PERCEPTIONS ON THERMAL COMFORT IN GENERAL WARDS FOR MALAYSIAN HOSPITALS

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Abstract

Environmental Quality Perception (EQP) is constructed to help in environmental studies and as an assessment tool for the environment and behaviour field studies. Using EQP assessment method in the hospital environment studies helps to understand the relationship between people and the hospital environment. Achieving sufficient thermal comfort level in existing government hospital buildings were seriously considered especially in general wards where patients and staffs most spend time in. The assessments were completed by 120 respondents (i.e. patients and staff nurse) from five different general wards located in different blocks in a Malaysian public hospital. To assess perception validity, one is focusing on objective physical observation evaluating the hospital environment correlated with subjective evaluation through questionnaire on social environment. The main objective of this research is to investigate the users' perceptions of existing thermal comfort quality in the different department's general wards of existing government hospitals in providing comparative table showing the different performance of thermal comfort. Overall reliability on thermal satisfaction by the occupants shows significant differences in all identified variables that were influenced by location and characteristic of the buildings as well as the respondents demographic. Mixed method analyses were used whereby data responds were analysed by multivariate (MANOVA) and univariate (ANOVA) analyses of variance for quantitative and triangulation analyses were tabled down for qualitative between average responses of thermal comfort perceived with the hospital physical. The findings concluded with majority perceived moderation on most thermal comfort elements indicates that there were growing acceptance and tolerance with the space that are subjected to duration of admitted and hours of working. Therefore, further investigation should be carried out to enhance the probability in perceptions with multiple hospitals for clear comparisons.

Key words: environmental quality perception, general wards, hospital buildings, users' perceptions

Introduction

Many studies have demonstrated that if people work or reside in good environmental conditions, their productivity and well-being will be improved (Huang et al., 2012; Indraganti & Rao, 2009). After numerous researches on physical environment in buildings, it is unavoidable to ignore the fact that it has an impact on the outcome of the users' perceptions (Andrade et al., 2012; Aripin, 2012; Baird, 2010). The importance of human comfort as an internal influence of the architecture and substance of sustainable building is essential in design criteria for creating a more sustainable interior design environment. However, for hospital buildings, despite the critical advantages on medical treatment and the advance of its medical procedure and medicines, it is crucial to look into the hospital environmental qualities that could enhance the health process in the long term which is being neglected (Abu Samah et al., 2012; Frumkin, 2007). Many patients and hospital staffs express their satisfaction level towards the condition of the indoor environment as unsatisfactory (Aiken et al., 2012; Hurst, 2008). Enduring long working hours for the staffs and uncomfortable conditions caused by illness which patients also have to abide; their perceptions on indoor environment quality (IEQ) in hospital buildings are different than other types of occupants. The need to investigate the perceptions of the hospital users regarding hospital environment quality are actually giving them the opportunity to criticize and participate in decision making on how the building should be built (Baird, 2010; Rechel et al., 2009). This paper aims to contribute to the discussion of the impact of perception of patients and staffs in the context of indoor environment on thermal comfort satisfaction in general wards and the significance of the hospital's physical environment. This paper investigates the effect of users' perception on overall satisfaction towards the thermal comfort of a government hospital building in Malaysia which has several different buildings built in different eras that houses the general wards. The environmental quality perception (EQP) is a method for gathering and analyzing public response towards the environmental assessment and has been adopted in this study. The next section will explain the EQP method which highlights the significance towards the importance of users' perception on environmental conditions.

Measuring hospital environmental quality perception

Measuring and understanding how patients and staffs evaluate the existing hospital environment conditions are useful in the future discussion for new planning and improving management in hospitals that are built. In many studies whereby EQP has become a major area of environmental studies and as assessment tools for environment and behavior field studies (Brown & Daniel, 1987). EQP is considerably an opted different ways of methods for gathering and analyzing public response towards their environment surrounding and has been developed for research and application in environmental assessment, planning and management (Huang et al., 2013; Verheyen et al, 2011). These several methods under EQP have one aim which is to obtain and validate assessment of public preferences for different approach of environmental conditions.

The assessment of the users' perceptions of a building can provide valuable information about its performance together with its overall satisfaction level of the occupants. A reliable and valid measure on hospital EQP is important for researchers who would like to contribute in hospital quality and environmental psychology (Andrade et al., 2012). The search for comfortable indoor environment has been discussed relying on objective and subjective indicators (Fransson et al., 2007; Verheyen et al., 2011). The evaluation on EQP is based on correlation studies between the objective evaluation; either physical measures (by means of measuring) or physical observation and subjective evaluation; users' perceptions (rating scale measure) (Fornara et al., 2006).

Both kinds of evaluations aim to assess the environment in which people live or work in, but with different values, EQP assessment underlie with the physical measurement or physical observation and users' experiences of the space (Fornara et al., 2006). The method that uses the physical measurement in EQP assessment is more tended used by researchers and more focused on technical aspects of building performance and also for accuracy in data collection. However, the validation using physical observation other than measuring instrument for post occupancy building correlate with users' perception is undoubted valid and reliable for EQP assessment (Baird, 2010; Fornara et al., 2006). According to Baird (2010), there are encouraging indications that increasing numbers of research have examined the building performance from the users' point of use. In his undertaking research on sustainable building performance, it involved numerous time of visits to the site to conduct a structured interview with the key architect and environmental engineer on the personal distribution and collection of a questionnaire survey seeking the users' perceptions of a range of factors (subjective evaluation). A detailed tour of each building and its facilities, photographing key features, and collecting relevant documentation as part of physical observation (objective evaluation) were also conducted for correlation studies.

The experts' rating from the EQP evaluations (physical observation) gives high congruence impact towards users' perceptions (Brown & Daniel, 1987; Fransson et al., 2007). The different point of views between the experts and the users could give significant impact on the building's environmental performance. Supported with field measurements is a method opted by many researchers in gaining factual data on site and expert opinions such as from professionals on related fields. However, feedback from the building occupants in environmental comfort has become an integral part of an EQP assessment exercise (Kamaruzzaman et al., 2011). The assessment by subjective evaluation method uses the questionnaire technique which provides one of the most efficient ways to gather such information. According to Kamaruzzaman et al, (2011), their research in finding the users' perception in environmental quality in refurbished historical building has used a questionnaire based assessment for six refurbished buildings in identifying particular aspects of the environment that need adjustment and improvement. Validating the findings on questionnaire assessments reliability of the occupants' perception was to use the questionnaires developed by ASHRAE, 1999 in United Kingdom, which elicits a 'fingerprint' that combines up to 22 factors relating to satisfaction with regards to the building.

