Sustainable principles in designing Lombok’s Beachside Area: a Gading Beach case study

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Abstract. Recognized as a global best halal tourism, Lombok in West Nusa Tenggara (NTB) is anticipating significant tourism growth. As a response to this, the local government are trying to accelerate the supporting facilities for tourism development, including the Gading Beach area. On contrary, however, buildings are known among the world’s biggest energy consumption. Therefore, the design proposal of these new buildings in the Gading Beach area ought to consider a holistic sustainable approach to create buildings that will encourage environmental, social and economic benefits. Five key sustainable design principles were utilized for the development of the Gading Beach area. Those principles are including site and ecology, community and culture, health, materials and energy. The implementation of these design strategies in the Gading Beach area is expected to exhibit an effective application of a sustainable approach in beachside buildings.

1. Introduction

In 2016, Lombok in West Nusa Tenggara (NTB) was recognized as the best halal tourism globally [1]. In addition, Lombok also scored the highest point in Indonesia Muslim Travel Index (IMTI) 2019 [2], where access, communication, environment, and services (ACES) are used as the main assessment criteria. These awards indicate the enormous potential of Lombok tourism, as well as the high demand for supporting infrastructures in the coming years as a response to this development.

One of the local government’s attempt to this matter was to improve several tourism spots across Lombok, including Gading Beach. The design must be developed to accommodate various tourism activities, as well as to provide a unique and attractive experiences. Buildings, on the other hand, are also known as the world’s biggest carbon emission contributor [3,4,5]. More than 30% of global energy was allocated for buildings [6,7,8], from construction to demolition process, including the transportation of building materials, maintenance, and daily operation [3].

Designing a beachside area is also significantly distinct from another area due to its particular soil structure, possibilities to abrasion, climatic condition and humidity, including its typical windy condition. Accordingly, the design process of the Gading Beach area should be undertaken comprehensively by considering the site’s characteristics and appropriate materials selection. The design should focus not only on the relationship between the user and the building but also on the interaction between the building and the environment. Therefore, the design proposal of these new buildings in the Gading Beach area will be using sustainable design principles as guidelines.
2. Literature review

2.1. The current issues

6.44 billion tons of CO2 were released into the atmosphere, data in 2002 shows [9]. Due to human activities, the current impact of global warming is inevitable, and it occurs at an accelerating rate. Buildings are among the biggest contributor to carbon emissions that lead to this condition [3,4,5] as they contribute to more than 30% of global carbon emissions [3,6,7,8]. As architects, therefore, it is essential to address energy use in the building by designing a low energy building while ensuring occupants’ comfort and well-being. However, what does it mean? Is it a realistic approach? More will be discussed below.

2.2. Sustainable design is the future

Currently, there is no single established definition of a sustainable building [7]. In some literature, it is described as a healthy building that was designed to reduce negative environmental impacts [10,11]. However, some argue that sustainable design should not only take environmental aspects into consideration [12]. It, instead, should involve a more pragmatic, holistic and comprehensive approach that oriented for the future [13,14,15]. To be successful, a sustainable approach should integrate energy efficiency, climate, renewable resources and the users into the design [4,7], while considering the entire building life cycle [7,13]. These principles are expected to improve occupants’ comfort, health, well-being, and productivity [4,14] and leads to a lower operating cost in building [5]. This condition indicates that the sustainable design approach is having a prominent value growth for the upcoming years and beyond [16].

2.3. Sustainable design principles

Five key principles in sustainable design described as follows.

2.3.1. Site and ecology

To date, nature plays a crucial part in fulfilling basic human needs as well as enhancing their quality of life in several ways. Natural environments influence human’s life at the psychological and physical level as they are able to provide shading, shelter, and cooling, while also purifying water and air that is essential to human beings [17]. During the design process, it is necessary to consider building shape, orientation and cross-ventilation to ensure that the buildings gain enormous benefits that the natural environments provided.

