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LIGHTING CONDITIONS AT STUDY AREAS IN ACADEMIC LIBRARY: ENHANCEMENT TO THE LEARNING ENVIRONMENTS

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Abstract

The library is the heart of academic buildings community especially in higher education institutions, colleges and schools. It should be designed not only to meet the requirements of good facilities, physical aspect of the environment such as lighting, temperature, humidity and the acoustic space that contribute to the student's learning activities but also its reference materials. Studies revealed that the physical environment in interior library did contribute to the positivity of student learning especially through reading and writing which the most common activities. Thus, the suitable lighting illuminance should be designed according to the Standard guideline. The objective of this paper is to measure the illuminance levels (lux) of the existing lighting conditions in the library by comparing between the Malaysian Standards of MS ISO 8995:2005 Lighting of Indoor Workplace, JKR and PERPUN Standards (Malaysian University Libraries Association) and will be conducted in four (4) different study spaces namely Open Study Space, Individual Carrel, Discussion Room and Leisure Reading Area in three (2) case studies in Perak State. The results can be applied to improve the lighting conditions for the better library environment and as the outcomes and benefits, it can be applied and will help in improving the conduciveness of current and future physical environments of the academic libraries in Malaysia as a place for learning and scholarship activities.

Keywords: academic library; physical environment; interior lighting conditions; lighting standard guideline

1. Introduction

Academic library has long been seen as vital components of academic life on campus, but the library environment has expanded substantially in recent years. Designers of educational spaces have always instinctively known that the built environment has a profound effect on its occupants. Yet little research has been available regarding to this gut feeling by W. Dittoe in 2002 (J.Gotsch and D. Holliday, 2007). Physical and psychological comfort environments have long been recognized as an important part of the adult education learning process (Jones 1985). On the university campus, the library ranks next to the classroom as an important learning setting (Campbell 1979, Fang C. 2008). Academic library environments is an essential component of an institution's intellectual expression. The ambiance should be conducive for academic purposes to encourage and inspire the students or users to use the library. Furthermore, many researches have examined aspects of learning environments and its impact of such environments in education level (Earthman 2002, Young et al 2003). Many studies and reviews have revealed and found that physical environments especially in academic building conditions indicate that students outcomes are affected positively or adversely by the visual, lighting, temperature, student comfort, acoustical and the classroom technology and environment are significantly positively related to student outcomes, including performance and attitude (Fisher 2001, Hurst 2005, Amirmudin, U. 2008). According to the information above there are particular impacts on physical environments particularly on physical comfort level in assisting students in their learning environments. Libraries in developing countries like Malaysia, where the university faculties and other university support services were required to monitor and maintain the quality of their services to fulfill the university's main objectives of providing quality environment for teaching, learning and research. (Roslah & Zainab, 2007).

1.1 Physical environments in comfort views.

The essential elements to be considered when planning or redesigning study places for students were under the factor of human comforts. According to Bennet, S.(1978) designing spaces that are physically and psychologically comfortable is essential to attracting repeat users to the library while Shill & Tonner (2004) concluded, based on

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their empirical research, that some previous studies and surveys on library physical environments and design can have significant impact on library usage. According to Bennet, S. (2003) added, library physical environments play important roles on impact to the learning environments. The environmental factors of a teaching institution itself have significant impact on the learning and teaching process. Environmental comfort comprises of four research fields: Thermal, visual, acoustic and ergonomic comfort by Kwong, A. Mariah & S.H Tang (2009). As Amirmudin (2008) cited physical environments in ergonomics perspectives comprises of elements of thermal environment, air temperature, humidity, indoor air quality, air movement, noise, ventilation, odor, color, and lighting. As Kruger, E.L and P.H.T. Zannin (2004) provides further proof that the four research comfort fields have impacts to the student's behavior, attention and performance. For example, inadequate lighting will have an effect on attention and student's performance and high quality lighting can improves student moods, behavior, concentration, and therefore their learning.

