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USER PERCEPTION OF ENERGY CONSUMPTION IN TWO HIGH-PERFORMANCE SCHOOL BUILDINGS

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Abstract - Today, environmental pollution is a significant challenge for the world. The need to find solutions in the construction sector has been developed. However, the resulting value is strongly influenced by environmental factors, location, and climate. Expected energy demand in 2030 will reach as much as 40% compared to 2007. Malaysia recorded a 31.2% increase in energy consumption for the years 2000 to 2010. Referring by World Markets Observatory (WEMO) on 2017 report shows the increasing by 4.8% on 2030 for Malaysia's energy usage (Yunus, 2017). To address the rising energy that directly affects the problems of urbanisation, and climate change, factor energy efficiency should be a critical action. The implementation of energy-efficiency policies can also improve the quality of life and reduce the impact of environmental pollution. One of the factors that significantly influence energy-efficiency in a building is user behaviour. According to Schipper and Meyers,a decision that made by human can affect energy consumption in a building(Lutzenhiser, 1993). Thus, the key to the energy consumption pattern in the future is to understand and identify the practical methods for managing user. However, based on Ron Widman study, there are relatively few studies that are related to user behaviour and energy toward building an institution. While Power Save School Program expects a reduction of 5% to 15%,this can only be achieved by changingin user behaviour in school(Widman, Simmons, Kaplan, & Young, 1984). This study aimed to investigate the perception of a user to use energy in building two high-performing schools in Malaysia. 140 questionnaires were distributed to the two schools with 70 polls for each school. Respondents who were involved comprised of students and teachers with 86% of students and 14% of teachers. A survey conducted referring to the three top factors influencing energy efficiency in buildings, namely: 1) Building Design, 2) Services Design and 3) User Behavior. The results from the analysis conducted by three essential user perceptions; Perception of Building Design (PBD), Perception Services Design (PSD) and Perception User Behavior (PUB) haveshown there is a relationship. The study also illustratedthe monthly energy consumption data for three years until 2014. The floor area around the building has been used in deriving the energy index of the building.
Keywords - User Behaviour, Energy Efficiency Building, And School Building

1 INTRODUCTION

Environmental pollution has become a significant challenge to all countries in the world. The level of pollution has been proven to increase daily at an alarming rate. The impact of this increase in pollution directly increases the need to find solutions in the construction development sector. The issue of greenhouse gases and the depletion of ozone layer were discussed at The 21st Agenda of the Earth's Agenda formulated from the United Nations Environment and Development Conference (UNCED) which took place in Rio de Janeiro in 1992.

Since then the green building assessment tool has begun to develop which resulted in the creation of BREEAM (The UK, 1990) and LEED (The USA, 1996). This assessment tool aims to reduce the negative impact of the environment contributed to the building through greenhouse gas emissions. The resulting evaluation criteria are intended to assist designers, customers and communities to consider the impact of greenhouse gases through each of the designs produced and their solutions through energy efficiency and low carbon technology. However, this assessment tool is profoundly influenced by location and environmental factors (Mun, 2009).

Energy Efficiency is a crucial factor for a green building assessment tool. However, green buildings do not use the same method to measure energy efficiency. Green Building is a term commonly understood as Green Building or Sustainable Building (Peterson, 2010). Although it is a process for the establishment of a Sustainable Development (Salleh, 2012),Green building criteria includes focusing on improving the efficiency of energy, water and building materials and reducing the impact of buildings on human health and the environment throughout the life cycle of buildings, through placement, design, construction, operation, maintenance, addition and modification, and destruction (Sanchez, 2008).

In Malaysia, practical green building in the supervision of Greenbuildingindex Sdn Bhd (GBISB) is based on six (6) criteria; Energy efficiency (EE), environmental quality (EQ), sustainable site planning and management (SM), building material and resources (MR), water efficiency (WE), and Innovation (IN).GBISB has developed six (6) types of measurement tools for buildings and a categorised measure for urban development (Mun, 2009). Influence of green buildings in Malaysia is undoubtedly due to the growing trend of efficient green building in the world by most governments, construction industry members, academics, researchers and the general public which havealso grown as a long-term business (Malangone, 2015).

