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Green buildings: a hype?

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Abstract. There is a consensus that green buildings have better building performance compared to conventional buildings. Whilst previous research has established the benefits of green buildings, it has been argued that this benefit might have been over exaggerated due to the evidence of dissatisfaction in green buildings performance. Thus, this calls for a research on occupants' satisfaction on green building's performance. An observation performed on ZEO building occupants indicated that the building occupants were moderately unsatisfied with the building's performance. This research adds to the growing body of literature and contributes to the understanding of academia and practitioners on green buildings. in constructing both.

1. Introduction

The environmental challenges that human beings need to face are climate change and adaptation to global warming. Human activities such as deforestation and burning of fuel for energy have also affected the destruction of the environment. The issue of global warming and climate change is getting worse, but there are some who are interested in developing sustainable development. This is because the construction industry is considered as a major contributor to climate change. Building is the world's largest source of energy demand which uses 40% of primary energy worldwide, ¼ of global greenhouse gas emissions. Commercial buildings represent one-third of total energy use by buildings (International Energy Agency, 2006).

According to the American Institute of Architecture (AIA, 2000), the construction industry is seen as the largest source of emissions and energy consumption in the United States and around the world. More professionals have begun building green buildings in order to obtain highly reputable certifications and awards for structure, innovation and initiatives to preserve the environment. Han et al (2009) states that green sustainable buildings are synonymous with high-performance buildings due to energy crisis, global warming and other environmental effects. It has been a fast-moving actor around the world in recent years.

Green development is undeniable that it can reduce environmental impact compared to conventional development methods that use materials that can endanger the environment. Studies show that the use of green building energy (20-34%) is higher than conventional buildings (Turner and Frankel, 2008). Additionally, one study has also reviewed by Leadership in Energy and Environmental Design (LEED) shows that 28-35% of LEED buildings have greater energy consumption than conventional buildings (Newsham et al, 2009). Circo (2007) has also revealed that maintenance costs



for energy-efficient buildings are higher than conventional buildings due to the cost of energy-saving facilities, management and eco-friendly materials.

An international organization, the World Green Building Council (WorldGBC) was established to influence the green building market. It is a network of greenhouse councils, comprising of 100 countries that have an important role to assist, support and influence the development of green buildings around the world. WorldGBC also promotes green building initiatives and addresses environmental issues such as reducing carbon emissions and climate change.

The Summit of Earth in Rio, Brazil in 1992 was one of the major international efforts to bring sustainable development into the mainstream. Some real estate companies in Malaysia are seen as leading sustainable property agendas, although real estate companies in Malaysia have room for improvement to align themselves with international best practices in sustainability (Newell & Manaf, 2016). In 2009, the Malaysian Government together with the Malaysian Architects Association (PAM) and Association of Consultants Malaysia (ACEM) have launched an environmental rating system called Green Building Index (GBI) for commercial and residential properties to promote green culture among industry in the country in response to enhancing environmental sustainability at the same time developers are encouraged to design and build properties that lead to energy and water efficiency, sustainable site planning and management, environmental quality and innovative processes under the framework of assessment.

In addition, the National Green Technology Policy has also been introduced. The aim of the National Green Technology Policy was to reduce energy consumption, to assist in the growth of Green Technology in the industry, to enhance innovation capabilities and competitiveness in the development of Green Technology in the international arena. It includes ensuring sustainable development and conserving the environment for the benefit of the next generation and raising the public's awareness of green technology and further promoting the use of Green Technology extensively (Ministry of Energy, Green Technology and Water, 2011). The government also highlights buildings and promotes renewable energy and energy efficiency in buildings such as rainwater harvesting, solar photovoltaics, and practicing green building indexes (Chua & Oh, 2011). In other countries there are also four major green building system rating BREEAM (UK); LEED (USA); Green Star (Australia); and Green Mark (Singapore). In addition, from an investor's perspective, there are several ways in which energy efficiency can affect financial assets. This is in relation to higher income (premium rent), reduction cost (lower operating expenses, lower vacancy rate) and reduced risk (Fuerst & McAllister, 2011).

