

INDOOR AIR QUALITY AT HIGHER INSTITUTION'S LABORATORY: A STUDY ON PRE-SYMPTOMS, AWARENESS AND UNDERSTANDING AMONG OCCUPANTS

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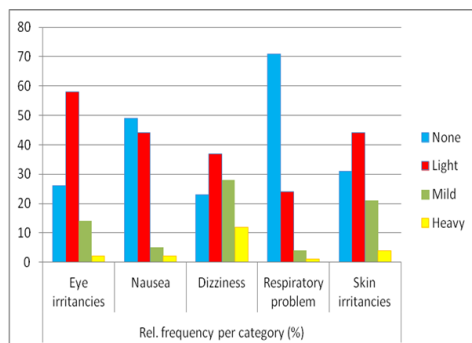
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Graphical abstract



Abstract

This study intends to show the effectiveness of indoor air quality (IAQ) at the higher institution laboratory. The objective is to determine the impact of current IAQ, to study the occupants' knowledge in the indoor air pollutants and to identify the significance of occupants' personality regarding the IAQ awareness. 100 respondents had responded to answer the questionnaires given. The questionnaires were analysed using XLSTAT2014 software for descriptive statistic and discriminant analysis in order to fulfil the outlined objectives. The finding shows that 56% of the respondents know about IAQ, while 40% and 4% did not know and not sure about the IAQ, respectively. By gender, there were 20 of male respondents having the IAQ knowledge and 21 of male respondents did not know about the IAQ. Meanwhile, 36 of female respondents have IAQ knowledge, 19 of female respondents did not know the IAQ knowledge and 4 of female respondents were not sure regarding the IAQ knowledge. Furthermore, the IAQ in the laboratory at the higher institution is considered as unhealthy based on the respondents' complaints of their health problem symptoms. Meanwhile, the results of personality tests show that women have more IAQ awareness compared to men. It indicated that the personalities of the occupants have significance to influence and able to determine their awareness on the IAQ. Hence, it described that IAQ is a significant factor to determine and influence the health of laboratory occupants.

Keywords: Indoor air quality, discriminant analysis, five factor model, Department Occupational Safety and Health

Abstrak

Kajian ini bertujuan untuk menunjukkan keberkesanan kualiti udara dalaman (KUD) makmal di institusi pengajian tinggi. Objektifnya adalah untuk menentukan kesan KUD semasa, mengkaji pengetahuan penghuni terhadap pencemar udara dalaman dan mengenal pasti kepentingan personaliti penghuni terhadap kesedaran KUD tersebut. Sebanyak 100 responden telah memberi maklum balas dengan menjawab soal selidik yang diberikan. Soal selidik ini telah dianalisis dengan menggunakan perisian XLSTAT2014 melalui mod statistik deskriptif dan analisis diskriminan bagi memenuhi objektif yang digariskan. Dapatan menunjukkan bahawa 56% daripada responden mengetahui tentang KUD,

manakala masing-masing 40% dan 4% tidak tahu dan tidak pasti mengenai KUD. Mengikut jantina, terdapat 20 responden lelaki mempunyai pengetahuan KUD dan 21 responden lelaki tidak mempunyai pengetahuan terhadap KUD. Sementara itu, 36 responden perempuan mempunyai pengetahuan KUD, 19 responden wanita tidak mempunyai pengetahuan KUD dan 4 responden perempuan tidak pasti mengenai pengetahuan KUD tersebut. Tambahan pula, KUD makmal di institusi pengajian tinggi dianggap sebagai tidak sihat berdasarkan aduan responden terhadap masalah kesihatan mereka. Sementara itu, keputusan ujian personaliti menunjukkan bahawa wanita mempunyai lebih banyak kesedaran KUD berbanding lelaki. Ini menunjukkan bahawa personaliti penghuni mempunyai peranan untuk mempengaruhi dan boleh menentukan kesedaran mereka terhadap KUD. Oleh itu, KUD adalah faktor penting untuk menentukan dan mempengaruhi kesihatan penghuni makmal.