2 ENERGY EFFICIENCY

The term Energy Efficiency is a generic one. In other words, it can also mean the efficient use of energy. Energy efficiency refers to low energy consumption but at the same time yields the same or better value (M.G., 1996). There is also an opinion that energy efficiency means energy conservation as it refers to the same meaning. Energy conservation refers to the user of low energy that isthe same as energy consumption (Kandar, Ahmad, & Ariffin, 2009). Meanwhile, the use of the term Energy Consumption illustrates the amount of energy used. There is a close relationship between the terms whose focus is interconnected against energy consumption towards efficient use.

The issue of green building is closely related to the increasing demand of the world's energy. Asevidenced inthe International Energy Agency's (IEA), it estimates that the increase in energy by 2030 will reach 40% higher than demand in 2007 (González, Díaz, Caamano, & Wilby, 2011). The increasing of energy is caused by three significant sectors of world energy consumption; Industry, transportation and others (including residential buildings). Other sectors which include buildings recorded the most considerable value of 36% compared to 28% for the Industry and 27% for transportation for energy consumption in 2008. While energy consumption in buildings (residential, commercial, office) has been identified to account for 20% to 40 % of total world energy consumption(R. Saidur, Saidur, Schipper, & Saidur, 2009).

However, Energy consumption in Malaysia is not the cause of this increase. It is considered an ordinary situation experienced by developing countries in meeting the needs of the state in improving their living standards. Indeed, the increased energy used will increase the amount of greenhouse gas (GHG) emissions (R. Saidur et al., 2009). Malaysia which recorded a 31.2% increase in electricity consumption for ten years from 2000 to 2010 has intensified the energy efficiency initiatives. This is a string of final energy demand forecasts which is projected to increase by almost 80% by 2030 (Unit Perancang Ekonomi, 2006).

Recently, a progressive step has been taken through the Department of Works (PWD) Malaysia,whereit is given theresponsibility to design and implement development projects by focusing on energy efficiency and green value in government buildings as an agenda. It is in line with Malaysia's target of reducing 40% of greenhouse gas emissions by the year from 2005 to 2020(Rashid et al., 2011). As one of the steps towards energy efficiency, the government has enacted the temperature of the building innot less than 24 degrees Celsius (Bernama, 2011). The Tenth Malaysia Plan outlines five approaches to reduce energy subsidies under the TS2.6 New Energy Policy.

It encompasses five main points: 1. Rationalizing energy prices, 2. Diversifying energy resources, 3. Enhancing initiatives of energy efficiency, 4.Improving governance and 5.Ensuring New Energy Policy implemented. As a determinant towards green building production and

subsequent sustainable development, thisis neededinemphasising theenergy issues in buildings through energy efficiency design.

This is evident in the United Nations Development Program, the United(Filippin, 2000). Nations Environment Program, and the World Bank where the Global Environment Facility (GEF) was established in183 countries aspartnership with international institutions, civil society organisations (CSOs) and the private sector toaddress theglobal environmental issues.

Through the grants from GEF, a Scientific and Technical Panel (STAP) has been formed and is known as the Building Sector Energy Efficiency Project (BSEEP). The goal of the department was to reduce GHG emissions from the building sector in Malaysia. The objective is to increase the energy efficiency of buildings in Malaysia, in the trade and government sectors, and to promote the design of energy conservation in new buildings and by upgrading operations in existing buildings (UNDP, 2015).

3 USER BEHAVIOR

The increase in global warming caused by climate change as a result of greenhouse gas emissions has resulted in the depletion of the ozone layer and subsequent destruction of natural habitats and loss of biodiversity. The effect of increasing energy consumption is one of the factors that affect the heat. Energy consumption in buildings has been identifiedincontributing to 40% of the world's energy consumption, 25% of the world's water and 40% of the world's resources. The building is also recorded as a 1/3 greenhouse gas emissions of the world which resulted from its use. However, the building also has the potential to reduce its energy use by 30% and 80% (United Nation Environment Programme, 2007). Today the value of its use is continuously rising which is in line with development and modernity especially in developing countries such as Malaysia.

