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INDOOR ENVIRONMENTAL QUALITY (IEQ): A CASE STUDY IN TAYLOR'S UNIVERSITY, MALAYSIA

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ABSTRACT

This overall research comprised of the introduction to Indoor Environmental Quality (IEQ) and how IEQ influence the building occupants in Taylor's University. Problems of the research was found out and relative objectives was established to carry out comprehensive research on the topic. Questionnaire is used as a method to collect data and analyse on these collected data subsequently. The factors which affect the occupants' indoor environmental necessities and preferences were evaluated. Health effects of poor IEQ were assessed based on the questionnaire collected. The health effects of poor IEQ, Sick Building Syndrome (SBS) are regularly feeling cold, headache and dizziness, confusion, irritation of eyes, throat, nose and/or skin, nausea, fatigue and respiratory problems. Lastly, perception and well-being of building occupants to indoor environment were studied. Preferable conditions of IEQ such as thermal comfort, IAQ, acoustic quality and lighting quality were studied.

Keywords: ***Indoor Environmental Quality (IEQ), Indoor Air Quality (IAQ), thermal comfort, acoustic quality, lighting quality***

1. INTRODUCTION

There is no clear definition for Indoor Environmental Quality (IEQ). Basically, IEQ was expressed in term of occupants' health determined by environmental aspects like Indoor Air Quality (IAQ), thermal comfort, acoustical quality and visual or lighting quality (Bluyssen, 2009; Kim and Haberl, 2012; Codreanu, 2013; Ng and Akasah, 2013).

In relation to the building occupants' health, World Health Organization stated that health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1984).

According to Bluyssen (2009), Indoor Environmental Quality does not consider psychological effects, individual and physical reasons such as age, diseases and degradation of parts of the human body as these are hard to determine. Whereas, the environmental aspects affecting the IEQ such as thermal comfort, Indoor Air Quality, acoustic quality and lighting quality are the main considerations in order to identify the IEQ of certain space.

2. INDOOR AIR QUALITY, THERMAL COMFORT, ACOUSTIC QUALITY AND LIGHTING QUALITY

Indoor Air Quality (IAQ) is interrelated to occupants' health and well-being. Health threats such as headache, fatigue, respiratory problems, and irritations or allergies of nose, eyes and throat may arise when the air consisting of pollutants such as biological contaminants, chemicals, particles and aerosols (Kubba, 2012).

Thermal comfort is defined as that condition of mind which expresses satisfaction with the thermal environment (Olesen and Parsons, 2002). It was identified that when 80 percent of the building occupants were satisfied with the surrounding thermal conditions, the thermal environment is then in a satisfactory condition (ASHRAE Standard, 1992). Parameters such as temperature, humidity, and air flow are take into consideration to recognize the thermal comfort level in particular zone (ASHRAE Standard, 2004).

According to Kim and Haberl (2012a), acoustic quality is studied to pinpoint the sound or vibration isolation and the level of noise from

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background. Acoustic quality is undesirable when the sound created has been observed as obnoxious, frustrating or distressing, vice versa (Genuit, 1996).

Research undertaken by Bülow-Hübe (2008) recognizes that lighting quality is influenced by factors such as the window area. The author states that bigger window area will result in higher occasion that a window might generates glare. Installation of blinds or curtains in interior of building can then help in achieving a glare free environment.

3. ISSUES OF INDOOR ENVIRONMENTAL QUALITY IN MALAYSIA

Md Din *et al* (2014) wrote that climate in Malaysia is hot and humid. Hence, it was very common to perceive that most of the office buildings in Malaysia are fitted out with Heating, Ventilation and Air-Conditioning (HVAC) systems in order to achieve optimum Indoor Environmental Quality (Khalil and Husin, 2009).

Despite the fact that the buildings are well equipped with HVAC systems, occupants still exposed to risks from having Sick Building Syndrome which symptoms are headache, mental fatigue, nausea, airway infections, wheezing, and itchiness to skin (Bluyssen, 2009; Codreanu, 2013). Problem arises when the poor indoor environmental circumstances may lead to low levels of work productivity amongst the occupants (Khalil and Husin, 2009).

4. PARAMETERS OF MEASURING IEQ

There are several parameters of measuring Indoor Environmental Quality which includes thermal comfort, Indoor Air Quality, acoustic quality and lighting quality.

4.1 Thermal Comfort

There are seven factors which affect the thermal comfort level which are air temperature (°C), radiant temperature (°C), air velocity (m/s), relative humidity (%), air pressure (Pa), rate of metabolism (met) as well as clothing (clo) of the occupants (Shaharon and Jalaludin, 2012; Sherman, 1985).

