

Application of Bioclimatic Architecture Concept in Novotel Suite Surabaya

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Abstrak—The development of technology and industry in both developed and developing countries contributes to improve human life for the better. However, it causes an increase in energy consumption and environmental damage which produces global warming. In Asia, according to the data of ASEAN Center for Energy (ACE), 48% of global warming is generated by buildings. This phenomenon is very influential if it occurs in big cities. One of the ways to respond to this phenomenon is to apply sustainable architecture (bioclimatic architecture). Bioclimatic architecture is an architectural concept related to nature and its environment. In Indonesia, the city of Surabaya is the second-largest city. Surabaya is currently envisioned to be a green and smart city, in order to respond to the issue of global warming which currently becomes the center of discussion of all parties. Surabaya City is the second-largest city in which the real estate/property develops very rapidly, especially in commercial building such as hotels. In response to this, this study aimed to determine the application of the concept of Bioclimatic Architecture in one of the buildings in the city of Surabaya, namely the Hotel. The paradigm used in this study is the postpositivist paradigm. A case study was used as the research methodology with field observation techniques to find out whether the Hotel Novotel Surabaya applies the concept of Bioclimatic architecture. The result showed that Novotel applied the Concept of Bioclimatic Architecture into the buildings with a percentage of 94.3%.

Kata Kunci—Bioclimatic Architecture, Hotel, Sustainable Architecture.

I. INTRODUCTION

ARCHITECTURE and environment are a unity that cannot be separated. Currently we are facing a phenomenon in overcoming the problem of unrenewable energy, which led to the development of Sustainable Architecture. Sustainable architecture is a concept that focuses on the balance between the built environment and the natural environment at the present time and into the future [1]. Sustainable Architecture cannot be separated from Sustainable Development. In the modern and globalization era today, architecture provides the biggest contribution to global warming in almost all parts of the world. According to ASEAN Center for Energy, 48% of global warming in Asia is generated by buildings [2].

Environmental Architecture has several concepts including Vernacular Architecture, Bioclimatic Architecture, Ecological Architecture, Biophilia Architecture, and Green Architecture. Meanwhile the concept which is known to concentrate to the surrounding environment is Bioclimatic architecture [3]. States that Bioclimatic architecture is the art

of designing buildings with energy-saving methods that focuses to the local climate and to solve climate problems by applying them to building elements [4]. It can be concluded that Bioclimatic Architecture is an approach to create comfort for the users themselves without excluding the surrounding environment.

In Indonesia, there has been a city that is heading to become an environmental-friendly city or Green and Smart City that is Surabaya. In addition to being a Green and Smart City based city, Surabaya is also the second-largest city in Indonesia with the very rapid development of Real Estate/Property [5]. This can be seen from high-rise buildings such as apartments, hotels, housing, industrial factories, etc. In the city of Surabaya, property that is growing rapidly currently exists in the Commercial sector, especially hotel buildings [5]. Hotel is a basic necessity for tourists outside the area as a place to rest or as a venue [6].

To respond to the phenomenon of global warming produced by the buildings is by applying the concept of bioclimatic architecture. As the hotel currently develops among other commercial sectors, this study aims to find out whether Novotel applies the concept of bioclimatic architecture to the Hotel building. A descriptive qualitative method is used to analyze the data as it deemed appropriate to be able to present data and analysis as it is in the form of a description. The expected hypothesis of this study is that the author finds that Novotel applies the concept of bioclimatic architecture.

II. LITERATURE REVIEW

A literature review was conducted in this study to determine the gap of knowledge in the related topic. It is also aimed to identify the development of bioclimatic architecture theory since it was first discovered to the implementation in today's practice.

