Green Architecture Approach on Mosque Design in Cipendawa Village, Cianjur, West Java, Indonesia

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Green Architecture Approach on Mosque Design in Cipendawa Village, Cianjur, West Java, Indonesia

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Abstract. Climate change has been a global concern as many buildings are constructed and maintained without considering environmental impacts. Global warming, flood and environmental damage have become everyday phenomena. Architecture plays a vital role to in shifting design paradigm green architecture that is sustainable and environmental friendly. This research-based design investigates the implementation of green architectural approach on a mosque design at a waqf land in Cipendawa Village, Cianjur. The site is located on the hill where water catchment is required. Green architecture approach is expected to minimize negative environmental impacts and provide solution for low budget mosque.

1. Introduction

The focus of this research-based design is to identify problems and potential features on the site and propose green architectural concept which enhances energy efficiency, effective building maintenance and at the same time provides comfort for users. Therefore, the approach is contextual.

In Indonesian society, a mosque serves both as a religious and as a social venue. People congregate on a mosque to pray and to have social agenda such as community meeting and learning activities. The needs for providing a mosque requires good knowledge on what the community needs. Majority of the villagers in Cipendawa Village, Cianjur West Java are moslem but the mosque are rarely to be found due to the budget constraint in constructing it. There are only two mosques found within the area and in far distance. This research-based design took place on a piece of waqf land in this village which serves community for religious activities. The closest mosques to this land are within 3 km (Al-Misbah mosque) and 5 km (Al Qossimiah Mosque). Considering the moslems should pray five times a day, these distance are not reachable in walking distance, especially for Friday or Eid prayings.

There is Mrs. Hj. Yuslida Hamid, who agrees to give away her 270 m2 land on Hanjawar road to build a mosque serving the community. However, she has some budget constraint in constructing the building. Understanding this constraint, the team agreed to take the challenge and propose the design.

The team surveyed the location and identified key potential points. The land is primarily located on the main road. It has beautiful scenery, and slightly cold weather. The development of the mosque should incorporate this potential weather condition. However, the restricted budget and the beautiful scenery require the low-cost budget and minimum impact to the environment. Therefore, this research-based design is aimed to carefully identifying problem on the site to correctly propose the design which accommodate people's need for religious activity and for reducing the carbon footprints. By closely analyze the environment, we propose passive design strategy to reduce energy consumption for the benefit of the occupants [1]. Furthermore, the developed green building concept is inline with the economically viable considerations, whereby the entire building life cycle – from concept to planning stage, from construction to operation and then back to denaturation – is taken into account. Green buildings, therefore, are based on an integrated and future-oriented approach [2].

Figure 1: The location of the proposed mosque design

Figure 2: The site condition

2. Research Method

In order to propose green architectural design, the team uses research design method of imaging, presenting and testing (Zeisel, 1984) [4].

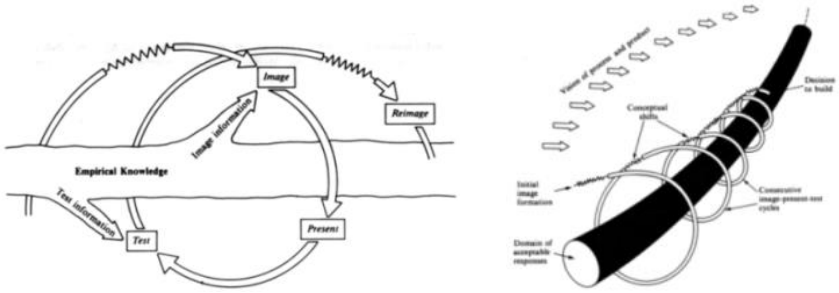


Figure 3**:** Design Development Spiral (Zeisel, 1984)

Imaging is proposing a new idea which illustrates criteria of best architectural practice in the future. Imaging includes problem identification, data gathering, analysis and synthesis. The goal is to propose a low-cost design serving the community and at the same time is environmentally friendly. There are four approaches in data gathering: literature study, precedent, site analysis and interview.

