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ASSESSING SICK BUILDING SYNDROME IN PERPUSTAKAAN SULTANAH ZANARIAH (PSZ) LIBRARY: TOWARDS IMPROVING HEALTH AND PRODUCTIVITY IN INDOOR ENVIRONMENT

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Abstract
Sick Building Syndrome (SBS) is one of the leading negative attributes associated with the Indoor Environmental Quality (IEQ) of buildings. This paper studies the SBS inPerpustakaan Sultanah Zanariah (PSZ) library building in Universiti Teknologi Malaysia (UTM). The five parameters studied are: Indoor Air Quality (temperature; ventilation and humidity); lighting; noise; furniture ergonomics; and Video Display Unit (VDU). The methodology used was more of a triangulation approach. The survey uses questionnaire and several "walkthroughs". Data analysis was both qualitative (descriptive) and quantitative (statistical). The students constituted the respondents for this study. Perception of students towards the five SBS sources and their accompanying symptoms were studied. Results obtained in the study revealed that PSZ is established to being a sick building, indicating that 21.89% of students suffer from the specific SBS symptoms and 29.67% of students suffer from the general SBS symptoms. Secondly, it was establish from literature that by employing the sustainability concept, significant improvement between the SBS sources (lighting, noise, furniture ergonomics and VDU etc), and students performance satisfaction could be enhanced. This confirms that IEQ variables are significantly positively related to student's performance, and those extremities of such variables lead to effects in performance satisfaction. The study proposes a strategy that is: feasible, physically practicable and cost effective, to continually improve the IEQ status of PSZ from its present state as perceived by students.

Keywords: Sick Building Syndrome, Indoor Environmental Quality, Performance and Cost Effective

1. Introduction

Sick building syndrome describes a range of health problems that can occur through exposure to the pollutants inside a home, office or other building. Sick building syndrome is usually related to indoor air quality, and can be caused by mold, radon, smoke or any number of chemical pollutants. Current trend nowadays view SBS holistically both from occupants' perspective to that of a building operating life cycle. In the quest to investigating parameters that affect a building occupant's comfort in recent times, most facilities where human beings cohabit are not left out. For example, Vasiliki and Costas (2004) researched on SBS in an air traffic control tower; Cynthia and Megan (2007) conducted their research in schools; Sui *et al.* (2008) conducted theirs in worker dormitories. From all these, more awareness is sought out for to the continual improvement on SBS factors that affect a building occupants comfort directly or indirectly thus optimizing productivity in any given task.

SBS problems can be localized for instance, it may be experienced by occupants in only one section of a building or it could be widespread and experienced throughout an entire building. As such, SBS refers to any building having disagreeable or unacceptable environmental characteristics. According to Stephen *et al.* (2008) the United States Environmental Protection Agency (USEPA, 1993), defines SBS as "situations in which building occupants experience discomfort and acute health effects that appear to be linked to time spent in building". Tomoko *et al.* (2009) asserts that SBS is a constellation of health problems whereby building occupants suffer from a variety of non specific subjective symptoms.

A libraries' core activity is reading and research. Students/library users constitute the major occupants in any library setup. In the main library of Universiti Teknologi Malaysia (UTM) otherwise termed **Perpustakaan**

Sultanah Zanariah (PSZ), a substantial amount of time is spent by students. Jack (2008) asserts that SBS is a leading negative factor to a building that causes widespread loss of productivity amongst occupants. Upon having a dialogue with the management of PSZ, it becomes obvious that SBS's degree/extent of prevalence amongst the students remains unknown, hence the need for conducting this research become necessary to investigate students' perceptions on SBS as it relates to IAQ; lighting; noise; furniture ergonomics; and Visual Display Unit (VDU) for the sustainability of the built environment.