A. Bioclimatic Architecture

The development of Bioclimatic architecture dates back to the 1960s as an architectural concept influenced by the climate. Bioclimatic Architecture is a reflection of Frank Lloyd Wright's discourse which is famous for architecture related to the natural environment. With the main principle that in the art of building it is not the only efficiency that is important but also calmness, harmony, wisdom, building strength, and activities in accordance with the building. Bioclimatic Architecture is an adjustment to natural and

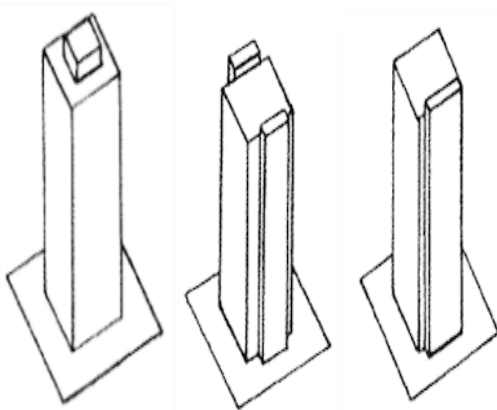


Figure 1. Core Positions.

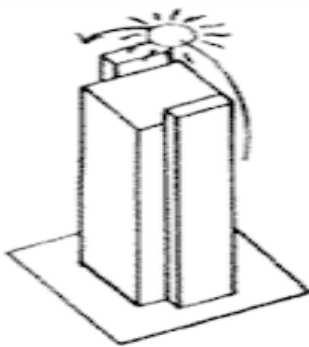


Figure 2. Determining Orientations.

environmental conditions, functional mastery, and maturity in the processing of selection of forms, materials, and architecture according to Oscar Niemeyer [7].

Besides Frank Wright and Oscar Niemeyer, architect Victor Olgay also began introducing bioclimatic architecture in 1963. After the 1990s, Kenneth Yeang started applying bioclimatic architecture to tall buildings with the Theory of Bioclimatic Skyscrapers. Only until then that many architects emerged in applying bioclimatic architecture. Bioclimatic Architecture is known as a design process that considers the level of adaptation of buildings to environmental balance, PLEA (Passive Low Energy Architecture), [8]. Bioclimatic architecture also offers attractive opportunities to achieve environmental, social, and economic benefits [9]. From the above-mentioned statements, it can be concluded that Bioclimatic Architecture is the application of a conceptual approach that wants to create comfort for the users without excluding the surrounding environment. This study used the application of bioclimatic architecture theory from Kenneth Yeang as he has focused on the development of the bioclimatic architecture in the tropical climate.

B. Bioclimatic Architecture Kenneth Yeang, 1994

The application of Bioclimatic architecture in the high-rise buildings has several principles as follows:

1) Core Positions

The service core position is very important in designing high-level buildings. Service cores are not only part of the

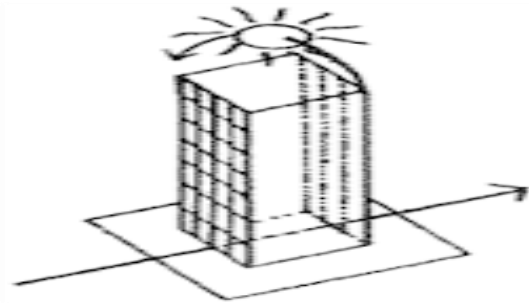


Figure 3. Placement of Window Openings.

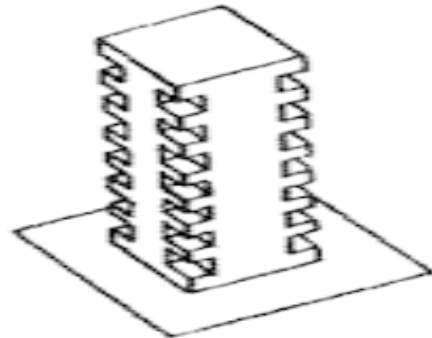


Figure 4. The Use of Balconies.

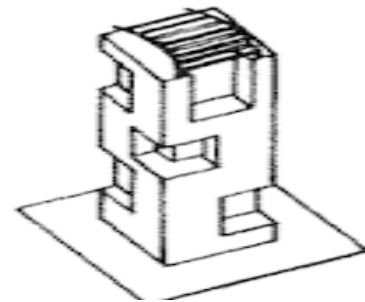


Figure 5. Transitional Spaces.

structure, but they also affect thermal comfort. Service core positions can be classified into three forms, namely:

- a. Central Core
- b. Double Core
- c. Single-sided core is located on the side of the building

The double core has many advantages including using two cores which can be used as a barrier to heat entering the building. Research must demonstrate the minimum use of air conditioning from the placement of dual service cores with window views facing north and south, and cores placed on the east and west sides. This can also be applied to cool climates. Core Positions can see Figure 1.

