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POST-OCCUPANCY EVALUATION (POE) OF CONVENTIONAL-DESIGNED BUILDINGS: THE EFFECTS OF OCCUAPNTS' COMFORT ON PRODUCTIVITY

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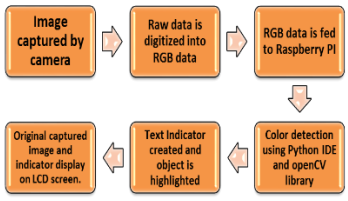
Graphical abstract



Abstract

POE is important to evaluate comfort level and satisfaction of building occupants because it indicates their productivity, health, and wellbeing. It is absolutely necessary to ensure building occupants are comfortable and satisfied about buildings' indoor environmental quality (IEQ). Productivity may be interrupted due to building occupants' discomfort, which affect their work performance. This study presents the how comfort and satisfaction affects the occupants' productivity in conventional-designed buildings. Five office buildings located in University of Malaya were selected as the case studies. 278 questionnaires feedbacks found to be useful to form a database on the IEQ. Data obtained were analyzed using SPSS software. The findings shows that majority of the respondents in conventional-designed building were slightly comfortable and satisfied about their IEQ comfort level which were indoor air quality, thermal, lighting, and noise comforts. Although, the design of conventional buildings did not taking into account on sustainability designing, it still functionally well and provided comfort which leads to increasing of employees productivity. The associative test showed significant correlation between illness symptom and IEQ components. Admin buildings had more noticeable illness symptoms in contrast with Faculty buildings. It could be concluded that building occupants' productivity were least affected by the conventional-design building.

Keywords: Post-Occupancy Evaluation (POE), conventional-designed building, comfort, productivity

Abstrak

POE penting untuk menilai tahap keselesaan dan kepuasan penghuni kerana ia berkait rapat dengan produktiviti, kesihatan dan kesejahteraan mereka. Ia perlu untuk memastikan penghuni bangunan selesa serta berpuas hati mengenai kualiti persekitaran dalaman bangunan (IEQ). Produktiviti boleh terganggu kerana ketidakselesaan penghuni bangunan yang boleh menjejaskan prestasi kerja mereka. Kajian ini membentangkan bagaimana keselesaan dan kepuasan mempengaruhi produktiviti penghuni dalam bangunan reka bentuk konvensional. Lima bangunan pejabat yang terletak di Universiti Malaya dipilih sebagai kajian kes. 278 maklum balas soal selidik didapati berguna untuk mewujudkan pangkalan data berkenaan IEQ. Data yang diperolehi dianalisis menggunakan perisian SPSS. Penemuan menunjukkan kebanyakan responden di bangunan reka bentuk konvensional adalah kurang selesa dan berpuashati tentang tahap keselesaan IEQ, kualiti udara dalaman, haba, pencahayaan dan bunyi. Walaupun reka bentuk bangunan konvensional tidak mengambil aspek kemampanan, ia masih baik dari segi fungsi dan kemudahan yang disediakan, seterusnya membawa kepada peningkatan produktiviti pekerja. Ujian hubungan menunjukkan hubung-kait yang signifikan antara gejala penyakit dan komponen IEQ. Bangunan admin mempunyai gejala penyakit yang ketara berbanding

bangunan Fakulti. Dapat disimpulkan bahawa produktiviti para penghuni bangunan kurang terkesan dengan reka bentuk bangunan konvensional.

Kata kunci: Penilaian pasca penghunian (POE), bangunan reka bentuk konvensional, keselesaan, produktiviti

1.0 INTRODUCTION

Malaysia has a vision of achieving fully developed country by year 2020, where gradually growing in efforts to develop sustainability in building performance as such the introduction of the Green Building Index (GBI). On top of that, implementation of green building provides more comfortable and satisfaction to the building occupants' especially in term of work environment and at the same time improves and enhances their productivity in work performance. Practically, conventional-designed building describes the building occupants are indoor environment passive recipient where they have a little control over indoor environment. This contradicts with "green" building designed which presumes the building occupants act as active indoor participant and have full control over comfort, which at the same time maximizing energy efficiency (Brown and Cole, 2008).

