ASSESSMENT OF MOULD GROWTH TOWARDS OFFICE ENVIRONMENT QUALITY AT OFFICE BLOCK (UTP)

By

RAVENDREN NAIR

16739

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UniversitiTeknologi PETRONAS

Bandar Seri Iskandar

31750 Tronoh

Perak DarulRidzuan

ABSTRACT

In the early days of abundant resources and minimal development pressures, there was only little attention given to growing environmental concerns over here in Malaysia. Awareness only increased after the haze episodes in Southeast Asia in 1983,1984, 1991, 1994 and 1997 respectively which imposed threats to the environmental management of Malaysia. Air pollution can be divided into two categories, which involves both indoor and outdoor contamination of environment. On the other hand, as for the indoor air quality, it could be defined as building that can be compromised by microbial contaminants which are caused by mold and bacteria's, chemicals such as carbon monoxide and formaldehyde, allergens, or any mass or energy stressor which can induce health effects. Although a lot of researches have been done on the causes and impacts of air quality, but it was merely focused on outdoor air quality only. Therefore, concern about indoor air quality should be increased especially on the source of mold since it contributes to most of the health effects and symptoms. Moulds can be found almost everywhere whereby they can grow on virtually any organic substance, as long as moisture and oxygen are present. This study was prompted by concerns that both lecture rooms and office rooms at University Technology PETRONAS might not provide healthful environment for students or lecturers. These concerns were based on the potential of mould contamination which can be found inside the building. Therefore, lecturers office rooms at Block 13 in UTP was chosen to do the research findings. Feedback from lecturers are crucial to identify persons who may have particular health risks and to collect information useful for the next stage which is visual inspection. The survey form will gather information in terms of building occupancy rate, questions to document their knowledge of the building and also occupants observation on moisture or mold related problems. Total of twelve lectures are involved in giving feedback and responds to the online survey form. From the inspection been made, mould and mould stains have been spotted at the areas such as glass and window panel, ceiling, chair, cupboard, and also at the fibrous insulation for the HVAC system inside the office rooms. Conditions that prompted these mould contamination were further discussed and analyzed with additional information about recommendations to enhance this research is added in this report.

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INTRODUCTION

1.1 Background

In the early days of abundant resources and minimal development pressures, there was only little attention given to growing environmental concerns over here in Malaysia. Awareness only increased after the haze episodes in Southeast Asia in 1983,1984, 1991, 1994 and 1997 respectively which imposed threats to the environmental management of Malaysia. The government then established Malaysian Air Quality Guidelines, Air Population Index, and the Haze Action Plan to improve air quality (Afroz, Hassan, & Ibrahim, 2003).

Malaysia's API		
Air Pollution Index (API)	**Air Quality Category**	**Color Code**
0-50	Good	
51-100	Moderate	
101-200	Unhealthy	
201-300	Very Unhealthy	
301+	Hazardous	

Diagram 1 : Malaysia Air Pollution Index ("Air quality index," n.d.)

According to the Malaysian Air Pollution Index, API is an indicator of air quality and was developed based on scientific assessments to indicate in an easily understood manner, the presence of pollutants and their impact on humans health (Afroz et al., 2003). The measurements was done based on five major pollutants in the ambient air which includes sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and PM10. If the level of API reaches more than 500, a state of emergency is declared at that particular area.

Air pollution can be divided into two categories, which involves both indoor and outdoor contamination of environment by any chemical, physical or biological agent that changes the natural characteristic of the atmosphere. Sources such as household combustion devises, motor vehicles, industrial facilities and forest fires are common sources of air pollution (Lee, Li, & Ao, 2002). However, the three most common sources in Malaysia can be categorized into mobile sources, stationary sources, and also open burning sources. Mobile sources are consist of smoke which are been released from the motor vehicles. Where else, smokes from industries and also power stations are categorized under stationary sources. As for the open burning sources it includes merely from forest fire and open burning activities. Figure 1 represents about the percentage of different type of sources which contributes to air pollution in Malaysia.

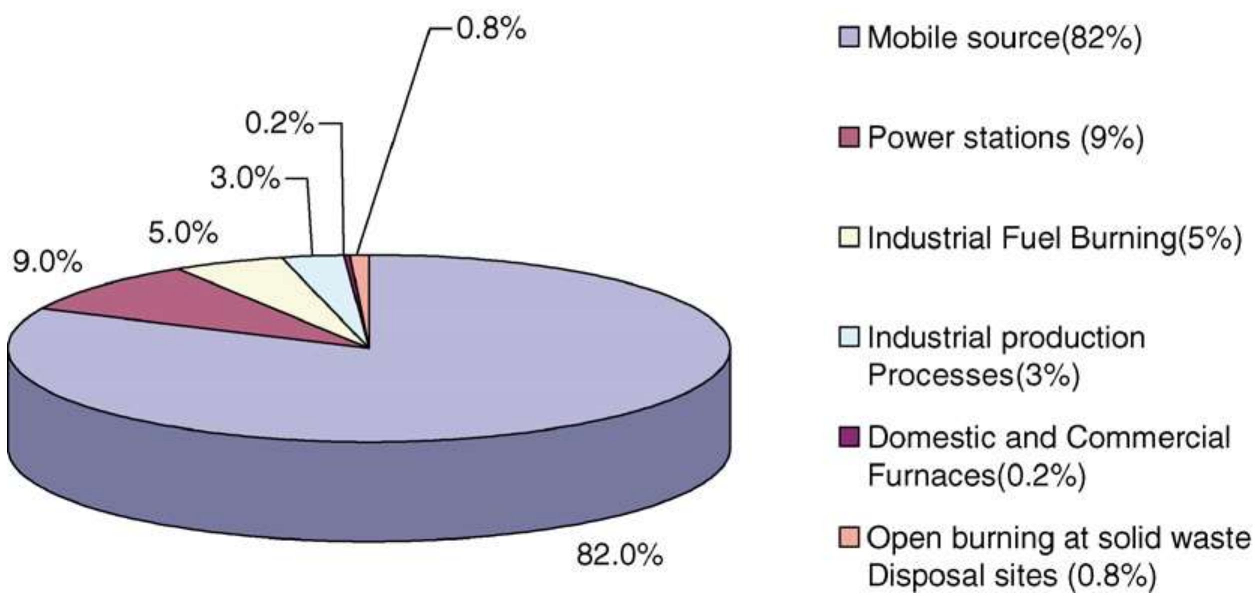


Figure 1: Sources of air pollution in Malaysia for 2015 ("Department Of Environment, Air pollutant index," n.d.)

According to the Department of Environment, the percentages of the air emission load by type were motor vehicles, 82 %, power stations, 9 %, industrial fuel burning, 5 %, industrial production processes, 3 %, domestic and commercial furnaces, 0.2 %, and open burning at solid waste disposal sites, 0.8 %.

On the other hand, as for the indoor air quality, it could be defined as building that can be compromised by microbial contaminants which are caused by mold and bacteria's, chemicals such as carbon monoxide and formaldehyde, allergens, or any mass or energy stressor which can induce health effects (Burton & Gibbins, 2011). During the past several years, people are starting to consider indoor air pollution has one of the major public health concern. This is mainly because, generally humans tend to spend more time indoor rather than outdoor (Ismail, Zafirah, Sofian, & Abdullah, 2010). Studies which have been conducted before this states that concentration of air pollutants were substantially higher indoors than outdoors (Burton & Gibbins, 2011). Therefore, indoor air quality is very crucial to people and communities. Indoor air pollution can be caused by many sources such as outdoor sources, cooking, smoking, building materials and furnishings, heaters and office equipments. It mainly depends on the type of building and also the condition of it.

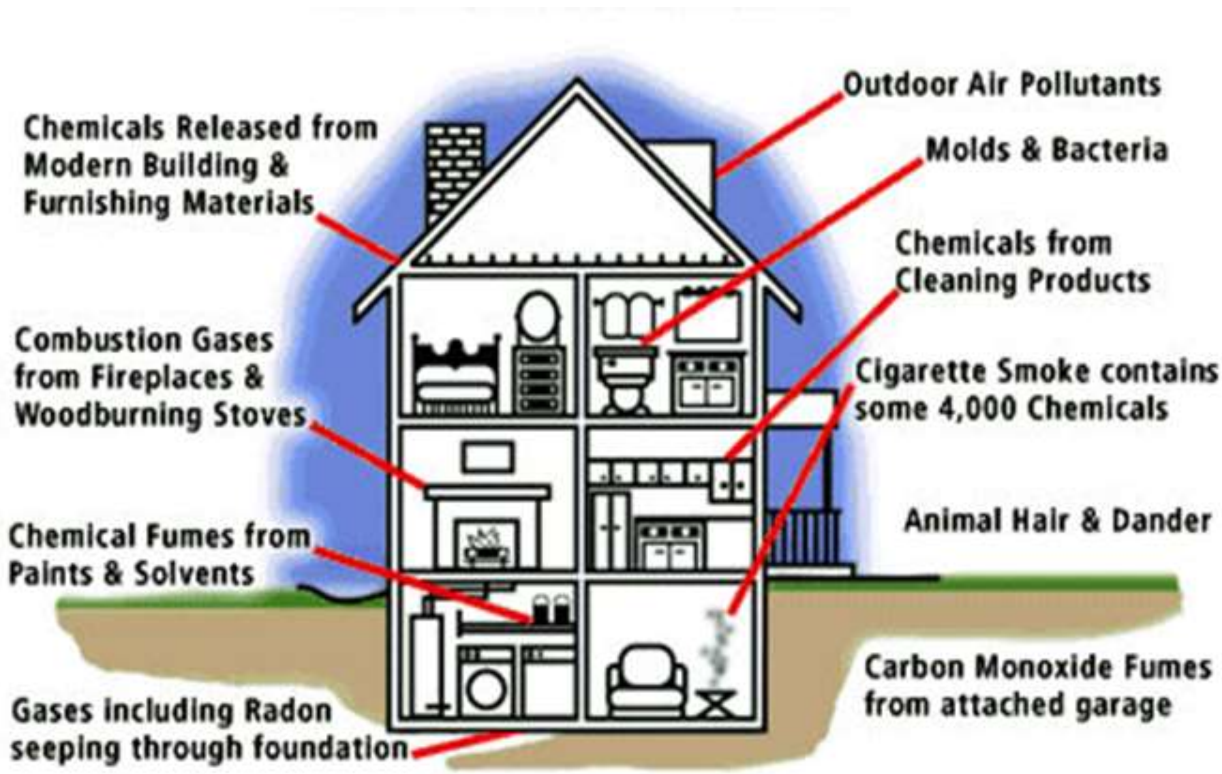


Figure 2: Sources of indoor air pollutants ("Indoor Air Quality IAQ Ottawa | Indoor Air Quality Ventilation Ottawa, 2015 n.d.)

Although a lot of researches have been done on the causes and impacts of air quality, but it was merely focused on outdoor air quality only. Therefore, concern about indoor air quality should be increased especially on the source of mold since it contributes to most of the health effects and symptoms. Moulds can be found almost everywhere whereby they can grow on virtually any organic substance, as long as moisture and oxygen are present (Roques & D'Orazio, 2012). It plays an important role in the decomposition of organic matter. The concentrations of fungal spores in the ambient air may vary greatly depending on the environment, the climate, the time of day and the season. Low humidity and characteristic of air movements at indoor spaces, provide favorable conditions for the living of mold. These mould spores can easily enter an indoor environment through open door airways, windows, heating, ventilation and air conditioning systems. Mold spores attach themselves to shoes, clothing and bags which are been brought in by people who enters a specific building (Haas et al., 2007). Besides that, an active growing mould can also be found at underneath sinks, potted plants, window sills, curtains, closets, papers and books that have absorbed moisture from the air and been holding that moisture content for some extended period of time. Figure 3 indicates a clear view of indoor mould resources .

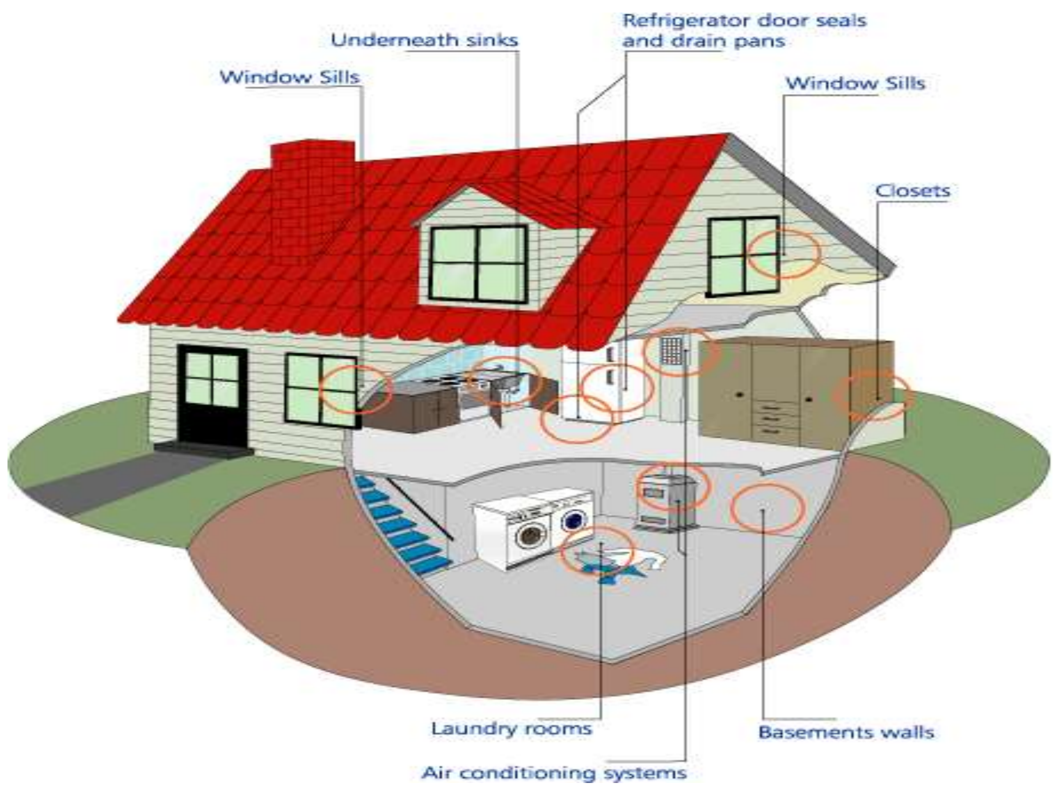


Figure 3: Indoor mould resources ("Indoor Air Quality IAQ Ottawa | Indoor Air Quality Ventilation Ottawa, 2015 n.d.)