Kata kunci: Kualiti udara dalaman, analisis diskriminan, model lima Faktor, Jabatan Kesihatan dan Keselamatan Pekerjaan

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1.0 INTRODUCTION

Indoor air quality (IAQ) is determined by constantly changing the interaction of complex factors that affect the types, level and importance of pollutants, especially in the indoor environment [1]. Apart from that, it also can be referred as air quality that occurs in the building, which affects the health, comfort and productivity of the building's occupants. The issues of IAQ can arise in various ways. The indoor activities such as working, cooking, washing, etc. at home, in a restaurant, laboratory, closed car parks, supermarket, sport centre, hospital, public transport and classroom may affect the quality of health and well-being. Constantly, people are always interacting with the air, which might be polluted by carbon monoxide (CO), carbon dioxide (CO₂), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), ozone (O₃), radon, particulate matter (PM), volatile organic compounds (VOC), asbestos, tobacco smoke, etc [2].

The air contaminants can be exposed into the human body through inhalation, skin absorption, ingestion and contact through wounds causing harm to the health of the occupants [3]. In Malaysia, IAQ is a new issue and most people do not know well. However, lessons learned can be retrieved from studies conducted in other countries such as the two IAQ studies by the US National Institute for Occupational Safety and Health (NIOSH) whereby in 1990, the US NIOSH had investigated over 500 problematic buildings [4]. In each building, NIOSH determined the single most important factor likely to be related to occupants' complaints [5]. Factors associated with complaints in descending order of frequency are 53 % caused by the inadequate ventilation, 15% of indoor pollutant sources, 10% of the outdoor contaminants, 5% of microbial problems, 4% of the building fabric contamination and 13 % by the unknown causation [6]. Numerous scientific studies proved that the air quality in home or building is worse than the air quality in open areas and industrial areas

[7]. This has caused many people to be infected with the disease, most noticeably among children, aged people, infants as well as respiratory and cardiovascular patients.

Air quality in buildings has become an environmental issue as people always use the most of their time doing activities at home and the workplace. Consequently, the people are exposed to the inevitable high risk on the contaminated air and thenceforth exposed to a variety of health problems [8]. The objective of this study is to identify the significant of human personality among occupants regarding on the IAQ awareness. The scope of research will mostly cover on the awareness, understanding and complaints of laboratory's occupants on the IAQ. However, this study does not focus on the indoor air pollutant identification in the laboratory.

2.0 METHODOLOGY

2.1 Questionnaire Survey

The Five Factor Model (FFM) questionnaire survey is widely used and developed to assess personality in the workplace [9]. The questionnaires offer a cheaper and more convenient approach to acquire information from large numbers of people over a wide geographical area and more reliable than those expressed in a personal interview [10]. Therefore, the questionnaire survey (QS) was applied in this research to collect data from the occupants in order to achieve the objective of the research. The QS was distributed to 100 of respondents, consist of students, lab staffs, janitors, technician, or lecturer at the higher institution. There were four sections in the questionnaires with part A was questions related to the respondent information, part B was questions related to the IAQ, part C was about the IAQ health problem symptoms and part D was questionnaires containing the personality test

showed in Table 1. The questions related to IAQ were modified based on the IAQ questionnaire from DOSH and the personality test was modified based on the FFM questionnaires from the journal of John and Srivastava [11]. The QS was bilingual, which was in Malay and English to facilitate the respondents to understand.

Table 1 The personality test classification question

Classification	Question Number
Extraversion	1, 6, 11, 16, 21, 26, 31, 36
Agreeableness	2, 7, 12, 17, 22, 27, 32, 37, 42
Conscientiousness	3, 8, 13, 18, 23, 28, 33, 38, 43
Neuroticism	4, 9, 14, 19, 24, 29, 34, 39
Openness	5, 10, 15, 20, 25, 30, 35, 40, 41, 44

2.2 Data Analysis

Subsequently, all of the data from the respondents were calculated by using the statistical analysis through XLSTAT2014 software. XLSTAT2014 is software based on Microsoft Excel (MS – Excel) and facilitate a powerful statistical analysis software solution and helpful for statistical process control (SPC) [12]. The descriptive statistic mode was used in order to determine the total of respondents' number based on gender, age, education level, occupation and period of service. This method also was used to determine the IAQ knowledge, IAQ condition in the laboratory and health problems among the occupants or respondents. Meanwhile, discriminant analysis was used for determining the personalities among the occupants in order to know their awareness in the IAQ. Discriminant analysis is a technique for classifying a set of observations into predefined classes [13, 14, 15].

