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The Implementation of Sustainable Architecture Concept in Places of Worship: A Case Study of Jami Al-Hurriyah Mosque Pasar Minggu

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ABSTRACT

In recent years, sustainable architecture has become a major focus globally as an attempt to address environmental issues caused by human activities or natural processes that damage essential elements of the environment. This effort is driven by the negative impacts experienced by the environment due to massive development. Sustainable architecture is a concept that emphasizes environmentally friendly development. Currently, sustainable architecture has begun to be applied to houses of worship. Jami Al-Hurriyah Mosque in Pasar Minggu is one example of a house of worship that applies the principles of sustainable architecture. This research examines the implementation of the concept of sustainable architecture at the Jami Al-Hurriyah Mosque. This research uses descriptive qualitative method, with primary data collected through direct observation at the research site and secondary data derived from journal articles, books, theses, and research papers relevant to the topic. The results showed that the Jami Al-Hurriyah Mosque has optimized energy utilization and water management, and maximized land use by making the parking area a water catchment area through the use of materials that support sustainability. However, the implementation of sustainable architectural principles in mosques presents numerous challenges, including the design of open spaces that allow birds and bats to enter the mosque, potentially disrupting its cleanliness and sanctity. Overall, the mosque succeeds in creating a comfortable environment for users and the surrounding community and contributes to reducing the potential for environmental damage by maximizing the use of natural resources and treating wastewater before it is discharged into the environment.

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1. INTRODUCTION

Massive development raises the potential for environmental damage caused by pollution, global warming, and environmental damage resulting from the development process itself. The construction industry is a major user of non-renewable energy and contributor to emission of greenhouse gases, thus requiring to achieve net-zero carbon emissions by 2050. Indeed, construction activities account for 36% of global energy consumption and 39% of global carbon dioxide emissions (Chen et al., 2023). There are numerous strategies to reduce emissions from energy use in buildings have been made. However, emissions from the construction process and the use of building materials remain a major problem. Significant progress has been made in reducing emissions resulting from the building construction process, including emissions from heating, cooling, and lighting. It is projected that these emissions will be reduced from 75 percent to 50 percent of the sector in the next few decades (Programme & Architecture, 2023).

Sustainable architecture provides an innovative solution to mitigate carbon emissions in the construction industry and encourage healthier environments. Sustainable architecture is a concept aimed at preserving natural resources and promoting a sustainable future for generations to come. The application of sustainable architecture in buildings continues to increase every year. Generally, sustainable architecture is applied to residential buildings, public buildings, and commercial buildings. However, recently some places of worship began to apply the principles of sustainable architecture, one of which is the mosque building. Research on the application of sustainable architecture principles in buildings has been widely done in the past few years. Nevertheless, earlier studies have exclusively concentrated on the principles and applications of sustainable architecture in commercial or residential buildings. The application of sustainable architecture in places of worship has received comparatively less attention.

Mosques are public buildings that are closely related to Islamic architecture and culture. The role of mosques in the history of the development of Islamic architecture is very important, because each period of time has unique architectural characteristics and describes the development of unique Islamic architecture and also describes the religious, social, and political development of Muslim society (Nurzal & Aidina, 2023). In this fast-growing era, mosque buildings have also undergone significant developments around the world. Mosque designs have evolved from traditional styles to more modern and futuristic designs. Originally, mosques were established as a means of worship to Allah SWT. However, as technology develops, mosques are now designed to be multifunctional, namely as a place of worship and also as a community activity center that provides study rooms, libraries, conference rooms and others. This is due to the adjustment of functions to the needs and challenges in modern times as well as a form of contribution in improving community relations (Mat Sharif et al., 2019). This foundation determines how the function of the mosque can coexist with community life, especially in terms of architecture (Presipitari Harahap et al., 2020). The development of the mosque function into a place that accommodates many activities is a form of adjustment to the times to meet the needs of the community. Jami Al-Hurriyah Mosque located in Pasar Minggu, South Jakarta is one of the mosques that has a modern design by taking the concept of sustainable architecture. This mosque is designed timeless with a strong approach to the site context such as climate, culture, community habits, and passive design strategies. The mosque, which is located in a dense settlement near the commuter train station, consists of three floors in which there is a school as a means of learning about Islamic religious knowledge (ArchDaily, 2022).

