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ROOFTOP SOLAR ENERGY AWARENESS ON BUILDINGS IN HIGHER EDUCATION INSTITUTIONS: CASE OF UNIVERSITY UTARA MALAYSIA

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ABSTRACT:

Rooftop solar energy is a system that is built at the roof of either a residential or commercial building. Many systems can be installed to make rooftop solar energy, with one of them being the photovoltaic (PV) system. The PV system is solar electricity that has been used on buildings owing to the several benefits accorded by it, among which are, cooling the environment in the building, reducing the cost of electricity bill, and facilitating an environment friendly. In order to ensure that rooftop solar energy is widely used, the KeTTHA, under the government, provides a few programs to the society, but regardless of such programs, the majority of people remain unaware of this rooftop solar energy. In this study, the researcher has examined awareness of solar energy among UUM's staff and students. Based on interviews and questionnaire survey, the researcher determined the level of knowledge and information they hold regarding solar energy, in general, and rooftop solar energy, in particular. The study calculated the percentage of awareness among male and female students, after which, the differences between their awareness were obtained. The benefits and methods used to calculate the results were also presented in this study. The results were solely based on the staff and students' perceptions at UUM. In the future, studies should include a more extensive group from Malaysian society.

INTRODUCTION

In this 21st century, the environment is increasingly getting more and more attention in terms of issues that breach the natural condition of the earth. Issues like pollution, waste problem, and climate change must be controlled. Climate change is caused by the effect of greenhouse gas emissions that come from construction activities such as, non-renewable energy and utilization of fossil fuels (Hwang & Tan, 2012), and from using energy for cooling IT (Al-Rejal, Udin, Hassan, Sharif, Al-Rahmi, Al-kumaim, 2020). The Government of Malaysia has promoted the development, of solar systems through the implementation of the Malaysian Building Integrated Photovoltaic (MBIPV) project in 2005. Sadly, people still lack awareness about green building because of the lack of information and understanding of green building sustainability (Siew& Abu al-Rejal, 2015; Zalina, Soebarto, 2013).

STATEMENT OF THE PROBLEM

The huge and accelerated technology development requires energy to operate. In each industry, power is the main input to accomplish operations, such education institutions run e-learning and systems (Rahmi, Ramin, Alamri, Al-Rahmi, Yahaya., Abualrejal& Al-Maatouk, 2019; Alamri, Al-Rahmi, Yahaya, Al-Rahmi, Abualrejal, Zeki, and Al-Maatouk, 2019), business functions and information and material flow in manufacturing (Al-Rejal, Udin, & Yusoff, 2018; Abualrejal, Doleh, Salhieh, Udin, & Mohtar, 2017; Abualrejal, Abu Doleh & Mohtar, 2017; Abu-Alrejal, 2007), and in e-health sector (Al-Fadhli, Othman, Al-Rejal, Al-Jamrh, 2018).

For that, Rooftop solar energy is generally used as solar-control systems that help reduce the energy generated from the synthetic lighting system to ensure healthy natural lighting, to provide visual comfort, to generate solar electricity and solar heat at the same time, and to reduce the cooling energy consumption in buildings (Khun, 2017). Malaysia is the fourth largest photovoltaic modules producer in the world but solar technology is not applied widely in the country. One of the reasons is the expensive cost of installing PV systems in Malaysia (Christopherteh, 2012). The Ministry of Energy, Green Technology and Water (KeTTHA) has set up a statutory agency, known as the Sustainable Energy Development Authority (SEDA), which functions as a one-stop Renewable Energy Centre. For every kilowatt-hour (kWh) of electricity, SEDA provides a fixed rate to the electricity generator that has been generated and exported to the grid through Feed-in Tariff (FiT) incentive. Besides, the government has started the FiT, modified a few policies, and improved the solar panel accordingly (Mun, Hafiza, Khalid, & Fazrena, 2015). To prove the sincerity of the Malaysian Government's desire to implement green initiatives in the country, Malaysia has launched a National Green Technology Policy (NGTP) in 2009 (Yasmin, Uyun, Najib, Nasir, & Daus, 2016). The issues of sustainabilityis essential toward firms competitive advantage (Makhloufi, Al-Rejal, &Mohtar, 2018; Makhloufi& Al-Erjal,2014), also in the environment of construction development that include reduction of energy consumption,

efficient resource distribution, promotion of activities reuse, reduction of embodied energy recycling, and other methods in the long and short-term (Ann & Abualrejal, 2015; Abualrejal, Zulkifli & Mohtar, 2017).
The main objectives of this research are as follows:
1. To identify whether people are aware of the importance of rooftop solar energy in buildings.
2. To identify the benefits of rooftop solar energy in buildings to society.
3. To apply the methods that can be used to make people aware of the rooftop solar energy in buildings.

