Happy Beach Coastal Landscape Design, Based on Landscape Engineering Adjustment

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Abstract. Coastal Landscape design based on landscape engineering adjustment is a coastal landscape design which applying theory, mathematical and physical modelling to practical design problems. The objective of this research is to analyze the characteristic of site and to design coastal landscape based on landscape engineering adjustment, in addition to make a sustainable site landscape design. Happy beach is one of unexposed black sand beach to many tourists, which has beautiful and clean ocean scenery. Dolphin watching tour is the main potential nature attraction to the site through riding boat at every sunrise. Methods that used in this research in design process; 1. Project acceptance; 2. Research analysis, by exploring some potential, amenity, obstacle and danger signal of site; 3. Design, the creative process of responding to condition while concentrating meaning; 4. Construction drawing. Landscape engineering approach was used to solve some specific site problem such us stormwater, climate, and beach sand which deadly for plants. The rainfall intensity value of 101.72 mm / hour. The amount of runoff is 13 m\textsuperscript{3}/s which has a relatively small value. From the temperature data of Tukadmungga Village for one year, which is listed in Table 1, it can be concluded that the highest temperature reaches 31 °C. The highest temperature occurs in September 2018 to March 2019. In the range of November to April, the position of the sun against the site can be illustrated with sun path diagram. By knowing the position of the sun, we can determine the exact position of vegetation planting, which is located in the west and east of the building. m\textsuperscript{3}/s0.13 m\textsuperscript{3}/s Happy Beach Landscape Design include the detail of material properties which has the best performance for its using, climate, and design concept. Coastal landscape design eventually will be a recommendation for Tukadmungga village perbekel office and also North Bali Ministry of public work.

Keywords. Hindu, infrastructure design, port, sustainable

1. Introduction

Bali island was divided from east to west into two plain by two mountain standstill in the middle. Northern and southern part has a big different landscape characteristic. North plain Bali has a narrow plain than South plain which influenced the development of South Bali rather more quickly than North Bali. Although northern region has been isolated from the rest of Bali, North Bali still has some interesting places to visit. From waterfall, hot springs, to the beaches, Bali has beautiful landscape with authentic culture and pristine The government see this opportunity with implementing a new Bali: one island-one management solution to the island’s tourism industry. The goal is to improve and increase tourism from developing the infrastructures. Short cuts from the north coast to central highlands and the south have already begun in the Regency of Buleleng which slated to be completed by 2021. Beside the infrastructure development, landscape design has been recognized as supporting role in the enhancement of the physical assets of destinations,
which create a sense of place to make the destination become special or unique. Landscape design also important to make sustainable landscape by using some engineering to prevent ecosystem destruction in the development tourism activity. By designing landscape we can boost tourism investment.

Principle of sustainable development in tourism is used in Bali Province Regional Regulation No. 10 of 2015. The vision of regional tourism development is to make sustainable and qualified cultural tourism. Landscape architecture is necessary to create a sustainable tourism which aesthetically attractive and consider the ecological aspect, so that the design can be sustainable. In designing landscape we need to analyze the problem of the site to solve the problem. The aim is to prevent the side effect that will be generated from the new landscape design.

Lovina beach is the name for a number of beaches with total length of approximately 12 km. Located just west of Singaraja, Lovina belong to the villages of Pemaron, Tukadmungga, Anturan, Kalibukbuk, Kaliasem, and Temukus. One of the undeveloped and well-designed black sand beach in Lovina beach is Happy Beach, Tukadmungga. Even Happy beach is unexposed to many tourist but has a great potential to be developed. Happy beach has a glistening sunrays on a clean glassy blue waters. Some wild dolphin live and migrate up and down the coast of Lovina. Tourist can ride a boat in the early morning to watch dolphins, feed dolphins, or just snorkeling around the beach. The final research is the design landscape of Happy Beach, Tukadmungga, Buleleng regency, based on landscape engineering adjustment that can be functionally useful and aesthetically beauty. The development direction of Perbekel of Tukadmungga is focused on coastal tourism which also the biggest reason of this research. Hopefully the design can be a recommendation for the Perbekel of Tukadmungga as well as Balai Litbang Pantai, ministry of public work.

2. Method

Happy beach is located in Tukadmungga, Buleleng regency, North Bali (see Figure 1). Geographically, this beach was located at approximately latitude 8º 08’ 09.62” S and longitude 115º 03’ 13.76” E. The beach is facing northwest with shoreline from southwest to northeast. The research begun from February 2019 till August 2019.

