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An Assessment of Green Mosque Index in Peninsular Malaysia

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Abstract: Sustainable concept has been frequently discussed and applied in attempts to balance the current and future needs. Sustainable principles in terms of Green Building Index (GBI) have been applied in various building types including residential and non-residential buildings. This article suggests a concept of sustainable religious building (i.e. mosque) to be established by forming green index for mosque. To evaluate potential sustainable principles for such building type, field observations were carried out in three states in Malaysia, namely Johor, Terengganu and Selangor in February and March 2015. The study was carried out qualitatively using non-verbal behaviour and direct observation on 45 selected mosques from the three states. From the study, 6 potential concepts can be used to establish Green Mosque Index (GMI) namely Energy Efficiency, Indoor Environmental Quality, Water Efficiency, Sustainable Site Planning and Management, Material and Resources and Innovation and Design. These concepts are potentially useful as embryos to a continuous assessment index for mosques in Malaysia.

Key words: Green · Index · Mosque · Sustainability

INTRODUCTION

World climate change which has significantly affected human being and the ecosystem directly or indirectly is currently a hot topic for discussion. Various factors have been identified as the cause to this phenomenon, including developments which neglect implication on environmental sustainability. Sustainable development fulfils the current needs without damaging the environment and not adversely affecting the capacity of future generation to fulfil their own needs [1]. The concept of building sustainability is particularly focusing on improving effectiveness in resources consumption (such as water) while reducing adverse implication from the building on human health and environment during its operation. This can be achieved through a better settlement effort, building design, operation, conservation and waste disposal system [2]. For this purpose, green technology was introduced as an initiative involving various techniques and materials' exploration using renewable clean energy without containing elements harmful to health [3].

On 20th October, 2009, the Ministry of Public Works was directed to ensure all new government's buildings to be integrated with the Malaysia Green Building Index (GBI) criteria. Researchers have discovered that several works have been carried out on sustainable principles in school buildings [4, 5], higher education institutions [6], universities [7, 8] and private as well as government's buildings [1, 3, 9, 10]. However, such sustainable building principles for mosques to the authors' knowledge receive little or no attention. The research works on which this article is referring to is an attempt to establish sustainable concept for mosque buildings which lead to the formation of Green Mosque Index (GMI).

Literature Review: The GBI, recognized by the Malaysian government is used to promote sustainability in built-environment and to increase awareness among developers, architects, engineers, planners, designers,

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builders and the public [5]. Recognition of GBI with green building characteristics will lead to energy and water conservation, reducing the rate of pollution, environmental conservation and continuously healthy indoor environment.

In implementing the green technology, there exist different issues and challenges among different countries. For example, in USA, the issues are the lack of knowledge and awareness, incorrect information [11], expensive environmental friendly products, lack of commitment and less stringent environmental regulation [12]; financial issue in United Kingdom [13]; lack of guidelines and information [14]; in Sweden; lack of administration resources, expensive products and services costs and public officers are often avoiding the use of environmental criteria in making decision [15] in China; lack of appropriate administrative methods and economy [16], in Malaysia, lack of awareness, knowledge and tools in identifying green products, insufficient awareness, system and law [17, 18, 19]. Social factors contributing to these issues are related to knowledge gap in green technology within the society, which is considered as still in the early stage. Obtaining approvals for projects tend to be time consuming; hence preparedness of market to implement green technology is low. Financial challenges include high project costs and limited financing schemes. Green technology projects received less support in terms of funding from other financial institutions. To several, the concept of green technology is new, record on project performance is lacking and companies are just beginning to register.

MATERIALS AND METHODS

The research, on which this article is referring, employed a qualitative method. Forty five mosques and *suraus* in Johor Bahru, Kuala Terengganu and Selangor were investigated by using direct *observation* techniques. The field works were carried out in February and March 2015. Implementation of sustainable practices was recorded based on a checklist prepared before the field work. Photographs were also taken as to further explain the collected data.

RESULTS AND DISCUSSION

From the observation, the majority of the mosques in the three case study areas have implemented some sustainable principles which appear in the Green Building Index (GBI). The practices tend to be varied in different states which can be observed in Table 1.

Water Efficiency (WE): One of the sustainable practices is efficiency of water consumption, particularly the effective consumption of water and the use of alternative water. Benefiting from alternative water supply is vital for long term consideration, as human kind will be facing a serious water crisis in the future. According to a report published by the United Nations Environment Programme, if people consume water at the current rate, two-third world's population will face difficulty in obtaining water supply by 2025 [21].

