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Green Building Concept of Banjar Traditional House in Kalimantan Selatan

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ABSTRACT

Human's house since the beginning of life has a very important role in human history. It was initially obtained by utilizing natural human conditions eventually progressed along with the increased of science and culture. Traditional house is made and developed with inseparable from adaptation to the circumstances surrounding environment. One of Traditional House in Indonesia is Banjar Traditional House in Kalimantan Selatan. The value of local wisdom of the building form and construction in Banjar Traditional House can be studied and applied for modern building design in order to have adaptation value and friendly with the environment and in line with the green building concept. This paper investigated the benefits for building occupants and the efficient use of natural resources from the green building concept that has been applied.

1. Introduction

The human process of finding a place to live originates from its instinct to adapt to the environment (Budihardjo E., 2009). But as time goes by, people begin to think that place not only serves as a refuge from various "threats", but also a place to live that can provide comfort and in adapted with environmental conditions (Mortimer, 2014).

The form of human's house undergoes several changes along with the development of knowledge with the characteristics of adjusting local environmental and cultural conditions. In the late 19'th and early 20'th century, buildings such as London's Crystal Palace (built in 1851) and Milan Galleria Vittorio Emanuele II (built in 1877) have used passive heating systems, such as roof ventilators and underground air conditioning spaces to modify indoor air temperature (Hansen, 1971; Cassidy, 2003 in Wang et al, 2013). Traditional house can be interpreted as a house that has been built in the same way in several generations (Rapoport, 1969).

One form of traditional house in Indonesia is Banjar Traditional House in Kalimantan Selatan. The main characteristic of the Banjar Traditional House is seen from the shape of the roof in the form of a space pattern that has anjung on the left and right side, with a twin door on the wall of the room. There are eleven types of houses that are characterized by Banjar traditional architecture, that is Bubungan Tinggi, Gajah Baliku, Gajah Manyusu, Balai Laki, Balai Bini, Palimasan, Palimbangan, Cacak Burung (Anjung Surung), Tadah Alas, Joglo dan Lanting. Banjar Traditional House is refers to the condition of geography and environment. This is seen from the configuration of high and steep saddle roof that is very suitable for tropical moist climates, and the structure of the house on stilts is more suitable with the ground surface on riverside and swamplands (Dahliani, 2015).

Brenda and Robert Vale (1991) establishing six principles of eco-friendly architecture, that is: (1) energy conservation; (2) build in harmony with the climate; (3) minimized the use of new resources; (4) look at the needs of the occupants; (5) appreciate surface of the ground; and (6) thinking and doing comprehensive. On the concepts above the emphasis is that the building to be created can't regardless of climatic factors and natural resources as material.

Several centuries ago, in areas with dry climates that wood

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became scarce, construction techniques were developed in which buildings were covered with mud brick domes or without the use of wood as a support (Minke, 2006). The limitation of the natural carrying capacity and the efforts of environmental protection ultimately led to the concept that is able to synergize between the development with the limitations of natural resources and environmental (Pasaribu, 2012).

The values of local wisdom from traditional houses can be applied to modern building concepts. This is due to some concepts from traditional houses containing the concept of adapting to the environment. The concept of local wisdom from the traditional house is also in line with the principle of sustainable development that is the principle of preservation and development of archaeological resources by interpreting the past for the present and the future (Hartatik, 2016).

Applying the concept of local wisdom to the design of modern building has advantages for both building occupants and the environment that can be calculated based on the need for clean water and green open space.

2. Materials and Methods

This research has been conducted by exploring Detail Engineering Design from Office of Regent of Hulu Sungai Selatan which is planned to be built in Sungai Raya Sub-district of Hulu Sungai Selatan Regency in Kalimantan Selatan with length 66,1 m and width 56 m not including green open space. The building consists of three floors of ground floor, first floor and second floor. The height of the building from the lower boundary of the ground floor to the ringbalk or the roof beam is 12.45 m (Department co Public Work of HSS, 2013).

The value of local wisdom from Banjar Traditional House taken to be applied in the DED from Office of Regent of Hulu Sungai Selatan is a design of house on stilts.

The application of the house on stilts design in a modern office building apart from minimizing the impact of the flood disaster can also be used as space to place a large reservoir or tank that can inhale the rainfall that falls on the roof of the building which is poured through the pipe and the soil surface with the infiltration system. This is in line with one of the green building concepts that have a system of rainwater harvesting and complement building with green open space as biological conservation and water absorption (Regulation of the Environment Ministry of Republic Indonesia Number 8 of 2010).