According to Craig *et al*. (2007), up to 30% of the world's buildings are sick and adversely affect the health of people who live or work in them. SBS is now widely recognized throughout the world. Despite decades of investigation and increasing scientific research on SBS symptoms in buildings, the problems still persist. SBS concerns and complaints transcend national borders and it is considered to being one of the key negative health aspects of a building. SBS grew out of proportion to being a serious environmental issue in Europe and the U.S. in the 1980s and in Asia in the 1990s (Wan and Jang, 2009). It was then evident that a buildings comfort level assessments played a critical role in influencing the performance of occupants. As such, it was established in researches (such as Vasiliki and Costas, 2004; Sanjeev*et al.*, 2007; Tomoko *et al.*, 2009) that improving a buildings indoor environmental conditions had a great impact in optimizing the productivity of its occupants.

Even though SBS may not cause any serious damage to health, it may however result to potentially problematic consequences to a building occupant (The Lancet Newsletter, 1997). This signifies the more uncomfortable a buildings indoor environment, the more prone for a drastic drop in human performance. As has been seen from the several researches conducted in school libraries, their methodologies might differ but the whole focus was SBS consequences. However, SBS researches of such were predominantly carried out on library staff (like works of Morris and Dennison, 1995; David, 1998; Reginald, 2002) whereas that on students lags behind.

2. Literature Review

The built environment is a man-made surrounding. As such, a harmony must be achieved at every given time between all the relationships of human activities that take place within an indoor environment. Bluyssen (2010) assert that a healthy building finds value in optimizing the health and well-being of its occupants through measures that increases morale and productivity. According to Ho *et al.* (2004), a healthy building is characterized by:

a) Not being too densely populated;
b) It should be isolated from noise and air pollution sources; and
c) Its environmental conditions should be clean and healthy.

Any building that does contrary to such is considered to being a sick building. Andrew and Michael (2009) assert that any building that infringes the comfort of its occupants in one way or the other is considered to being a sick building. Such buildings constitute an unhealthy environment for those working or residing within and are specifically noted to harbouring complaints covering non specific feelings of sickness. According to Wan and Jang (2009).

2.2 Sustainable Design for Health Benefits

Sustainable design is a collective process whereby the built environment achieves ecological balance in new and retrofit construction toward the long-term viability and humanization of architecture (Loftness et al., 2007). In an environmental context, this process merges the natural, minimum resource-conditioning solutions of the past (daylight, solar heat, natural ventilation) with the innovative technologies of the present into an integrated "intelligent" system that supports individual control to achieve environmental quality with resource consciousness. (Loftness et al., 2005).Based on their study of 'elements that contribute to healthy building design', they itemise the following factors as contributing to sustainability for health benefits of high-performance buildings;

Healthy, sustainable air; This component depends on commitments to improve the quality and quantity of outside air, maximize natural ventilation with mixed-mode heating, ventilating, and air-conditioning (HVAC) systems, and separate ventilation air from thermal conditioning, provide task air and individual control, and improve pollution source control and filtration. International case studies have demonstrated that high-performance ventilation strategies reduce respiratory illness 9–20%and increase individual productivity between 0.48 and 11%, with a small energy cost for increasing outside air rates with heat recovery, or 25–50% energy savings for natural ventilation and mixed-mode conditioning (e.g., Fisk and Rosenfeld 1997; Kroeling et al. 1988).

Healthy, sustainable thermal control; This second component depends on commitments to separate ventilation air from thermal conditioning design for dynamic thermal zone size, provide individual thermal controls (e.g., under floor air), design for building load balancing and radiant comfort, and engineer prototyped,

robust systems. International case studies demonstrate that providing individual temperature control for each worker increases individual productivity by 0.2–3% and reduces sick building syndrome (SBS) symptoms and absenteeism, while saving 25% of conditioning energy (e.g., Wyon 1996).

Healthy, sustainable light; The third component can be achieved by maximizing the use of daylight without glare, selecting the highest quality lighting fixtures, separating task and ambient light, and designing plug-and-play lighting with dynamic lighting zones. Case studies demonstrate that improved lighting design increases individual productivity between 0.7and 23%, reduces headaches and SBS symptoms by 10–25%, while reducing annual energy loads by 27–88% (Heschong et al. 2002*)*.

