Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 9 Issue 36 (June 2024) PP. 146-158
DOI 10/35631/JTHEM.936012

JOURNAL OF TOURISM, HOSPITALITY AND ENVIRONMENT MANAGEMENT (JTHEM)
www.jthem.com

EMPOWERING A MOSQUE COMMUNITY IN MELAKA WITH SOLAR LIGHTING TECHNOLOGIES APPLICATION: A COMMUNITY-BASED APPROACH

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Article Info:

Article history:
Received date: 18.04.2024
Revised date: 13.05.2024
Accepted date: 15.06.2024
Published date: 30.06.2024

To cite this document:

Ahmad, N. A., Khalid, M. K. A., Haron, N., & Haron, N. (2024). Empowering A Mosque Community In Melaka With Solar Lighting Technologies Application: A Community-Based Approach. *Journal of Tourism Hospitality and Environment Management, 9* (36), 146-158.

DOI: 10.35631/JTHEM.936012.

Abstract:

This research presents a community-based approach to address energy security and energy-saving initiatives through the installation of solar lighting systems for a mosque community in Melaka. The aim is to foster community development while promoting sustainable energy practices, thereby fostering a sense of ownership and responsibility towards sustainable practices. It employs action-based research on-site, which involves participatory projects and empirical observation. The significance of this research lies in its dual focus on community empowerment and environmental sustainability by engaging stakeholders and local people to ensure energy self-sufficiency and sustainability of the project through green resources. A mosque in Merlimau, Melaka, has been selected as a case study and involves a mixed-method approach that leads towards collaborative efforts between researchers, community leaders, and local residents in the decision-making process. Ultimately, this research has ensured engagement among the locals, which aligns with the daily energy priorities of the mosque. By harnessing the power of 25 solar lighting systems (ranging from 10 watts to 200 watts), this mosque has managed to reduce its reliance on traditional energy sources, thus contributing to energy security and saving 10% from the monthly electricity bills. It has served as a tangible demonstration of the benefits of solar energy, inspiring broader adoption within other mosque communities in Malaysia. In

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
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the near future, the dissemination of solar lighting technologies is anticipated to contribute towards more sustainable mosques and increase the community development through resilient approaches.

Keywords:

Community-based Approach, Community Development, Mosque Community, Sustainability, Solar Lighting System

Introduction

The proliferation of mosques in Malaysia over the past decade has significantly contributed to the surge in energy demand (Mat Zain, Ahmad and Tun Jamil, 2023), with people visiting these places of worship five times daily and utilizing various electrical appliances such as lighting, air conditioning systems, fans, and public automation systems (Hassan, et al., 2014; Azmi, et al., 2021). Notably, the lighting system ranks as the second highest energy consumer after air-conditioning systems in Malaysian mosques (El Fouih et al., 2020). This is due to the hot and humid climate in the country. However, the usage of lighting appliances extends beyond the external facades of the mosques, being operational 24 hours a day. This continuous operation, compounded by instances where visitors forget to switch off the lights after leaving the mosque, significantly contributes to the increase in electricity bills (Noordin Saleem, 2020). While lighting usage in the external compound of the mosque is essential for safety reasons, especially during night hours, this necessity inevitably contributes to higher electricity bills. In addition, mosques are known to open 24 hours every day, which leads to continuous energy consumption due to neglectful practices like leaving lights on unnecessarily (Utaberta et al., 2015). To address this escalating energy demand and the associated challenges, Mat Zain, Ahmad and Tun Jamil (2023) and Rahman, Ahmad and Sheikh Ahmad (2021) emphasize the pressing need to prioritize energy sustainability for mosques with the implementation of green energy technologies.