Site analysis starts with the macro and micro conditions to identify the problems on the site located on the hills. This site is required to function as a water catchment. The interview with Mrs. Hj. Yuslida Hamid was aimed to get ideas on the society's needs and religion-based activities on the surrounded area in Cipendawa village. After that, the team is analyzing design criteria to propose the space required and green architectural concerns to be applied onto the site, space, building form, interior and building facade.

Presenting is the result of applied criteria on the design using these principles: conserving energy, working with climate, respect for the site, respect for users, limiting new resources and holistic.
Testing is to evaluate on the proposed design based on the criteria applied. Testing is done by verifying the interview with the literature study and comparing the mosque design with the precedents.

3. Theoretical Framework

In the attempt to keep the environment sustainable and to reduce the environmental damage after building the mosque, the team uses green architectural approaches introduced by Brenda and Robert Vale (1991) [3] in the book, Green Architecture Design for Sustainable Future. The principles and criteria to achieve this green design is through the following ways:

3.1. Conserving energy

This approach is to operate the building with the minimum unrenewable energy. This is through the following methods:
3.1.1. The building is designed in elongated form in order to bring the light inside. Other attempt is to use skylight in areas which do not have direct sunlight.
3.1.2. The building uses sunlight as thermal energy to produce electricity by using photovoltaic devices. In addition, the uses of sunlight can also be used by tilting the roof facing the east-west walls or in line with the sun path.
3.1.3. The building uses low level electric devices and controls the high uses through automatic devices.
3.1.4. The building applies sunscreen on windows which can adjust the light intensity getting through the interior.
3.1.5. Interior uses light colors to enhance light intensity.
3.1.6. The building should avoid artificial heater. The heat should come from the inhabitants and the sunlight entering the building through ventilation.
3.1.7. The users should minimize the use of air conditioning to reduce the energy consumption.

3.2. Working with climate

This approach can be achieved through these following ways:
3.2.1. To locate the building orientation against the sun path.
3.2.2. To apply air pump system and cross ventilation.
3.2.3. To use plants and water as climate adjuster.
3.2.4. To use windows and roof which can be opened and shut depending on the users' need.

3.3. Respect for site

This approach requires interaction between the building and its site. This can be achieved through the following ways:
3.3.1. To minimize site alteration by deploying design following the site condition.
3.3.2. To use minimum building coverage ratio and to favor vertical building approach.
3.3.3. To apply local materials available from the surrounding area

3.4. Respect for users

This approach plays an important role as building has a close relationship with the users, activity and needs.

3.5. Limiting new resources

This approach is to limit the use of new resources and use the current available resources.

3.6. Holistic approach

This approach is aimed to design a building by applying these five principles. These green architecture design are linked and cannot be separated.

4. Analysis

4.1. Site Analysis

The proposed land is surrounded by the main Hanjarwar road, which functions as an alternative route from Puncak to Cianjur, West Java, on the north east side and walls on the south side (image 4). With the beautiful scenery and tranquility, this land has a very high quality for religious activities. To respond such quality the team deeply analyze the site to map the contour, potential points and environment.

The site contour is not that extreme, in fact it can be said as flat. The proposed land currently has some areas for planting sweet potatoes and peanuts. On the side near the main road, the area is currently being used for selling flowers. The rest of area are clear with grass covering most of it. This flat contour benefits the team in designing the mosque as there is no cut and fill approach involved.

Figure 4: Site Boundaries

The beautiful scenery and slightly cold weather are the other two main pints to be included in the design. The scene of mountain at the back of the land and will be captured and be part of the mosque design.

The noise level is practically low with the high intensity is towards the main road. When designing the mosque, there should be a treatment responding this noise level (Figure 5).

