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Sustainable Building and Energy Efficiency as an Independent Energy Building Concept in The Banjar Tribe Traditional Houses in South Kalimantan

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Abstract

Abstract— The traditional house is one of the highest representations of cultural results in a tribe in society. It is also applied in "Rumah Banjar" or Banjar Houses in the province of South Kalimantan. The "Rumah Banjar" is a typical Banjar people's houses whose building construction is made of wood with the interior of the upper part of the intersection without a ceiling installed. Until present, the "Rumah Banjar" still maintains a conventional building concept, without reforming time by time. Consequently, there is some res arise in the "Rumah Banjar" concept, such as still not having, 1) the concept of the house waste treatment process; 2) the friendly environment and efficient energy systems. Based on the problems that arise, the solutions offered for those are by applying the concept of Sustainable and Energy Efficient Building. The mechanism for applying this concept offers energy saving solutions through solar cell installation, the use of styrofoam on the walls of houses, and biogas processing systems produced by household waste. The method used in the preparation of this paper was using literature studies with a quantitative approach, namely research procedures that produce descriptive data in the form of written words from the analysis of the results of the deepening of the literature review. The use of the Sustainable and Energy Efficient Building concept is possible to apply in South Kalimantan which has geographical characteristics close to the equator, so the intensity of lighting received is quite large, with an annual average of 585.1 cal / cm2 (1 cal = 0.001163 Wh). The utilization of light intensity can be integrated to provide household energy in an effort to minimize costs. The electrical power produced using the Kyocera KD185GX-LPU type solar cell (16.3% efficiency), which is equal to 2342,4 watts/day. The application of styrofoam on the walls of the house is able to reduce heat transmission by 10^{o}C, so naturally, the room temperature can be controlled at 25^{o}C at noon. The implementation of the Sustainable and Energy Efficient Building concept to "Rumah Banjar" or Banjar tribe houses can improve the management of the houses to create a sustainable energy processing system and make efficient energy in the houses so it has natural and healthy lighting with the minimum energy utilization.

Keywords

energy-efficiency, Rumah-Banjar,solar-cell, sustainable-building

1. Introduction

During the last 30-49 years we have been sensing the bitter experience of global warming, ozone depletion, resource depletion, energy scarity, ecological toxicity, human toxicity, acir rains, etc.[2] Various kinds of activities carried out to anticipate global warming are intensively carried out throughout the world to protect the earth by implementing various efforts to efficiently use energy and minimize environmental damage. The proper construction and construction to improve the quality of human life is

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actually the biggest contributor to the destruction of nature. Globally, the building has a tremendous impact on the environment, uses about 40% of the natural resources extracted in the industry, consumes almost 70% of electricity and 12% of drinking water, and produces between 45% and 65% of waste disposed in our landfills . In addition, they are responsible for a large number of hazardous emissions, accounting for 30% of greenhouse gases, due to their operations, and an additional 18% are indirectly induced by material exploitation and transportation. Simultaneously, the poor quality of the indoor environment might result in health problems for employees in the office building, thereby reducing efficiency.[3]

South Kalimantan Province, located between 1 ° 21'-4 ° 10 'south latitude and 114 ° 19'-116 ° 33 'east longitude. The South Kalimantan Province covers an area of 36,535 square kilometers. The use of land in the South Kalimantan Province covers an area of 17,427 square kilometers of forest. One development that is being intensively carried out is residential / residential.[9]

One of the local wisdoms of South Kalimantan, is to have a traditional Banjar tribe house. The traditional house of the Banjar tribe in South Kalimantan is one of the banjar tribal residences where the construction of this building is made of wood with the interior of the upper part of the intersection without a ceiling. With the geographical location of the province of South Kalimantan around the equator latitude lines making the weather in this area enough to get a lot of sun time. However, this Banjar tribe traditional house still has problems that must be addressed, such as the lack of a room arrangement system that makes the air temperature follow the outside air condition, does not apply energy resource managers effectively and efficiently to the management of a building, there is no waste treatment and the lack of lighting is naturally an obstacle in this traditional Banjar tribal house. One solution to solving this problem is to apply the concept of the Sustainable and Energy Efficient Building to the traditional Banjar tribal house.

