

Effect of Environmental Comfort Factors in Enclosed Transitional Space toward Work Productivity

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Abstract: Problem statement: The investigated area in this study was the enclosed lift lobby, which distinguishes itself as a unique form of region categorized under building transitional spaces. Such region may act upon on the work performance of occupants, as occupants are sensitive towards the conditions of immediate surroundings. The objective of this study was to investigate the occupants' perceptions of environmental comfort in the enclosed transitional region with identification of current thermal, visual and acoustic conditions, as well as the effect of the environmental conditions towards work performance. **Approach:** This survey was performed using both objective and subjective assessments, where comfort related parameters were measured using electronic sensors and the outcomes were analyzed concurrently with results from questionnaire. **Results:** The results showed that thermal comfort prevails over other two parameters in defining human comfort in the enclosed building area and presumed by most respondents to have more significant impact on work performance. Besides, the environmental factors of the enclosed transitional space exert different level of influences towards work productivity of building occupants. **Conclusion:** It was necessary to maintain the environmental conditions in the enclosed transitional space, similar to the commonly occupied areas within a building. Further investigation on the individual behavior of occupants in the enclosed region of a building was suggested.

Key words: Enclosed transitional space, thermal comfort, visual comfort, acoustic comfort, work performance

INTRODUCTION

Environment comfort comprises of four research fields: Thermal, visual, acoustic and ergonomic comfort. The environmental factors of a teaching institution itself have significant impact on the learning and teaching process^[1]. For building services designers, focuses are made on achieving thermal, visual and acoustic comfort in a built environment. To ensure permanence of a healthy environment and productivity for occupants, conditions of indoor environment must be adjusted to ensure environmental comforts^[2,3]. Transitional spaces are defined as the architectural area situated between the outdoor and indoor environments and acting as both buffer spaces. Some of the examples are lift lobby, foyer, passageway as well as other ancillary spaces not directly occupied by occupants in relation to activity of buildings^[4,5]. Also, these spaces are referred as the parts of buildings where have close links to the external environment and conditions in such

areas may be perceived differently compared to commonly occupied rooms^[6]. Some thermal comfort studies had been directed to the transitional spaces^[7,8]. The current thermal comfort standards such as ASHRAE Standard 55^[9] and ISO 7730^[10] do not distinctly specify the thermal comfort requirements in the transitional spaces^[11]. Due to that reason, it is essential to study the environmental comfort in transitional spaces as such areas are often occupying a substantial portion of total building space. This study attempts to evaluate the occupants' perception of thermal, visual and acoustic comfort in an enclosed transitional space of an educational institution in Malaysia by means of both objective and subjective approaches. Another objective of this study is to identify the effect of each environmental comfort conditions towards the performance of students and staffs via results gained from field survey. Besides, the comparison of the results for three comfort parameters and effect on work productivity were made in this

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study. For assessment of thermal comfort parameters, the values of air temperature, relative humidity and air flow rate were measured. The acoustic, solar heat gain and luminance level in the investigated area were recorded concurrently by using suitable measuring equipments. As for subjective assessment, questionnaire which consisted of questions related to physical environmental comforts were presented to the respondents. The outcomes of the subjective assessment were gathered and analyzed alongside with the objective measurements.

Features of enclosed transitional space: The term “enclosed transitional space” refers to regions inside a building which are not normally occupied by human, subjected to certain degree of building services requirements and not directly linked to the external environment. One of the most easily identified of such region is the enclosed lift lobby, which is known as the place where people assemble and wait for the arrival of elevators. Figure 1 shows the enclosed lift lobby in the department of mechanical and manufacturing engineering, UPM. In some cases, this region may have several features that are similar to commonly occupied spaces in a building, where activities such as setting up of sales and promotion counters, meeting point and others are being performed. For enclosed-type of lift lobby in buildings, it is available in two forms, which are classified as protected or non-protected according to local fire protection specifications. Figure 2 shows the enclosed lift lobby which is built between indoor and external environment and Fig. 3 shows position of the lift lobby bounded within interior environment. These two forms of lift lobby are widely found in the tropical high-rise buildings. Referring to by-law 124 of the Uniform Building by-laws^[12], enclosed lift lobbies in Malaysia must be equipped with smoke detectors. Both protected and non-protected lift lobbies are sharing a similar requirement in cooling, where thermal environment in such areas should be controlled by mechanical means. In some of the transitional spaces, improving indoor environment via natural ventilation is encouraged^[13], but it is not practical to be applied in the enclosed lift lobby as possible effect on functionality of detectors which leads to interruption of fire fighting system may occur. Besides providing cooling sensation to the user of elevators, the air conditioning system in the lift lobby also serves as an apparatus to allow for air-change with the external environment. Artificial lighting is also required in such enclosed region to comply with the requirements of MS 1525: 2007.