Empowering green energy technologies, such as solar lighting systems, holds immense potential to mitigate these challenges. Solar lighting not only reduces monthly electricity bills but also enhances safety by providing brighter illumination, thereby deterring potential crimes like theft, a significant concern in poorly lit areas of mosques (Mat Zain, Ahmad and Tun Jamil, 2023). Despite Malaysia's favourable solar energy intensity, there is a noticeable lack of interest in embracing energy sustainability within mosque management practices, perpetuating issues like increased energy consumption and safety vulnerabilities (Rahman, Ahmad and Sheikh Ahmad, 2021), as evidenced by incidents like theft due to inadequate lighting (Jamil and Ahmad (2017). Therefore, emphasizing the adoption of green technologies like solar lighting systems is crucial to promote energy efficiency and safety in mosques across Malaysia. It can establish a tangible demonstration of the advantages of using solar energy for mosques in Malaysia in establishing more sustainable mosques and increase the community development through resilient approaches from green energy.

The primary obstacle in installing solar energy technologies in mosques in Malaysia is the cost. However, with the assistance of communities through community-based approach (CBA) programs, this obstacle can be overcome. CBA programs involve engaging local communities in the planning, implementation, and maintenance of solar energy projects, thus reducing costs through volunteer labor, community contributions, and shared resources. Additionally, CBA

Journal of Tourism, Hospitality and Environment Management
JTHEM
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Volume 9 Issue 36 (June 2024) PP. 146-158
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fosters a sense of ownership and empowerment among community members, leading to increased support and sustainability of the solar energy initiatives in mosques.

Literature Review

In order to empower community development with a solar energy project into a mosque community, the concept of establishing green mosque and Community-Based Approach (CBA) is essential and interrelated. This section will elaborate on this topic.

The Definition of Green Mosque

The concept of a "green mosque" is consistent with the larger drive towards sustainable building and construction practices. Green mosques seek to reduce their environmental effect and promote sustainability through a variety of means, including energy efficiency, water conservation, the use of environmentally friendly materials, and the incorporation of renewable energy sources. An example of a good green mosque initiative is Masjid Raja Haji Fisabilillah located in Cyberjaya. Completed in 2015, this mosque was designed with sustainability in the focus. Rainwater harvesting systems, energy-efficient lighting, and natural ventilation help to lessen the need for artificial cooling. The mosque also uses solar panels to generate electricity, which helps to reduce its carbon footprint (Danish, Shukri & Taib 2023).

In Malaysia, the Green Building Index (GBI) is a well-known certification method for evaluating building environmental efficiency. The GBI assesses several aspects of a building's design, construction, and operation to determine its level of sustainability (GBI, 2024). By implementing green building principles, mosques in Malaysia can receive GBI certification, proving their commitment to environmental responsibility. For example, the Sultan Salahuddin Abdul Aziz Shah Mosque in Shah Alam, Malaysia, also known as the "Blue Mosque," has been recognised for its environmentally friendly characteristics and is regarded a pioneer in green mosque architecture in the country. The mosque's use of energy-efficient lighting, water-saving fixtures, and passive cooling techniques earned it GBI accreditation (Azmi and Kandar, 2019). By incorporating green building principles into the design and construction of mosques, these institutions can serve as role models for environmental stewardship and make significant contributions to the overall sustainability efforts in their communities.

The Importance of Green Mosque for Local Communities

The significance of Green Mosques for local communities' development resides in their ability to act as versatile centres for environmental education, community involvement, and sustainable development. Table 1 listed the significant importance of green mosque for communities that will helps in empowering the community.

Table 1: The Importance of Green Mosque towards Community Development

Significant Aspects	Contributions
Environmental Education	Green mosques have the potential to serve as educational hubs for raising awareness about the environment and promoting sustainable practices within local communities. By featuring various green technologies, such as solar panels, rainwater harvesting systems, and energy-efficient lighting, these mosques can effectively educate visitors on practical methods to minimize their impact on the environment. Furthermore, through workshops, seminars,

