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The Green Mosque and Climate Change Mitigation: A Study of Green Mosques in The Klang Valley

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Abstract

Climate change is a pressing issue that demands changes in public behaviour and support from all sectors of society. Religious institutions such as mosques play a crucial role in promoting climate change mitigation efforts. Therefore, this study investigates the role and characteristics of "green mosques" in four Klang Valley mosques: Selayang Baru Mosque, Al-Hasanah Mosque (Bangi), Zaid bin Haritsah Mosque (Jalan Gombak) and Masjid Jamek Sultan Abdul Aziz (Petaling Jaya). The study data were obtained through observations and interviews with mosque committee members. In this light, the study's focus was on green mosque features that support climate change mitigation, including energy and water efficiency, solid waste management, and greening initiatives. The findings showed that all four mosques utilise LED lights, energy efficient air-conditioning and solar power to save electricity consumption. For water efficiency, there is the use of rainwater harvesting, wells, and water-efficient faucets. Additionally, the mosques implemented recycling programmes with designated bins, activities, and used cooking oil collection. Notably, some mosques incorporated hydroponics, aquaponics and herb gardens and conducted environmental sustainability programmes and outreach initiatives to foster community involvement. The waqf of green mosques and crowdfunding efforts by the local community provide financial sustainability for these green mosques. Overall, the efforts of these mosques could foster an environmentally friendly lifestyle within local communities and contribute to climate change mitigation efforts.

Keywords: *Green Mosque, Eco-Mosque, Climate Change, Mitigation, Sustainable Lifestyle.*

INTRODUCTION

Climate change, including rising temperatures, is a pressing issue that demands changes in our behaviour to mitigate its effects (Koehrsen, 2020; Chen, 2020; Hermann, 2020). The World Economic Forum's Global Risk Report 2020 identified climate change as the most significant global threat and highlighted the need for its mitigation and adaptation (The Global Risks Report, 2021). Various efforts have been taken to promote climate change mitigation behaviours, including education (Craig & Allen, 2015; Mbah et al., 2022), awareness programmes (Carpenter et al., 2016; O'Neill & Buckley, 2019) and social support (Culiberg & Gambier, 2016; Estrada 2017). In addition, policies related to the environment (Marshall et al., 2017; Sharma et al., 2021; Mbah et al., 2022) play an important role in fostering climate change mitigation behaviour in society.

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The Islamic Declaration on Global Climate Change (International Islamic Climate Change Symposium, 2015) emphasised integrating Islamic principles with science to address climate change. It highlighted concepts like K*halifa* (stewardship)*, Taqwa* (piety), and *Mizan* (balance). The declaration garnered international attention, which led to the United Nations Environment Programme publishing "Al-Mizan: An Islamic Covenant for Earth", underlining the vital role of Muslim organizations and leaders in tackling climate change.

Mosques play an important role in the realization of the Islamic Declaration on Global Climate Change. Mosques are central to the Muslim identity, and their roles extend beyond places of worship. They serve as social, economic, educational and environmental sustainability hubs (Abd Rahim et al., 202; Harsritanto, 2021). Iswanto et al. (2019) highlighted the importance of well-managed mosques, emphasising their potential to empower communities, particularly the younger generation and act as a civilisation centre. Therefore, mosques play an important and major role in educating the communities on climate change and act as centres of civilization beyond worship. Historically, the Nabawi Mosque, constructed by the Prophet Muhammad PBUH, is the best example of a green mosque; even though its design and technology are not compatible with some modern mosques, its sustainability principle offers valuable guidance (Omer, 2010; Azmi & Kandar, 2019).