In this research, the implementation of sustainable architecture principles in buildings of places of worship, especially mosques, will be examined more deeply. With a case study of the Jami Al-Hurriyah Mosque building that applies passive design to the building. This research is expected to make a new contribution to the development of sustainable architecture in buildings that are more adaptive and contextual, especially for buildings of places of worship.

Sustainable Architecture

According to Steele, sustainable architecture is defined as an architectural concept that emphasizes environmentally friendly development. The design must be sustainable, meaning it must consider the needs of current users without compromising the ability of future generations to fulfill their own needs (Steele, 1997). Sustainable architecture is a conceptual framework for designing buildings and urban spaces in harmony with natural environment, rather than in opposition to the natural environment. A further imperative is for buildings to assume responsibility for the natural environment, while concurrently ensuring the well-being of their occupants (Harsritanto et al., 2021). Sustainable architecture is a form of architectural effort to limit the negative impact of buildings on the environment, balance the use of materials and energy, and expand space and other aspects of the wider environment. The fundamental objective of sustainable architecture is to address the challenges confronting humanity, particularly in the domains of physical and mental well-being, welfare, and aesthetics (Dwi Harda & Kridarso, 2022). It can be concluded that sustainable architecture is a design approach that aims to create buildings that are not only functional and aesthetically pleasing, but also to reduce the building's carbon footprint, improve the quality of the living environment, and create healthy and comfortable spaces for its inhabitants.

In the book *"101 Rules of Thumb for Sustainable Buildings and Cities"* by (Heywood, 2019) the concept of sustainability signifies a long-term commitment of a building to the future. This entails that each design decision has the potential to exert a substantial influence on the quality of life experienced by future generations. Sustainable design is not merely a transient trend; rather, it is a comprehensive paradigm that integrates economic, social, and environmental dimensions in a holistic manner. The design of buildings based on sustainability principles ensures not only comfort and functionality but also actively contributes to the welfare of society and the preservation of ecosystems. The optimization of renewable energy sources, the selection of sustainable materials, and the implementation of adaptive design are pivotal in effectively reducing our carbon footprint and disrupting the destructive cycle of climate change. The integration of smart urban spatial planning and sustainable building development is crucial for the creation of a sustainable living environment for all.

The application of sustainable architecture is further strengthened by the existence of policies and standards formulated by various institutions. These policies aim to reduce the negative impact of development on the environment, encourage efficient use of resources, and create spaces for healthier living. In a book entitled *"Strategies For Sustainable architecture"*, (Sassi, 2006) explains that sustainable architecture has six basic principles, namely:

1. Land Use

Spatial planning is a critical component of sustainable architecture. The initial step entails strategic site selection, which must consider accessibility, ecological, and social factors. Through thoughtful planning, we can foster an efficient, flexible, and adaptable built environment that is resilient to the impacts of climate change. The integration of multifunctional areas, the repurposing of abandoned land, and the development of green

spaces can mitigate the adverse environmental impact of buildings and enhance the quality of life within the community.

2. Community

Sustainable community is a development concept that prioritizes the balance between human needs and environmental sustainability. To realize this kind of community, careful planning is needed with the involvement of all community members. A comfortable and safe physical environment is also an important factor in creating a sustainable community. A good environment not only provides physical comfort, but can also improve the quality of life and overall well-being of the community.

3. Health and well-being

Healthy buildings will create an optimal environment. Elements such as natural light, open space, and flexible design are instrumental in creating a healthy and comfortable environment. In addition to physical aspects, healthy buildings are also designed to support mental and social well-being. Well-designed spaces can increase productivity, reduce stress, and build a sense of community.

4. Material

The selection of building materials is a decision that can significantly impact the visual appeal, construction cost, and ecological impact of a building. The complete life cycle of building materials, from extraction to disposal, can have significant environmental impacts, including pollution, natural resource depletion, habitat destruction, and waste production. To mitigate these environmental impacts, it is imperative to prioritize building materials with low embedded energy, defined as the total energy consumed throughout their life cycle.