2. Occupants Satisfaction

The concept of green building, in broader terms, involves building, designed, constructed, operated, maintained or reused with the purpose of protecting the health of the occupants, enhancing employee productivity, utilizing natural resources wisely and reducing the environmental impact. In other words, the green construction process combines environmental considerations in the building construction stage. The process focuses on the design, construction, operation and maintenance phase and takes into account design and building efficiency, energy and water efficiency, resource efficiency, environmental quality, building maintenance and overall environmental impact (Simons et al, 2014).

The concept of green building was developed to incorporate the concept of sustainability into the building sector. Although there is no fixed term on the term 'green building', it is generally referred to buildings that are certified by green building evaluation schemes such as BREEAM (UK); LEED (USA); Green Star (Australia); and Green Mark (Singapore). Green buildings are usually designed and operated to be more environmentally friendly and energy-efficient (Kim et al, 2016). The rating system's structure consists of five categories: sustainable sites, water efficiency, energy & atmosphere, materials & resources, and indoor environmental quality (IEQ) (USGBC, 2002).

A survey by the United States Green Building Council shows that many of its members believe that sustainable building designs will become more common practice when human benefits are identified (Heerwagen, 2000). Understandably, human benefits should be a hot issue for the study of green buildings (Reeder, 2010; Sighn, Syal, Grady, & Korkmaz, 2010). Therefore, the comfort and satisfaction of the dwellers should be assessed to be the foundation of a healthy and productive

building. Although green buildings are a better building than non-green buildings, some green building occupants may experience discomfort or dissatisfaction (Zhonghua et al., 2013). There is no study that focuses on green buildings and its effects on occupants. On average, residents work at least 5 days a week and 8 days a day in the building. Conflicts identified highlight the limitations of existing knowledge about the relationship between green building performance and the comfort and satisfaction of the occupants.

New technologies have been developed that enable firms to dramatically reduce environmental impact. Whereas for the independent rating system, third parties have emerged to provide stakeholders interested in transparent evaluation and compliance certification with best practices on building design, construction, and energy efficiency.

The most obvious benefits of investment in green building designs in relation to reduced energy use (Harrison & Seiler, 2011). Additional benefits to green buildings have also been found in relation to increased employee productivity, strategic positioning and branding or marketing. This multi-tenant facility, creating the potential of coordination and enforcement of issues that may limit the flexibility of future tenants and the risk of accreditation status within the building. With regard to maintenance concerns, Addae-Dapaah et al. (2009) reported that 83 percent of sample building users in Singapore showed lack of faith in the long-term effectiveness of green products and initiatives, while 75 percent took into account the uncertainties in the reliability of renewable sources of major barriers to the use of green building technologies.

In addition, intangible benefits are classified into social and environmental benefits, such as reduction of carbon dioxide, greenhouse gases and chemical discharges, as well as solid waste. Another great benefit of investing in green properties is an increase in health and productivity. Thus, returns cover three aspects of environmental, economic and social performance (Mona et al., 2013). According to Nazir (2013), benefits derived from green building can be seen through three aspects namely economic, social and environmental. Table 2.1 explains the advantages of green building on three aspects.

The report by Lawrence Berkeley Laboratory and Capital E Group reveals the fact that actions that have a positive impact on employees' comfort, productivity and health can result in greater financial gains than construction and operating costs. A survey by the United States Green Building Council shows that many members believe that sustainable building designs will become more commonly practiced when human benefits have been identified (Heerwagen, 2000). Indeed, the benefit of mankind must become a hot issue for research on green building (Reeder, 2010; Sighn, Scarf, Grady, And Korkmaz, 2010).