A building can reduce energy use for room conditioning by 10-20% only by organizing an effective shape and orientation [13]. Without compromising occupants’ comfort, there is also potential to reduce mechanical ventilation by 70% by making effective use of a cross-ventilation system [13]. To minimize the negative impacts of the built structure on the environment, therefore, a design that responded to its site plays a significant role in a sustainable approach [7]. In addition, whenever possible, mixed-used development should be taken into consideration to achieve efficient land use while providing an attractive and more engaged development [17].

2.3.2. Community and culture

A sustainable building is not only assessed through environmental objectives, but also economic and social goals [8], which include community participation. Local knowledge from the community is crucial during the development process as it helps to define their needs, concerns, and current issues [17]. However, community participation should go beyond the design and completion process of the building. By giving them control to manage the facilities, they will develop a sense of ownership that results in a more responsible guardianship. Moreover, involving the community during the development process helps to establish a fairer society which often leads to a more productive and collaborative contribution [17].
2.3.3. Health

Occupants’ well-being is a vital aspect of a sustainable approach. Designing a healthy building, therefore, is essential, not only to prevent negative physical and psychological impacts but also to provide an enjoyable space for occupants which can uplift their spirit. Temperature, air movement and air quality, humidity, noise, and lighting are among many parameters that can help to define comfort [17]. Occupants can be benefited from the connection between buildings and nature. For instance, a space with sufficient natural daylight encourages users to be more active and positive, while a darker space often leads to depression [17]. However, daylight amount in a building should be carefully designed since excessive natural daylight may lead to glare discomfort while damaging occupants’ eye and skin [17].

2.3.4. Materials

Annually, building industries consume 3 billion tons of raw materials [18] which account for 40% of total worldwide use [18,19]. Materials play a robust role not only in shaping a building’s buildability, aesthetics, and cost [17], but also to ensure occupants’ health and well-being [13]. Accordingly, the material selection process is essential. Material resource, manufacturing process, energy, transport, longevity, and waste amount are the key aspects to consider when selecting materials for sustainability [4,17] as well as its life cycle [13]. Integrating all of these aspects into a holistic design approach can reduce negative environmental impacts. All things considered, there is an urge to use low-carbon or low-impact materials from the outset of the project [5,13].

2.3.5. Energy

To achieve an energy-efficient building, a three-stage design approach should be employed. The priority is to provide a low-energy design solution, followed by the utilisation of efficient appliances and the application of renewable energy [3,17]. These methods must be undertaken in this specific order, otherwise, it will be inefficient [3]. Passive measures are best for achieving energy efficiency in building, particularly in a tropical climate. These include building orientation, sufficient daylight, and the integration of natural ventilation [17]. Building orientation in respect to the sun, the wind, and the site characteristics help to provide adequate natural light into the building while reducing the undesirable solar gain [17]. Cross-ventilation, in addition, is also the most energy-efficient way of providing fresh air which can help to cool the building [17].

Another efficient method to reduce energy use is through the integration of landscape elements. Known as the best natural shading, trees can reduce light varying from 10-70% depending on its leaves condition [20]. It is also able to reduce electrical ventilation on building up to 50% when its shading and cooling feature are combined [21]. Integrating softscape elements into the design, not only can protect buildings from direct sunlight and help to control microclimate but can also help to reduce noise, improve privacy, enhance habitats for flora and improving aesthetic quality [17].

3. Methodology

This study aimed to find the most effective design for Gading Beach, Lombok using a sustainable approach. The methodology used in this design is including site visit and survey, discussion with the local community and stakeholders, literature studies, and comparative studies. Site visit and survey records the existing features of the site, including microclimate, topography, and existing landscape. By doing so, it helps to gain a comprehensive understanding regarding site condition, including its strengths, weaknesses, and possible opportunities for the design. All this site knowledge is complemented by a discussion with the local community and stakeholders since they are able to provide specific information regarding their concerns, issues, needs and priorities. Then, an assessment can be made of what kind of method is suitable for Gading Beach development.