Journal of Tourism, Hospitality and Environment Management
JTHEM
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	and educational programs held within these mosques, community members can be empowered to embrace eco-friendly behaviours and incorporate sustainable practices into their everyday lives (Musa, et al., 2024).
Community Engagement	Can enhance community engagement by providing spaces for residents to gather and interact, promoting social cohesion. Can be served as venues for a variety of community events, including green markets, eco-fairs, and recycling drives, where people can come together to share ideas and resources related to sustainability. Moreover, community members can get involved in volunteer activities, such as maintaining green areas surrounding the mosque or participating in environmental cleanup initiatives, further fostering a sense of belonging and collective responsibility for the environment (Omar, et al., 2018).
Health and Well-being	The health and well-being of local communities are positively influenced by green mosques. These mosques provide several environmental benefits, including improved indoor air quality, access to natural light, and enhanced thermal comfort. Furthermore, they offer spaces for relaxation, meditation, and reflection, promoting mental and spiritual wellness among visitors. Additionally, the presence of green spaces within mosque compounds encourages physical exercise and recreation, fostering active lifestyles and promoting overall community health (Muin, et al., 2024).
Economic Empowerment	Green mosques have the potential to boost economic development in local communities by offering opportunities for green jobs and entrepreneurship. By promoting initiatives like green building construction, renewable energy installation, and eco-friendly product manufacturing, these mosques can generate employment and support local businesses. Additionally, implementing sustainable practices such as water and energy conservation measures within the mosques can lead to cost savings. These savings can then be reinvested in community development projects or social welfare programs (Hermawati, et al., 2023).

Types of Solar Lighting Technology

There are two commonly utilized types of solar lighting technology, divided into indoor and outdoor solar lights (El Fouih, et al., 2020). With various types of poles or mounted-type of installation, it helps to lighten the space. Solar Magazine (2022) states that solar lighting

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
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DOI 10/35631/JTHEM.936012

systems can be deployed across various settings, encompassing residential areas, playgrounds, secluded and back lane, parking areas, and remote locations without grid infrastructure. A study by El Fouih et al. (2020) and Mat Zain, Ahmad and Tun Jamil (2023) have shown that solar lighting system from Photovoltaic (PV) panel proves more efficient compared to traditional lights, especially the outdoor lighting that has uncomplicated trenching and wiring operations. Figure 1 presents the types of solar outdoor lighting technology that is typical for buildings in Malaysia.

Figure 2: The Types of Solar Lighting Technology (Mounted and Pole-Types)
Source: (Alibaba.com, 2024)

The Benefits of Applying Solar Energy Technologies for Mosque

The benefits of using solar energy technology for mosques in Malaysia are wide and in sync with the concept of green mosque. With the additional advantages of Malaysia's geographical location, its offering ample sunlight throughout most of the year. The capacity for solar energy in Malaysia has been increasing over the last decade, from 139 Megawatts in 2013 to approximately 1.93 thousand Megawatts in 2022 (Statista, 2022). Figure 2 presented the solar energy capacity in Malaysia which has been increased every year and shown the huge potential of this energy in Malaysia. With this huge potential, mosques in Malaysia can harness solar energy to attain environmental sustainability, reduce electricity expenses, reach energy self-sufficiency, and provide educational prospects for the community. These contributions are essential towards a community development.

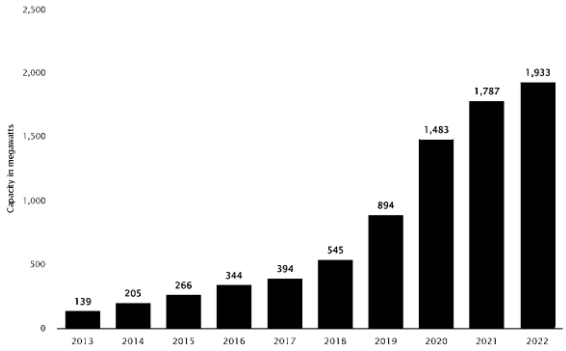

Figure 2: The Solar Energy Capacity in Malaysia (2013-2022)
Source: (STATISTA, 2022)

Solar energy technologies offer numerous benefits when applied to mosques. It provides a sustainable and renewable energy source that is in line with the environmental aspects and social responsibility principles adhered to by many religious institutions. Mosques can promote sustainability and lead by example in their communities by adopting solar energy systems. Table 2 presents that the solar energy offers advantages such as cost savings, energy

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 9 Issue 36 (June 2024) PP. 146-158
DOI 10/35631/JTHEM.936012

independence, and educational opportunities, in addition to its environmental benefits to mosque.