There are also efforts made by government of Malaysia to improve working productivity with regards in providing facilities at work place. For instance, the Malaysian green building index (GBI) introduced to develop green building design concept for sustainability since the features of green building provide good and quality working environment. Good working environment absolutely necessary for building occupants because it can affect productivity of building occupants. The workplace environment gives impacts to the employees' health and their job performance. Normally, there are four parameters involved in comfort level, which are the indoor air quality, thermal comfort, lighting/visual comfort and acoustic comfort. Good health among the building occupants will increase productivity and at the same time reduce absenteeism and turnover among them (Heerwagen and Zagreus, 2005). Therefore, it is vital to ensure that the building occupants are in comfort conditions of work environment so that they could be more productive.

1.1 Post Occupancy Evaluation (POE)

POE is the method to acquire feedback and response from building occupants about building performance (Jauzens *et al*., 2003). POE is the evaluation method especially for building managers to identify and evaluate the building performance, which necessary in order to ensure overall performance of the building could be sustained. POE conducts the assessment on how the performance of buildings met the users needed and able to identify measures to improve overall buildings such as buildings design, performance, and fitness of the buildings. Buildings occupants act as a benchmarking tool to improve building performance. In addition, POE also as a mutual interaction process between a building owner and occupants to improve building environment as needed by the occupants. POE is important tool in sustainable design of building aspect which is aimed to collect coveted energy, water usage, IEQ results, and building occupants' response to help building owners and designers to improve current and future buildings (Blackbird, 2009). Conversely, POE able to know what are the required work space that are needed by building occupants, which give impact to work performance and provide suitable setting of the work space for building occupants (Gou and Lau, 2013). Figure 1 shows POE process in Public Work Department of Malaysia.

Preiser (1998) explained that there are 3 stages involved in the implementing of POE. First is planning, followed by conducting and applying. At the first stage, the objectives of implementing POE would be defined. This stage is also known as the pre-evaluation process. In this stage a feasibility study will be reviewed for instance, the study on the background of the building. From the feasibility stage, the building owner would be abled to know the strength and weakness of the building performance, and would probably consider evaluating further on building indoors environmental. Figure 2 shows guideline in implementing POE exercise for government buildings in Malaysia.

The second stage of POE is collecting primary data. In this stage, the people who occupied the building would be responded by the questionnaire or interview. The data later would be analyzed to generate results. The final stage of POE involved reporting the findings and recommendation on what are the next actions plans that need to be taken up. The action plan normally consists of short, medium and long-term strategies for the building owner to improve their building. The remedial action also would be carried out based on the findings.

The benefits from POE implementation is act as the learning program which can be used as the references to improve the building performance in future before the building would be constructed. Second, the POE would be abled to know which parameters in IEQ that mostly make the buildings occupants are satisfy or dissatisfy and what are the aspects that contributed to the dissatisfaction. Second, the benefits of the

implementation POE is to differentiate between conventional and green buildings design despite different design and building features. This exercise also providing information about the building facilities whether its meet the requirement of building occupants', comfort level and satisfaction. This would give some advantages to the building designers in improving their design for the future projects (Whyte and Gann, 2001). Meir *et al*., (2009) described that the POE becomes an important exercise that often given unexpected interrelations between various aspects of buildings function. This includes buildings with sustainable building features such as energy saver gadgets, especially for heating ventilation and air-conditioning, and also the indoor environment quality for building occupants.

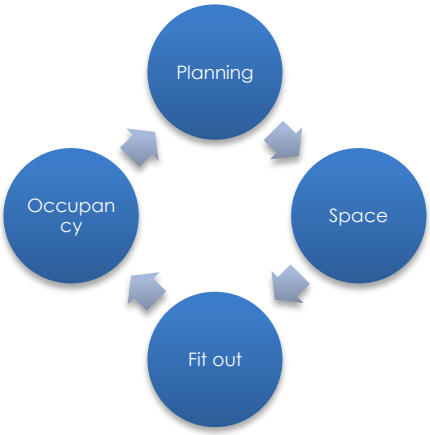


Figure 1 Post occupancy evaluation process. *Source:* Modified from Department of Public Work, Malaysia (2009), pp. 3