2) Determine the Orientation

High-rise buildings get full sunlight and heat radiation. Building orientation is very important to conserve energy. In general, the arrangement of buildings with openings facing north and south provides advantages in reducing heat insulation. The best building orientation is to place the smallest surface area of the building facing east-west and provide an external wall on the outside of the room. In a tropical climate, it is more preferred to lay the core on the east-west axis. This is intended as a buffer zone and saving

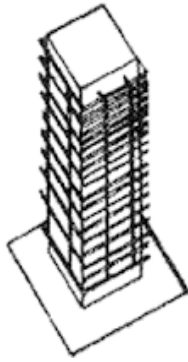


Figure 6. Design on the Wall.

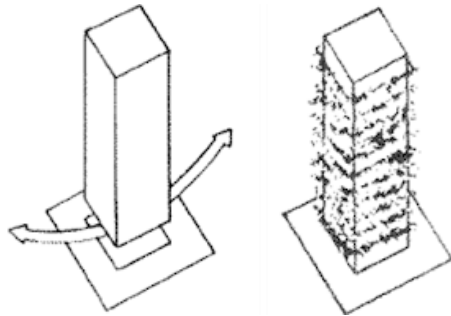


Figure 7. Relationship to the Landscape.

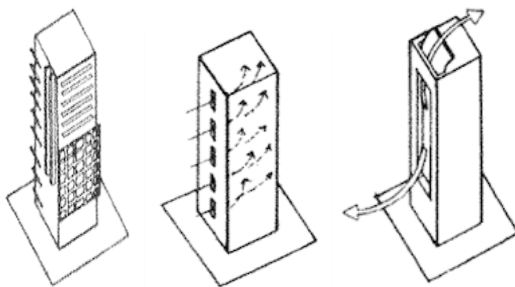


Figure 8. Passive Shading Devices.

the use of air conditioning in buildings. Determining orientation can see Figure 2.

3) Placement of Window Openings

Walls with window openings facing north and south are very important to get a view orientation. If you pay attention to aesthetic reasons, the curtain wall can be used on building facades that do not face the sun. In cool climates, transitional spaces can use glass in other facades and the terrace also functions as a 'sunlight room', gathering the sun's heat, like a greenhouse. The placement of window openings in the Bioclimatic building can be seen in Figure 3.

It is suggested to use window glass with the Metrical Bioclimatic Window (MBW) system that is parallel to the outside wall. MBW is designed as an element system with functions that are specific to ventilation, solar system protection, natural lighting, visualization areas, and personal freedom as well as active external systems. MBW system adapted to the current conditions. This system intends to regulate the thermal conditions of the room using engineering bioclimatic purposes, namely:

1. Decreased heat gained by solar radiation.
2. Control heat recovery by convection and the use of cross ventilation or by selecting chimneys.

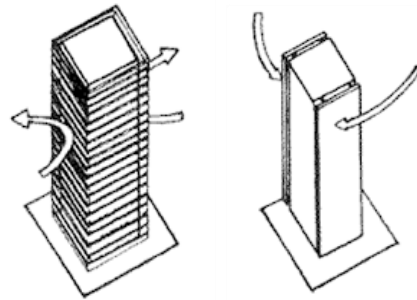


Figure 9. Thermal Insulation systems on the Floor.



(a) (b)

Figure 10. (a) Core Position on the Eastside at the back; (b) Core Position on the Eastside at the front.



Figure 11. Novotel Hotel Building Orientation.

Using the above-mentioned technique, it will maximize the lighting and the air at night can be cooler.