Environmental factors of the transitional area could have substantial effect towards sensation of occupants.



Fig. 1: Enclosed lift lobby of the department of mechanical and manufacturing engineering, UPM

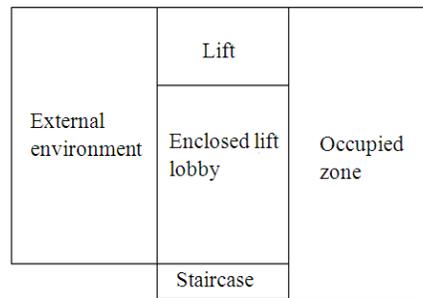


Fig. 2: Enclosed lift lobby connecting outdoor and indoor environment

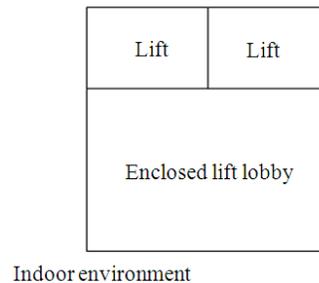


Fig. 3: Enclosed lift lobby bounded within indoor environment

This is due to the fact that human body is very sensitive towards changes in surrounding temperature and air flow rate^[14]. Also, acoustic and illuminance level in a particular space may have considerable influence towards human comfort^[1]. By that means, the work performance of building occupants may be affected due to the environmentally discomfort in the enclosed transitional space, as effect from immediate displeasing experience may last for a particular period of time. On

behalf of that reason, the necessity of investigating the effect of each environmental comfort parameter towards work productivity is required as under most circumstances poor work performance may result in severe consequences.

MATERIALS AND METHODS

A field assessment was performed at the enclosed lift lobby of the Department of Mechanical and Manufacturing Engineering, University of Putra Malaysia (UPM) which is also a part of the administration building for a period of 4 months, from August to November 2008. This building has a total of 7 floors in which every floor has its own lift lobby. The enclosed lift lobbies have common dimensions of 7.94 m in length, 3.16 m in width and 2.7 m in height and not linked to the external environment. Ceiling type centralized air-conditioning split units are installed in the lift lobbies to provide cooling and dehumidification of indoor air. Artificial lighting is available as well, due to local code of practice for buildings^[12]. Throughout the period of this survey, the thermostat temperature set-point of air conditioners in the lift lobbies was maintained at 26°C and natural daylight was applied without artificial means. This is to achieve energy saving purposes^[13] and to examine the comfort perceptions of occupants. In order to comply with the provisions of fire safety requirements, the windows of the enclosed lift lobby were not opened for interaction of external and indoor environment^[12]. Nearly all of the respondents entered the enclosed lift lobby from the administration offices and classrooms which were air-conditioned with temperature setting of 16-18°C, while others moved into from external environment where the temperature may exceed 30°C. Therefore, the test subjects were assumed to have experienced such changes in surrounding temperature, illuminance and acoustic level.

