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Indoor Environment Quality (IEQ) at Menara Sarawak Energy: An Analysis on Post Occupancy Satisfaction and Working Performance of Building Occupants

Amanda Moh Tiing Siew[1], Myzatul Aishah Kamarazaly[1*], Shirley Chin Ai Ling[1] & Hasmawati Harun[2]

[1] *School of Architecture, Building and Design (SABD), Taylor's University, Malaysia.*
[2] *College of Built Environment, Universiti Teknologi MARA, Shah Alam, Malaysia.*

* amandamoh25@gmail.com

Post occupancy survey was important for occupants to give feedback on the IEQ for further improvement, but it was a rare practice in Malaysia. Furthermore, there was no case studies conducted to investigate the IEQ issues present in Menara Sarawak Energy (MSE). Therefore, this research aimed to study the effects of IEQ towards building occupants' working performance in MSE. The objectives of this research were to identify factors influencing the IEQ in MSE, to investigate the building occupants' satisfaction level on the IEQ, to investigate the effects of IEQ towards the building occupants' working performance, and to propose appropriate solutions for the improvement of IEQ to ensure better working performance. Both qualitative and quantitative methods were carried out. Interviews had been conducted with three (3) Building, Facility and Infrastructure (BFI) key leaders to collect data regarding the possible IEQ issues in MSE while 254 valid survey responses were collected to investigate the occupants' satisfaction level on the IEQ and the effects of IEQ on their working performance. Thus, the findings encouraged the construction industry to use findings of this research study to improve the quality of design standards of future office projects to have a healthier working environment.

Keywords: Indoor Environment Quality, Working Performance, Satisfaction Level, Green Building, Menara Sarawak Energy

1. INTRODUCTION

Research shows that office employees spent approximately 90 per cent of their time indoors (Zein, 2018). Past research shows that green buildings were being chosen as the popular choices in peripheral country, such as China as their working places (Zhao et al., 2015). It is because green buildings provide comfortable working environment that benefits human health, via Indoor Environment Quality (IEQ) aspects, such as natural lighting and better air quality (Zein, 2018). To ensure ongoing expansion of adoption of green buildings, studies are done to evaluate the building performance and life cycle costs in newly constructed green buildings. IEQ is one of the aspects to be evaluated, especially in office buildings as IEQ could affect on occupants' satisfaction and working performance (al horr et al., 2016). Research shows there is a link between the variables of IEQ in green buildings and the productivity or satisfaction of building users. According to Paul and Taylor (2008), workers who had control over the volume and direction of air flow at their workstations were 11% more productive. Besides, Park and Yoon (2010) stated that better indoor air quality, with low concentrations of Carbon Dioxide and pollutants, and high ventilation rates, improves working performance of up to 8%. Moreover, a study reported better satisfaction on noise level can be obtained in the LEED buildings than conventional

buildings (Elnaklah et al., 2020). Furthermore, the study discovered that the most significant factor is Indoor Air Quality (IAQ), which is critical for increasing work productivity and improving occupant satisfaction. As a result, the research revealed that improving the quality of IEQ variables will most certainly boost occupant productivity, which will benefit businesses directly (Elnaklah et al., 2020). Therefore, this had led to the aim of this study which is to study the effects of IEQ towards building occupants' working performance in one of the green office buildings in the East Malaysia, which is Menara Sarawak Energy. The building is in Kuching, Sarawak and is the first GBI accredited green building in East Malaysia, obtaining silver rating under the Non-Residential New Construction (NRNC) Category in 2013. The objectives of this research are:

i. To identify factors influencing the IEQ in Menara Sarawak Energy (MSE)
ii. To investigate the level of occupants' satisfaction on the IEQ in MSE
iii. To investigate the effects of IEQ towards the building occupants' working performance in MSE
iv. To propose appropriate solutions for the improvement of IEQ in MSE to ensure the better working performance