Table 2: The Benefits of Solar Energy Technologies

Benefits	Descriptions
Environmental Sustainability	Solar energy helps decrease greenhouse gas emissions, aiding in mitigating climate change.
Cost Savings	Long-term cost savings on electricity expenses are achieved by the minimal upkeep and extended durability of solar systems.
Energy Independence	Mosques have the capability to produce their own electricity, ensuring security and reliability in case of power outages or system disturbances.
Educational Opportunities	Mosques may educate their people about sustainable practices and the advantages of solar energy.

Source: (IRENA, 2019)

Solar energy technologies installed in mosques can serve as an educational tool for the community. Mosques can offer conferences, seminars, and tours to educate their members and the public about the benefits of solar energy and the importance of sustainable practices. This can inspire others to adopt similar technologies in their homes and businesses. By generating their own electricity through solar energy, mosques can become less dependent on external energy sources. This energy independence provides a sense of security and resilience, particularly during power outages or disruptions in the grid (Ahmad, Abdullah Salleh and Jamil, 2019). Mosques can continue to function and provide essential services to their communities even in challenging circumstances.

A study has shown the potential that if photovoltaic solar panels are successfully installed on over 4 million rooftops of buildings in Malaysia, it could meet approximately 25% of the current electricity demand at a rate of 34,194 megawatts (MW) per household usage (MESTECC, 2019). This indirectly contributes towards reducing the monthly electricity bill costs for residents in Malaysia and can significantly be applied to any mosques in Malaysia. However, currently, only 2% of the electricity in Malaysia is generated using renewable energy sources, compared to fossil fuel sources such as petroleum, coal, or natural gas (MESTECC, 2019). Solar panel installation on mosque rooftops might result in significant cost reductions over time. Although the initial cost may be high, solar energy systems have a durable lifespan and need little maintenance (Rahman, Ahmad and Sheikh Ahmad, 2021). Mosques can achieve significant cost savings on electricity costs by utilising solar energy systems (Mat Zain, Ahmad and Tun Jamil, 2023).

The Community-Based Approach (CBA) in Applying Solar Energy Technologies for Mosques

A community-based approach for solar projects involves engaging and empowering local communities throughout various stages of planning, implementation, and maintenance of solar energy initiatives (Ahmad and Jamian, 2021). This approach emphasizes collaboration, participation, and shared ownership among community members, aiming to address both energy needs and community development goals. Key aspects of community-based solar projects for mosques include active involvement of residents in decision-making processes, leveraging local resources and knowledge, and fostering partnerships between community

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 9 Issue 36 (June 2024) PP. 146-158
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organizations, government agencies, and other stakeholders. The goal is to create sustainable and equitable solutions that not only provide clean energy but also strengthen community resilience, promote economic development, and enhance social consistency (Ahmad, Hussein, Anas and Jamian, 2020). This will promote the community involvement and develops resiliency. This community initiative is actually under the theory of the community-based approach introduced by the United Nations in 2008, targeting sustainable energy generation opportunities such as solar, mini-hydro, and wind power to address unstable electricity supply issues in most third world countries since 2000 (UNHCR, 2008). These sustainable energy generation projects continue to rapidly expand in many countries, enabling local communities to have basic electricity supply through renewable energy sources (UNDP, 2015).

Issues will arise among locals when electricity tariffs increase significantly or when there are disruptions in electricity supply within communities. Therefore, it is significant to introduce solar technologies through a community-based approach that can channel solar energy technology through contributions from financially capable individuals to rural communities, including mosque. Through this effort, communities can access supplementary electricity supply from solar energy without solely relying on the government aid.

The Community Development from a Community-Solar Energy Project

A solar energy project established through a community-based approach can yield numerous benefits for community development. Firstly, such initiatives empower local communities by involving them directly in the planning, implementation, and maintenance of the solar energy infrastructure. Through participation in decision-making processes and hands-on involvement in the project, community members gain valuable skills, knowledge, and a sense of ownership over the technology, fostering a spirit of empowerment and self-reliance (Ahmad and Jamian, 2021). Moreover, the introduction of solar energy infrastructure can significantly improve access to clean and sustainable energy sources within the community. By harnessing solar power for electricity generation, communities can reduce their reliance on traditional energy sources, such as fossil fuels, which are often associated with pollution and environmental degradation. This transition to renewable energy not only contributes to environmental conservation but also enhances energy security and resilience within the community, particularly in regions prone to power outages or energy supply disruptions (Tun Jamil and Ahmad, 2017).