The Malaysian government is currently encouraging its people to wisely use clean water supply [22]. The uses of alternative water supplies which are free of charge are required to overcome problems arising from disruption of the main water supply system. Sustainable practice in water consumption is shown in Figure 1. In Johor, all mosques and *suraus* receive water supply from the main provider '*Syarikat Air Johor Sdn. Bhd (SAJ)'*. However, there are 13% of the mosques and *suraus* receive water supply from an alternative source especially rain water harvesting system (RWHS). The stored water from RWHS is used to wash kitchen utensils. Quality of rain water is almost similar or even better than ground water because the content is free from sands and rocks [23] and it is proven to be clean [24].

According to Federal Department of Town and Country (JPBD) [25], RWHS is a method derived from the Best Management Practices (BMP) in the effective water management in Malaysia [26]. RWHS is an alternative supply which centres at green technology, safe, sustainable [27], able to slow down surface water flow [28] and other advantages such as reduce clean water consumption and reduce water bills [29].

RWHS has existed in mosques and *suraus* in Johor Bahru (13%) and 20% of them are potential users of RWHS in the future. This is based on observation that those mosques and *suraus* have already installed basic components of the system. In Terengganu, the use of RWHS for mosques has started with the provision of RWHS basic components (6%). While in Selangor, the tendency of the use of RWHS was not seen in the studied mosques and *suraus*. According to a study undertaken by National Hydraulic Research Institute of Malaysia (NAHRIM), 34% of treated water can be saved if rain water harvesting system is properly applied [22].

Table 1: The review of current sustainable practices in the observed mosques in the three states.

Green principles	Johor Bahru	Terengganu	Selangor
Water Supply:			
- SAJ / SATU / SYABAS	87%	80%	100%
- SAJ & SPAH	13%	0%	0%
- SATU & Well / Underground Water	0%	20%	0%
Rain Water Harvesting System (RWHS)			
o Available	13%	0%	0%
o Not Available	87%	100%	100%
	------	------	------
o Potential for RWHS	20%	6%	0%
Facilities in Ablution Areas:			
-Water Tap	100%	44%	82%
-Pond	0%	6%	6%
-Water Tap and Pond	0%	31%	12%
-Water Tap and Well	0%	13%	0%
-Water Tap/Pond/Well	0%	6%	0%
Facilities in Toilet Areas:			
-Toilets & Single Flushing Cistern	53%	60%	40%
-Toilets and Pail	0%	6%	7%
-Toilets & Single Flushing Cistern/Pail	20%	20%	53%
-Toilets & Double Flushing Cistern	7%	7%	0%
-Toilets & Single/Double Flushing Cistern	7%	7%	0%
-Toilets & Single/Double Flushing Cistern/Pail	13%	0%	0%
Facilities in Bathrooms:			
-Shower	47%	67%	33%
-Pail	7%	13%	20%
-Shower & pail	13%	0%	27%
-Only room without shower or pail	33%	20%	20%
Light source:			
-CFL / LED	33%	7%	0%
-Florescent	33%	86%	79%
-CFL / LED & Florescent	34%	7%	21%
Mechanical Ventilation:			
-Large Industrial Fan, fan & AC	12%	0%	0%
-Fan (Wall Mounted/Ceiling and Standing),	29%	33%	20%
-Fan & AC	59%	67%	80%
Sticker reminder for water and electric conservation:			
-Not Available	60%	40%	56%
-Available	40%	60%	44%
Location of Sticker Reminder:	------	------	------
o *Wudhu* area	13%	9%	22%
o Toilet area	5%	13%	5%
o Bathroom Area	0%	13%	0%
o Main Prayer Hall/at Electric Switched	22%	25%	17%
Recycle bins:			
-Available	65%	100%	100%
-Rubbish burning	2%		
-Not Available	33%		
Status of Recycle Bins:	------		
o Functioning	9%		
o Empty	2%		
o Mixed between Recyclable and Non-Recyclable Rubbish.	20%		
o Normal Rubbish	2%		

Source: Fieldwork (March 2015)