4.2 Indoor Air Quality (IAQ)

According to Codreanu (2013), IEQ is demarcated by the indoor air pollutants (CFUs/m^3) and the rate of fresh air circulation. IEQ of the particular building is achieved when the IAQ is satisfactory and IEQ is important in order to ensure the health of the building occupants (Yau, *et. al.*, 2012).

Spengler and Chen (2000) mentioned that the facilities managers discovered that among the operating issues of the building, IAQ is one of the common matters which influences the health of the occupants. The increase of awareness among the occupants to the IAQ shows that IAQ is one of the most common indoor environmental problems faced by them.

4.3 Acoustic Quality

Genuit (1996) indicated that when a sound which measured in decibel (dB), appeared in an unpleasant, frustrating or annoying ways, it can affects the IEQ within that particular spaces.

Similarly, Codreanu (2013) pointed out that noise from vibrations, outer or inner parts of the buildings would likely to affect the acoustic quality experienced by the building occupiers. The author specified that acoustic comfort is one of the physical needs for the tenants especially when they are in buildings which populated by public users (Codreanu, 2013).

4.4 Lighting Quality

According to Altan, *et al* (2008), the tendency of Architect to design buildings enclosed with glazing is anticipated to lower the IEQ of the building due to excessive glare caused by the too much radiation of natural light which hereafter causes visual discomfort to the occupants. Bülow-Hübe (2008) agreed that when the building environment is free from glare issues and achieved visual comfort among the building users, the building is held to have good IEQ.

A study by Codreanu (2013) shown that visual comfort is one of the physical criterias for the building occupants to identify their comfort level in indoor environment thus achieve good IEQ. Visual comfort is achieved when the illuminance and luminance levels (lux) are maintained in good conditions (Codreanu, 2013).

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5. HEALTH EFFECTS OF POOR INDOOR ENVIRONMENTAL QUALITY: SICK BUILDING SYNDROME (SBS)

The health effects of poor Indoor Environmental Quality consist of feeling cold; headache and dizziness; confusion; irritation of eyes, throat, nose and/or skin; nausea or fatigue and lastly, respiratory problems.

5.1 Feeling Cold

Guidry (2002) stated that the occupants are recognised as having SBS when have symptoms such as regularly feeling cold.

5.2 Headache and Dizziness

Redman *et al* (2011) carried out a research on significances of SBS and found that SBS which widely known is headache and dizziness. Guidry (2002) also has the same view by identified that symptoms of sick building is headache. The SBS of headache and dizziness is further supported by Mendell (2003), Roulet *et al* (2006), WHO (1984) and Rostron (1998).

5.3 Confusion

Guidry (2002) revealed that the occupants who temporary losing of memory is considered as having SBS. Rostron (1998) also specified that the conditions of SBS include misperceptions of the occupants.

5.4 Irritation of Eyes, Throat, Nose and/or Skin

Guidry (2002) stated the occupants are identified as having SBS when they are allergic to the pollutants. Redman *et al* (2011) indicated that SBS which widely known included skin irritation and dryness, throat irritation and dryness as well as eyes itchiness and dryness.

Rostron (1998) defined the SBS when occupants undergo mucus membrane inflammation which influence their eyes, nose and throat. The eye irritation may bring serious problems to occupants especially for those who is a contact lens user (Rostron, 1998). Other than that, Rostron (1998) stated that skin diseases is one of the syndromes which usually hard to be determined as SBS which caused by the poor indoor environmental conditions by way of the disorders may only happen in future.

Mendell (2003) and WHO (1984) have reached common ground by concluded that SBS cause the occupants to have irritated eyes, nose, skin and throat. In addition, Roulet *et al* (2006) stated the syndromes of sick building include congested nose, sneezing and runny nose, skin dryness and itchiness.

5.5 Nausea or Fatigue

Guidry (2002) stated that SBS comprises of feeling of lethargy among the occupants. Redman *et al* (2011), Roulet *et al* (2006) and WHO (1984) have the same opinions by determined that SBS took place when the feeling of tiredness and sleepiness is suffered by the occupants. Symptoms such as nausea occurs when there is odour causing discomfort to the occupants (Rostron, 1998).

5.6 Respiratory Problems

A research done by Guidry (2002) shows the occupants are identified as having SBS when they have sick symptoms such as respiratory problems. Redman *et al* (2011) has the similar view by stated that SBS which widely known is respiratory infections. Mendell (2003) explored that SBS includes inhalation difficulties which occupants had within the building.

According to Rostron (1998), the author mentioned that the asthma-like signs is one of the syndromes of sick building which largely due to the poor IAQ. Maroni *et al* (1995) shown that the respiratory problems include wheezing and asthma. Other than that, WHO (1984) found that the occupants might have out of breath if they stay within the sick building.

6. RESEARCH METHODOLOGY

Questionnaire technique is used to collect primary data which is the data obtained first hand.