The results obtained from questionnaire surveys and objective measurements for thermal, visual and acoustic comfort are presented in this study. Both assessments were conducted concurrently. Pilot studies were made to obtain useful information regarding the dimensions and characteristics of the investigated area. All information obtained from the pilot studies served as guidelines for this research, such as placement of measuring devices and development of relevant questions for enclosed transitional space conditions. There were 113 individuals participated in this survey, Only subjects who had stayed in the lift lobby for more than 30 sec are invited to participate in the survey,

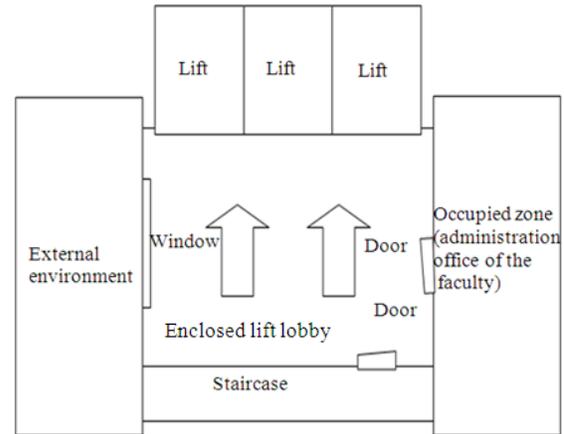


Fig. 4: Brief layout plan of investigated lift lobby

as the average waiting time for users of elevator in this area is calculated based on observation as 33 sec during peak hours, with variance of ± 17 s.

Objective measurement: The parameters of thermal, luminous and acoustic comfort were measured concurrently in this survey. For thermal environment measurements, methods and specifications of conducting field measurements are based on ASHRAE Standard 55^[9], where parameters relating to human thermal balance like air temperature, air velocity and relative humidity were measured at 1.1 m above the floor level and 1.0 m inward from the window of the enclosed lift lobby. Upon observation made on users' behavior in the lift lobby, most users occupied the two regions in between lift entrances, which are in front of lift control panels as indicated by block-arrows in Fig. 4 which is near to the measuring point. Air temperature was measured using electronic temperature sensor connected to the data logger. A precision digital-thermometer was employed to measure the relative humidity. For determining the rate of air flow, a thermo-anemometer with low friction vane probe attached was used.

Identification of luminance and acoustic levels are essential in environmental comfort studies. In this study, as natural daylight is available and being applied in the enclosed lift lobby, a digital luxmeter was applied as it is a suitable apparatus in checking and measurement of luminance level in the built environment. For measurements of acoustic level in this survey, a precision digital sound level meter which able to measure within range of 30-130 dB was applied. All the electronic sensors applied are as shown in Fig. 5. The indoor environment was continuously measured and recorded from 9.00 am-5.00 pm for each day of the survey and all data were transferred to the portable computer.



Fig. 5: Data logger and electronic sensors

Table 1: Rating scale for the subjective measurements

ASHRAE scale	Work performance	Acoustic level	Luminance level	Acceptability vote	McIntyre scale
-3 cold	Not at all	Quiet	Dim	Acceptable	Warmer
-2 cool	Fairly	Somewhat	Less bright	Unacceptable	No change
-1 slightly cool	Much	Noisy	Bright		Cooler
0 neutral			Very bright		
+1 slightly warm					
+2 warm					
+3 hot					

Subjective assessment - questionnaire surveys: To gain users' perceptions of environmental comfort, subjective assessment which applying questionnaire surveys were performed. The questionnaire consists of several sections, where the first part is the subjective ratings on a variety of thermal scales and questions of human preferences towards thermal comfort, as shown in Table 1. In addition, the effect of thermal sensation towards work productivity of staff and student of an educational institution was investigated in the field survey. The following parts of the questionnaire require participants to note down their perceptions on lighting intensity and acoustic level and possible effect on their work performance in the university. Several technical terms were translated into the Malay language to allow a better understanding for the respondents regarding the contents in the questionnaire.

In later sections of the questionnaire, test subjects were required to note down their respective demographics which included gender, age, height, weight, clothing, footwear, data and time when they were being interviewed and finally acquired their opinions on the environmental conditions of enclosed lift lobby which are not covered in the questionnaire.