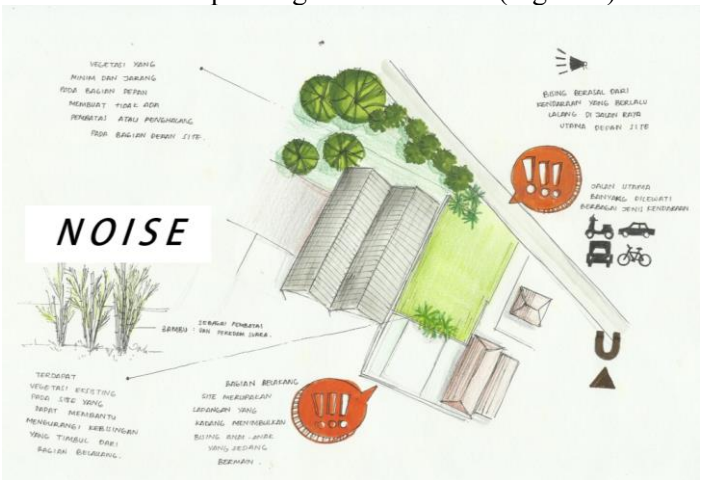


Figure 5: Noise Analysis

During the day, the weather on the site is comfortable because the wind speed is around 0,2 – 0,6 km/hr. The location of the site which is near the mountain makes the weather drops drastically during the night (figure 6)

Figure 6: Wind Direction Analysis

The site receives abundance natural lighting, especially the area near the Hanjarwar road. The site has nearly 12 hours full daylight during the day as not many of high shading trees around (Figure 7)

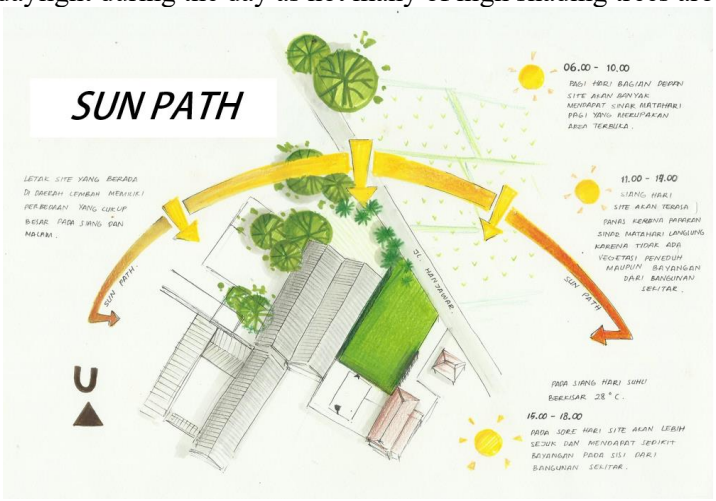


Figure 7: Sun Path Diagram

Apart from contour, temperature, wind direction and natural light, the team also analyses existing drainage system on the site. The team found that there is a drainage system right in the middle of the site with 1 m width and run through the city drainage system located on Hanjawar road. The water is categorized as grey water as it came from overflow rain and the land next to the site (Figure 8)

Figure 8: Existing drainage on the site

From the explanation above, the existing site has strengths points such as comfortable weather, beautiful scenery and significant amount of plantation. These strengths will be incorporated in the design. However, the team also need to anticipate the temperature drop during the night and the current drainage system right in the middle of the site.

4.2. Building response towards site analysis

Based on the site analysis, the team first respond to the weather condition. Since there are no big plantation surround the mosque, and the site receives direct sunlight, the team carefully treat this slightly cold weather by directing the wind inside of the building to create cross ventilation and minimize the use of air conditioning during the day. The ventilation is also required to anticipate the temperature drop during the night (Figure 9 and 10)