Furthermore, solar energy projects can stimulate economic development and job creation within the community. The installation, operation, and maintenance of solar panels often require skilled labor, providing employment opportunities for local residents. Additionally, community-based solar projects may stimulate the growth of local businesses, such as solar panel installation companies or maintenance services, further contributing to economic prosperity and livelihood improvement (Ahmad and Jamian, 2021). In addition to economic and environmental benefits, community-based solar projects can also foster social cohesion and solidarity within the community. By working together towards a common goal of sustainable energy development, community members build bonds of trust and cooperation, strengthening social ties and fostering a sense of unity. Furthermore, the shared experience of overcoming challenges and achieving collective goals through the solar project can instil a sense of pride and accomplishment among community members, bolstering community spirit and resilience in the face of future challenges (UNDP, 2015).

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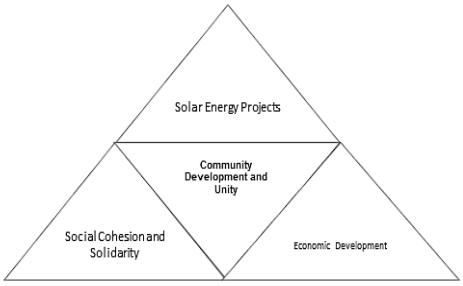

Figure 4: The Community Development (Constructed by Authors)

Overall, a solar energy project established through a community-based approach has the potential to catalyse holistic community development, encompassing economic empowerment, environmental sustainability, and social cohesion. By harnessing the power of solar energy in a collaborative and inclusive manner, communities can pave the way towards a brighter and more sustainable future for all.

The Methodology

The methodology of the research is based on qualitative method obtained through two approaches, namely (i) field research (site visits and observations) and (ii) action research method conducted directly at the study site. Action research method can be defined as a research endeavour conducted directly involving practical practitioners to observe the study results and actual strategies at the study site (Leonard & Glenwick, 2016). This methodology involves practical practitioners among technologists and volunteers for the practical installation of solar panel systems at the site for about 3 months. Researchers conduct direct observations and record data on-site to assess strategies, installation procedures, and the operational capabilities of systems at the study site. Meanwhile, other volunteers and community stakeholders (mosque and surrounding residents) serve as observers and provide physical assistance if needed. Figure 4 illustrates the phases of methodology for this study, based on action research methodology and utilizing a community-based approach program. The installation of the system was officially conducted over a period of 2 days, involving technologists, volunteers, researchers, and local residents in a special community program. The observation period at the study site lasted for 3 months (including the installation days), involving researchers in gathering data related to the efficiency level of the installed solar system.

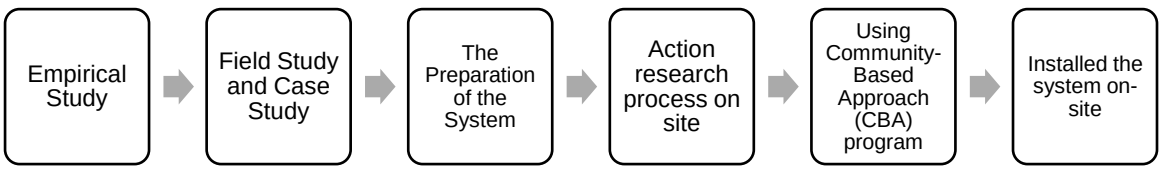

Figure 4: The Research Methodology Flowchart

The Case Study – Asy-Syujaah Mosque in Merlimau, Melaka

Masjid Asy Syujaah Merlimau Utara is registered under JAIM 8/351/14/1/3-46 and is located at Jalan Merlimau Jasin 77300 Merlimau Melaka. The mosque, chaired by Norhafiz Bin Haron, operates under the status of a Parliamentary Mosque, having been built in 2006. It serves a congregation estimated at 4,800 individuals and is part of the Merlimau Utara community. The mosque oversees several suraus within its jurisdiction, namely An Nur Muhibbah A, Al Muttaqin Harmoni, Al Aminun Muhibbah B, At Taqwa MU, Al Munawarah Merlimau Permai,

