypticase soy agar (TSA) and Sabouraud Dextrose Agar (SDA) agar plate. The agar plate was incubated and the colonies form was calculated. **Result:** The concentration of bacterial and fungal not exceeds the acceptable limit except for prayer room where bacteria counting exceeded the acceptable limits. There are no significant association between psychosocial factor and concentration of bacteria and fungi with respiratory symptoms. **Conclusion:** The exposure of bacteria and fungi at study location was safe and acceptable. Thus they study practices a few best practices to maintain the safe exposure of bacteria and fungi indoor such as maintaining air conditioning, frequent cleaning and avoid eating indoor.

Keywords: Indoor Air Quality, Bacteria and Fungi Concentration, Manufacturing Workers, Psychosocial Factors

ABSTRAK

HUBUNGKAIT DI ANTARA SOCIO-DEMOGRAFI, HAZAD BIOLOGI DAN FAKTOR PSIKISOSIAL DENGAN GEJALA PERNAFASAN DI KALANGAN PEKERJA PEMBUATAN DI SELANGOR

AIN NADIAH BINTI BAHARUDDIN

Pengenalan: Manusia menghabiskan sebahagian besar masa mereka setiap hari di dalam bangunan. Kualiti udara yang mereka bernafas setiap hari adalah penentu yang penting dalam kesihatan dan kesejahteraan hidup manusia. Parameter biologi menjadi tumpuan dalam kajian ini kerana aktiviti manusia dan peralatan didalam bangunan yang tertutup dipercayai menjadi faktor utama yang menyumbang kepada pengumpulan dan penyebaran pencemaran mikrob bawaan udara. Selain itu, aktiviti-aktiviti tertentu seperti bercakap, bersin, batuk, berjalan dan lain-lain boleh menjana zarah biologi udara. Berdasarkan WHO (2004) jangkita pernafasan adalah punca yang keempat kematian dan peyakit pernafasan adalah punca kelima kematian di dunia. Kemudian, sistem penyaman udara yang tidak diselenggara dengan baik boleh menjadi sumber pelbagai penyakit disebabkan pendedahan kepada mikroorganisma di dalam udara tersebut (Almoffarreh et al, 2016). Selain daripada itu, tidak ada NOEAL atau LOAEL yang dikenal pasti bagi pendedahan kepada bacteria dan kulat. **Objectif:** Untuk menentukan hubungan antara kepekatan bacteria dan kulat bawaan udara dengan gejala pernafasan di kalangan pekerja pembuatan. Untuk mengkaji hubungan diantara kepekatan bacteria dan kulat bawaan udara, faktor risiko psikososial dan factor socio demografi dengan gejala pernafasan di kalangan responden kajian. **Methodologi:** 108 pekerja di satu kilang pembuatan di Bandar Baru Bangi telah dipilih dalam kajian ini. Borang soal selidik yang dibina sendiri dan borang soal selidik daripada 'Job Content Questionnaire' (JCQ) dan 'International Union against Tuberculosis and Lung Disease' (IUATLD) telah digunakan dalam kajian ini. Secara umumnya, borang soal selidik melibatkan soalan berkenaan sosio-demografi, maklumat pekerjaan, faktor psikososial dan gejala pernafasan. Kemudian, pengumpulan data untuk kepekatan bakteria dan kulat telah dijalankan menggunakan alat bernama Duo Sas Super 360 dengan Trypticase soya agar (TSA) dan Sabouraud Dextrose Agar (SDA). Plat agar, dibiarkan dalam suhu dan masa tertentu dan pertumbuhan di atas agar tersebut dikira. **Keputusan dan Perbincangan:** Pendedahan kepada bakteria dan kulat di lokasi kajian adalah dalam linkungan selamat kecuali di surau perempuan. Beberapa faktor mempengaruhi kepekatan bakteria di surau perempuan yang menyebabkan ianya melebihi had yang ditetapkan. Tiada hubungan yang signifikn antara faktor psikososial dengan gejala pernafasan **Kesimpulan:** Kebanyakan pendedahan bakteria dan kulut di tempat kajian adalah dalam lingkungan selamat dan boleh diterima had. Oleh itu, beberapa amalan yang terbaik harus di praktiskan untuk mengekalkan pendedahan yang selamat seperti selalu menyelenggara pendingan hawa, melakukan pembersihan yang kerap dan elakkan makan di kawasan kerja.

Kata Kunci: Kualiti Udara Dalaman, Kepekatan Bakteria dan Kulat, Pekerja Pembuatan, Faktor Psikososial

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LIST OF ABBREVIATIONS

CFU	Colony Forming Unit
ICOP	Industrial Code of Practice
NIOSH	National Institute of Occupational, Safety and Health
TSA	Tryptic Soy Agar
SDA	Sabouraud Dextrose Agar
USEPA	United State Environmental Protection Agency
WHO	World Health Organization
IUATLD	Union Against Tuberculosis and Lung Disease
JCQ	Job Content Questionnaire

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CHAPTER 1

INTRODUCTION

1.1 Background

Healthy indoor air is recognized as a basic right of human beings (WHO, 2009). People spend a large part of their time each day indoors, including in homes, offices, schools, health care facilities, or other private or public buildings. Therefore the quality of the air they breathe in those buildings is an important determinant of their health and well-being. According to United State Environmental Protection Agency USEPA (2017), in the last several years, a growing body of scientific evidence has indicated that the air within homes and other buildings can be more seriously polluted than the outdoor air. USEPA (2017) stated that indoor air quality refers to the air quality within and around the buildings and its related to health and comfort of building occupants.

The health effect of indoor air pollutants may be experienced immediately after the exposure or and possibly years after the exposure (USEPA, 2017). According to USEPA (2017), usually, the immediate effect of indoor air pollutant is includes irritation of eyes, nose, and throat, dizziness, fatigue, and headache. These effects will immediately recover after the person leaves the building and other health effects may show up after many years of exposure or long term of exposure such as respiratory disease (USEPA, 2017).

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Based on 500 indoor air quality investigations last decade, the National Institute for Occupational Safety and Health (NIOSH) states that the primary sources of indoor air quality problem comes from 52% of inadequate ventilation, 16% of contamination from the inside the building, 10% of contamination from outside the building, 5% of microbial contamination, 4% of contamination from building fabric and 13% from unknown sources. Thus the microbial contamination was assessed as its contributed to the poor indoor air quality.

Prussin & Marr (2015)

Figure 1.1: Sources of contaminants

Based on Prussin & Marr (2015), it stated that the sources of microbial bioaerosols including bacteria and fungi might be from plumbing system, ventilation system, air conditioning system, animals, outside contaminant and also from human itself. Human occupancy might be the most important factor affecting the total number of bioaerosols present in the built environment, especially in poorly ventilated or heavily occupied environments (Adam et al., 2015).

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According to new research by Yale University engineers (Eric, 2012), the presence of one person in a room can add 37 million bacteria to the air every hour and material largely left behind by previous occupants and stirred up from the floor. Biological parameter becomes a concern in this study as the activity of people and equipment within the indoor environments is thought to be the principal factor contributing to the build-up and spread of airborne microbial contamination. Airborne microbial also known as bioaerosol which was defined as a tiny airborne particle such as a fungal spore, pollen grain, endotoxin, or particle of animal dander that is composed of or derived from biological matter. Bioaerosol can produce significant health effects by spreading infectious disease or triggering allergic responses or respiratory irritation. Particular activities like talking, sneezing, coughing, walking and washing can spread airborne biological particulate matter (Hayleeyesus et al., 2014). These activities contribute the microbial pollutant in the air that we breathe.

Microbial pollution involves hundreds of species of bacteria and fungi that grow indoors when sufficient moisture is available (WHO, 2009). Exposure to microbial contaminants is clinically associated with respiratory symptoms, allergies, asthma, and immunological reactions (WHO, 2009). The microbial indoor air pollutants of relevance to health are widely heterogeneous, ranging from pollen and spores of plants coming mainly from outdoors, to bacteria, fungi, algae and some protozoa emitted outdoors or indoors (WHO, 2009). They also include a wide variety of microbes and allergens that spread from person to person (WHO, 2009).

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Workers have right to have safe workplace and safe working environment including safe indoor air quality. Indoor air quality at workplace was employers responsibility as the employers need to provide their employees with safe and healthful workplaces (OSHA,1994). Under Section 15 of OSHA, it stated that employers are responsible for ensuring the safety, health and welfare of all employees. Section 24 (1) OSHA also explains that employees are responsible for ensuring reasonable care for the safety and health of himself and others who may be affected by his actions in the workplace. Thus, to ensure the safety of working environment for the workers, the study need to be conducted to know the level of hazard and how it can affect the worker's health. Therefore, this study was conducted to determine the association between concentration of indoor airborne bacteria and fungi and prevalence of respiratory symptoms among manufacturing workers.

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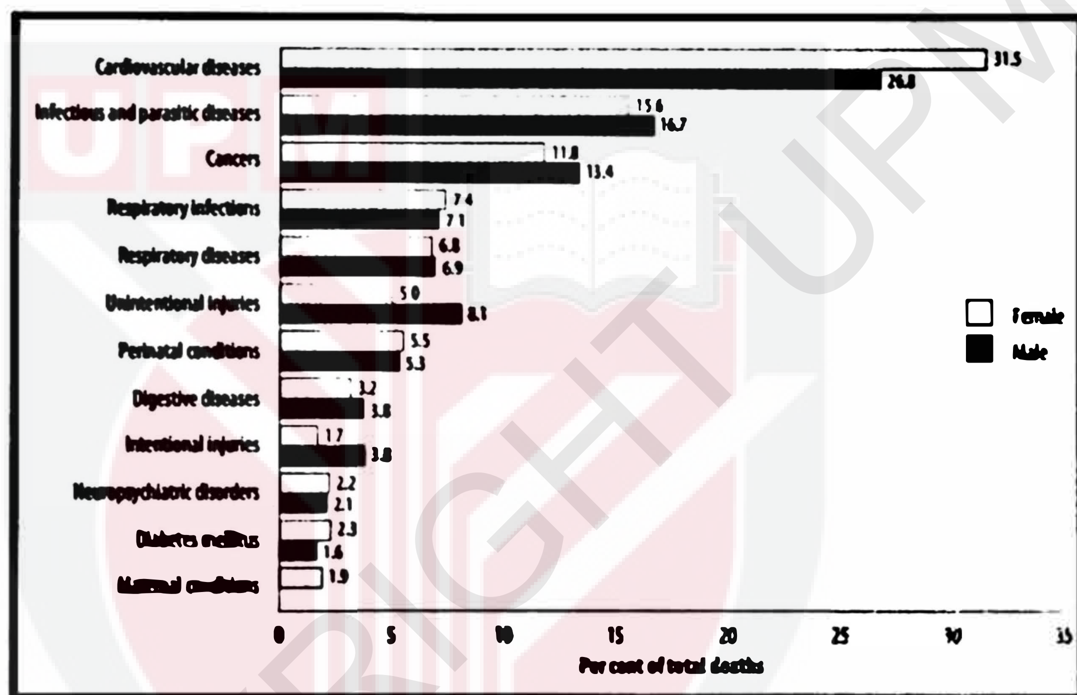
1.2 Problem Statement

In the National Hazard Exposure Worker Surveillance (NHEWS) report mentioned that Australian workers' compensation statistics indicate that each year approximately 1300 workers are compensated for diseases attributed to animal, human or biological factors.



Source: National Hazard Exposure Worker Surveillance (NHEWS) report

Figure 1.2: Distribution of deaths by leading cause groups, males and females ,world, 2004

Based on WHO (2004), Figure 1.2.1 shows the distribution of deaths at all ages for 12 major cause groups of disease. This also illustrates the relative different of the respective causes of death and of male and female differences. Cardiovascular diseases are the leading cause of death in the world, particularly among women. Infectious and parasitic diseases are the next leading cause, followed by cancers. The respiratory infections is a separate cause group from infectious and parasitic diseases, and are to be distinguished from respiratory diseases, which refers to noncommunicable respiratory diseases. Respiratory infection is the fourth cause of

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deaths and respiratory disease is a fifth cause of death in the world. This statistics shows that, biological hazard and respiratory symptoms should also be a concern in order to provide healthy work environment to the workers.

Almaffarreh et al. (2016) stated that the improperly maintained air conditioning systems and exposure to these microbial fragments and metabolites can be source of a wide variety of illnesses. Today, many buildings installed air conditioning system for their ventilation. The problem occurs when we used the air conditioning system and not properly maintained the system such as periodic cleaning, which is then lead to the colonisation of bacteria (Almaffarrreh et al., 2016). The air conditioning system was used to circulate air in the indoor environment. When the air conditioning system is polluted with bacteria, it can release the bacteria into the environment and will be inhaled by the occupants of that room. According to Almaffarreh et al. (2016), it's become worse when an infectious person sneezed, coughed or spoke as the pathogens in the air droplets would spread to others through the air via the air.

According to the President of Allergy and Immunology Association Malaysia (Latif, 2015), 30 – 40% of Malaysian suffers from sinusitis allergy because of poor indoor air quality. Latif (2015) stated that bacteria and fungus might cause allergies, respiratory health effect and asthma to occupants. There is also a growing evidence that exposure to biological agents in the indoor environment can have adverse health effects. Recently, a report on indoor air quality and dampness and mould by the World Health Organization (WHO) provided sufficient epidemiological evidence that inhabitants of damp or mouldy buildings, are at increased risk of experiencing

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respiratory symptoms, respiratory infections and exacerbations of asthma (Rajasekar & Balasubramaniam, 2016).

However, Watsel et al. (2015) mentioned that there is no health-related exposure limit for the exposure of bacteria and fungi. Health-related exposure limits based on data from toxicological and epidemiological studies have not been developed yet. This is because a NOAEL (No-Observed-Adverse-Effect Level) or a LOAEL (Lowest-Observed-Adverse-Effect Level) has not been identified for bioaerosol exposures. The NOAEL (No-Observed-Adverse-Effect Level) is a highest dose of an exposure at which there was no an observed toxic or adverse effect on human health (U.S National Library of Medicine, 2017). The LOAEL (Lowest-Observed-Adverse-Effect Level) is a lowest dose of an exposure at which there was an observed toxic or adverse effect on human health (U.S National Library of Medicine, 2017). Although there is an acceptable exposure of bacteria and fungi mentioned in Industry Code of Practise on Indoor Air Quality (2010) prepared by the Department of Occupational Safety & Health (DOSH) Malaysia, but the concentration of exposure to bacteria and fungi that can cause health effect to occupants have not yet been recognised. Due to the lack of epidemiological data that would permit the establishment of certain limits of exposure to the bioaerosols, the concentration of bacteria and fungi in the air that can cause the health effect has not been recognised. A study exploring on the effect of bacteria and fungi is therefore warranted.

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Recent research has shown that psychological stress influences susceptibility to experimentally induced upper respiratory tract illnesses and it is widely believed that life stressors increase susceptibility to infectious disease (Smith & Nicholson, 2001). The psychological factors become a concern as based on Candian Centre for Occupational Health and Safety (CCOHS) it can increased absenteeism, withdrawal behaviours, conflicts, strain, turover, loss of productivity, increased costs of medical and have a greater risk of accidents, incidents and injuries.

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1.3 Study Justification

This study gathered data on indoor airborne bacteria and fungi that can cause respiratory symptoms among manufacturing workers.. The concentration of bacteria and fungi in the air that can cause the health effect has not being recognised due to no establishment of certain limit of exposure to bacteria and fungi. So,this study is taking the first step in determining the concentration of bacteria and fungi in the air and associate the concentration of bacteria and fungi with respiratory symptoms. This study was recognised the concentration of bacteria and fungi that can cause respiratory symptoms to occupants. This study also revealed how much the concentration of bacteria and fungi that they breathe every day in their working environment and access whether the concentration exceeds the limit of exposure or not.

There is limited number of study about bacteria and fungi that was conducted in factory in Malaysia. The data of the assessment of indoor microbial contamination in Malaysia or other Southeast Asian countries which share common hot and humid climate was very limited (Er et al.,2015). There are a few study about bacteria and fungi conducted among school, waste water workers, university clinic (Er et al.,2015) but not in manufacturing workers. From the researcher point of view, the indoor are quality in manufacturing buildings may affect workers well being and their performance during work. Thus, it will also affect the productivity of the products. Hence, it is essential to evaluate the air quality in manufacturing building in order to determine the accumulation and diffusion of bacteria and fungi contamination.

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This study also provided the prevalence on respiratory symptoms among manufacturing workers in Bandar Baru Bangi, Selangor. Various studies on air quality and children's health indicate that indoor residential risk factors of primary interest for asthma, allergies, and respiratory health include biological agents (Bornehag et al., 2005; Cooley et al., 2004; Mendell, 2007). There are several studies involved the impact of biological hazard of children is carried out and there is a significant association between airborne bacteria and fungi with respiratory symptoms, but there is a little study conducted for the exposure on adult workers. Since, children and adults have different immune system that can prevent them from getting the disease, this study is carried out to look at the effect of airborne bacteria and fungi exposure to adult workers.