There are many types of moulds exist. Certain types of moulds are toxigenic, whereby they can produce toxins (Burton & Gibbins, 2011). However the mould themselves are not toxic or poisonous. One of the moulds which are commonly found inside a building is Stachybotrys chartarum. It is black in color and produce its conidia in slime heads. Another common mold is Cladosporium which produces itself in olive green to brown or black colonies. Besides that, it is quite often to find green color mould which is called as Penicilium and also Aspergillus which is commonly been seen in either red or gold color. Figure 4 shows the image of different types of common indoor moulds.

Figure 4: Common indoor moulds (“Mold and Mildew - PaintPRO Magazine,” n.d.)

However, all the moulds have the potential to cause health effects. Allergic reactions or even asthma attacks in people whom are allergic to mold can be caused due to the allergens which are been produced by those molds (Bailey, Piacitelli, Martin, & Cox-ganser, 2013). Those potential health concerns are an important reason to prevent mould growth. Therefore, it is an important aspect to be prevent such mould contamination in buildings to have a better indoor air quality.

1.2 Problem Statement

This study was prompted by concerns that both lecture rooms and office rooms at University Technology PETRONAS might not provide healthful environment for students or lecturers. These concerns were based on the potential of mold contamination which can be found inside the building. Concern about indoor exposure to mould have to be increased as the public needs to be aware that exposure to mould can cause a variety of health effects and symptoms, including allergic reactions.

Moulds can produce allergens that can trigger allergic reactions or even asthma attacks in people whom are allergic to mould. Others are known to produce potent toxins or irritants. It is important to determine which type of mould is found inside a building to know the causes and effects of it and also to come up with the best solution method.

Since mould requires water to grow, it is important to prevent moisture problems inside a building. Moisture problems can have many causes, including uncontrolled humidity. Sweat can also be a possible factor which contributes to the humidity and it can be divided into types of gender .

Besides that, condition of rooms with window and roof leaks, poor air ventilation system and internal plumbing leaks can also increase the level of humidity inside a building. Therefore method of remediation for mold should be considered as well to prevent such cases from continuing.

Mould remediation means method of removing or cleaning the required area which are been contaminated with mould growth. Mould remediation's goal is to remove or clean mold-damaged materials using specific type of work practices that could protect the occupants by controlling the dispersion of mould from the areas being cleaned and protect cleanup those cleanup workers from exposure to mould. Normally moldy areas and items are been cleaned with detergent and water using the gentlest cleaning method available. This is to ensure the minimization of material that becomes airborne. Although there many types of remediation method been discovered, but the best and most cost effective method is yet to be known. This could be crucial in preventing such cases from happening in nearby future. Therefore, research on finding the best mould remediation method should be analyzed.

In a way, this study helps to identify indoor moulds, determine the root cause of mould, characteristics of mould found in building , best remediation method and also to provide useful information regarding the condition of indoor air quality in lecturers office rooms in Universiti Teknologi Petronas (UTP).

1.3 Objective

1. Identify the existence of mold in lecturer's office rooms
2. To compare the causes and effects of molds inside lecturers office rooms
3. Identify and recommend actions that can be taken to remedy and prevent mould contamination inside a building

LITERATURE REVIEW

2.1 Moulds

Moulds can be defined as a microscopic organism, simple, and can be found almost everywhere, indoor and outdoor (Nielsen & Gill, 2011). It plays a crucial role in breaking down the leaves, woods, and other plant debris. Without moulds, our environment would be filled with large amount of dead matters. There are many types of moulds existed on this planet. Some of it can be seen visually where else some of the moulds can only be detected using microscope. Vereecken & Roels (2012), came up with a method called as original mould index classification. This method comes in hand especially in identifying mould growth rate and also determining the severity of the contamination. Table 1 shows the classification of original mould index.

Index	Growth rate	Description		
0	No mould growth	Spores not activated		
1	Small amounts of mould on surface	Initial stages of growth	Microscopic level	
2	<10% coverage of mould on surface			
3	10-30% coverage of mould on surface, **or < 50% coverage of mould (microscope)**	New spores produced		Visually detectable
4	30-70% coverage of mould on surface, **or > 50% coverage of mould (microscope)**	Moderate growth		
5	>70% coverage of mould on surface	Plenty of growth		
6	Very heavy, dense mould growth covers nearly 100% of the surface	Coverage around 100%		

Table 1: Original mould index classification (Vereecken & Roels, 2012)

Most commonly mould can be seen living in the soil, on plants, and on dead or decaying matter (Roques & D'Orazio, 2012). However, it can be still found inside a building due to its capability of producing tiny spores to reproduce. It is some sort of a reproducing act just like some plants which produces seed. This special capability enhances the chance of mould spores to be brought inside a building . Some moulds have spores that can be easily disturbed by air and can be waft into the air and settle constantly inside a building. Where else, some of the moulds need humans and animals help to transfer its spores which is sticky by clinging itself to the surface and then will be dislodged by brushing against them or by any other direct contact (Roques & D'Orazio, 2012).

Although, mould spores plays a vital role in accommodating mould inside a building, there are still other factors which can still cause mold to be found in a building. Building conditions can lead to massive growth rate of mould within a short space of time (Haas et al., 2007). Mould tend to grow bigger and digest on whatever they are growing on in order to keep on reproducing when mould spores land on a damp spot. Most preferable place whereby you can find moulds in a building would be the damp or wet areas. This is mainly because, mould needs both food and water to survive and since it can digest most things, water is the factor that could limit the rate of moulds growth. Figure 5 shows in detail about the mould spore formation.

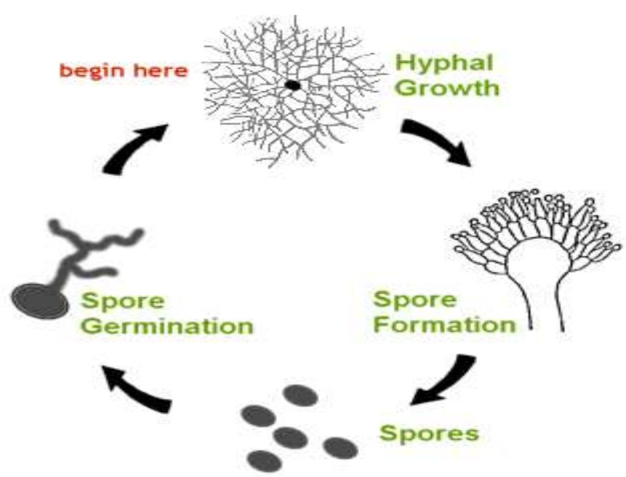


Figure 5: Mould spore formation (Dewain Tennant, 2015 n.d.)

Other condition, which contributes to the mould growth in a building would be the temperature. Air always contains a required amount of water vapor, however the maximum vapor content depends on the temperature of the room. There are numerous studies been conducted relating temperature and humidity conditions in which different types of building materials begin to mould (Johansson, Ekstrand-Tobin, Svensson, & Bok, 2012).

However it is clearly proven that a building, which has a ratio of high dampness will certainly increase the amount of mould contamination in it. Based on the research made by Hull (2003), the concentration of mould found in a non-leaky room is slightly lower than the amount of mould found at a nearby outdoor air. Whereby, high concentration of mould was found at leaky rooms which certainly has much high level of dampness compared with the other conditions. Table 2 shows the result which has been obtained from a research been made at different types of room conditions.

Fungal taxa	Location		
	Outdoor air	Leaky rooms	Non-leaky rooms
Cellulose agar			
Cladosporium cladosporioides	206.6	71.1	137.3
Cladosporium sphaerospermum	27.1	9.1	16.7
Alternaria alternata	7.8	2.3	1.3
Penicillium aurantiogriseum	0.4	5.3	1.2
Penicillium brevicompactum	16.3	6.3	11.4
Penicillium chrysogenum	4.0	210.8	6.3
Penicilllium commune	nd	12.6	0.3
Penicillium crustosum	0.6	21.9	1.0
Non-sporulating fungi-hyaline	5.0	61.9	110.8
Stachybotrys chartarum	0.06	0.5	nd
Ulocladium sp.[b]	2.6	0.9	0.4
[*Cladosporium* + *Alternaria* + *Epicoccum*]	268.1	92.4	165.9
[*Penicillium* + *Aspergillus*]	49.2	420.1	26.0
Total fungi	341.7	580.1	311.0
DG-18 agar			
Cladosporium cladosporioides	169.2	61.2	493.4
Cladosporium sphaerospermum	22.8	15.6	79.6
Alternaria alternata	6.7	0.9	1.2
Penicillium aurantiogriseum	1.1	15.0	nd
Penicillium brevicompactum	20.6	21.4	4.7
Penicillium chrysogenum	17.6	228.2	73.5
Penicilllium commune	0.5	54.2	0.6
Penicillium crustosum	0.3	163.2	0.7
Penicillium spinulosum	1.0	46.2	nd
Non-sporulating fungi-hyaline	7.6	45.0	23.1
Aspergillus versicolor	1.8	7.4	0.4
[*Cladosporium* + *Alternaria* + *Epicoccum*]	204.8	91.7	531.8
[*Penicillium* + *Aspergillus*]	72.0	565.2	90.9
Total fungi	300.0	712.0	675.3

Table 2 : Concentration of mould in leaky, non leaky and in the outdoor air which is measured in

(cfu m−3)a (Morey, Hull, & Andrew, 2003)

2.2 Types Of Indoor Molds

Stachybotrys chartarum is one of the most common mould which can be found inside a building. Commonly can be seen in black color. It is a cellolulytic genus which can easily grow on cellulose containing compounds (Foladi, Hedayati, Shokohi, & Mayahi, 2013). These specific type of compounds can be found at various area in a building such as in pipe insulation, water leakage parts, wood, ceiling tiles, wall paneling, unpainted plaster board surfaces, cardboard boxes, stacks of newspapers, gypsum, fiberglass, wallpaper, cotton and many more. Stachybotrys spores are sticky while the condition is still moist, but the fungus becomes powdery when the substrate dries out.

Its unique characteristic of small size and ellipsoid shaped allows them to be inhaled and reach to the lower respiratory tract (Vereecken & Roels, 2012). Besides that, Stachybotrys chartarum is a well known producer of a number of potent mycotoxins, including macrocyclic trichothecenes, roridin, satratoxins and isosatratoxins. Studies have indicated that these mycotoxins contributes to the sick building syndrome (SBS) (Syazwan Aizat, Juliana, Norhafizalina, Azman, & Kamaruzaman, 2009). Furthermore, some researches have also been proven that Stachybotrys chartarum could lead to some serious complications in infants. In almost 6% of the analyzed buildings, Stachybotrys was detected in indoor atmosphere with a median concentration of 12 CFU m^{-3} (Foladi et al., 2013). Figure 6 shows microscopic view of a Stachybotrys chartarum mould.

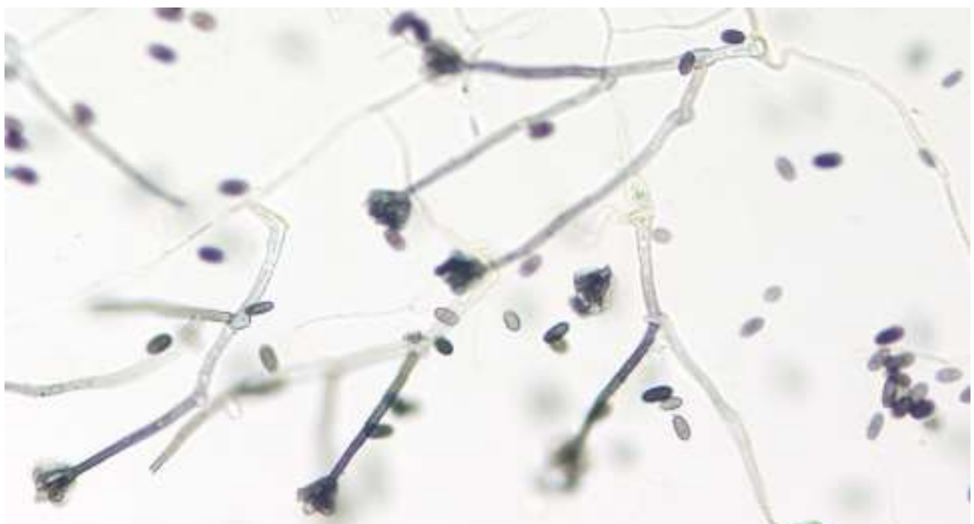


Figure 6: Stachybotrys chartarum (Foladi et al., 2013)

Another common type of mould is known as Cladosporium. It is normally formed in colonies which is either in green or black color. Similar to Stachybotrys chartarum, this specific type of mould grows well on cellulose surfaces (Terr & Francisco, 2004). It is often found growing in soil, plant litter and decaying plants as well as on leaves. Where else inside a building, it is normally spotted at areas such as wallpaper, carpet, moist window sills, tile grout, subfloor and often in bathrooms whereby the relative humidity is normally above 50%. Besides that , it does produce toxins known as cladosporin and emodin (Hernberg, Sripaiboonkij, Quansah, Jaakkola, & Jaakkola, 2014). Although Cladosporium is a very rare cause of human illness, but it has been known to cause several different types of infections including skin, eye, sinus and also brain infections (Jones, 1999). According to a research made by Haas (2007), Cladosporium were most frequently found at indoor spaces without visible mould growth. This proves that at times it is quite difficult to identify this specific type of mould in a building. Therefore sampling method is crucial in determining Cladosporium contamination in a building. Figure 7 shows microscopic view of a Cladosporium mould.