5. Air

The clean water crisis is a serious global problem. The main causes of this problem are unequal distribution of freshwater, poor infrastructure, and pollution from various human activities. To address this challenge, there is an imperative for sustainable water management strategies, including water conservation, the utilization of alternative water sources, and wastewater treatment. The ultimate goal of these efforts is to create water-self-sufficient buildings and reduce negative impacts on the environment.

6. Energy

A principal strategy for the realization of sustainable buildings is the optimization of renewable energy sources, such as solar and wind energy, as an alternative to fossil energy sources that produce greenhouse gas emissions. The design of energy-efficient buildings is of crucial importance, given the significant impact of factors such as location, climate, and building function on energy consumption. Through the judicious selection of building materials and optimal spatial planning, energy consumption can be minimized, thereby contributing to environmental sustainability and community well-being.

Application of Sustainable Architecture in Places of Worship

The application of sustainable architecture in places of worship still faces challenges, especially related to the considerable initial investment. The use of sustainable materials and environmentally friendly technologies often requires higher costs. Nevertheless, the positive trend of sustainable architecture in recent years has begun to increase in places of worship, where more and more places of worship are renovating or building new ones by adopting the principles of sustainable architecture.

Grøn Kirke or The Green Church Movement, under the Danish Council of Churches, is a notable example of this initiative. The program's objective is to inspire and motivate individuals, congregations, churches, cemeteries, ecclesiastical organizations, and schools to

share responsibility for addressing the global climate and environmental challenges. A notable exemplar of this commitment is Bellahøj Kirke, also known as Bellahøj Church, which has adopted sustainable architectural principles in its design and construction (Carsten Dybkjær, 2019).



Figure 1. Bellahøj Church
Source: <https://lex.dk/Bellahøj>

In the United Kingdom, A Rocha UK, a Christian non-profit organization dedicated to environmental conservation and restoration, has inspired numerous churches to engage in proactive environmental action. For instance, St. James Church in Piccadilly, London, has achieved the Gold Eco-Church award. By adopting renewable energy, creating wildlife habitats and encouraging outdoor worship, St. James has demonstrated a strong commitment to sustainability and harmony with nature (Adam Becket, 2018).



Figure 2. Solar Panel installed on the Roof of St. James Church
Source: <https://www.churchtimes.co.uk/>

In Indonesia, the DKI Jakarta Provincial Government, in collaboration with the ICLEI-Local Governments for Sustainability Indonesia Foundation, released the book *"Panduan Umum Eco-Rumah Ibadah 6 (Enam) Agama Untuk Pengendalian Perubahan Iklim"* in 2020. This book is part of an effort to encourage religionists, religious practitioners, religious communities and organizations, and activists working in the community to care for, maintain, and improve the quality of the environment, starting from their immediate surroundings (KH. Dr. Hayu S. Prabowo et al., 2020).

Application of Sustainable architecture in the Mosque

The mosque is a place for Muslims to carry out their obligations to worship the Creator. Beyond its function as a space for worship, the mosque also serves as a focal point for Muslim community activities. Prayer services, recitation, and social community activities are but a few of the ways in which Muslims engage with their religious practices in these spaces. In addition, in order to support environmental sustainability, the wise use of water needs to be considered. The implementation of advanced water treatment technologies, such as filtration and purification, holds significant potential in addressing this need by producing clean water that can be reused. However, the implementation of such technologies must be informed by both technical considerations and religious values to ensure that the integration of these practices does not disrupt the spiritual essence of the mosque (Adi, 2016).

A mosque that successfully applies the concept of sustainable architecture is the Istiqlal mosque in Jakarta. The Istiqlal Mosque in Jakarta has been recognized for its implementation of sustainable architecture principles. It has implemented green building principles, including energy efficiency, water efficiency, and embedded energy efficiency, making it a model for green building practices. The mosque has also implemented sustainable waste management practices, including the use of biodegradable cleaning products and the separation of waste into organic and non-organic categories. In addition, the mosque has a wastewater treatment plant that recycles water for use in ablution facilities and mosque gardens. The Istiqlal Mosque has also been recognized for its role as a center for energy conservation and clean energy literacy, highlighting its strategic importance in promoting sustainable practices for the future. The application of sustainable architecture principles in this mosque has resulted in significant energy savings and cost reductions, making it a model for other buildings to follow (Satriabhawana, 2024)