This study also provides data on the job demands, job decision latitude, co-workers support, supervisor support, job insecurity and job strain. Psychosocial risk factors such as work-related stress has the potential to negatively affect an individual's psychological and physical health (WHO, 2017). Recent research has shown that psychological stress influences susceptibility to experimentally induced upper respiratory tract illnesses (Smith & Nicholson, 2001). Smith & Nicholson (2001) also stated that it is widely believed that life stressors increase susceptibility to infectious disease. Hence, this study will provide the data on psychosocial factors of workers and will identify the stress level of workers.

This study also screened for an early occurrence of breeding site for bacteria and fungi in the building by conducting walkthrough in the building. The site that possibly become breeding site of bacteria and fungi was recognised for further intervention action. Control of the indoor bacteria and fungi can be proposed in order to reduce the exposure of these microorganisms to human thus reduce the effect on human health.

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1.4 Conceptual Framework

Figure 1.4 shows the conceptual framework of this study that highlights the independent variables and dependent variable. The study was conducted among manufacturing workers and indoor air quality was assessed. The biological parameter that consist of total bacteria count and total fungus count was measured. The main route of exposure for these parameters was inhalation that cause respiratory symptoms. Other factors that can contribute to the development of respiratory symptoms are socio-demographic factors, psychosocial factors and physical factors of building. So, the independent variables for this study are concentration of indoor bacteria and fungi, socio-demographic factors, psychosocial factors and physical factors of building. Then, the dependent variable is respiratory symptoms.

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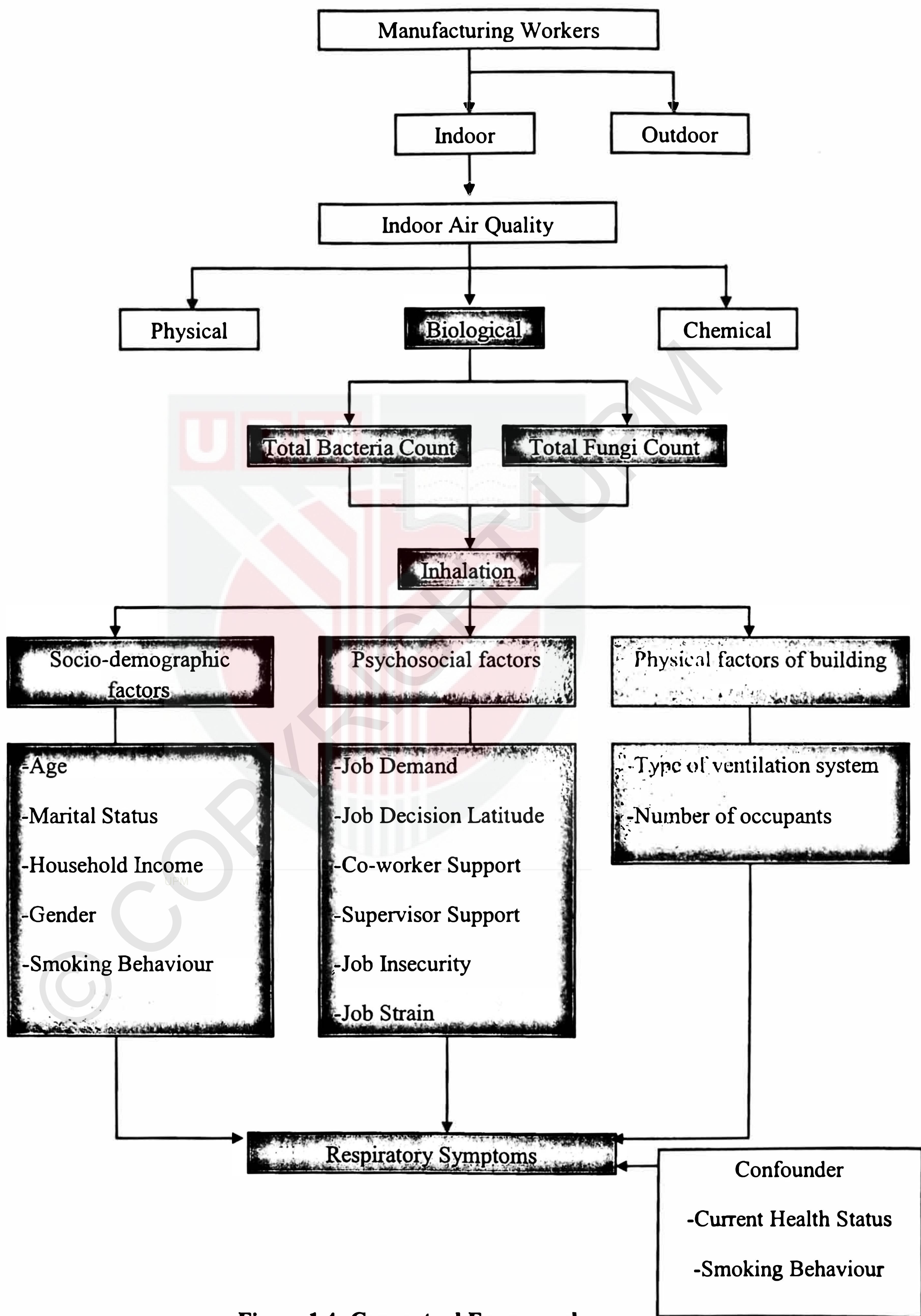

Figure 1.4: Conceptual Framework

1.5 Study Variables

1.5.1 Independent Variables

The concentration of indoor airborne bacteria and fungi, socio-demographic factors, psychosocial factors and physical factors of the building.

1.5.2 Dependent Variable

Respiratory symptoms among manufacturing workers

1.6 Objectives

1.6.1 General Objectives

To determine the association between concentration of indoor airborne bacteria and fungi and prevalence of respiratory symptoms among manufacturing workers.

1.6.2 Specific Objective

i. To assess the level of respiratory symptoms among respondents
ii. To measure the concentration of indoor airborne bacteria and fungi at the study location.
iii. To determine the psychosocial risk factors, socio-demographic factors and building's physical factors.
iv. To measure the association between concentration of indoor airborne bacteria and fungi , psychosocial risk factors, socio-demographic factors and building physical factors with respiratory symptoms among study respondents.

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1.7 Hypothesis

i. There is significant association between indoor airborne bacteria and fungi concentration, psychosocial factors, socio-demographic factors and building physical factors with the respiratory symptoms among respondents

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1.8 Definitions of Term

1.8.1 Conceptual Definition

a. Indoor Air Quality

Indoor Air Quality (IAQ) refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants.

b. Respiratory Symptoms

Respiratory symptom can be defined as the condition that resulted from disturbance of respiratory syste when inhale. There are various factors that contributed to the respiratory symptom such as cough and phelgm, wheezing, shortness of breath and chest tightness.

c. Psychososial Factors

Based on Suzuki & Takei (2013), psychosocial factors are influences that affect a person psychologically or socially. There are multidimensional constructs encompassing several domains such as mood status (anxiety, depression, distress, and positive affect), cognitive behavioral responses (satisfaction, self-efficacy, self-esteem, and locus of control), and social factors (socioeconomic status, education, employment, religion, ethnicity, family, physical attributes, locality, relationships with others, changes in personal roles, and status).

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1.8.2 Operational Definition

a. Indoor Air Quality

Acceptable indoor air quality is defined as air in which there are no known contaminants at harmful concentration as determined by recognize autorities and with which a substantial majority 80% or more of people exposed do not express dissatisfaction. During the sampling the indoor air qualityfor biological parameter was measured using air sampler brand duosas 360.

b. Respiratory Symptoms

The respiratory symptoms experienced by the respondents was determined using the questionnaire by International Union against Tuberculosis and Lung Disease (IUATLD).

c. Psychosocial Factors

The psychosocial factors was determined by the respondents using questionnaire adopted by Job Content Questionnaire (JCQ). The questionnaire was determine the stress factors such as job demand, job decision latitude, co-workers support, supervisor support , job insecurity and job strain.

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CHAPTER 2

LITERATURE REVIEW

2.1 Indoor Air Quality

According to Environmental Protection Agency (EPA) indoor air quality is the quality of air within and around building and structures and its related to the health and comfort of the occupants. The indoor environment is major concerns for human health as particularly most people spend more than 90% of their time indoors compared to outdoors (Baldacci et al., 2015).

Indoor environments are fundamental environmental factors that are capable to give impact on human health, and air quality of indoor environments also is one of the main factors affecting well-being and productivity of people (Hayleeyesus et al., 2014). Studies conducted in a variety of indoor environments showed a great variation in total concentrations of bioaerosols include bacteria and fungi (Rajasekar & Balasubramaniam, 2016). Although indoor environments are considered to be protective, they can become contaminated with particles that present in different environment (Kalogerakis et al., 2005). Sometimes it can cause more serious risks than those related to outdoor exposures, when the concentrations bacteri and fungi indoor exceed recommended maximum limits (Kalogerakis et al., 2005).

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Hayleeyesus et al. (2014) clarified that the activity of people and the equipment use in indoor environment is suspected to become the principal factors contributing to the development and spread of airborne microbial contamination. This is because the movement of people can produce the movement of dust on the floor and also can bring along the dust from outside into the inside room. Other than that, the various stuff like furniture, textiles, carpets, flowers and so on can release the various fungal spores into the air (Hayleeyesus et al., 2014) and all this airborne microbial cannot be seen through the naked eyes.

Based on Industry Code of Practise (ICOP) 2010 (DOSH,2010), the parameters to indicate whether an indoor environment is comfortable and healthy or otherwise can be summarised as chemical contaminants such as carbon dioxide, carbon monoxide, formaldehyde and environmental tobacco smoke (ETS); physical conditions, such air temperature, air velocity and humidity; biological agents, such as bacteria, fungi, mites, virus, and spores; and radiation such as radon. It is estimated that around 320 000 workers in worldwide die each year from communicable diseases caused by work-related exposures to biological hazards (Driscoll et al. 2005). Exposure to moulds and yeasts is common in some industrial processes, in workplaces with air conditioning systems and high humidity, and in the construction industry (Comcare, 2014). Comcare (2014) explained that exposure to biological hazards is widespread and the risk of exposure is not always obvious.

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2.2 Biological Hazard

Canadian Centre for Occupational Health and Safety (CCOHS, 2017) stated that hazard is any source of potential damage, harm or adverse health effects on something or someone under certain conditions at work. Biological hazard includes bacteria, viruses, insects, plants, and so on. Biological hazard also comes from allergens. Allergens are antigens that react with immunoglobulin antibodies and induce an allergic state (Baldacci, 2015). Allergens originate from a wide range of animals, insects, mites, plants or fungi, and indoor allergens are mainly originated from house dust mites, furry pets usually cats and dogs, cockroaches, moulds, plants and rodents (Baldacci, 2015). Sources of airborne bacteria in building environments include the presence of humans, pets, soils, and plants (Bowers et al., 2012; Lignell, 2008; Womack et al., 2010).

The sources of biological particulate matter also can come from human activities like talking, sneezing, coughing, walking, washing and toilet flushing. These activities can generate airborne biological particulate matter (Kalogerakis et al., 2005). The materials in our buildings also can generate biological hazard to us. Materials such as food stuffs, house plants and flower pots, house dust, pets and their bedding, textiles, carpets, wood material and furniture stuffing, occasionally release spores of *Alternaria*, *Aspergillus*, *Botrytis*, *Cladosporium*, *Penicillium*, *Scopulariopsis* into the air (Cox andWathes, 1995; Maeir et al., 2002).

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Prussin and Marr (2015), identified eight major categories of sources of indoor airborne bacteria, viruses, and fungi in the built environment. The major sources are from humans, pets, plants, plumbing systems, air-conditioning systems, mold, dust resuspension and the outdoor environment (Prussin & Marr, 2015). The respiration and the shedding of millions of skin cells daily contribute to bioaerosols in the environment (Prussin & Marr, 2015). Meadow et al. (2014) found that microbial communities in indoor air were significantly influenced by ventilation and occupancy. Other than that, humans carry many other types of bacteria and viruses in the respiratory tract and saliva and discharge the microorganisms into the environment by coughing, sneezing, talking, and even just breathing (Papineni et al., 1997). The ventilation systems can be a source of airborne microorganisms due to contamination (Batterman et al., 1995).

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2.3 Routes of exposure

Sources of airborne biological particles are released into the air by wind, rain, mechanical disturbance, or active discharge mechanisms and once particles have been launched into the air, their concentration decreases with increasing distance from the point of liberation (Lancey & West, 2007). The main routes of exposure to the biological hazard that can cause respiratory symptoms are through inhalation. Canadian Centre for Occupational Health and Safety (CCOHS, 2017) stated that the contaminated air in the workplace can be inhaled and the air is drawn through the mouth and nose and then into the lungs. An average inhalation and exhalation of people are about 12 times a minute and each of the 12 inhalations brings in about 500 mL of air, corresponding to 6 litres of air per minute, this inhalation will together with any contaminants contains in the air.

Breathing starts at the nose and mouth. The inhaled air will travel through nose or mouth, throat and trachea and the trachea will divides into air passages called bronchial tubes. For the best performance of the lungs, the airways need to be open during inhalation and exhalation and free from inflammation or swelling and excess or abnormal amounts of mucus (National Heart, Lung and Blood Institute, 2012).

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Microbial diseases may affect the upper or lower regions of respiratory systems. The upper region of respiratory systems consists of the nose, pharynx, and other structures such as the middle ear and sinuses. Based on Cliffsnotes webpages (Houghton Mifflin Harcourt, 2016), although there are many defensive mechanisms exist in this part of the body, such as ciliated hairs and mucous membranes, infections are common because of the proximity to the external environment. Then, the lower portion of the respiratory system consists of the respiratory tubes and alveoli of the lungs and the infection occurs here because of the excessive moisture and rich supply of nutrients.

Gurjar, Luisa and Ojha (2010) mention that the concentration of indoor pollutant depends on the relationship between the volume of air contained in the indoor space, the rate of production or release of the pollutant, the rate of removal of the pollutant from the air via reaction or settling, the rate of air exchange with the outside atmosphere, and the outdoor pollutant concentration. However the actual human exposures are often difficult to quantify as the behaviour and activity patterns of individuals will affect the level of exposures (Austin, J., Brimblecombe, P., & Sturges, 2002).

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2.4 Psychosocial Factors

Biological hazard is also associated with Sick Building Syndrome (SBS) and Gomzi & Bobic (2009) said that the complaints of SBS are influenced by various non-environmental variables, such as occupational, personal, and psychological factors, which can either directly or indirectly alter the stress load on a person, which in turn influences susceptibility and reports of SBS symptoms by individual workers. Psychosocial processes may act directly as stressors, causing symptoms through psycho-physiological mechanisms and they may render the individual more sensitive to normally tolerated physical and chemical factors in the environment (Gomzi Bobic, 2009).

Carducci et al. (2016) said that the probability of the infection happens depends on the infectivity of the pathogen, its concentration in the air, and exposure time. The exposure time of biological hazard can be measured by determining the duration of the people stays in the indoor area. Canadian Centre for Occupational Health and Safety (CCOHS, 2017) also stated that people involved in hard physical work activity will breathe harder than normal people as they take in more than 6 litres of air in a minute. So, over an 8 hours working day, more than 2,800 litres of air will be breathed in and out of the lungs. The possibility of people who do the hard work to inhale the contaminant is higher than people who do normal work as the volume of air entering into the lung is high.

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Based on American Psychological Association (2017), it said that the acute stress can cause the rapid breathing and prolonged stress or chronic stress can affect the immune system. This two effect of stress can cause lung draw more air containing contaminant when rapid breathing happen and the likelihood of getting sick will increase when the immune system getting low during stress (American Psychological Association, 2017).

The psychosocial factors that have been measured in the present study include job demands, job desicion latitude, job strain, co-worker support, supervisor support, and job insecurity which are included in the Job Demand Control Support Model (Synder et al., 2008). Job Demand Control Support Model have been used to predict standard occupational stress criteria and consists of components such as demand, control, support, and well-being (Synder et al., 2008). The job demands refers to the degree to which the working environment contains stimuli that require some effort and encapsulates the idea that job demands lead to negative consequences if they require additional effort beyond the usual way of achieving work goals (Peeters et al., 2015). The worker's control over the performance of his or her own job is measured by two theoretically distinct subdimensions of decision latitude that are usually highly correlated that are skill discretion and decision authority (Karasek & Theorell, 1990). Skill discretion is measured to the level of skill and creativity required on the job and the flexibility permitted the worker in deciding what skills to employ, then decision authority is assesses the organizationally mediated possibilities for workers to make decisions about their work (Karasek et al., 1998). Job strain is a combination of high demands and low control, increases the risk for poor outcomes (Campo, Weiser & Koenig, 2009). Co-

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worker support is a support that one worker provides to another in the form of information that can enhance their experiences (Ayman & Antani, 2008). Based on Powell (2011) supervisor support is defined as the extent to which leaders value their employees' contributions and care about their well-being. Job insecurity is a condition wherein employees lack the assurance that their jobs will remain stable in the future (Sweet, 2006).