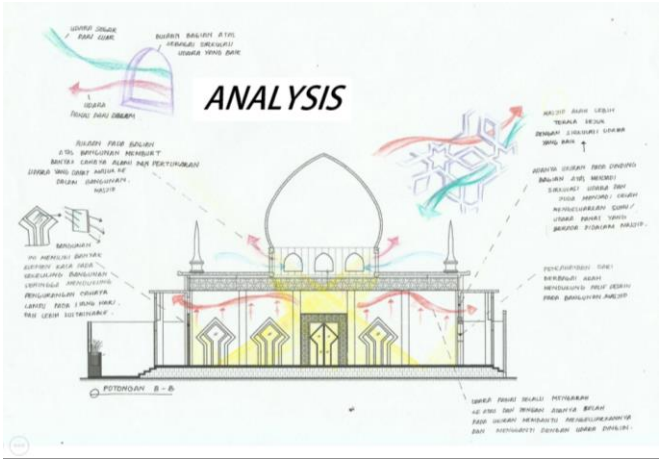


Figure 9: Building's Responses towards the Wind

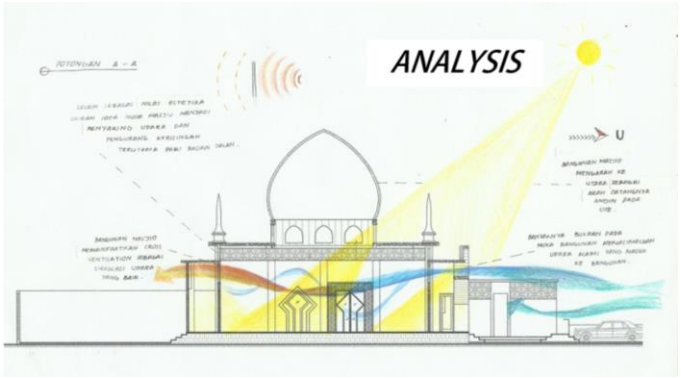


Figure 10: Building's Responses towards the Sun Path and Noise

Figure 11: Building orientation towards Northeast and Northwest

Table 1: Conserving Energy Principle

Conserving Energy	
PRINCIPLES	APPLICATION
To operate the building with the minimum unrenewable energy.	To position the building openings towards the northeast and northwest (minimizing the opening towards the west)
	To provide absorbtion ion well and biopori system to catch ground water.
	To maximize cross ventilation and passive cooling by providing green areas surrounding the mosque in order to avoid the use of Air Conditioner.

Figure 12. The building is designed in elongated form to bring the light inside facing the Southeast and Southwest.