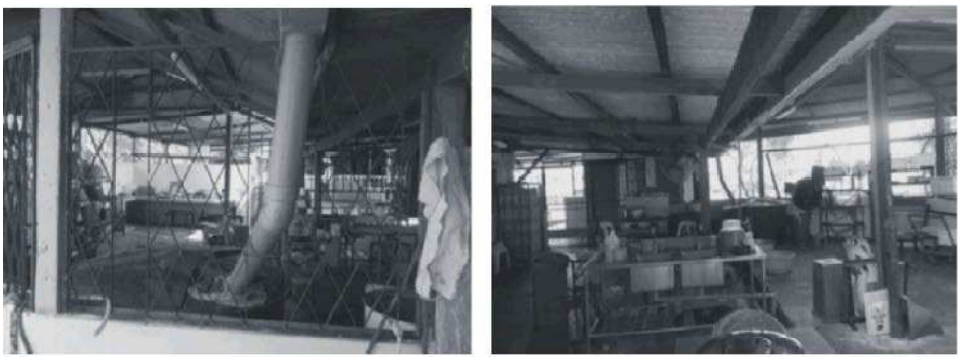

Fig. 1: RWHS at a Mosque in Johor Bahru

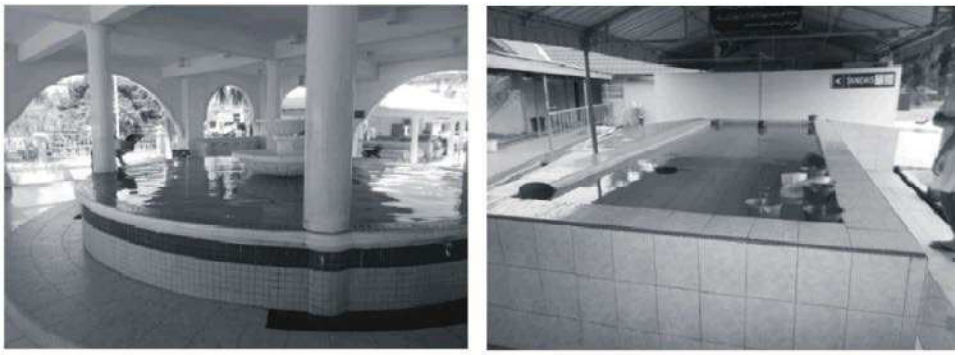

Fig. 2: The Use of *Wudhu* Ponds in Masjid Abidin Kuala Terengganu and Jameatus Solehah, Selangor

In Terengganu, the researchers have found that all mosques and *suraus* received water supplies from the main provider *Syarikat Air Terengganu Sdn Bhd (SATU)*. However, some of the mosques and *suraus* (20%) obtain water supplies from alternative resources particularly underground water using well or pump. Underground water is a potential alternative water source to be developed to overcome future water shortages [30]. In contrast, the studied mosques and *suraus* in Selangor all (100%) received water supply from *Syarikat Air Selangor Sdn Bhd* (SYABAS). There is no alternative water resources found in the studied mosques and *suraus*.

In the effort of conserving water in the units of analysis in the three states, the researchers have found various practices in *wudhu* areas. In Johor, all of them use water taps for ablution (*wudhu*) in *wudhu* area. In Terengganu, they use water taps (44%), *wudhu* ponds (6%) and a combination of water taps and *wudhu* ponds (31%), use collected water from water taps and well (13%) and all aforementioned modes of water collection (6%). In Selangor, majority of them are found to use water taps (82%). There are also mosques and *suraus* using ponds (6%) and a twelve per cent combination of water taps and *wudhu* pond (12%) (Refer to Figure 2). In the current scenario, many mosque users are not aware that they are consuming water excessively while making ablution [31].

Fig. 3: Application of Double Flushing Cistern for Toilets in Masjid Wakaf Tembesu Kuala Terengganu

Regarding water conservation in toilets, the researchers have found varied implementation in the three states. There are 53% of the studied mosques and *suraus* in Johor use 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 a similar pattern, 60% of the mosques and *suraus* in Terengganu are using toilets 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 (Figure 3). Also, 7% of them are using a combination of

Fig. 4: The Use of CFL Lamps in *Surau Al Falah*, Bandar Pulau Jaya 2, Johor Bahru and *Surau* Al Ameen, Bandar Mahkota Banting

Fig. 5: Natural Ventilation at Masjid Jamek Tan Sri Ainuddin Wahid, Johor

single and dual flushing cisterns. Surprisingly, in Selangor only 40% of the studied mosques and *suraus* are using single flushing cistern, while 7% are still using pail and 53% using a combination of pail and single flushing cistern. As the use of dual flushing cisterns is more water saving 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.