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2.5 Respiratory Symptoms

The indoor air pollutant can cause or contribute to short-term and long-term health problem (Maduriera, 2015). But, the likelihood that an individual will become ill from the presence of a contaminant depends on others factors such as the individual sensitivity to that contaminant, the concentration of contaminant, the current state of their psychological and physical health and the duration and frequency of exposure (Selther, 1997). Baldacci et al. (2015) said that the exposure to biological allergens may produce respiratory infections, sensitization, respiratory allergic disease. Epidemiological studies made by the World Health Organization (WHO) showed that, there is sufficient evidence for an association between indoor dampness-related factors and a wide range of effects on respiratory health, including asthma development, asthma exacerbation, current asthma, respiratory infections, upper respiratory tract symptoms, cough, wheeze and dyspnoea (Hayleeyesus et al., 2014).

According to American Lung Function Association (2017), bacteria can travel through the air, causing and worsening diseases. They get into the air easily. When someone sneezes or coughs, tiny water or mucous droplets filled with viruses or bacteria scatter. Inhaling these viruses or bacteria can spread coughs, colds, influenza and tuberculosis and other infectious agents.

Common respiratory symptoms faced were wheezing and chest tightness, shortness of breath, cough and phlegm, and asthma. Moore (2016) explained that

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wheezing is a high-pitched whistling sound made while you breathe and It's heard most clearly when you exhale, but in severe cases it can be heard when you inhale. It's caused by narrowed airways or inflammation. Based on Shiel (2016), most cases of shortness of breath are due to heart or lung conditions. The heart and lungs are involved in transporting oxygen to our tissues and removing carbon dioxide from that, and problems with either of these processes will affect our breathing.

The workers with disease was believed will not perform very well while do job. This also will affect the productivity of the products. Based on CDC Foundation websites, it stated that in Unite State, the productivity losses linked to absenteeism cost employers was 225.8 billion. This proves that the worker's health is important to ensure the productivity will not decrease.

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2.6 Rules and regulation in Malaysia

There are guidelines and standards that have been provided by the Department of Occupational Safety and Health (DOSH) to protect the health of workers and other occupants of an indoor or enclosed environment provided by mechanical ventilation and/or air conditioning (DOSH, 2017). The standard namely Industry Code of Practice on Indoor Air Quality was introduced by the Department of Occupational Safety and Health (DOSH) in 2010 to increase the compliance of designated workplaces (DOSH, 2017). The purpose of this industry code of practice is to provide guidance on improving the indoor air quality (IAQ) and to set minimum standard for selected parameters that will avoid discomfort and/or adverse health effect among employees and other occupants of an indoor or enclosed environment (ICOP, 2010).

Based on Industry Code of Practise on Indoor Air Quality (2010) prepared by the Department of Occupational Safety & Health (DOSH, 2017) , it mentions about the acceptable limit of biological contaminants. The Acceptable limit based on ICOP for the bacteria and fungi as following diagram.

Indoor air contaminants (Biological contaminants)	**Acceptable limit**
Total bacterial count	500* cfu/m^3
Total fungal count	1000* cfu/m^3

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CHAPTER 3

METHODOLOGY

3.1 Study Design

The cross-sectional study design was used to study the association between indoor airborne bacteria and fungi with respiratory symptoms among manufacturing workers from 10th January 2017 until 10th February 2017.

3.2 Study Location

This study was conducted at the manufacturing factory in Bandar Baru Bangi, Selangor. According to the Malaysia Department of Statistics (2010-2014), the contribution of Selangor to the overall manufacturing sector stood at the highest compared to other states with 28.8 percent recorded followed by Pulau Pinang (12.5 percent), Johor (12.4 percent) and Sarawak (12.0 percent). Since Selangor is the most industrialised state, it was chosen as the study location. Bandar Baru Bangi was chosen as study location as it was located in Hulu Langat District which is an important industrial area in Selangor. Hulu Langat District area is a third largest

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district which have a lot of industrial area. Then, for the estimation of industrial employment in Selangor for year 2010-2035, Hulu Langat District become the second largest district which have many industrial employment. The selection of manufacturing industry in Bandar Baru Bangi is randomly selected upon company approval.

Daerah	Bilangan	Keluasan (Hektar)
Sabak Bernam	3	95.65
Kuala Selangor	4	383.2
Hulu Selangor	12	1,481.5
Gombak	43	1,715.7
Hulu Langat	39	2,842.0
Petaling	49	5,549.1
Klang	28	2,645.3
Kuala Langat	13	1,078.4
Sepang	7	638.3
Jumlah	**198**	**16,429.15**

Sumber : Kajian Rancangan Struktur Negeri Selangor, 2035
Rancangan Tempatan bagi Daerah-daerah dalam Negeri Selangor
Majlis Bandaraya Shah Alam (2013)
Majlis Bandaraya Petaling Jaya (2013)
Majlis Perbandaran Ampang Jaya (2013)
Majlis Perbandaran Selayang (2013)
Majlis Perbandaran Kajang (2013)

Figure 3.1: The number and size of industrial area based on District on 2012

Daerah	2010	2015	2020	2025	2030	2035
Sabak Bernam	1,568	1,924	2,351	2,821	3,244	3,730
Kuala Selangor	5,202	6,325	7,770	9,324	10,722	12,330
Hulu Selangor	3,311	4,201	5,497	6,597	7,586	8,724
Gombak	36,045	43,497	53,080	63,696	73,250	84,237
Hulu Langat	94,930	121,302	153,385	184,062	211,671	243,421
Petaling	258,466	293,229	332,696	339,235	390,120	448,638
Klang	89,375	109,028	131,482	157,778	181,445	206,662
Kuala Langat	13,491	16,483	20,265	24,318	27,966	32,161
Sepang	3,881	4,837	6,121	7,345	8,447	9,714
Jumlah	506,269	600,826	712,647	795,176	914,451	1,049,617

Sumber: Kajian Rancangan Struktur Negeri Selangor, 2035

Figure 3.2: Estimation of industrial employment in Selangor in 2010 until 2035

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Hulu Langat District

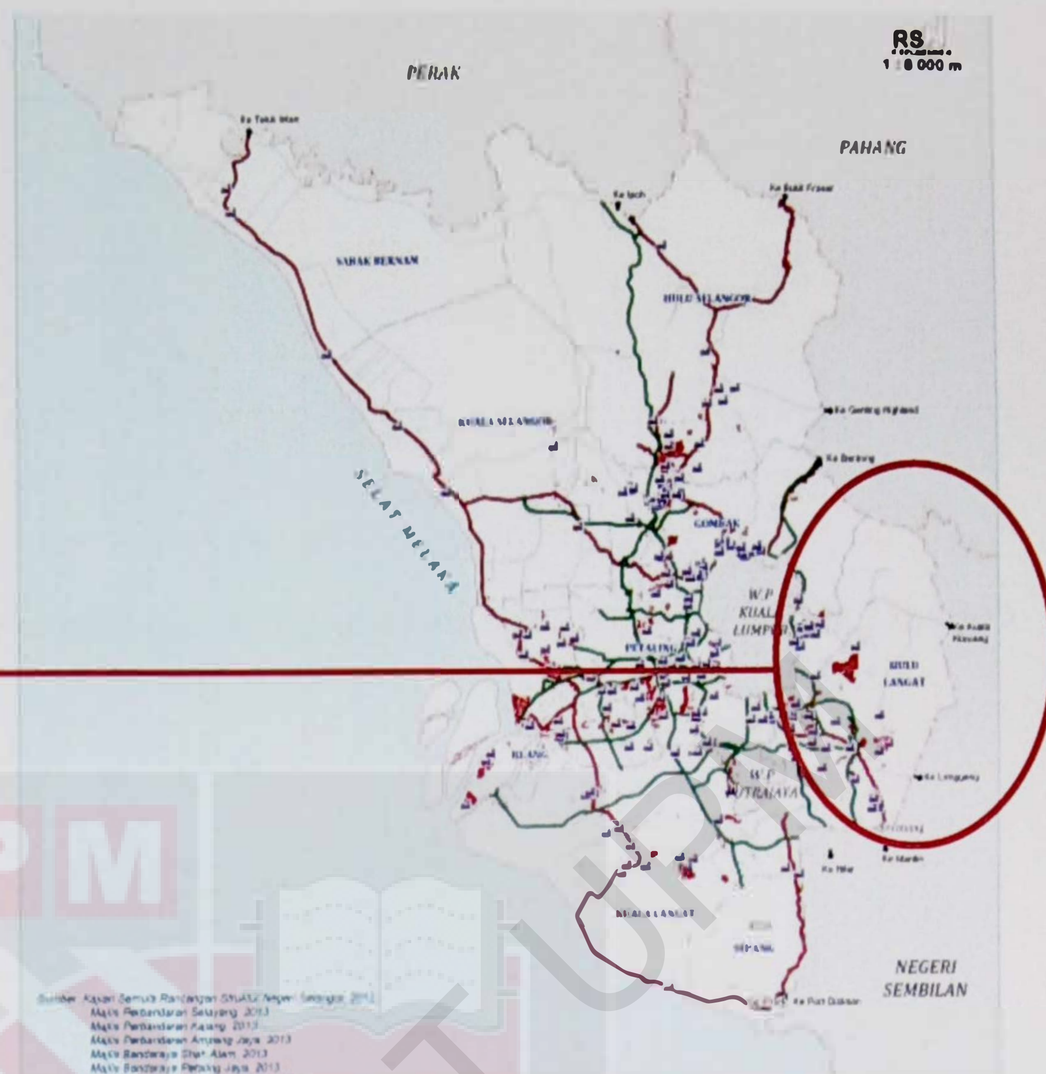

Figure 3.3: Hulu Langat District area

Study location: Bandar Baru Bangi

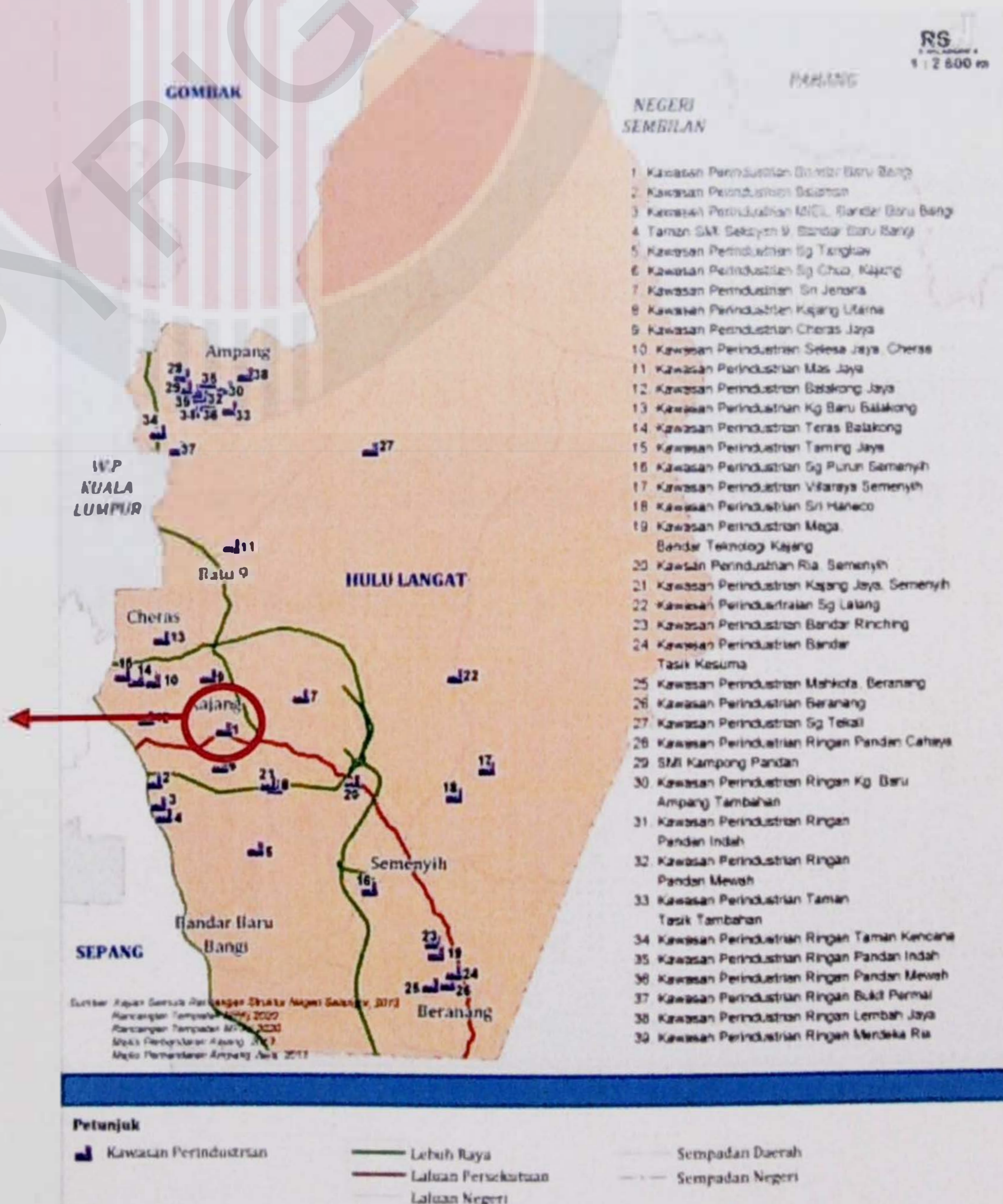

Figure 3.4: Study location at Bandar Baru Bangi

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3.3 Sampling method

3.3.1 Study population

The study population is manufacturing workers who were performing the job indoor.

3.3.2. Sampling Method

The sampling method used in this study was simple random sampling. Thirty-nine factories were written in a piece of paper and was put in a bowl. Five was randomly picked from the bowl. However only one factory gave the positive respond. Then the respondents at factory in Bandar Baru Bangi were purposively sampled based on their working department. The respondents were sorted by their department and will be classify based on department.

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3.3.2 Sampling Size

Sample size estimation was calculated according to Lemeshow (1990). The required size for the present study area was **53**. Below is the calculation of the sample size:

$$N = \frac{Z^2_{1-\alpha/2} \; P(1-P)}{d^2}$$

Where,

N = Sample size

$Z_{1-\alpha/2} = 1.96$

P = 0.03

The value of prevalence, is 0.03 according to (Djoharnis et al., 2012) on cases of shortness of breath in office workers .

Below are the sample size calculations for this study.

$$N = \frac{1.96^2 \times 0.03(1-0.03)}{0.05^2}$$

$N = 44$

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In order to recover the loss of respondent, 20% of the minimum sample size was added, which were :

$$20\ \%\ \text{of}\ 44 = 8.8 \approx 9$$

$$= 9 + 44$$

$$= \mathbf{53\ respondents}$$

This study requires 53 respondents based on Lemeshow (1990) calculation, but the total respondents used in this study were 108 respondents. Addition of respondents hopefully can generalize the data on the exposure of bacteria and fungi with respiratory symptoms for that population.

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3.4 Instrumentation

3.4.1 Questionnaire

Self-administered questionnaire was used in this study for the question on socio-demographic information and working information. The standardised questionnaires for psychosocial factors and respiratory symptoms were adopted from the Job Content Questionnaire (JCQ) and International Union against Tuberculosis and Lung Disease (IUATLD) respectively.

Karasek et al. (1998) stated that, Job Content Questionnaire (JCQ) was designed to assess job strain using three important scales, those are job demands, social support, and decision latitude. The total questions in JCQ was 27 that consisted of 5 questions on job demands, 8 question on social support (co-worker support and supervisor support), 9 questions on decision latitude (job skill discretion and job decision-making authority) and 3 question on job insecurity. A Likert scale was used in the study for measuring the items from 1 (strongly disagree), 2 (disagree), 3 (agree) and 4 (strongly agree). A well validated Malay version of JCQ questionnaire was used to measure psychosocial factors among workers. The reliability and validity of Malay version JCQ questionnaire used has been tested by study among secondary school teacher in Kota Bharu, Kelantan (Azlihanis et al., 2006). In that study, the reliability was determined using Cronbach alpha for internal consistensy. Based on Azlihanis et al. (2006), the result indicated that Cronbach

alpha coeffient revealed desicion latitude (0.75), job demand (0.80), social support (0.84), and job insecurity (0.80). Tavakol and Dennick (2011) stated that Cronbach's alpha of 0.70-0.95 was considered acceptable. Hence, JCQ used was valid and reliable instrument that has been used in this study.

An international comparison of the repeatability of the IUATLD questionnaire in a clinical population, using a two-week interval and a self administered questionnaire found Cronbach alpha ranging from 0.73 to 0.95 for wheezing and 0.70 to 1.00 for asthma. Another study assessing the repeatability of the IUATLD bronchial symptoms questionnaire in British adults found a Cronbach alpha obtained was 0.76 for the wheeze question over a six-week to six-month period. Tavakol and Dennick (2011), mention that Cronbach's alpha of 0.70-0.95 was considered acceptable. The IUALTD questionnaire used contained questions on wheezing and tightness in the chest, shortness of breath, cough and phlegm from the chest, allergies to animals, dust, feathers, asthma, breathing and smoking behaviour. For every question, the respondents needs to answer yes or no only. The IUALTD questionnaire was translated into Malay version and the validity of the questionnaire are assessed by lecturers from the Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, UPM.