RESULTS

Thermal comfort evaluation in enclosed lift lobby: The measured values of thermal comfort parameters are

as shown in Table 2. During this survey being conducted, two recruitment activities for new members from local students' organizations were being organized on 10-Oct and 17-Oct of year 2008, which was simultaneous with the field assessment in the enclosed lift lobby. The air temperature as measured was within 23-32°C, with mean value of 28.1°C. The range of relative humidity in the lift lobby was within 63 and 78 and with the mean value of 72.6. As for indoor air velocity, the measured value was from 0.1-0.20 and mean value of 0.15 m sec⁻¹ received. An equation derived by ASHRAE Handbook-Fundamentals^[15] is used for calculation of mean radiant temperature. These parameters were recorded with the purpose of determining the operative temperature of the investigated area. In some occasions, the maximum value of operative temperature in the lift lobby rise above 30°C, which exceeded the upper limit of the acceptable operative temperature range, recommended by ASHRAE standard 55^[9]. Similar to other tropical countries, the highest indoor air temperatures attained in a particular day are within 11 am-2 pm.

ASHRAE scale of thermal sensation was applied with presumption of people finding their thermal environment acceptable if they place their votes within the three central categories (-1. 0. 1). From the data obtained from field survey, it is identified that most of the subjects found the thermal environment acceptable for them. Referring to Fig. 6, 72% of the subjects were feeling comfortable with their thermal environment. Besides, 14% of the respondents indicated that the surrounding was too warm and only 6% of them felt 'cool' or 'cold' during the survey. From the thermal acceptability vote, 80% of the respondents were pleased with the thermal environment, while the remaining of them found the conditions unacceptable. An 8% difference is identified between the acceptability vote and sensation vote, as some of the respondents who voted their thermal perception as "cold" expressed that such thermal environment is acceptable for them. From the results, it is clearly shown that a high percentage of respondents preferred to be cooler in the lift lobby, where 58% of them claimed such. 36% of the subjects indicated that changes in thermal environment are not required, whereas only 6% of them stated that they prefer to be warmer.

Thermal sensation and work productivity: The main purpose of performing this portion of study was to figure out the possible influence of extreme thermal conditions in the lift lobby for the study performance of occupants. The respondents were required to note down their personal view on how greatly the extreme climatic

Table 2: Thermal comfort parameters and operative temperature

Date (08)	T _{op} (°C)	Thermal sensation vote							Thermal preference vote			Thermal acceptability vote	
		-3	-2	-1	0	1	2	3	Warmer	No change	Cooler	Acceptable	Unacceptable
17-Aug	27.34	0	1	2	5	0	1	0	2	3	4	9	0
13-Sep	27.31	0	0	3	2	2	0	1	0	4	4	7	1
21-Sep	27.95	2	1	2	5	2	0	0	1	8	3	12	0
10-Oct	28.01	0	0	3	4	8	4	3	1	6	15	17	5
11-Oct	27.80	0	1	2	5	2	0	1	0	6	5	9	2
17-Oct	27.66	0	0	2	7	11	8	3	1	5	25	18	13
3-Nov	26.66	0	1	0	3	3	2	0	0	3	6	8	1
4-Nov	25.89	1	1	4	1	3	1	0	1	6	4	10	1

T_{op}: Operative temperature

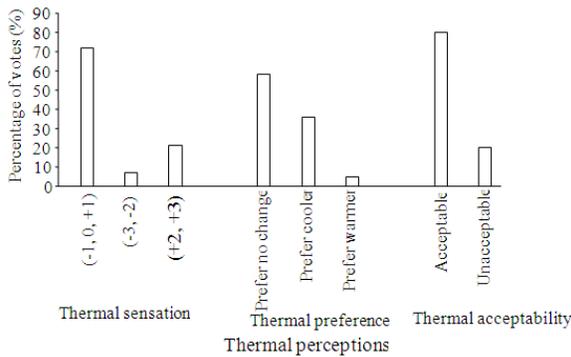


Fig. 6: Distribution of subjective thermal perceptions vote

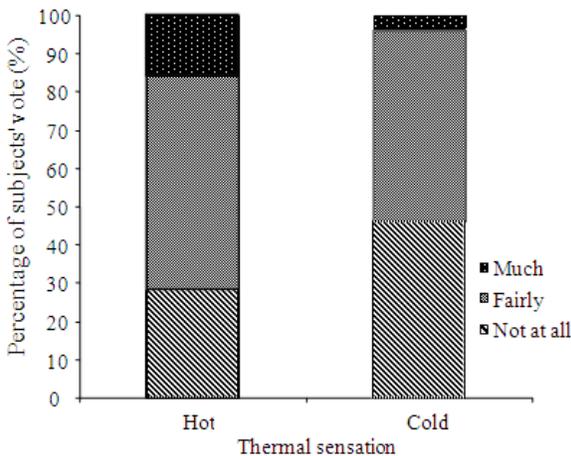


Fig. 7: Thermal sensation and work productivity

conditions may affect their emotions and work productivity. Referring to Fig. 7, higher number of respondents regarded cold environment would not have any effect on their emotions as compared to hot environment, where 45% of them claimed such. In this survey, 72% of the respondents considered hotter environment to cause disturbance in their work