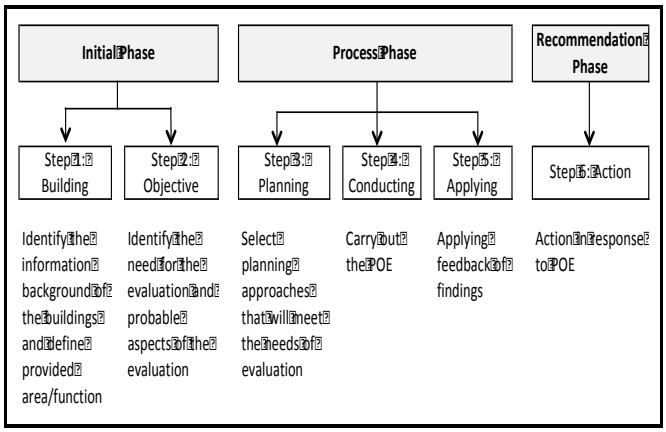


Figure 2 Proposed guidelines for POE for government and public buildings in Malaysia. *Source:* (Natasha & Nawawi, 2008)

However, some of the building occupants believed they did not enjoyed any benefit despite paying for the POE cost. This is due to the lack of POE information regarding the benefit and main objectives, which led to same mistakes to be repeated in the future. Additional cost and time identified among the factors hindered the implementation of POE. In addition, POE was least favorable by practitioners due to high cost involved, time consumed and unclear benchmarks. Literature also highlighted that not all the facilities manager in Malaysia had sufficient knowledge, understanding and skills on how to analyse user feedback and evaluate building performance. Moreover, practitioners and building owners are fear to deal if there are any negative outcomes from a poor building performance, or in the other words, Post-Occupancy Evaluation (POE) might reveal the weakness of the building performance. The other barrier of the POE is limitation of the size population that had to conduct and the reasonable of the types of question that will be asked in term of reliability and validity (Woon *et al*., 2013).

1.2 Building Comfort

Comfort can be described as a feeling of coziness and contentment (Chappells & Shove, 2004). In other words the occupants feel happy with current situation especially related in working environment where it affected humans' physical state and mental well being. But, every peoples has different degrees of comfort level, meaning that they have different tolerant in dealing with comfort level. In fact, it is difficult to determine degrees of comfort level because of different preference; for example, human body temperature, types of clothes, climate, building orientation, room temperature, and etc.

Buildings are one of the asset that contributed to the greenhouse gas emissions and effected climate change and global warming where the consumption of the heating and cooling are the most energy usage activities. It is proven that thermal environment is the one of factors that affecting building occupants' satisfaction and comfort in term of works performance. Green buildings provide most comfort and satisfaction to the building occupants in term of work environment since the implementation of green buildings are made from six main criteria which are energy efficiency, IEQ, sustainable site planning and management, materials and resources, water efficiency, and innovation. The suitable design and operations in building play an important role in contribute the comfort in workspace. Lately, most of the green buildings rating system aim to reduce building-related carbon emission to provide and improve building occupants' comfort and satisfaction especially in term of IEQ (Gou & Lau, 2013).

Similarly, Cole (2008) mentioned that the comfort standard act as the guideline for the designers and consultants as the reference for regulatory to identify whether 'acceptable' conditions have been provided and achieved especially for the building occupants' comfort and satisfaction at the workplace. There are also standard that could be referred by the consultants and designers such as American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): Thermal Environmental Conditions for Human Occupancy (55), International Standards Organization (ISO): Ergonomics of the Thermal Environment (7730) and The Chartered Institution of Building Service Engineers (CIBSE) that focusing on thermal comfort in

building based on study made by various laboratories and human physiological comfort perception (Gou and Lau, 2013). According to JKR (2013), the air temperature, humidity, air movement, clothing insulation, and metabolic heat rate, air speed, and radiant temperature are primary factors that must be addressed when defining conditions for thermal comfort. Besides, indoor environmental quality (IEQ) contributes as one of the factors affecting building occupants' satisfaction and comfort. Most of the buildings are used materials that contain high chemical ingredients especially in paints, coatings, and carpeting. These kinds of materials are potentially exposure hazardous to the building occupants through the air ventilation and air humidity. Similarly, Birt & Newsham (2009) mentioned that the occupants of green buildings had higher satisfaction with air quality and thermal comfort, whereas satisfaction with lighting showed little improvement between green and conventional buildings. Conversely, there was a clear trend towards a decrease in acoustic satisfaction with regards to green buildings.