Islam is the majority religion in Malaysia, with over 6,500 mosques (JAKIM, 2022) compared to 5,320 non-Muslim houses of worship (temples, churches, and other places of worship). In this regard, mosques have a significant impact on energy and water consumption as Muslims visit mosques every day from morning to night, and the number of worshippers increases during Friday prayers, causing a large amount of energy and water consumption. This situation undoubtedly affects the mitigation actions of climate change. In the meantime, Malaysia is committed to addressing the issue of climate change by targeting a 45% reduction in carbon emissions by 2030, in line with the RMK-12. The Ministry of Environment and Water (KASA) established its greenhouse agenda in 2020, focusing on energy and water efficiency, waste management, and sustainable product use (KASA, 2020). This agenda aligns with national policies and the UN Sustainable Development Goals (SDGs) 11 (sustainable cities and communities) and 13 (climate action). Thus, studying green mosques can provide valuable insights for achieving a greener mosque agenda. Research outcomes can improve environmental conditions, enhance mosque lectures on environmental issues, and position Malaysia as a role model for other mosques globally. At the same time, it is possible to strengthen the role of religious institutions in developing Islamic civilization through elements of environmental conservation.

The Role of Green Mosques in Climate Change Mitigation

There has been an increase in research focusing on climate change mitigation behaviour. While existing research has largely been focused on formal and informal education in schools (Cordero et al., 2020; Karpudewan, 2019; Wan Nur Hafizah et al., 2021), less attention is given to informal education through religious institutions like mosques. A study by Mostafa (2017) found a positive relationship between religious factors and climate change mitigation behaviours. In addition, education in religious institutions, such as education in mosques, also supports intergenerational education, as parents and communities influence children's climate change mitigation behaviour (Wang et al., 2022).

Past studies have highlighted various aspects of green mosques that can influence climate change mitigation behaviour: eco-friendly architecture (Purisari et al., 2017; Azmi & Kandar, 2019), sustainable landscaping (Sakıcı & Pişkin, 2019), efficient energy and water use (Fouih et al., 2020; Hidayat et al., 2018; Azmi & Kandar, 2019), proper ventilation (Husin et al., 2020) as well as solid waste management (Abd Aziz et al., 2019; Asmawati et al., 2018). For example, Monjed (2021) conducted a study to recycle dates at the Mosque in Mecca after breaking fast and found that date seeds have the potential to produce bioethanol. Thus, green mosque initiatives could significantly influence climate change mitigation behaviour within communities.

Religious institutions play a significant role in climate change mitigation by providing education (Asmawati et al., 2018; Abdul Aziz et al., 2019), which leads to behaviour change (Sharma et al., 2021) and impacts environmental policies (Sharma et al., 2021). Initiatives like green house of worships offer a creative and innovative platform for preaching and engaging local communities in environmental sustainability. Some studies explored the influence of green houses of worship on sustainability practices within local communities (Abdul Aziz et al., 2019; Asmawati et al., 2018). However, these studies have focused on the concept of

sustainable "surau" (smaller prayer halls) within educational institutions. Abdul Aziz et al. (2019) studied a school environment, while Asmawati et al. (2018) implemented the 'Imarah Green Project' at a surau (prayer room) in the Academy of Islamic Studies, University of Malaya (APIUM). Their findings suggested that a sustainable surau could promote environmentally friendly behaviours within the school community in several ways, particularly by disseminating ethical values and moral foundations and acting as a social agent in fostering a culture of sustainability and developing soft skills. This suggests that environmental lectures delivered in mosques can similarly shape climate change mitigation behaviour within communities.

RESEARCH METHODOLOGY

The data were obtained through observations and interviews with the committee members of four green mosques around the Klang Valley: the Selayang Baru Mosque (SBM), Al-Hasanah Mosque (AHM), Zaid bin Haritsah Mosque (ZHM) and Masjid Jamek Sultan Abdul Aziz (SAM). The observations focused on green mosque facilities that support climate change mitigation, namely energy efficiency, water efficiency, solid waste management, and greening. Purposive sampling was used in this study to select participants who could provide relevant information and answer the research questions.

Data Collection Procedures

The researchers contacted participants prior to conducting interviews for data collection. To ensure the smoothness of the interview session, they explained the purpose of the study and obtained their consent to participate. Researchers then scheduled a date and time for the interview based on the participants' availability and asked for permission to record all conversations related to the study.