3. Methodology

Questionnaires were designed based on theoretical review on green building benefits and distributed to 85 occupants of GreenTech Malaysia. The questionnaire consisted of two sections, Section A and Section B. Section A sought to obtain information pertaining to the respondents' background which include age, gender, years of work experience, educational background and work position. Meanwhile Section B comprised of questions on the factors affecting the level of satisfaction of occupiers in GreenTech Malaysia.

Respondents were required to select a number between one and five to reflect their opinions for green building factors affecting level of satisfaction listed in the questionnaire. Five options categorised from 'strongly dissatisfied' to 'strongly satisfied' represent positive and negative views of respondents. This method followed the Likert scale method, a technique developed by Likert (1967) to seek the views of respondents on a particular subject. Data obtained from the questionnaires were compiled and analysed using IBM SPSS.

4. Results and Discussion

Out of 85 distributed questionnaires, 77 questionnaires were completed by the respondents and used for analysis.

4.1. Respondents Background

Through 77 sets of questionnaires distributed at the location of the study, it was found that 44.2% of respondents were male respondents meanwhile 55.8% were female respondents. An analysis of the age of respondents found that the most populated GreenTech residents were in the age range of 31 to 40 years, which was 27.7%. Residents aged 20 to 30 represent 28.6%. 23.4% and 10.4% respectively were registered by the occupants of 41 to 50 years old and 51 years old. Majority of building occupants worked within 5 years and below at the GreenTech Malaysia building of 66.2% while 5 to 10 years of 29.9% and 3.9% worked over 10 years and above. Most of the respondents are executives reflected in their level of education where 51.9% of them hold a bachelor’s degree. Several respondents (1.3%) also hold a PhD. Meanwhile the rest are Diplome and SPM holders. In terms of work scope, there is almost an equal proportion of respondents coming from Technology and Innovation Department, Low Carbon Mobility Department, Smart Sustainable Cities Department, Sustainable Energy and Green Advisory Department and Green Catalyst Department. The highest and lowest number of respondents came from support services (22.1%) and administrative (6.5%) departments respectively.

4.2. Occupants Satisfaction

Overall, most respondents (96.1%) are satisfied with the comfortness of the building occupied. Only 3.9% of the respondents were uncomfortable working in GreenTech Malaysia building. A further analysis on the elements that affects their satisfaction are provided in the table below:

Table 1. Green Building Benefits and Level of Satisfaction

Scale Category	Index Range	Level of Satisfaction	Ave. Score
Very Satisfied	3.31 – 3.42	Employment Productivity	3.38
		Health	3.38
		Rainwater Harvesting	3.35
		Noise Level	3.16
Less Satisfied	3.07 – 3.18	Privacy / Personal Space	3.13
		Use of Eco-friendly Goods or Equipment	3.13
		Lighting	3.09
Not Satisfied at All	2.95 – 3.06	Ventilation	2.95

Based on Table 1, employment productivity, health and rainwater harvesting are the most beneficial elements to the occupants. Despite the increase in productivity and health, the occupants do not enjoy the element of privacy and the use of eco-friendly goods or equipment and lighting are less satisfactory. Finally, the main cause for dissatisfactory in the building was found to be ventilation.

4.3. Correlation Analysis

Correlation Analysis is used to identify the factors that most influence each element of satisfaction level. Table 2 shows the correlation between 8 elements of the level of satisfaction of building occupants and the factors that influence the level of satisfaction of GreenTech Malaysia occupants.