2. ISSUES

As of June 2021, there was no case studies conducted to investigate building occupants' satisfaction on IEQ in MSE. Feedback of building occupants on the MSE was vital for further IEQ improvement to boost working productivity. If there is no feedback, this is difficult to know whether the investment made by SEB in constructing this green office building was worth it or not in terms of social aspect, especially satisfaction level of occupants and the level of comfortableness. Thus, this research was very important to fill this gap by identifying the occupants' satisfaction level on IEQ in MSE and their working performance affected by IEQ. On the other hand, articles stated that that MSE scored 67 out of 100 points in 2013 and improvement could be made on areas, such as Indoor Environment Quality and Water Efficiency (Chen, 2013; Safri, 2013). However, there is limited in-depth case study on the mentioned aspects which could be improved. Therefore, this research was required to find out whether the IEQ issues present in MSE. Another issue is the development of green buildings in Sarawak is slow as compared to West Malaysia. The number of rated projects in Kuala Lumpur, Selangor, Penang and Putrajaya were 209, 186, 59 and 29 respectively (Green Building Index, 2021). However, there were only 16 out of 24 projects had been given rating. Therefore, this research was needed to highlight the importance of having high IEQ to increase working performance via adoption of concept of Green Building and encourage more development of green office buildings in Sarawak.

3. LITERATURE

3.1 Introduction to IEQ

IEQ is defined as the quality of a building's environment in relation to the health and wellbeing of the building users (*Indoor Environmental Quality*, 2013). Based on Abdulaali et al. (2020), factors of IEQ are categorized into physical and non-physical factors. There are four (4) main physical factors, such as Indoor Air Quality (IAQ), Thermal Comfort (TC), Lighting Quality (LQ) and Acoustic Quality (AQ). Whereas, non-physical factors include privacy, cleanliness, space layout, facilities, furnishings and views (Chon & Moon, 2017, as cited in Abdulaali et al., 2020). Physical factors are statistically more common to be studied than non-physical factors due to their capacity to be quantified.

3.2 Satisfaction Level of Occupants on IEQ Factors in Green Buildings

In terms of Indoor Air Quality (IAQ), several studies had found out building occupants were satisfied with the overall IAQ in green buildings (Esfandiari et al., 2021; Lee & Guerin, 2009; Nur Aishah & Ding, 2020). This due to stable, clean, fresh and good air flow, making the occupants would feel fresh (Nur Aishah & Ding, 2020). For Thermal Comfort (TC), Lee and Guerin (2009) found out the occupants are dissatisfied with it. Some past researchers had stated several reasons of thermal discomfort, such as uneven heating/cooling load distribution at different working space, overcooling, do not have control over thermal comfort and high Relative Humidity (around 70%) (Cheung et al., 2021; Esfandiari et al., 2017, 2021; Lee & Guerin, 2009). Furthermore, some studies had found out the occupants are satisfied with overall Lighting Quality (LQ) (Cheung et al., 2021; Esfandiari et

al., 2021; Lee & Guerin, 2009). Esfandiari et al. (2017) implied more attention was taken to enhance LQ in green buildings. However, problems related to LQ, such as presence of glare and poor daylight, could still occur (Esfandiari et al., 2021; Kamaruzzaman et al., 2017). On the other hand, Lee and Guerin (2009) found out the occupants in green buildings were dissatisfied with overall Acoustic Quality (AQ). Occupants had reported open office layout, causing noise interruptions/background noise, such as co-workers talking in neighbouring area, overhearing private conservations, or phone calls (Cheung et al., 2021; Esfandiari et al., 2017; Lee & Guerin, 2009).

For non-physical factors of IEQ, Cheung et al. (2021) found out occupants were most satisfied with cleanliness while dissatisfied with sound privacy, personal control and temperature. Lee and Guerin (2009) also found out the occupants reported not having any personal control over thermal comfort in their workspaces. They also discovered cleanliness and maintenance quality had the highest satisfaction followed by office furnishing quality. Furthermore, Lee (2010) indicated that AQ in open-plan offices with high cubicle partitions was lower than private rooms or shared rooms in green office buildings due to more noise interruptions in open-plan offices (Lee, 2010).

