

## THE APPLICATION OF GREEN TECHNOLOGY PRINCIPLES IN RESOURCE CONSERVATION OF MOSQUES IN JOHOR AND TERENGGANU

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**Abstract:** The government of Malaysia is currently encouraging the implementation of sustainability for buildings through the application of green technology principles. Most of previous studies on the implementation of green technology principles gave more emphasis on residential buildings such as terraced houses, condominiums and apartments, and commercial building such as offices, shopping complexes and factories. Study on the implementation of sustainable principles in the context of religious buildings such as Mosques and *suraus* is still lacking. The purpose of this article is to identify sustainable practices in Malaysian mosques in the context of resources conservation. The study employed qualitative approach through a field observation in February and March, 2015 and carried out on 30 selected mosques and *suraus* in Johor Bahru and Terengganu. Using observation techniques, a list of resources conservation practices based on green principles were identified in the visited buildings. This study has found some practices leading to conservation of water and electricity. Apparent practices includes the use of stickers at the switches or water taps as reminders to user about conservation of resources, the use of LED lamps to reduce electricity consumption, rain water harvesting systems, and the use of water from ponds (known as *kolah*). However, the implementation of sustainable practices tend to be vary between mosques management committee in both states and still considered as at low level. Therefore, the authors suggest that collaborative effort among the related agencies is encouraged and promotional programs and dissemination of information on the importance of green principles are enhanced. This is to increase awareness among mosque management committee on the need to inculcate sustainable principles.

### INTRODUCTION

The terms “green” and “sustainable” in development and environment are inseparable. Both of the terms are referring to unchanged and lasting situations. According to Mariani, (2008) both terms are interrelated in giving effects on the environment, users and the life itself. According to online Oxford Dictionaries (2015) the term ‘sustainable’ is referring to ‘conserving an ecological balance by avoiding depletion of natural resources.’

In Malaysia, response to the green technology principles can be seen when building owners started to register for ‘green’ recognition by an established evaluation agency based on green building rating system known as Green Building Index Sdn Bhd (GBISB). This agency is established, owned and administered by The Board of Architect Malaysia (PAM) and The Association of Consulting

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Engineers Malaysia (ACEM) (Yau, 2010:10). The aim of this system is mainly to upgrade competency in using the three main resources i.e. energy, water and building materials in preventing any adverse effects on health and the environment. The focus is on the process of building life-span, building orientation, design, construction, operation, maintenance, and refurbishment (Green Building Index, 2014).

The Board of Architect Malaysia and Association of Consulting Engineer Malaysia has outlined criteria for building to be recognized for Green Building Index (GBI):

- Buildings with high energy efficient – can be obtained through the use of solar or the use of renewable energy, home office connectivity and building should have sustainable maintenance system;
- Indoor environmental quality. Attention should be given to the quality of air, lighting, visual, and acoustical comfort in the respective building. For this purpose, green roof approaches can be applied to encourage the use of roof covering using natural elements such as grass or other green plants;
- Sustainable site planning and management. An important aspect is to observe water drainage system or storm water management;
- Material resources – to observe types of materials to be used particularly to encourage the use of recycled materials and to implement appropriate methods of construction waste management.
- Effective use of water – to encourage the use of rain water harvesting system (RWHS), water recycling system in the building and effective water and landscape services.
- Building innovative aspect and environmental design initiative in building design.

## LITERATURE REVIEW

Since 1980, numerous researchers in the developed countries such as Japan and Norway have investigated aspects of energy conservation (Baxter *et al.*, 1985:71; Wilhite *et al.*, 1996:802). In Europe alone researchers, such as in Greece (Sardianou, 2007:3778), in France (Chong and Dubois, 2009:1), in Sweden (Ek, 2010:1578) and in Belgium (Bachus and Van Ootegem 2011) have already studied various aspects of energy conservation. The same effort has already taken place in the developing nation in Asia particularly China, such as works of Xiao hua and Zhenmin (2005:102) and Cai dan Jiang (2008:1667).