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 9 Issue 36 (June 2024) PP. 146-158
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and Al Amin KKBU. The mosque engages in various activities aimed at religious worship, community development, education, and economic empowerment. These include congregational prayers, religious programs, mosque carnivals, blood donation drives, marriage ceremonies, Quran recitation sessions, memorial services, communal clean-up initiatives, and assistance programs for the needy and destitute. Additionally, the mosque provides educational services such as Quran memorization classes, Quranic recitation lessons, religious guidance sessions, and prominent lectures. It also fosters economic initiatives such as establishing a mosque cooperative, commercial mushroom cultivation programs, and organizing charity markets, and eco-friendly and green projects.

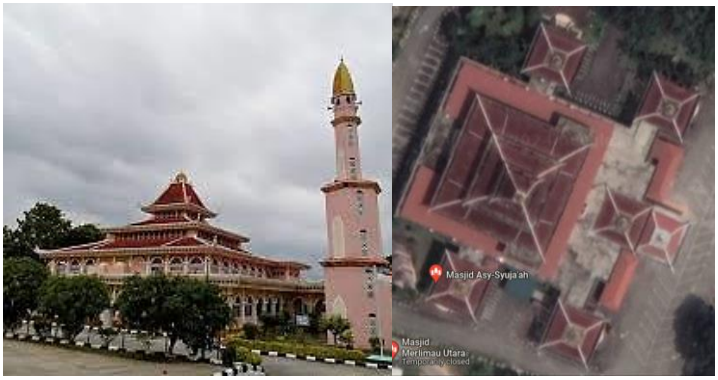

Figure 4: The Case Study

The solar lighting program took place over 2 days and 1 nights at Masjid Asy Syuja'ah, Jalan Merlimau, 77300 Merlimau, Melaka, involving mosque congregation members, representatives from the District Council, 40 individuals from UiTM Perak Branch, including 14 academic staff from UiTM Seri Iskandar campus, Perak, three external guests from the industry, three postgraduate students, and 20 undergraduate students. The project also received direct and indirect cooperation and support from various parties to ensure its success. Through this Community-based Approach (CBA) program, participants were expected to understand the importance of solar energy usage in their daily lives and to apply the knowledge imparted effectively. This project also benefits the community in the long term by increasing awareness and utilization of green energy technologies.

Figure 5: The Solar Community-Based Approach Program for Mosque

Two (2) types of solar lights have been installed in the mosque, namely 20 units of mounted-type lights and five (5) units of pole-street lights. The installation is based on empirical analysis on site, as shown in Figure 4. The data for the empirical analysis is shown in Table 3.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
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Table 3: The Empirical Data for Solar Lighting Technologies On-Site

Items	Descriptions	Watt (Power)
Solar Mounted-Lights	20 units with various power system (watt) due to location, height and shading factors	10-watts (min), 25-watts, 40-watts, 200-watts (max)
Solar Poled-Lights	5 units, for street lighting purposes (parking and graveyard areas)	200-watts due to height and location to disperse the lighting

Data Analysis, Finding and Discussion – Positive Impacts from the CBA Project

Solar Community-Based Approach (CBA) projects able to give positive impacts for the mosque, particularly in terms of energy efficiency and financial savings. The mosque community of the case study can significantly reduce their reliance on traditional energy sources, leading to substantial energy savings and lower electricity bills for up to 12%. This has been proven with the reduction of monthly electricity bill of the mosque (See Table 4). This transition not only contributes to environmental sustainability but also translates into tangible economic benefits for the mosque, as reduced energy consumption leads to lower utility bills over time. The mosque can allocate the saved funds to other essential expenses or invest in further energy-efficient upgrades, thus improving their overall financial well-being.