Al-Irsyad Satya Mosque in Bandung is a paradigm of a mosque that has been constructed according to the principles of sustainability. Ridwan Kamil's mosque applies the principles of sustainable architecture through the use of natural materials such as natural stone and the application of perforated building facades. These facades serve both aesthetic and functional purposes as natural ventilation, which reduces the need for air conditioning and conserves energy. The mosque's design, which maximizes daylight, reduces reliance on artificial lighting. The strategic incorporation of water elements, such as ponds and plants, may also signify an effort to optimize water usage, potentially through the implementation of a rainwater catchment system (Mushab Abdu Asy Syahid, 2015).

2. METHOD

Descriptive qualitative method was used in this research. Qualitative research allows for a deeper understanding of the phenomenon under study by studying it in more detail on a case-by-case basis. Descriptive research method is the nature of research that describes a phenomenon with accurate data that is systematically researched (Hafni Sahir, 2021). This research is located at Jl. Al-Hurriyah Mosque No.7, RT.7 / RW.3, Pasar Minggu, South Jakarta City, Special Capital Region of Jakarta 12520.



Figure 3. Research Location
Source: Google Maps

The data used in this research are of two types: primary and secondary. The primary data were obtained through direct data collection, which included observations at the research location. The secondary data were derived from official documents, annual reports, archives, and historical records. Additionally, relevant journal articles, books, theses, and research papers were consulted for further elucidation on the subject.