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The questionnaires were divided into the following components:

Part A: Socio-demographic information

Questions on age, gender, marriage status, education level, income and chronic respiratory disease were asked in the questionnaire.

Part B: Working Information

For working information, the question on the working period for the current position and how long they spent time working indoor every day.

Part C: Psychosocial factors

This part of question used the JCQ to determine the job skill discreation, job desicion making autority, job demands, job desicion latitude, job strain, co-worker support, supervisor support, and job insecurity. There was a formula provided by Karasek et al. (1998) to determine those components. The scoring formula is based on the table below:

Table 3.4.1: Formula for Job Contents Questionnaire

JCQ	Formula
Job Skill Discreation	[Q1 + Q3 + Q5 + Q7 + Q9 + 5 - Q2] x 2.
Job Desicion Making Autority	[2 x (Q4 + Q6 + Q8)] x 2.
Job Demands	3x(Q10 + Q11) + 2x(15 - Q13 - Q14 - Q15).
Job Desicion Latitude	skill discretion + decision-making authority
Job Strain	(Demands x 2) / Decision-Latitude.
Co-worker Support	Q17 + Q18 + Q19 + Q20.
Supervisor Support	Q21 + Q22 + Q23 + Q24.
Job Insecurity	Q25 + Q27 + 5 - Q16.

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Part D: Respiratory Symptoms

The questions for respiratory symptoms adopted from International Union against Tuberculosis and Lung Disease (IUATLD). A few symptoms like wheeze and tightness in the chest, shortness of breath, cough and phlegm from the chest, breathing, and also smoking behaviour were also asked in this question.

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3.4.2 Air Sample Collection

Source: http://www.cherwell-labs.co.uk/cleanroom-equipment/sas-microbial-monitoring/sas-hand-held-samplers/

Figure 3.4.2 : Air sampler brand Duo Sas 360

The method used for air sampling was adopted from NIOSH method 0800 (1998). Air sampler brand Duo Sas Super 360 with Trypticase soy agar (TSA) and Sabouraud Dextrose Agar (SDA) agar plate was used to sample the air containing bacteria and fungi. The sampling of air is conducted during the working hours of workers to ensure normal and routine activities are taken in place during sampling.

3.4.3 Observation physical characteristic of the building

During walkthrough, the physical characteristic of the building such as type of ventilation system and the number of occupants in the room have been observed. The observation result then recorded.

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3.5 Procedure of Data Collection

3.5.1 Walkthrough Survey

One day walkthrough survey was conducted for each building and rooms to gather the information on:

- Number of floors
- Floor, wall and ceiling conditions
- Past occurrence and visible problems related to mould and water
- Ventilation system
- Numbers of occupants

3.5.2 Questionnaire distribution

The questionnaire was distributed to 180 respondents, but due to inclusion and exclusion criteria for this study, only 108 respondents were accepted for this study. A short briefing on how to answer the questionnaire was given to them together with the consent form. Workers were given a few minutes to answer the questionnaire. After they finish answering the questionnaire, the token was given to all of them as gratitude for their involvement. The questionnaire was collected based on workers department. All the collected questionnaire was kept in secure files and place.

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3.5.3 Air sampling

The procedure used was adopted from NIOSH Method 0800 (1998). Following are the details data collection procedure:

i. The sampling site with different work area and department was determined. Based on the walkthrough, the total sampling point identified were 28 points.
ii. Trypticase soy agar (TSA) and Sabouraud Dextrose Agar (SDA) plate was prepared. The agar plates was ordered from trusted laboratory that was Isolab Sdn Bhd and was shipped from UPM. The quality control of agar plates always being considered before, during and after sampling. Before the sampling was conducted, the agar plates should be out from refrigerator more early about 3 to 4 hours before to ensure there is no water vapour left inside the plates. The plates were marked with type of agar and point location.
iii. The sampler was first set for the duration of sampling and the volume of air that will be drawn.
iv. Then, the sampler stages was carefully and thoroughly wiped using rubbing alcohol before run to ensure the instrument will not contaminate the agar.
v. Then the sampling media for both SDA and TSA were loaded into the air sampler Duosas 360 by removing the covers from the media and were attached on the sampler to pump.
vi. Indoor samples were collected near occupants' breathing zone approximately 0.7 - 1.5 m above the floor. Sampling locations were no closer than 1 m to a wall, window, door, or ventilation system. During the

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data collection the sampler was put on the table and the ventilation system, door and wall was considered. The sampler was not placed near those ventilation system, door and windows as the contaminant concentration is higher at those location and there will be the contaminants from outside.

vii. The sampling was run for 2 minutes based on Hussin et al (2011).

viii. The sampling was unloaded from the sampler and put the cover on it. The sampling media then was sealed using parafilm to avoid the contamination from the environment.

ix. The sampling media underwent for the incubation period for the analysis of microbial.

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3.5.4 Microbial handling

Using method mentioned by Hussin et al. (2011) bacterial plates were incubated in an inverted position at 37°C for 2 days for bacteria culture and at 20-25 °C for 5 days for fungi culture with daily observation to ensure there is no overcrowded growth on agar plate. After the desired duration of incubation, the colonies formed were counted. The calculation to express colony forming unit/m^3 mentioned in Hussin et al. (2011) showed as the following formula:

$$X = \frac{Pr \times 1000 \text{ CFU per litre of air } (1000 \text{ litre} = 1m^3)}{V}$$

Where,

X= CFU per 1000 litre of air (1000 litre= $1m^3$)

Pr= Probable count obtained

V= Volume of sampled air (200 litre of air)

Based on Industry Code of Practise on Indoor Air Quality (2010) prepared by the Department of Occupational Safety & Health (DOSH), it mentions about the acceptable limit of biological contaminants. The Acceptable limit based on ICOP for the bacteria and fungi as following diagram.

Indoor air contaminants (Biological contaminants)	**Acceptable limit**
Total bacterial count	500* cfu/m^3
Total fungal count	1000* cfu/m^3

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The Lab Technician from Microbiology Department, Faculty of Medicine and Health Sciences assisted in recognizing and counted the bacteria and fungi. The counted number of bacteria and fungi then was referred to him to confirm the number of counts and proceed to calculation of colony forming unit (CFU) for both bacteria and fungi.

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3.6 Quality Control

The techniques for sampling the air was used as proposed in the NIOSH Method 0800 (1998). Quality control action was taken into the consideration during air sampling and analysis the sample to avoid the contamination on the sampling media.

During air sampling

- During sampling, gloves and mask was used to avoid the microbial contamination from the human.
- The air sampler was always cleaned between sample collections with cotton wipes wetted with isopropyl alcohol
- After sampling, the agar media plates were sealed using parafilm to avoid cross contamination from the environment.
- The surface of agar was not allowed to touch.
- The field blank was prepared to ensure the contamination from the instrument does not happen.

During sample analysis

- The agar plate was incubated in the inverted position to avoid air vapour from falling down into the agar and contaminate the agar.

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3.7 Ethic

The ethical approval and consent was obtained from the Universiti Putra Malaysia (UPM) Ethical Committee for research involving human subject and can be refer with JKEUPM Ref Number FPSK(EXP16-OSH)U051. Besides that, the consent form and the questionnaire used in this study were explained to the respondents and respondents were guided while filling the questionnaire. All information given by the respondents was kept private and confidential and only used for research and scientific publication purposes.

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3.8 Statistical Analysis

All data were analyzed by using Statistical Package for Social Science (SPSS) Version 21.0. The descriptive test was used to calculate mean, median, percentage and standard deviation. Meanwhile, Kolomogorov Smirvov test and skewness was used to determine the normality of the data. This test is very crucial in determining the appropriate test that will be used for further data analysis. Below are the tests that will be used to analyse the objectives of the study.

Objective 1: To determine the association between concentration of indoor airborne bacteria and fungi and prevalence of respiratory symptoms among manufacturing workers.

Statistical analysis: Descriptive Analysis

Objective 2: To assess the level of respiratory symptoms among respondents

Statistical analysis: Descriptive Analysis

Objective 3: To measure the concentration of indoor airborne bacteria and fungi at the study location.

Statistical analysis: Descriptive Analysis

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Objective 4: To determine the psychosocial risk factors, socio-demographic factors and building's physical factors of respiratory symptoms among study respondents.

Statistical analysis: Descriptive Analysis

Objective 5: To measure the association between concentration of indoor airborne bacteria and fungi , psychosocial risk factors, socio-demographic factors and building physical factors of respiratory symptoms among study respondents.

Statistical analysis: Pearson's Correlation for parametric test and Spearman Correlation or Chi-Square for non-parametric test.

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CHAPTER 4

RESULT AND DISCUSSION

The aims of this study is to determine the association between concentration of indoor airborne bacteria and fungi and prevalence of respiratory symptoms among manufacturing workers. This study was successfully conducted according to plan to achieve the study objectives. 108 respondents were selected to participate in this study thus contributed to 100% of the response rate.

4.1 Socio-demographic information and lifestyle

Table 4.1 shows the socio-demographic information and lifestyle of respondents in this study. The socio-demographic information included in this study were gender, age, education level, marriage status and income. Lifestyle on smoking behavior also included in this study. From total 108 respondents, 74.1% of respondents were males and 25.9% of respondents were females. The number of male respondents was higher that female respondents as the workers population are mainly male workers. Mostly the respondents average age was 41-50 years old (45.5%). The education level of respondents was mostly equal between finished school and university/college graduates. The respondents who finished the school

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either primary school or secondary school was 49.1% from the population and the respondents who were university or college graduates was 50.9% from the population. Most respondents (77.8%) were married,21.3% of them were single and only 0.9% of them were divorced. According to Central Bank of Malaysia Report 2013, if the family income is more than RM5000 it was categorized as high income and family income less than RM5000 categorized as low income. Based on data that have been gathered, 84.3% of respondents categorized as low income and only 5.0% of respondents categorized as high income. For the smoking behaviour, majority of them as 67.6% were not smoking and only 32.4% of them were smoking.

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Table 4.1: Socio-demographic information and lifestyle of respondents (N=108)

Variables	N%	Mean[a]/Median[b] ± SD
Gender		
Male (1)	80 (74.1)	1.00[b] ± 0.440
Female (2)	28 (25.9)	
Age		
20-30	14 (11.6)	2.69[a] ± 0.891
31-40	22 (18.2)	
41-50	55(45.5)	
51>	17(14.0)	
Education Level		
Finished School (1)	53 (49.1)	2.00[b] ± 0.502
University/College Graduates (2)	55 (50.9)	
Marriage Status		
Single (1)	23 (21.3)	2.00[b] ± 0.427
Marriage (2)	84 (77.8)	
Divorced (3)	1 (0.9)	
Income		
Low (<5000) (1)	102(84.3)	1.00[b] ± 0.230
High (>5000) (2)	6(5.0)	
Smoking		
Yes (1)	35 (32.4)	2.00[b] ± 0.470
No (2)	73 (67.6)	

N=108. Descriptive analysis

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4.2 Physical factors of building

Two type of air conditioning system are used at study location. That are split air conditioning system and centralized air conditioning system. Based on observation that have been conducted, 75% of sampling location used split air conditioning system and only 25% was used centralized air conditioning system. The numbers of occupants at sampling location ranged in 2 to 20 peoples. Mostly the room have 6 occupants but for the management office especially Corporate Development, Procurement, Finance and Business Development, the number of occupant stated the highest number as they consist of 10 to 15 workers. It may be cause by the working environment designed to ensure the workers can work together and easier for the work purpose.

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4.3 The concentration of airborne bacteria and fungi

This study was conducted among 108 manufacturing workers at Bandar Baru Bangi, Selangor. Table 4.2 shows that the total count of the bacteria and fungi that have been isolated on SDA and TSA agar plates. The colony forming (CFU) unit for bacteria and fungi have been identified on 24 locations. Among the 24 samples that have been collected, the minimum colony forming unit (CFU) identified for bacteria was 75 CFU and for fungi was 40 CFU. Then, the maximum CFU identified for bacteria was 650 CFU and a fungus was 800 CFU. Based on acceptable limit stated in Industrial Code of Practices (ICOP) that acceptable limit for bacteria was 500 CFU and a fungus was 1000 CFU. Based on the result the maximum count (CFU) for bacteria was exceeding the acceptable limit.

Figure 4.2 shows the concentration of bacteria and fungi based on colony forming unit (CFU) at each sampling location. A finding shows that there is one sampling point which is a female prayer room, which has the total count of bacteria that is highest as it stated the value of 650 cfu/m^3. Based on Industrial Code of Practice on Indoor Air Quality 2010 (ICOP 2010), the acceptable limit for total bacteria count is 500 cfu/m^3. This shows that the female prayer room has exceeded the acceptable limit of ICOP 2010 while other sampling points for bacteria do not exceed the acceptable limit. However, high total count of bacteria in female prayer room is justifiable since bacteria live on every material in every environment with adequate humidity. In that female prayer room, there are split unit air conditioning system, female prayer cloth, carpet and the size of the rooms is small. All of these materials can be a factor of accumulation of bacteria in the prayer room.

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For fungal total count, the outdoor result shows the highest cfu/m^3 obtained was at Tooling Room in the Production area. The acceptable limit for the total count of fungal was 1000 cfu/m^3. Thus, they result obtained for the fungi exposure still in the range of acceptable limit. Tooling room score the highest cfu/m^3 due to the location of the room as the room always visited by the workers and always have in and out workers. The outside fungi can be entered the room as the door is open when workers entering the room. It also can be caused by the activity of the workers during the data collection. The presence of workers who walk beside the instrument during the data collection also can affect the reading. Furthermore, due to our limitation, the factor may come from our poor technical procedure during monitoring such as lack monitoring of instruments to avoid the activity of the workers that can affect the reading.

WHO set 500 cfu/m^3 is the standard for acceptable limit of exposure to bacteria and 1000 cfu/m^3 is standard for fungi. The result obtained shows bacteria (Median= 220 cfu/m^3) and fungi (Median= 90 cfu/m^3) did not exceed the standard value.

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Table 4.3: Total viable count of the bacteria and fungi isolates on SDA and TSA agar plates

Total viable count	Number of sample	Minimum viable count (CFU)	Maximum viable count (CFU)	Median ± SD
Bacteria	24	75	650	220±131.173
Fungi	24	40	800	90±146.235

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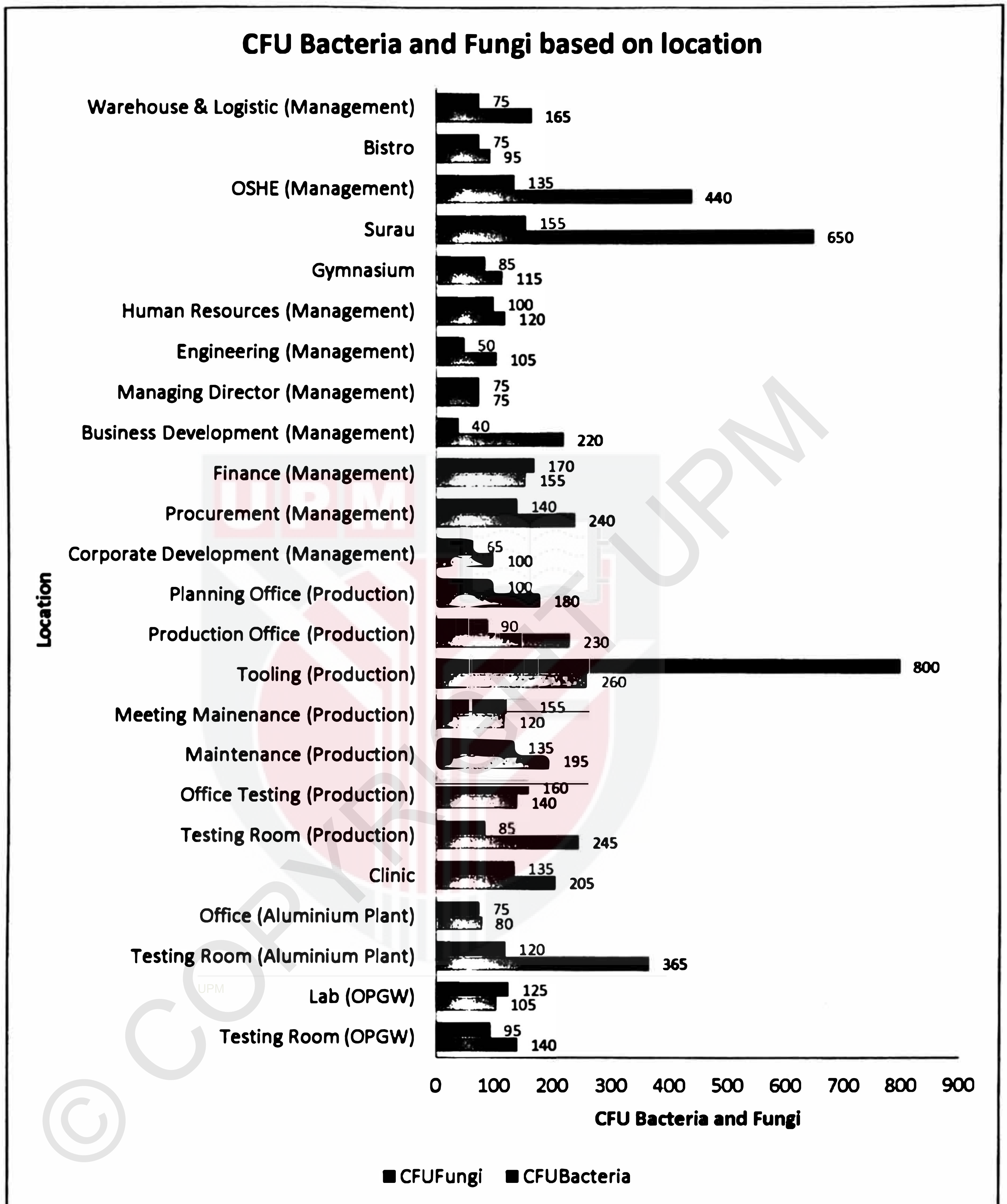

Figure 4.3: CFU Bacteria and Fungi based on different location.