3.0 RESULTS AND DISCUSSIONS

3.1 IAQ Knowledge Descriptive Statistics

Table 2 shows that 56% of respondents know about IAQ, while 40% and 4% of respondents did not know and not sure about the IAQ, respectively. Figure 1 illustrates the IAQ knowledge among the respondents.

Table 2 IAQ knowledge descriptive statistics

Category	Frequency per category	Rel. Frequency per category (%)
Yes	56	56.0
No	40	40.0
Not Sure	4	4.0
Total	100	100.0

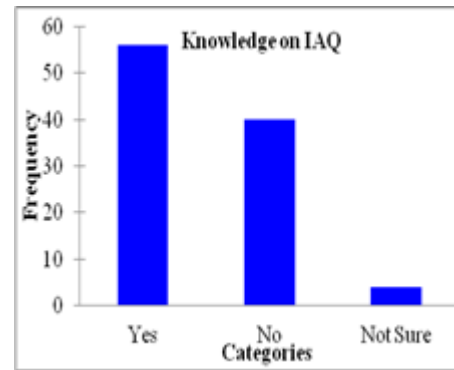


Figure 1 Bar chart of IAQ knowledge among the respondents

The majority of laboratory staffs and students had knowledge and understanding regarding the IAQ. However, gender able to influence it whereby women have more knowledge on the IAQ compared to men in a ratio of each gender respondent. Commonly, they acquired the IAQ information through training and learning syllabus at workplaces in the higher learning institution.

3.2 IAQ Condition in the Laboratory

The condition in the laboratory was determined by the respondents' complaints via the questionnaires. Hence, based on Table 3, there were 9% of respondents complained that their laboratory is hazardous, 8% very unhealthy, 38% unhealthy, 37% moderate and 8% good condition. Figure 2 illustrates the IAQ condition in the laboratory.

Table 3 IAQ condition in the laboratory

Category	Frequency per category	Rel. Frequency per category (%)
Hazardous	9	9
Very Unhealthy	8	8
Unhealthy	38	38
Moderate	37	37
Good	8	8
Total		100

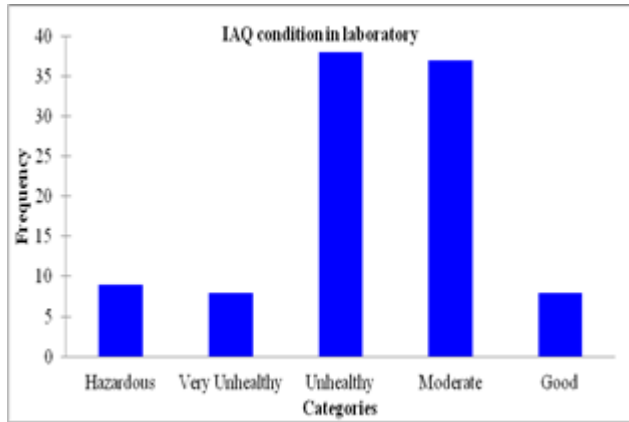


Figure 2 Bar chart of IAQ condition in the laboratory

Most of them known about the pollutants exist in the laboratory such as CO, PM, O₃, CO₂, bacteria, fungal, formaldehyde, VOC, etc. The laboratory should be clean and the odor caused by gases that inflict harmful effects to human health could be minimized by installation of the ventilation system. The ventilation system in the laboratory needs to be operational and efficient to exhaust the harmful gas in the laboratory and circulate the clean air.

