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INFLUENCE OF LIGHTING AND COLOUR USAGE IN HIGHER EDUCATION, A CASE STUDY OF AN ARCHITECTURAL STUDIO.

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Abstract
An architectural studio is where architecture students spend a large amount of time to do their respective works. Most of the architectural studios nowadays do not meet the lighting requirement for comfortable working spaces. This case study aims to find out if the architecture studio space in UiTM Cawangan Perak meets the requirements for visual comfort for students in terms of lighting and colour. The architecture studio is evaluated in terms of brightness and colour. The data of brightness in the studio is taken at intervals of two hours for a twelve hour span in a day. The data then is presented in a series of tables and graphs to be reviewed. Colours of the studio are observed and recorded through photographs. After the collected data is calculated through the Lumen method, it is found that the studio does not follow the Malaysian Standard (MS) 1525: 2007 "Code of Practice on Energy Efficiency and use of Renewable Energy for Non-Residential Building." The lux is too low although the number of luminaires is sufficient. The colour of the studio is also dull which can make the environment boring and unproductive.

Keywords: Architecture Studio, Brightness, Visual Comfort, Colour

1.0 INTRODUCTION

A well-designed and curated workplace can indeed increase the productivity and lessen absentees whether it is a classroom, the office or a studio. The space should not only improve the productivity to provide a wholesome education and/or work output, it should also improve the mood to lessen the stress that is already provided by the workload.

1.1 Defining Visual Comfort

Visual Comfort is defined based on Kwallek (2009). According to her, the occurrence of visual comfort is when the brain can function without any obstruction so that all the senses could function at their optimum level without distractions. It is also stated in the journal that visual comfort is of importance for working area. Factors affecting visual comfort is light distribution and colour usage in the area.

1.2 Defining Productivity

The correct definition of productivity according to the Oxford Dictionary is the state or quality of being productive. According to Sutermeister (1976), the definition of productivity is "output per employee hour, quality considered." In the case of this research, productivity of a student can be measured by observing the rate of work that is produced in the hours spent in the studio. Sutermeister (1976) also said that the motivation of productivity in employees is fed by well-being and positivity environment but not necessarily all employees with well met needs can produce more quality products.

1.3 Lighting Arrangement

Hameed (2009) upon her research on office design affecting productivity found that lighting plays the most important role in productivity. She also said that employees who work in dimly lit spaces can cause disturbances to the eyes like eye strain. Wojcik (2012) said that a researcher name Jennifer Veitch had found that a person who could adjust and control their own lighting can affect their mood and also reduce

the energy consumption of a workplace by 10 percent. Arup (2007) states that the "objectives of lighting design is to produce good lighting for the occupants of the space." General lighting provides a good all over consistent lights. Localised lighting are lighting that provides lights to certain area like desks and workstations and such lighting is recommended to known furniture layout plans for easy fixtures. Arup (2007) also discusses the importance of light distribution in the space. According to him, colour, reflectance and texture of surrounding finishes play a role in this. He further adds that the ceiling should have 30 percent of task illuminance while the walls should have 50 % task illuminance.

1.4 Lumen Method

The definition based on Thorns (2012) defines lumen method as a calculation to identify the number of luminaires required in the space for sufficient illuminance. It is applicable for empty rectangular spaces with simple reflectance which is wall, floor and ceiling (Thorns 2012). The following is the lumen method formula that was used in this research.

$$N = \frac{E \times A}{F \times UF \times MF}$$

Lumen Method Formula

1.5 Colour on Finishes

Kwallek (2009) conducted several studies involving the colour of the office and how it affects the mood and errors of the employees. In the first experiment, she puts the 36 subjects through tasks that required them to stay in a red office or a blue office and also switching from one another. The results from the study show that subjects who stay in their respective offices show less error and the subjects who switch offices show more error than the other subjects. Another finding is that the subjects relate the colours with moods. Red for anxiety and blue for depression. In another experiment by Kwallek (2009) the subjects go through monochromatic offices which include the furniture of various dull and saturated colours. The results vary from the male and female subjects. Female subjects found that their emotions are more aggressive in duller offices while on the contrast, males found their moods downgraded in saturated coloured offices. The least preferred are the orange and purple offices and most of the subjects preferred the white or beige coloured offices. Although they prefer the duller office more, more errors were made in them rather than saturated coloured office. Kamaruzzaman and Zawawi (2010) said that duller offices cause boredom to the employees in the office building and if the employees spend longer hours in the office, it makes them lose focus and concentration on their tasks. This is said to lessen productivity. Colours are also used to lessen eye strain from prolonged work hours in front of the computer screens. Hulshof (2013) in his research of colour and scents affecting moods in meeting rooms found that cooler colours decrease work stimulation than warm tone colours.