Same studies on EQP also have already delved in educational buildings and office buildings (De Giuli et al., 2012; Kim et al., 2013; Mahbob et al., 2011) – to investigate the perceptions and attitudes of the users towards the importance of indoor environmental parameters in providing comfort in the spaces. The studies towards EQP are generally the same method for both building types but however the users' target are different (educational users are students while office users are adult workers) and their perceptions are also different for productivity achievement.

The influence of thermal comfort perceptions of hospital physical environment on users' health outcomes

The adaption of thermal comfort for the occupants is a first step in the development of sustainable thermal comfort standards (Indraganti & Rao, 2009) which includes environmental, behavioural and psychological adaptation which are deemed important for thermal acceptance (Nagano & Mochida, 2003). An adaptive thermal comfort theory was developed as a result of extensive various field studies on laboratory experiments on thermal acceptance theory (Verheyen et al., 2011) concluded that it can develop thermal satisfaction after continuously experiencing the thermal conditions of the environment. The investigation on thermal perception of users which is influenced by behavior and psychological adaption are giving high impact on the EQP assessment.

A healthy, comfortable indoor environment is created and developed on thermal satisfaction that human can have of buildings in a hot and humid country is protection from excessive thermal elements. Malaysia is a country which adheres in tropic climate which constantly in the environment of hot and humid inside and outside of a building resulting in installation of air conditioning and creating good ventilation systems in the building to sustain a comfortable indoor environment for the occupants (Lomas & Ji, 2009; Sookchaiya et al., 2010). Several studies shown in seeking the perception of the users in thermal comfort were affected by the demographic background (Indraganti & Rao, 2009; Kim et al., 2013). For instance, Indraganti et al (2009) found that thermal acceptance of women and older subjects in a residential building in India were high even though age and gender characteristic were to be correlated weak with thermal comfort.

According to Frontczak et al (2011), resulted in the literature survey of their studies indicated the perception of satisfaction level with the thermal environment varies. Thermal comfort can be described with different variables of air temperature, air velocity, relative humidity and globe temperature. The survey also showed the questions asked about thermal state and preference with the thermal environment to predict the vote of thermal conditions of a group of people (Frontczak & Wargocki, 2011).

Research methods

The methods of evaluating the EQP in a hospital are mix methods, both quantitative and qualitative which emphasize assessments through objective evaluation (hospital physical observation for qualitative) and subjective evaluation (questionnaire for quantitative).

Building types and descriptions

The hospital buildings selected for this research purpose in finding EQP in general wards are located in Kuala Lumpur and are one of the main government hospitals. It has become the largest hospital under the Ministry of Health, Malaysia. It is also one of the largest public hospitals in Asia with approximately 150 acres total of prime land area. This hospital has 38 different departments that include administrative and financial department, pharmaceutical department, and 23 different clinical departments. The hospital also provides inpatient care and caters for a wide variety of patients from diverse background of citizens.

Several different buildings design was developed prior to pre independence and post-independence (Mohd Nawawi, 2012). The earliest was built in the year 1870 as a district hospital with only 3 wards provided. Some of the hospital's architectures during the late pre independence were recorded as low-rise sprawling concrete buildings with timber structure (Mohd Nawawi, 2012) which still can be found at one of the hospital building and is still in use as an inpatient ward. However, most of the buildings have been redeveloped and refurbished during post-independence starting in the year 1962 in four phases and classified as standard design and redevelopment or upgrading of the old hospital buildings. Secondly, the majority type of general wards provided in each and every different department for inpatient buildings are the Nightingale Ward arrangement (Hosking & Haggard, 1999) which has multiple beds sharing in a wide long open space. The arrangement of multiple beds in a huge open ward is categorized as the third class bed design, while the second class bed design places four beds in a room and the first class bed design only has a single bed in one room. Currently, the hospital has 49 different departments and units inclusive of 81 hospital wards in total and 2,502 beds.

Five selected buildings which cater for different departments in finding the EQP in this research of the general wards premises were chosen. The buildings are Nephrology and Urology (NU) institute, Radiotherapy and Oncology (RT) institute, Obstetrics and Gynecology (OG) institute, Wisma

Kayu (WK) (known as being constructed with timber at the top floor), and the final is Main Building (MB) which consists of different departments such as Ophthalmology, Emergency and Trauma, Nuclear Medicine, Respiratory Medicine, Dermatology and General Medicine.

Selected general wards

Different buildings for different departments were selected for the patients' and staffs' comfort studies in general wards. The general wards internal layouts for every selected building are almost similar and adopt the Nightingale Ward design (Hosking & Haggard, 1999; Yau et al., 2011) which is an open space in a rectangular shape with high numbers of beds arranged parallel. There were also high numbers of windows constructed along the perimeter of the space ratio with the ceiling heights average of 3.6 meter. However, for WK the wards design have similar numbers of windows and ceiling height but consists of several concrete walls and columns in between minimizing the space volume. This building was originally built during pre-independence and previously used as pediatric wards with internal concrete walls and which later were constructed to divide rooms specifically for babies' area. Hence the physical design attributes minimal in environmental comfort, general wards in WK currently catered for passive patients.

Mainly the arrangements of beds in all general wards selected are typically arranged stretching all alongside on one or both side of the perimeter of wall without solid partition in between. However, in some cases, provision of curtains or loose folding panels as partitions for privacy is needed. The typical general ward space design especially in a tropical country, mechanical fan are provided and needed as a cooling system in large government hospitals (Hwang et al., 2006). Each department has different numbers of beds accommodation in their general wards with approximately 35 to 40 beds. There are also estimated around 25 nurses (including matrons and sisters) with 3 to 5 other staffs (such as assistant nurse and department runners) for each ward. Likewise for passive ward at WK with approximately only 25 beds with 7 nurses in each ward.