This study is carried out in Taylor's University, Malaysia as the respondents are accessible.

All the closed questions will be analysed based on the percentage formula as shown in

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Formula (1). The five-point likert scale questions were analysed based on the weighted mean or mean score formula as shown in Formula (2). The level of acceptance for each mean score will be determined according to the Table 1.

$$\text{Percentage, \%} = \frac{\text{No. of Responses}}{\text{Total Number of Respondent}} \times 100\% \quad (1)$$

$$\text{Weighted mean/ mean score, } \bar{x} = \frac{w_1x_1 + w_2x_2 + \ldots\ldots + w_5x_5}{\sum x} \quad (2)$$

Where,

w – Weight given (scale)
x – Number of responses
$\sum x$ – Total number of respondents

Table 1. Analysis of Mean Scores (Alston and Miller, 2010)

Mean Scores	Level of Acceptance
1 - 1.49	Worst
1.5 - 2.49	Not Acceptable
2.5 - 3.49	Acceptable
3.5 - 4.49	Good
4.5 - 5	Extremely Good

Section A is the respondent's profile. Closed questions such as gender, study duration in Taylor's University as well as the respondent's age is set.

Section B focuses on the questions to answer the first research objective. Closed questions were set based on Alston and Miller (2010) five-point likert scale where participants were required to choose the option which best represents his or her assessment. Example of five-point likert scale is shown in Table 2.

Table 2. Five-Point Likert Scale (Alston and Miller, 2010)

1	2	3	4	5
Least Important	Not Important	Neutral	Important	Very Important

Section C are closed questions which predetermined to answer the second research objective. Three questions were set up under this particular section and were analysed based on Formula (1).

Section D is the last section of the questionnaire where six questions were set up to answer the third research objective. All questions fall under this section were set up as closed questions and four out of six questions were administered based on Alston and Miller (2010) five-point likert scale. The other two closed questions were analysed based on Formula (1).

7. DATA ANALYSIS

A total of 372 questionnaires were distributed to the respondents. 252 questionnaires were lost during the data collection process. Total of 120 questionnaires were received from the respondents. A total of 120 questionnaires were received and 80 questionnaires were found to be invalid. There is only 40 valid returned questionnaires which to be analysed. By using Formula (3), the response rate achieved is 32%. Nevertheless, the more the responses collected, the better it is.

$$\text{Response rate achieved} = \frac{\text{Number of responses}}{\text{Number of questionnaire sent out}} \times 100\% \quad (3)$$

7.1 Results on Factors Which Affect the Occupants' Indoor Environmental Necessities and Preferences

Table 3 shows the summary of factors which affect the occupants' indoor environmental necessities and preferences.

Thermal comfort has the highest weighted mean which is 4.30. Clements-Croome and Li (2000) stated that thermal comfort is one of the major factors which contribute to IEQ. Kim and Haberl (2012) as well as Ng and Akasah (2013) also concluded that thermal comfort would likely to impact on IEQ. Codreanu (2013) in his research found that thermal comfort was one of the physiological requirements by the building occupants.

Indoor Air Quality ranks second where weighted mean of 4.25 is obtained. The significance of the IAQ is determined meanwhile in first century BC where the IAQ is determined as the principal factor of having poor IEQ (Vitruvius and Morgan, 1960). Kim and Haberl (2012) and Ng and Akasah (2013) have the same view as Vitruvius and Morgan (1960) by clinched that IAQ would possible affect the overall IEQ within the building.

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Lighting Quality ranks third and has weighted mean of 4.23. A study by Codreanu (2013) shown that visual comfort is one of the physical criteria for the building occupants to identify their comfort level in indoor environment thus achieve good IEQ. Moreover, Khalil and Husin (2009) carried out researches to recognise the perception levels of the building occupants to the IEQ and classified visual comfort as one of the IEQ variables.

Acoustic Quality is the least important factor and has weighted mean of 3.85. However, it still considered one of the important factors which affect occupants' indoor environmental necessities and preferences. Kim and Haberl (2012) have included acoustics as one of the parameters which is associated to IEQ in their assessments. Ng and Akasal (2013) also made acoustics as part of their considerations when conducting their researches. Khalil and Husin (2009) agreed to the statement by the author, Cheong and Chong (2001) by settled that noise is one of the main factors which decide the occupiers' comfort fulfilment to the IEQ.

Table 3. Summary on Factors Which Affect the Occupants' Indoor Environmental Necessities and Preferences

Indoor Environmental Quality	Weighted Mean	Rank
Indoor Air Quality	4.25	2
Thermal Comfort	4.30	1
Acoustic Quality	3.85	4
Lighting Quality	4.23	3

7.2 Results on Sick Building Syndrome (s) Experienced in Taylor's University

Figure 1 displays results on Sick Building Syndromes experienced by the respondents in Taylor's University.