In terms of implementation of water conservation in bathroom, researchers discovered that the practice tends to be different in the study areas. In Johor, 47% of the units of analysis have shower in bathrooms, 7% use pail and 13% use both shower and pails for in bathrooms and 33% do not have shower and pail in bathrooms. In Terengganu, a large percentage (67%) has shower in bathrooms, 13% use pails and the rest 20% do not have shower and pails in use bathrooms. While in Selangor, 33% of them have shower, 20% use pail and 27% use shower and pails in bathrooms.

Energy Efficiency (EE): According to statistic published by the International Energy Agency (EIA), Malaysia has shown an increase in the consumption of electricity in 2010, 109.82 billion kilowatt-hours (kwh) compared to 102.78 billion kwh in 2009. This indicates an increase in electric consumption for 7.04 billion kwh per year [32]. Malaysians are urged to change their lifestyle towards energy conservation and environmental friendly, so that sustainability of the environment can be maintained [33].

Researchers have discovered that there are differences in the practice of managing electrical lighting in the three states as shown in Figure 4. In Johor, there are 33% of the studied mosques and *suraus* using CFL lamps 33%, florescent lamps 33% and a combination of CFL lamps and florescent lamps 34%. In Terengganu, 7% of them are using CFL lamp, 86% are using florescent lamps and 7% are using a combination of florescent and CFL lamps. In Selangor, 79% of them are using florescent lamps and 21% are using CFL and florescent lamps. Currently, the use of environmental friendly lamps is increasing, such as LED and CFL lamps which offer better luminance compared to florescent lamps and bulbs [34, 35]. They are also more economical [36], more lasting and safe [37, 38].

A good building is one that has good ventilation [39]. Bad air ventilation may adversely affect health [40], causing negative consequences physiologically as well as psychologically [41]. Every building has a ventilation system, mechanically such as fan and air-conditioning system, as well as natural ventilation system (Figure 5) which relies mainly on the design of the building [40].

Table 2: Proposed Sustainable Index for Mosque according to the Green Concept

Value Sustainable	Green Mosque Index (GMI)
Energy Efficiency (EE)	-Availability of written reminders (eg. sticker reminder)
-The use of sustainable lamp (eg. LED/CFL)	
-Building design that allows more daylight into the building	
-Building design that allows more natural ventilation into the building	
-Availability of alternative power sources (eg. solar cell)	
-Availability of automatic sensing to control the use of lighting	
Indoor Environmental Quality (EQ)	-Availability of spaces which allow natural air flow
-Availability of air penetrable wall	
-The use of materials which generate less heat (eg. timber)	
Water Efficiency (WE)	-Availability of Rain Water Harvesting System.
-Availability of pond	
-Availability of well and reserve water source	
-Availability of economical water cistern in toilet (eg. double flushing water cistern)	
-Availability of water tap with automatic control	
-Availability of water taps with infra-red.	
-Regular maintenance	
Sustainable Site Planning & Management (SM)	-Recycle-able ablution water
(Recycle *wudhu* water can be used for various purposes such as for plants watering,	for use in toilets)
-Using water from RWHS for various purposes (eg. washing kitchen utensils, for plants	watering, for toilet use, etc)
-Using water from well for various purposes (eg. plants watering, for toilet use)	
Material & Resources (MR)	-Using transparent or translucent roof at suitable areas.
-Using easy cleaned materials for walls, floors, etc.	
Innovation & Design	-Innovative design for controlling mechanical lights (eg. automatic switches) Renewable energy (eg solar cell)
-Passive design to facilitate natural light and ventilation into the building.	

In Johor Bahru, use 29% of the mosques and *suraus* use only fan for mechanical ventilation, 59% use fan and air-conditioning system and 12% of them use a combination of fan, air-conditioning system and large scale industrial fan. The industrial fans are believed to be able to reduce electrical consumption as it compensates the use of small fans more effectively. In Terengganu, 33% of them use only fans for mechanical ventilation and 67% use fans and air-conditioning system. In Selangor, majority (80%) of them use a combination of fans and air-conditioning system, while the rest 20% rely only on fans. The increased use of air-conditioning system reflects less sustainable practice, as the use of such ventilation system contributes to carbon release, which in turn reduces the ozone layer [13, 36].