Figure 1. Location [A] Bali Island, [B] Buleleng Regency, [C] Happy Beach

This research was conducted for twelve months starting from October 2018 until September 2019. Landscape design methods that used is according to Booth [1], the stages are:

1. Project acceptance
2. Research and analysis
   a. Base map preparation
   b. Inventory and interview, was done by a field survey. several important aspects needed including physical and biophysical aspects.
   c. Analysis, is based on data that has been collected to get the potential, amenity, constraints and danger signals found on the site. The results of the analysis can be in the form of descriptive sentences, schematics, or pictures.
d. Synthesis, The synthesis phase is carried out to determine the problem solving which is then applied in making the concept development.

3. Design, stages in organizing and enriching the quality of outdoor space through the placement of plants and structures in relation to a pleasant and beneficial natural environment [2].

4. Detail construction drawing

3. Case

3.1 Climate

The Bali Island region is classified into AW climate according to the Koppen climate classification or savanna climate with dry winters [3]. This climate has hot temperatures, a rainy season, and a longer dry season when compared to the rainy season. Dr. Wladimir Koppen who made a worldwide climate classification based on average rainfall and temperature, both monthly and also annual [4]. This climatic condition will greatly affect the diversity of flora which also impacts the diversity of fauna. With the classification of AW Koppen, the dominant vegetation is tropical savanna. Through climatic conditions, we can also analyze the comfort of the site users, which will be analyzed using the Thermal Humidity Index (THI). The average temperature in the Happy Beach tourist area is 27.54 °C and the relative relative humidity of 82%. These climate aspects can be used as a basis for calculating user comfort in activities on the site using the THI.

Table 1. Humidity, Rainfall, and temperature Data at Desa Tukadmungga

| Month  | Humidity | Rainfall  | Temperature Max | Temperature Min |
|--------|----------|-----------|-----------------|-----------------|
| May-18 | 79%      | 76.20 mm  | 29.00           | 25.23           |
| Jun-18 | 78%      | 71.12 mm  | 28.00           | 24.83           |
| Jul-18 | 76%      | 50.80 mm  | 28.10           | 24.00           |
| Aug-18 | 74%      | 22.86 mm  | 27.00           | 23.00           |
| Sep-18 | 76%      | 40.64 mm  | 29.00           | 24.00           |
| Oct-18 | 81%      | 91.44 mm  | 30.10           | 24.84           |
| Nov-18 | 85%      | 154.94 mm | 30.10           | 25.27           |
| Dec-18 | 89%      | 292.10 mm | 30.50           | 25.70           |
| Jan-19 | 86%      | 247.98 mm | 30.40           | 25.20           |
| Feb-19 | 88%      | 287.02 mm | 30.00           | 25.00           |
| Mar-19 | 85%      | 213.36 mm | 30.30           | 25.42           |
| Apr-19 | 81%      | 93.98 mm  | 30.93           | 25.70           |

Source: https://weather.com

\[ T = \text{Average temperature} \]
\[ \text{THI} = 0.8T + (RH \times (T / 500)) \]
\[ \text{THI} = 21\text{-}27 \text{ (Comfortable)} \]
\[ \text{THI} > 27 \text{ (Not comfortable)} \]

THI value generated based on the equation is 26.55. Based on the THI value, user convenience on the site, according to [5] is included in the level of comfort that is relatively comfortable, but is approaching the range of discomfort limits. So it needs to be improved and rearranged the elements of the landscape that exists on the site both softscape and hardscape in order to increase the value of the comfort index.

3.2 Hydrology

Land in the welcoming area has a low permeability level, so that flooded area can be found after rain falls. This condition is exacerbated by the slope of land that is very low so that the land tends to be flat and the water is difficult to flow then stagnate. This problem can be solved using the rain garden concept. The tread water inlet enters through the southeast with the outlet of the Tukad Bangke river and also into the sea.
3.3 Beach and Sea Characteristics
Happy Beach has a beach character that is formed from fine black sand, this beach is not muddy or rocky, making it suitable for swimming. The seabed morphology shows an undulating seabed with a slope about 10° and a maximum depth about 500 m. The beaches in North Bali with steep coastal morphology generally have the influence of fluctuations and the speed of the current to the small coast. This beach has a high salinity sand. Salinity becomes a problem when enough salts accumulate in the root zone to negatively affect plant growth. Excess salts in the root zone hinder plant roots from withdrawing water from surrounding soil.