Guidry (2002) stated that the occupants are recognised as having SBS when have symptoms such as regularly feeling cold. As shown in Figure 4.3, most of the respondents have suffered feeling cold which is 90% of the total respondents.

The next SBS which they experienced more is nausea or fatigue, which consists half of them. Guidry (2002) stated that SBS comprises of feeling of lethargy among the occupants. Redman, *et al* (2011), Roulet, *et al* (2006) and WHO (1984) have the same opinions by determined that SBS took place when the feeling of tiredness and sleepiness is suffered by the occupants. Symptoms such as nausea occurs when there is odour causing discomfort to the occupants (Rostron, 1998).

Headache and dizziness ranks third of SBS experienced which is 37.5% of the respondents. Redman, *et al* (2011) carried out a research on significances of SBS and found that SBS which widely known is headache and dizziness. Guidry (2002) also has the same view by identified that symptoms of sick building is headache. The SBS of headache and dizziness is further supported by Mendell (2003), Roulet, *et al* (2006), WHO (1984) and Rostron (1998).

Furthermore, 22.5% of participants experienced respiratory problems. A research done by Guidry (2002) shows the occupants are identified as having SBS when they have sick symptoms such as respiratory problems. Redman, *et al* (2011) has the similar view by stated that SBS which widely known is respiratory infections. Mendell (2003) explored that SBS includes inhalation difficulties which occupants had within the building. Maroni, *et al* (1995) shown that the respiratory problems include wheezing and asthma. Other than that, WHO (1984) found that the occupants might have out of breath if they stay within the sick building.

A slightly lower percentage of respondents, which is 20% of respondents, have irritation of eyes, throat, nose and/or skin. Guidry (2002) stated the occupants are identified as having SBS when they are allergic to the pollutants. Redman, *et al* (2011) indicated that SBS which widely known included skin irritation and dryness, throat irritation and dryness as well as eyes itchiness and dryness. In addition, Roulet, *et al* (2006) stated the syndromes of sick building include congested nose, sneezing and runny nose, skin dryness and itchiness.

Minority of respondents which is 10% of them suffered confusion. Guidry (2002) revealed that the occupants who temporary losing of memory is considered as having SBS. Rostron (1998) also specified that the conditions of SBS include misperceptions of the occupants.

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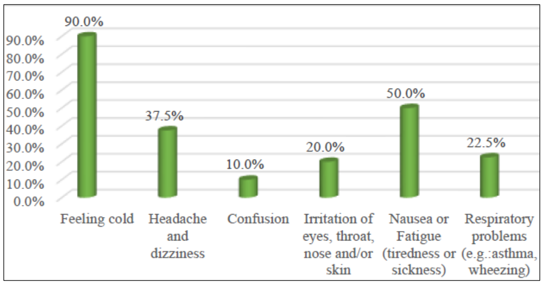

Figure 1. Results on Sick Building Syndromes Experienced in Taylor's University

7.3 Results on Sick Building Syndrome(s) Which Cannot Tolerant With

Figure 2 displays that the SBS which respondents regularly cannot tolerant with is feeling cold, where 37.5% of them purported that they cannot withstand cold environments. Guidry (2002) stated that the occupants cannot withstand SBS such as regularly feeling cold.

The second most SBS the participants cannot tolerate with is headache and dizziness which comprises 32.5% of them. Guidry (2002) identified that one of the symptoms of sick building which building occupants cannot tolerant with is headache.

Syndromes such as respiratory problems and nausea or fatigue cannot stand with 10% of the respondents respectively. Mendell (2003) explored that occupants of the building do not likely to experience inhalation difficulties when they were within the indoor environment. According to Rostron (1998), the author mentioned that the asthma-like signs is one of the syndromes of sick building which building occupants cannot tolerant with. Maroni, *et al* (1995) shown that the respiratory problems which occupants cannot bear with include wheezing and asthma.

There are 7.5% of respondents cannot bear with irritation of eyes, throat, nose and/or skin. Mendell (2003) and WHO (1984) have the same view by concluded that occupants cannot stand with SBS such as irritated eyes, nose, skin and throat.

Lastly, there are 2.5% of them cannot bear with confusion. Guidry (2002) also revealed that some of the occupants would not likely to experience temporary losing of memory.