NU building currently has 2 general wards for nephrology and 2 general wards for urology separated for each male and female patient. RT department housed general wards in 4 storeys of the building where each level have 2 wards separating the male and female patients. While at OG building has 4 storeys housing their general wards but only cater for female patients. At WK building houses passive wards currently have 2 general wards that separate male and female patients at ground floor. While at the MB building houses, different departments of different medical comprised of 4 storeys of general wards with each storey housing approximately 6 general wards were allocated there.

Respondents

A total of 120 patients and staffs of the selected general wards were randomly interviewed and questionnaires were distributed respectively regardless of gender, age and ethnicity. The selected respondents were those who were fully conscious, able to communicate verbally and willing to take part in the survey.

More than half of the occupants consist of 79 patients and 41 staffs. The patients were interviewed based on the prepared questionnaire while the staffs were given the questionnaire to fill in. The general ward's staffs consist of mainly the staff nurses, assistant attendances, sisters, matrons and others. Since their job tasks require most of their time, the questionnaire were given to those who willing to spend time to fill in and at the same time to return back to the author once it is finished. However, to retrieve feedback from patients require a mutual conversation one-to-one before start asking questions based on the questionnaire. This is because they are not in good health condition and required understanding and a friendly environment.

The questionnaire instrument on the thermal comfort was developed in three stages. The items of the questionnaire were identified based on literature reviews; (Fornara et al., 2006; Kim et al., 2013; Mourshed & Yisong, 2012; Zalejska-Jonsson & Wilhelmsson, 2013). The reason of the review was to identify the type of environmental questions that is appropriate with hospital environment specifically. The questions were given the effect of users' perception and satisfaction with the thermal physical environment. Walkthrough observation and a few interview sessions with the sisters and matrons were carried out to explore their perceptions on the existing thermal environmental comfort correlating with the physical environment that can be addressed during work or stay in the hospital premises. Figure 1 shows the total number of respondents related to the selected buildings.

A draft of questionnaire was developed by incorporating the findings from the first two stages. The questionnaires were produced in English medium without translating them to the local language.

This is not to be a problem because they were answered by professionals whom are English literate, while patients were interviewed and verbal translation by the author based on the structured questionnaire due to their disability and as well to create mutual interaction. The questionnaire was developed into three parts; Part A is the demographic questions structured separately for both patients and staffs, Part B is the detailed thermal comfort perception questions for both patients and staffs, and lastly Part C is the overall comfort satisfaction questions for both patients and staffs.

The questionnaire included 15 structured questions to rate the users' perceptions towards their experiences with hospital general wards' thermal environmental comfort excluding 10 questions for demographic information's. Questionnaire for users' perceptions, respondents were asked to rate their thermal perception of an item on a 5-point Likert-scale (1 = Strongly Unsatisfied; 2 = Unsatisfied; 3 = Moderate; 4 = Satisfied; 5 = Strongly Satisfied). In addition, the questions to rate satisfaction on other environmental variables were measured using the same scale.

Demographic information such as age and gender were included. Data regarding the length of service in the hospital wards and daily working hours were recorded for the staffs while data regarding the duration of stays in the wards and mobile disability level were recorded for the patients.

Table 1 summarizes demographic profile of patient according to gender, age, number of days admitted, bed position from window, experiencing difficulties in mobility, the presence of family member and frequency of visiting. There were about an equal number of male (45%) and female (55%) patients. Almost half of the patients aged between 21 to 40 years old (49.3%) and most of the patients have been admitted in the ward for less than 3 days (39.2%). Most of the patients (36.7%) stayed in bed near to the window and most of the patients (41.8%) experienced difficulties in mobility. More than half (54.4%) of the patients had family members accompany them while they were admitted.

Table 2 summarizes demographic profile of staffs according to gender, age, length of services, working hours, and experience of discomfort with thermal within the space. There were more female (92.7%) staffs than male (7.3%) staffs who agreed to participate in filling the questionnaires. Majority of the staffs that work in the general wards were of ages between 21 to 30 years old (78.0%). Most of the staffs have been working between 1 to 5 years of services (53.7%) with working hours of 7 to 12 hours per day (80.5%). More than half of the staffs have mixed feeling of experienced thermal comfort (56.0%) with sometimes either feel hot or cool. However, 34.0% admitted they had experienced discomfort with thermal.

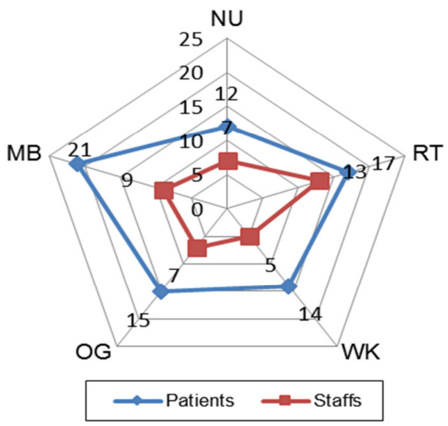

Figure 1: The total number of respondents related to the selected buildings

Table 1: Patient's demographic profile

Variables	Characteristics	Patients %
Gender	Male	45.6
	Female	54.4
Age	21-30	21.5
	31-40	27.8
	41-50	10.1
	>50	22.8
	no response	17.7
Wards admitted (days)	1-3	39.2
	4-6	31.6
	7-10	17.7
	11-15	7.6
	>15	3.8

Bed position from windows	Near	36.7
	Medium	32.9
	Far	30.4
Experiencing difficulties in Mobility	Yes	41.8
	Sometimes	30.4
	No	27.8
Presence of family members	Yes	54.4
	No	45.6
Frequent of visitation	Always	15.2
	sometimes	25.3
	Less	13.9

Table 2: Staff's demographic profile

Variables	**Characteristics**	**Staffs**
		%
Gender	Male	7.3
	Female	92.7
Age	21-30	78.0
	31-40	17.1
	41-50	2.4
	>50	0.0
	no response	2.4
Length of services (years)	<1	19.5
	1-5	53.7
	6-10	24.4
	>10	2.4
Working hours	1-6	9.8
	7-12	80.5
	13-18	9.8
Experiencing thermal comfort problem	Yes	34.0
	Sometimes	56.0
	No	10.0

EQP findings and results

Two instruments were used: physical observation by the author's objective evaluation of the hospital thermal environmental attributes and questionnaire evaluation for hospital users (patients and staff). While the focus of this studies on which the findings are based on the users' perceptions of this particular hospital buildings, it is highly influenced by the physical environment that contribute to the perceptions (Andrade et al., 2012; Baird, 2010).