The impact of this increase which is a significant cause of global climate change should be addressed. To address this issue an understanding of the factors that contribute to the use of energy in the building should be identified. Three (3) factors can influence energy efficiency in buildings; as a) construction design; B) Operation and maintenance; And c) User-generated behaviour(Al-Mofleh, Taib, Salah, & Azizan, 2009). The behavioural factors of the user significantly affect the energy efficiency of the building. This is due to a user who has a direct relationship with the use of space and its activities (Hoes, Hensen, Loomans, De Vries, & Bourgeois, 2009). This shows the user's behaviourdoes influence the pattern of power consumption in the building. Ordinarily user-building behaviour studies are based on the assumption of behaviour without observation measurement or prediction model. These assumptions resulted in limitations in simulation decisions and result in weak decisions. The difference in results for energy efficiency was based on expectations, rather than the actual ones that occurs. This is evident when the research is produced without taking into account the user factor in the simulation analysis. In most cases, the waste of energy in the building is when it is uninhabited(Masoso & Grobler, 2010).

Behavioural energy consumption behaviour has begun to get the attention of researchers as early as the 1970s, after the energy crisis (Bin, 2012). Most investigations involving user behaviourfocused on energy consumption behaviour on residential buildings. However, since then, the convergence has shifted to commercial buildings. The study of user behaviour and the power of institution building is very remote as has been developed by Ron Widman (Widman et al., 1984). The importance of studying the behaviour of energy consumption in the building deserves attention as stated by the PowerSave School Program where a reduction of 5% to 15% can only be achieved based on changes in user behaviour at school.This demonstrates the user's behaviour on energy efficiency is a real issue that significantly influences energy issues in the building. This argument can be seen through the words of Lee Shipper in the cynic that says: ". . . Those of us who call ourselves energy analysts have made a mistake. . . We have analysed energy. We should have analysed human behaviour(Lutzenhiser, 1993).

There are various methods used in assessing the performance of building energy. Among them are using Post Occupancy Evaluation (POE) Assessment Methods as a guideline for building physical design checks, as well as involving users to get the real perception of energy efficiency usage

behaviour,besides exploring knowledge on the level of greenhouse gas emissions (Wheeler, Boughlaghem, & Malekzadeh, 2011).

4 METHODOLOGY

This study involved two high-performance schools; namely Boarding School High-Performance Integration (Sekolah Menengah Berasrama Penuh Integrasi Berprestasi Tinggi (SBPI)), Gopeng, Perak, Malaysia and, High School of Science Tengku Abdullah (Sekolah Menengah SainsTengku Abdullah (SMSTA)) Pahang, Malaysia. 140 respondents participated in this study, 70 respondents from SBPI and 70 respondents in SMSTA.

The respondents involved in this study were formed by five students who form the highest level in secondary schools. The selection of students is important because 17 years old is considered matured andhave a good understanding of the needs of their responsibility for the school. The questionnaire is intended to measure the attitude as well as the sense of responsibility of respondents' towards the school area especially in electricity used and comfortable of space. A face to face interview approach was usedfor this study to ensure that the respondents fully understood the questions. To avoid any confusion or misunderstanding, the researchers introduced themselves as well as explained the purpose of the study undertaken.

4.1 Measuring the Construct

The questionnaire contains four parts: part A- demographic background, part B- the perception of user behaviour (PUB), part C- the perception of building design (PBD) and, part D- the perception of service design (PSD). All variables were measured using a 5 point Likert Scale of 1 – strongly disagree, 2 – not agree, 3 – agree, 4 – highly agree and 5 – strongly agree. This questionnaire was used in a pilot survey to identify any circumstances of the tricky question. The output from the pilot survey the question was restructured again for this study(Salleh, Kandar, & Sakip, 2015). The validation and confirmation of all constructs were done using Exploratory Factor Analysis (EFA). EFA wasused to gather information about the interrelationship among a set of variables (Pallant, 2005). The result for the level of reliability was found by calculating the Cronbach's Alpha. The result found the variable of PUB variable has a good reliability value as the Cronbach's Alpha (α) value = 0.74, POD; α = 0.81 and PEE; α = 0.83. However, two items in POD wereeliminated because the corrected item-total correlation value is below than 0.3. All variables have a Cronbach's Alpha value exceeds 0.60 variables (Nunnally & Bernstein, 1994)as shown in Table 1.