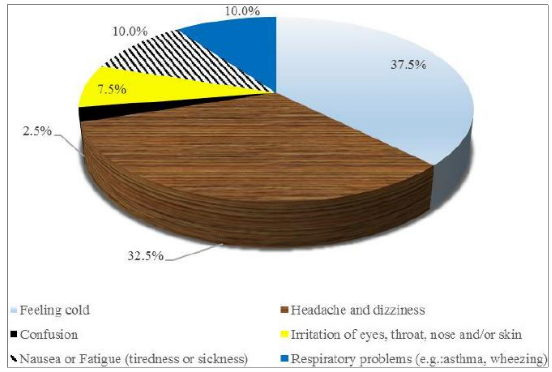

Figure 2. Results on Sick Building Syndromes Which Cannot Tolerant With

7.4 Results on Sick Building Syndrome (s) Which Can Tolerant With

Bluyssen (2009) stated that not every individual receives, perceives and responds in the same way due to physical, physiological and psychological differences (Bluyssen, 2009). Khalil and Husin (2009) have the similar views by asking question that how individual occupants can fulfill their different needs of indoor environmental conditions.

Based on Figure 3, more than half of the respondents, which is 60% of them claimed that they can tolerant with feeling cold condition. The second most of the SBS they can withstand is confusion, which consists 15% of them and followed by irritation of eyes, throat, nose and/or skin which involves 10% of the participants. There are 7.5% of the participants held that they can tolerant with nausea or fatigue, 5% of them claimed that they can stand with headache and dizziness and lastly, only 2.5% of them supposed that they can withstand respiratory problems.

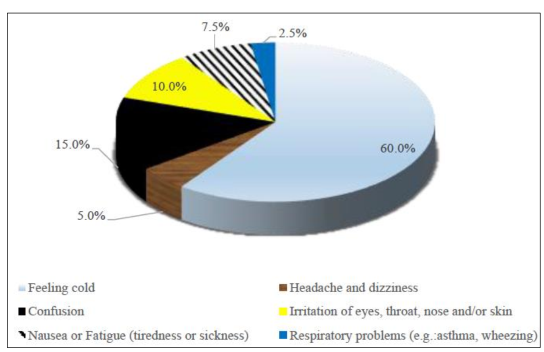

Figure 3. Results on Sick Building Syndromes Which Can Tolerant With

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7.5 Results on Perception and Well-Being of Building Occupants to Indoor Environment

7.5.1 Indoor air quality

The weighted averages of the scores voted by the respondents on their perceptions to IAQ are as shown in Figure 4.

For Taylor's library, highest average of 3.48 is recorded where the respondents have perceptions that the IAQ in library is acceptable. According to Hellgren, *et al* (2011), building occupants prefer to stay in an environment which contains lesser dust and dirt as these may cause uneasiness among them.

In lecture theatre 10 (LT10), it has a slightly lower score than library where weighted mean of 3.43 is voted by the respondents. Nevertheless, 3.43 is still presented as an acceptable rating as identified by Alston and Miller (2010).

Computer lab 8 and classroom D8.11 have evaluated 3.18 and 3.00 respectively which at the acceptable level as well. The building occupants alleged that IAQ was below standard when they have SBS which majorly caused by poor ventilation rate within the indoor environment (Hellgren, *et al*, 2011). Seppanen, *et al* (2004) also established that building occupants achieve their requirements in IAQ when there is optimum ventilation rate which then reduce the SBS among the occupants.

Library	w	x	wx	
Poor	1	2	2	
Fair	2	5	10	
Average	3	11	33	
Good	4	16	64	
Excellent	5	6	30	
		40	139	3.48
Lecture Theatre (LT10)	w	x	wx	
Poor	1	1	1	
Fair	2	2	4	
Average	3	19	57	
Good	4	15	60	
Excellent	5	3	15	
		40	137	3.43
Computer Lab 8 (Block C, Level 7)	w	x	wx	
Poor	1	1	1	
Fair	2	10	20	
Average	3	11	33	
Good	4	17	68	
Excellent	5	1	5	
		40	127	3.18
Classrooms (D8.11)	w	x	wx	
Poor	1	2	2	
Fair	2	7	14	
Average	3	22	66	
Good	4	7	28	
Excellent	5	2	10	
		40	120	3.00

Figure 4. Results on Perception and Well-Being of Building Occupants to Indoor Air Quality

7.5.2 Thermal Comfort

The weighted means of the scores voted by the respondents on their perceptions to thermal comfort are as shown in Figure 5.

Taylor's library has obtained the highest average of 3.55 where the thermal comfort is good. The acceptable indoor temperature for occupants in hot and humid countries is greater as compared to the ASHRAE standards (Azizpour, *et al*, 2011).

Classroom D8.11 has second most average score of 3.28 and subsequently 3.23 assessed to computer lab 8. Both of the classroom and computer lab are acceptable by the respondents. Study carried out found that building occupants prefer to study or work in a cooler environment due to the hot and humid climate in Malaysia (Md Din, *et al*, 2014).

In lecture theatre 10 (LT10), respondents have graded lowest average of 3.00 to the thermal comfort level which is acceptable. The authors Md Din, *et al* (2014) carried out a study to identify the thermal sensation of occupants in Putrajaya, Malaysia and shown that most of the respondents perceive the thermal comfort in their occupied environment is acceptable and do not affect their study or working performances.