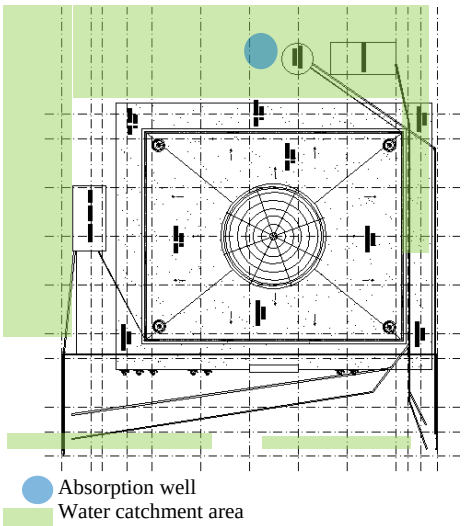


Figure 13. Absorption well and water catchment area

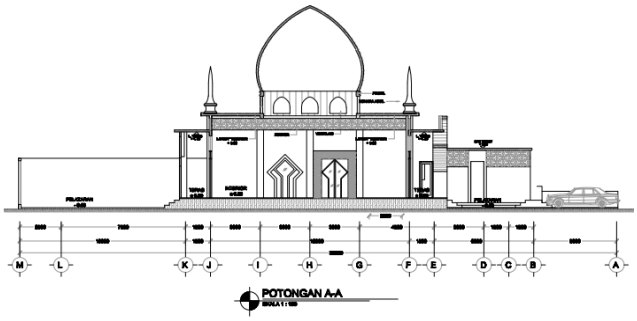


Figure 14. Green area surrounding the Mosque

To respond to the drainage in the middle of the site, the planning is to divert this drainage so that it will not be in the middle. Since the water came from the neighboring site, the team decided to move the drainage to the neighboring site so it will have direct access to the city drainage system. The site has a good capacity to catch the water and reduce the amount of water that goes to the city drainage system.
The team also considers the input from the land owner. Ibu Hj. Yuslida Hamid wants the design to be contemporary but does not exclude the symbol of a mosque as a religious building. Specifically she insists to have a lower level open court before the main entrance, a space for marbot (the person who cleans up the mosque), ablution space on the west and southeast sides, as well as parking space at the front facing the Hanjarwar road.

4.3. Green building approach in the building.

Based on the building response towards the site analysis, the application of the green building approach is as followed:

Table 2: Working with Climate Principle

Working with Climate	
PRINCIPLE	APPLICATION
To adjust and use the existing weather, climate and environment	To locate the building orientation against the sun path.
	To use plants and water as climate adjuster
	To use windows and roof which can be opened and shut depending on the users' need.
	To design terrace as buffer/ shading area.

Figure 15: Building orientation and vegetation to adjust the climate

Figure 16: Roof ventilation enabling light and wind circulation

Table 3: Respect for Site Principle

Respect for Site	
PRINCIPLE	APPLICATION
This approach requires interaction between the building and its site	To minimize site alteration by deploying design following the site condition.
	To apply local materials available from the surrounding area
	To use absorption well to catch rain water.
	To apply biopori holes in green areas surrounding the mosque.