Data Analysis Procedures

The study data were collected through semi-structured interviews and questionnaires. Once the interviews were completed, the researchers transcribed the interviews verbatim. The transcripts were then analysed manually using a three-stage thematic analysis approach to derive themes and sub-themes.

FINDINGS

The study's findings will be discussed based on four key characteristics of the green mosque, namely energy efficiency, water efficiency, solid waste management and greening. Additionally, the discussions explored the role of mosque lectures in promoting environmental sustainability, the involvement of mosque committees and strategic partners, and the importance of local community support. Challenges faced by mosque management were also presented, including issues related to foreigners, managing the stray cat population, the costs of maintaining sustainable practices, and a potential lack of environmental awareness among mosque attendees.

Energy Efficiency

The green mosques in the study implement energy-saving measures by utilising alternative energy sources, such as solar power.

Here, there are about 50 panels because the power is about 22.71 kW… approximately 50,000 kilowatt-hours per year, with an average savings of about 12,000 per year…" (AHM)

we also installed solar panels for the lights. This is a small-scale application…" (ZHM)

just started with practising to reduce the electricity load at night...we use small solar lights to provide nighttime illumination...so, we don't use conventional lights...generating cost savings..." (ZHM)

there's only one light we use solar…a spotlight near the pump, for the house with the bored well... There I use solar, one spotlight only...there's only one we use solar...a spotlight near the pump..." (SBM)

> "Solar power for the mosque has been approved by the Department of Islamic Affairs Selangor (JAIS). We are currently using solar panels for our hydroponic garden." (SAM).

In addition, the mosques have adopted LED lighting as a strategy to reduce electricity consumption.

> "We prioritise to use green products as much as possible... green products like light bulbs, solar panel, LED, and now if we look around this mosque, everything..." (AHM)
>
> "Now our lights, mostly we use LED...We've changed our lights to LED lights. So, whatever we can use, it's still within tolerance...if it burns out, we will convert it to LED...Almost 60 per cent we've changed to LED lights..." (SBM)

"We've already switched to LED lights..." (ZHM)

"The prayer rooms are now illuminated with LED lights..." (SAM)

Maximising natural daylight within the mosque is another sustainable strategy to reduce electricity consumption.

> "…previously, we relied on large spotlights to illuminate the main hall. However, we made a significant change by opening up the dome to maximise natural daylight. This eliminated the need for any artificial lighting, including solar-powered lights, during the day, we use daylight only. natural lighting..." (AHM).

Water Efficiency

Regarding their water efficiency practices, two of the mosques studied use alternative sources like wells to increase water efficiency.

> "So far, for water conservation, it's well... actually, there are two tube wells here... tube... the mosque utilises two on-site tube wells. The well water undergoes treatment before use. However, there could be potential challenges in the future, as the water storage tank might need to be located underground due to gravity-fed systems requiring lower tank placement." (AHM)
>
> "We also have a bored well... we have one, we connected it for... we use it for washings. We use the bored well... We have that water efficiency aspect towards that direction..." (SBM)
>
> "Our new well able to use this year in April, just before Eid. We spent April preparing everything—the pool, the pump—and we've been utilising it for over three months now." (SBM)
>
> "Wells are indeed efficient to save water..., but when the water is saved, the water pump becomes almost the same, maybe a little less..." (SBM)

Moreover, there are three mosques in the study that utilise rainwater harvesting systems as a water conservation practice. The harvested rainwater is primarily used for plant irrigation and flushing toilets. "...We have a new source... from rainwater. Harvesting evenly from the roof into the tank... the rainwater is used to irrigate seedling plants, promoting water conservation in landscaping...the rainwater is also used for flushing toilets, further reducing reliance on municipal water supplies." (AHM)

"Installation of rainwater harvesting system for plant irrigation…" (ZHM)

Moreover, the studied mosques also collaborate with strategic partners like MGTC to implement water-efficient practices. These partnerships facilitate the installation of water-saving fixtures that promote sustainability in these mosques.