3.3 The Effect of IEQ on Working Performance

Loftness et al. (2003) found that better IAQ, such as low concentration of Carbon Dioxide and high ventilation rate leads to improvement of productivity of 8% - 11%. Furthermore, studies done by Milton et al. (2000) discovered short term sick leave was found to be lower in office building ventilated by higher ventilation rate compared to offices ventilated by lower ventilation rate. The findings of the study done by Seppänen and Fisk (2006) also agreed higher ventilation rate reduces the application of sick leaves. In terms of TC, Esfandiari et al. (2017) stated that temperature between 21℃ and 22℃ will increase productivity while temperature between 23℃ and 24℃ will cause productivity decrease relatively. However, studies done by Seppänen and Fisk (2006) is slightly different. They found out there is no effect on working performance in range of temperature of 21℃ – 25 ℃ while an increment of temperature in the range of 25℃ – 32℃ decreases performance by 2% per degree Celsius. Moreover, poor indoor LQ can adversely affect the working performance and efficiency of the workers due to glare, flicker, and lighting luminaires (Katabaro & Yan, 2019). Besides, studies have discovered a gain in working performance due to proximity to windows and views from windows, particularly a view of nature (Alker et al., 2014). Furthermore, Singh (2018) also found out the working efficiency of the staff improved where indoor plants were present.

Several past researchers discovered modest degrees of personal control over TC can increase working performance. For example, Wyon et al. (2000) said personal control over temperature in a range of 4℃ led to improvement of logical thinking and typing performance respectively. Alker et al. (2014) and Fard (2006) also found similar results. Furthermore, past researchers found out working in open plan office caused employee 15% less productive and experiencing concentration difficulty, losing up to 10 minutes of concentration (Borzykowski, 2017). Therefore, the findings suggested noise distraction can due to overhearing conversation from colleagues, noise from machine and telecommunication system in office and working space layout. Haynes (2008) also concluded that the respondents found the openness of the environment counterproductive in terms of increased disturbance and distractions.

4. METHODOLOGY

In this study, both quantitative and qualitative research methods were chosen. For quantitative method, simple random sampling, convenient and snowball sampling methods were adopted to collect data on the occupants' perspectives on their satisfaction level (Research Objective 2) and performance level in relation to the IEQ in MSE (Research Objective 3). In addition, respondents were given a flexible time to answer the survey since they are preoccupied with works and the data obtained are more reliable due to large sample size. Online survey questionnaires were distributed to 1,900 occupants via official corporate mail. The population (1,900) was known from Interview Respondent 2 of this research. A total of 266 respondents was received. 12 responses were invalid due to repetitive respondents filling up the surveys, making it to be 254 validated responses only, which contributed to a response rate of 79.38% out of the predetermined sample size (320). According to Miller and Salkind (2012), this was considered a very good response rate even though the required

sample size could not be achieved due to reaching of cut-off date and short data collection period.

For qualitative method, purposive sampling method was adopted to conduct interviews with three (3) BFI key leaders as they were more familiar with the facility management of MSE, involved in the process of GBI certification submission and were willing to participate in this study. Qualitative method was chosen to obtain the perspectives of the BFI key leaders on the main factors that influence the IEQ in MSE (Research Objective 1) and appropriate solutions to solve the identified issues (Research Objective 4). Face-to-face interview was conducted with Respondent 3 to have a building tour after the interview session. The tour had given opportunities to uncover and capture the IEQ issues present in the building to support findings from interview sessions. On the other hand, video-conference meetings were conducted with Respondent 1 and Respondent 2 due to the COVID-19 outbreak and remote working situation of the respondents.

To analyse quantitative data, descriptive analysis methods (frequency, mean, percentage) were used to present the demographic profile of the survey respondents. Statistical data were presented in the forms of tables and graphs to illustrate the data analyzed. Furthermore, multi-attribute analysis method was used by applying several equations such as Satisfaction Index (SI), Relative Satisfaction Index (RSI), Working Performance Index (WPI) and Relative Working Performance Index (RWPI). As the names implied, both SI and RSI determined the level of satisfaction of occupants on the IEQ in MSE while WPI and RWPI indicated the level of working performance affected by IEQ in MSE.

For qualitative data, thematic analysis was adopted to highlight the similarities and differences of the perspectives of the different respondents on the IEQ issues present in MSE and suggested solutions for the improvement of IEQ. Moreover, softcopy records related to the latest GBI certification status, result of GBI assessment details and post occupancy satisfaction survey conducted by MSE facility management, were shared by Respondent 2 to further analyse and support the interview findings.