Figure 7: Cladosporium (Hernberg et al., 2014)

Penicilium is a type of mould which is green in color and it is also listed in one of the most common indoor moulds. However, Penicilium is commonly called as the blue or green mould because of its unique capability of producing enormous quantities of greenish, bluish or even yellowish which gives it the characteristic of color (Kung, 2010). It often produces microbial volatile organic compounds that makes it to have a musty odor. Thus it can be spotted at growing in soil, decaying plant debris, compost piles and fruit rot. As for the indoor area, it is normally can be seen growing on water damaged building materials such as plywood, wallpaper, carpet as well as on food items like cheese, fruits and cereals (Lee, Guo, Li, & Chan, 2002). Penicilium also produces various type of toxins such as penicilic acid, decumbin, patolin, ochratoxin and many more. The detection of Penicilium in a research conducted by Haas (2007), whereby it was done in an apartment shows clearly that the concentration of Penicilium is way much higher than the other types of mould. Due to the increasing size of affected area, spore concentrations of Penicilium in indoor air rose significantly (Haas et al., 2007). Figure 8 represents details of the research finding.

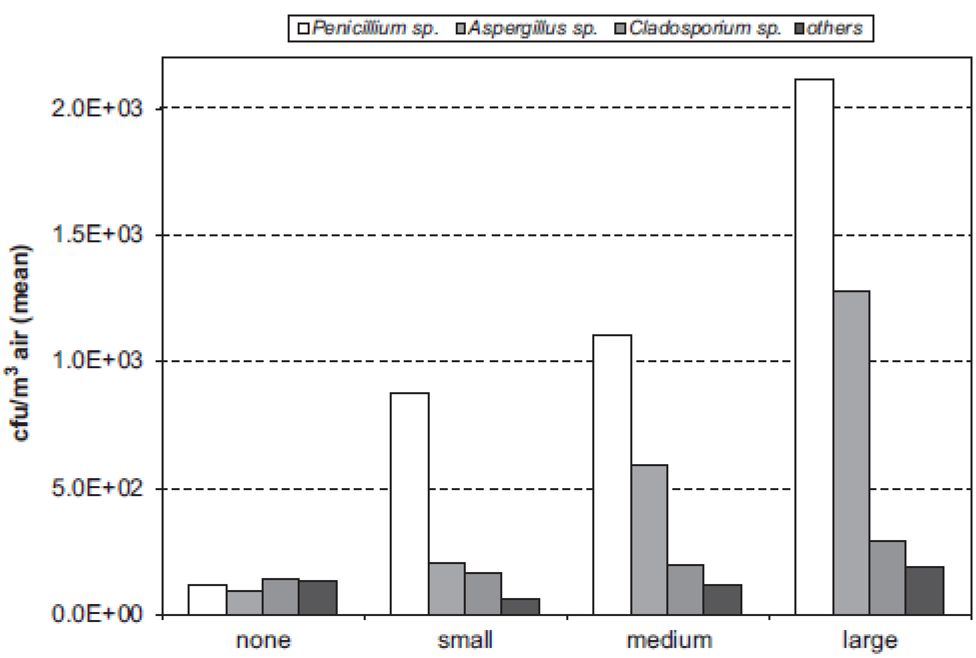


Figure 8: Indoor air borne concentrations (CFUm_3) air related to extent of mold growth categories (Haas et al., 2007)

Penicilium can cause some people to experience symptoms like hay fever, asthma, and hypersensitivity pnuemonitis. Due to its allergenic capabilities, it is widely recommended to have professional remediation to be done at those affected buildings. As for the air samples analyzed through direct microscopy, it is hard to differentiate between spores of Penicilium from those of Aspergillus . This could be also a reason on why most of the times both of these moulds are often reported as Penicilium or Aspergillus (Kung, 2010). Figure 9 presents a microscopic view of a Penicilium mould.

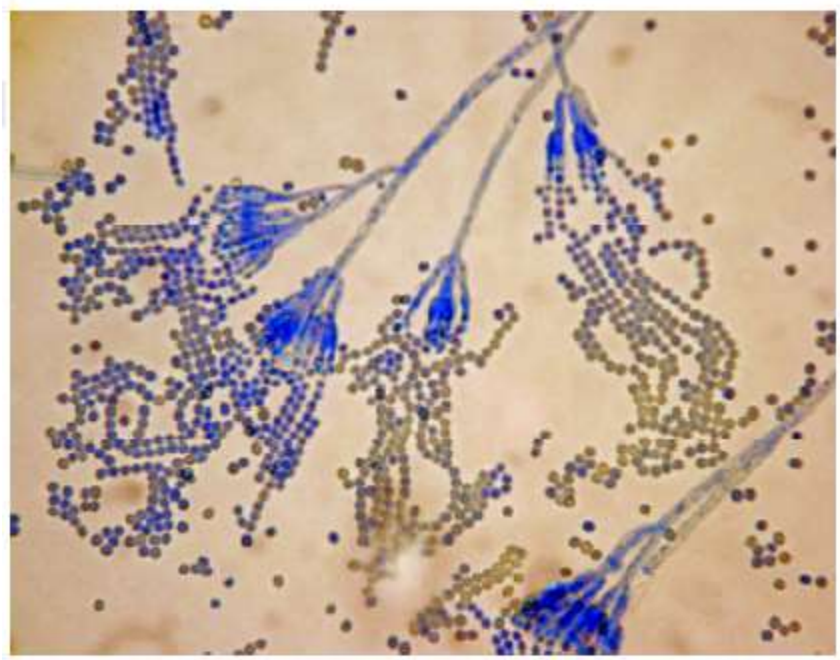


Figure 9: Penicilium (Kung, 2010)

Another type of indoor mould which can be identified almost all the time would be Aspergillus. It is commonly been detected in either red or gold color. Microbiologists have identified over 200 types of Aspergillus species (Whittaker & Ph, 2009). It grows in the same type of environment as the other 3 types of mould which have been mentioned earlier. Aspergillus can be classified under three different categories which is Aspergillus niger, Aspergillus flavus and Aspergillus fumigatus (Terr & Francisco, 2004). Aspergillus niger can grow on a large varity of items and causes "fungal ball" whereby the fungus multiplies quickly inside a human lung while forming a ball, tough it doesn't invade the lung tissue. Where else, Aspergillus flavus produces toxin which is called as aflatoxin, which is one of the most potent carcinogen (Johansson et al., 2012). Lastly the most common type of Aspergillus is known as Aspergillus fumigatus. This specific type of mould can be very hazardous whereby it could cause people whom are exposed to it too much to develop a hypersensitivity to the spores and could suffer from relentless allergic reactions (Whittaker & Ph, 2009). According to Whittaker and Ph (2009), potent toxins which are been produced by Aspergillus has the capability to withstand environmental elements that could destroy most other toxins. Therefore, medical professionals in US regard it as more influential in affecting human health compare with other types of moulds (Foladi et al., 2013). Figure 10 shows the microscopic view of a Aspergillus mould.

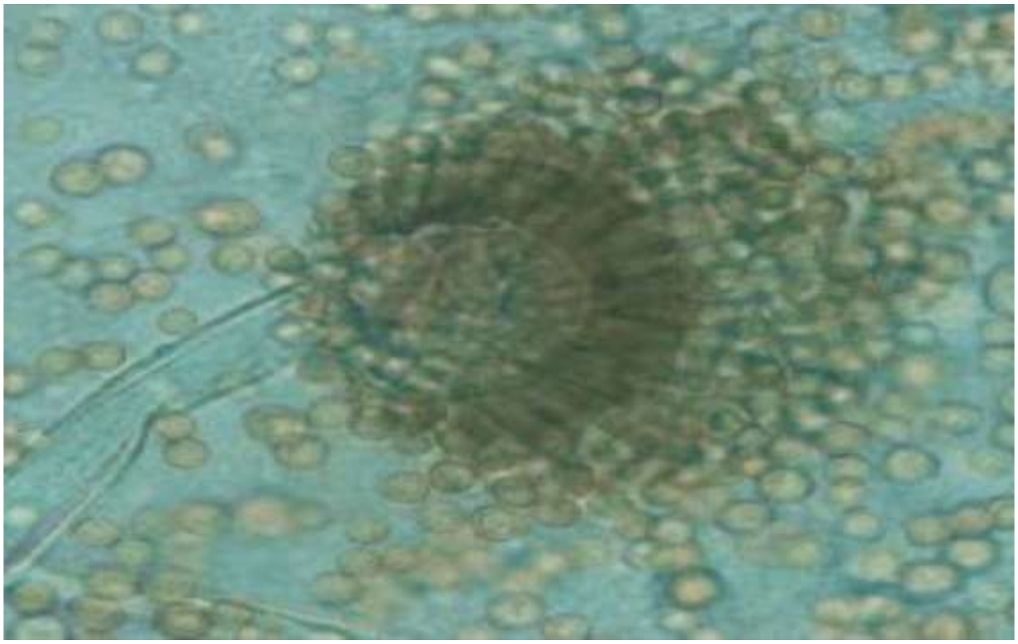


Figure 10: Aspergillus (Foladi et al., 2013)

2.3 Causes Of Mould In A Building

Moisture content could be a crucial point in finding the existence of mold in a building. This is merely because of its characteristics which requires water to grow. Common places whereby mould could be detected in a building would be areas like bathroom tile, basement wall, areas around windows where moisture condenses, and near leaky water fountains or sinks (Vereecken & Roels, 2012). All these areas have a high level of moisture content. Besides that, materials that could be find inside a building such as wallpapers and carpet, may not allow moisture to escape easily. Other common moisture problems in a building includes roof leaks, deferred maintenance, condensation associated with high humidity or cold spots, localized flooding due to plumbing failures or heavy rains, slow leaks in plumbing fixtures, and also malfunction or poor design of humiliation systems. Particularly in hot and humid climates, source of moisture leading to mould growth could be uncontrolled humidity (Owners, 2006). Water vapor from unvented or poorly vented areas like kitchen, bathrooms, combustion appliances, and steam pipes can also create conditions for mould to grow. Therefore it is a crucial factor to maintain a good air ventilation system in building. Figure 11 , 12, and 13 are obtained from the investigation made by Owners (2006), which is conducted in schools and commercial buildings.

Figure 11: Mould growth in a closet due to condensation of room air (Owners, 2006)

Figure 12: Mould growth on air diffuser in ceiling (Owners, 2006)

Figure 13: Mould growth at the back side of wallboard (Owners, 2006)

2.4 Effects Of Mould In A Building

One of the major effects of mould contamination in a building is reduction of indoor air quality. Indoor air quality is influenced by microbial contaminants or particulates that could result in poor health conditions. This is crucial because indoor air quality is one of the most important factor that influence our daily life quality. It is merely because human tend to spend about 80- 95 % of their lives at indoor rather than at outdoor (Reijula, 2011). For a very long time, we have ignored the fact that mold could interact directly with human body causing philological disorders, intoxications and infections. However only when the reorganization of the sick building syndrome during 1970s and in many cases has proved the connection between human and mould contamination which hereby launched again the interest in the study of indoor mould (Cabral, 2010). Poor indoor air quality can be a major factor that leads to sick building syndrome. The sick building syndrome is defined as a spectrum of varied symptoms and signs that include nasal drainage, itchy, watering eyes, headaches, fatigue, generalized malaise, and increased airway infections (Jones, 1999). The symptoms can be noticed only after entering a building and it will immediately disappears within a short period of time after leaving the building.

Most people have not experience health effects from exposure to the moulds present at indoor. However, some individuals who has underlying health conditions could be more sensitive to moulds. Individuals who have asthma, sinusitis, or other lung diseases could be affected more easily. The most common health effects associated with mould exposure includes eye irritation, coughing, congestion, sneezing, runny nose, aggravation of asthma, and skin rash (Owners, 2006). Besides that, mould can also sauce much more severe health reactions such as hypersensitivity pneumonitis. Toxins that are been produced by moulds which are causing the reactions in humans. Therefore, preventative measures of mould should be considered seriously to create a better indoor air quality for humans to live. Table 3 represents clinical data obtained from published cases of Terr & Francisco (2004). It gives a brief information about mould and its effects on humans in United Kingdom.

Reference	History attributed to mold exposure	Physical examination	Affected building	Specific mold(s) implicated
Croft et al, 1985[16]	5 persons: cold, flu, sore throats, diarrhea, headaches, fatigue, dermatitis, alopecia, malaise	Repeatedly negative	Home	*Stachybotrys* species
Brunekreef et al, 1989[22]	6273 US children (respiratory questionnaire); no control subjects	Not done	Homes	Total molds, spores
Platt et al, 1989[25]	1169 UK children in 597 households: excess bad nerves, aching joints, nausea and vomiting, backache, blocked nose, fainting spells, constipation, breathlessness	Not done	Homes (measured dampness or mold)	Total molds, spores
Strachan et al, 1990[24]	Children with asthma wheezed more in homes with higher mold counts	Yes, spirometry	Homes (mold quantitation)	Total molds, spores
Hyndman, 1990[26]	345 Bengalis in London: depression was only symptom related to mold spore count	Not reported	Homes	Total molds, spores
Johanning et al, 1993[17]	43 workers: questionnaire to elicit symptoms but no control subjects	Not done	Office	*Stachybotrys* species
Augur et al, 1994[28]	13 members of 4 families: chronic fatigue and URIs on the basis of alleviation of symptoms after relocation	Not reported	Homes	*Penicillium* species, *Trichoderma viride*, *Phoma* species
Li and Hsu, 1996[23]	1370 children: questionnaire for self-report of dampness, mold, and respiratory symptoms	Not done	Homes	Total molds, spores
Johanning et al, 1996[19]	53 workers and 21 control subjects: questionnaire history (air and surface sampling for molds not done for control subjects)	Not done	Office	*Stachybotrys* species
Hodgson et al, 1998[18]	197 workers: questionnaire history, "case-control" study (control buildings not tested for mold quantitation)	Not Done	Office	*Aspergillus* species, *Penicillium* species, *Stachybotrys* species
Cooley et al, 1998[20]	622 adult workers at 48 schools with indoor air quality complaints; no control subjects	Not done	Schools	*Penicillium* species, *Stachybotrys* species
Johanning et al, 1999[21]	Descriptive study: 22 children and 125 adults with multiple symptoms	Done but not reported	Homes (no data on fungal exposure)	*Stachybotrys* species
Santilli and Rockwell, 2003[27]	Rhinitis questionnaire: 85 students and teachers	Not done	2 schools	Total molds, spores

UK, United Kingdom; *URI*, upper respiratory tract infection

Table 3: Clinical data from published cases (Terr & Francisco, 2004)

2.5 Mould Remediation Of Building

According to Owners (2006), mould remediation is defined as prevention method done to prevent mold and mold spores from being dispersed into the air whereby it could be inhaled by the indoor occupants. It is necessary to do cleaning at areas which are been infected with mould because dead mould is still allergenic and some are potentially toxic. The key factor in controlling mould is moisture control. Most important initial prevention is done by visual inspection. Regular checking of the buildings envelope and drainage systems should be made to ensure that they are in working order (Haas et al., 2007). Besides that sources of dampness, high humidity and moisture should be eliminated.