Figure 1. One type of Banjar Traditional house with the named Bubungan Tinggi

This research used quantitative method where the calculation of the amount of rainwater that can be harvested is calculated by using simple calculation formula from local rainfall data, catchment area, and runoff area coefficient. The area of green space that can be constructed is calculated by using the ratio of the basement area of the building being the parking location.

The amount of potential rainwater that can be collected or rainwater harvesting is calculated using the method of calculating catchment area of the roof and rainfall data (Heryani, 2009 in Harsoyo, 2014), i.e:

The amount of rainwater that can be harvested = Catchment area X millimeters of rain X runoff coefficient

In this case, the catchment area is the rooftop area from DED of Office of Regent of Hulu Sungai Selatan. Millimeters rainfall is obtained from monthly rainfall data for Sungai Raya sub-district of Hulu Sungai Selatan Regency. For runoff coefficients a value of 0.8 assumes only 80% of the total rainfall can be harvested (20% lost due to evaporation or leakage) (Harsoyo, 2014). Local rainfall data is obtained from the rain observation station that located in Sungai Raya Subdistrict where the DED location will be built, that is:

No	Month	Monthly Rainfall (mm)	Number of Rainy Days In One Month	Average Daily Rainfall (mm)
1	January	215,4	20	10,77
2	February	157,5	15	10,5
3	March	223,9	17	13,17
4	April	294,8	20	14,74
5	May	180,4	16	11,28
6	June	99,8	16	6,24
7	July	168,3	11	15,3
8	August	89,8	9	9,98
9	September	96	11	8,73
10	October	126,6	14	9,04
11	November	282,4	19	14,86
12	December	518,8	30	17,29

Tabel 1. Rainfall Data of Sungai Raya Subdistrict in 2017
Source : *Laboratory of Pest Disease Observation of Food Crops and Horticulture of Kalimantan Selatan*

The highest rainfall is in December in which the end of the year marks the beginning of the wet months. While there are minimum rainfall in August which is usually a dry month period.

Rainwater harvesting method in addition to having the function of reducing the volume of surface runoff water that can cause flooding, also can be as a substitution of clean water from Local Water Supply Utility so as to obtain cost efficiency from the use of clean water by building occupants.

The area of the Green Open Space that can be built by converting the parking lot into the building basement can be obtained by a simple formula:

The Area of the Green Open Space = Long of Basement x Wide of Basement

From the extent of the Green Open Space constructed, rainwater harvesting methods can be applied from water absorptions that fall on the surface of the grass or a water catchment-specific paving block that will also flow into the reservoir.

The calculation of rainwater harvesting from the surface of the grass or a water catchment-specific paving block is calculated using the formula of catchment area calculation, rainfall and runoff coefficient (Christopher & Jeremiah, 2010), that is:

The amount of rainwater that can be harvested = Green Open Space Area X Millimeters Rainfall X Runoff Coefficient

For the runoff coefficient, a value of 0.75 is assumed to be only 75% of the total rain that can be harvested from water absorbed into the surface of the grass or a special paving block.

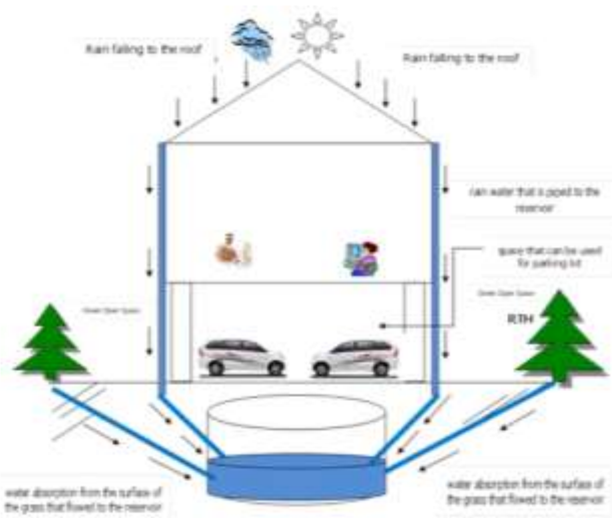

Figure 2. Design of Implementation of House on Stilts Construction at DED of office of Regent of Hulu Sungai Selatan

3. Results and Discussion

Rainwater Harvesting Rooftop

The volume of rainwater that can be harvested from the roof area is calculated based on the roof dimension of the building:

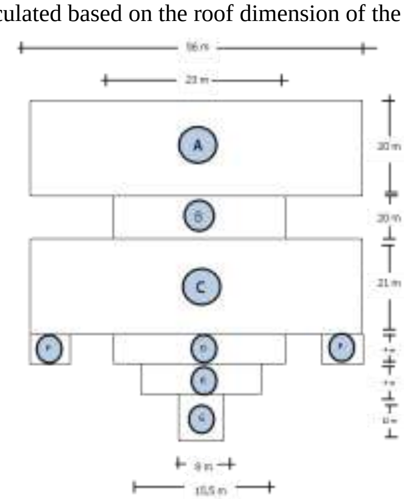

Figure 3. Segment of the rooftop from DED of office of Regent of Hulu Sungai Selatan

The calculation of the rooftop area of each segment can be seen in the following table:

No	Segment	Long (m)	Wide (m)	Area (m2)
1	A	56	20	1120
2	B	23	20	460
3	C	56	21	1176
4	D	23	4	92
5	E	15,5	4	62
6	F	5,5	4	44
7	G	13	8	104
			Total Area	3058

Table 2. Calculation of Rooftop Area by Segment and Total (Catchment Area)

In Table 2, the results obtained from the calculation of the rooftop area is 3,058m². From the above data, it is calculated the volume of rainwater that can be harvested in January in daily and monthly periods using the formula, i.e :

- Rooftop Area = 3058 m² = 305.800 dm²
  Monthly Rainfall = 215,4 mm = 2,154 dm
  Runoff Coefficient = 80% = 0,8
  The amount of rainwater that can be harvested
  = 305.800 dm² x 2,154 dm x 0,8
  = 526.954,6 dm³
  = 526.954,6 liter/month
  Average daily rainfall = 10,77 mm = 0,11 dm
  The amount of rainwater that can be harvested
  = 305.800 dm² x 0,1077 dm x 0,8
  = 26.347,7 dm³
  = 26.347,7 liter/day

Volume of rainwater that can be harvested monthly and daily within a period of one year presented in the following table:

Table 3. Data of Rainfall Volume that Can be Harvested in One Year Period

No	Month	Volume of rainwater that can be harvested monthly (litre)	Volume of rainwter that can be harvested daily (litre)
1	January	526.954,6	26.347,7
2	February	385.308,0	25.687,2
3	March	547.749,0	32.220,5
4	April	721.198,7	36.059,9
5	May	441.330,6	27.583,2
6	June	244.150,7	15.259,4
7	July	411.729,1	37.429,9
8	August	219.686,7	24.409,6
9	September	234.854,4	21.350,4
10	October	309.714,2	22.122,4
11	November	690.863,4	36.361,2
12	December	1.296.192,3	42.306,4

The calculation of the green open space that can be built by moving the parking lot previously located on the right and left side of the building into the basement or the area under the building can be calculated by first taking the segment area from the basement to be used as parking area, that is in Fig 4.

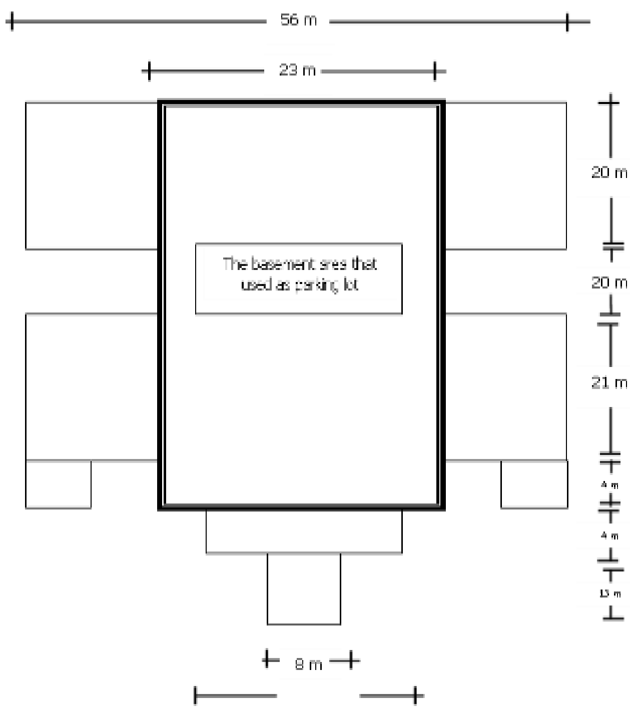

Figure 4. The Basement Area for parking Lot

From the area obtained from the Fig 4 can be calculated the extent of green open space that can be built:

The Extent of Basement Parking Area = The Extent of Green Open Space That Can Be Built: 65 m x 23 m = 1.495 m²

Assuming green open space that can be built is on the right and left side of the building then in one green open space is: 1.495/2 = 747,5 m². If calculated from the value of the need for green open space with reference to Earth Summit in Rio de Janeiro, Brazil (1992), and confirmed on Earth Summit in Johannesburg, South Africa (2002) that the extent of the green open space requirement is 30% from total building areas (Samsudi, 2010), that is:

Total Building Areas = 53 m x 82 m = 4.346 m². The need for green open space from the total area of the building is: 4.346 x 30% = 1.303,8 m². From the green open space that can be built above the 1,495 m², it can be said that the extent of the needs of open green space for buildings can be fulfilled.