Physical observation

The architecture features overall in every selected buildings is observed. Mainly all selected buildings are oriented along a North-South axis with all room windows facing East-West direction. They are also designed with vertical and horizontal exterior concrete fins as part of the window façade and as sun shading device. Unlike for WK building, the window façade used the normal louvered glass with extended roof on exterior. An average modular dimension for the typical general wards is 30 meter by 10 meter in rectangular form and average ceiling height of 3.6 meter. Detailed observations were made in the selected five case study buildings namely NU, RT, OG, WK and MB. The observations for all the five wards were taken prior to the questionnaire distributions and interview sessions.

Table 3 shows the plan view of the selected buildings of RT and WK with general wards layout together with pictures taken by the author (Figure 2 – Figure 7) to exemplify the differences on the exterior and interior of physical attributes. Typically, all the general wards are open spaces without solid partition to segregate each of the patient's bed. In contrast to WK, its general wards consist of several existing concrete walls with few windows to accommodate the small spaces. All of the general wards are equipped with ceiling fans as a mechanical cooling system and louvered type of windows for maximum flow of air ventilation. The detail specification based on observations is summarized in Table 4.

Table 3: The detail of plan views and pictures of interior and exterior of the selected buildings

Building of Radiotherapy and Oncology (RT)

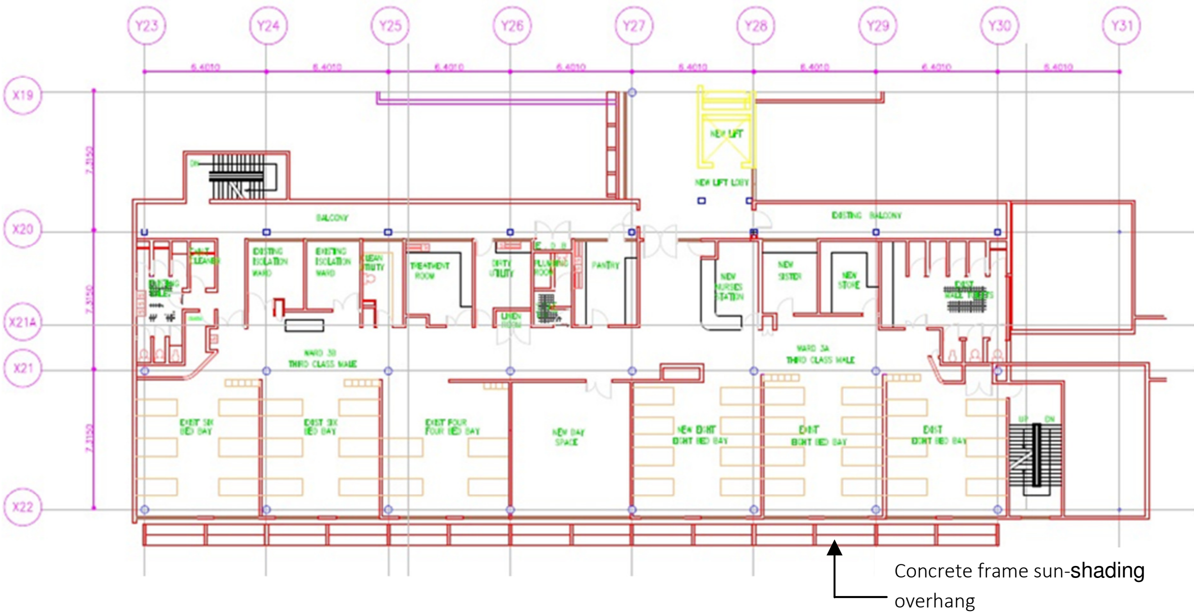

Figure 3: Shown the exterior of facade design at the RT building using concrete frame sun-shadingoverhang at the ward area

Figure 4: Shown the interior views of beds area of an open space with the bed arrangement near the 2.1m height windows. The nurse station shows its location far from the windows and without ceiling fan and an additional table fan was used

Building of WismaKayu (WK)

Figure 5: Typical layout plan of WK general ward

Figure 6: shows the façade of the main entrance of the two-storey building with the ground floor constructed with concrete to support the upper floor constructed with timber. The second picture shows the exterior window of the ward area with short overhang

Figure 7: The interior view of ward area and nurse station. The windows availability are at one side of wall which close all the time with view of next building distance of 0.6 meter only. The nurse station's high cabinet almost cover the windows with no view