Moisture due to condensation can be prevented by increasing the surface temperature of the material where condensation is occurring. Or else, it could be done by reducing the moisture level in the air which is the humidity level (Syazwan Aizat et al., 2009). To reduce the moisture level in the air, repair leaks and also increase air ventilation. Indoor relative humidity should be always remained below 70 % according to Owners (2006). Besides that, ventilation systems should be always checked and cleaned particularly for damp filters and overall cleanliness. This is because components which are exposed to water such as drainage pan, coils, cooling towers and humidifiers can increase the chances of mold spores to be released into the indoor air stream.

Another prevention method would be the cleaning process of air duct in a building. Generally, air duct cleaning refers to the various types of heating and cooling systems. The components of these systems has high potential to have moisture content which could result in mould contamination if cleaning is not done regularly (Roques & D'Orazio, 2012). Other than that, a constant inspection inside the building is required to identify water leaks, problem seals around doors and windows, and visibility of mold in moist or damp part of the building. Based on a research made by Owners (2006), he has concluded the best strategies to respond to water damage within 24 - 48 hours. These guidelines are designed especially to help avoid the need for remediation of mould growth by taking quick action even before the mould starts to grow. Table 4 represents the details of the research.

Guidelines for Response to Clean Water Damage within 24 – 48 Hours to Prevent Mold Growth*	
Water-Damaged Material[†]	**Actions**
Books and papers	* For non-valuable items, discard books and papers. * Photocopy valuable/important items, discard originals. * Freeze (in frost-free freezer or meat locker) or freeze-dry.
Carpet and backing – dry within 24 – 48 hours[§]	* Remove water with water extraction vacuum. * Reduce ambient humidity levels with dehumidifier. * Accelerate drying process with fans.
Ceiling tiles	* Discard and replace.
Cellulose insulation	* Discard and replace.
Concrete or cinder block surfaces	* Remove water with water extraction vacuum. * Accelerate drying process with dehumidifiers, fans, and/or heaters.
Fiberglass insulation	* Discard and replace.
Hard surface, porous flooring[§] (Linoleum, ceramic tile, vinyl)	* Vacuum or damp wipe with water and mild detergent and allow to dry; scrub if necessary. * Check to make sure underflooring is dry; dry underflooring if necessary.
Non-porous, hard surfaces (Plastics, metals)	* Vacuum or damp wipe with water and mild detergent and allow to dry; scrub if necessary.
Upholstered furniture	* Remove water with water extraction vacuum. * Accelerate drying process with dehumidifiers, fans, and/or heaters. * May be difficult to completely dry within 48 hours. If the piece is valuable, you may wish to consult a restoration/water damage professional who specializes in furniture.
Wallboard (Drywall and gypsum board)	* May be dried in place if there is no obvious swelling and the seams are intact. If not, remove, discard, and replace. * Ventilate the wall cavity, if possible.
Window drapes	* Follow laundering or cleaning instructions recommended by the manufacturer.
Wood surfaces	* Remove moisture immediately and use dehumidifiers, gentle heat, and fans for drying. (Use caution when applying heat to hardwood floors.) * Treated or finished wood surfaces may be cleaned with mild detergent and clean water and allowed to dry. * Wet paneling should be pried away from wall for drying.

Table 4: Actions required to prevent mould growth in water damaged material (Owners, 2006)

METHODOLOGY

3.1.1 Location Of Study

This study was conducted at lecturers office room which is located at Block 14 respectively at Universiti Technologi Petronas, Bandar Seri Iskandar. Universiti Technologi Petronas has a site area of 400 hectares, of which 275 hectares are forest with hills and valleys, and the remaining 125 hectares are plain with lakes and dunes. There is a difference of 110meteres between the highest and lowest points of the site. This indicates the humidity level outside the building is high due to the surrounding nature plus the inhabitance of animals such as monkeys and birds are present as well. Both these factors could be a crucial factor in determining the existence of indoor mould in this research. Figure 14 and figure 15 shows map location and also the aerial view of Universiti Technologi Petronas (UTP).

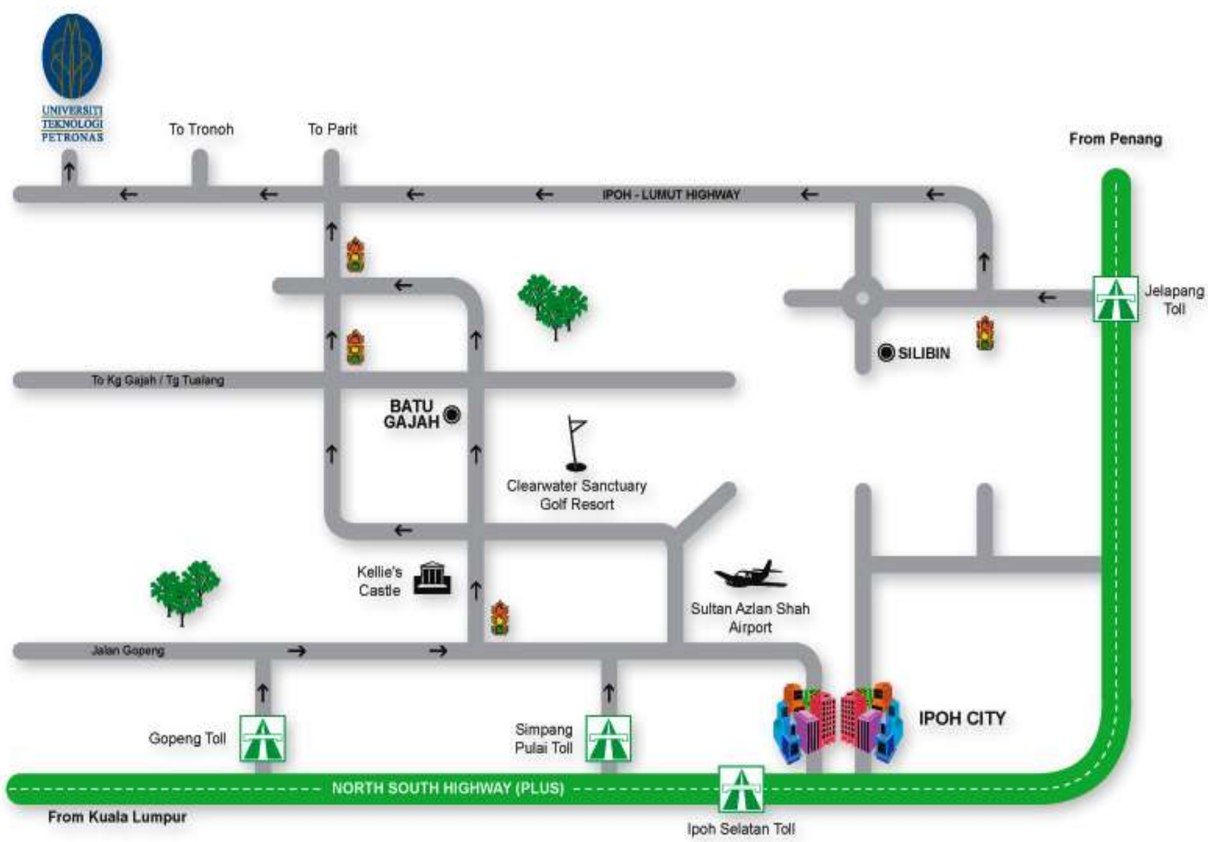


Figure 14: Map location of Universiti Teknologi Petronas (Kara,2007)

Figure 15: Aerial view of UTP (Kara, 2007)

There are a total number of 30 office rooms in Block 14. In total it can be occupied by 30 lecturers. The academic building is facing east with large window glazing area which has nearly 100% of glazing area and it is located on above 32m of sea level. It has three levels with 4m height on each floor. The lecturers office rooms are located at top most floor which is at level 3. The layout of the lecture's office rooms are the divided into two sections at level 3 of the buildings. Figure 16 shows the layout of academic building at level 3, Figure 17 shows sketched diagram of academic block elevation and Figure 18 presents the captured image of Block 14.

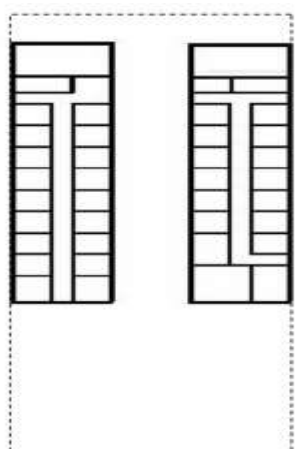


Figure 16: Layout plan of lecturers office rooms at Level 3 (Bhaskoro, Gilani, & Aris, 2013)

Figure 17: Sketched diagram of academic block elevation (Bhaskoro et al., 2013)

Figure 18: Block 13 & Block 14

3.1.2 Office Rooms Details Of Block 14

Where else, the details of building materials which are been used for the block is presented in Table 5. Plasterboards are been used in office rooms as partition walls and also optiwhite type of glass window is installed at the whole block including the office rooms. Both these materials could contribute to the level of humidity inside the office rooms which could lead to mold contamination.

Building construction	Details (thickness-thermal conductivity)
External wall	Steel (5 mm-54 kJ/h m K), Air gap (0.047 hm^2 K/kJ), Steel (11 mm-54 kJ/h m K)
Partition wall	Plasterboard (25 mm-0.576 kJ/h m K), Air Gap (92 mm-0.047 h m^2 K/kJ), Plasterboard (25 mm-0.576 kJ/h m K)
Flooring	Concrete slab (100 mm-4.07 kJ/h m K), Common concrete (550 mm-7.56 kJ/h m K)
Window	Optiwhite glass (8 mm-0.9 kJ/h m K)
Roofing	Aluminium (1 mm-846 kJ/h m K), Rockwool (25 mm-0.162 kJ/h m K), Aluminium foil (1-846 kJ/h m K), Common concrete (10 mm-7.56 kJ/ h m K)

Table 5: Block 13 & 14 Building material specification (Bhaskoro et al., 2013)

As for the HVAC (heating, ventilation, air conditioning) system is concerned, a centralized AC ((air conditioning) system with absorption chiller was used to cover the cooling load for all the academic blocks. Each level has two wings of group zones which are labeled as left and right wings. The building is fully sealed and fresh air is supplied by the air handling unit on each floor. There are two air handling unit on each level. Air handling unit 1 is used to provide air supply to right wing where else air handling unit 2 is for the left wing. A variable fan speed and also a regulating valve is installed to give variable supply of air and chilled water flow rate. Besides that, the HVAC system use variable air volume system to control supply of air flow rate entering the room according to the cooling load. The AC system is being operated from 7 am till 7 pm every day. Indoor humidity level would be kept floating depends on the indoor temperature. Therefore HVAC system conditions in office rooms are crucial as well for this research.

Diagram 2 shows the air conditioning duct located outside of office room , diagram 3 and diagram 4 presents the condition inside office rooms where else diagram 5 and 6 presents the condition at outside of lecturers office rooms. All these figures are been captured at level 3 Block 14 respectively.

Diagram 2: Air conditioning duct outside office rooms

Diagram 3: Plasterboard material used for ceiling and optiwhite type of glass window is used both inside and outside the lecturers room

Diagram 4: Lecturers office rooms at both side

Diagram 5: Outside lecturers office rooms

Diagram 6: Outside lecturers office rooms

3.1.3 Office Room Occupancy Rate

Working schedule for lecturers has 5 working days which is from Monday till Friday and has a total of 8 hours per day which is from 8am till 5pm. Generally, there will be no occupancy during Malaysia national Holidays and also on weekends. However, lecturers won't be inside their office rooms all the time as they might have other commitments such as going for meetings and giving lectures for students. It is important to determine the exact amount of time being spent by lecturers in their respective office rooms daily. This information could lead to a useful data gathering especially on health effects on humans caused by mold contamination.

3.2.0 Information Gathering

3.2.1 Survey From Respondents

A survey is created using questionnaires and then will be distributed to the respective occupants whom are the lecturers. Questions are related to demography, office room observation, health condition, ratings based on observation and also the opinions and knowledge of lecturers on indoor air quality specifically about this research study. This information would be crucial in determining the importance of this study which has the title of assessment of mould growth towards environment quality at office block. Besides that, it can also provide useful information which could be a potential lead in determining the existence of mould in lecturers office rooms. Tools which was used to prepare this survey was obtained from website www.surveyplanet.com. It is an online survey creation method which can gather information and data analysis in a short period of time depending on the feedback of the respondents.

3.2.2 Visual Inspection

Checklist is created and then would be inspected in order to know the real conditions inside the lecturers office rooms. Mainly it is done to gain information on the HVAC system which has details such as distance from the office room, contaminant sources, blockages, and also malfunctions. Besides that, data's such as amount of books and papers stored inside the office rooms and also presence of carpet is included in the checklist. This visual inspection will be conducted in all the office rooms at one section of the block which is located at Block 14. Total number of twelve (12) office rooms will be inspected using the checklist. By doing this inspection, it could give a lead in identifying the office rooms which has high and low potential of mould contamination. Tools which was used in creating this checklist is Microsoft Document 2007. Devices such as hand phones and cameras was also used in capturing the images inside the office rooms. Purpose of capturing image is to get a clearer view of the condition inside office rooms and also to capture the images of mold found inside the building. This could be a crucial factor in achieving the objective of this research.

3.3.0 Project Gantt Chart And Key Milestone

The project Gantt chart and key milestone for both final year project (FYP) 1 AND (FYP) 2 are as in Table 6 and Table 7.