5. RESEARCH FRAMEWORK

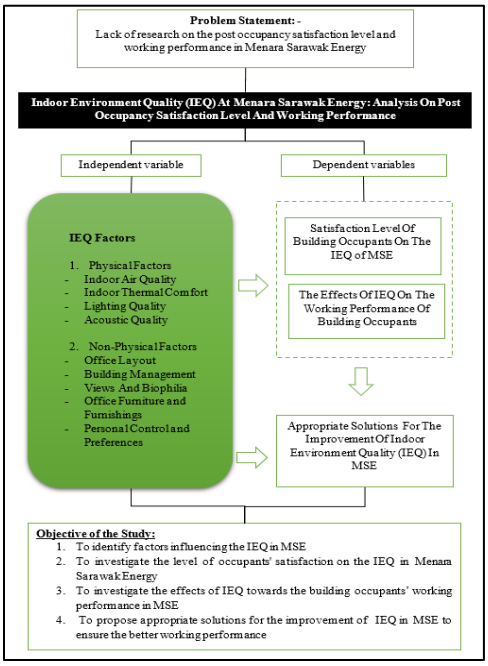

Figure 1: Research Framework

Figure 1.0 shows the conceptual framework of this project, showcasing the connection between the identified independent variable and dependent variables.

6. FINDINGS AND DISCUSSION

6.1 Demographic Profile

For survey respondents, 37% of them are professional, which includes engineers, financial analysts, Information Technology (IT) consultants and lawyers. The second highest number of position was the respondents who are doing technical works, followed by administrative works. Both business operational and human resource positions stand the lowest at 4%. As for Interview Respondent, both Respondent 1 and 2 were from managerial level who supervises facility maintenance teams from SEB's Western, Central, Northern Region offices and respond to any emergency pertaining to the building operations. Respondent 3, who was team leader of BFI team in MSE, managed requests from employees for repair and maintenance works in MSE.

6.2 Key Results in Relation to Objective 1: Factors Influencing the IEQ in MSE

Table 1: Main Factors Influencing the IEQ in MSE

IEQ Factors	Significant comments/ feedbacks	Respondent(s)
Thermal Comfort	- Warmer Air - Uneven Cooling Load	- R1, R2 - R3
Acoustic Quality	- Noise From Occupants	- R1, R2, R3
Lighting Quality	- Sudden Switching Off Of Lighting Causes Meeting Interruption - Sufficient Luminance Level - Light Flickering - Sufficient Daylighting	- R3 - R2 - R3 - R2
Office Layout	- Overstaffing - Ease Of Interaction - Adequate Working Space - Lower Visual Privacy	- R1, R2, R3 - R2 - R1, R2, R3 - R2
Office Furniture	- Adjustability and Comfort of Furniture	- R1, R2, R3
Personal Control and Preferences	- Little Personal Control Over Lighting - Personal Control Over Ventilation	- R2 - R2, R3

Figure 2: Open Office Space Layout in Menara Sarawak Energy

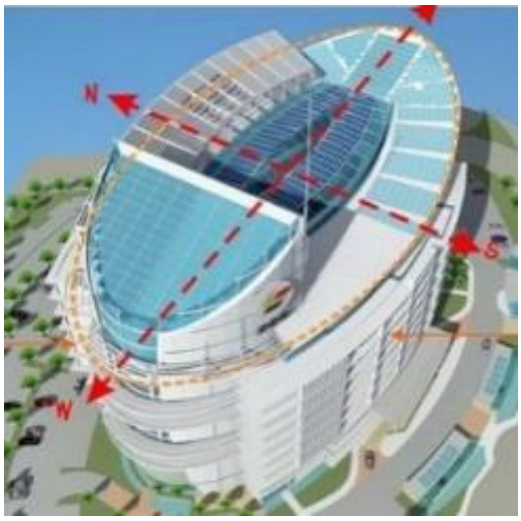

Figure 3: Building Orientation

Based on Table 1.0, R1 and R2 had voiced out occupants experiencing warm temperature even though it is within the tolerance range of temperature setpoint at 24 ℃. R2 revealed it is due to relocation to new office building (MSE) from Wisma SESCO, a conventional office building, in which had a cold working environment of below 22 ℃. This finding is supported by Ravindu et al. (2015) who discovered the occurrence of higher air temperature in green buildings, which contributes to lower occupants' satisfaction level.