2. Methods

2.1 Sustainable Building

Sustainable building is a building that is designed, built and operated optimally by building the quality of its environment and minimizing the smallest possible negative impact on its natural environment.[6] The increasing global population, decreasing fossil-based energy resources, rising emissions of harmful gases are the main motivators of energy efficiency in buildings.[7]

The sustainable development approach is seen as a way for the building industry to move forward to achieve sustainable development taking into account environmental, social and economic issues. This is also a way to describe the responsibility of the industry for the protection of the environment.

The principles of sustainability issues (social, environmental and economic) are:

1. Conservation of resources
2. Cost efficiency and
3. Design for human adaptation[9]

2.2 Energy Efficiency in Sustainable Building

Energy Efficient Building is a building that is well constructed by applying the right design concept can reduce the amount of energy use.[8] The key to energy efficiency in new buildings is to have a comprehensive integrated perspective during the design phase that seeks to:

a) Reduce heating, cooling, and lighting loads through taking advantage of the building

site and climate attributes.

b) Use ofrenewable energy increases energy security and reducesdependence on fossil fuels.
c) Use project specifications to lay the groundwork forenergy efficiency, specifically stating project goals, targets,and strategies for energy efficiency.
d) Employ sensors that control loads based on occupancy andavailability of natural resources such as daylight or naturalventilation.
e) Integrate water saving technologies that reduce the energy burden that comes along with providing potablewater such as Water Sense fixtures and rainwater harvestingpractices.[3]

2.3 Material Selection

Bubungan Tinggi House is one of the forms of vernacular architecture in South Kalimantan. The combination of the climate and geography of South Kalimantan in the form of a humid tropical climate on wetlands (swamps) also influences the completion of the Bubungan Tinggi House. [4] When looking at the long journey of architecture in the past, our ancestors have been more wise in utilizing nature. They make buildings that were built at that time with great attention to natural behavior, especially in simple ways, namely in efficient use of resources.

With the richness of the wood material owned by Kalimantan, the Banjar house building, especially Bubungan Tinggi, is dominated by natural products. Some wood products used include:

a) **Ulin wood**. It is a wood with high durability and the most water and heat resistance, used for poles, sticks, girders, to the door and window frames and roof truss.
b) **Galam Wood and Kapur Naga**. Usually used for good home foundations for swamp land. Both types of wood have a resistance of up to 70 years if they grow in swampy areas and 60 years if they come from dry land.
c) **Lanan wood**. Is wood for wall material.
d) **White Damar Wood**. This wood is usually used for cutting / girder material.
e) **Bamboo** (local people know it by Paring). It is a material that is mostly used for the floor of the kitchen area or service zone.
f) **Rumbia leaves** for roof cover, but in its development, Ulin wood commonly used for construction is also used in the form of roof coverings (thin and small cut) to be more resistant to environmental stresses such as high winds and extreme weather.[1]

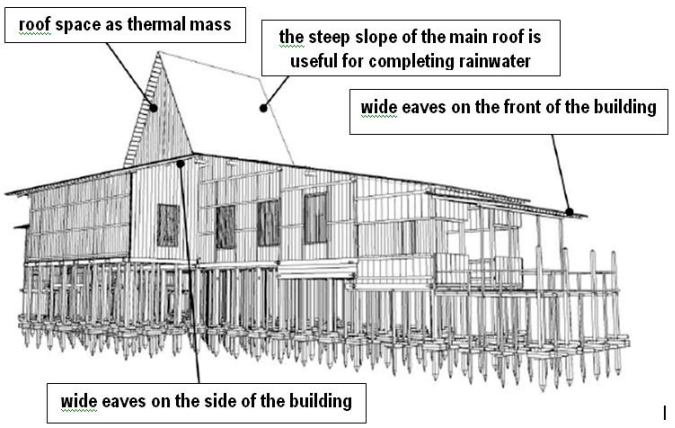

Fig. 1 Bubungan Tinggi House [4]