Table 2. Correlation Analysis

Level of Satisfaction	Factors	Correlation Value
Employment Productivity	A conducive environment allows employees to increase productivity in their work	0.609
	Surroundings workspace makes employees to be more creative and to maintain the quality of work at its best	0.276

	Workspace has eco-friendly environment makes employees feel healthier and more active	0.403
	Buildings are built with eco-friendly materials, so employees are less likely to be infected with any diseases	0.511
Health	A healthy environment has made the reduction taking sick leave	0.486
	Reduction of sick leave has resulted in lower hiring of new workers	0.301
	Computer glare reduces worker focus on the screen for a long time	0.271
	Reducing the glare prevents workers from eye illness	0.196
Rainwater Harvesting	Buildings provide the re-use of rainwater, so it's a good action in the reduction of the use of tap water	0.751
	Rainfall harvesting has prevented the wastage of water in this building	0.809
Noise Level	Has less noisy environments and can give attention to work well	0.406
Privacy / Personal Space	Providing good privacy and non-interference from any interruptions during work	0.291
Use of Eco-Friendly Goods or Equipment	Most equipment materials are made of volatile compounds (VOCs)	0.388
	The use of eco-friendly equipment taken from sustainable resources and recycled	0.360
	Good natural lighting allows occupants to perform well	0.314
Lighting	Energy efficient electric lighting and sophisticated facilitate occupants to complete the work more effectively	0.472
	Good glare reduction in the workspace makes the occupants to easily perform work	0.341
	A good ventilation system makes occupants more comfortable to work in this building	-0.008
	Sufficient natural ventilation allows occupants to focus more on the work	-0.08
Ventilation	Sophisticated ventilation and mechanical systems have made the atmosphere of the workplace healthier and refreshing	0.625
	The occupant's workplace provides internal cultivation, so residents have fresh air to breathe	0.288
	Workplace provide the best indoor air quality, so it allows occupants to breathe comfortably	0.585
	Good indoor air quality makes the occupants able to focus on work	0.520

According to the elements that get the highest score in a satisfied ranking for example employment productivity element, the factor that affects the level of satisfaction of GreenTech Malaysia's occupants is a conducive environment enabling employees to increase productivity in work with a 0.609 correlation value. For the highest score with the same score as the employment productivity score, health, the strongest correlation value of 0.511 indicates that most occupants think they are less likely to be infected with any illness as buildings are built with eco-friendly materials.

There is clear evidence that the health and productivity of the occupants have a positive correlation with comfort and satisfaction (Leaman and Bordass, 2001).

Many GreenTech Malaysia occupants agree that re-use of rainwater has avoided the wastage of water in this building with the strongest score of 0.809. In terms of privacy, most occupants argue that their workplace has less noisy environment and can pay attention to their work with a correlation value of 0.406. The providing good privacy and non-interference from any interruptions during work is also among the occupants' opinions on privacy satisfaction of having a correlation value of 0.291. In terms of the use of eco-friendly goods or equipment, with a correlation value of 0.388, many occupants agree that the factors affecting the level of satisfaction of the occupants are that most of the material is made of volatile compound (VOC). With the strongest correlation value of 0.472 for lighting elements, GreenTech Malaysia occupants feel that energy efficient and sophisticated lighting facilitates occupants to work more effectively.

Finally, the ventilation element is the element that gets the lowest rank. However, the ventilation element has the strongest correlation value of 0.625, many occupants agree that sophisticated ventilation and mechanical systems have made the atmosphere of the workplace healthier and refreshing. However, most occupants feel that inadequate natural ventilation has made them less focused in the work done according to the correlation value analyzed -0.080. So, it is concluded that they are satisfied with ventilation in terms of making the environment a healthier and refreshing environment, but the ventilation does not help them focus on doing their job.

5. Conclusion

Overall, this study has determined the elements of satisfaction level and the factors influencing the level of satisfaction of the residents of GreenTech Malaysia Building. The most satisfying elements of satisfaction level by occupants of GreenTech Building Malaysia were employment productivity and health elements. This clearly demonstrates that GreenTech Malaysia's building management is concerned about the productivity of their employees' work and health so many occupants of the building are satisfied with these elements. However, the indoor ventilation system is not in good condition as many occupants are unhappy with the ventilation system. Hence, the GreenTech Malaysia building management should do something to alleviate indoor ventilation systems problems and thus ensure the comfortness of all building occupiers.

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