Acceptable limit for bacteria was 500 CFU and a fungus was 1000 CFU based on Industrial Code of Practices (ICOP)

4.4 Descriptive analysis of psychosocial factors

The psychosocial factors that have been evaluated were job demands, job decision latitude, co-worker support, supervisor support, job insecurity and job strain. Based on table 4.3, the mean score for the job demands was 31.60. For job decision latitude the mean score was 67.61. Both co-workers support and supervisor support have mean 11.53 and 12.11 respectively. For job insecurity, the mean score was 5.08 and for the job strain was 0.94

The mean for job demands and job insecurity shows that most of the respondents have score more than half of total score. It indicated that most respondents have high job demands and job insecurity. For job decision latitude and co-workers support, both shows that mean score was low than median score and indicated that most respondents do have low job decision latitude and low co-workers support. For the job strain the mean score was 0.94 and the result is more than median 0.50, so it's indicated that all respondents do not have job strain.

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Table 4.4: Descriptive analysis of psychosocial factor

Stress Factor	Mean ± SD	Median	Range
Job Demands	31.60 ± 3.754	30	24-48
Job Decision Latitude	67.61 ± 7.242	68	52-90
Co-worker Support	11.53 ± 1.009	12	8-14
Supervisor Support	12.11 ± 1.608	12	4-16
Job Insecurity	5.08 ± 1.422	5	3-10
Job Strain	0.94 ± 0.138	0.50	1

N=108. Descriptive analysis

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4.4.1 Distribution score of job demands

Based on table 4.3 the median score for job demand was 30 and the Figure 4.3.1 shows that the distribution score of job demand of respondents. As the median score for job demand is 30, the score 30 and below considered as low job demand and the rest above 30 considered high job demand. The mean of job demand stated that it was high job demand as it more than 30 median. Different job task perform by different respondents cause the difference in job demand score as the respondents not only among operation workers but also among office workers. Both have their own job demand as the operation workers usually work based on job schedule in order to fulfill the orders from customer and the office workers need to do management of the company and need to deal with many people.

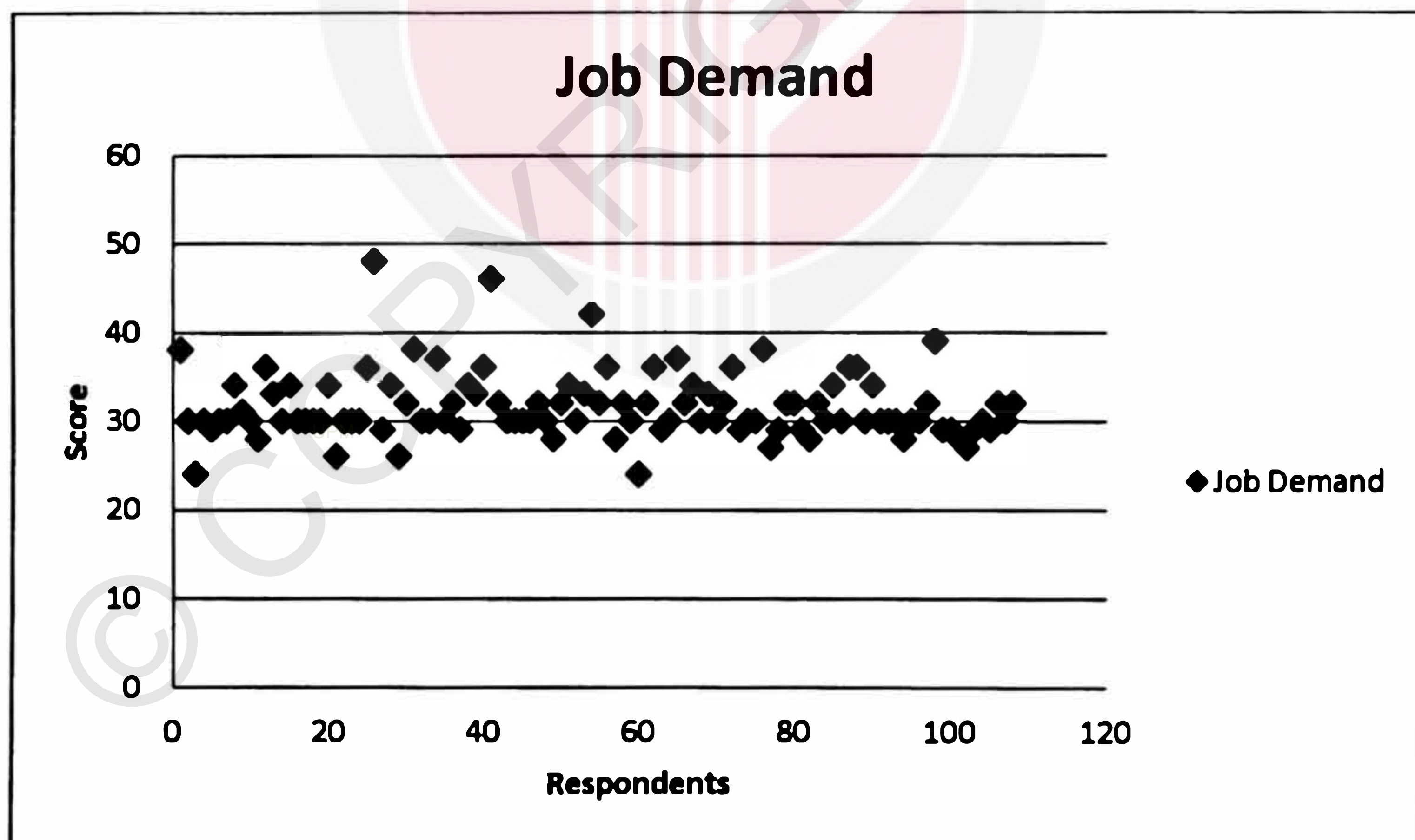

Figure 4.3.1: Distribution score of job demand

4.4.2 Distribution score of job decision latitude

Figure 4.3.2 showed the distribution score of job decision latitude of the respondents. The median was 68, so based on the median, the score 68 and below were considered as low job decision latitude and the score above 68 were considered as high job decision latitude. The mean calculated was 67.61 and it's was below that 68, so it was considered that, the workers do have low job decision latitude. This shows respondents do not too freely make a decisions and exercise control over their work.

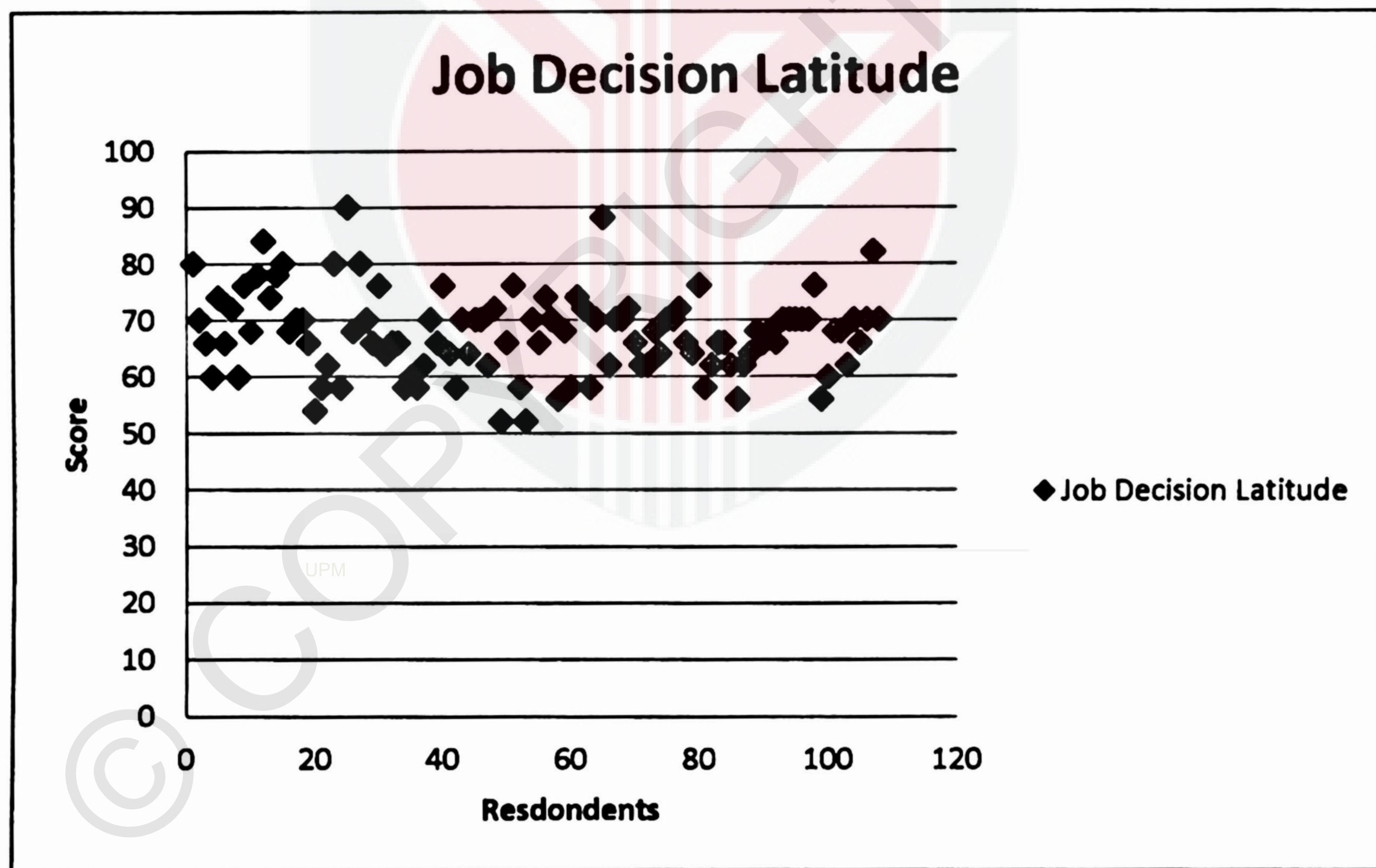

Figure 4.3.2: Distribution score of job decision latitude

4.4.3 Distribution score of co-workers support

The median score for co-worker support was 12. The score below 12 was considered low co-workers support and the score above the 12 considered high co-workers support. The Figure 4.3.3 showed the distribution score of co-workers support. Based on table 4.3 mean score for co-workers support was 11.53 and it shows below than 12. This indicates most of the workers do have low co-workers support while working.

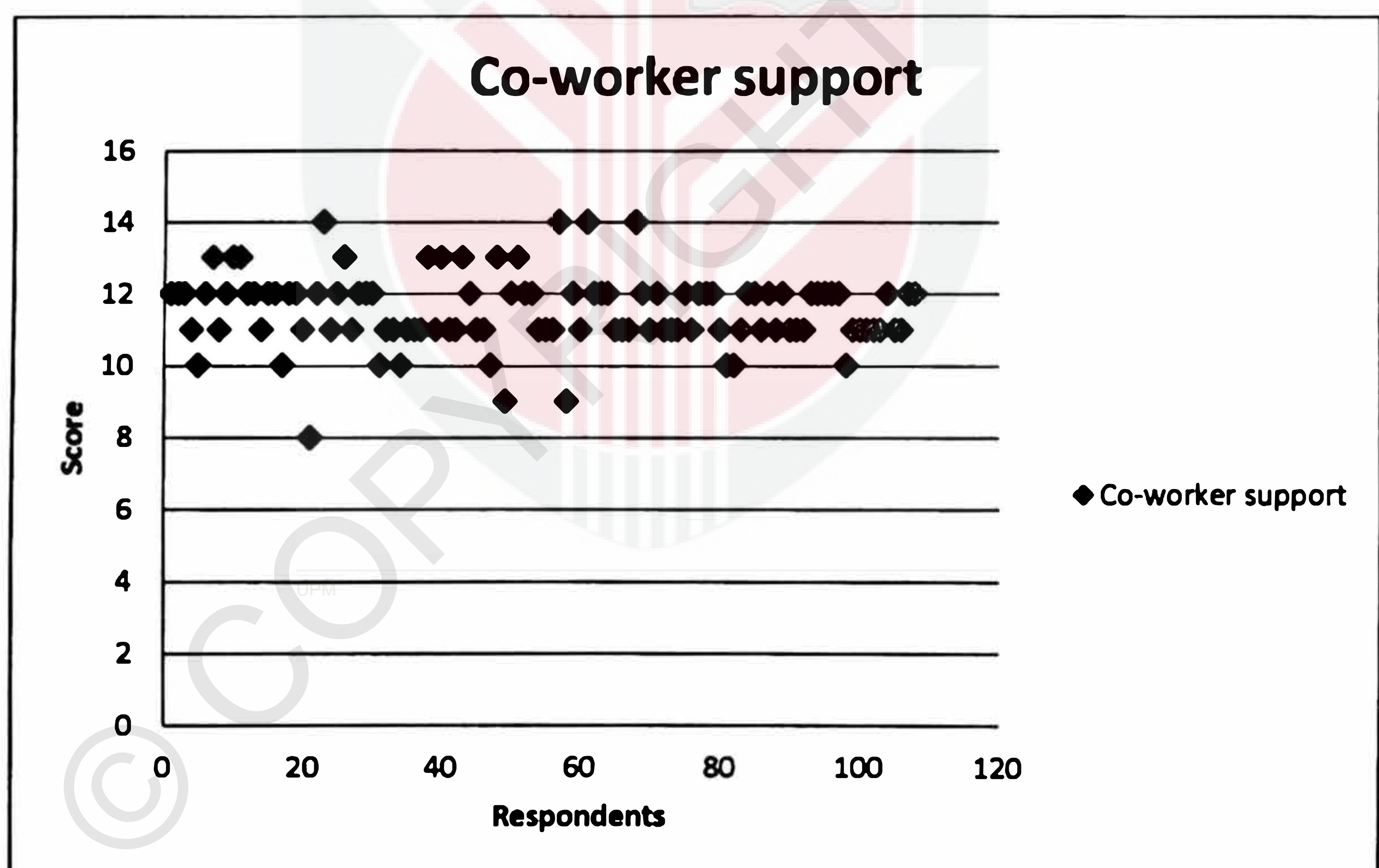

Figure 4.3.3: Distribution score of co-workers support

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4.4.4 Distribution score of supervisor support

Based on table 4.3 the median score for supervisor support was 12 and the Figure 4.3.4 showed the distribution score of supervisor support. As the median score for supervisor support was 12, the score 12 and below considered as low supervisor support and the rest above 12 considered high supervisor support. Based on table 4.3, mean score for supervisor support was 12.11 and its shows the value high supervisor support. Most of the respondents have high supervisor support while performing their job task.