Table 6: The project Gantt chart and key milestone for (FYP) 1

NO	PROGRESS	1	2	3	4	5	6	7	MIDSEM BREAK	8	9	10	11	12	13	14
1	Selection of project topic															
2	Preliminary research work															
3	Submission of extended proposal															
4	Proposal defense															
5	Project work continues															
6	Submission of Interim Draft Report															
7	Submission of Interim report															

Key milestone

Process

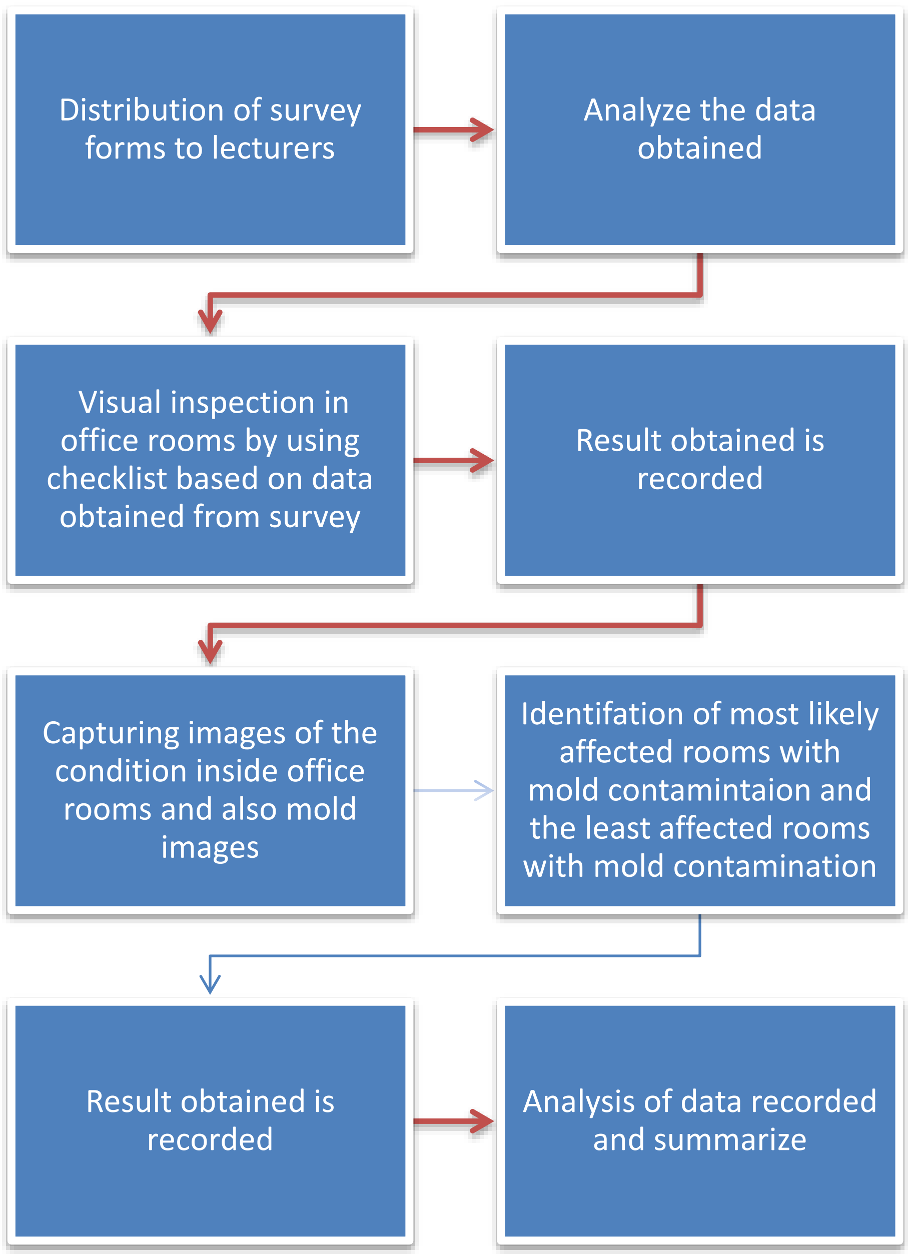
Table 7: The project Gantt chart and key milestone for (FYP) 2

NO	PROGRESS	1	2	3	4	5	6	7	MIDSEM BREAK	8	9	10	11	12	13	14
1	Project work continues	■	■	■	■	■	■	■								
2	Submission of Progress Report									●						
3	Project Work Continues															
4	Pre-SEDEX									■	■	■	■	■		
5	Submission of Draft Report												●			
6	Submission of Dissertation (soft bound)													●		
7	Submission of Technical Paper													●		
8	Oral Presentation															●
9	Submission of Project Dissertation (hard bound)															●

Key milestone ●

Process ■

3.4.0 Methodology Flowchart



RESULT AND DISCUSSION

4.1 Online Survey Form

The online survey form was distributed to those respective lecturers whom offices are located at Block 14. After obtaining their email address from e- learning website (www.elearning.edu.utp), it is then been forwarded to their emails to complete the survey forms. The survey form in total consists of twenty four questions. Whereby it is divided into five sections which includes Section A: demography, Section B: office room observation, Section C: health condition, Section D: ratings based on observation and lastly Section E: opinion and knowledge. Introduction about mould is also added before the start of the survey so that it could give a better idea and understanding to the lecturers about this research. Feedback from lecturers are crucial to identify persons who may have particular health risks and to collect information useful for the next stage which is visual inspection. The survey form will gather information in terms of building occupancy rate, questions to document their knowledge of the building and also occupants observation on moisture or mold related problems. Total of twelve lectures are involved in giving feedback and responds to the online survey form which will been sent to their email address. It took approximately a month to get the survey responds from the lecturers and it is clearly due to their hectic schedule. The sample of the online survey form is attached in Appendix A.

4.2 Visual Inspection

Visual inspection is done referring to the checklist which has been created using Microsoft Word 2007. The checklist has the title of Mold Inspection Checklist . It consists of four categories which includes Section A: books, Section B: papers, Section C: condition inside office rooms and lastly Section D: HVACs system. These different type of categories are being selected for the inspection because it could give a better view of the condition inside the lecturers office rooms. Plus it could also enhance the chance of finding mould contamination areas inside the rooms since materials such as papers, books and also the HVACs system which are prone to mould contamination. The sample of Mold Assessment Checklist and also the data obtained using the checklist through visual inspection are attached in Appendix B.

4.2.1 Summary Of Data recorded

Environmental conditions on the day of the inspection is recorded along with a cursory elevation of the type and condition of exterior building envelope components and a quick walk through of interior spaces to identify the interior odors before becoming odor adapted. Based on the inspection been done, there were no any particular type of odor been sensed inside the lecturers office rooms. Besides that, moisture events such as leaks, seepage, condensation, flooding, etc should be documented as a potential clue, and to direct the focus of more careful inspection at the affected areas (Burton & Gibbins, 2011). There were many leakages and water seepage marks found inside the office rooms specifically at the ceiling whereby the air con duct is located. Diagram 7, 8, 9, 10, 11 & 12 shows the water marks found at the ceiling inside lecturers office rooms. Where else, diagram 13 & 14 presents mould contamination at the ceiling due to excessive water seepage.

Diagram 7: Water seepage marks found at the ceiling

Diagram 8: Water seepage marks found at the ceilin

Diagram 9: Water seepage marks found at the ceiling

Diagram 10: Water seepage marks found at the ceiling

Diagram 11: Water seepage marks found at the ceiling

Diagram 12: Water seepage marks found at the ceiling

Diagram 13: Mould contamination spotted due to excessive water seepage

Diagram 14: Mould contamination spotted due to excessive water seepage

A systematic visual inspection of each interior space is included in the scope of the inspection method, therefore in a way it helps to ensure that other problems areas are not overlooked. Moreover types of building materials and finishes present and any observed damages, distinguishing between materials that are porous and non- porous are been inspected as well. Natural wool or cotton fibers used in carpets are prone to microbial contamination (Roques & D'Orazio, 2012). Furthermore, surfaces exposed to conditions which are suitable for human habitation are susceptible if moisture is available. Diagram 14, 15 & 16 indicates some of the stains found on the floor mat which has been installed inside all the office rooms.

Diagram 15: Stains found on the floor mat inside office rooms

Diagram 16: Stains found on the floor mat inside office rooms

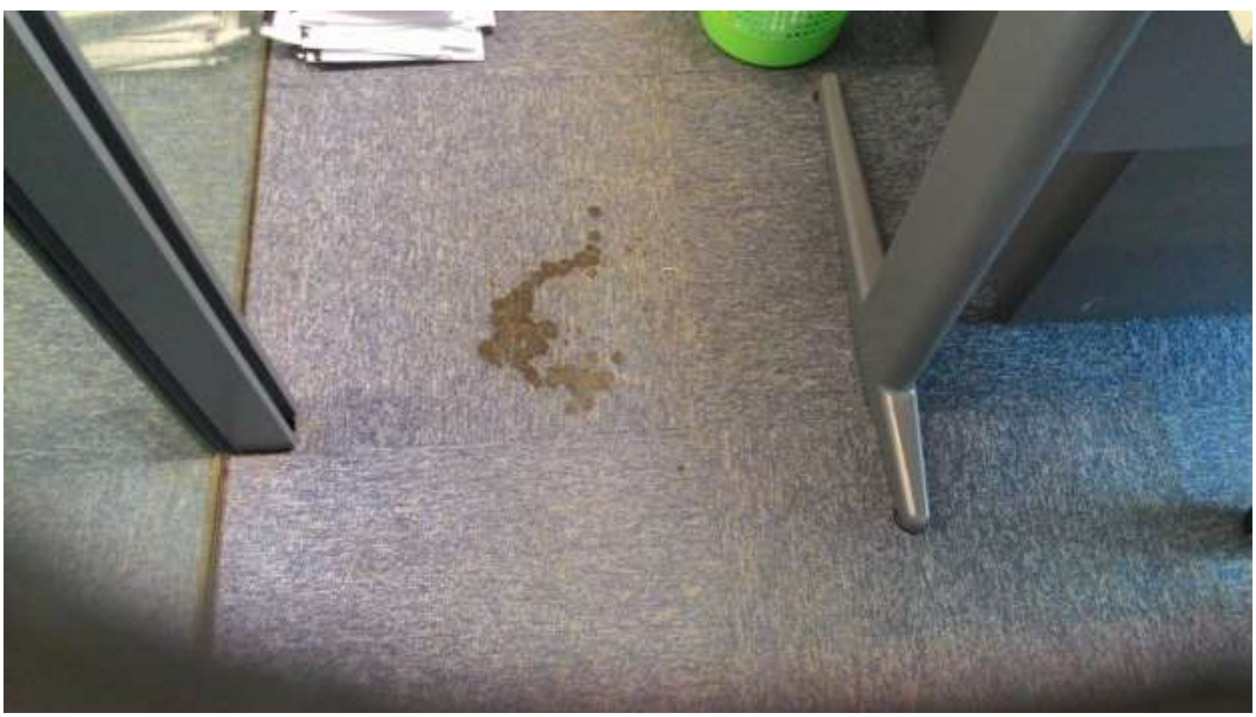


Diagram 17: Stains found on the floor mat inside office rooms

Observe damage for clues on the source of water or moisture problems. It is considered that moisture problems maybe seasonal, for example condensation problems that could occur only during humid or cold weather. Condensation is particularly difficult to trace to a source since it results from migration of water in its gaseous form, and the source is typically not visible. In simplest terms, water or water vapor invariably enters a building through pressure differential. Pressure differences maybe driven by gravity, wind or capillary action. Vapor pressure differences result from a difference in relative humidity or maybe temperature driven. In either warm or cold climates, the surface of cupboards maybe susceptible to concealed condensation. In a warm climate where air conditioning is provided, the exterior face of the cupboard is normally the first condensing surface (Hernberg et al., 2014). Where else, in cold climates with heated interior spaces, the inside face of the cupboard is usually the first condensing surface. Plus materials such as cupboards are a well known processed cellulose products which are good nutrient sources for mold growth. Diagram 17, 18, 19, 20, 21 & 22 shows some of the mold found at the interior and exterior of cupboards in lecturers office rooms.

Diagram 18: Mould found at the exterior of cupboards

Diagram 19: Mould found at the exterior of cupboards

Diagram 20: Mould found at the exterior of cupboards

Diagram 21: Mould found at the interior of cupboards

Diagram 22: Mould found at the interior of cupboards

Diagram 23: Mould found at the interior of cupboards

As for the HVAC system is concerned, it might be the source of contamination or the means of its distribution between spaces, or might indirectly contribute to the concentration of indoor air contaminants by providing inadequate ventilation. Therefore the inspection included all major components of the air distribution system with particular attention to cooling coils, humidifiers, air intake locations and also surfaces near air diffusers. Fungal contamination may occur where dust or other organic food resources are moistened by air conditioning or humidification equipment (Bhaskoro et al., 2013). Besides that, fleecy surfaces exposed to the air stream such as fibrous insulation are of particular concern, as they can collect dust and moisture, resulting in microbial amplification sites within the ventilation system. It could also cause stains and discoloration. Damp or wet niches may occur where access for cleaning and inspection is difficult hence it provides sites for fungal implication. Diagram 23, 24, 25, 26 & 27 indicates the stains and discoloration found at the air conditioning fibrous insulation inside lecturers office rooms.

Diagram 24: Discoloration of fibrous insulation

Diagram 25: Discoloration of fibrous insulation

Diagram 26: Discoloration of fibrous insulation

Diagram 27: Discoloration of fibrous insulation

Diagram 28: Discoloration of fibrous insulation

Besides that, all edge surfaces inside office rooms are been inspected closely, especially seams and crevices along the base of walls and the base of all window and door jambs. Observed stains and discoloration might be far removed from the point of entry, as water can travel through concealed spaces and between layers of construction materials(CG Bornehag, Blomquist, Gyntelberg, & Jarvholm, 2001). Slow or intermittent leaks can make detection difficult if moisture does not penetrate to interior finishes. However, condensation can be particularly difficult to trace and the chances of fungal spores to travel in the air through the gap of the window and reach itself inside the building is still high. Based on the inspection, office rooms which were facing the sunlight and building exterior exposed to rain has mould contamination. These mold were found at the exterior of the office building and spotted mainly at the window edges. Diagram 28 & 29 indicates the finding of mold at the exterior of office building. Where else , diagram 30, 31 & 32 shows mold contamination at the exterior of the building which was captured inside the building and diagram 33 & 34 shows mold stains found at the glass door panel inside the office rooms.