Workplace ergonomics and environmental quality; Improving this fourth component has, as its goals, the well-being and efficiency of individual workers with energy-efficient technologies; optimal lighting, temperature, and placement of furniture; and healthy interior materials. Sustainable design depends on the use of materials that support healthy environments while reducing transportation energies that carry secondary health concerns. Material selection is critical to thermal performance, air quality and out gassing, toxicity in fires, cancer-causing fibres, and mold, all which affect respiratory and digestive systems, eyes, and skin (Dainoff 1990*)*.

Access to the natural environment; The fifth component is achieved by providing individual access to nature by maximizing the use of daylight without glare, maximizing the use of natural ventilation with mixed-mode HVAC, and designing for passive solar heating and cooling. Access to the natural environment may increase in dividual productivity between 0.4 and 18%and reduce absenteeism, SBS, and recovery time while saving even 40% of lighting energy (Centre for Building Performance and Diagnostics/Advanced Building Systems Integration Consortium 2005).

3. Methodology

The methodology involves examining a sample of occupants (students) in the academic library on parameters relating to IEQ. Questionnaires were used as the major tool to gathering data for this research. A total of 265 questionnaires were distributed and a total of 234 (about 88 percent) were successfully retrieved in the field survey conducted in the study. Concurrently to such data gathering technique, some physical observations were used, by conducting several "walkthroughs" and deducing observations in PSZ.

From findings obtained from the field survey using SPSS, data were analyzed presented statistically. The findings seek to establish whether or not PSZ is a sick building. The associations/relationships were also established between SBS sources, SBS symptoms and students performance satisfaction, which is aimed at yielding significant results. Simple statistical method was used to analyze and interpret the data. Subsequently, significant associations/relationships were established through correlating the several SBS constructs studied. Self-estimated scales were used from results of the questionnaire to quantitatively analyze the opinion of students concerning the internal environmental comfort of PSZ as it relates to SBS symptoms.

4. Result and Analysis

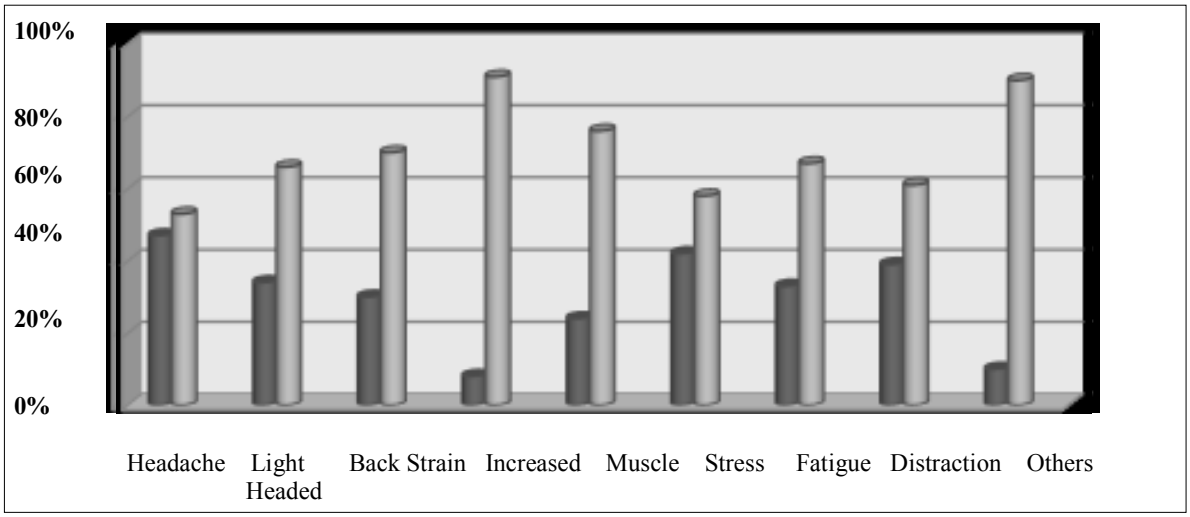

Fig 1. General SBS symptoms variable rating (Authors field work 2011)