LITERATURE REVIEW AND HYPOTHESIS

Rooftop Solar Energy Awareness

In this research, the researcher reviews the literature on green building and green roof.

Green building - It is a sustainable building (Bu, Shen, Anumba, Wong, Liang & 2015) and a high performance one (Howe, 2010). A Green building is a building that reduces the interference to the environment to improve the ecosystem in every way and require building performance criteria through the life cycle (Min, 2015). Based on efficiently applied resources, the primary objective of green building is to create a healthy environment (Min, 2015). In literatures has found that sustainable competitive advantage contribute toward organizations performance (Makhloufi, & Al-Rejal, 2016; Makhloufi, Al-Rejal&Mohtar,2018),green buildings can increase performance by enhancing their residents' health and decreasing energy and material usage (Singh, Syal, Grady, & Korkmaz, 2010). Green envelope components are generally chosen because of their effectiveness in providing indoor thermal comfort, minimizing a building's energy consumption, and other environmental benefits (Yu, Tian, Xu, & Wang, 2015). The building envelope has components, comprising a major part of a building, which includes walls, windows, roof, and floor. It also acts as the physical separator or interface between the indoor and outdoor environments (Sadineni, Madala, & Boehm, 2011).

Green Roof - For application on contemporary residential buildings, the green roof was developed by a German roofer in 1900. German cities have buildings that have roofs built with fire protection. This type of roof is quite durable and has an almost free maintenance cost. In Berlin, the aspect of urban ecology has been investigated since 1980. Universities in German cities improved and tested substrates, leading, drainage, and sealing to guide the implementation in terms of technical aspects (Kohler, Schmidt, Laar, Paiva, & Tavares., 2002). The system works much better in dry climates because when green roofs transfer heat, it is provided through the latent heat process. The thickness and thermal characteristics of the vegetative roof state transfers heat and value to the building at the same time. Through the layers, the characteristics and type of the plants, and the transfer and the shading levels of radiation are taken into consideration. Watering is important to ensure that latent heat control releases the thermal balance of the roof (Santamouris, 2014).

Benefits of Rooftop Solar Energy on Buildings

There are several benefits to using rooftop solar energy as evidenced by the review of literature, among which are, energy-saving rooftops cool the building and reduce energy consumption.

Cooling the building – Buildings are cooled by following the natural passive cooling strategy (Kamal, 2012). There are two factors required to activate effective strategies, to eliminate the heat, and to prevent it from entering the building. One factor is a heat sink whose temperature is lower than the interior air and the second factor is an improved mechanism to transfer the heat towards the heat sink (Al-Obaidi, Mazran, &Rahman, 2014).

Reduce energy consumption - Solar energy can reduce emitted pollution, increase energy security, and reduce the energy used in homes, and it saves money from non-renewable sources of energy. If the user plans to install a small renewable energy system to make his electricity (e.g., small wind turbine or solar electric system), it would reduce the electrical loads, and being that the system is small, this could be the first step to save money (Department of Energy, 2016), also with antenna network (Fazea, Amphawan,&Abualrejal, 2017).. Statistics show that in the environment, 30% to 40% of global energy consumption is connected to greenhouse gas (GHG) emissions and this presents the most capable prevention of GHG emissions and energy-saving (Dunphy, Morrissey & Mac Sweeney, 2013).

Help increase energy saving - Property development companies have been using the energy management system to bring about energy efficiency in development projects. They follow a standard to control and manage the consumption of energy and to ensure energy consumption. The increase of energy efficiency is possible through investments in green technologies (Abualrejal, Zulkifli&Mohtar 2017; Ann&Abualrejal, 2015).