efficiency. The percentage of respondents stated hot atmosphere may cause much discomfort to them is about 12% higher than similar effect from colder one. In general, absolute majority of the test subjects which constituted an average of 63% stated the thermal environment has certain level of impact on their work performance.

Visual comfort evaluation in enclosed lift lobby: The luminance factor in a building could have significant effect on human comfort, although it is not as easily sensed by the occupants as compared to thermal conditions. Referring to field survey performed by Steward^[19], visual comfort may have certain level of influence towards general comfort of students and amount of daylight as a possible influence upon behavior was notified. Natural lighting is available via windows in the location being surveyed, as solar emission into buildings is normally encountered in the tropical countries^[20]. The enclosed lift lobby is installed with artificial lighting, as required by local building standards. Throughout this survey, only natural lighting from external environment was being applied and measured. This is to reduce the energy consumption as operation of artificial light may increase required cooling load^[21] and to investigate the sufficiency of daylight towards providing comfortable environment to the occupants. There were no shading devices such as blinds or curtains for the windows.

Table 3 shows the results obtained from field survey. The illuminance (Lux) level measured was within the range of 87-255, with a total averaged value of 165. This value is higher than the recommended average illuminance levels by MS 1525: 2007^[13], where 100 lux level is suggested for entrance hall, lobbies and waiting room. From Fig. 8, the acceptability rate of respondents to the current illuminance environment is found to be 64%. Slight majority of the respondents preferred to have lower illuminance level in the enclosed lift lobby during the survey being performed.

Table 3: Visual comfort parameters and illuminance (lux) level

Date (08)	Avg lux level	Highest lux level	Lowest lux level	Luminous response vote			Luminous preference vote			Luminous acceptability vote		
				Dim	Less bright	Bright	Very bright	Darker	No change	Brighter	Acceptable	Unacceptable
17-Aug	177	230	97	0	4	5	0	6	1	2	7	2
13-Sep	151	219	92	0	1	7	0	2	0	6	2	6
21-Sep	163	238	89	2	3	7	0	3	2	7	5	7
10-Oct	176	243	97	0	8	14	0	12	2	8	14	8
11-Oct	165	252	91	1	2	8	0	8	0	3	8	3
17-Oct	173	242	93	0	16	14	1	13	6	12	19	12
3-Nov	167	255	87	0	5	4	0	6	2	1	8	1
4-Nov	157	231	93	1	3	7	0	8	0	3	8	3