Figure1. Results for the general SBS symptoms in an ascending order indicate that more respondents experience headache (47%), then stress (42%), then lack of concentration (39%), then feeling heavy headed (34%), then fatigue/tiredness (33%), then muscle strain (24%) and then increased blood pressure (8%). Ten percent of the respondents also confessed to experiencing other SBS related symptoms other than those aforementioned. For the "general SBS symptoms", the overall proportion of respondents that attested to experiencing such in this study is 29.67%. These SBS symptoms are by products of the several SBS sources studied.

Table 1: Specific SBS symptoms rating (Authors field work 2011)

SBS SYMPTOMS	AREAS AFFECTED	RATING (%)
Eyes	Itching/ irritated eyes	33
	Eye strain	27
	Wattery eyes	26
Ears	Ear irritation	23
	Mental Stress	21
	Dizziness/ Drowsiness from noise	6
Nose	Itching/irritated nose	33
	Blocked or stuffy nose	27
	Congested/running nose	21
Throat and Chest	Itching/irritated throat	28
	Sore throat/cough	21
	Chest tightness	19
	Breathing difficulty	17
	Flu like symptoms	15
Skin	Itching/irritated skin	28
	Skin rashes	14
	Dry skin/redness symptom	13

With respect to the specific SBS symptoms, the following can be deduced from the table 1 above:
a. Eyes: More respondents experience watery eyes (33%), then eyestrain (27%) and then itching/irritated eyes (26%).
b. Ears: More respondents experience dizziness/drowsiness from noise (23%), then mental stress (21%) and then ear irritation (6%).
c. Nose: More respondents experience blocked or stuffy nose (33%), then congested/running nose (27%) and then itching/irritated nose (21%).
d. Throat and chest: More respondents experience flu like symptoms (28%), then sore throat/cough (21%) then itching/irritated throat (19%), then breathing difficulty (17%) and then chest tightness (15%).
e. Skin: More respondents experience dry skin/redness symptom (28%), then itching/irritated skin (14%) and then skin rashes (13%).
With all such however, the overall (total) proportion of respondents that attested to experiencing the 17 "specific SBS symptoms" covered in this study are 21.89%.

Watery eyes and blocked or stuffy nose shows the highest scores of 33% and these are vital to the users' productivity and could hinder students' performance satisfaction. Which confirm that, IEQ variables are significantly positively related to student's performance, and those extremities of such variables lead to effect in performance satisfaction.

5. Conclusion

Results obtained in the study reveal two things. First, PSZ is established to being a sick building from the results showing that 21.89% of students suffer from the specific SBS symptoms and 29.67% of students suffer from the general SBS symptoms. These results comply with assertions made by Thad (1995), Ertugrul *et al.*, (2004) and Thomas *et al.* (2005). Secondly, it is established from literature that, by employing sustainability concepts positive significant improvement could be achieved between the other SBS sources (lighting, noise, furniture ergonomics and VDU etc), SBS symptoms and students performance satisfaction. These findings comply with researches of Oseland (2004, Ertugrul *et al.* (2004), Nyuk and Wy (2002) and Morris and Dennison (1995) which confirm from correlation analysis that IEQ variables are significantly positively related to students' performance, meaning that extremities of such variables lead to an effect in performance satisfaction.

Both the SBS sources and their accompanying symptoms are in-exhaustive. As such, other studies of SBS symptoms related to Volatile Organic Compounds (VOC's) and psychological factors can be conducted.

Due to the positive significant correlations obtained in this study, more vulnerable areas relating to SBS in educational institutions (laboratories, lecture rooms/theaters) and/or other facilities may be explored in future. Furthermore, research using benchmarking mechanisms can be done to designing and/or formulating IEQ and/or SBS continual improvement guidelines/strategies. Also, a more in-depth study if conducted may reveal BRI related results that are diagnosable.

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