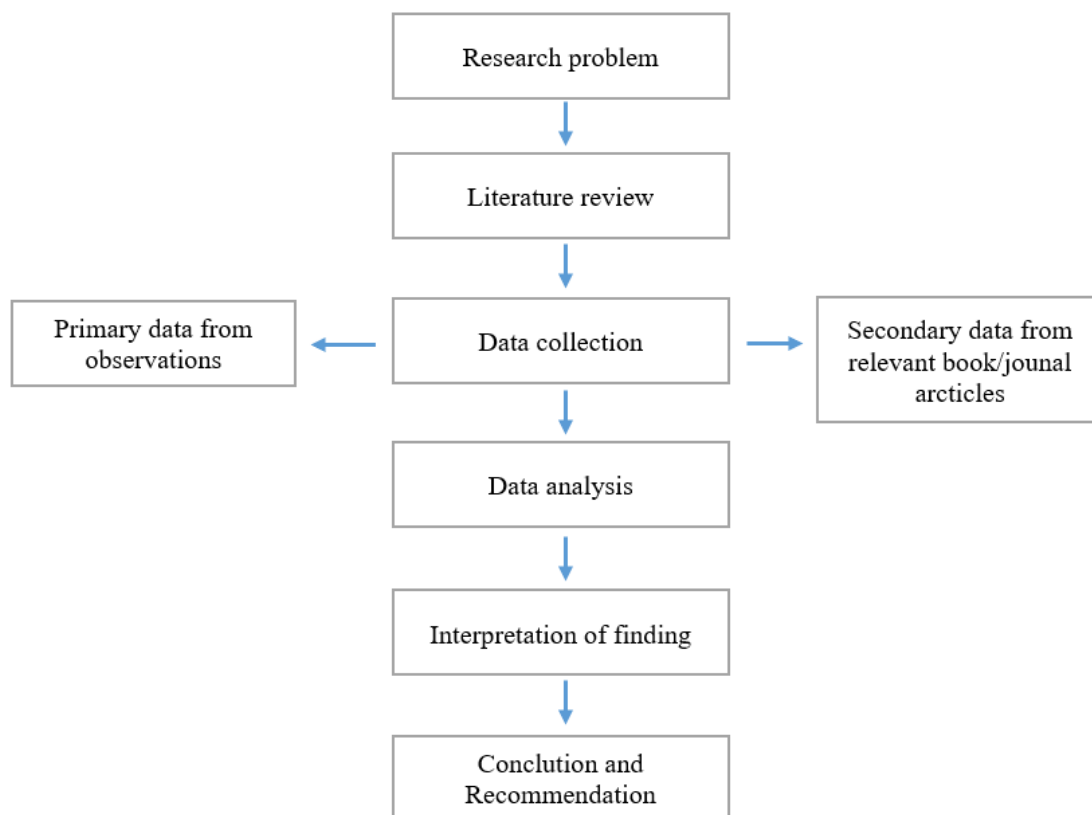


Figure 4. Research Flow Diagram

3. RESULTS

3.1 Land Use

The Jami' Al-Hurriyah Mosque was established in a highly strategic location, situated within a densely populated residential area adjacent to Pasar Minggu Baru Station. The mosque's proximity to the train station, at a distance of 11 meters, ensures optimal accessibility for individuals utilizing various modes of transportation, including public transportation and private vehicles. Despite the mosque's compact land area, the architectural team designed a 745-square-meter building divided into three floors. In addition to its role as a place of worship, the ground floor of the mosque functions as an educational space. The mosque's open courtyard, which has no fence surrounding it, serves as a public space that can be utilized by the community for various social and community activities (Ago Architects, 2020).

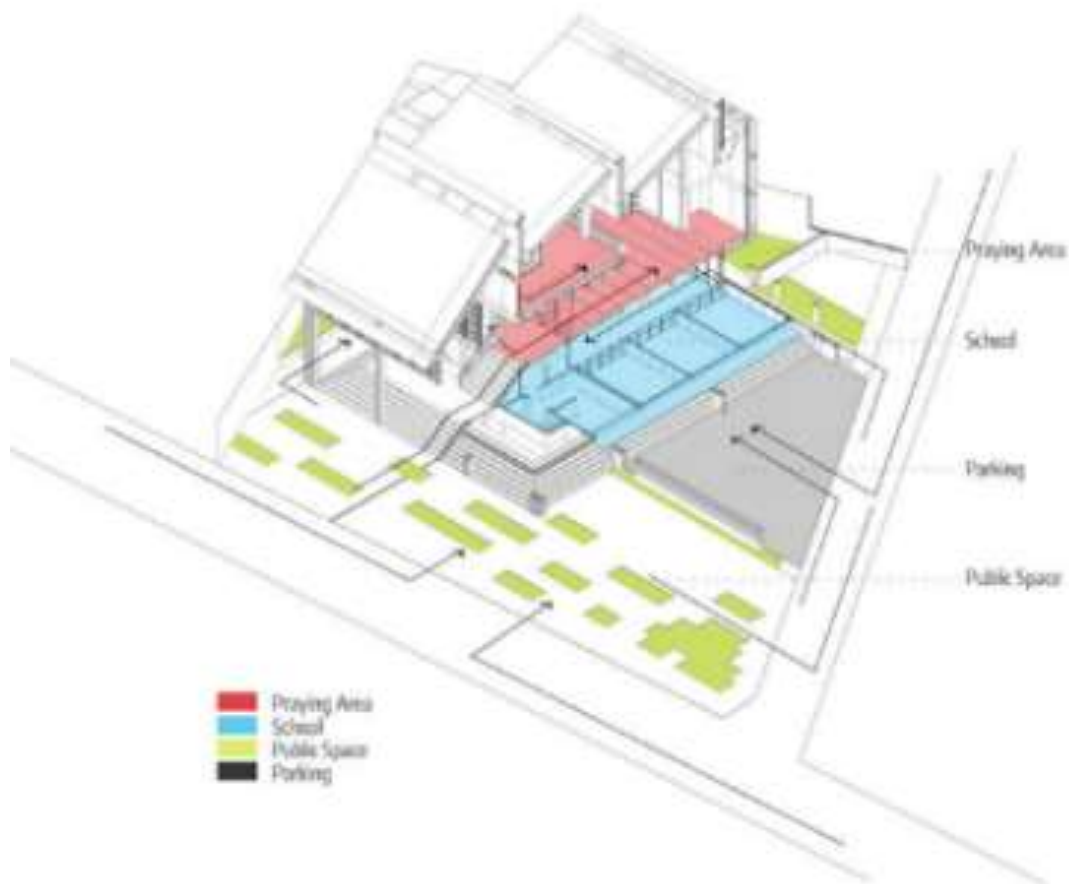


Figure 5 Area of Jami Al Hurriyah Mosque

Source: www.agoarchitecture.com

Despite being built on a relatively limited plot of land, the mosque is still equipped with green areas and environmentally friendly parking facilities. The integration of grass blocks within the parking area serves a dual purpose: it enhances the aesthetic appeal while concurrently fulfilling an ecological function by augmenting groundwater absorption and providing a conducive environment for vegetation growth.