4. Happy Beach Landscape Design
4.1 Basic concepts
The basic concept of landscape design refers to "Tri Hita Karana". This philosophy has taught harmony in all Balinese lives. The area arrangement intended in the architectural environment came to be known as the Tri Mandala which is a balanced and proportional division of space into three spaces for Parahyangan (holy place), Pawongan Room (a place where people engage in activities with another people), and palemahan space (green open spaces or a place to dispose the results from human activities). A description of the basic concepts can be seen in Figure 4.

4.2 Design Concept
Happy Beach, located in North Bali, where the statue of Lord Vishnu is allowed to be placed. One attribute attached to Lord Vishnu is the Lotus Flower. This lotus flower formation is then transformed into the formation of landscape element formation. Pavement patterns applied to the formation of a circle centered on the statue. This circle formation refers to the shape of a lotus.
flower. Then in the pond there is a lotus blossom that has a water nozzle so that when the water comes out, the flower formation will be more visible. Transformation of lotus flower formation as a design concept can be seen in Figure 4.

![Figure 4. Basic Concept and Design Concept](image)

4.3 Development Concept
Happy Beach which was originally used as a place of worship. The principle of harmony between humans, God and nature must be formed in the footprint. Based on Tri Hita Karana, the Happy Beach tourism area is generally intended as a tourist site (Human-human relations), a place of natural interpretation (Human-natural relations) and as a place of worship (Human-God relations). To overcome the problem of runoff in the parking area can use a rain garden system or water management system by collecting and infiltrating water into the soil layer. Rainwater that falls will not be directed to the water body, but infiltrated into the ground which can also precipitate pollution so that it is trapped in the ground. Block plan and siteplan are shown in Figure 5. The vocal point from this design is the pool under the Vishnu statue with a nozzle arranged to form a blooming lotus flower crown, shown in Figure 6 (A). The main pattern applied to the pavement pattern and the planting plan is formed from a circle taken from a lotus leaf formation, with the main center on the statue of Vishnu. Children's playground is inspired by the formation of lotus flowers buds. In the reception area, there is a Happy Beach signage and also a pergola as a hardscape element that can make a shaded area and also a vine for *Quisqualis indica*. The vegetation that dominates the reception area is *Saribus rotundifolius*, because the shape of the crown which clumps at the top Happy Beach Jetty/port is placed straight in front of Vishnu Statue, shown at Figure 6. Jetty design and DED are shown in Figure 7.

![Figure 5. Block plan and Siteplan](image)
4.4 Landscape Engineering adjustment
4.4.1 Stormwater management
Stormwater management in an architectural landscape has many applications and issues and is interpreted as a prediction and direction of stormwater runoff movement. The relatively flat topography has a big advantage in this problem, because a flat tread state can increase infiltration capacity than a tread with greater slope conditions. The solution offered consists of two kinds, namely the use of grass blocks and also making rain garden. Rain garden combines water filters using physical elements and also water filters with biological elements such as plants. The use of this concept requires a fairly deep mixture of planting soil. In 1889, Kuichling introduced The Rational Formula to estimate the highest runoff value from rainfall which is widely used in calculating the amount of runoff with the following formula [6].

\[
Q = KCAI
\]

\[
Q = \text{Highest runoff value in m / hour} \quad I = \text{Rain intensity in mm / hour} \\
K = \text{Constant (0.0028)} \quad A = \text{Watershed area in Hectares} \\
C = \text{Rainwater runoff efficiency}
\]

To get the value of rain intensity, a mononobe formula is used with the following formula

\[
I = \frac{R24}{24} \left(\frac{24}{t}\right)^{2/3}
\]

\[
I = \text{Rain intensity (mm / hour)} \\
R = \text{maximum rainfall} \\
t = \text{duration of rain (24 hours)}
\]

The calculation of rainfall intensity in Tukadmungga Village is attached as below:

\[
I = \frac{R24}{24} \left(\frac{24}{t}\right)^{2/3}
\]

\[
I = 25.43 \times 4.00 \\
I = 101.72 \text{ mm/hour}
\]
The rainfall intensity value of 101.72 mm/hour is obtained, then from the rainfall intensity value

\[ Q = K CIA \]
\[ Q = 0.0028 \times 0.450969 \times 101.72 \times 1.07 \]
\[ Q = 0.13 \, \text{m}^3/\text{s} \]

The runoff obtained has a relatively small value, this is because beach sand has the ability to absorb good water. Inundation that was previously present on the site could be due to the use of the area as a parking lot making the soil solidify and reduce the ability to absorb water. This can be overcome by creating a rain garden and the use of grass blocks as a pavement for parking areas.