Most of the researchers such as Wang *et al.* (2011:3550), Abrahamse and Steg (2009:711), and Barr *et al.* (2005:1425) put research emphasis on the role and contribution of the household with an assumption that households play an important role in the use and conservation of energy. Households are seen as a neutral entity

in the method of enforcement of the regulation of energy consumption (Hori *et al.*, 2013:354). According to Meyerson (2008) gradual implementation is a suitable approach assuming that users are the most appropriate to start the change compared to parties which are given the regulation by the authority. Although through this approach the rate of success tends to be low, it can be implemented continuously and able to bring about a bigger change in the future. In the context of building classification application, researchers discover that several works have been carried out to ensure sustainable principles is applied in School Buildings (Saibani, 2012:13; Nuri, 2010:5), Higher education institutions (Johar, 2013), Universities (Seng, 2011; Hanif, 2011) as well government buildings (Azizah and abidin, 2011:4; Bakar *et al.*, 2011:55)

In Malaysia, the emission of greenhouse gas is contributed by the generation of electrical energy (Sadrzadehrafiei, 2011:2287), whereas according to Stern (2006:43) the main source is anthropogenic activities. In his study on the city of Johor Bahru, Kubota *et al.*, (2011:62) have discovered that 60% of energy consumption is contributed by the use of air conditioning system at an average of 6 hours usage per day. In fact, electricity consumption for air conditioning is recorded as the highest electricity consumption by electrical appliances due to the nature of buildings made of concrete and bricks.

From the above mentioned research, it can conclude that researchers gave more emphasis on the role of households in the use and conservation of energy in the developed and developing countries. However, there is very little attention given to the role of religious buildings in implementing the sustainable practices. This is the gap that this article is addressing. In particular, this article compares sustainable practices in mosques in two states in Malaysia i.e. Johor and Terengganu.

## **METHODOLOGY**

The research that this article is referring to employed qualitative research methods. The study was carried out using observation on mosques and *suraus*<sup>1</sup> around Johor Bahru and Kuala Terengganu during March, 2015. The researchers recorded the practices which were considered as promoting sustainability in a total of 30 mosques and *suraus* in Johor and Terengganu. Selected mosques located in urban areas within 20 km from the city center.

## **RESULTS AND DISCUSSION**

### **Sustainable Practices in the Management of Water Resources and Use**

Based on the observation, sustainable practices have been in existence with apparent variations which is illustrated in Table 1. One form of sustainable practice is the use of alternative supply and effective use of water.

The use of alternative water supply (other than the main water supply provided by the authority) is seen as vital as in the future, people are predicted to face a serious crisis on water resources. According to a report established by the United Nations World Water Development Report (WWAP, 2014) if each person consumes water as they practice now, two or three persons will experience difficulty in getting sufficient water supply by the year of 2025. Lately, the Government of Malaysia is encouraging the population to save water consumption from the main water supply (Man et al., 2014:98). Effort on alternative water supply such as rain water is considered as vital to overcome water shortages in the event of problems faced by the main water supply system, such as water rationing, maintenance works, pipe repairs, etc.

In Johor, all the studied mosques receive water from the state's water supply authority which managed by 'Syarikat Air Johor sdn bhd (SAJ).' There are 13% of the studied mosques and *suraus* obtain water from alternative mean, particularly rain water harvesting system. They harvesting system is a simple one, i.e. by using large moveable containers and the water is used for mosques' activities (Picture 1).



**Figure 1: Simple water harvesting system in Intan ABU Bakar Mosque, Johor Bahru. The water is used for washing kitchen utensils.**  
*Source: Fieldwork 2015.*

Water harvesting system is regarded as the Best Management Practice (BMP) that has been implemented in Malaysia (Man et al., 2014:98). This system is not only meant for slowing down surface water discharge, it is also a viable source of alternative water supply, it is free and safe for use (Shaaban et al., 2000). The use

of rain water harvesting system is also contributing to other positive consequences (Department of Irrigation and Drainage Malaysia, 2000), such as:

- Able to save the use of clean water supply,
- Reduce water bills,
- Slow down the rate of surface water discharge,
- To overcome water supply problems in rural areas.