Table 4: Summary of the physical attributes of each buildings

Physical Attributes	NU	RT	OG	WK	MB
Space volume at ward area	960 sqm	1,200 sqm (Separated of 2 ward area of 600 sqm each)	1,044 sqm	330 sqm	960 sqm
Ceiling height	3.6 m	3.0 m	3.6 m	3.6 m	3.0 m
Opening:					
Window size	Standard 0.9m x 1.2m	Standard 0.9m x 1.2m	2 x Standard 0.9m x 1.2m	Standard 0.9m x 1.2m	Standard 0.9m x 1.2m
Windows quantity (nos)	12	25	40	24	12
Windows type	Louvre	Louvre	Louvre	Louvre	Louvre
Windows location	One side of wall facing E-W	One side of wall facingE-W	Both side of walls facing N &E-W	One side of wall facing E-W	One side of wall facing E-W
Ventilation type	Fixed louvre opening ceiling fan additional standing fan for staff	ceiling fan additional table fan for staff	ceiling fan	ceiling fan additional table fan for staff and wall fan for patients	ceiling fan
Exterior sun shading type	Deep concrete fins	Deep concrete fins	Deep concrete fins	Roof overhang	Deep concrete fins
Other attributes:					
Building constructed	During post-independence (1975)	During post-independence (1968)	During post-independence (1963)	During pre-independence between 1883-1910 and upgraded in year 1989	During post-independence between 1968-1972 and phasely upgraded interior from 2000 till now
Building Storeys	3 storeys The wards at level 1 and 2	4 storeys The wards at level 1, 2 and 3	5 storeys The wards at level 1, 2 and 3	2 storeys The wards at level ground floor	5 storeys The wards at level 1, 2, 3 and 4
Wall materials	Concrete with paint fin.	Concrete with paint fin.	Concrete with paint fin.	Brick wall with plaster & paint fin./ Partition of gypsum	Concrete with paint fin.
Floor finishes	Terazzo	Terazzo	Terazzo	Terazzo	Terazzo
Ceiling materials	Paint fin.	Paint fin.	Paint fin.	Paint fin.	Paint fin.
Partition for each patients	Curtain track	Folding partition	Few with curtain track	Curtain track	Curtain track
Bed occupancy per ward	38	45	40	25	35
Close proximity between each patients	Near of 0.35m distance	Near of 0.33m distance	Near of 0.3m distance	Near of 0.3m distance	Near 0.33m distance
Outdoor View from windows	view of open landscape and low rise buildings	view of another buildings	view of open landscape and low rise buildings	view of another buildings	view of open landscape and low rise buildings
Outdoor noise level from the windows	Near the main highway Some noise occurred	In the middle of hospital premises Less noise occurred	Fair distance from the main highway Less noise occurred	In the middle of hospital premises Less noise occurred	In the middle of hospital premises Less noise occurred

Results and discussion on subjective evaluation

Subjective evaluation were also features on overall satisfaction perceptions by selected respondents using questionnaire distribution for staffs and structured interview for patients. The evaluation is by means of statistical analyses on personal perceptions towards comfort of thermal within several independent variables influence (demographic and location of buildings) that which been identified and several dependents variables (environmental comforts).

Demographic influence on thermal comfort

The demographic influences in this statistic investigation for both patients and staffs were gender and age. Separately, the demographic between both patients and staffs were also identified; duration admitted in ward and positions with the windows were for patients while length of services and working hours were for staffs. These factors were the *independent* variables under socio demographic. Noted that thermal comfort is the main environmental comfort studies, however, this investigation also includes other variables of visual and acoustic as supportive to overall comfort. These variables are as *dependent* variables under comfort categories. Therefore, the mean score for each comfort and for each socio demographic sub-group were subjected to multivariate analyses of variance (MANOVA) and to univariate analyses of variance (ANOVA) as appropriate options. The demographic analyses were divided into two categories of respondents; patient and staff and were both tested at 0.05 significant levels. However the outcome of the tested analyses has concluded that there is no significant difference under all independent variables and does not influence both patient and staff towards thermal comfort level except for duration admitted in ward for patients' shows a significant influence. Hence, Least Significant Difference (LSD) post hoc multiple comparison was conducted to locate the group difference in socio demographic sub group.

The MANOVA on comfort level and duration of wards admitted indicated significant influence (Wilks' lambda = 0.724; F(3,61) = 2.062, $p>0.05$). Follow-up univariate ANOVA indicated significant differences of duration of wards admitted associate with thermal comfort (F (4,74) = 2.987, $p<0.05$). Post hoc investigation (Least Significant Difference) as shown in Table 5 revealed that patients whose duration in the ward between 10-15 days had lower levels of satisfaction on thermal comfort than other group of patients.

Table 5: Summary result of LSD post hoc thermal comfort with patients' duration admitted

m (days) / l (days)	1-3	4-6	7-10	10-15	>15
1-3	-	0.0538	0.0342	0.6091	0.2519
4-6	-0.0538	-	-0.0196	0.5552	0.1981
7-10	-0.0342	0.0196	-	0.5748	0.2177
10-15	-0.6091*	-0.5552*	-0.5748*	-	-0.3571
>15	-0.2519	-0.1981	-0.2177	0.3571	-

*Mean differences (l-m) showed the lower level of satisfaction on thermal comfort

Significant differences on thermal satisfaction between selected case study buildings

The respondents were asked on their satisfaction level towards each of the potential problems. The questions asked related to thermal comfort are such *"how do you perceive the air temperature in your environment?"; "how do you find the ability to control the 'too hot' or 'too cool' in your environment"; "how do you perceive humidity level in your environment?"; "how do you find the ability to control the extreme humidity from your environment?"; "how do you perceive the air freshness in your environment?"; "is the window availability giving sufficient ventilation?"* and *"does the hospital clothes / uniform give thermal comfort?"*. Questions also asked on other environmental satisfaction that include with other variables such as overall temperature, air quality, lights quality, outdoor view, indoor view, noise and privacy.

The MANOVA analyses was carried out to determine the influence of general wards in different buildings and the perceptions with it that is affected by the different case studies. The result in Table 6 showed that the influence of different building is significant for the thermal comfort and other satisfaction comfort (Wilks' lambda = 0.5612; F(4,115) = 6.0841). Post hoc investigation (LSD) found that respondent in NU felt less comfortable for thermal comfort compared to other departments. Fig.8 showed the result of LSD post hoc multiple comparisons.

Table 6: Summary result of MANOVA (thermal comfort level and other environmental comfort with different ward buildings)

Statistics	Ward Buildings				
	NU	**RT**	**OG**	**WK**	**MB**
Thermal					
n	19	30	22	19	30
Mean	2.6767	2.919	3.1299	2.9398	2.9095
SD	0.4438	0.6046	0.4807	0.6251	0.3172
F(4,115) = 2.0902, p>0.05					
Visual					
n	19	30	22	19	30
Mean	3.3289	3.4583	3.5682	2.9474	3.4750
SD	0.4718	0.5535	0.6600	0.3780	0.4273
F (4,115) = 4.6524, *p*<0.05					
Acoustic					

n	19	30	22	19	30
Mean	2.6316	2.9500	2.9432	3.5921	3.0167
SD	0.2683	0.6242	0.5055	0.4945	0.2537

F (4,115) = 11.1072, p<0.05

In determining the significant differences on overall satisfaction with other environmental factors; overall temperature, air quality, lights quality, outdoor and indoor view, noise and privacy were also included in the questionnaire as another set of *independent* variables. The mean score was computed and the univariate ANOVA was carried out to determine the significant differences between buildings. Fig. 8 shown there were significant differences in the satisfaction level of all environmental factors except for outdoor and indoor view and privacy. This revealed that the influence of the buildings do affect the users' perception on overall environmental factors.
Analyses on the mean score of satisfaction found that with the exception of noise, OG received the highest level of satisfaction while NU registered the lowest level of satisfaction for overall temperature, air quality and noise. Overall, OG registered the highest level of satisfaction while NU received the lowest level of satisfaction.