Moreover, acoustic comfort also contributes to the factors that affect the building occupants' satisfaction and comfort. Unwanted noise can make the building occupants annoyance and can cause stress. But, acoustic comfort not quite well used in building design. Usually, lack of the adequate speech privacy and control of noise levels are the source of the dissatisfaction among the building occupants because it disturbs their work (Field, 2008). Good acoustic design must consider some factors such as building location, adequate insulation of partitions, noisy mechanical equipment, and so forth. Smith *et al*. (1996) highlighted that acoustic comfort requires sound reaches and is evenly distributed to all parts of the room, other noise should be at an acceptable level and not mask the primary sound, and the reverberation time of the sound in the room should allow for clarity of speech and/or fullness of music". The level of clarity sometimes was polluted by the unwanted sound produced by various sources. JKR (2013) reported that vibration-induced noises are often major sources of building occupant complaints in buildings. Furthermore, lightweight construction in new buildings increases susceptibility to vibration and vibration-related problems. Some complaints of noise came from the sound produce by air-conditioning components such as air diffuser, piping and other sources of noise are conversations among the colleagues, scrapping chairs, and etc. (JKR, 2013).

Hassanain (2007) defined that IAQ is an air in which there are no known contaminants at harmful concentrations and with which a substantial majority is 80% of the occupants exposed do not express dissatisfaction. Most of the office buildings in Malaysia are using mechanical ventilation system for example air-conditioning to maintain indoor air environment in building since Malaysia is hot and humid tropical type climate. But, the mechanical ventilation systems only will provide fresh air if in good condition only and well maintained and sustained. If the mechanical systems not maintain properly, it will produce unclean air to the indoor environment and affected the building occupants' health (Kamaruzzaman & Sabrani, 2011). Besides that, building renovation especially paints part became the source of the pollutants. According to OSHA, (2011), building furnishing also identified as one of the sources of the pollutants in the building where timber wood products may release pollutants into the indoor air.

On the other hands, Pritchard (1999) mentioned that visual comfort requires satisfactory luminance of the task that is being undertaken and agreeable general appearance of the interior. Creating high performance luminous environment through the careful integration of natural and artificial light sources will improve on the lighting quality of a structure (Sharif *et al*., 2013). Most of the building occupants had problems in glare from the sunlight and sky.

In Table 1, Ismail (2013) summarised the comfort baseline for IEQ, which include the acceptable range for thermal comfort, IAQ, indoor lighting and indoor acoustic.

Table 1 Baselines for better comfort levels

Parameter	Measure	Unit of Measure	Acceptable range/limits
Thermal Comfort	i. Temperature ii. Relative humidity	°C %	23 – 26 40 - 70
Indoor Air Quality	i. Air movement ii. Carbon dioxide iii. Carbon monoxide iv. Formaldehyde v. Particulates matters vi. Total volatile organic compounds (TVOC)	m/s ppm ppm ppm mg/m3 Ppm	0.15 – 0.5 1000 10 0.1 0.15 3
Indoor Lighting	Luminance	Lux	300 – 400
Indoor Acoustic	Ambient sound	dB(A)	40 – 50

Source: (Ismail, 2013)

1.3 Conventional-Designed Building

Generally, conventional-designed buildings are using older construction techniques compared to green buildings, which mostly used sustainable approach and green materials. This obviously contributes to different characters of IEQ. Warren and Peter (2007) reported findings from building occupants' comfort perceptions; green buildings have good IEQ aspects compared to conventional buildings, which turned out more productive workforce. So far, there was limited study focused on POE in conventional-designed buildings carried out especially in Malaysia (Nawawi and Natasha, 2008). Hence, it is vital to get some perceptions of occupant in conventional building on the IEQ aspects via POE approaches.

1.4 Productivity

The building occupants' comfort and satisfaction in office buildings is influenced by indoor air quality, thermal comfort, acoustic comfort, lighting comfort, and other factors such as personal control on lighting and cooling. This comfort and satisfaction has relationship with their work productivity and performance. Building occupants who are least comfortable with their working environment in the office most likely would affect their work productivity. (Leaman and Bordass (2005) outlined the best offices workplace for human productivity when there are personal controls on lighting, ventilation, and cooling aspects; work placed designed with natural ventilation and availability of room for everyone. Study on workers productivity recorded frequent complaints related to thermal comfort, sick building syndrome (SBS), and health problems while were at workplace. By improving indoor environmental in office building, the building occupants' productivity could be increased by 4 to10 percent (Haynes, 2008).