Figure 6. Parking Area

Source: Personal Documentation, 2024

3.2 Energy Efficiency

The Jami' Al-Hurriyah Mosque has been designed according to a smart passive concept, which aims to make optimal use of the surrounding natural environment. The building's careful orientation towards the sun, coupled with its large openings, ensures that natural sunlight illuminates the interior space optimally during the day. The building's passive design also utilizes natural ventilation, ensuring a comfortable indoor environment without the need for artificial cooling systems. This sustainable architectural approach not only conserves electrical energy but also contributes to environmental conservation.

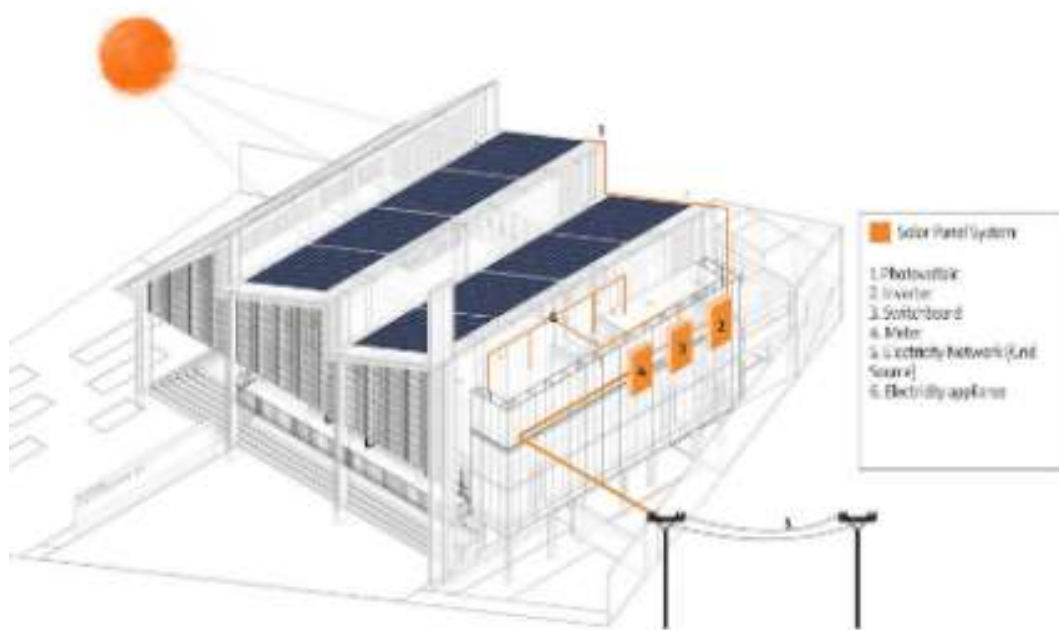


Figure 7. Energy Source Management of the Jami Al-Hurriyah Mosque

Source: www.agoarchitecture.com

Open-concept architectural designs with skylight roofs offer a deep spiritual connection with nature. However, if openings are not carefully calculated, they can lead to significant issues. Small birds can easily enter through these gaps, leaving behind droppings that disrupt the building's cleanliness and tidiness. Moreover, the high intensity of tropical rain in Indonesia can cause water seepage through poorly sealed joints.



Figure 8. Skylight Roof

Source: Personal Documentation, 2024

This mosque uses solar panels to generate electricity from sunlight. Adding architectural elements such as light shelves or shading devices that help distribute natural light more evenly into the room, reducing glare and overheating.

3.3 Water Efficiency

Water efficiency is a water resources management practice that optimizes water use. Strategies like infrastructure improvements, water-saving technologies, and changes in water use behavior can slash water consumption. Water efficiency is key to ensuring the availability of clean water and reducing the burden on wastewater management systems.