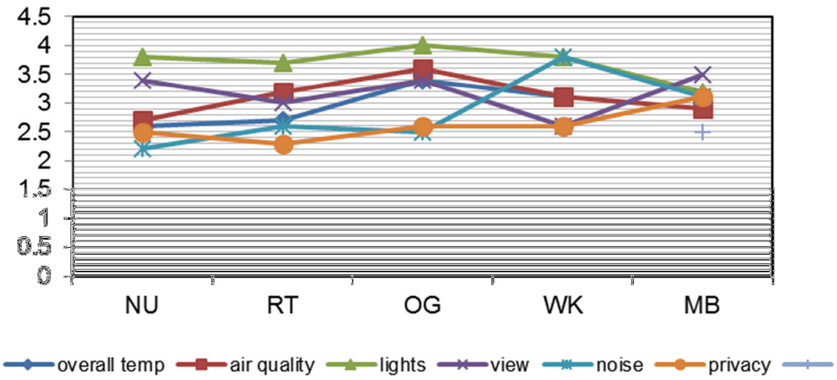

Figure 8: Summary Result of MANOVA between overall comfort and buildings

Average responses on thermal and overall environment satisfaction

As far as the analyses of significant differences on thermal satisfaction were concerned, finding the higher scores of average responses to comfort perceptions is however able to determine on which scale of satisfaction the respondents had perceived. All averaged out close to a score of 5 (on a scale of 3 – moderate were majority perceived) using the 6-items questionnaire on thermal comfort and 8-items on overall environmental comfort. It is also indicating that the scale of 1 and 2 are negative perception; 3 are moderate; and 4 and 5 are positive perception. Figure 9 and Table 7showed the summaries of average response for all five selected buildings both thermal comforts perceived and overall environmental satisfaction.

In NU building the significant difference of average response for thermal comfort perceived indicated unsatisfied perception towards thermal control ability with the score of 5.2 but perceived satisfaction with ventilation sufficiency with score of 4.7. The average response for overall environmental satisfaction in NU responded unsatisfied with outdoor noise and privacy with average score of 7.8 and 5.9 respectively but perceived satisfaction with indoor lights quality (7.8) and outdoor view (4.7).

In RT, the respondents perceived balance score of unsatisfied and moderately on air temperature with average score of 2.3 but satisfied with both ventilation sufficiency and hospital clothes with average score of 4.6. For overall environmental satisfactions, RT respondents perceived unsatisfied with overall temperature and privacy with average score of 4.3 and 7.0 respectively but satisfied with lights quality with score of 7.0. As for WK building showed the average response for thermal comfort perceived unsatisfied with ventilation sufficiency (5.7) and hospital clothes (4.2) but satisfied with humidity level of score 4.2. While there were different perceptions in overall environmental satisfaction where the respondents perceived satisfied with overall temperature (3.6), air quality (4.7), lights quality (6.8), outdoor noise (7.8) and indoor noise (6.8) and perceived unsatisfied for outdoor view and privacy with the score of 4.7 and 5.7 respectively.

However in OG building, they perceived balanced score of 2.7 for unsatisfied and satisfied with thermal control ability and perceived satisfied with air quality (5.0), ventilation sufficiency (5.9) and hospital clothes (4.5). For overall environmental satisfaction, they perceived unsatisfied with outdoor noise (5.4) and privacy (5.4) while perceived satisfied with lights quality (5.0), air quality (5.0) and indoor view (4.0). In MB building, most of the average response in all items perceived moderate except perceived unsatisfied with privacy with score of 5.3.