All data and information related to the design case are collected and assessed during literature studies. The resources are including research papers, articles, and related websites. In addition, a study on the existing building design, particularly ones with the sustainable design approach, also gives an
overview of the practical applications in the field. The combination of site survey, literature and comparative studies help to establish the most appropriate approach that can be integrated into the design.

4. Result and discussion

As suggested in the previous section, sustainability is a holistic approach that integrates many aspects into the design. It not only focuses on minimizing ecological footprints during a building’s life cycle but also improving the user’s psychological and physical well-being. To achieve these purposes, therefore, the design of the Gading Beach area ought to consider the local climate conditions, including five sustainable aspects below.

4.1. Local climate conditions

Located in the south area of Mataram, West Nusa Tenggara, the local climate in the Gading Beach area is similar to most tropical climate areas in Indonesia. Throughout the year, the climate generally has two seasons, the dry and rainy seasons, which each season requires specific design approach of a building. As a response to a high rainfall intensity, all buildings in the area were designed with a tilted roof, ranging from 10° – 15°. In addition, the temperature in the area ranges from 21° – 34° C with extensive sunlight all around the year.

Regarding sunlight intensity, particularly in tropical climate, west and east side are two orientations that best avoided. In the design of the Gading Beach, however, the west side is the main attraction of the area. It is where the beach, the sunset and Mount Agung are located hence this orientation offers the best view, beautiful scenery, and sunset for visitors. Therefore, site plan in figure 1 shows that most buildings are oriented to this side.

![Figure 1. Building masses on the site that accommodate various purposes.](image)

Despite the view, it has to offer, the building orientations to this side are susceptible to glare and visual discomfort for occupants. Therefore, to reduce glare and sunlight intensity, the main building was designed with a curved shape to avoid perpendicular orientation to the west side as shown in figure 2a. Figure 2a and 2b illustrates the two-meters wide shading that the main buildings have on all
sides. Combined with the shades created from the adjacent landscapes, these aspects help to reduce the sunlight intensity significantly.

Figure 2a. Restaurant floor plan and roof plan. The floor plan is showing the curved-shape of the building while the roof plan is showing the two-meters wide shading that surrounding the building.

Figure 2b. Tenant and seating area floor plan and roof plan. The roof plan is showing the two-meters wide shading that surrounding the building.

4.2. Site and ecology
To establish a comfortable built environment, the mutual benefits between the development site and its natural environment needs to be well-considered. Figure 1 shows the relationship between site and the designated buildings on the site. Mixed-used development was used in the Gading Beach design to encourage efficient land use while generating an attractive development. The designated area was defined to accommodate various purposes, from refreshing area to culinary to water sports and playground. These various purposes were categorized into several buildings, where each building mass was located into different zoning on the site. This massing plan promotes improvement on pedestrians while conserving the existing trees on the site. Hence, the natural habitats for wildlife on the site can be protected. New vegetation was also introduced to enhance the existing landscape. Enough vegetation on the site will serve not only environmental benefits but also aesthetic, psychological and physical benefits.
4.3. Community and culture
Residents and local government involvement are one of the sources of input during the development of the Gading Beach area. Several informal discussions with their representatives were undertaken to gather information regarding their priorities, concern, and expectations. This involvement not only helps to increase local people awareness about the development plan but also give them a sense of ownership. In the future, after the completion of the buildings, the government are expected to collaborate with the residents to manage the whole area. When buildings become part of the community’s, they have been proven to be more economically and socially sustainable because the community has gained a responsible guardianship to the area. As a result, the Gading Beach area can be a significant asset for West Nusa Tenggara, particularly Mataram, for many years to come.

4.4. Health
Designing for occupants’ comfort and well-being is not a luxury. It, instead, a necessity to establish a healthy built environment. As shown in figure 3, the main idea of the Gading Beach design was to provide contact with nature by creating a vague distinction between indoor and outdoor spaces. This idea is translated into the buildings, where the use of massive walls is minimized. As a result, it allows each building mass to have sufficient access to natural daylight and ventilation throughout the day. This design also encourages air movement, improve the air quality, and help to achieve a comfortable temperature. All these parameters are essential in creating a healthy environment.