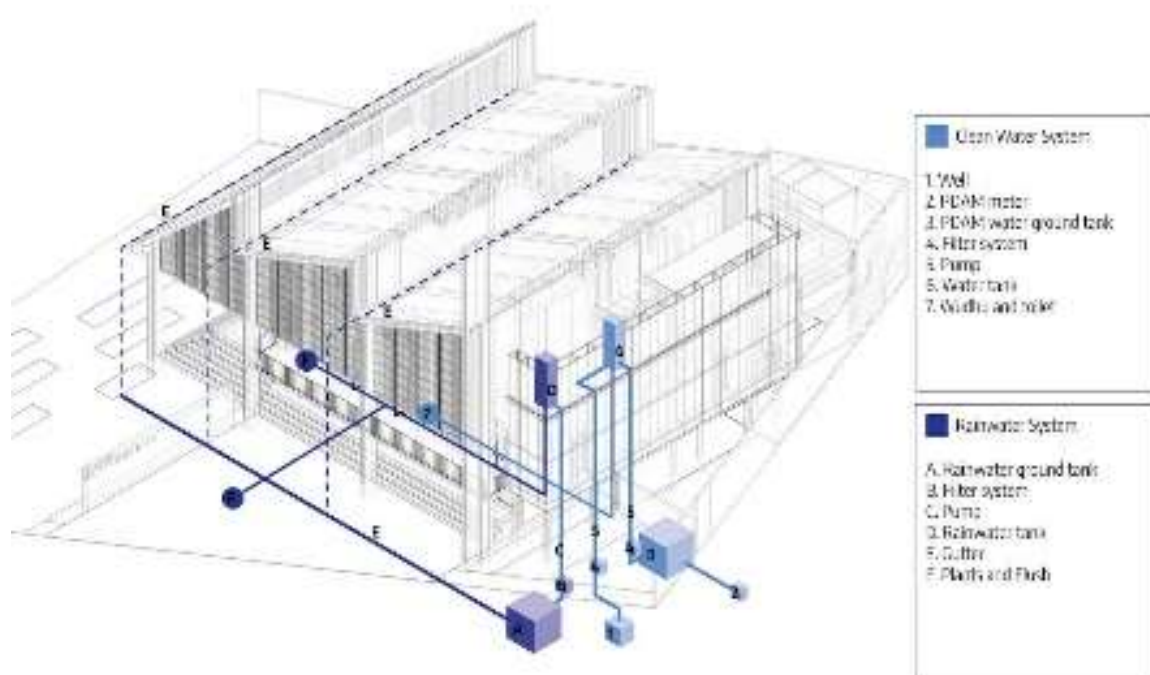


Figure 9. Water Management at Jami Al-Hurriyah Mosque

Source: www.agoarchitecture.com

This mosque uses a gutter system. The gutter system installed along the roof of this building plays a crucial role in managing rainwater flow. Rainwater that falls is collected by the gutter and channeled directionally to the ground through drainage pipes. This system

prevents puddles from damaging the building's walls and foundations. It also keeps the surrounding environment clean by avoiding rainwater splashes that carry dirt. The water flowing through the gutter is not discharged; it is treated and utilized to the maximum through a filtration process to remove impurities. Then, it is stored in a storage tank. This treated, clean water is then utilized for various non-potable purposes, such as watering plants and flushing toilets. This reduces dependence on clean water sources and contributes to environmental preservation.

3.4 Material

The use of building materials is critical to reducing environmental impact and promoting sustainable development. Green building materials are essential for creating structures that are environmentally friendly throughout their life cycle, from production to demolition. These materials save energy and reduce greenhouse gas emissions, while also improving occupant health and conserving natural resources (Shivakumar, 2023).

The mosque's architectural design is minimalist, with exposed concrete as the dominant element. The concrete's rough texture and natural color create a strong and modern impression while fostering an intimate and contemplative atmosphere. Exposed concrete is not only sturdy and durable, but also offers superior thermal insulation properties. This ensures a more stable room temperature, reducing the need for air conditioning. Exposed concrete's simple construction process and minimal maintenance make it an economical and environmentally friendly choice. This material choice aligns with the principle of sustainability, as it reduces the use of other materials that could potentially damage the environment.