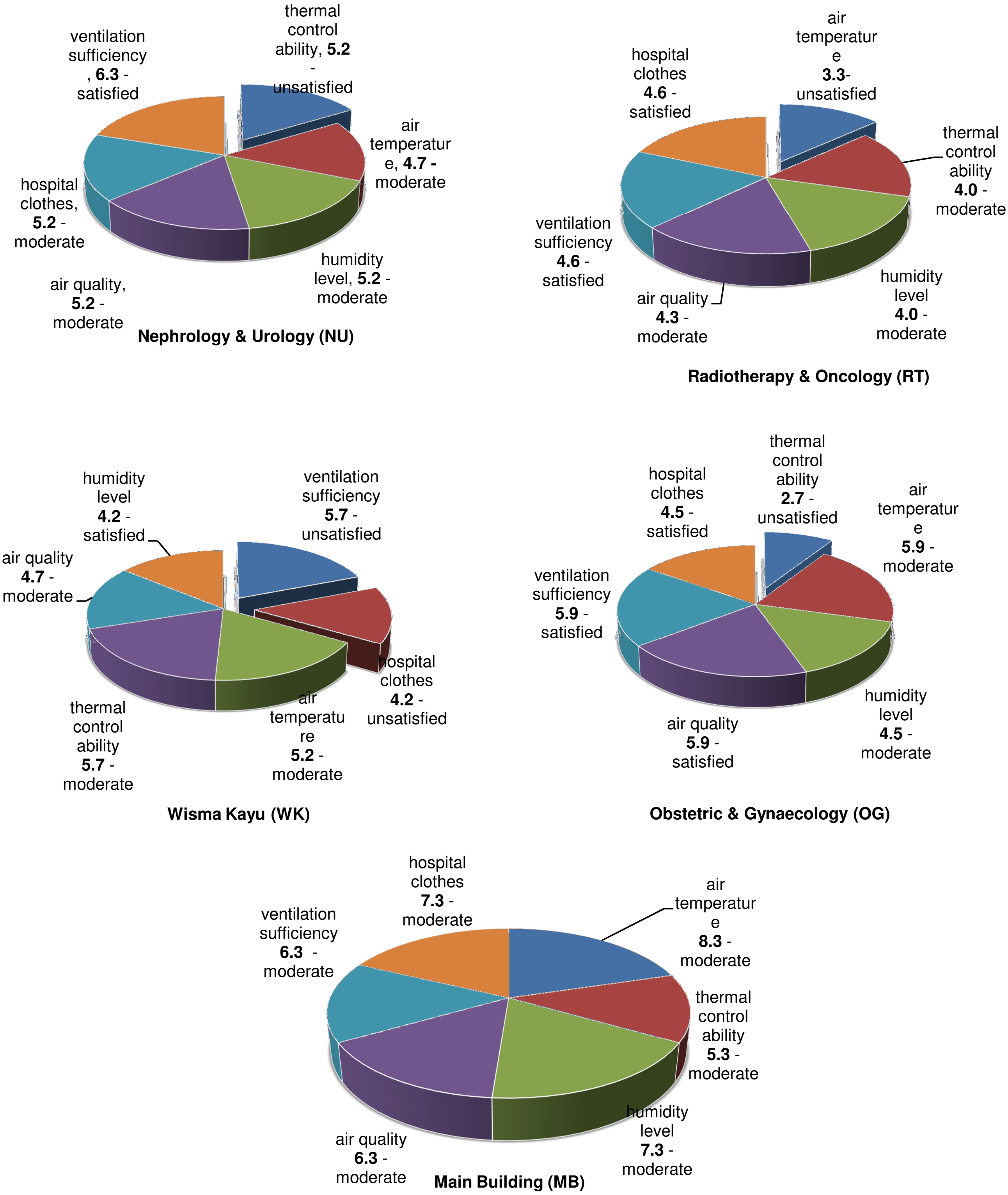

Figure 9: Average Respond of Thermal Comfort Perceived of each different building

Table 7: Summary result of Average Response of Overall Environmental Satisfaction of each different building

No	Item	NU - Avg Response					RT - Avg Response					WK - Avg Response					OG - Avg Response					MB - Avg Response				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Overall Environmental Satisfaction																									
16	Overall temperature	0.0	4.2	*5.7	0.0	0.0	0.6	*4.3	2.6	2.3	0.0	1.0	2.1	2.6	*3.6	0.5	0.0	0.4	*5.4	3.6	0.4	0.0	1.0	*8.6	0.3	0.0
17	Air quality	0.0	3.6	*5.7	0.5	1.0	0.3	0.6	*5.0	4.0	0.0	0.5	2.6	2.1	*4.7	0.0	0.0	0.0	4.5	*5.0	0.4	0.0	0.0	*8.0	2.0	0.0
18	Lights quality	0.0	0.0	2.1	*7.8	0.0	0.0	0.3	2.0	*7.0	0.6	0.0	0.0	2.6	*6.8	0.5	0.0	0.0	2.2	*5.0	2.7	0.0	0.3	4.0	*5.6	0.0
19	Outdoor view	0.0	1.0	4,2	*4.7	0.0	0.3	2.0	*4.6	3.0	0.0	0.0	*4.7	*4.7	0.5	0.0	0.0	1.8	*3.6	3.1	1.3	0.0	0.6	*8.0	1.3	0.0
20	Indoor view	0.0	2,1	*6.3	1.5	0.0	0.0	0.3	*8.3	1.3	0.0	0.0	1.0	*7.3	1.5	0.0	0.0	2.2	3.1	*4.0	0.4	0.0	1.0	*8.3	0.6	0.0
21	Outdoor noise	0.0	*7.8	2.1	0.0	0.0	0.3	3.3	*6.3	0.0	0.0	0.0	0.0	2.1	*7.8	0.0	0.0	*5.4	3.6	0.9	0.0	0.0	0.0	*9.0	1.0	0.0
22	Indoor noise	0.0	3.6	*6.3	0.0	0.0	0.0	1.3	*7.6	1.0	0.0	0.0	0.0	3.1	*6.8	0.0	0.0	2.2	*5.0	2.7	0.0	0.0	0.3	*9.0	0.6	0.0
23	Privacy	0.0	*5.7	3.6	0.5	0.0	0.0	*7.0	2.6	0.3	0.0	0.0	*5.7	2.6	1.5	0.0	0.0	*5.4	3.1	1.3	0.0	0.0	*5.3	4.6	0.0	0.0

1: Strongly Unsatisfied; 2: Unsatisfied; 3: Moderate; 4: Satisfied; 5: Strongly Satisfied

* marked the highest score of average response

Triangulation analyses

Given that the physical observation is by the author's observations and the response on thermal comfort is by the occupants' perceptions, it was of interest to see the correlations on both physical observations and environmental perceptions that inherent differences on relationship between both. As in previous similar studies (Baird, 2010), had shown that strong correlations existed between several factors between perceptions and physical buildings were analysed. Hence, it was appropriate to see for this particular hospital buildings with several different characters to check on the strength of correlation with the users' perceptions.

The triangulation analyses in correlation studies between the physical observations and the users' perceptions is determined in qualitative analyses with the terms of building attributes from observation data and the score of average respond received for each building. As this is to view the outcome of respondents' perceptions towards satisfaction level with the thermal comfort and the buildings' attributes that contribute to the perceptions. Additional information's were explained in the analyses to strongly support the correlation outcomes as well as to justify the probabilities of the perceptions. The information's were obtained while having conversation with the patients and staffs. Table 8 summarized the triangulation analyses between both perceptions and building observations for 'strongly unsatisfied' and 'unsatisfied' in each selected buildings that give significant in this study and some were supported with the relevant information.