Only R3 pointed out the issue of uneven cooling load at different working place. R3 stated this issue occurred in two situations, such as (1) North and South wing and (2) open plan office. In the first situation, the chiller is located at the basement level of East Wing of MSE, so the "*South wing is too far from the chiller"*. This causes the refrigerant flow is not high enough, resulting in higher indoor temperature in South Wing (25 ℃ - 26 ℃) than office at North Wing (22 ℃ – 23 ℃). *Refer to Figure 3.0 for illustration of MSE's building orientation.* In the second situation, R2 claims uneven cooling load in same open plan office zone happens due to issues of Variable Air Volume (VAV) box, such as *"... actuator not working*" and *"... damper come out of place*".

R3 had pointed out receiving complaints mostly from managers on sudden switching off of lighting causing meeting interruptions. Besides, R2 also discovered frequent occurrence of light flickering due to wearing off of ballast in fluorescent tubes. This is aligned with studies done by MacNaughton et al. (2016) discovering

complaints from occupants on frequent flickering light in green buildings. The building design structure allows in sufficient daylight as R2 mentioned that daylighting is provided to 52% of Net Lettable Area of the building.

All 3 respondents mentioned MSE is confronting with issue of overstaffing with the statement given by R1: "*... have around 1900 staff in Menara, but the building itself can only accommodate around 1200 staff ....*". Both R1 and R2 further explained the consequences of the issue, such as lacking workstation and parking lots. Furthermore, "open office space layout" concept, as shown in Figure 2.0, had been implemented in MSE to save floor space with adequate personal working space. According to R1, personal space working area of 6 m^2 is provided to every MSE's workers in open office, while managers are provided with personal rooms which are mostly located along the perimeter of the building façade. This had reflected that the findings is in line with past researchers' studies, reporting open space office is mostly used in green buildings (Cheung et al., 2021; Lee, 2010; Lee & Guerin, 2009). In addition, merely R2 had conveyed open office concept eases interaction between workers, lifting the barrier between non-managerial and managerial workers and encouraging cultural transparency. This is supported by Khoshbakht et al. (2018), who also found out the same outcome. Nonetheless, open office concept generates complaints of lower visual privacy from MSE's workers due to high density in an open space office and exposure caused by heavy usage of glass partitions. Kim and de Dear (2012), as well as Lee and Kim (2008) also found out visual privacy in green buildings also affected the satisfaction level.

Based on R1 and R3, the furniture provided for workers are well-maintained and in tip top condition. All respondents mentioned ergonomic chairs are given to all workers for body support. R2 and R3 further elaborated adjustable height desk will be provided to workers only if proof of evidence is presented to BFI division. The outcome of the findings showed that there is no significant problem in terms of adjustability and comfort of furniture in MSE.

In terms of personal control over lighting, separate controls are provided to different working zones. The indoor lighting system functions as "manual on, auto off" principle, meaning workers need to manually switch on the lighting if the lighting is automatically switched off. For indoor lightings that are set within 4 meters from the perimeter of building facade, they are controlled by the brightness of the working environment. R2 explained if brightness level goes beyond the threshold level set in the lighting system, the lightings will be switched off automatically. Whereas, the lightings that are set further than 4 meters are controlled by motion sensors.

In terms of personal control over temperature and ventilation, both R2 and R3 stated workers are given zero control to change the temperature settings. However, zone cooling is provided by allocating temperature sensors at different working zones and having standard setpoint. This is in line with studies done by Lee and Guerin (2009) discovering some occupants not having personal control over thermal comfort.

6.3 Key Results in Relation to Objective 2: Satisfaction Level of Occupants on IEQ in MSE

Table 2.0. Satisfaction Level of Occupants on Physical and Non-Physical IEQ Factors in MSE

[**Level of satisfaction** : 5 = Very satisfied; 4 = Satisfied; 3 = Somewhat satisfied; 2 = Dissatisfied; 1 = Very dissatisfied]*