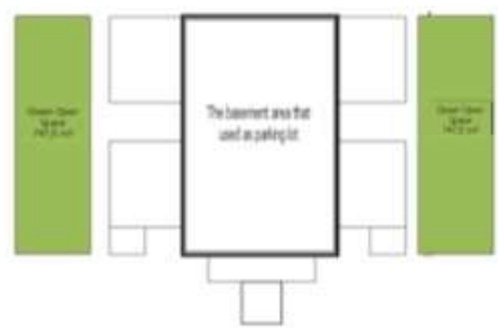

Figure 5. The Green open space that can be built

Rainwater Harvesting from Green Open Space

From the Fig 5, it can be calculated the volume of rainwater that can be harvested because rain water that falls on green open space can be absorbed either on the surface of grass or a special paving block that can absorb water with a piping system that drains water into reservoir under the basement.

The volume of rainwater that can be harvested from green open space is equal to the calculation of rainwater harvesting on the roof area of the building by multiplying the catchment area with rainfall and runoff. The area used for calculation is 1,495 m² or 149,500 dm². The taken runoff value is 75% or 0.75 for a special grass surface or paving block (Christopher & Jeremiah, 2010).

Calculation of the volume of rainwater that can be harvested monthly and daily from green open space in the one year period is presented in the Table 4. The calculation of the efficiency of the utilization of paid water from the Local Water Supply Utility is calculated by taking data on the use of clean water from the current Office of Regent of Hulu Sungai Selatan with the assumption of the same number of employees at the time of moving to the new Office of Regent of Hulu Sungai Selatan that planned in DED. The substitution of rainwater harvesting is calculated from the total volume of rainwater that can be seen in Table 5.

Table 4. The volume of rainwater that can be harvested from green open space

No	Month	Volume of rainwater that can be harvested monthly (litre)	Volume of rainwter that can be harvested daily (litre)
1	January	241.517,3	12.075,86
2	February	176.596,9	11.773,13
3	March	251.047,9	14.767,52
4	April	330.544,5	16.527,23
5	May	202.273,5	12.642,09
6	June	111.900,8	6.993,80
7	July	188.706,4	17.155,13

8	August	100.688,3	11.187,58
9	September	107.640,0	9.785,45
10	October	141.950,3	10.139,30
11	November	316.641,0	16.665,32
12	December	581.704,5	19.390,15

From Table 5, it can be seen that the volume of clean water consumption of all employees at Office of Regent of Hulu Sungai Selatan if occupying the new Office of Regent of Hulu Sungai Selatan assuming the same number of employees and rainfall in the current year can be entirely fulfilled with rain water volume which are harvested in the reservoir. So if this can be realized, then the cost efficiency of clean water consumption can be achieved.

Table 5. Total of Rainwater Harvesting and Volume of Used Clean Water at Office of Regent of Hulu Sungai Selatan

No	Month	The Volume of rainfall that can be harvested in one month (m³))	Utilization of clean water from local water supply from Hulu Sungai Selatan Regent Office in 2017 ((m³)
1	January	768	263
2	February	562	253
3	March	799	200
4	April	1052	282
5	May	644	284
6	June	356	393
7	Nuly	600	296
8	August	320	313
9	September	342	230
10	October	452	245
11	November	1088	113
12	December	1851	247

4. Conclusions

Implementation concept of traditional houses on the design of modern buildings was in line with the concept of green building. In this research, the application of concept in traditional house is taken from shape of house on stilts, so that when applied to modern buildings, the construction of houses on stilts can utilize the basement as an area to place the rainwater harvesting reservoir and parking lot.

Rainwater harvesting can increase efficiency of the used of clean water paid and can even cover the needs of clean water from all occupants. The parking lot area previously provided on the side of the building can be changed into green open space. Green open space besides functioning as oxygen supply can also be used as recreation room for occupants of buildings and publics.

There is a need for further research to see in terms of the costs required to change the construction of the building from the usual form into the construction of houses on stilts as well as the form of construction from the reservoir and piping to accommodate rainwater harvesting.

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