Rain water harvesting system (RWHS) has been found in 13% of the studied mosques, while 20% of them have the potential of implementing RWHS in the future as these mosques have already have basic components of RWHS that is drainage system for rain water. In Terengganu, in contrast, implementation of RWHS seems low, except for 6% of the studied mosques which have basic components of RWHS. According to a study carried out by the National Hydraulic Research Institute of Malaysia (NAHRIM), 30% of treated water can be saved if the implemented RWHS are properly operated (Haslinda, 2011).

All mosques and *suraus* in the state of Terengganu obtain water supply from 'Syarikat Air Terengganu SDN BHD' (SATU). On top of that, 20% of the mosques obtain water supply from the main source provided by the government and alternative sources such as wells and from underground water. According to The National Economic Recovery Plan in 1998 (Saimy, 2015:39), underground water regarded as potential sources in the future to be further developed into a viable alternative sources of water to overcome water shortages. It is estimated that Malaysia has around 5,000 billion cubic meter of underground water reserve that is still untouched. The water is considered as safe for use due to it is derived from the rain water which is absorbed into the ground and is not exposed to pollution as it is located between 50 to 100 meters below ground. It is regarded as an alternative solution for future water crisis.

In the current practice of water consumption in mosques and *suraus*, many of the users do not realize the wastage made during performing ablution (wudhu'). This has been proven in a study on people's (jemaah) perception on water consumption during ablution (Syah, 2008). Muslims in this country tend to consume around five liters of water for performing ablution, where as one liter of water is sufficient to perform a perfect ablution. In the effort of improving water consumption in mosques and *suraus* in the two states, researchers have experienced various practices in ablution areas. In Johor, all mosques and *suraus* use the standard water taps for ablution areas. While in Terengganu mosques and *suraus* using water taps are only 44% of the total mosques and *suraus* studied. The rest are using water from collecting ponds (6%) and using both means, from water taps as well as ponds (31%), using water from water taps and wells (13%), and using water taps, well and water from wells (6%). According to a study carried out by "Aqua Mutlaq" the use of pond (*kolah*-Figure 2) for ablution is saver compared to using the water taps.<sup>2</sup>



**Figure 2: Water in pond (KOLAH) in *Masjid Takwa*, Terengganu to be used for ablution (WUDHU)**



**Figure 3: The use of water cistern with dual flushing system for toilet in WAKAF TEMBESU MOSQUE, TERENGGANU**  
*Source: Field work March 2015*

Regarding water conservation in toilets, the researchers found varied implementation in the two states. Fifty three percent (53%) of the studied mosques and *suraus* in Johor are using toilets with conventional single flushing water cistern, 20% of them use single flushing water cistern and pail, 7% use water cistern with dual flushing system, 7% use a mixture of single and dual flushing cisterns, and 13% use single and dual flushing cistern as well as pail. In Terengganu 60% of the mosques and *suraus* are using wc with single flushing water cisterns, 20% using single flushing cisterns and pail, 6% using pails only, while 7% of the studied mosques and *suraus* are using dual flashing cisterns. Also, 7% of them are using a combination of single and dual flushing cisterns. As the use of dual flushing cisterns is more saver than that of the single flushing, the results indicate that in

majority, the mosques and *suraus* in Johor and Terengganu are still employing the less saving means of water consumption in their toilets.

It is interesting to note that implementation of water conservation in bathroom in both states tends to be more economical compared to their practices in toilets. This is evident in Johor, where the majority (47%) of the studied mosques and *suraus* are using shower in their bathrooms, 7% are using pail, and 13% of the studied mosques and *suraus* are using both shower and pails for their bathrooms. In Terengganu, an even larger number of the studied mosques and *suraus* (67%) are using shower in their bathrooms, and the rest 13% are using pails only. The use of shower has been found as more economical as compared to using other means to obtain and store water, such as bath-tub.