Table 1 Cronbach's Alpha Value forAll Variables

Variables	Items	Description of Items	Corrected item-total correlation	Reliability (Cronbach's Alpha)
The perception of user behaviour (PUB)	Item 1	A Light switch is always off after a classroom/ space is not used.	0.68	
	Item 2	A fan switch is always off after a classroom/ space is not used.	0.69	
	Item 3	An air conditioner switch is always off after a classroom/ space is not used.	0.55	
	Item 4	I am aware of the use of electricity with prudently is to avoid the wastage of electricity.	0.40	**0.74**
	Item 5	I am always to make sure the electric switch is always turned off when the classroom/ space in my school is not used.	0.45	
	Item 6	The switch of lights, fans and air conditioners that still on without anyone on the room/space will be turned off by school staff.	0.30	

The perception of building design (PBD)	Item 1	The classroom/ space in this school will feel hot especially in the morning (7 am-noon)	0.64	
	Item 2	The classroom/ space in this school will feel hot especially in the afternoon (noon – 2 pm)	0.57	
	Item 3	The classroom/ space in this school will feel hot especially in the evening (2 pm – 7 pm)	0.51	
	Item 4	The classroom/ space in this school will have a glare in the morning (7 am-noon)	0.52	
	Item 5	The classroom/ space in this school will have a glare in the afternoon (noon – 2 pm)	0.55	**0.81**
	Item 6	The classroom/ space in this school will have a glare in the evening (2 pm – 7 pm)	0.53	
	Item 7	There is a glare of sunlight in the classroom/space in this school	0.59	
	Item 8	There is a glare of lighting in this classroom/space in this school	0.35	
	Item 9	The lights are needed for this classroom/space in this school because depending on sunlight in the classroom/space is not enough.	0.30	
	Item 10	The fans are needed for this classroom/space in this school because the natural ventilation in space still not provide comfortable	0.40	
	Item 11	The air condition is needed for this classroom/space in this school because depending on the natural ventilation still not provide comfortable	0.36	
	Item 12	The use of curtains or blinds is necessary to prevent heating from sunlight.	0.26	
	Item 13	The temperature in the classrooms in the school is cold all year round	-	
	Item 14	The temperature in the classrooms in the school is always comfortable all year round	-	
	Item 15	The temperature in the classrooms in the school is always hot all year round	0.31	
The perception of service design (PSD)	Item 1	There is noise from outside classrooms/space that in used causing by the machine or electrical equipment such as air conditioner components	0.53	
	Item 2	There is noise from inside classrooms/space that in used causing by the machine or electrical equipment such as air conditioner components	0.58	
	Item 3	Throughout the year, I am not comfortable because no natural ventilation in a room is used	0.65	
	Item 4	Throughout the year, I am not comfortable because there are no fans in the room that is used	0.66	
	Item 5	Throughout the year, I am not comfortable because there is no air-conditioning in a room that is used	0.48	**0.83**
	Item 6	Most of the time the lighting system is not in good condition as far as I use this room in this school	0.74	
	Item 7	Most of the time the fans are not in good condition as far as I use this room in this school	0.76	
	Item 8	Most of the time the air-conditioning is not in good condition as far as I use this room in this school	0.73	
	Item 9	There is the use of the air conditioning system in a room/space with windows that are not airtight and open	0.35	
	Item 10	Lighting systems will not off automatically because of the system application that hasbeen set in this school	0.44	
	Item 11	I do not feel comfortable in school for throughout the year because of there is no ventilation or breeze in a classroom/space	0.67	

Note: (-) = Items eliminated because of corrected item-total correlation is below than 0.3.

4.2 Result and Discussion

The respondents who participated in this study constituted 55.1% male, and 44.9% female with a total of 140 respondents (n=140). The respondents involved in this study are students (86%), teachers (8.1%) and supporting staff (5.9%). The age range was between 16 to 20 year old(85.4%), followed with 31 to 35 year old (8%), 26 to 30 year old(3.6%), 41 to 45 year old (1.5%) and 21 to 25 year old and 36 to 40 year old respectively 0.5%. A total of 94.8% has servedthe schools for 1 to 5 years, 4.5% served for 11 years and above, and 0.7% served in the school for 5 to 10 years.