Table 4: The Positive Impact from the Economic Aspect (Bill Saving)

Electricity Tariff (From TNB)	Power Bill/MYR (Before the Installation)	Power Bill/MYR (After 1 month of the Installation)
Bill (every month)	RM 4015 (bill per month) #	RM 3530.50 (bill per month) #
First 200kWh* (RM 0.44 x 200 kWh = RM88.00)	The usage of the first 200kWh (RM 0.44 x 200 kWh = RM88.00)	The usage of the first 200kWh (RM 0.44 x 200 kWh = RM88.00)
Next 201kWh* (RM 0.51)	The later usage of remaining watt (RM 0.51 x 7700 kWh* = RM3927.00)	The later usage of remaining watt (RM 0.51 x 6750 kWh* = RM3442.50)
Total Bill Saving (MYR)	No Saving	4015.00 - 3530.50 = 484.50
Total Bill Saving (%)		12.11%

* Retrieved from TNB (2014).
\# Retrieved from the Case Study

Moreover, solar CBA projects foster increased community development through green education and awareness initiatives. This has been illustrated in Figure 6, where the feedbacks from the mosque communities are positive after the solar lighting installation, in term of (i) willingness to install the technology (Figure 6a) and (ii) the level of community development skills increased (Figure 6b).

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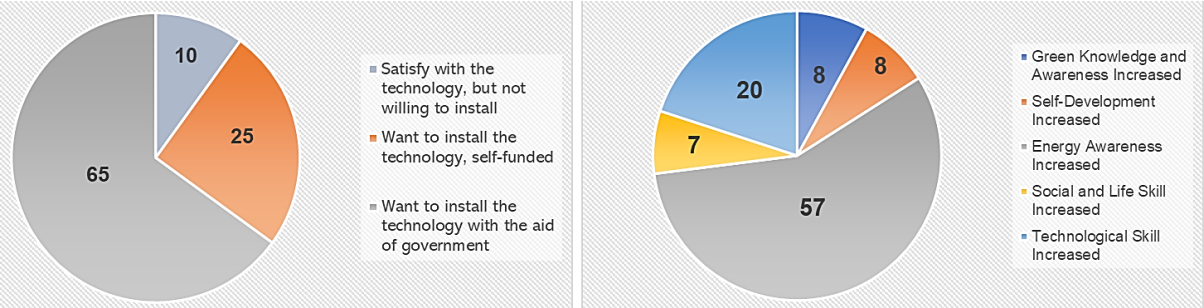

Figure 6: The Positive Impact from the Community Aspect, (a) Willingness to Install the Technology, and (b) The Level of Community Development Skills

From the results, it has proven that by integrating solar technologies into community spaces, such as mosques, 65% the communities have the opportunity to learn about the importance of renewable energy and environmental conservation firsthand and 57% of the population can increase various community development skills. Educational programs, workshops, and outreach campaigns run around solar energy empower community members with knowledge and skills to adopt sustainable practices in the locals' daily lives.

Conclusion

As locals become more informed about the benefits of solar energy and its positive impact on the environment, they are inspired to embrace eco-friendly behaviours and advocate for renewable energy solutions within their communities. This research has successfully achieved the objective of heightening awareness among the community, not only promotes environmental stewardship but also strengthening social cohesion and collective action towards a greener and more sustainable mosque in the future. The study's contribution lies in its successful attainment of several key objectives that have broad implications for community and environmental initiatives. By heightening awareness among the community, the research fosters a more informed and conscious public, which is crucial for long-term environmental sustainability. Additionally, the promotion of environmental stewardship provides a sense of responsibility and proactive behaviour towards environmental protection among community members. Strengthening social cohesion and collective action underscores the importance of community solidarity in achieving shared environmental goals. Collectively, these achievements contribute to the development of a greener and more sustainable mosque, serving as a model for similar community-based environmental efforts. This holistic approach not only addresses immediate environmental concerns but also lays the groundwork for enduring community engagement and sustainable practices.

Acknowledgement

We would like to express our deepest gratitude to the committee of Masjid Asy Syujaah in Merlimau, Melaka, especially Mr Norhafiz Haron and his team for granting us the permission to conduct the research at their esteemed location. Their support and cooperation have been invaluable to the success of this study.

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