The usual method of measuring the level of comfort in area utilization is based on the evaluation of the measurement area according to specific guideline standards. Several study was conducted to measure the space environment comfort level in several different settings such as studies on comfort level in working in factory, (Anuar, M. Jauhari and M. Riduan 2011), Visual comfort analysis in the studio (AR Musa, 2011), comfort levels in hospitals (R.Ulrich and C.Zimring, 2004), school comfort level (IAQ) Ismail M. and M. Sofian, and Nur Zafirah A., A.Makmon (2010), ergonomic comfort in academic libraries (AM Chandra, 2009), Hostels comfort levels T.Yew Fei (2008) and (E. L. Kruger and P.H.T. Zannin, 2004) comforts in classroom. It's clearly stated that physical environments have profound and significant impacts to the user in various settings and places.

2. Review on Literature

Lighting effects on visual task and learning environments

The academic library should playing importance role in the context of the learning paradigm and as the intellectual core of the institution it serves. Conditions of high visual comfort should be emphasized and it is important to address gaps in the research in the library learning spaces, including activities that require the visual task such as reading, writing, and using a computer screen. This is due to visual task for long periods can affect the behaviour, productivity and health of consumers. As according to Joseph Brennan (2007), school, universities and other institutions of learning pose an interesting challenge for lighting designers which are occupants of these building have to concentrate for long periods of time and to facilitate this, comfort is a key design point. According to S.Mohanty (2002) lighting is an important part of library ambiance, but one of the most difficult to control. Cost concerns must be considered, as well as practical versus aesthetic needs and lighting may be one of the most important subjective factors determining 'warmth' and 'atmosphere' in a library" Murphy(1956) in S.Mohanty (2002). This clearly shows that the lighting in schools or related to the learning environments is attributable to and likened to space in the library buildings. This is because the frequency of the students using the facilities in the library learning space is high. There have been many study of academic libraries use by Williams in 1995 (Anthonia E. 2008) surveyed Canadian undergraduate library use, and found that active learners who participate more in class, and who read, write and study more are regular and active library users. As visual tasks such as reading, writing are of great importance during the research periods in libraries, it is essential to provide the visual comfort conditions at a high level Feride S.and Alpin K.Y. (2008).

According to Heschong et al (2002) in (S.Higgins, E.Hall, K.Wall, P.Woolner and C.McCaughey,2005) demonstrated the relationship between lighting and performance in schools. Learning spaces must have a fixed arrangement for integrated lamps for light work schedule to spread the work surface. According to Ott Biolight Systems, Inc. in 1997, the body systems will affected by lighting which is wavelengths of light help control the human body's chemistry and many functions, including the nervous system, circadian rhythms, pituitary gland, endocrine system, and the pineal gland are affected by different wavelengths of light (L. Edwards and P. Torcellini,2002). According to the review from (S.Higgins, E.Hall, K.Wall, P.Woolner and C.McCaughey,2005) in relation to student achievement it is argued that day lighting offers the most positive effect (Earthman, 2004; Heschong Mahone Group, 2003) as daylight produces biological effects on the human body (Wurtman, 1975). Boyce (2003) empirical research details of conceptual framework *See (Figure 1)* was elaborates the ways of lighting conditions influence on human performance.

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Figure 1: A conceptual framework setting out the three routes whereby lighting conditions can influence human performance. The arrows in the diagram indicate the direction of effect. Source: Boyce (2003)

Distribution of light is important when designing a study or work space. Lighting at the table of service must be sufficient to use a computer, reading and writing tasks, and it can cause glare to the use of a computer screen or reading a book that has the texture of glossy paper that can be difficult reading and discomfort to the eye. Research made by Liberman in 1991, a school with insufficient light can also reduce a student's ability to learn due to the effect lighting has on physiology. Poor spectral light can create strain on students' eyes, leading to a decrease in information processing and learning ability, causing higher stress levels (Liberman 1991). There are several studies conducted previously stated that the physical level, especially the lighting in the space environment gives impact to the satisfaction of library users.