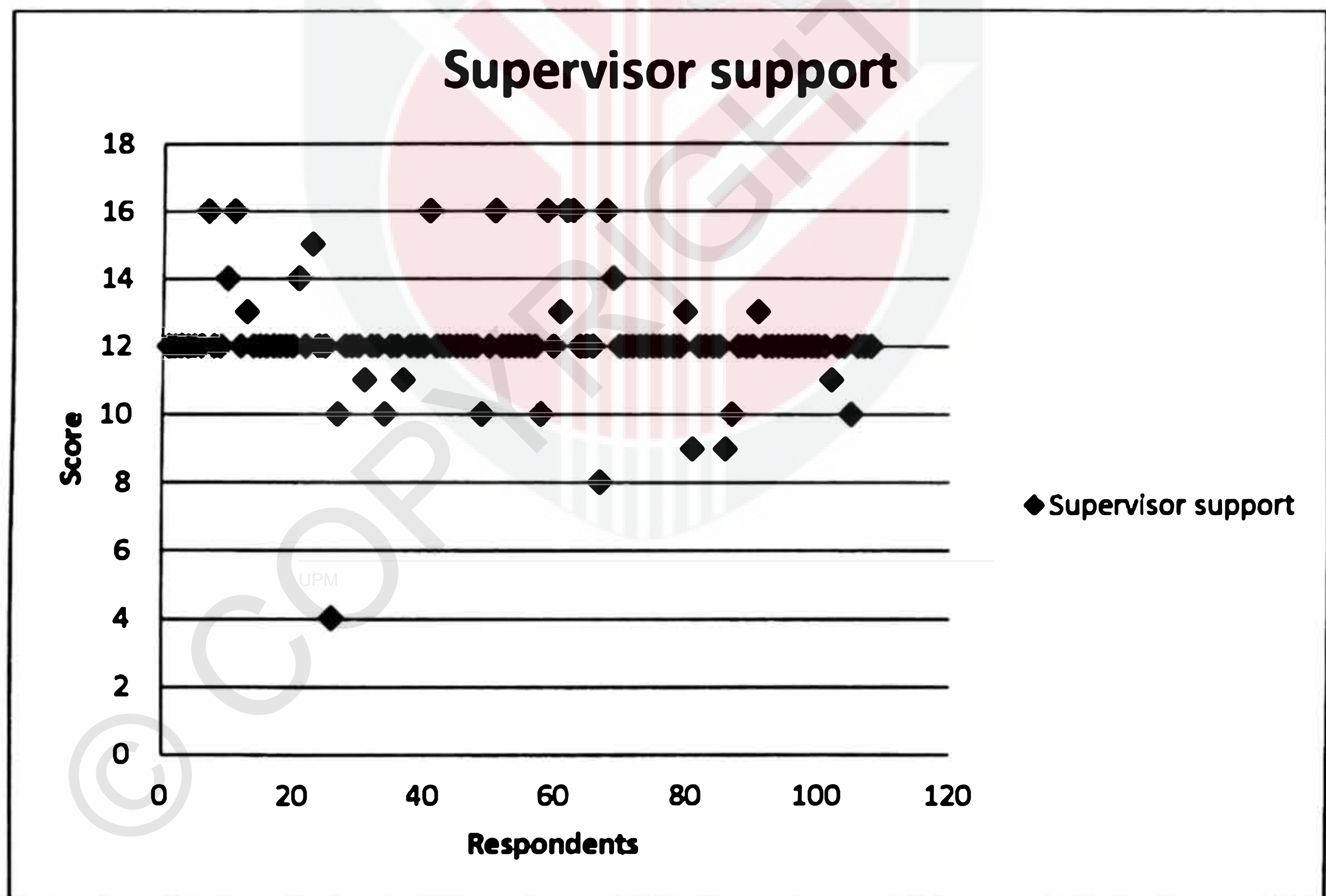

Figure 4.3.4: Distribution score of supervisor support

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4.4.5 Distribution score of job insecurity

Figure 4.3.5 shows the distribution score of job insecurity of the respondents. The median for job insecurity was 5. Based on the median, the score 5 and below were considered as low job insecurity and the score above 5 were considered as high job insecurity. The mean score of respondents for job insecurity was 5.08. The score above 5 indicate that the worker have high insecurity for their job. They feel insecure with their current work position and less possibility to loss it.

Figure 4.3.5: Distribution score of job insecurity

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4.5 Determination of the prevalence of respiratory symptoms among respondents

The respiratory symptoms measure in this study were wheezing and chest tightness, shortness of breath, cough and phlegm, allergies to animal, dust and fur and asthma. Based on table 4.5 only 20.4% of respondents had wheezing and chest tightness. For shortness of breath, only 5.6% of respondents experiencing those symptoms and 94.4% were not experiencing this symptom. 22.2% of respondents having cough and phlegm. Only 5.6% of respondents were allergies to animal, dust and fur. Based on the findings the most prevalent symptoms was cough and phlegm. This symptoms recorded the highest prevalent among others symptoms as the cough and phlegm may be caused by smoking behavior. The smoking behaviour will trigger the development of the mucus and phlegm in our respiratory systems (R.Vann, 2010),. Other than that, the dry air cause caused by air conditioning system also can contribute to the development of mucus. Hurst (2010) explained that heating and air conditioning can dry out our sinuses - cavities in our skull around our cheeks. This means they're more vulnerable to irritants and infection, which then causes the tissue lining the sinuses to become inflamed (Hurst, 2010). Most of the management workers spend their working hours in air-conditioning room and this will lead to development of this symptoms.

Table 4.5: Descriptive analysis of respiratory symptoms of workers in a manufacturing company (N=108)

Symptom	N %		Median ± SD
	No	Yes	
Wheezing and Chest Tightness	86 (79.60)	22 (20.4)	2.00 ± 0.405
Shortness of breath	102 (94.4)	6 (5.6)	2.00 ± 0.230
Cough & Phlegm	84 (77.8)	24 (22.2)	2.00 ± 0.418
Allergies to animal, dust and fur	102 (94.4)	6 (5.6)	2.00 ± 0.230
Asthma	92 (85.2)	16 (14.8)	2.00 ± 0.357

N=108. Descriptive analysis

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4.6 The association between socio-demographic factors with the prevalence of respiratory symptoms

4.6.1. Association between socio-demographic with wheezing and chest tightness

Table 4.6.1 shows that there were no significant association between age, gender, marriage status, education level, income and smoking behaviour with wheezing and chest tightness as all the p-value is greater than 0.05. Based on Moore (2016), wheezing can happen in everyone and there are certain risk factors that can increase a person's chances of developing a wheeze such as hereditary of asthma disease. Other than that, wheezing also can occur in people with allergies, people with cancer, children in day care, past and current smokers (Moore, 2016). But based on the present finding, smoking behaviour did not significant with wheezing symptoms. This may be caused by less number of smokers among study respondents.

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Table 4.6.1: Association between socio-demographic with wheezing and chest tightness

Socio-demographic	Wheezing and Chest Tightness				
	Yes	No	Total	x^2	p
Age					
20-30	2 (14.3%)	12 (85.7%)	14 (100%)	5.634	0.131
31-40	3 (13.6%)	18 (86.4%)	22 (100%)		
41-50	10 (18.2%)	45 (81.8%)	55(100%)		
>51	7 (41.2%)	10 (58.8%)	17 (100%)		
Total	22(20.4%)	86(79.6%)	108(100%)		
Gender					
Male	13(16.3%)	67(83.8%)	80(100%)	3.230	0.072
Female	9(32.1%)	19(67.9%)	28(100%)		
Total	22(20.4%)	86(79.6%)	108(100%)		
Marriage Status					
Single	5(21.7%)	18(78.3%)	23(100%)	0.283	0.868
Married	17(20.2%)	67(79.8%)	84(100%)		
Divorced	0(0%)	1(100%)	1(100%)		
Total	22(20.4%)	86(79.6%)	108(100%)		
Education Level					
Finished School	12(23.1%)	41(77.4%)	53(100%)	0.331	0.565
University/college graduates	10(18.2%)	45(81.8%)	55(100.0%)		
Total	22(20.4%)	86(79.6%)	108(100%)		
Income					
Low (<5000)	20(19.6%)	82(80.4%)	102(100%)	0.658	0.417
High (>5000)	2(33.3%)	4(66.7%)	6(100%)		
Total	22(20.4%)	86(79.6%)	108(100%)		
Smoking					
Yes	8(22.9%)	27(77.1%)	35(100%)	0.197	0.657
No	14(19.2%)	59(80.8%)	73(100%)		
Total	22(20.4%)	86(79.6%)	108(100%)		

N=108, Chi-square test, Significant at $p<0.05$

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4.6.2. Association between socio-demographic with shortness of breath

Table 4.6.2 shown the association between socio-demographic with shortness of breath. Based on analysis, there are no significant association between age, gender, marriage status, education level, income and smoking behaviour with shortness of breath. Based on American Lung Institute, smoking is a major risk factor as it causes diseases that result in shortness of breath. Findings showed that there was no significant association between smoking and shortness of breath. This is due to less number of respondents who are smoking.

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Table 4.6.2: Association between socio-demographic with shortness of breath

Socio-demographic	Shortness of breath				p
	Yes	No	Total		
Age					
20-30	1 (7.1%)	13 (92.9%)	14 (100%)	3.672	0.299
31-40	0 (0%)	22 (100.0%)	22 (100%)		
41-50	5 (9.1%)	507 (90.9%)	55 (100%)		
>51	0 (0%)	17 (100.0%)	17(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Gender					
Male	4(5.0%)	76(95.0%)	80(100%)	0.182	0.670
Female	2(7.1%)	26(92.9%)	28(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Marriage Status					
Single	1(4.3%)	22(95.7%)	23(100%)	0.148	0.929
Married	5(6.0%)	79(94.0%)	84(100%)		
Divorced	0(0%)	1(100%)	1(100%0		
Total	6(5.6%)	102(94.4%)	108(100%)		
Education Level					
Finished School	3(5.7%)	50(94.3%)	53(100%)	0.002	0.963
University/college graduates	3(5.5%)	52(94.5%)	55(100.0%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Income					
Low (<5000)	5(4.9%)	97(95.1%)	102(100%)	1.495	0.221
High (>5000)	1(16.7%)	5(83.3%)	6(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Smoking					
Yes	3(8.6%)	32(91.4%)	35(100%)	0.898	0.343
No	3(4.1%)	70(95.9%)	73(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		

N=108, Chi-square test, Significant at p<0.05

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4.6.3. Association between socio-demographic with cough and phlegm

Table 4.6.3 shows that the association between socio-demographic with cough and phlegm. There were no significant association between age, gender, education level and smoking behaviour with cough and phlegm. There are significant association between marriage status and income with cough and phlegm as (X^2 = 6.310, p-value=0.043) and (X^2 = 7.261, p-value=0.007). Most of the respondents were married and have an income below than RM5000. The justification for the significant association between marriage status and income with cough and phlegm is the married people tend to be stress than unmarried people and people. The findings of the study indicate that working married women have to face more difficulties in their lives like they experienced more stress and depression as compared to non-working married women (Nagaraju & Nandini, 2013). Other than that, Dhamodharan & Arumugasamy (2011) mentioned that, work is the main cause of stress in their life because a significant positive relation as been revealed between job related stress and role overload, role conflict and strenuous working condition. Based on Cohen (1995) stressful life events are commonly believed to suppress host resistance to infection.

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Table 4.6.3: Association between socio-demographic with cough and phlegm

Socio-demographic	Cough and phlegm			x^2	p
	Yes	No	Total		
Age					
20-30	1 (7.1%)	13 (92.9%)	14 (100%)	4.298	0.231
31-40	3 (13.6%)	19 (86.4%)	22 (100%)		
41-50	16 (29.1%)	39 (70.9%)	55(100%)		
>51	4 (23.5%)	13 (76.5.0%)	17(100%)		
Total	24(22.2%)	84(77.8%)	108(100%)		
Gender					
Male	18(22.5%)	62(77.5%)	80(100%)	0.014	0.907
Female	6(21.4%)	22(78.6%)	28(100%)		
Total	24(22.2%)	84(77.8%)	108(100%)		
Marriage Status					
Single	2(8.7%)	21(91.3%)	23(100%)	6.310	0.043
Married	21(25.0%)	63(75.0%)	84(100%)		
Divorced	1(100%)	0(0%)	1(100%)		
Total	24(22.2%)	84(77.8%)	108(100%)		
Education Level					
Finished School	11(20.8%)	42(79.2%)	53(100%)	0.130	0.719
University/college graduates	13(23.6%)	42(76.4%)	55(100.0%)		
Total	24(22.2%)	84(77.8%)	108(100%)		
Income					
Low (<5000)	20(19.6%)	82(80.4%)	102(100%)	7.261	0.007
High (>5000)	4(66.7%)	2(33.3%)	6(100%)		
Total	24(22.2%)	84(77.8%)	108(100%)		
Smoking	9(25.7%)	26(74.3%)	35(100%)	0.365	0.623
Yes					
No	15(20.5%)	58(79.5%)	73(100%)		
Total	24(22.2%)	84(77.8%)	108(100%)		

N=108, Chi-square test, Significant at $p<0.05$

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4.6.4. Association between socio-demographic with allergies to animal, dust and fur

Table 4.6.4 shows that the association between socio-demographic with allergies to animal, dust and fur. There are no significant association between age, gender, education level, income and smoking behaviour with allergies to animal, dust and fur. But there is significant association between marriage status with allergies to animal, dust and fur (X^2 = 17.165, p-value < 0.05). Same as justification for association between marriage status with cough and phlegm, marriage status and allergies to fur, dust and fur show significant association as the respondents was assumed facing stressful life event. Nagaraju & Nandini (2013) indicate that working married women have to face more difficulties in their lives like they experienced more stress and depression as compared to non-working married women. This research was undertaken to marital status highly influence on stress of women employee. Thus stressful life event believed to suppress host resistance to infection (cohen, 1995).

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Table 4.6.4: Association between socio-demographic with allergies to animal, dust and fur

Socio-demographic	Allergies to animal, dust and fur				
	Yes	No	Total	x^2	*p*
Age					
20-30	0(0%)	14(100%)	14(100%)	6.856	0.077
31-40	0(0%)	22(100%)	22(100%)		
41-50	3(5.5%)	52(94..5%)	55(100%)		
>51	3(17.6%)	14(82.4%)	17(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Gender					
Male	4(5.0%)	76(95.0%)	80(100%)	0.182	0.670
Female	2(7.1%)	26(92.9%)	28(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Marriage Status					
Single	1(4.3%)	22(95.7%)	23(100%)	17.165	0.000
Married	4(4.8%)	80(95.2%)	84(100%)		
Divorced	1(100%)	0(0%)	1(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Education Level					
Finished School	2(3.8%)	51(96.2%)	53(100%)	0.630	0.427
University/college graduates	4(7.3%)	51(92.7%)	55(100.0%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Income					
Low (<5000)	5(4.9%)	97(95.1%)	102(100%)	1.495	0.221
High (>5000)	1(16.7%)	5(83.3%)	6(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		
Smoking					
Yes	2(5.7%)	33(94.3%)	35(100%)	0.002	0.960
No	4(5.5%)	69(94.5%)	73(100%)		
Total	6(5.6%)	102(94.4%)	108(100%)		

N=108, Chi-square test, Significant at $p<0.05$

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4.6.5. Association between socio-demographic with asthma

Table 4.6.5 shown association between socio-demographic with asthma. Based on analysis there were significant association between gender and income with asthma as (X^2 = 5.668, p-value = 0.017) and (X^2 = 6.232, p-value = 0.013). There weree no significant association between age, marriage status, education level and smoking behaviour. The relationship between sex hormones and asthma has been evaluated in several studies and it shows significant association between gender and asthma. In the children, the prevalence of asthma was higher in boys than in girls (Bouman, Heineman and Fass, 2005). But after the puberty, the frequency and severity of asthma increase among girls, such as it was common among women by age of 20 (Kynyk, Mastronarde and McCallister, 2011). After the menoupause, prevalence between men and women decreases (Kynyk, Mastronarde and McCallister, 2011).

Based on Institute of Medicine (US) Committee on Damp Indoor Spaces and Health (2014), some factors may influence people's exposure to indoor agents, their ability to respond to circumstances in which indoor exposure may increase the risk of adverse health outcomes, and their health in general, among those factors is socioeconomic status (SES). They also mentioned that low SES may be a contributory or independent factor in some of the health outcomes, affecting their incidence of severity.

Table 4.6.5: Association between socio-demographic with asthma

Socio-demographic	Asthma				
	Yes	No	Total	x^2	p
Age					
20-30	1(7.1%)	13(92.9%)	14(100%)	1.826	0.609
31-40	2(9.1%)	20(90.9%)	22(100%)		
41-50	10(18.2%)	45(81.8%)	55(100%)		
>51	3(17.6%)	14(82.4%)	17(100%)		
Total	16(14.8%)	92(85.2%)	108(100%)		
Gender					
Male	8(10%)	72(90%)	89(100%)	5.668	0.017
Female	8(28.6%)	20(71.4%)	28(100%)		
Total	16(14.8%)	92(85.2%)	108(100%)		
Marriage Status					
Single	3(13.0%)	20(87.0%)	23(100%)	5.826	0.054
Married	12(14.3%)	72(85.7%)	84(100%)		
Divorced	1(100%)	0(0%)	1(100%)		
Total	16(14.8%)	92(85.2%)	108(100%)		
Education Level					
Finished School	8(15.1%)	45(84.9%)	53(100%)	0.006	0.936
University/college graduates	8(14.5%)	47(85.5%)	55(100.0%)		
Total	16(14.8%)	92(85.2%)	108(100%)		
Income					
Low (<5000)	13(12.7%)	89(87.3%)	102(100%)	6.232	0.013
High (>5000)	3(50.0%)	3(50.0%)	6(100%)		
Total	16(14.8%)	92(85.2%)	108(100%)		
Smoking					
Yes	7(20.0%)	28(80.0%)	35(100%)	1.103	0.294
No	9(12.3%)	64(87.7%)	73(100%)		
Total	16(14.8%)	92(85.2%)	108(100%)		

N=108, Chi-square test, Significant at $p<0.05$

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4.7 The correlation between psychosocial factors with respiratory symptom

The spearman rho correlation test was conducted to correlate between psychosocial factors with respiratory symptoms and the result shows there is no significant association between psychosocial factors such as job demands, job decision latitude, co-workers support, supervisor support, job insecurity and job strain with respiratory symptoms such as wheezing and chest tightness, shortness of breath, cough and phlegm, asthma and allergies to animal, dust and fur. Thus, the hypothesis has been rejected.