4) The Use of Balconies

Placing a balcony will make the area clean of the panels that will also reduce the heat. As for the placement, it should be on the north-south side. Using wide terraces will make it easier to place plants that can be used as natural light shading and as a flexible area that can be adjusted to the need in the future, as shown in Figure 4.

5) Making Transitional Space

According to Yeang, transitional spaces can be placed in the middle and around the sides of buildings as an atrium. This space can be an intermediary between the inner and outer spaces of buildings. This space can be an outside corridor like the old shophouses of the early nineteenth century in the tropical countries. Making transitional spaces in the facade of a Bioclimatic building can be seen in Figure 5.

Yeang also stated that the placement of terraces in sections with high heat levels can reduce the use of heat-resistant panels. This can provide access to the terrace which can also

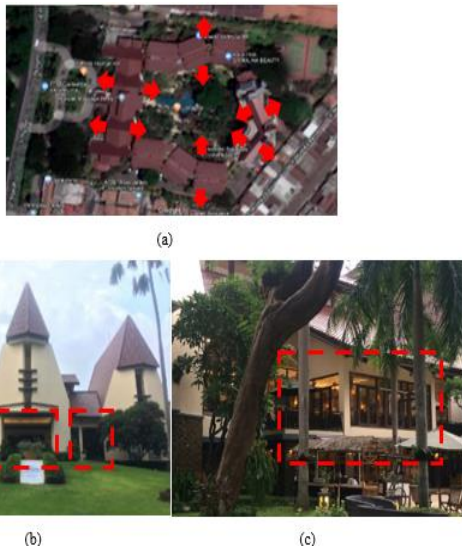


Figure 12. (a) Opening area; (b) Openings in the Lobby; (c) Opening in the Restaurant.



Figure 13. (a) The use of a Balcony at 3 floor building; (b) The use of a Balcony at 10 floor building.

be used as an evacuation area during an event of a disaster such as a fire. The use of balconies in bioclimatic buildings can be seen in Figure 4. The atrium should be closed, but placed in between rooms. The top of the building should be protected by roof fins that push wind into the building. This can also be designed as wind scoops to control the natural air that enters the building.

6) Design on the Wall

The use of membranes that connect buildings with the environment can be used as a protective skin. In cool climates, the outer wall must be able to withstand the cold of winter and the heat of summer. In this case, the outer wall must be a good insulation protector but can be opened during the dry season. In tropical countries, the outer wall must be movable and adding cross ventilation to improve comfort in buildings. The wall design in a bioclimatic building is shown in Figure 6.

7) Relationship to the Landscape

According to Yeang, the ground floor of a tropical building should be more open-ended and use natural ventilation respecting the importance of the relationship between the ground floor and the road. The function of the atrium in a



Figure 14. (a) Transitional Space at Novotel; (b) Transitional Space at Novotel other side.



Figure 15. (a) Design of sun visor in Buildings; (b) Use two layers of glass.

room on the ground floor can reduce the level of traffic. Plants and landscaping are used not only for ecological and aesthetic purposes but also for making buildings cooler. The relationship to the landscape can be seen in Figure 7. By integrating biotic elements on plant and the building, it can provide cool air in the buildings and help the process of O₂ absorption and CO₂ release.

8) Passive Shading Devices

According to Yeang, shading is the essence of refracting sunlight on the wall facing the sun directly (in the tropics on the east and west sides). Meanwhile, cross ventilation should be used (even air-conditioned rooms) to increase fresh air and release heat. The use of passive shading devices can be seen in Figure 8. It is also suggested to provide adequate ventilation in the room with volumetric airflow regulations. With the ventilation, the hot air above the building can be channeled to the outside so that it can refresh the room again.