	Physical factors	Remark	Relative Satisfaction Index	Rank
A	INDOOR AIR QUALITY			
1	Odour	Satisfied	0.206	1
2	Indoor air freshness	Satisfied	0.205	2
3	Presence of allergens	Somewhat Satisfied	0.197	3
4	Number of openings for air movement	Somewhat Satisfied	0.196	4
5	Presence of Volatile Organic Compounds	Somewhat Satisfied	0.196	4
			1.000	
B	THERMAL COMFORT			
1	Humidity	Somewhat Satisfied	0.252	1
2	Air movement	Somewhat Satisfied	0.251	2
3	Indoor air temperature	Somewhat Satisfied	0.251	3
4	Uniformity of cooling load	Somewhat Satisfied	0.246	4
			1.000	
C	LIGHTING QUALITY			
1	Artificial lighting level	Satisfied	0.170	1
2	Light flickering	Satisfied	0.168	2
3	Glare from daylighting	Satisfied	0.166	3
4	Ability to block or control direct sunlight	Satisfied	0.166	4
5	Glare from artificial lighting	Satisfied	0.165	5
6	Daylighting level	Satisfied	0.165	6
			1.000	
D	ACOUSTIC QUALITY			
1	Outdoor noise	Satisfied	0.276	1
2	Indoor noise from mechanical system	Satisfied	0.265	2
3	Ability of indoor sound insulation materials	Somewhat Satisfied	0.234	3
4	Noise from occupants	Somewhat Satisfied	0.225	4
			1.000	

	Non-Physical factors	Remark	Relative Satisfaction Index	Rank
A	OFFICE LAYOUT			
1	Ease of interaction with colleagues	Satisfied	0.280	1
2	Amount of personal working space to accommodate work materials and equipment	Satisfied	0.262	2
3	Visual privacy	Somewhat Satisfied	0.230	3
4	Acoustic privacy	Somewhat Satisfied	0.228	4
			1.000	
B	BUILDING MANAGEMENT			
1	Quality of cleanling service provided	Satisfied	0.254	1
2	Overall workspace cleanliness	Satisfied	0.252	2
3	Overall building cleanliness	Satisfied	0.251	3
4	Quality of building maintenance service provided	Satisfied	0.243	4
			1.000	
C	VIEWS AND BIOPHILIA			
1	Outdoor view of nature	Satisfied	0.340	1
2	Access to outdoor view	Somewhat Satisfied	0.333	2
3	Indoor view of nature	Somewhat Satisfied	0.327	3
			1.000	
D	OFFICE FURNITURE AND FURNISHINGS			
1	Colour and texture of surface finishes	Satisfied	0.256	1
2	Comfort of furniture	Satisfied	0.253	2
3	Attractiveness of your working space	Somewhat Satisfied	0.247	3
4	Adjustability of furniture	Somewhat Satisfied	0.244	4
			1.000	
E	PERSONAL CONTROL AND PREFERENCES			
1	Personal control over lighting	Somewhat Satisfied	0.368	1
2	Personal control over ventilation system	Somewhat Satisfied	0.320	2
3	Personal control over indoor temperature	Somewhat Satisfied	0.312	3
			1.000	

The findings in Table 2.0 highlighted all LQ parameters could bring satisfaction to occupants in MSE. This revealed that they were comfortable with the lighting level in MSE. However, this study found that the occupants were only 'somewhat satisfied' with all Thermal Comfort parameters. Since the concept of open office layout had been implemented in MSE, it had caused occupants to perceive factors, such as noise from occupants, indoor sound insulation materials provided, visual privacy, and acoustic privacy to be 'somewhat satisfied' only. On the bright side, occupants were 'satisfied' on the overall building cleanliness and cleaning and maintenance service provided at their working place.

6.4 Key Results in Relation to Objective 3: The Effect of IEQ on Working Performance in MSE

Table 3.0. The Effect of Physical and Non Physical IEQ Factors on the Working Performance of Occupants in MSE

[**Working Performance** : 5 = Significantly Enhances; 4 = Enhances; 3 = Somewhat Enhances ; 2 = Interferes; 1 = Significantly Interferes]*