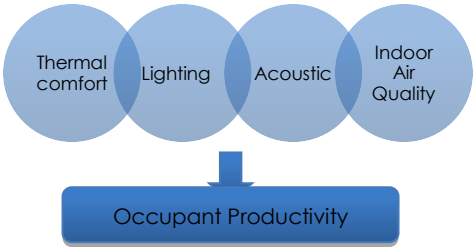


Figure 3 Relationship between comfort levels with productivity

Figure 3 illustrates the relationship between comfort levels with productivity. From the literature review, it could be concluded that occupants' productivity is influenced by comfort parameters in IEQ. Therefore, this paper intends to investigate any relationship between those factors for the conventional-design buildings.

2.0 RESEARCH METHODOLOGY

This study adopted quantitative research technique, where a set of questionnaires was used to collect data and information regarding building occupants' comfort and satisfaction. Five conventional-designed buildings were selected as case studies. For the purpose of this paper those buildings named as Admin 1, Admin 2, Admin 3, Faculty 1 and Faculty 2. The samples of this research were building occupants/employees in those five buildings who provide responses and feedbacks. The questionnaires was divided into eleven sections which were the background, building overall, thermal comfort, IAQ, noise, lighting, respondent experience, personal control, workplace environment, knowledge, and response to problems. The question mainly used seven points of semantic differential scale from very low to very high. Example of the question asked in the survey was as follow:

How do you rate room temperature in your work area?
Very hot OOOOOOO Very cold
How do you rate the cleaning?
Very unsatisfactory OOOOOOO Very Satisfactory

A total of five hundred questionnaires were distributed randomly among the building occupants. The respondents participated in the survey need to fulfill some criteria such as at least spend their working time average of 8 hours per day for 5 days a week. The respondents also were worked in the building for minimum of 1 year. Two hundred and seventy eight respondents returned and could be used to form a database for analysis. The feedbacks obtained given a total response rate of 55.6 percent. A Statistical Package for Social Science (SPSS) software was used to analyse the raw data. Both descriptive and inferential data analyses techniques were used such as mean, mod, Kruskal Wallis, Mann-Whitney U and Spearman Correlation test. Mean score of 1.0 to 3.0 considered unsatisfied, 3.01 to 5.0 were fair and 5.01 to 7.0 considered satisfied.

3.0 RESULT AND DISCUSSION

Figure 4 shows that percentage of respondents participated in the survey from 5 different buildings. The highest respondents come from building Admin 1, which is 23 percent. On the other hand, building Admin 3 is the lowest no of respondents, which are 17 percent or 47 people.

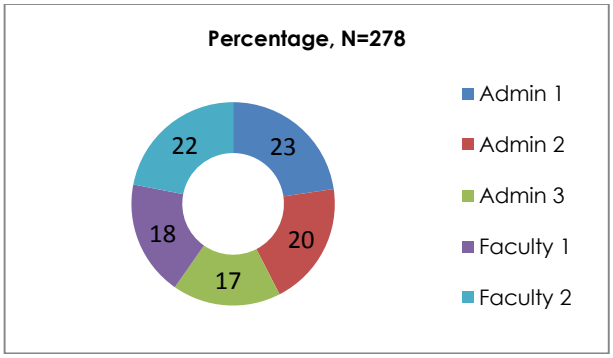


Figure 4 No of respondents participated in the survey

3.1 Demographic Profile of the Buildings

Table 2 shows result for building characteristics. The building characteristics covers 5 major aspects, which are building design, facilities meet the needs, space usage, safety and cleaning. The overall result indicates the employees quite satisfied with building characteristics with the mean score of 4.53 ranging to

5.88. The result shows there is no significant difference for all 5 buildings on the aspects of the building facilities except for the cleaning. This indicates that there was different level of cleanness amongst the five buildings. The plausible explanation could be the different level of services provided by the cleaning workers due to different contractor responsible for each of the buildings. The mean score generally more than 4 shows that the occupants in all 5 buildings satisfied with the design, facilities and cleaning services provided.