> "...we've also implemented water-saving measures by installing water-efficient fixtures and pipes. Compared to conventional fixtures and pipes, these allow us to better control water flow and potentially reduce overall usage by half..." (AHM)
>
> "...the implementation of water-efficient fixtures has been successful in maintaining our water usage levels. However, we recognise the potential for further improvements in water conservation..." (ZHM)
>
> "...thirdly, thanks to a recent sponsorship, we've been able to upgrade to water-saving faucet heads throughout the mosque. We'd be happy to show you these new fixtures..." (SBM)

"…with MGTC's support, we've upgraded to water-saving fixtures to promote water conservation within the mosque." (SBM).

Lastly, some of these mosques implement water-efficient ablution practices, including the use of *kolah* (ablution pool), to minimise water usage.

"...we also use *kolah* for performing ablution..." (SBM)

"...both of our *kolah*, the ones over there, we brought them there..." (ZHM).

Solid Waste Management

The studied mosques incorporate recycling as part of their solid waste management strategies. The initiative involves providing recycling bins or establishing dedicated recycling collection centres.

"We have, we already have recycling bins..." (ZHM)

> "...recycling bins, we do have them but not fully practice yet..." (SBM)
>
> "...we actually told the congregation to separate food waste into one bin, plastic into another because plastic...we already have a recycling collection centre...we have a supplier who manages it..." (AHM)
>
> "...The collection centre is there...there's a party that manages it periodically, they place bins in the mosque area..." (SAM)
> "The recycling bins...We actually did make them..." (SBM)
>
> "For food...we used to do buffet style and wrapping, but now we prefer wrapping... So, food waste has reduced here..." (SAM)

On the other hand, one of the mosques no longer carry out the collection and sale of used clothes actively,

> "...previously, it was there, the Muslim women used to do a lot. They made pre-loved clothes..." (AHM)
> The study also revealed that some mosques successfully collect used cooking oil for recycling to create a revenue stream for the mosque. However, some of the mosques face limitations due to existing used cooking oil collection programmes organised by local residents' associations, highlighting potential areas for collaboration in future waste management efforts.
>
> "...the used cooking oil contributes to the mosque...usually, it's from business owners, restaurants, but actually, most of it comes from individuals because we try as an effort to get our oil, we try nearby restaurants, ask them to send oil here...With what the buyers of used oil say they will take...we have a collection centre, we have a supplier, every year we open bids for used oil suppliers... they are eager to buy from us because the price of used cooking oil fluctuates in the market...used oil price is very high. Initially, we got 22 cents per kilo...every 4 days, if not much collected, they pick up. The estimated sales from used cooking oil are around RM3,000 per month, which can cover the mosque's operating costs." (AHM).
>
> "Not implemented by the mosque, but the residents' association does it in this area..." (SAM).
>
> "...So, what we do during Ramadan and Syawal is collect used cooking oil. Our target for this zone is to get 300 KG..." (ZHM)

Greening

Observations of the mosque's surroundings and interviews with committee members revealed their commitment to creating a green environment. This is evident in the presence of fruit trees and herbs around these mosques' compounds.

> "Our herb garden features a variety of labelled plants, allowing visitors to easily identify each herb. Additionally, the mosque grounds incorporate ornamental plants for aesthetic appeal, shade-providing plants for comfort, and various grasses…" (AHM).

Fruit trees are planted around the mosques in two scales: individual fruit trees and orchard development. Individual fruit trees involve planting specific fruit trees in designated locations around the mosque grounds.

As for orchard development, the mosque has established or is planning to establish a dedicated orchard area with various fruit trees.