Library	w	x	wx	
Poor	1	2	2	
Fair	2	3	6	
Average	3	11	33	
Good	4	19	76	
Excellent	5	5	25	
		40	142	3.55
Lecture Theatre (LT10)	w	x	wx	
Poor	1	3	3	
Fair	2	6	12	
Average	3	20	60	
Good	4	10	40	
Excellent	5	1	5	
		40	120	3.00
Computer Lab 8 (Block C, Level 7)	w	x	wx	
Poor	1	0	0	
Fair	2	8	16	
Average	3	18	54	
Good	4	11	44	
Excellent	5	3	15	
		40	129	3.23
Classrooms (D8.11)	w	x	wx	
Poor	1	1	1	
Fair	2	7	14	
Average	3	15	45	
Good	4	14	56	
Excellent	5	3	15	
		40	131	3.28

Figure 5. Results on Perception and Well-Being of Building Occupants to Thermal Comfort

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7.5.3 Acoustic Quality

Figure 6 presents the weighted averages and rating chosen by the respondents on their perceptions to acoustic quality. Taylor's library has ranked the highest average of 3.95 where the participants feeling good to the acoustic quality in library. The occupants observed that the indoor environment is favorable where the acoustic quality is not subjected to the application of fans, low frequency sounds and sound generated from the neighbouring regions (Kim and Haberl, 2012a).

Computer lab 8 is the second highest where an average of 3.80 rated by the respondents. Then, good rating is given by the respondents to classroom D8.11 with weighted average of 3.60. Preferences and well-beings of building occupants to the indoor acoustic quality is determined by the author Khalil and Husin (2009) by questioned the overall acoustic quality experienced by the building users.

Lecture theatre 10 (LT10) has been rated the lowest perception level of 3.33 among the participants though it still acceptable. According to Broner (2005), the building occupants may come across with annoyance when the indoor environment has high loudness level.

Library	w	x	wx	
Poor	1	0	0	
Fair	2	3	6	
Average	3	8	24	
Good	4	17	68	
Excellent	5	12	60	
		40	158	3.95
Lecture Theatre (LT10)	w	x	wx	
Poor	1	3	3	
Fair	2	2	4	
Average	3	21	63	
Good	4	7	28	
Excellent	5	7	35	
		40	133	3.33
Computer Lab 8 (Block C, Level 7)	w	x	wx	
Poor	1	2	2	
Fair	2	4	8	
Average	3	3	9	
Good	4	22	88	
Excellent	5	9	45	
		40	152	3.80
Classrooms (D8.11)	w	x	wx	
Poor	1	2	2	
Fair	2	5	10	
Average	3	7	21	
Good	4	19	76	
Excellent	5	7	35	
		40	144	3.60

Figure 6. Results on Perception and Well-Being of Building Occupants to Acoustic Quality

7.5.4 Lighting Quality

For lighting quality in Taylor's University, there is no good or extremely good of weighted averages as displayed in Figure 7 where all the mean scores obtained are lesser than 3.50%. Lighting quality in all of the locations such as library, lecture theatre (LT10), computer lab 8 and classroom D8.11 are perceived as acceptable.

Library has the highest mean score of 3.30, next is classroom D8.11 with slightly lower score of 3.23 and followed by computer lab 8 with 3.18 of mean score. These lower scores indicate that there is some respondents who do not satisfied with the lighting quality in these locations. A research studied by Kim and Haberl (2012a) shows that occupants were remain pleased with the visual comfort within the building even if the sources of lighting only from sunlight and eliminate the usage of light fittings. However, there is still some of the building occupants do not contented with the lighting quality (Kim and Haberl, 2012a).

Last but not least, lowest average score of 3.10 is voted to the lighting quality in lecture theatre (LT10). Occupants complained that they were exposed to excessive light due to the overhead lights (Kim and Haberl, 2012a). Ng and Akasah (2013) found that occupants are likely to experience glare issues when the building façade is designed to have maximum number of windows.

Library	w	x	wx	
Poor	1	2	2	
Fair	2	7	14	
Average	3	13	39	
Good	4	13	52	
Excellent	5	5	25	
		40	132	3.30
Lecture Theatre (LT10)	w	x	wx	
Poor	1	2	2	
Fair	2	10	20	
Average	3	11	33	
Good	4	16	64	
Excellent	5	1	5	
		40	124	3.10
Computer Lab 8 (Block C, Level 7)	w	x	wx	
Poor	1	0	0	
Fair	2	9	18	
Average	3	15	45	
Good	4	16	64	
Excellent	5	0	0	
		40	127	3.18
Classrooms (D8.11)	w	x	wx	
Poor	1	0	0	
Fair	2	5	10	
Average	3	21	63	
Good	4	14	56	
Excellent	5	-	-	
		40	129	3.23

Figure 7. Results on Perception and Well-Being of Building Occupants to Lighting Quality

7.6 Overall Satisfaction with Indoor Environmental Quality (IEQ) in Taylor's University

Results on overall satisfactions with IEQ by the participants is as shown in Figure 8. There

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are 87% of them satisfied with the IEQ in Taylor's University and 13% of them do not satisfied with the IEQ.