9) Floor Insulation

According to Yeang, good heat insulator on the skin of the building can reduce the sweltering heat exchange with cold air coming from inside the building. The characteristics of thermal insulation are mainly determined by its composition. For this reason, thermal insulation is divided into five main

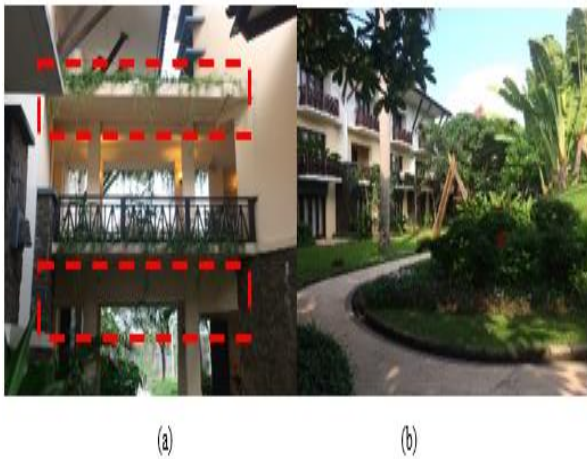


Figure 16. (a) Vines in the transition room; (b) the front area of the room.

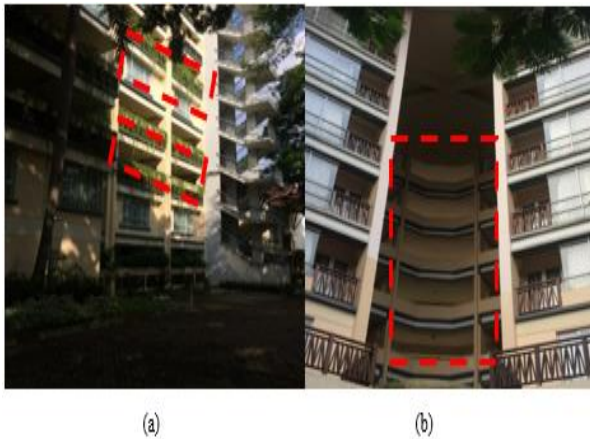


Figure 17. (a) Openings cross ventilation on the core at the back; (b) Openings cross ventilation on the core at the front.

parts, although many of the main insulators are derivatives of these types of products. Thermal insulation on the floor of the Bioclimatic building can be seen in Figure 9 below. The five main types of thermal insulation: Flake, Fibrous (granular), Granular (granular), Cellular (composed of cells), and Reflective (bouncing). Thermal insulation system on the floor can see Figure 9.

The mass structure of the building works to release heat during the day and release cold air during the day. In cool climates, the structure of the building can absorb the sun's heat throughout the day and release it during the day. Solar window or solar collector heat is placed in front of the physical building to absorb the sun's heat.

C. Hotel

According to Sulastiyono in Hilal, a hotel is a company that is managed by the owner by providing food, beverage and room facilities for people who travel and are able to pay a reasonable amount based on the services without any special agreement [6].

III. METHODOLOGY

The paradigm used in this study is the Pospositivist paradigm. Postpositivists are characterized by external



Figure 18. (a) Side of the building at the front; (b) Side of the building at the back.

realities, which can be fully examined at some level of "probability"[10]. The researchers do this by observing the phenomena in the field. The postpositivist research process assumes that objectivity is a goal that may not be the same as what is in the field [10]. Researchers take data as is in the field with the possibility of the results obtained will not be the same as it is. Explains that the problems examined by postpositivist research reflect the need to identify the causal factors that affect the final outcome [11].

After the researcher gets the data in the field, the researcher will collect data from other sources that will support the final results, such as the secondary data. The research strategy used is Case Study, an empirical study that investigates a phenomenon in a real-life setting [12]. Researchers do this stage by identifying the object of study in the event of a phenomenon in accordance with the topic raised. Case studies can use both quantitative and qualitative evidence. By using a single case study, research with a single subject provides a statistical framework for making inferences from quantitative or qualitative case study data.

The object chosen was the Novotel Suite Surabaya, with a purposive sampling technique, as various sources stated that Novotel applied the use of the concept of bioclimatic architecture. This type of research provides evidence and will increase the level of consumer confidence in decision making when making investment decisions on a property product. With the results obtained that Novotel uses the concept of bioclimatic architecture that gives confidence to consumers. Descriptive analysis is performed on the group of observational data [13]. This descriptive analysis was carried out on one variable, the bioclimatic architecture variable. The stages of the evaluation process include the process of defining the problem, determining the scope of the assessment, data collection, analysis, and conclusions.