Table 8: Summary of triangulation analyses for significant of 'strongly unsatisfied' and 'unsatisfied' perceptions for each selected buildings

NEPHROLOGY AND UROLOGY (NU)			
Comfort Parameter	**Perception From Questionnaire**	**Building Observation**	**Comments**
Thermal	Unsatisfied with thermal control ability	With space volume of 960 sqm and number of windows availability is only 12 units located at only one side of wall may hindered the efficiency of cross ventilation.	The dissatisfaction comments were majority coming from the staffs as they were frequent moving walking back and fro attending the patients and their work station located far from windows with limited access to the ceiling fan.
		The windows are facing directly to East-West directions giving direct sunlight (at low angles) penetrate at certain period during the daytime giving patients and staffs experienced unwanted warmth and discomfort.	Half of the patients were bedridden unable to move away from the heat or to control the window louvered either to close it from heat or open it for ventilation.
		Bed occupancy of 38 beds can escalated the thermal discomfort from human heat.	
Outdoor Noise	Unsatisfied with Outdoor Noise	The windows are facing the main busy road of Kuala Lumpur, so the noise is unavoidable.	
Privacy	Unsatisfied with Privacy	With the distance of 0.35 meter from the next patient's bed giving less privacy to the patient.	Even though there were curtain tracks giving view privacy to the patients but allowed by the staffs only when to perform medical treatment.
RADIOTHERAPY AND ONCOLOGY (RT)			
Comfort Parameter	**Perception From Questionnaire**	**Building Observation**	**Comments**
Thermal	Strongly Unsatisfied with air temperature	With the windows facing another building in a close proximity minimized the efficiency of cross ventilation.	The dissatisfaction comments were majority coming from the staffs as they were frequent moving walking back and fro attending the patients and their work station located far from windows with limited access to the ceiling fan.
			The medical conditions also contribute to this perception as the patients in this ward are cancer stricken patients with on-going chemotherapy procedure that contribute unwanted extra heat in their bodies.
Thermal	Unsatisfied with overall temperature	Observed additional table fan were used both staffs and patients due to the lacked of ceiling fan for the staff's station and insufficient for the patients after chemotherapy.	
Privacy	Unsatisfied with Privacy	With the distance of 0.33 meter from the next patient's bed giving less privacy to the patient.	
		There were no curtain tracks provided at each bed area but instead of limited numbers of folding partition used only permissible by the staff.	
OBSTETRIC AND GYNAECOLOGY (OG)			

Comfort Parameter	Perception From Questionnaire	Building Observation	Comments
Thermal	Unsatisfied with thermal control ability	The windows are facing directly to East-West directions giving direct sunlight (at low angles) penetrate at certain period during the daytime giving patients and staffs experienced unwanted warmth and discomfort. With the windows located at both side of walls increased the probability.	Furthermore this building is exposed directly on both side of wall to the heat of sun directly without barrier.
Outdoor Noise	Unsatisfied with Outdoor Noise	The windows are facing the main busy road of Kuala Lumpur, so the noise is unavoidable.	Between the OG building and the busy road is a huge open field without any trees as a sound barrier.
Privacy	Unsatisfied with Privacy	With the distance of 0.3 meter from the next patient's bed giving less privacy to the patient.	
		There were limited curtain tracks provided at certain area of the beds. Majority of the beds were without the curtain tracks.	Even though there were curtain tracks giving view privacy to the patients but allowed by the staffs only when to perform medical treatment.
WISMA KAYU (WK)			
Comfort Parameter	**Perception From Questionnaire**	**Building Observation**	**Comments**
Thermal	Unsatisfied with ventilation sufficiency and hospital clothes	With the windows facing another building in a close proximity minimized the efficiency of cross ventilation.	During observation also noticed the windows were all mostly closed
		With additional table fan for staffs and wall fan for patients indicated insufficient of air flow.	The clothes provided for the staffs were of thick fabric giving uncomfortable with humidity.
Outdoor View	Unsatisfied with Outdoor View	The windows are facing the next building with close proximity giving less appealing view for both patients and staffs.	
Privacy	Unsatisfied with Privacy	With the distance of 0.3 meter from the next patient's bed giving less privacy to the patient.	
MAIN BUILDING (MB)			
Comfort Parameter	**Perception From Questionnaire**	**Building Observation**	**Comments**
Privacy	Unsatisfied with Privacy	With the distance of 0.33 meter from the next patient's bed giving less privacy to the patient.	

Overall findings concerning the different buildings conditions, as shown in the results obtained above under thermal comfort generally show that the occupants experienced uncomfortable thermal condition when the heat immersed in the space and that patients are unable to control the heat personally to suit individual needs. The implications of the above findings would cause excessive body sweats and body heat that may affect the healing process for patients and ineffective work quality by staffs (Abu Samah et al., 2012; Frumkin, 2007).

Issues and conclusions

The study of physical elements and its thermal comfort perceived by both patients and staffs were investigated in this study. Number of 120 respondents from five different buildings in different departments was studied in between December 2012 and January 2013. EQP assessments with two instruments in finding correlation between the physical attributes of buildings and the occupants' thermal comfort satisfaction perceptions were adopted. Physical observation looks into the physical characters of the buildings that attributes to the thermal and overall environmental comfort which conclude to the 8-aspects of thermal attributes. The thermal comfort responses of the respondents were analyzed in demographic influence as well as on different selected buildings. The average responses on thermal were analyzed under different 14-aspects that correlate with the physical observation.

In the analyses outcome, there were some issues in the findings that can be concluded of which most of the selected buildings experienced 'unsatisfied' with the ability to control the thermal situation meaning personal control with the ceiling fan and the windows from the scorching heat of sun. The buildings with windows facing east west direction allowing direct heat transmission into the internal space resulted in 'unsatisfied' perception with the air temperature. In addition, having windows located only on one side of the wall allow further insufficient cross ventilation in the internal space. Respondent's perceptions for the NU and RT wards were highly unsatisfactory as their space is smaller in volume. Furthermore, the nature of RT patient's with medical experience having extra heat senses due to their routine exercise of chemotherapy treatments. In WK building, the occupants experienced uncomfortable with stalled air resulted from minimal cross ventilation. This is also due to design failure where minimal space was allocated in between the wall separation. Therefore, this study can conclude that providing personal control of individual ceiling fan and the effectiveness of cross ventilation are important for the occupants' thermal comfort.

This study is aim at one aspect that is facilitating better healing environment and workplace for hospital occupants. Having to assess the environmental comfort for the occupants' health and safety, for future recommendations is that to possibly assess other spaces that facilitate public user to generalize the overall satisfaction of the hospitals thermal condition.

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