> "...fruit trees are beneficial to humans and animals, so we plant fruit trees. I don't know, maybe you can go after this to places where there are durian trees... here we have Musang King durian, Black Thorn durian...We plant mango trees, coconut trees, date palms, mangosteen trees, many types of herbs we plant...planting fruit trees..." (AHM)

"...the garden is still under construction..." (ZHM)

> "...we establish and create... vertical greenery and so on...we plant herbal plants... salads... herbs for consumption..." (ZHM)
>
> "...Some are still growing, we call it a garden... our garden, we plant fruit trees...We convert ordinary trees that have no yield, at least we get greenery, and we get yields from the trees..." (SBM).

Additionally, the mosques studied promote sustainable practices by incorporating hydroponics and vertical hydroponic planting systems. These techniques allow efficient plant cultivation in limited spaces.

> "...the produce from our hydroponic system is donated to the congregation members. The congregation generously volunteers their time and effort to care for the plants, contributing to this and other mosque activities. We are also planning to introduce catfish cultivation in the future." (SAM)

"...It's like in front there, vertical farming... hydroponic plants... there are..." (ZHM).

Masjid al-Hasanah also implements an aquaponics system. This system integrates two elements of the natural environment: animals (aquaculture) and plants (through hydroponic cultivation). It has an aquaponics system called the urban kit provided by the mosque through grants from MOSTI to families in need (asnaf). Each asnaf family will take care of one urban kit. The produce from hydroponically grown plants such as *Selom* and *pegaga* (pennywort), along with tilapia fish, will be sold to nearby restaurants to provide income to these asnaf families.

"At Masjid Hasanah, we have a programme called the Urban Kit Aquaponics Project involving vegetable cultivation and fish farming. This project is specifically aimed at assisting the asnaf and B40 groups, with a target of at least 100 asnaf individuals. The project received funding of RM150,000 from MOSTI. So, with the funds provided by MOSTI, we generate income for the asnaf... They not only sell vegetables and fish but also use them for their daily needs. From a research perspective, there is indeed data. We conducted a survey on these participants regarding kitchen expenditure savings. They were able to save 79.80, approximately RM80. As for the sales of vegetables, they generated up to RM156.00 from selling vegetables and fish. However, lately, we have also educated the participants to produce pennywort..." (AHM)

Mosque Outreach

The findings from the interviews also revealed that under the theme of mosque outreach, the study mosques encourage the involvement of youth in various activities. However, some mosques are inconsistent in carrying out community engagement programmes, especially those related to environmental initiatives. "Yes, it's part of MGTC's program. It has been held several times... we had representatives from Air Selangor come for a special Friday sermon on water conservation, and they provided plastic equipment for the pipes so that the water would flow out slowly... representatives from TNB have also participated in educational presentations, typically during Friday sermons when attendance is highest...." (AHM)

> "...we have a youth club..." (ZHM)
>
> "...that day, the youth representatives organised a mobile legend competition, with prizes...There are still more activities, their director is a youth representative...We have bowling nights and badminton sessions...that night, even the imam got involved in badminton. The youth handle bowling, and on Sundays, we have youth-run Sunday futsal; they oversee it..." (SBM)

> "Alhamdulillah. Youth involvement is very active... Many programmes are conducted together, including hiking in Bukit Gasing, badminton, and soccer..." (SAM). These mosques have seamlessly integrated environmental elements into their programmes, activities, and even in their Friday sermons to promote sustainability.

"Yes, it's part of MGTC's programme related to the environment..." (AHM)

> "We once had representatives from Air Selangor come to talk about water management..." (AHM)

> "TNB representatives have also presented, usually during Friday sermons because there are more attendees..." (AHM)

"So, we want to distribute seedlings, plant seeds..." (ZHM)

"Yes, with the Department of Irrigation and Drainage (JPS)..." (ZHM)

"We've conducted lectures related to the environment..." (MZH)

> "We've organised environmental programmes, but it's been a while, 2-3 years ago..." (SBM)

"Environmental programmes are organised by MGTC after Zuhur prayer." (SAM)

> "Planting trees and so on... so we want to distribute seedlings, plant seeds...they plant them...at that time, at least they get vegetables and so on to share...part of JAWI's program" (ZHM)

> "So... it's *sukan rakyat* (recreational activities) ... what we're doing to achieve more objectives. Hopefully, to further enhance mosque education and so on... what we're doing as part of lectures and so on... we want to do this... sharing knowledge like bringing water harvesting, palm water management, club management, and so on... to have these courses conducted at the mosque..." (ZHM).