The need for openings is also applied to the floor by raising the floor to the stage and using floor slats that allow air to flow from below. Elevation of the floor is also intended to

avoid floods, high tides, and animal disturbances. The roof is the dominant element in the form of high and large, waterproof but at the same time able to breathe, has a tilt angle to drain rain, does not have a high thickness, and is extended with a wide trinity to protect from heat and rain at the same time the need for ventilation.

3. Result and Analysis

3.1 Use of Solar Cell in Banjar Tribe's traditional house

Seeing from the geographical location of the province of South Kalimantan the application of Solar Cell is very possible. For the South Kalimantan region for the past 1 year, it can be seen that the average intensity of the sun is 585,1 kal/cm^2 (1 kal = 0,001163 Wh).[5]

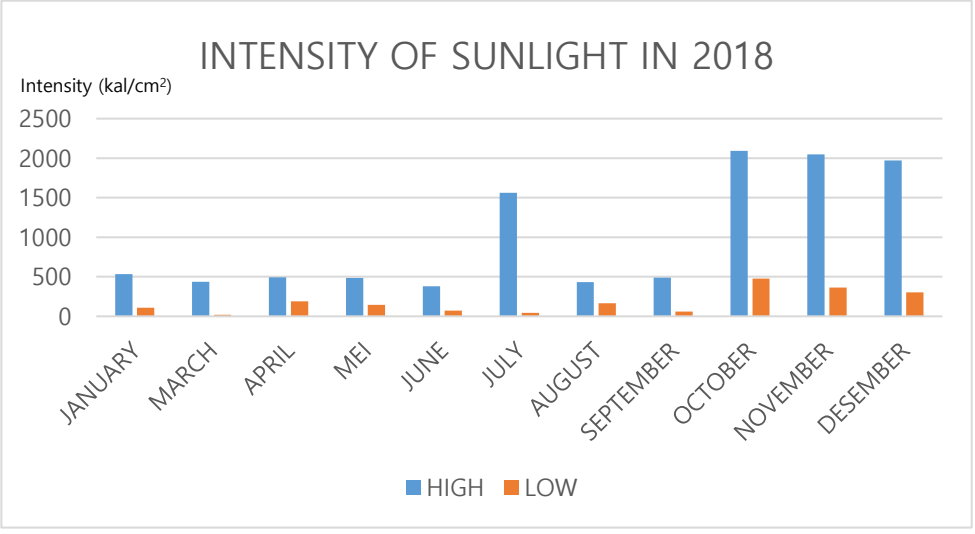

Fig. 2 intensity of sunlight in 2018 using Gunn Bellani

The use of Solar Cell for 10 hours / day from 07.00-17.00 is used to charge the battery. The analysis of calculations, as follows:

a. Unit Conversion

$$\text{Light Intensity} = \frac{\text{Intensity x heat}}{0.0001} \quad (1)$$

$$= \frac{(270{,}03)\,(0{,}0011630.0001)}{0.0001}\ \text{Wh/m}^2$$

$$= 6804{,}7\ \text{Wh/m}^2$$

Average intensity of the existing sun:

$$\text{Light Intensity} = \frac{\text{Amount of Intensity}}{\text{irradiation time}} \quad (2)$$

$$= \frac{6804{,}7\ \text{Wh/m}^2}{10\ \text{h}}$$

$$= 680{,}4\ \text{W/m}^2$$

So, the solar power that can be absorbed by solar modules in South Kalimantan is 680,4 Watt/m^2.

b. Applicatin of Solar Cell Module

The specifications for the use of Solar Cell modules in this plan are:

Merk	: Kyocera KD185GX-LPU
Power Peak	: 185 Watt
Eficiency	: 16,3 %
Dimension	: p ×l ×t (133,8 ×990 ×46) mm

$$A = P \times l \quad (3)$$
$$= 133{,}8 \text{ mm} \times 990 \text{ mm}$$
$$= 1324620 \text{ mm}^2$$
$$= 1{,}32 \text{ m}^2$$

For Solar Cell module Kyocera KD185GX-LPU the amount of power per module that can be produced with the average solar intensity is:

Eficiency Module = 16,3%

$$\text{Eficiency } (\eta) = \frac{\text{Woutput}}{\text{Winput}} \times A\ (\eta\ Module) \quad (4)$$
$$16{,}3\% = \frac{\text{Woutput}}{680{,}4\ \text{W/m2}} \times 1{,}32$$
$$W_{output} = 680{,}4\ \text{W/m}^2 \times 16{,}3\% \times 1{,}32\ \text{m}^2$$
$$= 146{,}4 \text{ watt}$$

Previously, for the use of Solar Cell on some of the roofs of traditional Banjar tribal houses, 16 modules were needed to obtain power of 1080.56 watts, with the following calculations:

$$P = \text{Jumlah modul} \times \text{Woutput} \quad (5)$$
$$= (16)\ (146{,}4 \text{ watt})$$
$$= 2342{,}4 \text{ watt}$$

c. Battery Charger planning control

The battery charger controller used in this plan is the T80 Turbo Charger, with the following specifications:

Maximum output current : 80 Amps

Battery voltages : 12, 24, 36, atau 48 VDC nominal

The number of charger controllers required is:

$$\text{Number of charger (n)} = \frac{\text{Number of module}}{10} \quad (6)$$
$$= \frac{16}{10}$$
$$= 1{,}61 \approx 2 \text{ charger controller}$$

Charger controller capacity for usage for 10 hours is:

$$Q = I \times \text{jumlah charger} \times \text{jumlah jam} \quad (7)$$
$$= 80 \times 2 \times 10$$
$$= 1600 \text{ Ah}$$

d. Battery palnning

To ensure the system can operate properly and in accordance with the needs of the load, it is necessary to plan a battery system. For planning with TROJAN 18DC-500ML batteries, the battery for what is needed is:

$$\text{Number of Battery (n)} = \frac{\text{Charger Capasity}}{\text{Battery Capasity}} \quad (8)$$
$$= \frac{1600}{450}$$
$$= 3{,}55556 \approx 4 \text{ battery (Pararel)}$$
$$\text{Number of Battery (n)} = \frac{\text{Volt Charger}}{\text{Volt Battery}} \quad (9)$$
$$= \frac{24}{36}$$
$$= 0{,}67 \approx 1 \text{ battery (seri)}$$
$$\text{Number of Battery} = \text{Series} + \text{Parallel} \quad (10)$$
$$= 1 + 4$$
$$= 5 \text{ Battery}$$

So, the use of Solar Cell in the Banjar tribe's traditional house, produces 2080.56 Watts with 16 pieces of modules installed on some of the roofs of traditional Banjar tribal houses. The following is a picture of installing a Solar Cell module on a part of the roof of a traditional Banjar tribal house:

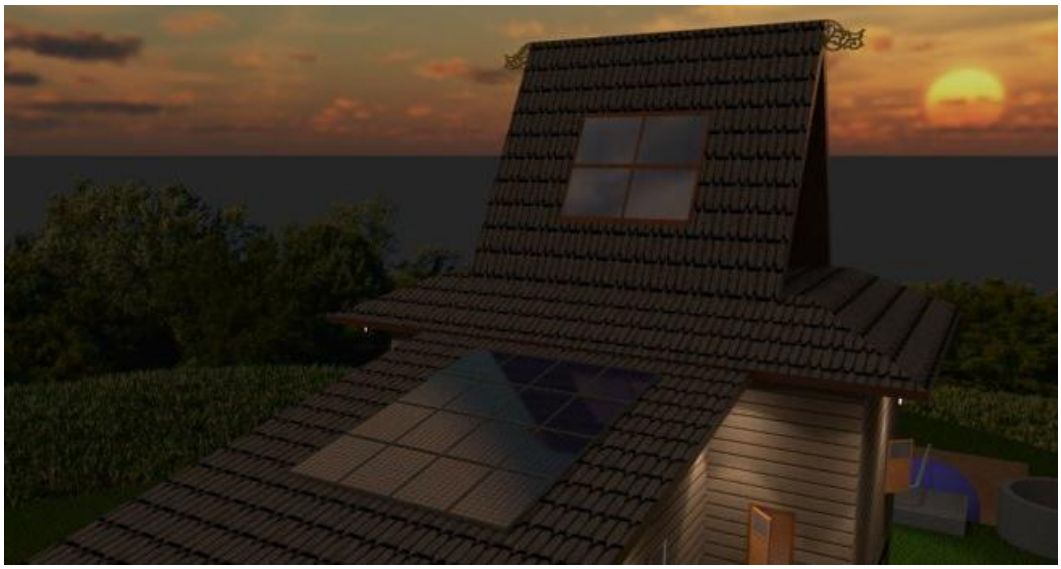

Fig. 3 Illustration of Solar Cell installation on part of the roof of Banjar Tribe traditional house.

2.2 Application styrofoam on the walls of the Banjar tribe's traditional house

The influence of the geographical location of the province of South Kalimantan which is on the equator's latitude causes heat in South Kalimantan to be around 35°C. The use of Styrofoam is used as a wall covering in a traditional Banjar tribal house. The goal is to inhibit / reduce the sun's heat from outside into the room, so that it can maintain the desired room temperature of 25°C.

a. Calculation of Heat Transfer

The thickness of the wood on the Banjar tribe's traditional house wall is 2 cm with a value of thermal conductivity of 0.08 N/m.°C. While styrofoam used has a thickness of 8 cm with a value of thermal conductivity of 0.157 N/m.°C. The room temperature maintained is 25° C.

T_1 = 35°C T4 = 25°C

T_2 = ?

T_3 = ?

ΔXA = ΔXC = 2 cm = 0,02 m (Papan)

ΔXB = 8 cm = 0,08 m (Styrofoam)

$$q = \Delta T\, \Delta X \qquad (11)$$

$$= \frac{T1-T2}{\frac{\Delta XA}{KA.A}} = \frac{T2-T3}{\frac{\Delta XB}{KB.A}} = \frac{T1-T2}{\frac{\Delta XC}{KC.A}}$$

$$= \frac{T1-T2}{\frac{\Delta XA}{KA.A}} = \frac{T3-T4}{\frac{\Delta XA}{KC.A}}$$

$T_1 - T_2 = T_3 - T_4$

$35°C - T_2 = T_3 - 25°C$

$T_2 + T_3 = 35°C + 25°C$

$= 60° C$

$T3 = 60° C - T2$

a) T_2

$$\frac{T1-T2}{\frac{\Delta XA}{KA.A}} = \frac{T2-T3}{\frac{\Delta XB}{KB.A}} \quad (12)$$

$$\frac{35°C - T2}{\frac{0.02}{0.08}} = \frac{T2-(60° C - T2)}{\frac{0.08}{0.157}}$$

$$\frac{35°C - T2}{0.25} = \frac{2T2 - 60° C}{0.5}$$

$$35°C - T_2 = \frac{(2T2 - 60° C)}{0.5} \times 0.25$$

$$35°C - T_2 = \frac{2T2 - 60° C}{2}$$

$$35°C - T_2 = T2 - 30°C$$

$$2T_2 = 35°C + 30°C$$

$$= 65°C$$

$$T_2 = 32.5°C$$

b) T3

$$T_3 = 60°C - T_2 \quad (13)$$

$$= 60°C - 32.5°C$$

$$= 27.5°C$$

The following is a Heat Transfer chart on a traditional Banjar tribal house:

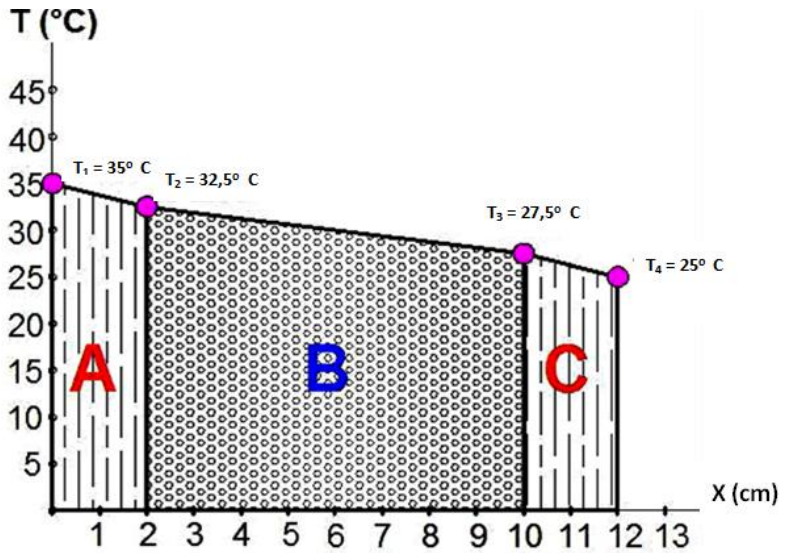

Fig. 4 Heat Transfer Chart at Banjar tribal traditional house.

Based on figure 4, the influence of Styrofoam with a thickness of 8cm can reduce 50% of the heat that moves from the outside by 35°C through 2 layers of boards, each of which has a thickness of 2cm. So that the final temperature of 25°C makes the room cool. At night conditions, the use of Styrofoam serves to maintain room temperature from the effect of decreasing the temperature of the environment, so that the room temperature at night stays warm.

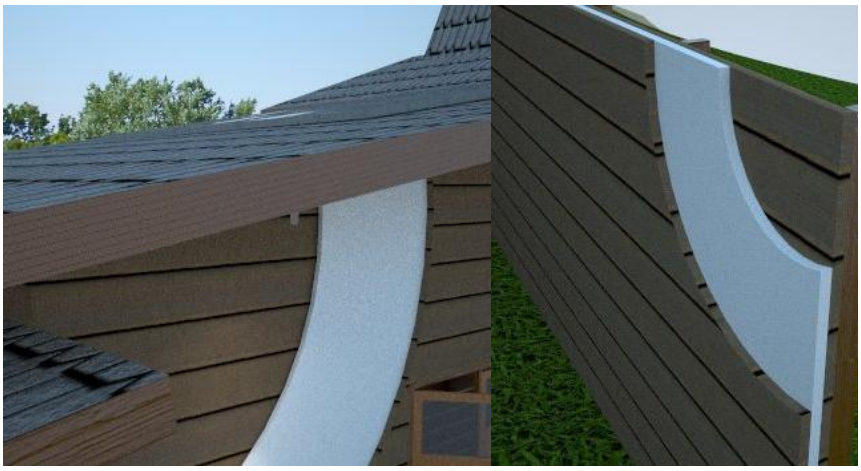

Fig. 5 Illustration of Styrofoam installation on the walls of the Banjar tribe's traditional house

3. 4 Biogas Processing

Human manure waste and domestic water waste are flowed directly into the reservoir, after being evenly mixed it is flowed back to the bottom of the digester, together with Organic waste which was previously accommodated in the reservoir to be input into the digester. Biogas is a major product of anaerobic fermentation of biodegradable organic waste. It has a calorific value of about 22.4 MJ/ m3 and contains about 50-60% methane. 30-45% carbon dioxide and a small percentage of hydrogen sulfide, hydrogen, carbon monoxide, ammonia, water vapour and mercaptans. The gas is useful as a fuel substitute for firewood, dungs and agricultural residues as well as for petrol and diesel for electricity generation[10].