International lighting standards determine of adequate levels of lighting for parts of the library building and the designer should consider the emphasis on eye health and library users as well. Knez (1995) found evidence that lighting conditions that induced negative affect reduced performance, and therefore, lighting conditions that induced positive affect improved performance. Veitch (1997), however, argued that lighting has no effect on mood or performance. There is research relating to different kinds of lighting, from daylight to artificial, and there is disagreement among researchers on which form of lighting is the most suitable for the classroom. However there is also an opinion that the use of daylight source merely is not encouraged and less practical. According to Barnitt (2003) points out that combination of both direct and indirect lighting is suggested by Benya (2001,p.1) to increase the effectiveness used, daylight should be supplemented by the controlled electric lighting that dims automatically in response to daylight levels.

3. Methodology

Studies were carried out on evaluation of comfort elements; visual comfort levels of illumination of lighting intensity on the current conditions of three libraries. The evaluation was conducted by measuring and comparing the standard limits or rates results which complying with the standard requirements that apply with the Malaysian Standards of MS ISO8995:2005 *Lighting of Indoor Workplace*, JKR and PERPUN Standards (*Garis panduan Persatuan Perpustakaan Universiti*) . The evaluation study was conducted in four (4) measured areas of study spaces namely 1) Open Reading Areas (SS1), 2) Individual Carrels (SS2), 3) Discussion rooms (SS3) and 4)Leisure Reading Area (SS4) in every 15 minutes for one hour. Light meter pocket (Model LX-101-*ISO-9001, CE, IEC1010*) was used and lux Meter measurement through sensors take readings at the level of activities on the table because most students use the table for readings and study.

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Standards & Industrial research Institute of Malaysia (SIRIM) has introduced standards or guidelines for the appropriate lighting level of ISO8995:2005 *Lighting of Indoor Workplace*, and general guideline MS1525: 2007 *Code of Practice on Energy Efficiency & Use of Renewable Energy for Non-Residential Building*, (See Table 1 (a) and Table 2 (b) which gives guidance of visual environment suited to the function of the interior and recommended standards for lighting and specifies lighting requirements for indoor workplaces and for people to perform the visual tasks efficiently, in comfort throughout the whole period.



Table 1 (a) Recommended average luminance levels by MS1525:2007; (b) MS 8995:2005 Lighting of Indoor Workplace.

As according to the research schedule, the research was conducted within two (2) weeks in September 2012. Whereby the collection data for lighting measurements on illumination lighting (lux) was conducted on a week in early September and the questionnaire Survey was distributed on mid of September 2012. The evaluation of user satisfaction was based on response by user Satisfaction Surveys of fifty (50) respondents of each library. Figure 2 shows the understanding of the research work flows.





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Each of the measurements was recorded and noted by the tools which was used on previous studies and adopted from (N.A.Karim, 2008) and has been redesigned and revised by the researcher. *See Table 2: Measuring Field Worksheet.* The evaluations was conducted on according to the sampling stations in four (4) main study spaces which marked on the Layout Plan in three libraries. Hence, it also carried out a questionnaires survey on students' satisfactions on lighting conditions of the library and observation through students' behaviour while using the space. The method of Convenient Sampling method (Krejcie, Robert V., Morgan, Daryle W., 1970). The number of respondents (students) was 50 nos. according to the sample size of populations in each library and distributed directly to the students who came to the library.



Table 2: Measuring Field Worksheet. Source: H.Hambali, S.Sufar, A.Talib & M.N.Aziz (2012)