This is because not everyone perceive the same as what Bluyssen (2009) mentioned. Not every individual receives, perceives and responds in the same way due to physical, physiological and psychological differences (Bluyssen, 2009).

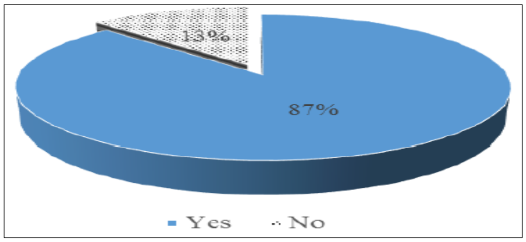

Figure 8. Results on Overall Satisfaction with Indoor Environmental Quality in Taylor's University

7.7 Overall Experience on the Indoor Environmental Quality in Taylor's University

Figure 9 shows that 45% and 42.50% of the respondents voted good and neutral separately to the overall experience on the IEQ. There are only 5% of the respondents answered the overall experience is very good whereas 7.50% of them responded they have poor experience on the IEQ. However, there is no one purported that their experiences on the IEQ is very poor in Taylor's University.

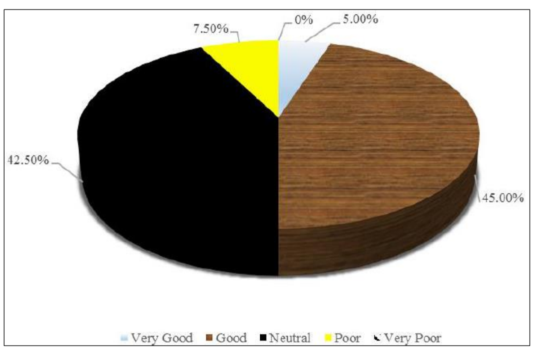

Figure 9. Results on Overall Experience on the Indoor Environmental Quality in Taylor's University

8. CONCLUSION

In a nutshell, IEQs within the university shall be maintained or improved by the Taylor's management teams to avoid or reduce SBSs among the students or occupants.

9. REFERENCES

1. Alston, A. J. & Miller, W. W. (2001). Analyzing the Barriers and Benefits toward Instructional Technology. *Journal of Southern Agricultural Education Research 59*, 51(1), 50-62.

2. Altan, H., Ward, I., Mohelníková, J. & Vajkay, F. (2008). Daylight, Solar Gains and Overheating Studies in a Glazed Office Building. *International Journal of Energy and Environment*, 2(2), 129-138.

3. ASHRAE Standard (1992). Standard 55-1992. Atlanta, GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers.

4. ASHRAE Standard (2004). Standard 55-2004. Atlanta, GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers.

5. Azizpour, F., Moghimi, S., Mat, S., Lim, C., & Sopian, K. (2011). Objective and Subjective Assessment of Thermal Comfort in Hot-Humid Region. *In 5th WSEAS International Conferences on Recent Researches in Chemistry, Biology, Environment and Culture*. 29-31 December. Montreux, Switzerland, 207-210.

6. Bluyssen, P. M. (2009). *The Indoor Environment Handbook: How to Make Buildings Healthy and Comfortable*. (1st ed.) Sterling, London: Earthscan.

7. Borrell, L. N. & Samuel, L. (2014). Body Mass Index Categories and Mortality Risk in US Adults: The Effect of Overweight and Obesity on Advancing Death. *American Journal of Public Health*, 104(3), 512-519.

8. Broner, N. (2005). What Did We Learn from ASHRAE RP-879? *ASHRAE Transactions*, 111(1), 661-671.

9. Bülow-Hübe, H. (2008). *Daylight in Glazed Office Buildings. A Comparative Study of Daylight Availability, Luminance and Illumince Distribution for an Office Room with Three Different Glass Areas*. Division of Energy and Building Design Department of Architecture and Built Environment. Lund University. Faculty of Engineering.

10. Cheong, K.W & Chong, K.Y. (2001). Development and Application of an Indoor Air Quality Audit to an Air-Conditioned

ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

Building in Singapore. *Building and Environment*, 36, 181-188.

11. Clements-Croome, D. & Li, B. Z. (2000). Productivity and Indoor Environment. *Proceedings of Healthy Buildings*, 1, 629-631.