The Role of Mosque Committee Members in Promoting Environmental Sustainability

Mosque committee members serve as essential pillars in mosque management. Their dedication extends beyond daily operations to actively championing environmental sustainability initiatives. Their creativity plays a key role in the mosque's successful implementation of various green practices, fostering a harmonious environment for the community.

> "...this clock... it's been almost 30 years since it stopped working. We couldn't find a replacement, so we couldn't look for it anymore. So, we turned it... we turned it into a lamp... So, we strengthened it..." (ZHM).

The Role of Strategic Partnerships in Environmental Sustainability

Mosques benefit greatly from fostering strong relationships with strategic partners. The Malaysian Green Technology and Climate Change Corporation (MGTC) exemplifies such a partnership. MGTC goes beyond providing valuable advisory services, they actively collaborate with the studied mosques to organise impactful programmes that promote environmental sustainability within the mosque communities.

> "...we always take MGTC's advice on how to implement green initiatives for this mosque... Yes, it's part of MGTC's program... We are constantly audited by MGTC..." (AHM)

> "Our water conservation efforts are implemented in partnership with government agencies... the Department of Minerals and Geoscience... which provided tapware for Masjid al-Hasanah for ablution water use" (AHM)

"RHB sponsored us to install solar panels..." (AHM)

> "The programme called urban kit aquaponics project involves planting, vegetables, and fish farming... this project is funded by MOSTI..." (AHM)

> "We received a request from the University of Malaya to organise a seminar in September." (ZHM)

> "...we launched the Ramadan Syawal Go Green programme in collaboration with UM... UM came here because they have a module... So, what we did during this programme was collect used cooking oil. Our target was to collect 300 KG from this zone..."(ZHM)

"MGTC has audited our water and electricity consumption..." (ZHM)

> "The second one is with the Ministry of Food Security under the Department of Fisheries. So, they want to collaborate with mosques. They supply fish farming..." (ZHM)

"...in terms of the environment. It comes from MGTC..." (SBM)

> "MGTC has conducted workshops, provided water-saving faucets, and conducted water-saving awareness campaigns..." (SAM).

Strategic partners also play a crucial role in supporting the studied mosques' sustainability journeys. This support extends beyond technical expertise and programme collaboration. Many partners also provide vital funding, enabling the mosques to implement green initiatives and achieve their sustainability goals.

"...received funding from MOSTI amounting to RM150k..." (AHM)

> "...RHB sponsored us to install solar panels... we understand RHB isn't just for one phase only... how much their allocation is... that's why RHB... helped..." (AHM)

> "The sustainable urban garden project using vertical planting methods is funded by the Waqf Malaysia Foundation..." (ZHM).

Support from the Local Community

The local community around the mosques serves as a cornerstone in achieving sustainability goals. Their active participation and collaboration are crucial for preserving and promoting environmentally friendly practices within the mosque.

> "They volunteer to contribute their energy to taking care of plants and also for community activities..." (SAM)

Endowment programmes for plants and food banks are examples of how these mosques integrate environmental considerations into their charitable practices (*infak* or *sedekah*). These initiatives not only support the needy but also serve as indirect educational tools. By promoting resourcefulness and reducing waste through food banks and by fostering connections with nature through plant donations, the mosques subtly encourage the community to embrace environmental sustainability principles. This approach aligns perfectly with Sustainable Development Goal 1 (SDG 1) of ending poverty in all its forms.