2.0 TOOLS AND METHOD

A number of methods were used to carry out this qualitative research. The research includes a studio in the east wing in the Faculty of Architecture of Universiti Teknologi Mara, Seri Iskandar, Perak. The studio is the first semester students' studio. Observations of the overall studio is made through photography. Observations of the colours used in the studio were also collected such as furniture colours and wall finishes. Observational sketches were taken to collect the data of the wall finishes and furniture. The physical measurements of the studio is taken in a span of a day which is on Monday. Measurement of the studio is also taken including the floor plan, furniture layout and reflected ceiling plan. This was to know how the lighting arrangement is placed and whether it follows the guidelines to maximize performance and productivity in the studio. Data collection of lux was taken upon a span of 12 hours which is from 10:00 AM to 10:00 PM. The time that the lux reading is taken is 10:00 AM, 12:00 PM, 2:00 PM, 4:00 PM, 6:00 PM, 8:00 PM and 10:00 PM. The measuring tool that was used is the LM-8100 4-1 electronic metre. The studio was divided into 12 zones following the beam of the ceiling in the studio.

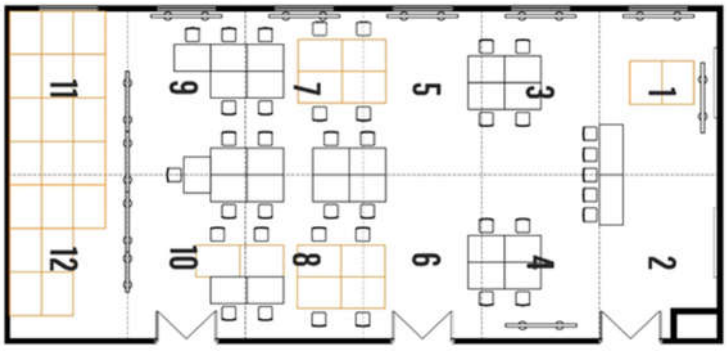

Figure 1 Floor plan of Studio 1A

3.0 DATA ANALYSIS AND FINDINGS

3.1 Analysis of Data

Zone 1 is located at the front of the studio. The space is a storage place where they display all their past projects and also place cupboards and an extra whiteboard. It includes windows that let in the morning sun. This includes glare to the studio. The students ended up covering the window with partitions. This includes all the windows on the east side of the studio. Most of the artificial lighting is turned on. The lighting reading includes the significant amount of daylight that goes through the partition. The data shows that in the morning, the lux is the highest at 600 lx because of the glare and continues to show higher lux reading in the afternoon which is 440 lx.

Zone 2 is located also at the front of the studio on the west side. A door is included in the zone and also an LCD screen. This space includes The lux in this area is at the highest at 2 in the afternoon because the natural daylight that affects the readings which is at 237 lx. The lux in this zone decreases as the time in the day goes by reaching the lowest readings at night. The data reads at 179 lux at 10 P.M. at night. The reading stays constant throughout the day and decreases drastically at night. Zone 3 includes the partitions that act as a shade for the windows and also part of working drafting tables and students' workplace. The highest of the readings was in the earliest data recording which is at 10 A.M. in the morning. The reading was 450 lux. The reading decreases slowly in this zone as more data was collected. The data includes fluctuation in the lighting. As shown, the reading can be from 308 lux at 4 P.M. and increase to 342 at 6 P.M but decreases back to 219 at 8 P.M. The lowest of the reading is at 8 P.M.

Zone 4 includes a part of the discussion table in the middle of the studio and also part of the student's workplace. This zone has a non-working light included. So, there is only one artificial lighting in this zone instead of two. The readings are quite consistent throughout the day with a decrease at night. The highest readings are at 10 A.M. which is 200 lux and 4 P.M. which is at 201 lux. The zone has the least lux reading at 8 P.M. at 121 lux. Zone 5 has large windows and the partition that the students placed for shading from the sun. It also includes the workplaces of the students but are placed without grid. The readings in this zone are the highest in the morning because of the morning sun. The reading is 353 lux. Other than that, the other readings are quite constant throughout the day. The lowest readings out of them is 220 which is at 8 P.M.