Rooftop Solar Energy Method

Rooftop photovoltaic system and the solar thermal system is also known as rooftop solar energy method based and an overview is provided under this section from information gathered through literature review.

Rooftop Photovoltaic System - A photovoltaic (PV) system or solar power system is a system designed to supply solar power. It consists of an arrangement of several components including, a solar inverter that changes electric current from DC to AC and solar panels to absorb and convert sunlight into electricity. The urban environment has a large space of empty rooftops and can naturally avoid potential land use and environmental concerns. The solar PV project is divided into two steps, which are operation work and construction. The operation work takes 21 years and the construction works

take four months. The project life cycle is categorized into three major phases namely, procurement, planning, engineering, and design (Jali, Sarkawi, Izzuddin, Sulaima, & Nasir, 2014).

Solar Thermal System – It has been the most frequent solar thermal collector with rear ventilation that has been installed on buildings. There is an air gap between the collectors and the building envelope (Maurer, Cappel, &Khun, 2017). In general, a BIST element can provide a few functions when it is operating well in a system comprising of the pump, piping, a thermal storage tank, and a membrane expansion vessel. Building Integrated Solar Thermal System (BISTS) includes system features, a range of operating parameters, and mounting configurations. The system characteristics of BISTS are environmental, technological/performance, integration, architectural, functional, and aesthetic (Aelenei, Symth, Platzer, Norton, Kennedy, Kalogiraou, & Maurer, 2016).

Eco World Development Sdn. Bhd uses passive design and crosses ventilation through the orientation of windows to prevent increased indoor temperature, to reduce the usage of the air conditioner, and to reduce GHGs emission. The problem of climate change and air pollution caused by humans can be reduced by reducing the total amount of GHGs in the atmosphere and this is an important step to decrease the impact of climate change (Ann&Abualrejal, 2015).

RESEARCH METHODOLOGY

In this research, a combination of the qualitative and quantitative approach is used as a research method. Qualitative data are analyzed to explain the opinions, interpretations, and personal experience of the interviewees, without being matched with the pre-existing philosophies (Koch, Niesz, McCarthy, 2014). Quantitative data, on the other hand, deals with the numbers that are measurable. The word quantitative refers to quantity such as length, height, area, and weight. There are several quantitative methods to analyze the obtained data.

Data are presented as original data because the interview sessions were conducted for the purpose of the current research alone and have not been published before. Qualitative data collection comprises interviews, in-depth interviews, case studies, and group observation (Carter & Little, 2007). The group interview is also known as a focus group (Arendt, Roberts, Strohbehn, Ellis, Paez, & Meyer, 2012). The interview method is one of the qualitative data methods that is commonly applied while performing field studies (Qu & Dumay, 2011). An in-depth interview is also known as a semi-structured interview and is effective in collecting trustworthy and comparable qualitative data (Newton, 2010).

For this research, we use primary data obtained from the interviewees in the Welcome Centre and JPP staff from Universiti Utara Malaysia (UUM). The researcher prepared the questions to ask during the interviews and they are as follows:

1. Aspect of Background
(a) Which department are you from and what position do you occupy?
(b) How many years have you been working in UUM?
2. Aspect of awareness (Ordonez, Jadraque, Alegre, Martinez, 2010)
(a) Do you know about green technology? If yes, based on your understanding what is green technology?
(b) Do you know that a building in the UUM uses green technology? If yes, which building is it?
(c) Do you know about solar energy? If yes, based on your understanding what is solar energy?
3. Aspects of benefit (Santamouris, 2014)
(a) What are the benefits of using rooftop solar energy?
4. Aspects of the method (Mekhilefa, Safari, Mustaffaa, Saidurb, Omara, Younisc, 2012)
(a) Do you know the rooftop solar energy program under the Ministry of Energy, Green Technology and Water of Malaysia (KeTTHA)? If yes, what is the program about?