Table 2 Summary of the building characteristics

Building Characteristics	Mean, Total N=278	Kruskal Wallis, Significant Difference: P <0.05
Overall building design		
Admin 1	4.60	0.805
Admin 2	4.59	
Admin 3	4.58	
Faculty 1	4.89	
Faculty 2	4.97	
Facilities meet the needs		
Admin 1	4.78	0.202
Admin 2	4.70	
Admin 3	4.69	
Faculty 1	4.92	
Faculty 2	4.98	
Space usage		
Admin 1	4.56	0.106
Admin 2	4.58	
Admin 3	4.59	
Faculty 1	5.68	
Faculty 2	5.88	
Personal safety in the building		
Admin 1	4.96	0.454
Admin 2	4.67	
Admin 3	4.78	
Faculty 1	5.86	
Faculty 2	5.54	
Cleaning		
Admin 1	5.22	0.021
Admin 2	4.53	
Admin 3	4.86	
Faculty 1	4.86	
Faculty 2	4.71	

3.2 Thermal Comfort

Thermal comfort covers seven aspects which are comfort level, level of temperature, air flow, humidity, air quality, odor, and conditions of comfort overall. Result from the survey shown in Table 3. Four out of seven aspects of the thermal comfort show significant differences in occupant perception, except for airflow, odor and overall comfort conditions. The difference occurs in comfort level probably due to building occupant had different preferences in term of the comfort level. Furthermore, there is a possibility the HVAC system and standard of maintenance carried out among the buildings were different.

Table 3 Summary of thermal comfort condition

Thermal Comfort	Mean, Total N=278	Kruskal Wallis, Significant Difference: P <0.05
Comfort Level		
Admin 1	4.30	0.006
Admin 2	4.76	
Admin 3	5.23	
Faculty 1	5.01	
Faculty 2	5.28	
Level of Temperature		
Admin 1	4.56	0.000
Admin 2	4.76	
Admin 3	4.58	
Faculty 1	5.12	
Faculty 2	5.30	
Air Flow		
Admin 1	4.38	0.327
Admin 2	4.20	
Admin 3	4.07	
Faculty 1	5.20	
Faculty 2	4.98	
Humidity		
Admin 1	4.16	0.024
Admin 2	3.89	
Admin 3	4.56	
Faculty 1	5.43	
Faculty 2	4.92	
Air quality		
Admin 1	3.88	0.028
Admin 2	3.76	
Admin 3	3.28	
Faculty 1	4.98	
Faculty 2	5.02	
Odor		
Admin 1	3.64	0.127
Admin 2	3.51	
Admin 3	3.07	
Faculty 1	5.40	
Faculty 2	5.48	
Overall Comfort Condition		
Admin 1	4.80	0.791
Admin 2	4.82	
Admin 3	4.93	
Faculty 1	4.86	
Faculty 2	5.41	

The difference occurs in temperature level aspect probably due to different setting of temperature for different buildings. Although average temperature standard for University of Malaya imposed is 24°C, sometime it depends also on the ability of HVAC system that serve the buildings. Moreover, types of attire used can resulting in different heating and cooling. From observation, some of the occupants wear sweater type of clothes that provide heat conditions and different with shirt types of clothes. Other than that, body

temperature resulting different comfort level because when someone caught in flu or fever, their body temperature is higher than normal people they might feeling hot or cold drastically. The different of condition occurs because of ventilation system might not functioning well in these five buildings. The different of humidity in the buildings occur also resultant from poor ventilation system. Similarly, the level of air quality which resulting significant difference in five buildings because of volatile organic compounds (VOC) came from furnishing, paint, and carpet.

3.3 Source of Noise

Suitable noise levels are required to provide good ambience for the building occupants in buildings. Table 4 shows result for noise condition that covers six aspects, which are noise in work area, noise from colleagues, noise from other people, other noise from inside, noise from outside, and unwanted interruptions. All scores show significant difference for all noise aspects except noise in work area (P< 0.05). Faculty buildings have better results which the mean score of 4.93 to 6.01.This could be due to different nature of work for all building especially admin and faculty buildings. The possible reasons because factors such as sound characteristics, poor acoustical qualities and also hinder verbal communication for Admin buildings. Acoustic wall and sound absorptions should be used to absorb unwanted noise interruptions and at the same time provide privacy when needed. Another source of noise detected in the building comes from the air conditioning compressor. This needs to be considered by the designers to locate the HVAC compressors in suitable place, which away from working area.