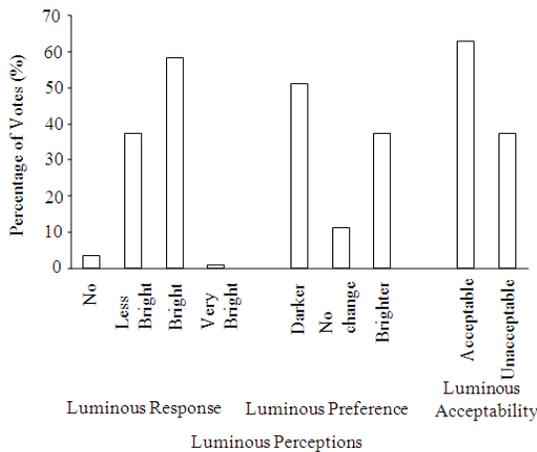


Fig. 8: Distribution of subjective luminous perceptions vote

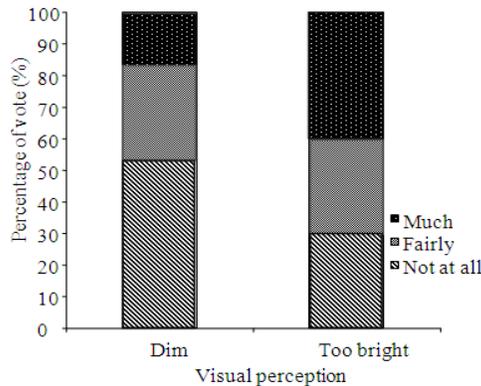


Fig. 9: Visual perception and effect on work productivity

As luminous comfort without artificial lighting is often based on the brightness of environment and emission from external daylight^[20], the luminous acceptability of respondents was based on the preference vote, where subjects who prefer darker and no-change to the existing environment were termed to be satisfied.

Visual perception and work productivity: A large portion of the respondents expressed that the perceived unsatisfactory luminance level in the enclosed region may have significant effect on their emotions and work productivity, even though most of them may not stay in the area for long. An average value of 59% was obtained for respondents who considered the luminance conditions in the enclosed transitional space may affect their work efficiency. As comparing the conditions of “too dark” and “too bright” in the investigated area, most of the respondents stated that the darker environment may not have any notable effect on their work productivity, as shown in Fig. 9. Conversely, 71% of the respondents marked in their questionnaires that an environment with higher illuminance level may have remarkable influence on their working performance and majority of them who claimed such selected that influence towards their work productivity as “much”.

Acoustical comfort evaluation in enclosed lift lobby: Noise is often being defined as unwanted sound. For educational institution, the acoustic comfort is one of the important factors in ensuring proper delivery of events. For measurement of acoustic related parameters, it is suggested by Kruger and Zannin^[1] that critical noise levels and the urban noise frequencies should be measured during peak hours. In this study, the critical periods for noise level as observed in the enclosed lift lobby were before office hours (7.30-8.00 am), during lunch hours (12.00-2.00 pm) and after office hours (5.30-6.00 pm). The focuses were placed on the two former periods during the survey being conducted, as consideration on acoustic comfort for human exiting the working place was not applicable in this study.

The acoustical level in the built environment is difficult to be improved without large sum of funds, as the improvement may required some level of building re-construction and introduction of sound insulation materials. Besides, the external sources which are able to create changes in acoustical level in the transitional space are often difficult to be controlled.

Table 4: Acoustical comfort parameters, sound pressure level (dBA)

Date (08)	Lowest dB (A)	Highest dB (A)	Mean Sound Level	Acoustical reception vote			Acoustical acceptability vote	
				Quiet	Somewhat	Noisy	Acceptable	Unacceptable
17-Aug	43.4	67.5	45.93	7	2	0	9	0
13-Sep	43.3	66.8	45.33	6	2	0	8	0
21-Sep	42.9	67.5	46.52	5	7	0	12	0
10-Oct	43.6	68.4	47.35	10	8	4	18	4
11-Oct	43.4	67.9	47.04	7	4	0	10	1
17-Oct	43.0	69.2	48.55	15	13	3	25	6
3-Nov	43.1	68.3	45.60	6	3	0	9	0
4-Nov	42.9	68.6	45.71	7	3	1	10	1

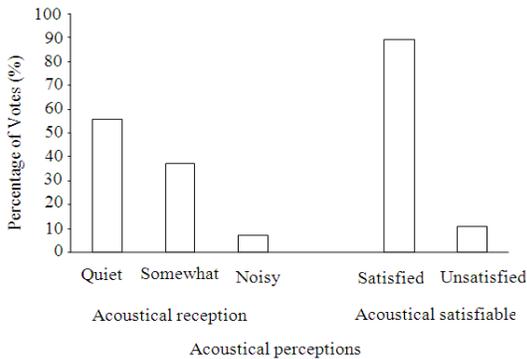


Fig. 10: Distribution of subjective acoustical perceptions vote

As the region being surveyed is a protected area according to UBBL: 1984, changes to the acoustic level are impractical and preference towards desirable acoustic conditions is not to be taken into account. Koenigsberger *et al.*^[25] affirmed that noise control in the tropics is impractical and noted the conflict between thermal and aural requirements especially in tropical climatic conditions due to lightweight construction of buildings. The results obtained from field survey are as shown in Table 4.