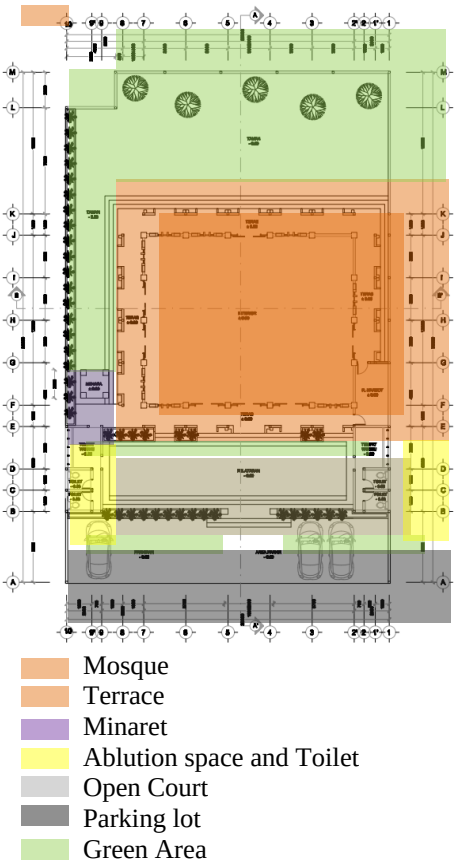


Figure 17**:** Site Plan Mosque

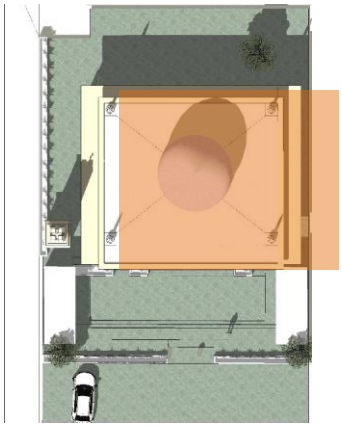


Figure 18: Building mass following the site

Figure 19: The use of local roster ornament in the facade

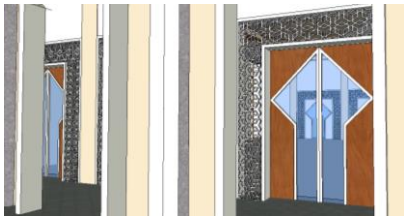
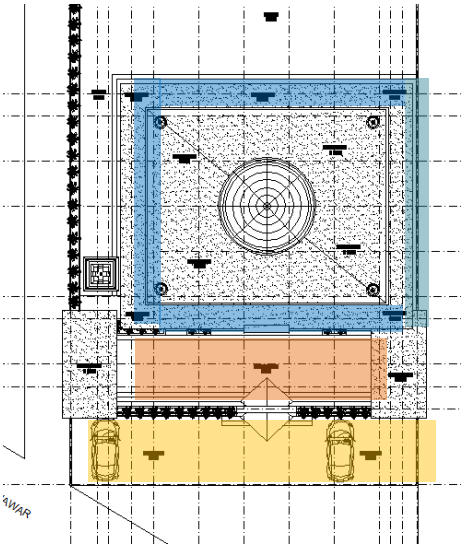


Figure 20: The use of local timber in the Mosque doors

Table 4: Respect for Users Principle

Respect for Users	
PRINCIPLE	APPLICATION
To pay attention on the users' needs, social condition and building maintenance.	To design a contemporary mosque which attracts and welcome visitors
	To provide parking space in front of the mosque to enable travelers have comfortable break in their journey..



Open court to welcome visitors and function as transitional space between inside and outside
Parking Lot
Open terrace

Figure 21: Floor Plan Mosque

Figure 22: View from Northwest

Figure 23: View from Northeast

Figure 24: Front Building Façade

Figure 25: Side Building Facade

Table 5: Limiting New Resources Principle

Limiting New Resources	
PRINCIPLE	APPLICATION
to limit the use of new resources and use the current available resources	To use low-cost material and construction but environmentally friendly.

Figure 26: Open court using Paving Block

Figure 27: Building facade using granite

Figure 28: Paint finish on walls and minaret

Built environment is an important factor in supporting users' activities. Through this design, green architecture approach shows to be the best solution in emitting carbon emission.

Table 6: Holistic Approach Principle

Holistic approach	
PRINCIPLE	APPLICATION
To design a building by applying these five principles	To ensure and evaluate the approaches according to the principles.

5. Conclusion

The analysis and the design approach of the mosque show that designing a building requires comprehensive strategy in formulating the concept based on the existing site condition. Green architectural approach is then applied to minimize the environmental damage, reduce the building cost yet accommodating user's need. Applying the green approach enables users to maintain the building easily and at the same time reducing the running cost.

The Mosque in Cipendawa Village is designed following the green principles which carefully looks at the site, space, form and facade as well as interior. This can be achieved through the following ways: (1) to position the building orientation against the sun path and wind direction; (2) to provide absorption well and biopori system to catch ground water; (3) To maximize cross ventilation and passive cooling by providing green areas surrounding the mosque in order to avoid the use of Air Conditioner; (4) to use plant as climate adjuster; (5) to use low-cost local material but environmentally friendly; (6) To provide open court as transitional space between inside and outside; (7) to provide parking lot and green areas as much as possible.

By applying this, the users will have a different perception while having activities in the mosque. In this case, green architecture does not only deal with the physical appearance only but can also provide a positive psychological effect to the users.

6. Acknowledment

We would like to thank University of Pembangunan Jaya for providing us with internal grant to conduct this research-based design. Also, we would like to thank Mrs. Hj. Yuslida Hamid, who agrees to give away her 270 m2 land to build the mosque.

7. References

[1] Bauer, M. *Green Building-Guide Book for Sustainable Architecture.* Heidelberg: Springer. 2010.
[2] Sahid, Larasati, D., Victoria, P. *Towards Implementation of Green Criteria in Indonesia; Needs dan Reality*. I-Dwell International Conference, 10th-13th August 2015, Lombok, Indonesia. 2015.
[3] Vale, R., Vale, B. *Green Architecture: Design for a Sustainable Future*. London: Thames and Hudson Ltd., p70-186. 1991.
[4] Zeisel, John. *Inquiry by Design: Tools for Environment-Behavior Research*, Cambridge: Cambridge University Press. 1984.