Zone 6 has students' workplace which is similar to zone 5's arrangements. The zone includes a door and small windows above the door. The reading is constant throughout with a decrease at 6 P.M. The highest reading is at 2 P.M., which is 285 lux and the lowest is at 6 P.M. which is 220 lux. The difference in reading and brightness is not drastic. This makes this zone the most constant throughout the day. Zone 7 is one of the zones with the most student's workplaces. The total number of workplaces involved in this zone is 12 workplaces. Although not all are fully in the zone. The zone includes windows and partitions. The zone differentiates between more or less 200 lux to 300 lux. With the highest in afternoon and the lowest at night. At 12.00 P.M., the readings reach its highest at 335 lux and the reading of 204 lux as its' lowest.

Zone 8 is another zone with the highest number of student's workplaces. The arrangements of the workplace is similar to zone 7 as shown in the diagram. The zone has small windows. The highest reading of this zone is 246 and the lowest 203. The range of reading is quite small in this zone. This zone is darker than others considering it is one of the zone with 12 workplaces. Zone 9 is one of the zones that is the last of the workplaces. Student's workplaces are present and windows as well. The sun is shaded by the partitions that are placed in front of the window. This zone has the highest reading in the early morning at 600 lux and the lowest readings is 28 lux at 8 PM. The lighting in this zone was turned on at 9 PM. Zone 10 is has only two working spaces that is included. The zone is darker through the day with an increase at 10 PM. This is because the lights were switched on at 9 PM. The highest reading in the zone is at 10:00 PM because of the lights. The most lowest reading is at 8:00 PM which is at 35 lux. Lastly, Zone 11 and 12 are storage zones in the studio. The zones includes a big amount of drafting tables that are not used. Half of the Zone 12 is used for praying. Both these zones' lights are not switched on throughout the day. The zones have the same lowest reading which is 0 lux, both at 8:00 PM. The highest of the zones are 750 lux and 51 lux for Zone 11 and Zone 12 respectively.

3.2 Calculations

Table 1 shows the lighting arrangement and its description should come first before the calculation.

Table 1: Lighting Arrangement and Description (before calculation)

Area		23m x 10m
Ceiling Height		3 m
General Illumination Required (Malaysian Standard (MS) 1525: 2007 "Code of Practice on Energy Efficiency and use of Renewable Energy for Non-Residential Building")		300 – 400 lx
Fluorescent Lamp		65 watt / 50 lumen
Utilization Factor [µF]		1.0
Maintenance Factor [MF]		1.0
AREA x Illumination Required = 23 m x 10 m x 350 lux = 80500	Fluorescent Lamp per unit = 65W x 50 lumen/watt = 3 250 lumen	Total lamps without corrections = 80500 / 3 250 = 24.76 @ 24 units

Figure 2. Reflected Ceiling Plan

The lighting arrangement of reflected ceiling plan after the calculations is the same with the existing one. Although the reflected ceiling plan is the same with number of luminaires, the lux is still not enough for the workplace.

3.3 Colour Usage in the Studio

The colour usage of the studio is grey with a dark blue furniture and doors and also orange table stands. The majority usage of grey can make the students feel lethargic and not active. This may result in students not doing work for prolonged time in the studio. Warmer colours can evoke happiness and excitement but cooler colours can create a sense of calmness.

4.0 CONCLUSION AND RECOMMENDATIONS

Lighting in the studio should be a main priority for not only improving the productivity and quality of work among students but also The studio does not follow the Malaysian Standard (MS) 1525: 2007 "Code of Practice on Energy Efficiency and use of Renewable Energy for Non-Residential Building." The lux value is lower than required of an architecture studio even though the number of luminaires is sufficient in number. This is a concern because "the students perceived it as normal (good) and this does not hinder them from staying longer inside the studio. (Musa et al., 2012). It was based on the study they took at UKM's architectural studio. So, the illuminance in the studio must increase for visual comfort among students.

"We experience color as fundamental quality in our visual perception" (Kwallek (2009), n.d.) The colour of the environment affects the moods and emotions among humans but the studio does not use mood evoking colours for the students. The environment may have an effect in the feeling of boredom or lack of motivation in prolonged work hours. This is a concern because the level of productivity of the students can decrease over time and can result in poor quality in their work. A warmer tones colour scheme can change the mood of the studio making it lively and possibly creating an active mood for the students.

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