	Physical factors	Remark	Relative Working Performance	Rank
A	***INDOOR AIR QUALITY***			
1	Indoor air freshness	Enhances	0.210	1
2	Number of openings for air movement	Enhances	0.203	2
3	Presence of Volatile Organic Compounds	Somewhat Enhances	0.198	3
4	Odour	Somewhat Enhances	0.195	4
5	Presence of allergens	Somewhat Enhances	0.193	5
			1.000	
B	***THERMAL COMFORT***			
1	Indoor air temperature	Enhances	0.251	1
2	Humidity	Somewhat Enhances	0.250	2
3	Air movement	Somewhat Enhances	0.250	3
4	Uniformity of cooling load	Somewhat Enhances	0.249	4
			1.000	
C	***LIGHTING QUALITY***			
1	Daylighting level	Enhances	0.176	1
2	Artificial lighting level	Enhances	0.175	2
3	Ability to block or control direct sunlight exposure	Enhances	0.170	3
4	Glare from artificial lighting	Somewhat Enhances	0.162	4
5	Glare from daylighting	Somewhat Enhances	0.161	5
6	Light flickering	Somewhat Enhances	0.156	6
			1.000	
D	***ACOUSTIC QUALITY***			
1	Ability of indoor sound insulation/control materials provided to block noise	Somewhat Enhances	0.259	1
2	Outdoor noise	Somewhat Enhances	0.256	2
3	Indoor noise from mechanical system	Somewhat Enhances	0.249	3
4	Noise from occupants	Somewhat Enhances	0.235	4
			1.000	

	Non-Physical	Remark	Relative Working Performance Index	Rank
A	***OFFICE LAYOUT***			
1	Ease of interaction with colleagues	Enhances	0.264	1
2	Amount of personal working space to accommodate work materials and equipment	Enhances	0.255	2
3	Visual privacy	Somewhat Enhances	0.242	3
4	Acoustic privacy	Somewhat Enhances	0.239	4
			1.000	
B	***BUILDING MANAGEMENT***			
1	Quality of cleaning service provided	Enhances	0.252	1
2	Overall workspace cleanliness	Enhances	0.251	2
3	Overall building cleanliness	Enhances	0.250	3
4	Quality of building maintenance service provided	Enhances	0.247	4
			1.000	
C	***VIEWS AND BIOPHILIA***			
1	Access to outdoor view	Enhances	0.336	1
2	Outdoor view of nature	Enhances	0.334	2
3	Indoor view of nature	Enhances	0.330	3
			1.000	
D	***OFFICE FURNITURE AND FURNISHINGS***			
1	Comfort of furniture	Enhances	0.255	1
2	Colour and texture of surface finishes	Enhances	0.250	2
3	Adjustability of furniture	Enhances	0.248	3
4	Attractiveness of your working space	Enhances	0.247	4
			1.000	
E	***PERSONAL CONTROL AND PREFERENCES***			
1	Personal control over lighting	Enhances	0.346	1
2	Personal control over ventilation system	Somewhat Enhances	0.328	2
3	Personal control over indoor temperature	Somewhat Enhances	0.326	3
			1.000	

Based on Table 3.0, it can be clearly observed that the occupants in MSE have perceived that all of the IEQ factors had either 'enhanced' or 'somewhat enhanced' their working performance. Occupants in MSE reported that most of the parameters used in physical IEQ factors could only 'somewhat' enhance' their working performance. Apart from that, these findings showed that physical IEQ factors are not the only factors that should be considered during post occupancy survey. The non-physical factors that were emphasised to be used in this research, proved that the factors can help to enhance working performance. For examples, all parameters in Building Management and Views and Biophilia, as well as Office Furniture and Furnishings perceived to 'enhance' working performance of occupants in MSE. Therefore, this revealed that green office buildings could contribute to the working performance of workers.

6.5 Key Results in Relation to Objective 4: Proposed Solutions for the Improvement of IEQ in MSE

For thermal comfort, R3 commented that there was no solutions currently to solve the issues of uneven cooling load between North and South wing based on Table 4.0. R2 opined that workers should try to adapt into the new indoor working environment with new temperature setpoint in MSE. Both R1 and R2 had opined that seeking employees' understanding is important by providing solid explanation to solve "warmer air" issue. R1 expressed that workers and stakeholders should understand that green office buildings are built not to satisfy everyone's needs, but to bring less impact on the environment. R2 also mentioned BFI team should show the occupants that the temperature setpoint was unchangeable due to GBI's requirement. R3 had mentioned that frequent maintenance on HVAC system is required, such as checking the VAV box and chiller plant and monitoring the Air Handling Units refrigerant temperature. In order to solve issue of overhearing private conversation, R2 had expressed that workers could have private conversations at meeting rooms, which could fit in 4 to 6 people each.