The perception of the user in energy use in two high-performing schools building was divided into three main constructs; PUB, PBD and PSD. The descriptive analysis using mean differences between two schools (SBPI and SMSTA), shows that there is no much meaningful difference between PUB (SBPI; M=22.04, SD=2.91, SMSTA; M=21.08, SD=3.39), PBD (SBPI ;M=42.75, SD=6.96,

SMSTA; M= 43.04, SD=7.31), and PSD (SBPI; M=29.01, SD=7.15, SMSTA; M=28.62, SD=5.16) as shown in Figure 1,

These findings can be explained that there is no difference in energy consumption in both schools. Even though the SBPI (Secondary School Boarding High-Performance Integration / Boarding High School of High-Performance Integration) is a boarding school. It was believed that there had a relationship with the management of energy us in their schools.

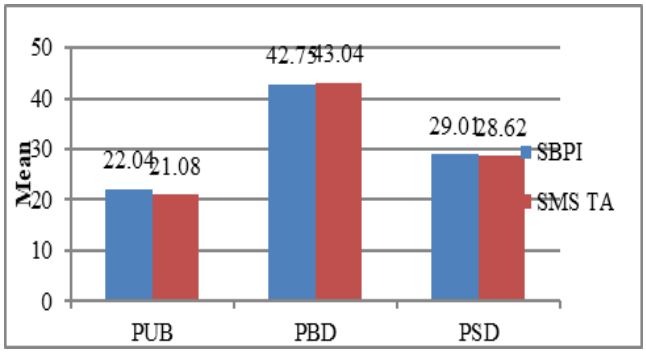

Figure 1 Perception of users towards energy use in building in High of School High-Performance Integration (SBPI) and High School of Science Tengku Abdullah (SMSTA).
Note: PUB= perception of user behaviour, PBD= perception of building design, PSD= perception of service design

The correlation between perception of user behaviour (as measured by the PUB) with the perception of building design building (as measured by the PBD) and the perception of service design (as measured by the PSD) was investigated using Pearson product-moment correlation coefficient. The result wasshown in Table 2. The output shows that there was a medium, positive correlation between the two variables [r=0.358, n=124, p=0.00), with the perception of building design (PBD) and the perception of service design (PSD). The output explains that PBD helps to explain nearly 13 per cent of the variance in respondents' score the PSD. Meanwhile, there was a small, positive correlation between the two variables [r=0.273, n=132, p=0.00), with the perception of building design (PBD) and the perception of user'sbehaviour (PUB). There is 7 per cent PBD explainationon the variance of respondents' score on PUB. The result is shown in Table 2.

Table 2 Pearson product-moment correlation between the perception of user behaviour with the perception of building design and the perception of service design

		The perception of user behaviour (PUB)	The perception of building design (PBD)	The perception of service design (PSD)
The perception of user behaviour (PUB)	Pearson Correlation	1		
	Sig. (2-Tailed)			
	N	138		
The perception of building design (PBD)	Pearson Correlation	**.273****	1	
	Sig. (2-Tailed)	**.002**		
	N	132	134	
The perception of services design (PSD)	Pearson Correlation	.065	**.358****	1
	Sig. (2-Tailed)	.465	**.000**	
	N	128	124	130

**. Correlation is significant at the 0.01 level (2-tailed).

This finding can be explained that if the perception of user behaviour on energy efficiency is increased, user perception of the building design will also increase. It shows that the design of the building gives an influence ofuser behaviour in energy consumption in a building. Similarly, if the perception of the building design on energy use increases, the user's perception of services design will also increase. Thisexplainsthat the user behaviourdo influence building and services design.

5 CONCLUSION

This study has found that the user behaviour of the respondents to increase the user's perception of energy efficiency in the school building design. The resultsrecognised the relationship between the variables in proving this method can be used for benchmark energy efficiency at the design of school buildings factors. In the design process, the user behaviour factor must be taken into account, and more research neededto be done to find out the level of customer's satisfaction and not just based on the measurement of user's comfort based on scientific studies to neglect the study and measurement of the real comfort of users in the field. Case studies need to be made in the design of new school buildings. This is necessary for granting rights to users whose majority is a student of the child category until we deny the right of their comfort by determining the level of comfort without us checking and surely it gives the level of comfort. In addition to the energy demand pressures that are being reduced to an understanding of energy efficiency and energy saving that often fail to be well understood.

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