12. Codreanu, M. (2013). 'Indoor Environmental Quality. Risk Assessment Concerning Occupants Comfort and Health', *Bulletin of The Polytechnic Institute Of Iasi - Construction & Architecture Section*, 63(1), 191-201.

13. Genuit, K. (1996). Objective Evaluation of Acoustic Quality Based on a Relative Approach. *Proceedings-Institute of Acoustic*, 18, 3233-3238.

14. Guidry, K. (2002). Sick Commercial Buildings: What Appraisers Need To Know. *The Appraisal Journal*, 70(1), 28-33.

15. Hellgren, U. M., Hyvärinen, M., Holopainen, R. & Reijula, K. (2011). Perceived Indoor Air Quality, Air-Related Symptoms and Ventilation in Finnish Hospitals. *International Journal of Occupational Medicine and Environmental Health*, 24(1), 48-56.

16. Khalil, N., & Husin, H. N. (2009). Post Occupancy Evaluation towards Indoor Environment Improvement in Malaysia's Office Buildings. *Journal of Sustainable Development*, 2(1), 186-191.

17. Kim, H. & Haberl, J. S. (2012a). Field-Test of the New ASHRAE/CIBSE/USGBC Performance Measurement Protocols: Intermediate and Advanced Level Indoor Environmental Quality Protocols. *ASHRAE Transactions*, 118 (2), 58-65.

18. Kim, H., & Haberl, J. S. (2012). Field-Test of the New ASHRAE/CIBSE/USGBC Performance Measurement Protocols for Commercial Buildings: Basic Level. *ASHRAE Transactions*, 118(1), 135-142.

19. Kubba, S. (2012). Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes. Butterworth-Heinemann, 215-348.

20. Maroni, M., Seifert, B., Lindvall, T. (1995). Indoor Air Quality. A Comprehensive Reference Book. *Elsevier Science*, 29-87.

21. Md Din, M. F., Lee, Y. Y., Ponraj, M, Ossen, D. R., Iwao, K., & Chelliapan, S. (2014), 'Thermal Comfort of Various Building Layouts With a Proposed Discomfort Index Range for Tropical Climate', *Journal Of Thermal Biology*, 41, 6-15.

22. Mendell, M. J. (2003). Indices for IEQ and Building-Related Symptoms. *International Journal of Indoor Environment and Health*, 13(4), 364-368.

23. Ng, B. H., & Akasah, Z. A. (2013). 'Post Occupancy Evaluation of Energy-Efficient Buildings in Tropical Climates – Malaysia', *Archnet-IJAR*, 7(2), 8-21.

24. Olesen, B. W. & Parsons, K. C. (2002). Introduction to Thermal Comfort Standards and To the Proposed New Version of EN ISO 7730. *Energy and Buildings*, 34(6), 537-548.

25. Redman, T., Hamilton, P., Malloch, H. & Kleymann, B. (2011). Working Here Makes Me Sick! The Consequences of Sick Building Syndrome. *IÉSEG School of Management Human Resource Management Journal*, 21(1), 14-27.

26. Rostron, J. (1998). *Sick Building Syndrome – Concepts, Issues and Practice.* Abingdon, U.K.: E & FN Spon.

27. Roulet, C. A., Johner, N., Foradini, F., Bluyssen, P., Cox, C., Fernandes, E. d. O., Műller, B. & Aizlewood, C. (2006). Perceived Health and Comfort in Relation to Energy Use and Building Characteristics. *Building Research & Information*, 34(5), 467-474.

28. Seppanen, O.A., Fisk, W. J. & Mendell, M. J. (2004). Association of Ventilation Rates and CO^2 Concentrations with Health and Other Responses in Commercial and Institutional Buildings. *Indoor Air*, 9(4), 226-252.

29. Shaharon, M. N., & Jalaludin, J. (2012). Thermal Comfort Assessment-A Study toward Workers' Satisfaction in a Low Energy Office Building. *American Journal of Applied Sciences*, 9(7), 1037-1045.

30. Sherman, M. H. (1985). Simplified Model of Thermal Comfort, *Energy and Buildings*, 8, 37- 50.

31. Spengler, J. D., & Chen, Q. (2000). Indoor Air quality Factors in Designing a Healthy Building. *Annual Review of Energy and the Environment*, 25(1), 567-600.

ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

32. Vitruvius, P., & Morgan, M. H. (1960). *Vitruvius: The Ten Books on Architecture*. Dover Publications, New York.

33. World Health Organization (1984). Indoor Air Quality Research. *Euro-Reports and Studies 103*. Copenhagen, Denmark.

34. Yau, Y. H., Chew, B. T., & Saifullah, A. Z. A. (2012). Studies on the Indoor Air Quality of Pharmaceutical Laboratories in Malaysia. *International Journal of Sustainable Built Environment*, 1(1), 110-124.