4. Finding

The finding in Figure 3, shows the lighting level measurements at the four (4) sampling stations in the three (3) academic libraries. All four (4) study spaces have a different frequency range of light readings. There were lighting level measurements recorded less than minimum standards of 300 lux readings or exceed the standard maximum of 500 lux recommended by SIRIM MS ISO 1525:2007. According to MS ISO 8995, the lighting levels should be in a range of 500 lux at reading areas which means, there are many of study spaces did not meet the standard requirements. According to the JKR and PERPUN Standards, the lighting level is within range of 350 to 500 lux. There were significant differences for all lighting lux readings measured areas. For example, LIB 3, recorded value exceeds the maximum standards in SS2 space than in LIB 2, which recorded a reading below the minimum level of standards. This means that areas with higher levels of reading value is very high and exceeds the standard were not suitable and should take into account the sensitivity to the glare and eye discomfort. It should have control over the situation glare or shading device measures. According to research, the window is a medium that is important to bring light during the day into the space or the interior of the building Karlen and Benya (2004). However, factors such as glare, brightness, eves discomfort and important shading devices should be emphasized. Based on observation there were no blind or shading devices used or provided in LIB 3 and LIB 1. Lighting is always has been an important factor in designing and operating environment for learning because its influence on interacting parameters on the indoor environment quality (Plymton et al., 2000; Benya, 2001). However, some level of measurement is appropriate and in accordance with the recommended standards such as SS1 in the library of LIB 2 and LIB 3, SS2 on LIB 1, SS3 in the library LIB 1 and LIB 3 and SS4 on LIB 2. However, based on researcher observation, there were still students' uses the place which is not in a good range of lighting conditions.



Figure 3: Lighting illuminance level according to area of measurements at different study places in three (3) academic libraries and level of standards by SIRIM MS ISO 8995:2005. Source: H.Hambali, S.Sufar,A.Talib & M.N.Aziz (2012)

5. Result and Analysis

Based on this research, it can be concluded that:

- The suitability of lighting illuminance levels in the various study space in the three (3) academic libraries were vary widely ranging from very poor lighting conditions to very good condition. Condition of very poor lighting levels visible from the low lux reading compliance to the measurement results of the standard used. The greater or closer of the measurement point to the lux reading compliance, thus its perceived the good lighting conditions in the room.
- There are many lighting conditions found inadequate and not in accordance (exceeds) to the measurement points: The problem were identified as:
 - i. Lack of good light distribution in the library. This can be caused by the layout of study table in the library not correspond to the position of the light source.
 - ii. The suitability of types of lamps used so that the intensity of light or lumens produced by light is not able to provides good lighting.
 - iii. Lack of suitability of percentage of WWR (wall window ratio) especially for the study area that gets illumination from the natural lighting which cause glare that affect the activity of students and there's no shading device such as blind/curtain provided at certain study spaces.
 - iv. Lack of lighting source from natural lighting which causes the room looks gloomy and no sense of wellbeing (should be considered 2 source of lighting: natural and artificial lights).

Lighting is one of the most important parameter in achieving the Indoor Environment Quality (IEQ) for library study space. The finding from the measurement shows that, the light settings were not within the range of Malaysian Standard MS 1525:2007 in certain study spaces, but according to the interview survey, the students perceived it as normal (good) and do not hinder them to stay longer and study in the library. Unfortunately, this situation will affect the student ability to perceive visual stimuli in a short term and health in terms of students' vision in a long run.

CONCLUSION

According to H.Levin, (1996), in designing of indoor environments, especially in lighting design, the designer should take responsible steps to minimise the occupant discomfort, irritation, and illness. One of the most significant parameters in achieving the Indoor Environmental Quality (IEQ) is lighting design in the buildings. This study

should be carried on and step forwards can be applied others related issues arousing the comfort level in library area, so that planning and corrective measure can be implemented. It will help the service provider to learn about their customer's expectation and subsequently shape the delivery of services appropriately. In providing quality environments for learning and research, academic libraries need to monitor and maintain their services in terms of maintenance of interior lighting in order to fulfill the user needs. The building maintenance library should conduct on inspection of the appropriate lighting levels regularly. Hence, Lighting engineers and Designers should collaborate on designing lightings and interior design in early stage of design phase especially in determining the illumination lighting (lux) of each study space in library.

As for further studies, the researcher intended to highlight on other comfort levels issues on temperature, humidity and noise and acoustical levels in especially academic libraries in Malaysia scenario.

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