4.4.2 Material Properties

The beach area has high average temperature, so the majority has a low comfort value. During the day, the roof can have a hotter temperature than air temperature. When the radiation is absorbed by the roof, then some of the heat radiation will be reconfigured back into the air and the rest is carried down through the roof material then irradiated into the building. Foil barrier faced with air space can stop the transfer of heat radiation because the low emissivity of aluminum foil reflects heat radiation well and does not transmit radiation energy. This system is commonly referred to as a Radiant barrier system [7].

![Figure 8. DED roofing and Application radiant barrier (Source: www.radiantguard.com)](Image)

The roofing material chosen for the design of shop, toilets and prayer rooms is bamboo. Bamboo has a higher level of tension compared to iron. The flexibility of bamboo is good, so it is easy to be created, well deflected, shaped, laminated. Another advantage possessed by this material is that it is easily renewed so it is inexpensive and is sustainable because it is environmentally friendly. Transparent material will carry the heat radiation received to enter the building. To reduce the transmission size, the selected glass material is low-e glass. High Density Polyethelene (HDPE) was chosen as a playing area climber material inspired by the lotus bud formation. This material was chosen because it can be created in shape, and is safer for children. Plastics in general have a level of tension that is almost the same as wood, plastic stiffness is also high. HDPE recycle can be used as climber material, so it can be a solution to the problem of plastic waste that is difficult to describe [8]. The playground design shown in Figure 9.
4.4.3 Climate engineering
Landscape design in hot areas requires micro-climate considerations from the tread area. Vegetation, water and also hardscape can be used as a solution to these problems. Vegetation is the most effective landscape element in modifying soil surface temperature and air temperature. The variety of shapes, textures and colors of plants provides beauty and useful uses for landscapes or provides protection against walls. Ground cover can reduce unwanted blinding light and also to prevent excessive heat around the site. The cover crop used in the site is *Arachis pintoi*.

From the temperature data of Tukadmungga Village for one year, which is listed in Table 1, it can be concluded that the highest temperature reaches 31 °C. The highest temperature occurs in September 2018 to March 2019. In the range of November to April, the position of the sun against the site can be illustrated as Figure 10. By knowing the position of the sun, we can determine the exact position of vegetation planting, which is located in the west and east of the building. In addition, trees, shrubs and ground cover plants can reduce direct solar radiation or reflection and also absorb heat. Hardscape and building elements can be used as a micro climate protection for the site area. The hardscape element applied in the site to engineer microclimates is the use of pergolas. In hot climates, shading is the most effective passive landscape control strategy.
5. Conclusions and Suggestions

5.1 Conclusions

Happy Beach is one of the beaches in North Bali that has high tourism potential, it is necessary to have a landscape arrangement to support tourism activities on the beach. The THI value obtained on this site is 25.57, so it has a moderate level of comfort. To increase the Comfort Level can be done by managing and planting vegetation to reduce temperatures, increase air humidity and reduce surface temperature. Happy Beach landscape design has a basic concept of "Tri Hita Karana", the concept aims to have a balance between the three important aspects. The design concept applied to the site was inspired by Lotus Flower, which is as one of the attribute of Lord Vishnu. The Lotus is transformed in the form of pavement, ponds, play areas, and also signage.

5.2 Suggestion

Happy Beach has great tourism potential because it has a variety of attractions that can be enjoyed by tourists. Accessibility to the site is also very easy to reach. The tourism potential needs to be developed so that visitors can enjoy tourist attractions more optimally. Bathimetry data collection should be done further to be able to produce an appropriate and accurate Jetty design. Therefore, landscape design is very necessary to advance North Bali Tourism. Maintenance of landscape design needs to be implemented. Intensive maintenance needs to be done especially in children’s play areas, to absorb dust and sea water. The maintenance needed includes cleaning to drying.

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