Figure 3. The floor plan and section of the restaurant.
Both images indicate the open design where no massive walls. This design promotes connection to nature and surrounding view while enhancing occupants’ health and comfort by providing sufficient natural daylight and ventilation.

On the other hand, the minimum use of massive walls also provides limitless visual access to the surrounding views. Combined with multiple options of seating area as illustrated in figure 4a and figure 4b, the visitors are expected to find it enjoyable and delightful as they are more connected to nature. Accordingly, it will uplift their spirit and benefitted them psychologically.
Figure 4a. Bean bag seating area as one of the seating options in the area

Figure 4b. Multiple options of seating area helps to create a more enjoyable spaces which help to improve visitors’ happiness.

4.5. Materials
To comply with the initial target to maximize the use of natural resources, buildings in the Gading Beach area are mostly constructed using wood as indicated in figure 5 and figure 6. Wood is selected due to several reasons. First, it is renewable and natural. Second, it is locally available in the area, thus, the energy used for transporting materials to the site can be significantly reduced. Third, it can be easily disassembled at the end of the building’s life which will increase the opportunity for reusability and recyclability. Accordingly, there will be a waste reduction. Forth, it is also durable and suitable for beachside microclimate. All these factors contribute to minimizing the embodied energy produced throughout the buildings’ life cycle.

Figure 6 also illustrates that recycle materials were also utilized in several areas for finishing and interior materials, for instance, food court cladding and dining area tables, also restroom cladding, and children playground. There are many several benefits to doing this, such as energy reduction for resourcing and manufacturing process, waste reduction, and cost reduction. Moreover, each of these recycled materials has specific visual characteristics that can be aesthetically appealing.

Figure 5. Wood as the primary material for the buildings in the Gading Beach area.

Figure 6. Wood as primary material combined with the recycle wood for food court cladding.

4.6. Energy
As discussed above, the buildings in the Gading Beach area were designed to relate to nature as seen in figure 7. This approach is not only beneficial in creating a healthy and attractive environment, but it also helps to establish an energy-efficient building. Figure 8 illustrates that minimum use of massive walls provides sufficient daylight and promotes cross-ventilation that will passively cool and ventilate the building.
Figure 7. Massing design that allows contact with nature.

Figure 8. The minimal use of massive walls to create connection between spaces.

The bird eye view perspective in figure 9 shows that all buildings in the Gading Beach area were designed to be slim and break into different massing. This approach to ensure that each building has sufficient access to natural resource. Combined with the ability of vegetations on the site in providing natural shading, the energy used for electrical lightings and mechanical cooling can be significantly reduced while still ensure occupants’ comfort.

Figure 9. Bird eye perspective of the Gading Beach area.

5. Conclusion
Buildings are one of the biggest contributors to global energy use [3,4,5,6,7,8] have potential lives spanning many years to come and affecting future generations. To support tourism, many beachside areas are being developed, particularly in Lombok. This development involves the construction of new buildings. Therefore, a comprehensive approach needs to be undertaken during the design process of the new building. Previous studies show that sustainable design is a holistic and comprehensive approach [13,14,15] that will not only environmentally beneficial [11,12] but will also enhance occupants’ health, comfort, and well-being [4,10,14,17].

Site, community, health, materials, and energy are five key principles of sustainable design [17] that was implemented into the design of the Gading Beach area. Specifically, these aspects include climate, building shape and orientation, solar protection, renewable resources, and the users into the design process [4,7,13]. Therefore, this study is expected to illustrate a comprehensive application of sustainable principles in building, particularly in the beachside area.
This research, however, has many limitations and needs to be improved in the future. The sustainable design strategies described above have not been evaluated using the assessment tools/criteria. Therefore, an evaluation tool needs to be formulated to help to assess the success level of sustainable buildings in the future.

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