"We also have plant endowments..." (AHM)

"We used to have a food bank, but it wasn't very successful..." (AHM)

"We have an Express aid kiosk..." (ZHM)

> "...there are also contributions from volunteers... programmes with youth, community clean-ups with the local community..." (SAM)

Challenges Faced by Mosques in Preserving the Environment

Green mosques face various challenges in ensuring environmental sustainability. External factors such as cats, foreign residents, and homelessness pose challenges. The location of the mosque near the market causes external vehicles to park there for extended periods. This affects efforts to preserve the mosques due to air pollution from vehicle exhaust.

> "...with the issue of cats... Providing food for cats is good, but when they litter on the carpet where we pray... It's already done…causing trouble… " (SBM)

> "...Many foreign residents... Even here..." (SBM)

> "...there are homeless people here..." (SBM)
>
> "Here is the market, people go to the market and park their cars here..." (SBM)
>
> "...the mosque area is surrounded by residential areas, they don't have parking... Parking is here... Even lorries park here... So, when the lorries... big lorries... These fruit lorries emit black smoke... so our environment is different... it is smoke... contribute to air pollution... with all the vehicles parked here..." (SBM)

Internal factors also play a role in hindering mosque sustainability planning, such as financial constraints (for example, water treatment from rainwater harvesting), space limitations, lack of awareness among congregants, and waste management challenges (such as Littering by KAFA students and theft of recyclable materials can create setbacks in maintaining a clean and sustainable environment. Strategies to address these issues need to be developed).

> "...costs for water treatment from rainwater harvesting... for drinking water, the cost is higher... we need a treatment plan..." (AHM)
>
> "...these congregants... some are even smarter than the committee members, they tamper with the taps to make them flow faster... They open the end part, even though we've installed everything... it's difficult to achieve savings when the congregants themselves do this... we, as the mosque committee, want to save water..." (SBM)
>
> "We also have a school nearby, so when school is in session... if there are 100 kids... they have all kinds of behaviours, like mixing water and throwing things around... when we scold them, it becomes an issue... so, it's wasteful..." (SBM)

"...they throw trash everywhere..." (SBM)

"...A contest was held, so they stole the collected used cooking oil..." (AHM)

"...For recycling, there are people who take them to sell these items..." (SBM)

"...we lack funds... unable to install solar panels." (ZHM)

> "...for this mosque, we can't install solar panels... we're just starting with practices and reducing loads at night... If there are any, it's small solar lights to illuminate at night... so, we don't use conventional lights... because it's challenging to install a solar system... this mosque is surrounded by tall buildings… tall buildings cast significant shade… reducing the amount of sunlight reaching potential solar panel... minimal sunlight... so only small solar lights are feasible..." (ZHM).

DISCUSSION

A green mosque emphasises environmental sustainability elements that play a crucial role in climate change mitigation through energy and water efficiency, waste management, and greening. In energy efficiency, various methods have been implemented by the mosque, including the use of solar power and LED lights. The use of solar lights (Suparwoto & Qamar, 2021) and LEDs (Abdallah, 2023) has also become a common practice for mosques in Indonesia. Radwan et al. (2023) further emphasised the importance of alternative energy sources like solar power due to increased electricity consumption during Ramadan. Additionally, Efe & Farhan (2020) confirm that LED lights not only save energy but also enhance illumination, providing comfort to worshippers. Green mosques in this study also implement daylighting, which further reduces electricity use by eliminating the need for lights during the day.

Rainwater harvesting (RWH) is one of the water conservation initiatives taken by mosques. Hurayra & Rahman (2022) studied RWH in the Australian mosque, while Tholibon et al. (2023) focused on perceptions of RWH usage in the Kuala Lumpur Mosque. However, research by Eusof et al. (2015) on the Green Mosque Index in Selangor suggests that many mosques lack proper financial controls to manage excessive energy and water use. Additionally, Naziri et al. (2022) found that rainwater harvesting in mosques is not extensively discussed, with only 13% of mosques and suraus in Malaysia having access to such systems. This is despite Malaysia's high

rainfall and the significant potential of rainwater harvesting systems (RWHS) for buildings with high water usage, like mosques (Mat Daud et al., 2021).