Diagram 29: Mould contamination at the edge of windows (building exterior)

Diagram 30: Mould contamination at the edge of windows (building exterior)

Diagram 31: Mould contamination found on windows at the building exterior (captured inside the office room)

Diagram 32: Mould contamination found on windows at the building exterior (captured inside the office room)

Diagram 33: Mould contamination found on windows at the building exterior (captured inside the office room)

Diagram 34: Mould stains found on the glass door panel

Diagram 35: Mould stains found on the glass door panel

Lastly as for the equipments inside the office buildings are concerned, there were mold found on the office chairs. It was spotted almost on all the chairs particularly at the back of the chair. Mold growth is likely to occur in standing water or on wet surfaces (Hernberg et al., 2014). In this case, a particular persons sweat, who is sitting on the chair could provide a platform of wet surface which enhances the mould growth. Besides that, mould which are found commonly settled in dust samples typically arise from the outdoors, reflect housekeeping practices and also an immediate concern to human health. This is due to the direct contact of human utilizing the usage of chairs. Diagram 35 & 36 shows the mould been spotted at the back of the office chair. Where else, diagram 37 & 38 indicates the finding of mould dust on the chair and diagram 39 indicates the finding of mould dust under the chair.

Diagram 36: Mould dust spotted at the back of the office chairs

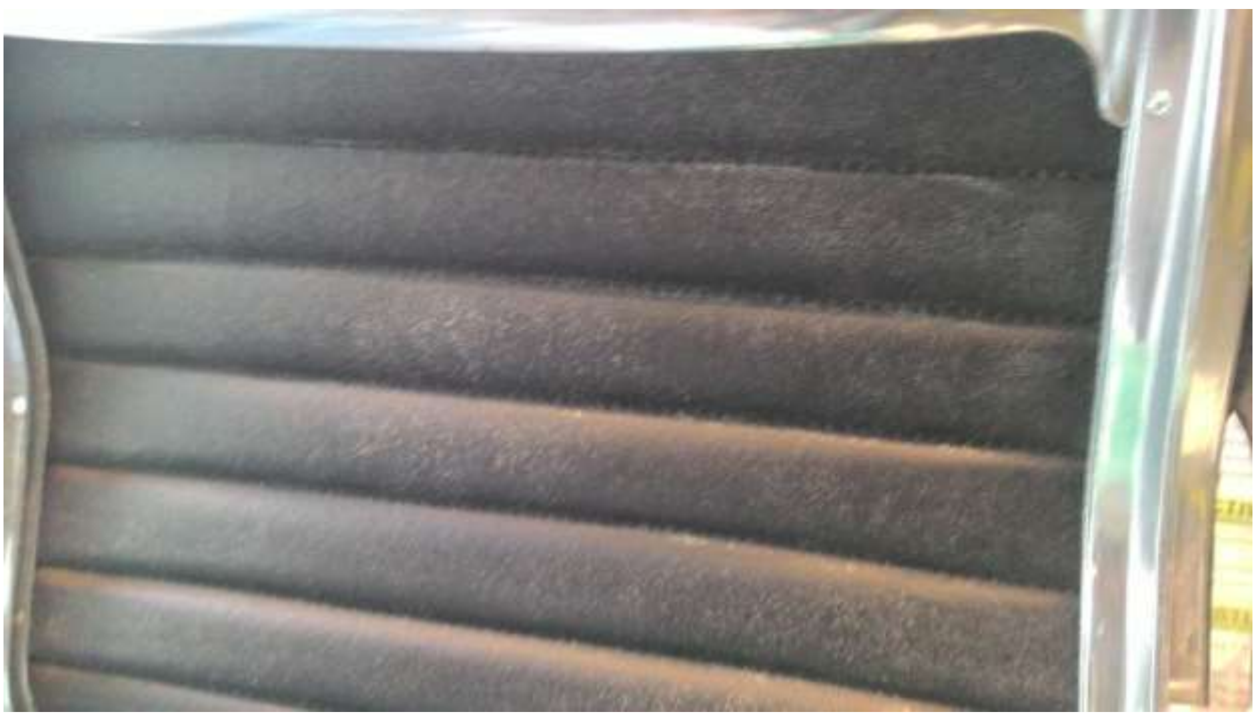


Diagram 37: Mould dust spotted at the back of the office chairs

Diagram 38: Mould dust spotted on the office chairs

Diagram 39: Mould dust spotted on the office chairs

Diagram 40: Mould dust spotted under the office chairs

4.2.2 Summary of Findings

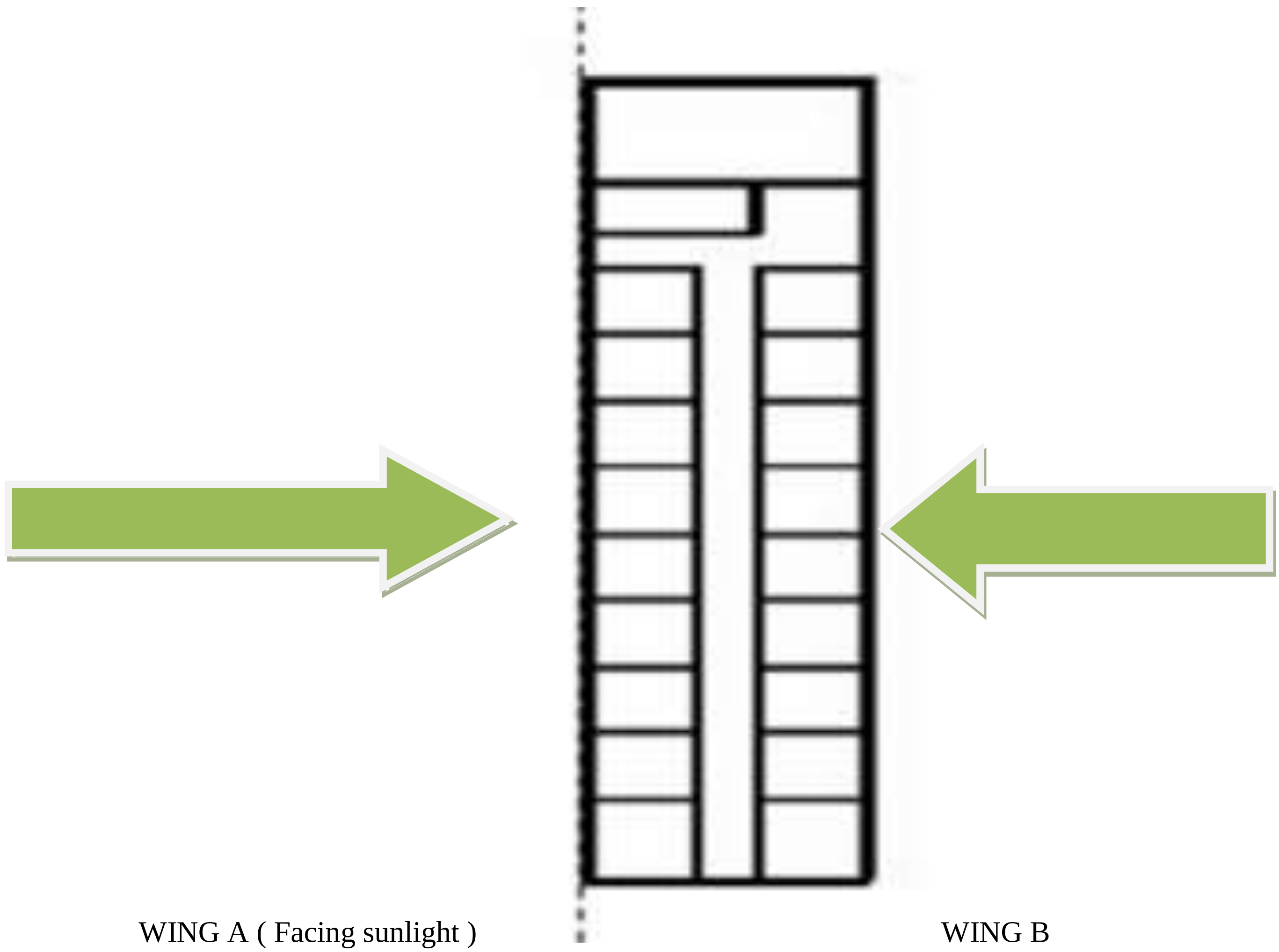


Figure 19: Layout plan of lecturers office room Block 14 (Bhaskoro et al., 2013)

	MOULD CONTAMINATED AREAS INSIDE OFFICE ROOMS					
	HVAC	**CEILING**	**CARPET**	**CHAIR**	**CUPBOARD**	**GLASS DOOR & WINDOW PANEL**
WING A (6 Office rooms)	X	X	X	X	X	X
	X	X	X	X	X	X
	X	X	X	X	X	X
	X	-	X	X	-	X
	X	-	X	X	-	X
	X	-	-	X	-	X
WING B (7 office rooms)	X	X	X	X	X	X
	X	X	X	X	X	X
	X	-	X	X	X	X
	-	-	X	X	-	-
	-	-	-	X	-	-
	-	-	-	X	-	-
	-	-	-	X	-	-

X = CONTAMINATED WITH MOULD

Table 8: Summary of mould infected areas in office rooms

RECOMMENDATIONS

The following recommendations are meant to provide general remediation procedures based on the information obtained from the investigation been done. These recommendations should not be construed as the only effective methodology for remediation and no warranty is expressed or implied with these recommendations. The main goal of a remediation process is to correct all existing moisture conditions that promote mold growth and to physically remove all mould contaminated/non restorable materials in accordance with the mould remediation standard.

The HVAC system should be isolated from the work area to minimize the risk of cross contamination. Portable dehumidification maybe necessary during the remediation process to maintain conditions that will not support additional mold growth. Intrusive investigation should be performed in areas with water damage and /or elevated moisture content to identify the full extent of areas requiring remedial treatment.

Besides that, the areas of water damaged and/or stained carpeting should be discarded. Areas of carpet pads that have been wet should always be discarded. Porous building materials that have been water damaged to the point that drying and cleaning will not restore them to their pre-water exposure condition or have sustained loss of integrity should be removed and discarded, whether or not there is visible evidence of mould growth.

All visible mould must be physically removed. Areas that have developed mould growth should be vacuumed and cleaned thoroughly with materials such as baking soda and vinegar. A good housekeeping method is the best tool to prevent mould contamination within a building. As per discovered in this research, office rooms which are exposed to sunlight and rain (wing A) have high mold contamination compared to the other which are not exposed (wing B). Housekeeping should not only be focused inside the building but also be done outside the building as well. However if the mould growth is imbedded within the material and cannot be cleaned , removal of contaminated materials plus an additional one foot of material beyond the affected area should also be removed. Lastly equipment that could be found inside a building with mould growth on it such as chairs and cupboards, could be kept under the hot sun and let it to dry after cleaning. This would get rid of the mould on it and can be used back unless if the contamination is much severe, then disposal would be a much better option. Substrates that cannot be cleaned must be disposed.

CONCLUSION

Maintaining healthful and comfortable conditions for building occupants is the primary purpose of shelter and is of primary concern to the public and to those in the construction industry. Scientific studies have shown an association between damp buildings and adverse health effects. Based on this research paper, findings have shown clearly that there are mould contamination inside lecturers office rooms and most of them aren't aware of the possible health effects caused by mould. In a way this research has helped to create awareness among lecturers and also students about the severity of mould contaminated areas.

All remediation efforts requires identification of the extent and location of mould growth based on visual inspection. Litigation and news reports involving toxic moulds has created public alarm and an increase in the demand for trained inspection services. Various stages of inspection and investigation may be required, depending on the complexity and extent of the problem.

Further work is needed towards collecting useful data, and on improving inspection methods for finding concealed mould growth. An assessable database of collected health and inspection information might help inform the public and building professional of systems and materials that require special attention during manufacture, design, inspection, remediation, and to help establish casual relationships between construction methods, moisture problems, and adverse health effects. Collected data might also help establish exposure limits for specific type of mould. Affordable and improved testing techniques for locating concealed microbial growth are also needed, to improve effectiveness of inspections and reduce the disruption of more destructive methods.