For objective measurement, the mean equivalent noise level which signifies the average value of the resultant noise levels obtained from sound level measurement was determined in daily basis. The mean pressure noise levels were calculated based on the equivalent noise level measured. The range of the measured sound level was between 40-70 dBA and the mean values within range of 45-51 dBA were obtained in each respective day of the survey being conducted. These values are within the recommended range of 45-55 dBA according to ARI Standard 885: 1998^[26] for such area. Most of the time, the sound pressure level did not exceed 45 dBA except when the alert bell for elevators rang or when heavy vehicles passed by. It is to be remarked that the difference in noise level in about 3 dBA creates no significant influence on acoustic receptions.

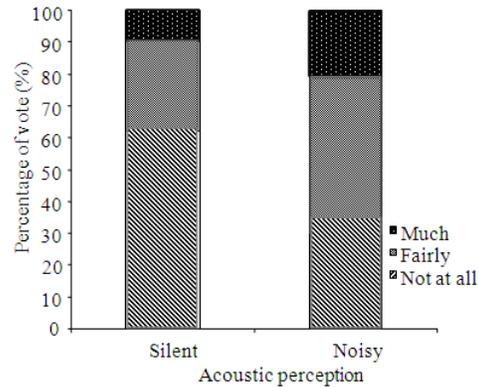


Fig. 11: Acoustical perception and effect on work productivity

The results from field survey are as shown in Fig. 10. It is found that 56% of the respondents termed the acoustic condition as “Quiet” and only a handful of them selected the opposed option. Besides, it is observed that human occupancy level in the enclosed lift lobby has certain degree of influence on the perception of acoustic comfort, in which some respondents termed the surrounding as “Noisy” during 10 and 17 October.

Acoustical effect towards work productivity: From the outcomes obtained from field assessments, most of the respondents stated that the acoustical conditions of the enclosed transitional space plays some influences towards their ability in performing their respective tasks. This is agreeable to the results of survey conducted in regions which are commonly occupied by people, where noise level and stress factor of occupants are correlated^[27]. It is distinctly shown in Fig. 11 that a good number of the respondents declared work performance will not be affected by any means if the surrounding is silent, which doubled as compared to number of votes for noisy environment. Meanwhile, it is identified in this survey that most of the people find noisy environment annoyed as such condition may

affect the work performance of about 72% of them. During this survey being conducted, some of the respondents entered the investigated region during peak hours and termed the immediate acoustical surrounding to have more significant influence than people engaged throughout other periods. Based on Fig. 11, an average of 53% of the test subjects alleged that the acoustic level in the enclosed transitional space may act as an important factor in determining their effectiveness in working and studying.

DISCUSSION

Thermal comfort assessment: In this survey, a self-contradictory phenomenon was discovered as a significant number of subjects voted on the utmost point of the thermal sensation scale, but rated their perceptions as comfortable. More over, some of the respondents stated that the thermal environment is acceptable to them, but preferred to be cooler/warmer in the thermal preference scale. These findings reflect the research done by Feriadi and Wong^[16], where people in the hot and humid climate generally prefer cooler environmental condition. As shown in Table 2, the respondents' thermal sensation move towards the warmer side as number of occupants increased in the enclosed lift lobby. This shows that the human occupancy level in the enclosed transitional region is one of the major elements which greatly affect thermal comfort perception of occupants. This is mostly due to the amount of heat generated by human body^[17], which in certain extent causes a rise in internal temperature of the lift lobby during survey being performed. Besides, some underlying factors which possibly contributed to this phenomenon, such as perception of human in crowded places and personal fondness within a building were encountered during the survey being conducted. These findings reveal that people in the tropics are generally more tolerant towards cooler surroundings than the opposed condition and the work of Wong and Khoo^[18] in tropical classrooms showed similar results in thermal preference. Besides, thermal comfort plays a more significant role in defining general human comfort as compared to other environmental factors. This has proposed the importance of air conditioners in controlling temperature within the enclosed transitional spaces. A concealed fact that leads to excessive usage of air conditioning system in the transitional spaces of the tropical educational institutions is revealed and an opportunity for energy efficiency for such facility may be looked into in the future.