The interview sessions were conducted with a Welcome Centre manager, customer and service officer from Welcome Centre, an electric engineer from JPP, architects from Right Landscape from JPP, and an assistant engineer from JPP in UUM. The interviews were about awareness of the rooftop solar energy in one of the UUM buildings. The interviews used a face-to-face approach and were carried out in the fourth quarter of 2017, in the duration of 15 to 30 minutes for each interview. The researcher prepared a set of questions as an interview guide to achieve the research objectives. The data was recorded in written notes and by phone. The tools that the researcher used during the interview wasa smartphone to take pictures and record the interviews aside from note-taking on paper. The aim of this interview is to collect useful information and data for this research objective concerning the awareness of rooftop solar energy among the interviewees.

The survey method has been conducted by several longitudinal and cross-sectional studies based on interviews or questionnaire for data collection. The quantitative data collection is brought about through telephone interviews or online questionnaires. The quantitative data analysis method is a statistical data analysis usually in the form of tabulations. It involves the calculations of percentages, means, or standard deviation and the findings are conclusive and usually descriptive in nature. Collecting and analyzing data are completed in continuous iteration, through analysis that entails data gathering (Arendt et al., 2012).

Therefore, the researcher used quantitative method of collecting data by using a survey questionnaire (Harwell, 2011). The questionnaire copies were distributed manually to all the students at the Library Sultanah Bahiyah in UUM on 7th October 2017. There were 10 male students and 20 female students as the study sample that completed the questionnaire. Each student answered three parts of questions, with the first part

dedicated to the awareness of the importance of rooftop solar energy on a building, the second part about the benefits of rooftop solar energy, and the third part about the methods that can be used to make people aware about the rooftop solar energy on buildings. Part one has ten questions, part two has ten questions and part three has five questions. The main objective of the questionnaire is to determine the level of awareness among students about rooftop solar energy.

DATA ANALYSIS AND FINDINGS

For the interview, the interviewees knew about green technology and that in the welcome centre, there are two places that used green technology which are, general office and office manager. Interviewees said that green technology saves electricity and is beneficial to health. The interviewees also stated that solar energy and green technology are good to use as they expand the scene, spread harmony, peace, calm, and coolness. Based on the interviewees' understanding, green technology is a recycled technology, while solar energy uses power from the sun. Interviewees were aware that solar energy is obtained by using solar panel and can be operated in the building to light up lamp offices when solar panel is installed on the roof. Interviewees also knew the benefit of rooftop solar energy in that it supplies unlimited power supply and reduces electricity cost. However, they did not know how to maintain the rooftop solar energy and about the programme of the solar energy under KeTTHA. It was concluded that the interviewees were happy to work in UUM because it is comfortable to work in with green scenery and surrounded by nature.

For the questionnaire method, the researcher distributed the questionnaire copies to 30 students (20 female students and 10 male students). The students were required to answer the three parts of the questionnaire, which are dedicated to the awareness of the importance of rooftop solar energy on buildings, the benefits of rooftop solar energy and the methods that can be used to make people aware about the rooftop solar energy on the building. Part 1 has 10 questions, part two has 10 questions and part three has 5 questions. So the total number of questions is 25. The main objective behind the questionnaire use in data collection is to identify the awareness of rooftop solar energy among the students of UUM, between male and female. So the first thing we calculated was the awareness of male and female students and the difference in awareness based on questions.

Awareness of Rooftop Solar Energy

Figure 1 and 2 explains in detail about the percentage of awareness and lack of awareness between male and female students. Overall, 72 percent of the male students were aware about the objectives of research compared 28 percent, who lacked awareness. For the female students, 64 percent ofstudents were aware, while 36 percent were not aware.