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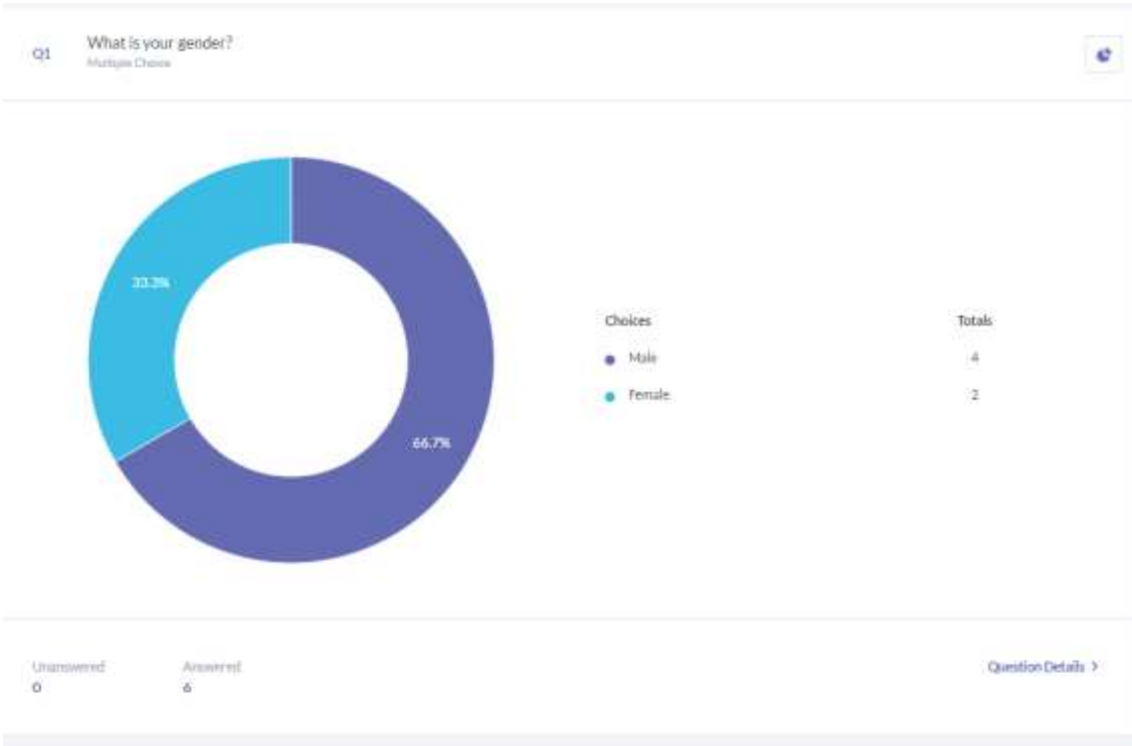
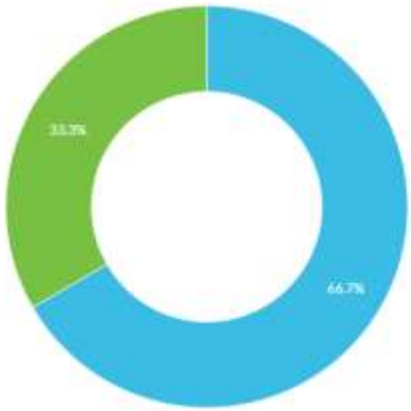
APPENDIX A


Q1
What is your gender?
33.3%
66.7%
Choices
Totals
Male
4
Female
2
Unanswered
0
Answered
6
Question Details ›


Q2
What is your age?
50%
50%
Choices
Totals
Below 25
0
26 - 35
3
36 - 45
0
46 - 55
0
55 or older
3
Unanswered
0
Answered
6
Question Details ›

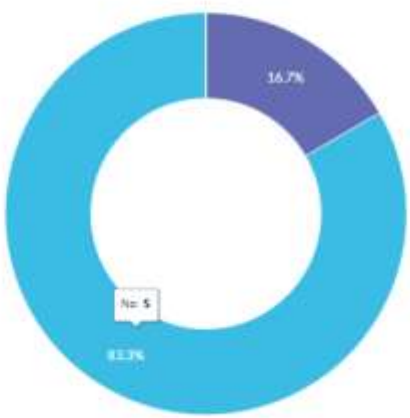
Q3 How long would you be in the office in a day?
Multiple Choice



Choices	Totals
3- 6 hours	0
6- 9 hours	4
more than 9 hours	2

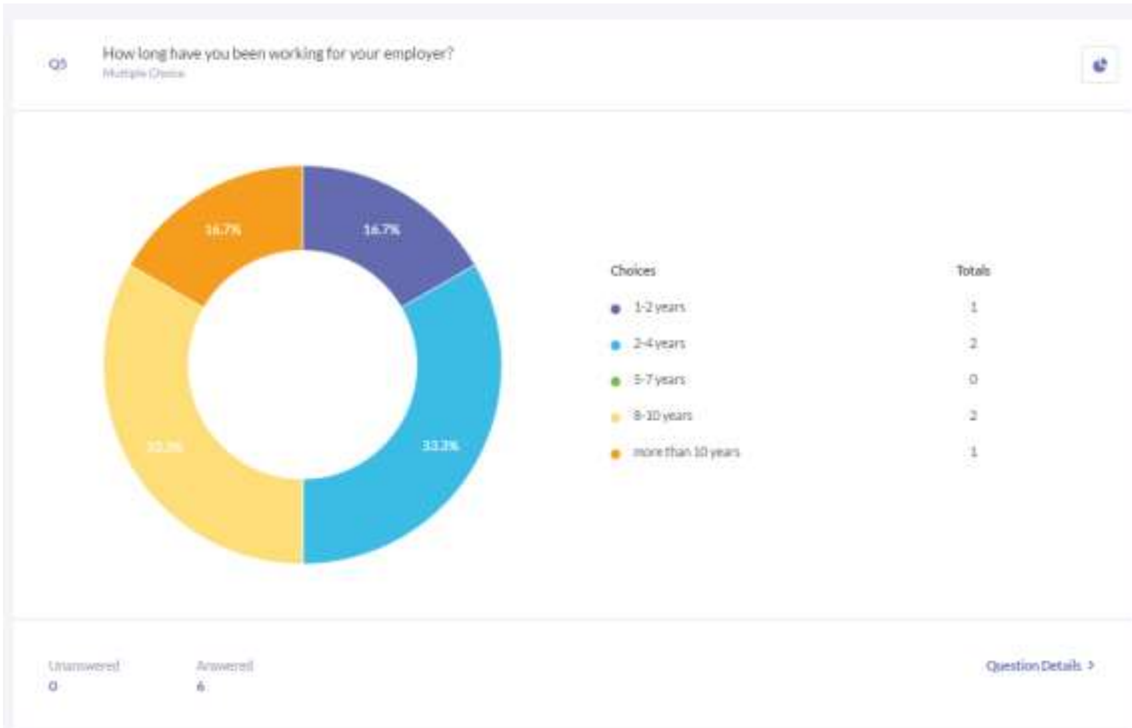
Unanswered 0 | Answered 6 | Question Details >

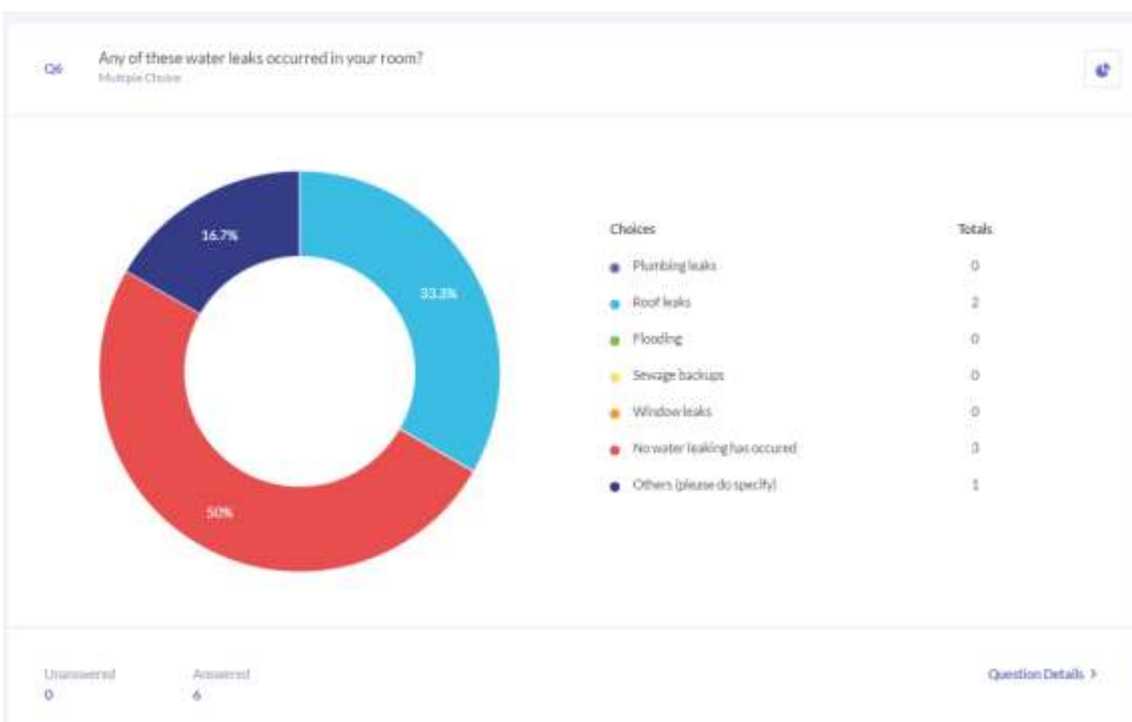
Q4 Does any of your work activities generate dust/particulates/odor?
Multiple Choice



Choices	Totals
Yes	1
No	5
If Yes, please do specify	0

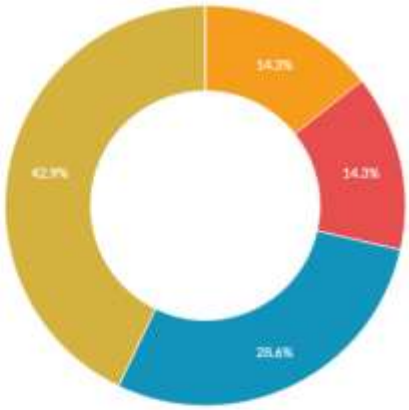
Unanswered 0 | Answered 6 | Question Details >


Q5
How long have you been working for your employer?
Multiple Choice
16.7%
16.7%
33.3%
33.3%
Choices
Totals
1-2 years 1
2-4 years 2
5-7 years 0
8-10 years 2
more than 10 years 1
Unanswered
0
Answered
6
Question Details ›


Q6
Any of these water leaks occurred in your room?
Multiple Choice
16.7%
33.3%
50%
Choices
Totals
Plumbing leaks 0
Roof leaks 2
Flooding 0
Sewage backups 0
Window leaks 0
No water leaking has occured 3
Others (please do specify) 1
Unanswered
0
Answered
6
Question Details ›

Q7 Have you ever noticed the existence of mold in any of these items in your r

Multiple Choice



Choices	Totals
Books	0
Wall	0
Ceiling	0
Floor	0
Carpet	1
Shelf	1
Furniture	0
Chair	2
Table	0
None of the above	3
Others (please do specify)	0

Unanswered 0 Answered 6

Question Details ›

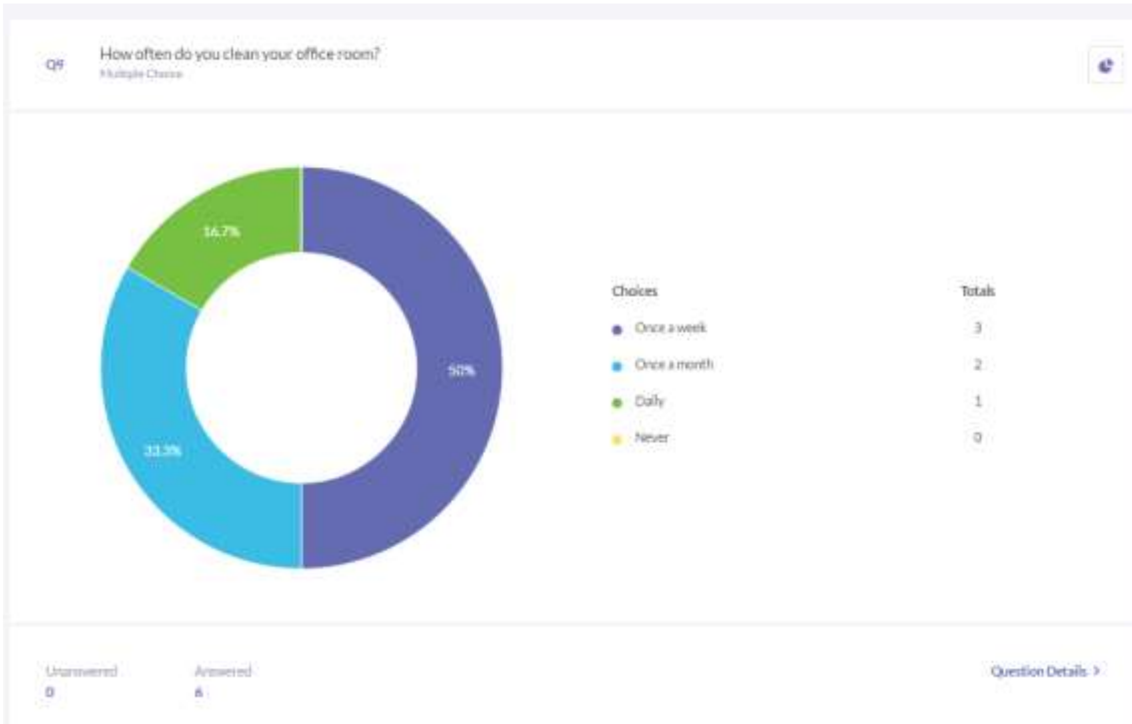
Q8 Have you ever noticed any of these conditions in your room?