However, this finding is only held by R2 only. It is interesting to discover the solution of setting up "phone-booth like" discussion pods with small table and seating is introduced and implemented, as mentioned by R1 and R2. These pods are set up in newly renovated department, such as Procurement department. Each could accommodate approximately 2 people. Furthermore, R2 stated that BFI team could not dismantle the lighting system to solve light interruption during meetings as it is a requirement of GBI and the solution of covering the sensors with black tape is implemented to ensure continuation of switching on of lightings. As mentioned prior by R2, the lighting level in MSE's office space, which is within 350 – 450 Lux, is lower than Wisma SESCO's. R2 also commented that the lighting level in MSE is "*not so bright but just nice*", but "*people are not used to it*". Hence, only R2 stated that this issue requires workers to adapt into the new working environment. R2 also mentioned that workers "*got used it and preferred it more due to lighting level is based on standard in MS1525*."

As mentioned by R3, the manufacturer of the existing ballasts used in MSE had discontinued to manufacture the product and the changing cost for ballasts is high. Due to GBI requires high frequency ballasts to be installed over a minimum of 90% of NLA, this leads to statement given by R3: "*I had requested to change the building lighting to LED for easier maintenance but I couldn't due to GBI requirements …*" Hence, R2 had suggested to seek newer manufacturer to purchase ballasts. To solve the issue of "overstaffing", both R1 and R3 opined that hybrid working system had been implemented in conjunction with the current pandemic situation. This meant that only 50% workforce was allowed to work at office, while another half working from home.

This system was done in weekly rotation basis. They also mentioned that "non-ownership of working space" practice was introduced to solve overstaffing issue but had yet been approved. With this practice, workers could seat anywhere at any time, which is similar to the concept of SOHO (Small Office. Home Office), as commented by R1. R3 also proposed to implement solutions such as "workstations with no partitions" and "remove glass partition at managers' personal rooms", but these solutions had not been approved in MSE. These solutions help to encourage transparency and allow more space for MSE's workers.

7. CONCLUSION

This research has successfully achieved the objectives of this research. For Objective 1, this research managed to discover the main IEQ issues,

such as uneven cooling load, light flickering and overstaffing. Objective 2 was achieved too as the occupants was either satisfied or somewhat satisfied on the overall IEQ factors. For Objective 3, they reported that the IEQ factors had either enhanced or somewhat enhanced their working performance. For Objective 4, the BFI leaders had proposed several main solutions, such as frequent maintenance on HVAC system, providing discussion pods and implement hybrid working system. Therefore, it can be concluded that Menara Sarawak Energy achieved having an overall comfortable and healthy working environment for the occupants. This research also managed to emphasise that non-physical IEQ factors should be incorporated when conducting post occupancy survey as the findings of the research revealed that these factors could enhance occupants' performance, especially workspace cleanliness and views and biophilia.

This research also managed to highlight the importance of having high IEQ to increase working performance via adoption of Green Building concept. The first recommendation for future studies is to investigate the relationship between the indoor environment quality, satisfaction level and working performance of the building occupants that are affected by the IEQ in chosen green buildings. This helps to identify which IEQ factors have higher or lower impacts on occupants' satisfaction or working performance in chosen green buildings. Apart from that, it is recommended to perform objective measurement on physical IEQ factors integrated with a survey in chosen green buildings. This helps to provide a holistic perspective of the circumstances in which occupants responded to in the questionnaire survey, as well as, to identify and improve any potential source of IEQ dissatisfaction. Some of the physical IEQ parameters that can be monitored are indoor temperature, relative humidity, air velocity, illumination level, and indoor sound pressure level.

8. CONTRIBUTION OF THIS STUDY

This research highlights the reason to conduct Post Occupancy Evaluation (POE) survey in green office building. Parties in construction industry could use POE survey to improve the quality of design standards in order to build more office buildings with a better and healthier environment and more efficient working environment, as all the factors affect the working performance. Addressing IEQ issues provides data to help understand how buildings are performing compared to their design intention on green buildings.

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