Using stickers is seen as a common effort to encourage sustainable practices in water and electricity conservation. In the studied mosques and *suraus* in Johor, stickers with reminders for water and electric consumption have been used by 40% of the studied mosques and *suraus*. Thirteen percent of the reminders are found in *wudhu* areas, 5% in the toilets and 22% in main prayer halls especially reminders for electrical consumption. Similarly in Terengganu, sticker reminders have been used in many (60%) mosques and *suraus*. Nine percent (9%) of this figure are found in *wudhu* areas, 13% in toilets, 13% in bathrooms and 25% are found on elctrical switches in the main prayer halls. In Selangor, sticker reminders are found to be practiced by as many as 44% of the studied mosques and *suraus*; out of this figure, 22% are found in *wudhu* areas, 5% in the toilets and 17% reminders for electrical consumption in the main prayer hall. It is expected stickers as reminders would generate user's energy saving awareness by three key components of knowledge, visualization and action [42].

Waste Recycle of Material & Resources (MR): In 2005, around 7.5 million tons domestic waste were recorded throughout the country and the total is expected to increase by 30, 000 tons daily by the year of 2020 [43, 44]. On average, a citizen disposes 0.8 kg rubbish daily and this amount is increasing to 1.5kg in urban areas. The Ministry of Housing and Local Government in 2001 discovered around 16, 247 tons of rubbish produced by Malaysians every day and it was expected to rise to 30, 000 tons daily until 2020 [6]. The practice of waste recycle is able to reduce congestion in waste dumping ground [45].

Different practices of waste recycle are found in the studied mosques in the three states (Refer to Table 1).

The study found that the 33% of them provided recycle bins in the mosque areas. However, the recycle bins provided were not yet fully utilized. The recycle bins seemed to be regarded by the visitors as normal litter bins. The results show that there are still empty bins (2%), bins containing normal rubbish (2%), with mixture of recyclable and non-recyclable waste (20%). From researcher's observation, there was only one *surau* without any recycle bin. Rubbish around the *surau* would be collected and cleared by burning. This practice, (rubbish burning) according to U.S. EPA in the year of 2001, will produce poisonous gases which are harmful to health and the environment, including CO, CH4, NOX, SOX, PCDD/F (Polychlorinateddibenzo-para-dioxin, polychlorinated dibenzofurans), VOC, TSP, PM10, PM2.5, etc. These poisonous particles potentially cause respiratory problems, carcinogenic cancer and hormonal disturbances [46]. In Terengganu and Selangor, the units of analysis have no recycle bins placed in their compounds.

A Proposed Green Mosque Index (GMI) in Peninsular Malaysia: Based on the results, implementation of sustainable values has existed to a certain level in the three states. Efforts are undertaken by the researchers to form index for sustainable practices for mosques and *suraus* in Peninsular Malaysian. It will be based on sustainable building characteristics recognized by the Malaysian Institute of Architects (PAM) and the Association of Consulting Engineer Malaysia (ACEM) which can be seen in Table 2.

Each mosque and *surau* should have efficient use of renewable energy, such as solar energy which is not found in any of the studied mosques and *suraus*, as well as practice sustainable maintenance. Excessive energy and water consumption can be reduced by using reminder stickers at electrical switches, *wudhu* places, toilets, bathrooms, etc. which directly remind users of sustainable practices. Mosques and *suraus* are also to have effective drainage system management. The existing RWHS in mosques and *suraus* should be used for non-drinking purposes (*wudhu*, washing, watering plants, etc) as an alternative to main water supply. The used *wudhu* water can be recycled and be used for other purposes such as watering plants in the compounds. Sustainable practices should conserve water wisely and efficiently. This can be implemented through the use of pond in *wudhu* places shower will use water excessively and the use of double flushing cistern in toilets. Mosques and *suraus* should be designed to be environmental friendly, facilitating effective airflow across the building in order to optimize natural ventilation. The building should be designed to optimize the use of daylight and to reduce dependence on mechanical means. The design of the building should be able to offer quality air, lighting and acoustic comfort to the users. More trees should be planted in the compound areas to provide shade and absorb heat.

CONCLUSION

In conclusion, this study suggests that some sustainable practices which have already existed in the three states with some variations. The findings suggest religious buildings especially mosques and *suraus* inculcate sustainable practices in design and layout planning and management of the physical and non-physical resources of the buildings. Existing buildings may incorporate sustainable practices which are more practical and less costly in the short and medium term, as most religious buildings rely on people's donations as their main source of income.

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