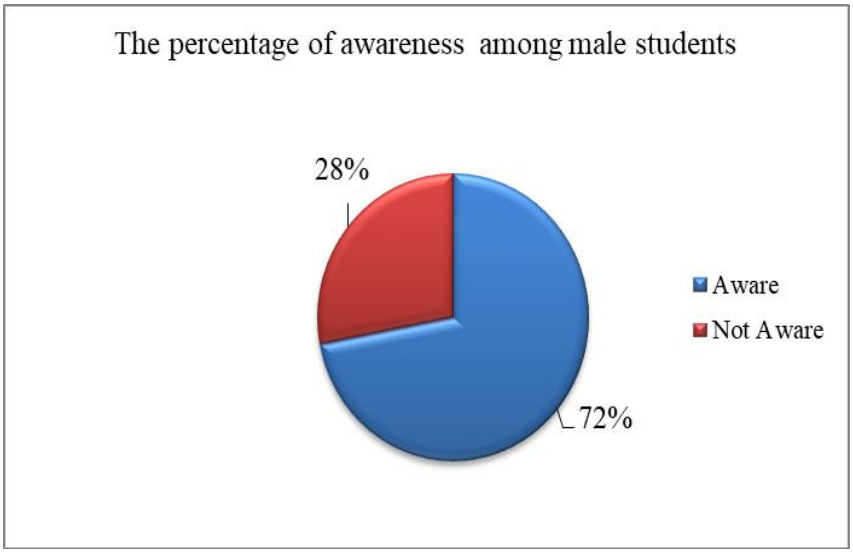

Figure 1 The percentage of awareness between male students

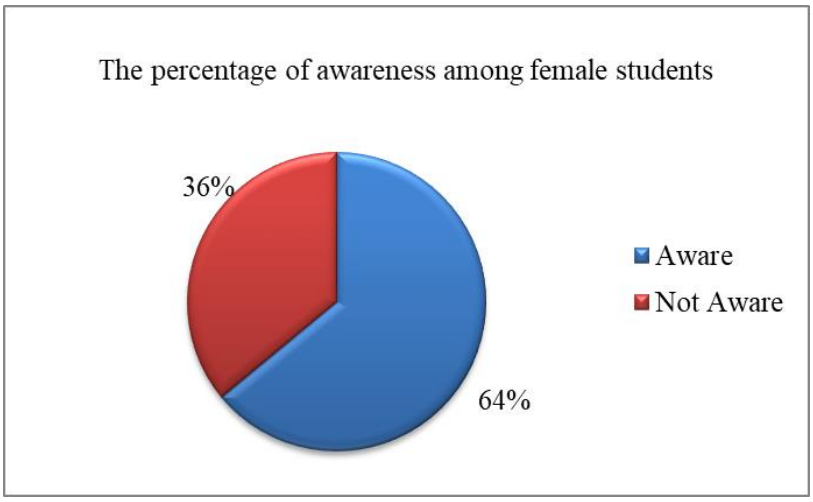

Figure 2 The percentage of awareness between female students

Table 1 shows the percentage of awareness and lack of awareness between male and female students. For part 1, there were 50 percent of male and female students who were aware and 50% of the same who were not aware. For part 2, male students were found to be more aware by 6 percent compared to female students. Finally, for the part 3, male students were more aware by 34 percent compared to female students. Figure 2(a), 2(b) and 2(c) explain the results in detail using a pie chart.

Table 1. Percentage of awareness and lack of awareness between male and female students

Students	Aware	Not Aware

By part	Male (%)	Female (%)	Male (%)	Female (%)
Part 1	50	50	50	50
Part 2	53	47	33	67
Part 3	67	33	43	57

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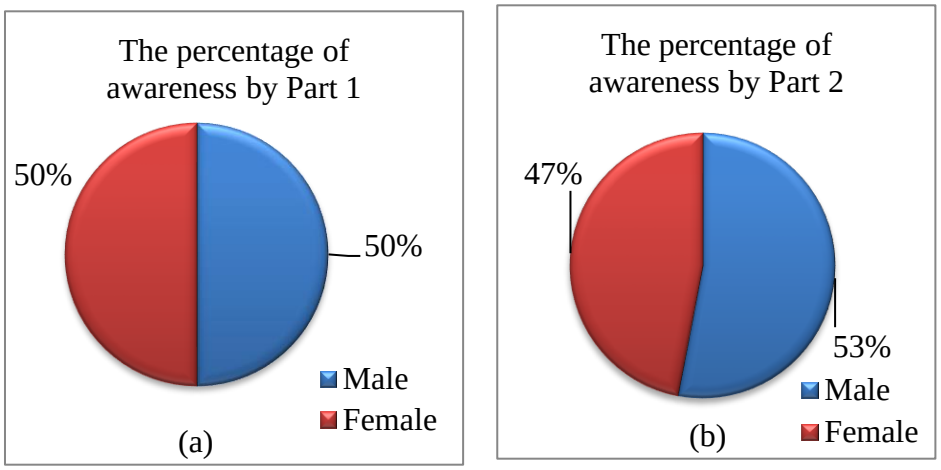