Figure 10. Exposed Concrete Finish on the Building
Source: Personal Documentation, 2024

Enhancing the exterior appearance, the facade of this building is decorated with vertical lattice made of Conwood. Conwood is an innovative material that combines cellulose fibers and cement, so it can produce natural textures with a charming modern look (PT Conwood Indonesia, 2020). Conwood vertical lattice has been used as a substitute for wood due to its durability and weather resistance, enabling it to resist the effects of natural conditions while preserving the aesthetic appeal of the building over time. In addition to its material strength, Conwood employs a waste management system that aligns with its environmentally friendly production process. The manufacturing process prioritizes the recycling of materials, energy, and waste, ensuring that the environmental impact of production is minimized.



Figure 11. Conwood Lattice
Source: Personal Documentation, 2024

The doors are made of full glass, which allows maximum daylight into the room. This creates an atmosphere that is bright, warm and at one with nature. The presence of natural light is believed to enhance the spiritual and tranquil atmosphere. Furthermore, the glass walls also provide a wide view of the surrounding environment, creating a sense of openness and unity with nature. This can provide a more meaningful worship experience and connect worshippers with nature.

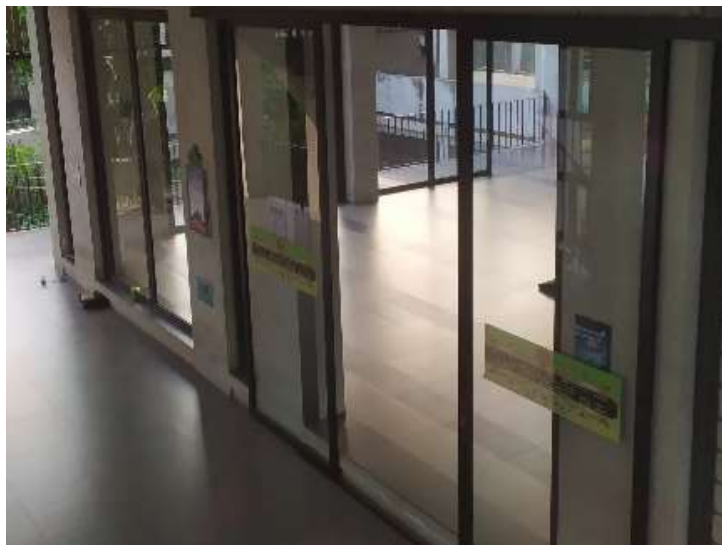


Figure 12. Use of Full Glass Doors and Windows
Source: Personal Documentation, 2024

4. CONCLUSION & RECOMMENDATIONS

4.1 Conclusion

The research study on sustainable architecture design, which was the focus of this study, highlighted the prioritization of achieving a balance between human needs and environmental sustainability. The Jami Al-Hurriyah Mosque is a paradigm of this approach, as evidenced by its commitment to land utilization, energy efficiency, water management, and the selection of environmentally friendly materials. Despite its constrained land area, the mosque features green open spaces and parking areas with grass blocks that facilitate natural water absorption. The mosque's design incorporates natural lighting, air circulation, solar

panels, and a rainwater harvesting system that is reused for non-potable water needs, thus demonstrating a commitment to water efficiency. The materials used in the mosque have been selected for their durability and minimal environmental impact. However, the open-air design presents challenges related to building hygiene, particularly in maintaining the sanctity of the place of worship from animal feces. In summary, the Jami Al-Hurriyah Mosque contributes to environmental conservation while also providing a comfortable worship space for its users.

4.2 Recommendations

1. Controllerd Opening Design

The implementation of a circular opening in a place of worship building involves a careful consideration of its dimensions to ensure it does not disrupt the building's indoor hygiene conditions. The selection of a flexible operational mechanism is important for achieving optimal ventilation settings, aiming to maintain the cleanliness of the room while maximizing the circulation of fresh air.

2. Good Maintenance System

A regular maintenance schedule is imperative for the cleaning of the area surrounding the skylights and ventilation openings. This process requires the removal of any external debris that may have entered the structure. The implementation of regular cleaning protocols is instrumental in preventing external contamination and preserving the building's integrity and aesthetic appeal.

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