Furthermore, green mosques also prioritise responsible solid waste management, which is crucial for environmental sustainability. A notable example is Masjid al-Hasanah, which established recycling centres and sells used cooking oil for charitable purposes. This initiative promotes sustainability practices not only within the congregation but also within the local community. The estimated monthly sales of RM3,000 from used oil can even cover the mosque's operating costs. Separately, Masjid Zaid bin Haritsah runs a Food Bank program, providing an express assistance kiosk in addition to food distribution. However, the Food Bank programme in Masjid Al-Hasanah received a lukewarm reception.

In ensuring the implementation of green concepts in mosques, many mosques integrate urban agriculture within their grounds. This includes the cultivation of vegetables through hydroponics or aquaponics. Some mosques also cultivate fruit trees and herbal gardens. According to Fatnanta (2021), vegetable cultivation can help mosques finance their operations. Masjid Al-Hasanah receives plant endowments to support its green mosque efforts. Bangun (2023) explains that in implementing a good waqf (Islamic endowment) management system, waqf also encompasses the agricultural sector, whether through small-scale farming or animal husbandry.

Addressing the challenges in maintaining green mosque status requires a collaborative effort from all parties, including mosque committees, congregants, the local community, and strategic partners. Among the problems faced in green mosque sustainability include funding, managing stray cat populations, potential flooding issues related to foreign workers' presence, homelessness, and a lack of public awareness about environmental practices. As a solution to funding issues, NRES, in collaboration with the Waqf Malaysia Foundation, has launched a special waqf programme for green places of worship to support environmental sustainability. As of September 2023, four mosques have received this endowment to support projects related to green mosques, such as the installation of solar panels, efficient water systems, and hydroponic kits. Mosque greening initiatives related to environmental sustainability programmes can cultivate awareness of the environment among congregation members and the local community.

CONCLUSION

The impact of climate change requires integrated solutions to foster climate change mitigation behaviours. In response, the Ministry of Environment and Water (KASA), later known as the Ministry of Natural Resources, Environment, and Sustainability (NRES), launched the '100 Green Places of Worship' agenda to promote a green lifestyle culture among congregations. Green mosques also play a role as exemplary organisations in environmental sustainability agendas such as energy efficiency, water efficiency, waste management, and the use of sustainable products. Green mosques further integrate eco-friendly elements by promoting sustainable lifestyles among the local community. Involvement from the local community is crucial in ensuring the effectiveness of the green mosque agenda.

Overall, the green mosques in this study have played a significant role in climate change mitigation through environmental sustainability actions such as energy and water efficiency, waste management, and greening initiatives. Emphasis is placed on the use of green technologies such as solar and LED lighting. Rainwater harvesting is also highlighted as an important practice, but it still needs to be promoted more widely among mosques in Malaysia. Waste management is also emphasised, with examples such as the sale of used cooking oil through charitable initiatives. Greening through farming in mosque areas also needs to be strengthened by emphasising the use of vegetable plants. Challenges in maintaining green mosque status include funding issues, managing stray cat populations, potential flooding issues related to foreign workers 'presence, and the lack of public awareness about environmental care. Support and awareness from all parties, including mosque committee members, congregation members, and the local community, are important for the success of these sustainability efforts. Through endowment initiatives and mosque greening programmes related to environmental sustainability, public awareness of environmental issues can be enhanced.

However, the impact of green mosques on social aspects remains understudied, even though the primary goal of green mosques is to cultivate sustainable practices among congregation members and the local community.

Further research is needed to explore how the environment and characteristics of these green mosques support climate change mitigation behaviours among the community. This study has implications for the NRES in enhancing mosques that have achieved green mosque status by improving the environmental sustainability of mosque environments. An effective strategic plan can transform green mosques into role models for other mosques, both locally and internationally.

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Institutional Review Board Statement

Ethical review and approval were waived for this study, as this study involves no more than minimal risk to subjects.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.

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