Figures a. b. and c. Percentage of awareness between male and female students based on part 1, 2 and 3

The Benefits of Rooftop Solar Energy on Buildings

Sell excess electricity - Households can sell home solar electricity to TNB when installing a home solar system. This opportunity enables the household to install solar panels on the rooftop of the house to absorb radiation energy emitting from the sun. The energy will be absorbed and goes through a process known as a photovoltaic process. During this process, electricity is generated. The generated electricity will be connected to the electricity grid and exported into the grid (Christopherteh, 2012). The household should be made aware that the benefit of installing solar energy on the rooftop is the fact that they can sell excess electricity in the house to TNB. With that, it can generate new financial resources, while at the same time, reducing the cost of electricity bill.

Furthermore, one of the methods that can be used to make people aware of the Rooftop Solar Energy takes the form of the Malaysian Building Integrated Photovoltaic (MBIPV) project. The Green Technology Sector has undertaken several studies to translate the National Green Technology Policy into an action plan and implementation. The main research is about the Green

Technology Master plan and the Electric Vehicle Infrastructure Roadmap. The MBIPV project is one of the instruments of solar energy developed by the government. SURIA was introduced to make the public aware of the benefits and potential of using solar energy in their lives (Mekhilefa, Safari, Mustaffaa, Saidurb, Omara, &Younisc, 2012).

From the obtained findings, we can conclude that only a few students and staff members of UUM were less aware of rooftop solar energy. Almost all of the respondents knew the benefits of rooftop solar energy and they mentioned cooling the building and reducing energy consumption. However, only a few respondents knew that excess electricity in the house can be sold. Other respondents also brought up the issue that the cost of installing rooftop solar energy is way more expensive than a normal roof. The government has to come up with more projects and initiatives to make people of solar energy benefits. In the future, it is hoped that considerable information will be made public to make people aware of it.

DISCUSSION AND CONCLUSION

This research aimed to identify the awareness of the rooftop solar energy on building in University Utara Malaysia (UUM) among staff members and students. The objectives of this research were achieved by interviewing Welcome Centre Manager, Customer Service Officer from Welcome Centre, Electric Engineer from JPP, Architects Right Landscape from JPP, and Engineer Assistant of JPP in UUM. The objective was also achieved by distributing questionnaire copies to 30 UUM students. The research also aimed to identify whether people are aware of the importance of rooftop solar energy on buildings, to identify the benefits of rooftop solar energy on buildings to society, and to apply the methods that can be used to make people aware of the rooftop solar energy on buildings.

The researcher recommends collecting data and information from each state in Malaysia to obtain a more accurate analysis result. As it is known, there are many benefits when using rooftop solar energy, which includes cooling of the building, reducing energy consumption as well as selling excess electricity when using rooftop solar energy on a building, especially on a house. With regards to the methods that can be used to make people aware of rooftop solar energy, they include increasing awareness campaigns in society. The government can also adopt a serious role to promote awareness. Despite the few programs introduced by the government, people are still less aware of such programs. With the power of social media nowadays, sharing information about the advantages that can be reaped from rooftop solar energy on their residential building can be carried out easily.

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CONCLUSION

In conclusion, the interviewees appeared to be aware of green technology. In the welcome center, two places are using green technology which is, general office and office manager. Interviewees stated that green technology saves and reduce electricity cost. They believed that solar energy and green technology are good to use because they extend the scene, harmony, peace, calm, and coolness. The interviewees in the Welcome Centre were happy to work in UUM because it is very comfortable with green scenery that promotes nature. Based on the result of the questionnaire, the researcher can conclude that the students of UUM are aware of the importance of rooftop solar energy in the building (72% of male students and 64% of female students). For Part 1 of the questionnaire, it can be concluded that male and female students have the same level of awareness (around 50%). Meanwhile, for Part 2, the benefits of rooftop solar energy in building to society were brought up by 53% of the male students and 47% of the female students. Finally, for Part 3, 67% of the male students were aware and just 33% of female students were found to be aware.

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