Visual comfort assessment: A noteworthy occurrence discovered in this survey was a portion of respondents

whom did not feel comfortable with the "bright" environment of the enclosed lift lobby and preferred to have darker surroundings. This proves that not only insufficient lighting may have deleterious effect on human comfort in buildings^[22], but excessive natural lighting as well. Meanwhile, another fact pointed from this result was natural daylight is sufficient in providing visually comfortable environment to most of the occupants of educational building while this survey being conducted. The higher percentage of subjects' vote on preferring darker environment indicated that luminance level in the enclosed transitional space is to be controlled. The work of Li *et al.*^[23] suggested control of luminance level may be made via shading devices, glazing or by other means in high illuminance area to provide a better thermally and visually comfortable environment.

High luminance level in indoor environment is found to be undesirable by some respondents. Such phenomenon is partly due to the high luminance level at the external environment, which is common for tropical countries^[24]. People who entered an indoor space from external environment may presume that gloomier surroundings are more visually comfortable for them. Besides, another cause for obtaining these results is due to higher number of participants who joined the survey during lunch hour (12 am-2 pm) and outdoor solar emission into the building was extremely high. As the visual environment may induce some effect on work performance, glazing materials are to be introduced to the fenestrations available for improvement and sustainability of human visual comfort in the enclosed transitional area^[23]. This finding proves to be a useful guide for energy efficiency purpose in tropical buildings, as operation of artificial lighting is not required during certain period of a day.

Acoustical comfort assessment: External sources may act upon on acoustic comfort of human-beings^[28], but did not pose as significantly in the enclosed transitional space. Differ from the commonly occupied region; the most possible factor which may cause changes in acoustic level is the human occupancy. This is evidenced in Table 4, where the environment was termed by more respondents as "Noisy" when the number of occupants increased.

A number of respondents also felt slightly disturbed acoustically during peak hours. Also, external sources such as vehicles' sound which penetrated the wall and windows in the transitional space, does not affect the respondents much in terms of acoustic comfort. This has suggested that people passing through the transitional space in a building generally pay less

attention to the acoustical condition as compared to other environmental factors. Similar results were obtained from survey conducted in the occupied zones, where the work of Chew *et al.*^[27] suggested that correlation between noise level and stress factors is generally lower as compared to lighting level and work size area. The percentage of influence for acoustical comfort is comparatively lower than the results for thermal and visual comfort, as people tend to place less focus on the sound level of their surroundings. Thus, it can be concluded that the importance of acoustic comfort in defining total comfort is less significant compared to other comfort parameters. Some other efforts can be made to control the acoustic level due to human occupancy in the enclosed lift lobby, similar to the thermal environment.

CONCLUSION

Field survey was conducted in the enclosed lift lobby of a higher educational institution to investigate the environmental comfort perceptions of occupants and consequences of each environmental comfort factors towards work performance. The environmental environment of the enclosed transitional space is equally important as the normally occupied spaces in an educational building, as some activities which require human occupation are occasionally being carried out in such area. The findings prove that although people do not stay in the transitional space for long, the environmental conditions do exert a certain level of effect towards work productivity. It is identified in this survey that thermal comfort prevails over other comfort parameters in defining significance of effect towards occupants' work performance in the enclosed region, as percentage of presuming influence for thermal, visual and acoustic comfort is 64, 59 and 53% respectively. Hence, more focus can be given to sustain thermal comfort of travelers in the enclosed transitional spaces as it also forms a better opportunity in energy efficiency. Besides, from the analyzed results, it is proven that the thermal and acoustic comfort in the transitional space is directly proportional to the level of human occupancy per period of time, while visual comfort is not affected with similar event. For this reason, good employee management system can be proposed to control the level of human occupancy in the lift lobby. The air conditioner temperature setting of 26°C and natural daylight are able to provide most of the occupants with a comfortable surrounding, without much interference towards their work performance.

Further studies are recommended on determining the individual perceptions of environmental comforts

and more information can be gathered to provide a more statistically significant results. Besides, similar work may be performed at other building transitional spaces with different features and usages to investigate the effect of environmental conditions on emotions of occupants.

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