Schneiderman et al. (2008) stated that stressed people, for instance, might seek more outside contact and thus be exposed to more viruses. Those individuals with the most stressful life events and highest levels of perceived stress and negative affect had the greatest probability of developing cold symptoms (Schneiderman et al., 2008). Based on descriptive analysis of psychosocial factors, the results for job strain shows there were no job strain among respondents. Thus, the correlation between psychosocial factors and respiratory symptoms was not significant. Other than that, the descriptive analysis of respiratory symptoms shows that, the respondents who have respiratory symptoms were less than respondents who did not have respiratory symptoms.

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Table 4.7.1: Correlation between psychosocial factors with respiratory symptoms

Psychosocial Factor	Wheezing and chest tightness		Shortness of breath		Cough and phlegm		Allergies to animal, dust and fur		Asthma	
	r	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value
Job Demands	-0.97	0.319	-0.179	0.064	0.121	0.213	-0.027	0.779	0.138	0.156
Job Decision Latitude	0.063	0.518	-0.49	0.677	-0.049	0.615	0.076	0.436	0.074	0.446
Co-worker Support	0.60	0.537	-0.036	0.712	-0.027	0.778	0.043	0.660	0.068	0.484
Supervisor Support	0.107	0.269	-0.140	0.149	0.059	0.544	0.091	0.351	0.063	0.515
Job Insecurity	0.017	0.859	-0.009	0.923	-0.073	0.455	0.007	0.939	0 .035	0.717
Job Strain	-0.106	0.273	-0.092	0.343	0.114	0.241	-0.064	0.509	-0.040	0.683

N=108, Spearman Rho Correlation, Significant at p<0.05

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4.8 Association between concentration of bacteria and fungi with respiratory symptoms

The chi-square test was conducted to determine the association between concentration of bacteria and fungi with respiratory symptoms. The concentration of bacteria and fungi was categorized based on median obtained from descriptive analysis of concentration of bacteria and fungi. The concentration of bacteria was categorized low CFU if the value is 220 and below and high if the concentration is 221 and above. Then for the fungi concentration it was categorized low if the value is 90 and below and categorized as high if the value is above 90.

Based on the result obtained in table 4.8.1, there were no significant associations between concentration of bacteria and fungi with respiratory symptoms.. According to Mendell et al. (2011), quantitatively determined concentrations of microbiological agents do not show a consistent association with respiratory health outcomes. The inconsistent association between exposure to bacteria and fungi with health outcomes in different studies, could due to variations in study design, sampling and analysing method, season of the year for the measurements, region where the measurements have been made, climate and indoor activities, etc. (Ren et al., 2001; Chew et al., 2003).

Pasanen (2001) also mentioned that there are also limitations in culture-based sampling methods for characterizing health-related bioaerosol composition and concentration indoors that cause variations in results. Other than that, Holme et al. (2010) found no significant association between fungi concentrations and health outcomes despite the significant associations with specific genera as Fungi species of Penicillium, Aspergillus and Cladosporium have been the most frequently associated with allergy and exist both in indoor and outdoor environments (Daisey et al., 2003; Jo and Seo, 2005).

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Table 4.8.1: Association between concentration of bacteria and fungi with respiratory symptoms.

Variables	Low bacteria <220 (cfu/m³)	High bacteria >220 (cfu/m³)	X^2	p-value	Low fungi <90 (cfu/m³)	High fungi >90 (cfu/m³)	X^2	p-value
	Total (%)	Total (%)			Total (%)	Total (%)		
Wheezing and chest tightness								
Yes	12 (17.6)	10 (25.0)	0.839	0.360	13 (21.0)	9 (19.6)	0.032	0.828
No	56 (82.4)	30 (75)			49 (79.0)	37 (80.4)		
Shortness of breath								
Yes	5 (7.4)	1 (2.5)	1.130	0.288	4 (6.5)	2 (4.3)	0.223	0.637
No	63 (92.6)	39 (97.5)			58 (93.5)	44 (95.7)		
Cough and phlegm								
Yes	12 (17.6)	12 (30.0)	2.224	0.136	15 (24.2)	9 (19.6)	0.327	0.567
No	56 (82.4)	28 (70.0)			47 (75.8)	37 (80.4)		
Allergies to animal, dust and fur								
Yes	3 (4.4)	3 (7.5)	0.458	0.668	5 (8.1)	1 (2.2)	1.746	0.186
No	65 (95.6)	37 (92.5)			57 (91.9)	45 (97.8)		
Asthma								
Yes	10 (14.7)	6 (14.8)	0.002	0.967	12 (19.4)	50 (80.6)	2.377	0.123
No	58 (85.3)	34 (85.0)			4 (8.7)	42 (91.3)		

N= 108, Chi-square test, Significant at $p<0.05$

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CHAPTER 5

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on statistical analysis that have been conducted, all hypothesis have been answered and some was accept the null hypothesis and some was rejected the null hypothesis. Below are the conclusion based on study hypothesis:

Hypothesis: There is significant association between socio-demographic factors with respiratory symptoms.

The null hypothesis has been rejected as there were an association between socio-demographic factors with respiratory symptoms.

Hypothesis: There is significant association between indoor airborne bacteria and fungi with respiratory symptoms.

The hypothesis was accepted the null hypothesis as the results obtained was not significant.

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Hypothesis: There is significant association between psychosocial factor with respiratory symptoms.

The null hypothesis has been accepted as there were no significant association between psychosocial factors with respiratory symptoms.

Based on result obtained the most of respondents was male respondents , average age of 26-30 years old, married, have income below than RM 5000 and do not smoke. The concentration of bacteria and fungi were on average safe as most location are no exceed the acceptable limit except for female prayer room. The concentrations of bacteria at female prayer room exceed the limit as the material in female prayer room and the ventilation in the female prayer room was not good. Other than that, female room also have small area compare to others rooms. The acceptable limit for bacteria is 500 CFU and acceptable limit for fungi is 1000 CFU. So, only one sample exceeds the acceptable limit.

For the socio-demographic, there are only significant association between marriage status and income with cough and phlegm, marriage status with allergies to animal, dust and fur and significant association between gender, marriage status and income with asthma. For psychosocial factors and concentration of bacteria and fungi, there are no significant association with respiratory symptoms.

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Based on result the exposure of bacteria and fungi at study location was safe as it not exceeding the acceptable limit except at female prayer room. Thus, there are no development of respiratory symptoms cause by exposure to bacteria and fungi. Exposure of bacteria and fungi at study location did not cause respiratory symptoms.

In conclusion, the indoor air pollutant may affect the health of the person who exposed to it. The Indoor Air Quality assessment carried out to identify the air quality related problem that may affect the workers in the building as well as to measure the compliance with the available standard. The biological parameter that has been measured was complied with the ICOP on Indoor Air Quality 2010 except for total count for bacteria at female prayer room. The best work practices for improvement have been included in this report to enhance the good indoor air quality in the workplace.

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5.2 Limitation

The study was conducted using cross sectional study design that only conducted in short time period. So, the season and whether during sampling did not take into consideration in this study as the season also can affect the number of bacteria and fungi in the environment. Thus, for the study that will be conducted in the future, the weather of current environment also need to take into the consideration and related the current environment with the development of bacteria and fungi.

Other than that, this study also have less of control of respondents bias. The respondent bias can influence the responses of participants away from an accurate or truthful response. The respondents will be unable to answer the questions 100% accurately due to various reasons, but most often responds give inaccurate responses due to unfamiliarity, faulty recall, question format and question context. So for future research it is better if the researchers can conduct interview with the respondents instead of self answered by the respondents.

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5.3 Recommendation

As the result obtained is not significant, it was recommended the company do maintain the current progress and try to improve the indoor environment to ensure that the workers are provided with the clean and safe indoor air while working. Some recommendation need to apply to the female prayer room to reduce the concentration of bacteria. The ventilation system in the room need to undergoes maintenance, the carpet in the room need to wash frequently, same with prayer cloth also need to wash frequently and practise hanging the prayer cloth instead of fold it. Than, several possible best work practices can be done by the company to improve the indoor environment such as do the maintenance of ventilation system in all locations monitored regularly to provide good ventilation. The used of split air conditioning system is a good choice as the outside contaminant will not draw into indoor as its only circulate the air inside the room. Other than that, do a daily housekeeping to removes the dust and prevent the bacterial and fungal growth (ensure building materials not damp or wet) especially in the female prayer room. Arrange the cleaning schedule with reference to occupancy patterns and activity levels. Then, encourage workers to eat at the place provided rather than eat at working rooms, Provide 'No Smoking' sign in all room in order to prevent the workers from smoking in the indoor areas and enforce no smoking indoor. Last approaches that can be done by management are do the training for good Indoor Air Quality contents and provide information to the workers about poor indoor air quality sources and its health effect.

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Appendix 1:

Ethical Approval

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ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS
(JKEUPM)
UNIVERSITI PUTRA MALAYSIA

Research title	:	**Association Between Bioaerosol In Indoor Air And Acute Respiratory Infection Among Manufacturing In Shah Alam Selangor**
Study Site	:	**Shah Alam, Selangor**
JKEUPM Ref No.	:	**FPSK(EXP16-OSH)U051**
Researcher	:	**Ain Nadiah Bt Baharuddin**
Supervisor	:	**Dr. Emilia Zainal Abidin**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 18/10/2016
2. Respondent Information Sheet & Consent (English) Version 2 dated 3/1/2017
3. Respondent Information Sheet & Consent (Malay) Version 1 dated 20/2/2017
4. Proposal (English), Version 1 dated 18/10/2016
5. Questionnaire (English), Version 1 dated 18/10/2016
6. Questionnaire (Malay), Version 1 dated 3/1/2017
7. Curriculum Vitae of:
   a. Dr. Emilia Zainal Abidin
   b. Dr. Irniza Rasdi

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.

Decision by JKEUPM:

[X] Approved

[X] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**

[ ] Disapproved

Please note that the approval is valid until 3 March 2018

Researchers should comply with the following:

I. Complete a Study Final Report upon study completion (Form D).

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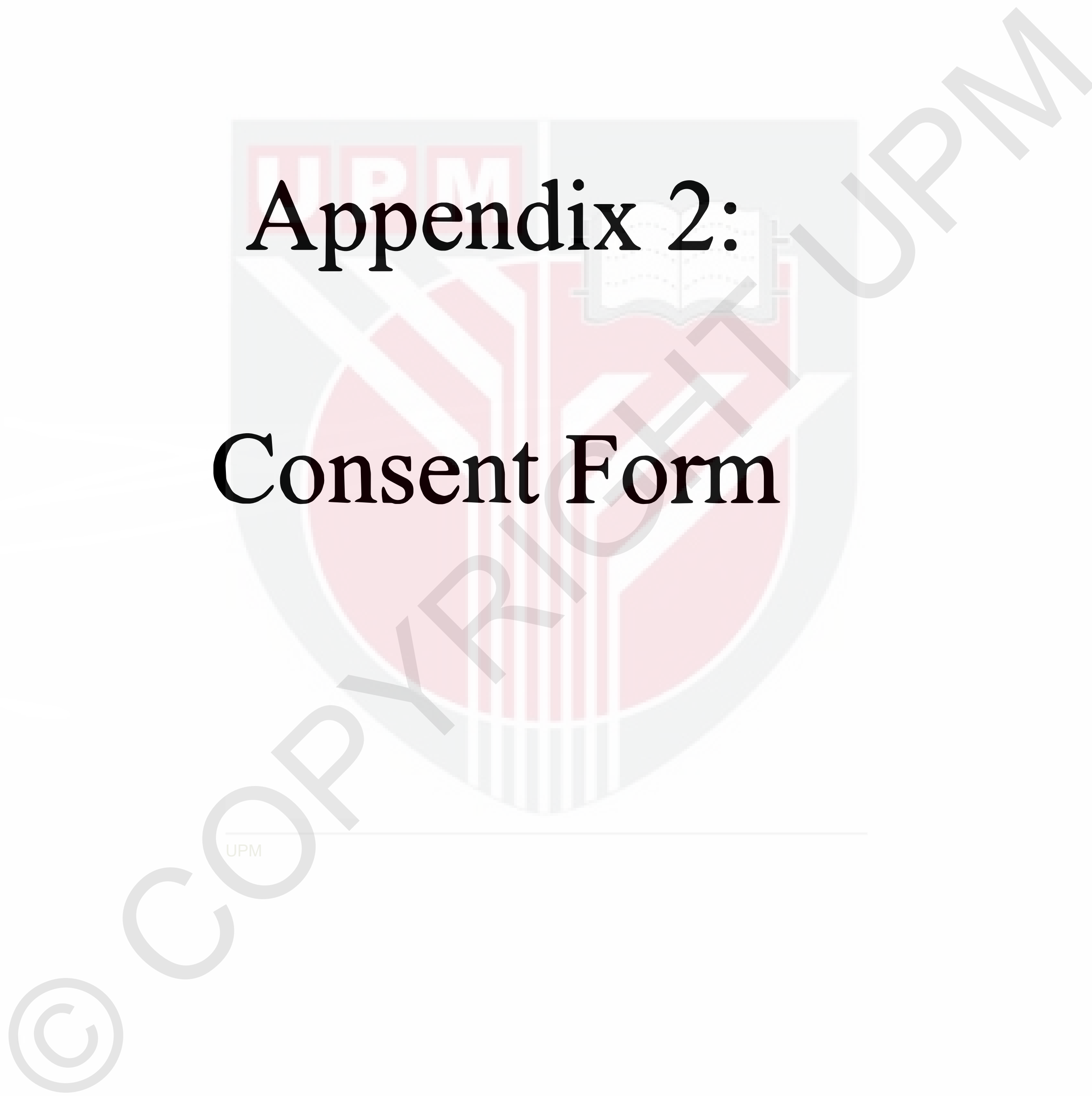

Appendix 2:

Consent Form

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JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA

BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN

Hubungkait di antara Socio-demografi, Hazad Biologi dan Faktor Psikisosial dengan Gejala Pernafasan di Kalangan Pekerja Pembuatan di Selangor

2. PENGENALAN

Kebanyakkan orang menghabiskan sebahagian besar masanya di dalam bangunan termasuk lah di pejabat, sekolah, kemudahan kesihatan ataupun bangunan awam atau swasta yang lain. Kualiti udara yang mereka bernafas didalam bangunan merupakan penentu penting bagi kesihatan penghuninya. Parameter biologi menjadi perhatian dalam kajian ini kerana aktiviti manusia dan peralatan di dalam bangunan dipercayai menjadi faktor utama yang menyumbang kepada pengumpulan dan penyebaran pencemaran mikrob bawaan udara. Selain daripada itu, aktiviti-aktiviti tertentu seperti bercakap, bersin, batuk, berjalan kaki dan basuh boleh menjana zarah biologi udara. Pendedahan kepada pencemaran mikrob secara klinikalnya menyebabkan gejala pernafasan, alahan, asma, dan tindak balas imunologi. Kajian mengenai pendedahan kepada bioaerosols di udara dan kesan jangkitan pernafasan akut akan dijalankan di kilang pembuatan di Bandar Baru Bangi, Selangor.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Responden perlu menjawab semua soalan-soalan dalam borang soal selidik yang disediakan. Semua jawapan mesti benar-benar dialami oleh responden.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Pekerja baru dan juga pekerja yang mengalami penyakit asma dan penyakit pernafasan yang kronik. Perempuan mengandung juga dikecualikan dari kajian ini.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Kajian ini akan mengukur kandungan bacteria dan kulat didalam udara di dalam bangunan. Risiko mendapat penyakit pernafasan disebabkan oleh pendedahan kepada bacteria dan kulat di dalam udara akan diketahui melalui kajian ini.

b) KEPADA PENYELIDIK?

Para penyelidik dapat mengumpulkan data mengenai kandungan bacteria dan kulat dalam udara di dalam bangunan.

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6. ADAKAH IA BERISIKO?

Tidak. Responden hanya perlu menjawab soalan yang diberikan didalam borang soal selidik

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Ya. Segala maklumat peribadi dan sulit responden akan dirahsiakan dan hanya akan digunakan untuk tujuan pembelajaran.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

019-2967523
Ain Nadiah Binti Baharuddin
Penyelidik
Jabatan Kesihatan Persekitaran dan Pekerjaan
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Universiti Putra Malaysia

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Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini _______

9. PERSETUJUAN

Saya.. No Kad Pengenalan. .... beralamat...
............................dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan .... (*Responden*)

Tarikh :...

Tandatangan .... (*Saksi*)

Nama :...

No. K/P: ....

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh ....

Tandatangan .... (*Penyelidik*)

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Appendix 3:

Questionnaire

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UPM
UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

Code: | | | |

Department of Environmental and Occupational Health

Faculty of Medicine and Health Sciences,

Universiti Putra Malaysia

"Association between Socio-Demographic, Biological Hazard & Psychosocial Factors with Respiratory Symptoms among Manufacturing Workers in Selangor."