3.4 Lighting Characteristic

Result for lighting characteristics shown in Table 5. In general at the working area, the employees quite satisfied with lighting characteristics in their building with the mean scores of 4.88 to 5.12. Except for the lighting design, there are significant difference of lighting arrangement for all 5 buildings such as natural light, glare from sun and sky, artificial light, glare from light. The Kruskal Wallis test shows P value is less than 0.05, which is significant. Probably, the arrangement of workplace and also better combination of natural and artificial light required for the buildings. Natural light is important to reduce energy consumption. This could be achieved by using more natural lighting system, which reduces the usage of artificial light. The electricity bill could also be reduced because of the artificial lighting usage up to 50% from the overall building energy.

Table 4 Summary of noise condition

The Noise Condition	Mean, Total N=278	Kruskal Wallis, Significant Difference: P <0.05
Noise in work area		
Admin 1	4.70	0.563
Admin 2	4.62	
Admin 3	4.91	
Faculty 1	5.76	
Faculty 2	5.86	
Noise from colleague		
Admin 1	3.64	0.003
Admin 2	3.98	
Admin 3	2.86	
Faculty 1	5.84	
Faculty 2	5.11	
Noise from other people		
Admin 1	3.42	0.000
Admin 2	3.42	
Admin 3	2.44	
Faculty 1	4.93	
Faculty 2	6.01	
Other noise from inside		
Admin 1	3.54	0.000
Admin 2	3.47	
Admin 3	2.49	
Faculty 1	5.22	
Faculty 2	5.54	
Noise from outside		
Admin 1	3.24	0.017
Admin 2	3.11	
Admin 3	2.44	
Faculty 1	4.98	
Faculty 2	4.90	
Unwanted interruption		
Admin 1	3.54	0.000
Admin 2	3.76	
Admin 3	2.28	
Faculty 1	4.90	
Faculty 2	5.30	

Table 5 Summary of lighting characteristic

The Lighting Characteristic	Mean, Total N=278	Kruskal Wallis, Significant Difference: P <0.05
Overall Quality of Lighting in Work Area		
Admin 1	4.98	0.585
Admin 2	5.18	
Admin 3	4.98	
Faculty 1	4.88	
Faculty 2	5.21	
Natural Light		
Admin 1	4.52	0.000
Admin 2	4.31	
Admin 3	4.32	
Faculty 1	5.11	
Faculty 2	5.26	
Glare from Natural Light		
Admin 1	3.96	0.000
Admin 2	3.73	
Admin 3	1.70	
Faculty 1	4.98	
Faculty 2	4.88	
Artificial Light		
Admin 1	4.46	0.018
Admin 2	4.16	
Admin 3	3.67	
Faculty 1	4.87	
Faculty 2	5.12	
Glare from Artificial Light		
Admin 1	4.30	0.001
Admin 2	4.09	
Admin 3	3.26	
Faculty 1	4.24	
Faculty 2	4.56	

3.5 The Effect of IEQ towards Worker's Health

Spearman rank correlation coefficient employed between 3 components of IEQ, which are the thermal comfort, lighting and noise characteristics on workers' illness symptoms. The result shows in Table 6.

Humidity and temperature has closed linkage as well as majority of people tend to feel more sensitive towards temperature comfort than humidity. Admin 1, Admin 2 and Admin 3 had the least preferable comfort for room temperature comfort compared to Faculty 1 and Faculty 2. Illness symptoms such as stuffy, tired or dry eye, dry skin and difficulty in concentration could be found in these buildings. Five significant correlations detected between those illness symptoms and thermal comfort for Admin1, Admin 2 and Admin 3 buildings, with the reading of -.504, -.466, -.881, -.602 and -.809 respectively. The results contribute to high number of absenteeism for Admin 2 and 3 buildings. It is reasonable understand that under high humidity, it will bring an effect of feeling stuffiness and easily fatigue most of the time (OSH, 2011).

The correlation test result also shows that Admin 1 tends to have issues on both lighting and noise comfort such as easiness in tired, blur vision, glaring and tired eye seem to be more noticeable. This has showed clear a reflection on the least presence of lighting and visual comfort towards the symptoms of illness found. Spearman correlation coefficient detected significant relationships for easily tired and blur vision with lighting comfort with coefficient of -0.785 and -0.784 respectively. Meanwhile, high correlation is obtained for both tired eye and glaring symptoms with coefficient of -0.569 and -0.611 respectively. Kort and Smolders (2010) stated that under condition of dim light, employees in office tend to have higher symptoms as easily fatigue hence from the measurement of lighting level obtained. Luminance level in Admin 1 building rather low compared to the rests as well as Malaysian Standard MS1525 (2007). Thus, it provides strong indication that Admin 1 has insufficient lighting amount, which leads to employees having as such illness symptoms.