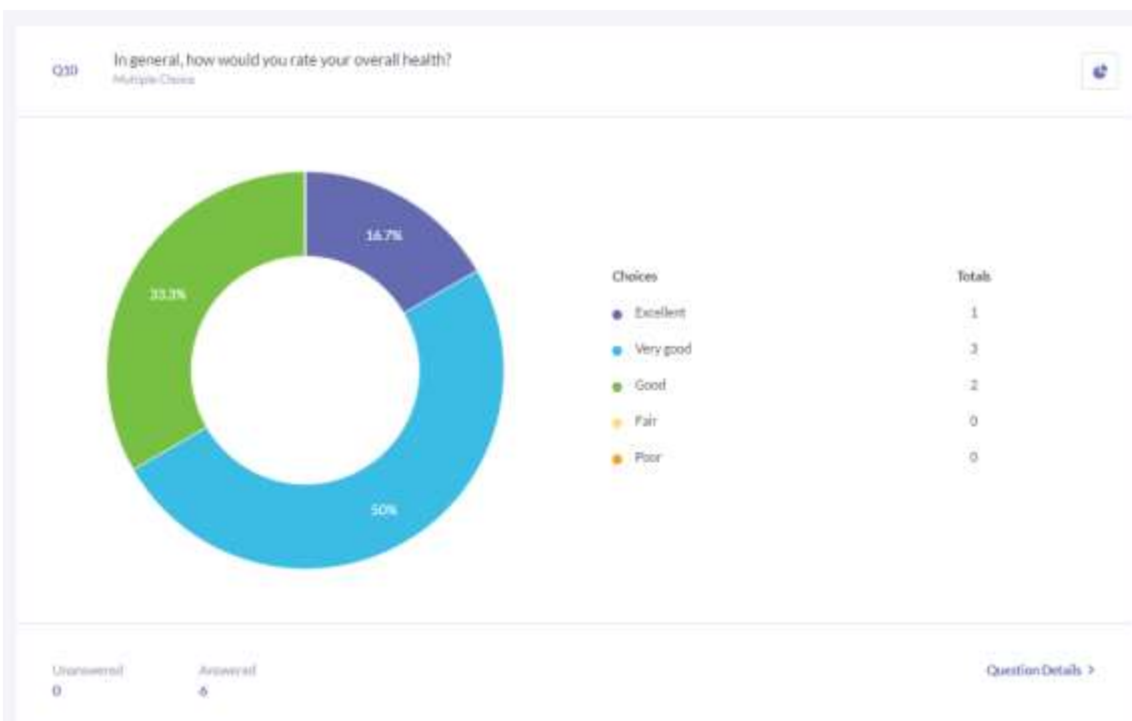
Multiple Choice

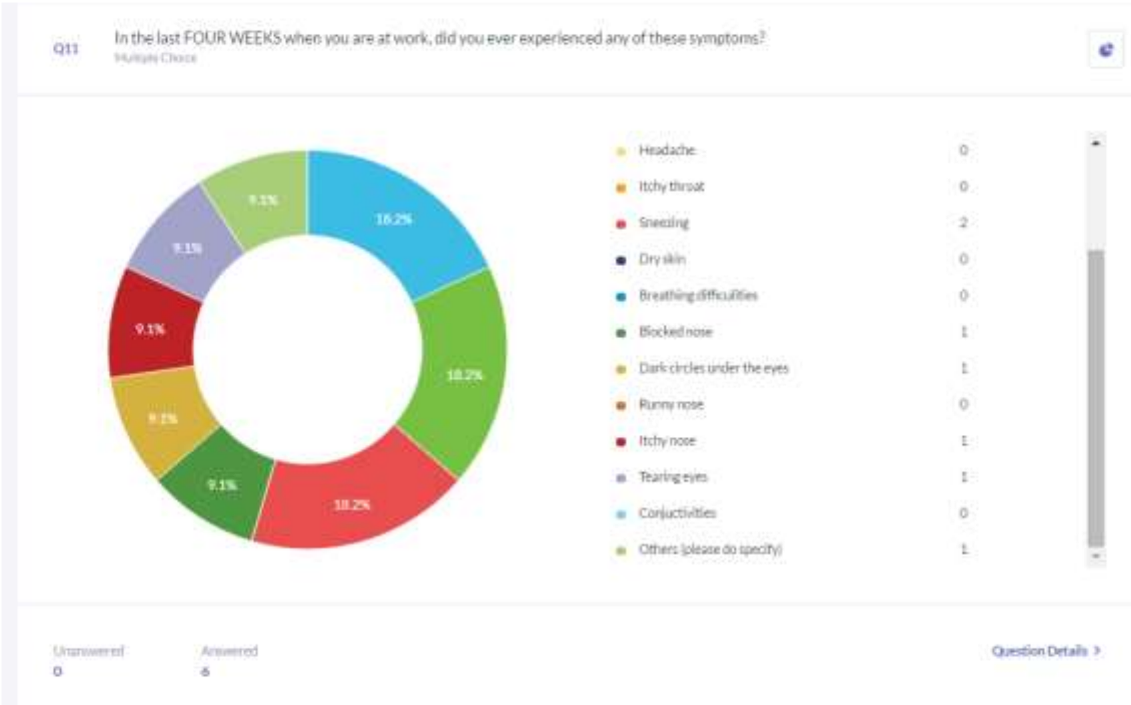
Choices	Totals
Unusual odors	1
Stuffy air	2
Dusty	2
Work area is too cold	3
Work area is too warm	0
The temperature varies from each room	1
None of those mentioned above	1
Others (please do specify)	0

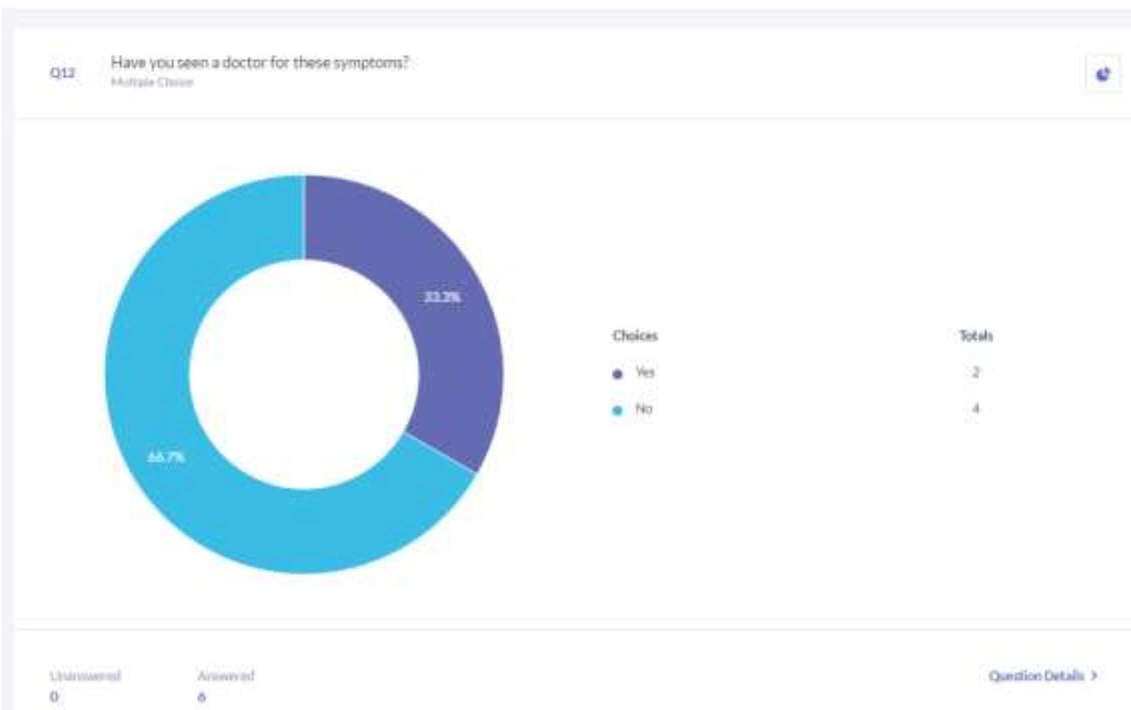
Unanswered 0 Answered 6

Question Details ›

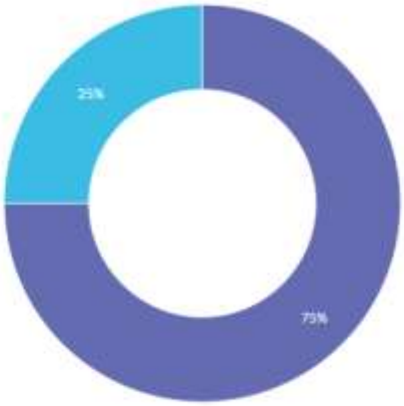

Q9
How often do you clean your office room?
Multiple Choice
16.7%
50%
33.3%
Choices
Totals
Once a week
3
Once a month
2
Daily
1
Never
0
Unanswered
0
Answered
6
Question Details >


Q10
In general, how would you rate your overall health?
Multiple Choice
16.7%
33.3%
50%
Choices
Totals
Excellent
1
Very good
3
Good
2
Fair
0
Poor
0
Unanswered
0
Answered
6
Question Details >


Q11
In the last FOUR WEEKS when you are at work, did you ever experienced any of these symptoms?
9.1%
18.2%
9.1%
9.1%
18.2%
9.1%
9.1%
18.2%
Headache 0
Itchy throat 0
Sneezing 2
Dry skin 0
Breathing difficulties 0
Blocked nose 1
Dark circles under the eyes 1
Runny nose 0
Itchy nose 1
Tearing eyes 1
Conjuctivities 0
Others (please do specify) 1
Unanswered
0
Answered
6
Question Details


Q12
Have you seen a doctor for these symptoms?
33.3%
66.7%
Choices
Totals
Yes 2
No 4
Unanswered
0
Answered
6
Question Details

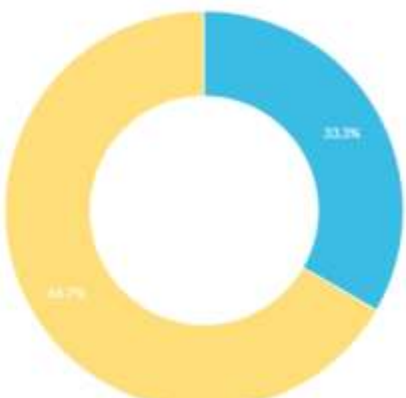
Q13 When did the symptoms go away?
Multiple Choice



Choices	Totals
Overnight	3
After a week being away from work place	1

Unanswered 2 | Answered 4 | Question Details >

Q14 In your point of view, do you think your health is interfered with your work place?
Multiple Choice



Choices	Totals
Very significant	0
Significant	2
Moderate	0
Not significant	4

Unanswered 0 | Answered 6 | Question Details >

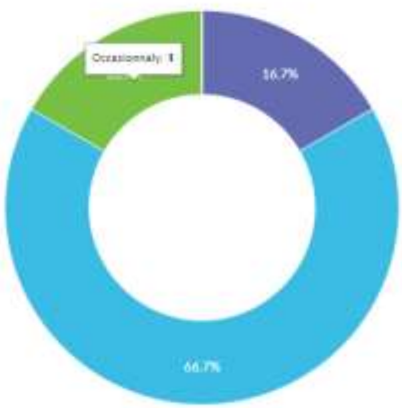
Q15 How would you rate air humidity in office rooms?
Rating

Choices	Totals	Ratings
0 - Too humid	0	0
0 - Humid	1	0
0 - Average	5	0
0 - Hot	0	0
0 - Too hot	0	0

Unanswered	Answered	Average Rating
0	6	Unavailable

Question Details >

Q16 Does the air smells?
Rating



Choices	Totals	Ratings
0 - Never	1	0
0 - Once in a blue moon	4	0
0 - Occasionnaly	1	0
0 - Frequently	0	0
0 - Always	0	0

Unanswered	Answered	Average Rating
0	6	Unavailable

Question Details >

Q17 How would you rate the temperature in office room?
Rating

Choices	Totals	Ratings
0 - Too cold	0	0
0 - Cold	4	0
0 - Average	2	0
0 - Warm	0	0
0 - Too warm	0	0

Unanswered	Answered	Average Rating
0	6	Unavailable

Question Details >

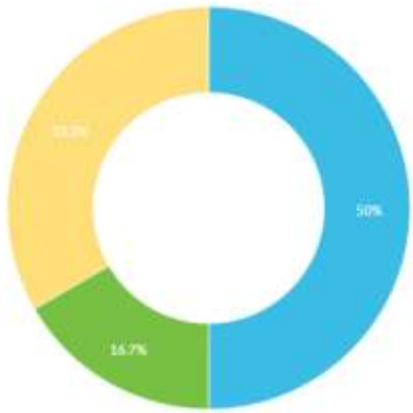
Q18 How would you rate the lighting at your work place?
Rating

Choices	Totals	Ratings
0 - Too dim	0	0
0 - Dim	1	0
0 - Moderate	2	0
0 - Bright	3	0
0 - Too bright	0	0

Unanswered	Answered	Average Rating
0	6	Unavailable

Question Details >

Q19 Is there any significant distraction resulted in noise from the air con duct?
Rating



Choices	Totals	Ratings
0 - Very Significant	0	0
0 - Significant	3	0
0 - Moderate	1	0
0 - Not Significant	2	0

Unanswered 0 | Answered 6 | Average Rating Unavailable | Question Details >

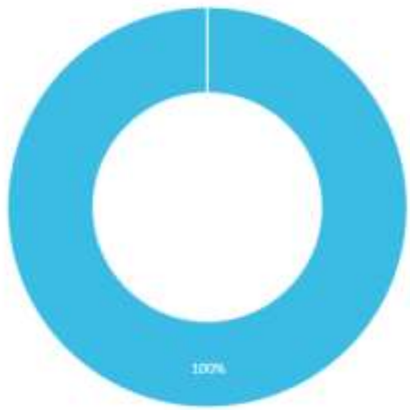
Q20 In your opinion, is your office room safe from mold contamination?
Multiple Choice

Choices	Totals
Definitely	1
Doubtfull	3
Contaminated	1
Highly contaminated	1

Unanswered 0 | Answered 6 | Question Details >

Q21 Do you think the materials which are kept in your office room such as papers, books and food items could be a source of nutrient for microorganisn especially mold?

Multiple Choice



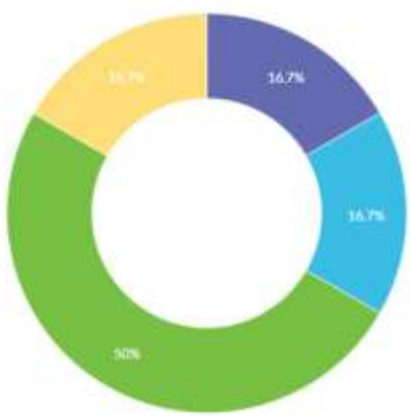
Choices	Totals
Disagree	0
Maybe	6
Agree	0
Strongly Agree	0

Unanswered	Answered
0	6

Question Details >

Q22 Do you know that exposure to mold will affect your health?

Multiple Choice



Choices	Totals
Disagree	1
Maybe	1
Agree	3
Strongly Agree	1

Unanswered	Answered
0	6

Question Details >

APPENDIX B

UNIVERSITI
TEKNOLOGI
PETRONAS

Mold Assessment Checklist

Building :

Inspection Date :

Inspected by :

ID	1.0 BOOKS	YES	NO	NOTES
1.1	Number of books less than 20?			
1.2	Number of books more than 20?			
1.3	How long the books have been kept?			
1.4	Availability of dust on the books?			

ID	2.0 PAPERS	YES	NO	NOTES
2.1	Number of papers countable?			
2.2	Number of papers uncountable?			
2.3	How long the papers been kept?			
2.4	How frequent the papers will be cleared?			
2.5	Availability of dust on the papers?			

ID	3.0 CONDITION INSIDE OFFICE ROOMS	YES	NO	NOTES
3.2	Clean?			
3.3	Availability of carpet/ floor mat?			
3.4	How many number of carpet / floor mat?			
3.5	Leakages?			
3.6	Odor?			
3.7	Mold visibility?			
3.8	Presence of food items?			

ID	4.0 HVAC SYSTEM	YES	NO	NOTES
4.1	Intake vents blocked/ rusted/frozen?			
4.2	Debris present inside intake vents?			
4.3	Condition of filters clean?			
4.4	Distance from rooms to outdoor air intake?			
4.5	Bird nest found at outdoor air intake?			
4.6	Air con duct clean?			