3.3 IAQ in the Laboratory Pre-Symptom

Based on Table 4, dizziness was the highest in the heavy symptoms that consists of 12% respondents, 2% in eye irritancies, 2% in nausea, 4% in skin irritancies and 1% in the respiratory problem. Meanwhile, in the mild symptoms, dizziness also the highest percentage that consists 28% of respondents experienced in the health problem, 21% in the skin irritancies, 14% in the eye irritancies, 5% in the nausea and 4% of the respiratory health problem. Furthermore, in the light symptoms, eye irritancies had the highest percentage that consists 58% of respondents experienced in the health problem, respectively 44% in the nausea and skin irritancies, 37% in the dizziness and 24% in the skin irritancies. Figure 3 shows the health symptoms that occurred in the laboratory.

Table 4 Pre-Symptoms by the IAQ Laboratory

Category	Rel. Frequency per category (%)				
	Eye irritancies	Nausea	Dizziness	Respiratory problem	Skin irritancies
None	26.0	49.0	23.0	71.0	31.0
Light	58.0	44.0	37.0	24.0	44.0
Mild	14.0	5.0	28.0	4.0	21.0
Heavy	2.0	2.0	12.0	1.0	4.0

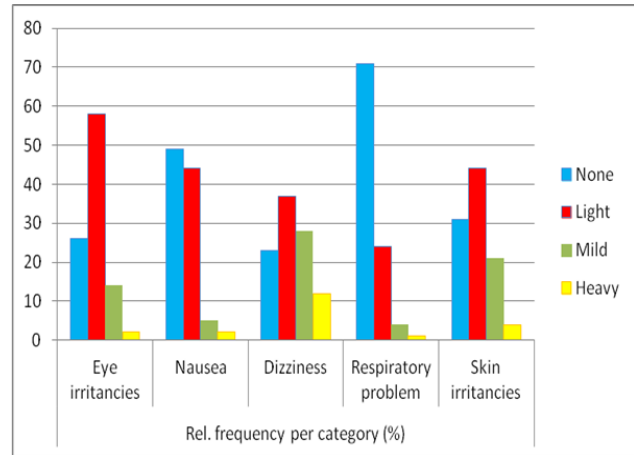


Figure 3 Different health symptoms occurred by IAQ laboratory

3.4 Personality Test

Gender was the most appropriate data in this research because in gender not too many variable data which consists of two data only which are male and female. Based on the results, gender data was more equivalent and the highest compared with others. Therefore, it showed that gender is more significant data compared with the others demographic result. Hence, gender was used as data in this research in order to determine the IAQ awareness among the occupants. Confusion matrix in discriminant analysis was used to estimate the percentage of correct in the occupants' personality.

3.4.1 Extraversion vs. Gender

Based on Table 5, 18 out of 41 male respondents had the extraversion traits that consist of 43.9% correct. In fact, the rest of them were confused with their personalities in themselves. Meanwhile, 50 out of the 59 female respondents had the extraversion trait that consists of 84.8% correct. The rest of them were actually confused in their identities. This indicates that female respondents were more dominant than male in the IAQ knowledge and curiosity on the significance of IAQ. It showed that they were more alert, aware or excitability on the IAQ pollutants so that the situation will not jeopardize their health.

Table 5 Confusion matrix for the estimation of extraversion

Gender	Male	Female	Total	% correct
Male	18	23	41	43.9%
Female	9	50	59	84.8%

3.4.2 Agreeableness vs. Gender

Based on Table 6, 16 out of 41 male respondents had agreeableness nature that consists of 39.0% correct. In fact, the rest of them were confused with their personality's traits in themselves. Instead, 49 out of 59 female respondents had agreeableness trait that consists of 83.1% correct. Meanwhile, the rest of them were confused with their identities. It showed that the female respondents were more agreeable than male respondents that the exposure of poor IAQ will lead to the health problems.

Table 6 Confusion matrix for the estimation of agreeableness

Gender	Male	Female	Total	% correct
Male	16	25	41	39.0%
Female	10	49	59	83.1%

3.4.3 Neuroticism vs. Gender

Based on Table 7, 25 out of 41 male respondents had neuroticism nature that consists of 61.0% correct. In fact, the rest of them were confused with their personality traits in themselves. Instead, 10 out of 59 female respondents had agreeableness trait that consists of 83.0% correct. Meanwhile, the rest of them were confused with their identities. It showed that the female respondents were more worried than male respondents that poor IAQ exposure will cause severe impact to their health.