**TABLE 1: COMPARISON BETWEEN MOSQUES IN JOHOR AND TERENGGANU IN TERMS OF SUSTAINABLE PRACTICE IN THE MANAGEMENT OF RESOURCES AND USAGE OF WATER.**

<i>Green principles Practices</i>	<i>Johor Bahru</i>	<i>Kuala Terengganu</i>
Source of Water:		
– SAJ / SATU	87%	80%
– SAJ & RWHS	13%	0%
– SATU & Well/ ground water	0%	20%
Rain Water Harvesting System (RWHS)		
– Available	13%	0%
– Not Available	87%	100%
– Potential for RWHS	20%	6%
Facilities in Ablution areas:		
– Water Tap	100%	44%
– Pond	0%	6%
– Water Tap and Pond	0%	31%
– Water tap and well	0%	13%
– Water Tap/Pond/well	0%	6%
Facilities in toilet areas:		
– WC & Single Flushing cistern	53%	60%
– Pail	0%	6%
– WC & Single Flushing cistern/pail	20%	20%
– WC & double Flushing cistern	7%	7%
– WC & double Flushing cistern/pail	7%	7%
– WC & Single and double Flushing cistern	13%	0%
Facilities in bath rooms:		
– Shower	47%	67%
– Pail	7%	13%
– Shower&pail	13%	0%
– Only room without shower or pail	33%	20%

Source: Field work March 2015.

### Sustainable Practice in Conserving Electricity

Two major challenges in the field of energy management are; insufficient supply and expensive, and negative consequences of human activities on the environment. The implementation of energy efficiency around the world is due to the increased demand for energy resources (Rokiah, 2013:984). Generation of electric power is considered as the main contributor to the emission of greenhouse gasses (Saidur, 2007:84). Results from the studied mosques and *suraus* in Johor and Terengganu have shown that conservation of electricity has already in existence in various forms as shown in Table 2.

In Johor, 33% of the studied mosques and *suraus* have used LED lamps to save energy. Some 33% of them are still using the conventional fluorescent lamps, while 34% are using a combination of LED and fluorescent lamps. In Terengganu, the rate of LED lamps usage tends to be lower (7%) compared to that of Johor, while 86% of the studied mosques and *suraus* are still relying on fluorescent lamps. A small percentage of them (7%) have combined the use of LED and fluorescent lamps. According to Saputro (2013:21), Ghafar (2010), the use of heat lamps, bulbs and fluorescent lamps are the main contributors to the emission of harmful greenhouse gasses such as halogen, mercury and carbon dioxide. The use of LED is considered as safer as it does not contribute to environmental pollution. Advantages of LED lamps compared to heat lamps and fluorescent lamps (Imran, 2011; Islam, 2012) are as follows:-

- LED lamps consume electricity more efficiently compared to heat and fluorescent lamps,
- Low heat emission,
- LED Lamps is free from mercury and easy to dispose,
- LED lamps do not use choke/ballast and starter,
- No sound produced by the lamps,
- Long life,
- Instant lighting,
- LED lamps emit little infrared light and produce almost no UV. It is suitable for outdoor lighting as it is unattractive to insects.

Suitable building design is also vital in reducing the use of mechanical means - hence electricity - of obtaining comfort, such as fan and air conditioning system. Good building design should facilitate optimized use of natural light and natural ventilation. Good air ventilation is necessary to maintain comfort for the occupants (Govindasmy, 2005).

Poor air ventilation, will lead to negative effects on the occupants physically as well as psychologically, and is detrimental to health (Makhbul, 2007:123). In general, the studied mosques and *suraus* have been found to have good



ventilation. Paradoxically, most of the studied mosques are also relying on fans and airconditioning system to attain comfort. It can be assumed that relying on natural ventilation alone is insufficient for attaining the required comfort levels particularly during large congregations (eg. Friday prayer). Therefore, effective use of energy depend very much on the design of the building design (Balasbaneh, 2010).