Feeding with cow dung is carried out continuously so that the waste water in the digester will rise in height, then it will exit the discharge pipe. The formed biogas will occupy empty space in the digester and above the discharge pipe so that it can be removed through the gas pipe to the stove. Waste that has undergone an anaerobic process in the digester will be released to the discharge tank which is flowed to the infiltration well through a leach pipe to be composted.

Fig. 6 Illustration of making biogas processing equipment in Banjar tribe's traditional house

Conclusion

Sustainable and Energy Efficient Building is a concept that aims to develop healthy homes that minimize the waste produced by buildings. Applying this technology to traditional houses while maintaining the distinctive characteristics of traditional Banjar tribal homes can reduce household energy consumption and the effects of carbon emissions that cause global warming. The electrical power produced using the Kyocera KD185GX-LPU type solar cell (16.3% efficiency), which is equal to 2342,4 watts/day. The application of styrofoam on the walls of the house is able to reduce heat transmission by 10^{o}C, so naturally, the room temperature can be controlled at 25^{o}C at noon. Sustainable and environmentally friendly building materials need to be used correctly and contextually in every community development. The application of sustainable building materials not only minimizes transportation costs, carbon emissions, and in many cases material costs, also offers employment and skills development opportunities for community members, and is able to improve the existence of Bubungan Tinggi traditional houses as a pilot for energy-independent traditional houses.

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Author’s Biography

Miranti Diah Prastika is a fourth-year physics education student at Lambung Mangkurat University. She was born on October 26th, 1997 in Kebumen. She is interest in physics began as a teenager, especially in engineering physics. She is received several awards like, an Ambasador of Indonesian Youth Againts Corupption 2017 (IYAC 2017) Makassar, she was 3rd winner of National Conference of Research and Innovation 2018, Malang, 1st winner of KBA Marketing Competition 2018 which is held by PT. Astra International, Tbk, Delegation of Ekspedisi Nusantara Jaya Lambung Mangkurat University 2017, Exchange Student of SEA-Teacher Program 2018 in Thailand, that held by SEAMEO. She also active in some organization, Association of physics education students, Association of

research student *Forum Inovasi Mahasiswa* Lambung Mangkurat University, ect.

Eka Dahliani was born in Banjarmasin, on April 10th, 1997. She started elementary school education at Elementary School of and graduated in 2009. Then, she continue her study in Islamic Junior High School of Kelua, and graduated in 2012. Then, Islamic Senior High School of Kelua, and Graduated in 2015. The next education, she is studying at Lambung Mangkurat University, Faculty of Teacher Training and Education, Major of Science Education. She is really likes the real and concrete things with Science so she chose a science education and aspired to become a Science Teacher.

Eka has a high interest in change that has led her to various research, scientific and social organization activities. Some of his work in the organization is to become the General Treasurer of UKM Penalaran dan Penelitian FIM ULM, members of the UKM Fkip Mengajar ULM, members of the religious department of Himpunan Mahasiswa Sains. Besides that, Eka has an interest in the world of community service, with a proven delegation of youth from South Kalimantan in carrying out a mission from the Maritime Coordinating Ministry in the Nusantara Jaya Expedition in the Masalembu Islands, East Java. Not only is it active in the organization, Eka also has achievements of her academic such as the 3rd Winner of Call for Paper National Conference (UMM, 2018), being the best 3 young researchers (UMM, 2018), 1st Winner of the KBA Marketing Competition (South Kalimantan, 2018), became a delegation of student exchange SEA Teacher Project (Philippines, 2019), runner-up 1 educational debate competition in the Teacher Training and Education Faculty, national education debate delegation (UNNES, 2017), delegation to the national education debate (UIN SGD, Bandung 2018), delegation Write Scientific National Born-SF (UNTAN, 2017). In 2017, she was chosen as an ambassador for science education. In 2018 she was selected as "Science Education Achievement Student", etc.
The various activities those being a her efforts to develop themselves and contribute to creating a better Indonesia with its capabilities as students of Science Education