Table 7 Confusion matrix for the estimation of neuroticism

Gender	Male	Female	Total	% correct
Male	25	16	41	61.0%
Female	10	49	59	83.0%

3.4.4 Conscientiousness vs. Gender

Based on Table 8, 23 out of 41 male respondents had conscientiousness nature that consists of 56.1% correct. In fact, the rest of them were confused with their personality traits in themselves. Instead, 40 out of 59 female respondents had conscientiousness trait that consists of 67.8% correct. Meanwhile, the rest of them were confused with their identities. It showed that the female respondents were more careful, responsible and organized than male respondents regarding on the IAQ in the laboratory.

Table 8 Confusion matrix for the estimation of conscientiousness

Gender	Male	Female	Total	% correct
Male	23	18	41	56.1%
Female	19	40	59	67.8%

3.4.5 Openness vs. Gender

Based on Table 9, 22 out of 41 male respondents had openness nature that consists of 53.7% correct. In fact, the rest of them were confused with their personality traits in themselves. Instead, 12 out of 47 female respondents had openness trait that consists of 79.7% correct. Meanwhile, the rest of them were confused with their identities. It showed that the female respondents were more concerned or curious on their working environment condition and has effort to improve it in order to ensure their safety and health.

Table 9 Confusion matrix for the estimation of openness

Gender	Male	Female	Total	% correct
Male	22	19	41	53.7%
Female	12	47	59	79.7%

The results can summarize that the women had more IAQ knowledge compared to men. It was proved by this personality test that gender able to influence the IAQ awareness and knowledge whereby women have more understanding and responsive on the IAQ compared with men.

The findings showed that the respondents had experienced with the health problem symptoms or SBS (Sick Building Syndrome) such as eye irritancies, nausea, dizziness, respiratory problem and skin irritancies. Quite a number of them had experienced the severe dizziness and a majority of them had exposed on the light symptom of eye irritancies. Consequently, the majority of the respondents complained that IAQ condition in the laboratories was unhealthy. It shows that the laboratories were polluted with the IAQ pollutant. The presence of pollutants in the laboratories perhaps because of the research and teaching activities whereby several types of volatile chemicals such as acid, organic or inorganic solvent were frequently utilized consequences the VOC or pollutant gases were produced simultaneously pollute the indoor air inside the laboratories.

Although the respondents had exposed with the light symptoms of those health problems, it may become worse or can lead to the occupational diseases such as lung cancer, asthma or microbial infection if control measures were not taken immediately. The contaminated air will be accumulated in the laboratory

and it may affect to another area and consequently other places will also be polluted by the air pollution through the central air conditioning. The control measures can be implemented such as installing the most efficient of heating, ventilation and air conditioning (HVAC) system, doing air monitoring and use the fume hood during handling the volatile chemicals concurrently comply with the DOSH regulations [16]. In addition, safety signage such as smoking prohibition, use hood systems and wearing personal protective equipment (PPE) can be published in order to remind the laboratory occupants for complying the rules during working or being in the laboratory.

4.0 CONCLUSION & RECOMMENDATION

Based on the occupant's complaint, it can be summarized that IAQ in the laboratories at the higher learning institution is unhealthy. Apart from that, not all peoples have ample knowledge and awareness regarding the IAQ. Meanwhile, the personalities of the occupants have significance to influence and able to determine their awareness on the IAQ. Thus, IAQ is a crucial factor for determining the health of occupants in the laboratory. It must be controlled and maintained accordingly to meet the acceptable level and comply with the DOSH IAQ regulations so that the occupants will not be exposed to the pollutants or health problems and will not produce the indoor air pollutants while being in the laboratory. It is important to fulfill the OSH rule and regulation thereby the occupants can work in safe, healthy, comfortable condition and without the health disorders.

As a recommendation, the number of respondents and variable of data should be increased on the future research in order to strengthen and confirm the data output regarding the IAQ. It includes quantifying the level of pollution in the laboratories thoroughly. It is significant because of the result data will confirm the IAQ condition either in good or otherwise, simultaneously further action and control measures can be taken meticulously. The research on this matter should be extended continuously so that it can develop and promote the good IAQ in the laboratory.

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