Three significant correlations detected between noise characteristics, which are dizzy and difficult to concentrate for Admin 1, Admin 2 and Faculty 1 buildings (correlation coefficient at .740, .694, .494 respectively). These symptoms however do not contribute to high degree of absenteeism of the employees.

Correlation result shows that there are significant impact towards both employee's illness and absenteeism rate. As what had stated by Sullivan *et al*. (2013), the measure of absenteeism is very likely to measure productivity while Ronald *et al*. (2003) states that identifying illness symptoms encountered by employees lead to obtaining their rate of absenteeism. It is understandable that how workplace environment comfort creates health issues and causes employees to absent themselves from work and indirectly affecting work productivity (Danielsson and Bodin, 2008). By looking at the above analysis, Admin 1, Admin 2 and Admin 3 buildings had more noticeable illness symptoms in comparison with Faculty 1 and Faculty 2 buildings.

Table 6 Spearman Correlation between Illness Symptom and IEQ Component

Illness Symptoms	IEQ Components for 5 Buildings														
	Admin 1			Admin 2			Admin 3			Faculty 1			Faculty 2		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Running nose	-.236	-.300	-.086	.165	.112	.322	-.420	-.363	-.243	.129	.162	.217	-.270	-.311	-.233
Stuffy	-.215	-.258	-.111	.317	.039	.363	**-.881****	.021	.002	.116	.179	.463	-.145	.062	.082
Tired or dry eye	.386	**-.569***	.159	.000	.074	.148	**-.602***	-.030	-.040	.019	.064	.044	-.301	-.129	-.140
Glare	.329	**-.611***	-.067	.048	.000	.380	-.345	-.217	-.437	.054	.101	.289	-.281	-.128	-.317
Blur vision	.189	**-.784****	-.102	.120	.000	.393	-.344	-.310	-.320	.151	.120	.493	-.187	-.251	-.217
Easily tired	.097	**-.785****	-.057	.337	-.076	.304	-.015	-.127	-.117	.247	-.156	.327	-.125	-.117	-.117
Headache	-.180	-.371	.318	.195	.193	.324	-.314	-.099	-.029	.159	.203	.154	-.112	-.083	-.089
Dizzy	.069	-.341	.347	.337	.154	.694*	-.403	-.171	-.211	.234	.045	**.494***	-.211	-.154	-.183
Dry skin	**-.504***	-.366	.194	**.466***	-.116	.324	-.156	-.285	-.255	.186	-.151	.424	-.056	-.183	-.081
Difficulty in concentration	.051	**-.566***	**.740***	.320	-.221	.295	**-.809****	-.364	-.314	.211	-.121	.295	-.207	-.181	-.038
Tension or stress	-.100	-.591	.292	-.398	-.175	.262	-.419	.108	.188	-.127	-.101	.262	-.211	.009	.098
Number of days absent	.056	**-.802****	-.095	**-.747***	-.037	-.332	**-.535***	.186	.096	-.217	-.037	-.332	-.237	.181	.206

Legend: A: Thermal Comfort
B: Lighting Characteristic
C: Noise Characteristic
*: Correlation at 5% significance level
**: Correlation at 1% significance level

4.0 CONCLUSION

From the findings, it could be concluded that the comfort level of the building occupants was fair. Comfort parameters did not affect building occupants' productivity and health because their productivity and health were rather fair. In the other words, working environment in conventional-designed buildings was good and comfort and they quite pleased with working environment. Even though, conventional-designed buildings did not take into account about sustainability aspect during construction stage, the indoors environmental functionally well and provide comfort and satisfaction for the building occupants' productivity. A part from that, these conventional-designed building were probably had potential to be awarded with green building status with the further improvement of the IEQ, which is indoor air quality, thermal comfort, acoustic comfort, and lighting comfort.

The IEQ significantly give an impact to the building occupants. Good quality of IEQ resulting in several positive feedbacks, where building occupants working in happy work environment. This indirectly would improve building occupants' productivity and work performance. In addition, the correlation results showed good environmental quality could be resulting a good health and wellbeing that would reduce absenteeism among the building occupants.

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