Instructions question:

1.The questionnaire contains four (4) sections:

Section A: Socio-demographic Information
Section B: Working Information
Section C: Psychosocial Work Factors
Section D: Respiratory Symptoms

2. You are required to answer all the questions that are in this book
3. To answer, please mark your answers on the boxes has been provided
4. The answers will be private and confidential, only for study purpose.
5. Questionnaires were returned to the researchers after answering all the questions

Employee ID : ....

Organization : ....

Date : ....

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PART A: SOCIO-DEMOGRAPHIC INFORMATION

1. Gender

☐ Male ☐ Female

2. Age: .... Years

3. Current marital status

☐ Single ☐ Married ☐ Divorced

4. Ethnic background

☐ Malay ☐ Indian ☐ Chinese ☐Other (..................)

5. Educational Level

☐ Not attending school ☐ UPSR ☐ PMR/SPM

☐ STPM/Sijil ☐ Diploma ☐ Degree

6. Total Income (RM): .... / month

PART B: WORKING INFORMATION

1. What is your job task?

....

2. Where is your working area?

....

3. Working experience ....Years

4. How many days do you work in a week?

.... Days

5. How many hours do you spend your time in the working area everyday?

.... Hours

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PART C: PSYCHOSOCIAL WORK FACTORS

	Strongly disagree	Disagree	Agree	Strongly agree
1. My job requires that I learn new things	1	2	3	4
2. My job involves a lot of repetitive work	1	2	3	4
3. My job requires me to be creative	1	2	3	4
4. My job allows me to make a lot of decisions on my own	1	2	3	4
5. My job requires a high level of skill	1	2	3	4
6. On my job, I am given a lot of freedom to decide how I do my work	1	2	3	4
7. I get to do a variety of things on my job	1	2	3	4
8. I have a lot to say about what happens on my job	1	2	3	4
9. I have an opportunity to develop my own special abilities	1	2	3	4
10. My job requires working very fast	1	2	3	4
11. My job requires working very hard	1	2	3	4
12. My job requires lots of physical effort	1	2	3	4
13. I am not asked to do an excessive amount of work	1	2	3	4
14. I have enough time to get the job done	1	2	3	4
15. I am free from conflicting demands others make	1	2	3	4
16. My job security is good	1	2	3	4
7. People I work with are competent in doing their jobs	1	2	3	4
8. People I work with take a personal interest in me	1	2	3	4
9. People I work with are friendly	1	2	3	4
20. People I work with are helpful in getting the job done	1	2	3	4
21. My supervisor is concerned about the welfare of those under him	1	2	3	4
22. My supervisor pays attention to what you are saying	1	2	3	4
23. My supervisor is helpful in getting the job done	1	2	3	4
24. My supervisor is successful in getting people to work together	1	2	3	4

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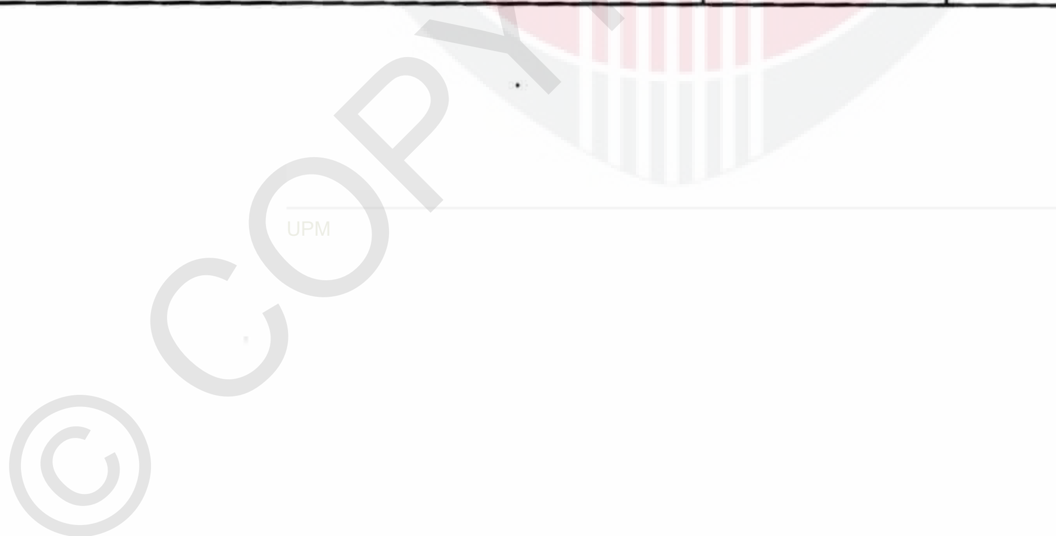
	Regular and steady	Seasonal	Frequent Layoffs	Both seasonal and frequent layoffs	Other
25. How steady is your work?	1	4	4	4	9

	Never	Faced laid possibility once	Faced possibility more than once	Actually constantly	Laid off
26. During the past year, how often were you in a situation where you faced job loss or layoff?	1	2	3	4	5

	Not at all likely	Not too likely	Somewhat likely	Very likely
27. Sometimes people permanently lose jobs they want to keep. How likely is it that during the next couple of years you will lose your present job with your employer?	1	2	3	4



PART D: : RESPIRATORY SYMPTOMS

Only answer Yes or No. Tick (/) for the answer.		
Wheeze and tightness in the chest	Yes	No
1. Have you, at any time in the last 12 months, had no yes wheezing or whistling in your chest?		
2. Have you, at any time in the last 12 months, woken up with a feeling of tightness in your chest first thing in the morning?		
Shortness of breath	Yes	No
3. Have you, at any time in the last 12 months, had an attack of shortness of breath that came on during the day when you were not doing anything strenuous?		
4. Have you, at any time in the last 12 months, had an attack of shortness of breath that came on after you stopped exercising?		
Have you, at any time in the last 12 months, been woken at night by an attack of shortness of breath?		
Cough and Phlegm from the chest	Yes	No
6. Have you, at any time in the last 12 months, been woken at night by an attack of coughing?		
7. Do you usually cough first thing in the morning?		
If yes to 7 answer question 7a & 7b 7a.Do you have a cough like this most mornings for as much as 3 months per year?		
7b.How many years have you had this cough?		
8. Do you usually bring up phlegm from your chest first thing in the morning?		
If yes to 8 answer question 8a & 8b 8.a Do you have phlegm like this most mornings for as much as 3 months per year?		
8b. How many years have you had this phlegm?		
Animals, dust, feathers	Yes	No
9. When you are in a dusty part of the house or with animals (for example, dogs, cats or horses) or near feathers (including pillows and quilts) do you		

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ever: a. Get a feeling of tightness in your chest? b. Start to feel short of breath?		
Asthma		
10. Have you ever had asthma?		
11. Have you had an attack of asthma at any time in the last 12 months?		
12. Are you currently taking any medicines (including inhalers, aerosols or tablets) for asthma?		
Breathing		
Only check one answer (/)		
13. Which of the following statements best describes your breathing?		
i. I never or only rarely get trouble with my breathing ii. I get repeated trouble with my breathing, but it always gets completely better iii. My breathing is never quite right		
Smoking		
Only answer Yes or No. Tick (/) for the answer.		
14. Have you ever smoked for as long as one year. If Yes answer question number 15.		
Only check one answer (/)		
15. Do (did) you usually smoke i. cigarettes ii. pipe iii. cigars iv. Other (Please state)_______________		
16. Have you: i. Continued to smoke? ii. Given up smoking altogether, but less than 4 weeks ago? iii. Given up smoking altogether, at least 4 weeks ago?		
Please state your answer		
17. How many <u>cigarettes</u> do (did) you smoke each day, on average?...........		
18. For how many years have you smoked (did you smoke)........		

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Appendix 4:

Certificate of Calibration

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EI.16.35820 SAS SUPER DUO 180 AIR SAMPLER SN: 05.DC.6146 LEFT HEAD RESULTS 12/12/2016

NOMINAL HEADING	UNITS	LOWER LIMIT	UPPER LIMIT	INITIAL RESULT	FINAL RESULT
10.000	L	9.500	11.000	10.148	10.148
20.000	L	19.000	22.000	20.388	20.388
30.000	L	28.500	33.000	30.414	30.414
50.000	L	47.500	55.000	51.017	51.017
100.000	L	95.000	110.000	102.003	102.003
200.000	L	190.000	220.000	203.944	203.944
500.000	L	475.000	550.000	509.708	509.708
1000.000	L	950.000	1100.000	1019.386	1019.386

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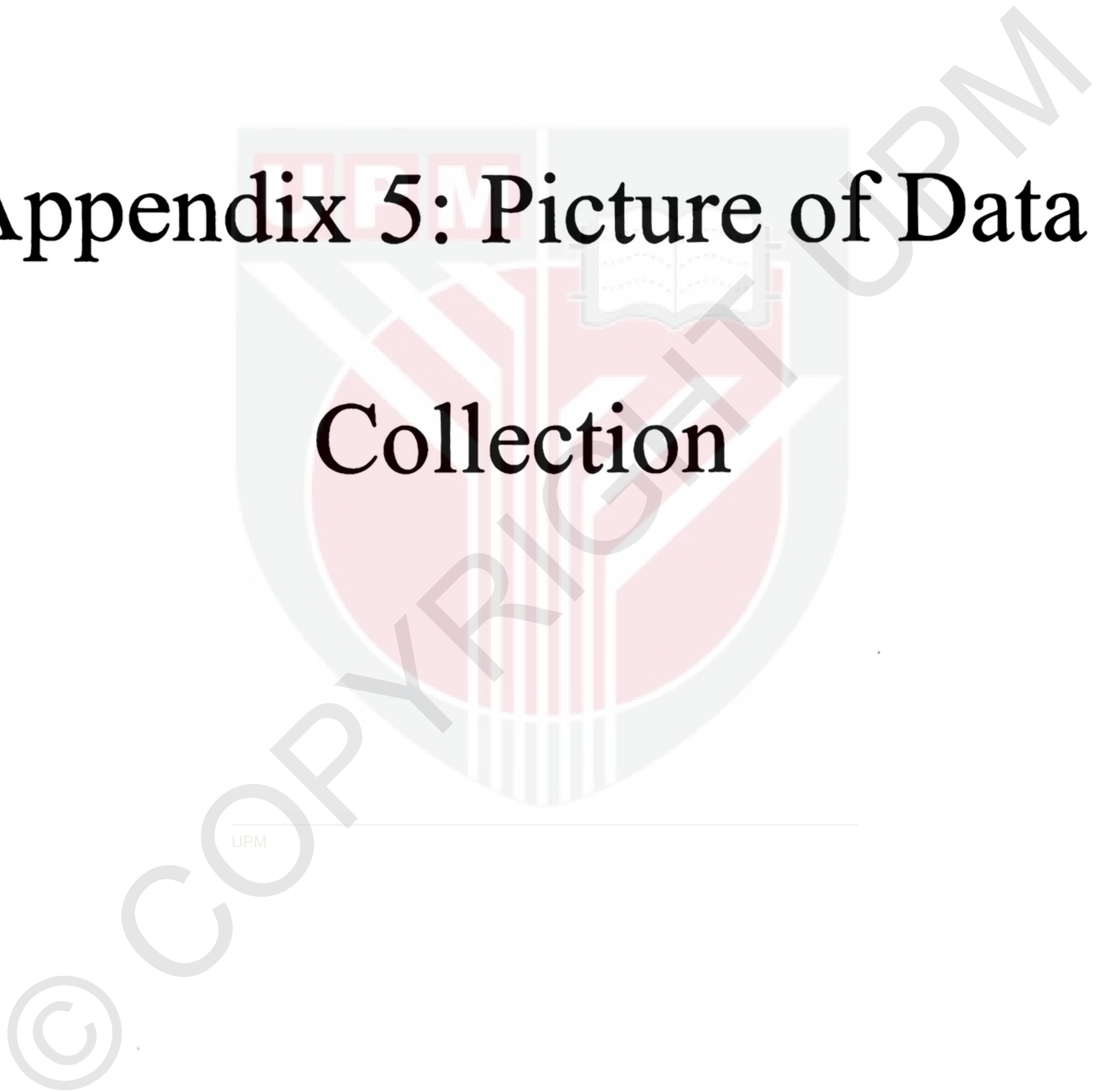
Appendix 5: Picture of Data Collection



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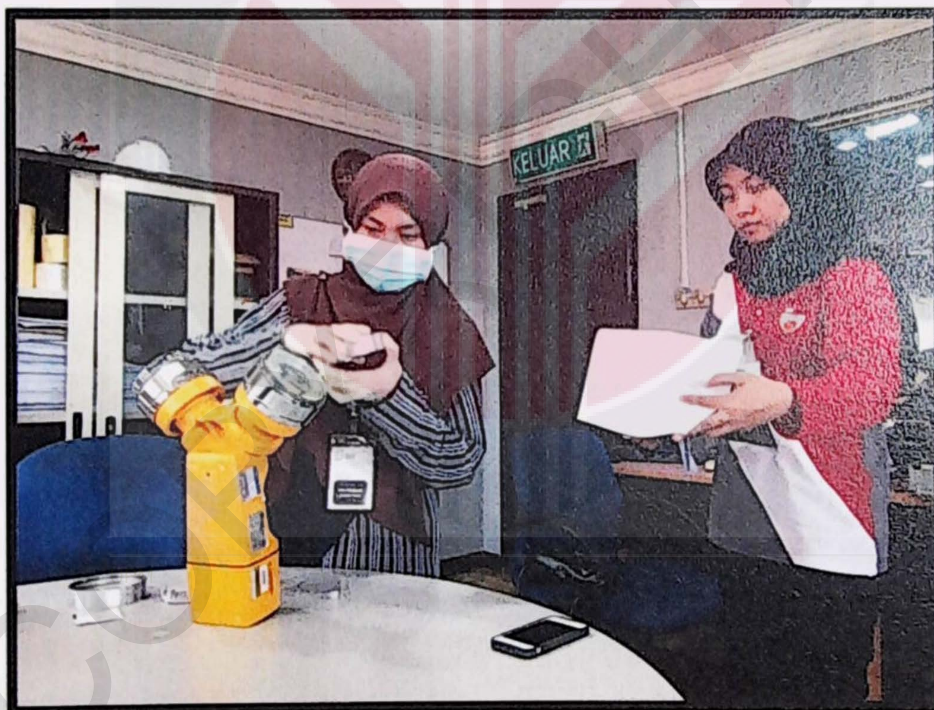
Picture 1: Setting of instrument before conducting the assessment



Picture 2: Installing of sample medium into the air sampler

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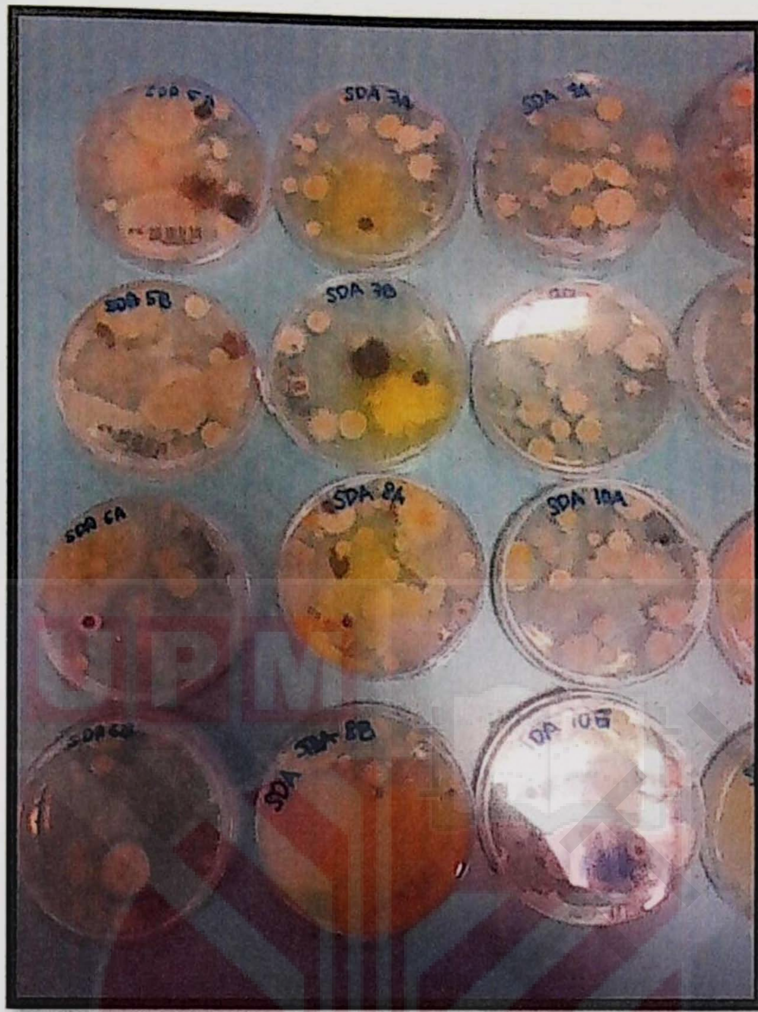

Picture 3: Some of the result growth on the agar medium

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