**Figure 4: The design of Pulau Perdana mosque in Johor that less electrical consumption either for light and air flow**  
*Source: Field work March 2015*

In Johor, 33% of the studied mosques and *suraus* use only electrical fans to enhance thermal comfort, while the majority (67%) use a combination of fans and air conditioning system. This result is worrying as the trend seems to consume more electricity. Interestingly, a new trend in Johor is using large industrial ceiling fans. This type fan is claimed to be more effective than using small fans in obtaining thermal comfort. However, being a new approach in enhancing thermal comfort, economic implication in terms of energy consumption is still little known. Almost the same tendency can be seen in Terengganu, where 27% of the studied mosques and *suraus* are relying only on fans for mechanical means of ventilation, and 73% use a combination of fans and airconditioning systems. As expressed earlier, the result is alarming to the effort of energy consumption. The tendency in both states are to employ more energy consuming mechanical means of ventilation, although air conditioning system is known to be detrimental to the atmospheric ecosystem as it reduces the ozone layer (Johar, 2013).



Figure 5: The practice of electrical energy conservation in Surau Haji Ibrahim, Kuala Terengganu  
 Source: Field work March 2015

Using stickers is seen as a common effort to encourage sustainable practices in water and electricity conservation. The stickers are immediate reminders to all users to be mindful with switching or turning on/off electrical switches or water taps, as their actions may help to reduce electricity and water consumptions. This method has been in existence in some of the studied mosques and *suraus* in both states. In the studied mosques and *suraus* in Johor and terengganu 40% and 60% respectively of them have implemented this practice. The main focus are the toilets, ablution areas, and the main prayer halls.

**TABLE 2: COMPARISON BETWEEN SUSTAINABLE PRACTICES IN JOHOR AND TERENGGANU IN TERMS OF ELECTRICAL ENERGY CONSUMPTION**

<i>Green principles Practices</i>	<i>Johor Bahru</i>	<i>Kuala Terengganu</i>
Source of illumination:		
– LED lamps	33%	7%
– Fluorescent lamps	33%	86%
– LED and Fluorescent lamps	34%	7%
Mechanical ventilation:		
– Fans	33%	27%
– Fans and air conditioning system	67%	73%
Sticker reminder:		
– Not available	60%	40%
– Available	40%	60%
Location:		
◦ Ablution area	13%	9%
◦ Toilet area	5%	13%
◦ Bath room	0%	13%
◦ Prayer area and electrical switches	22%	25%

According to Redzuan (2001) stickers as reminder capable to generate user's energy saving awareness by three component of knowledge, visualization and action. It also lead to keep in mind the attitude to conserve (Afgani *et al*, 2015:119).



**Figure 6:** The resources reminder stickers at Surau Pulau Emas, Skudai Johor Bahru

*Source:* Field work March 2015

## CONCLUSION

As indicated earlier, sustainable practices have been in existence in the studied mosques and *suraus* in Johor and Terengganu. However, the practices show various differences between the two states, in general are considered as still at a low level. Interesting effort carried out in Johor are the implementation of Rain Water Harvesting System and the sticker reminders. In Terengganu, the use of alternative water resources such as wells and underground water can be potentially viable and sustainable. Several other approaches to conserve energy and water in mosques and *suraus* have yet to be explored.

However, the efforts and future explorations cannot be concluded based on face value. The effort should be seen holistically, as the effort should be assisted by enhancing economic ability of the mosques management. As a public entity, support from the relevant authorities (Government agencies such as Islamic departments, KeTTHA, etc.) and community in terms of knowledge, encouragement as well economical helps is another area for further study. This is to ensure sustainable practices are materialized in mosques and *suraus*.

## Acknowledgement

The authors wish to express their gratitude to Mosques and *Suraus* committee members in Kuala Terengganu and Johor Bahru for their assistance during data collection for the research. The authors are indebted to the Center of Research Innovation and Management (CRIM) UniSZA under RACE project: RACE/F1/SS15/UNISZA/14 and The Ministry of Education Malaysia for all their financial, advisory and technical support.

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