IV. RESULT AND DISCUSSION

The results of the study were an analysis of the application of the bioclimatic architecture concept to the Novotel Suite Surabaya hotel. Data collected through field observations were analyzed using descriptive qualitative.

A. Core Positions

At the Novotel Hotel, the core is placed in the middle of the building as a service area for the elevator, pantry, and toilet. The core position of Novotel falls into the category of the central core because it is located in the middle. The core at the Novotel Hotel is located on the east side of the building, and the western part of the building is used as a window opening that leads to the swimming pool and landscape. Based on data that has been obtained from the observation, the core placement is in accordance with Kenneth Yeang theory. A good core placement is on the east side of the building, which also functions as a building skin to protect from the sun's heat. Core position at the back can see Figure 10a and Core position at the front can see Figure 10b.

B. Determine the Orientation

At the Novotel Hotel, the orientation of the building the front facade is on the west side while the rear facade is on the east side. The north-south axis is placed on the left and right side which at the Novotel is used as a window opening area and transition space. Based on data that has been obtained from observations, building orientation is in accordance with the theory of Kenneth Yeang. The orientation of the building should follow the east-west axis as the smallest surface area of the building to reduce the incoming heat insulation. Meanwhile, the north-south axis is used for air circulation and visualization to see the scenery. Novotel hotel building orientation can see Figure 11.

C. Placement of Window Openings

At the Novotel Hotel, window openings or ventilation are placed on almost every side of the building. Windows on each side of the building, such as in the corridor, lobby, and the rooms, have different designs. For window opening orientation, the Novotel building mostly faces the north-south side of the building. With a large number of openings and almost every room has a window that can maximize natural light during the day. Based on data that has been obtained from observations, the placement of window openings is in line with Kenneth Yeang's theory. The placement of window openings is on the north-south side of the building and on the side that has a wide surface to maximize the air circulation. Opening area can see Figure 12a, opening the lobby can see Figure 12b, and opening in the restaurant can see Figure 12c.

D. The Use of Balconies

At Novotel Hotels, Balconies are found in almost every room and on every side of the building. As a result of the presence of balconies in each room, the building's facade is free of panels thus reducing the heat side of the room area. Placement of the balcony leads directly to the landscape view which is more valuable than the placement of the balcony. The balcony area in the Novotel building also functions as a place to grow vines. Based on data that has been obtained

from observations, the use of balconies is following Kenneth Yeang's theory. The balconies should be placed around the building to provide shade and visualization as well as function to place vegetation can see Figure 13.

E. Making Transitional Spaces

At the Novotel Hotel, the transitional space is located in the middle and around the building. The distance between each transitional space is about 10m. The transitional space at Novotel is aimed to allow the natural air to enter the building. Based on data that has been obtained from observations, the transitional space in the hotel is in accordance with Kenneth Yeang's theory. The transitional space at Novotel also functions to optimize the natural lighting of the entrance corridor and to provide the air-flow which makes the existing corridor cool. In addition, the transitional space is also used as a space to see the view out of the building and can see Figure 14.

F. Design on the Wall

At the Novotel Hotel, there are fewer sections of the building that get direct sunlight for openings or windows. The glass design uses a double skin system / uses two layers of glass to reduce the heat entering the space and the opening area is reduced. More hotel buildings use walls in general. However, the Novotel building does not use membranes or additional protection as building skins. Novotel buildings only use walls like buildings in general or use only one layer of walls which is permanent and cannot be moved. The Novotel hotel only uses curtains to cover areas exposed to direct sunlight. Based on data that has been obtained from observations, the design on the hotel wall is in line with Kenneth Yeang's theory, as it still pays attention to the side/parts of the building that are more exposed to sunlight by minimizing openings and using double-skin glass and can see Figure 15.

G. Relationship to the Landscape

At the Novotel Hotel, the relationship between the building and the existing landscape is that almost every room has a window opening that leads to a garden or swimming pool view. In addition to a direct view of the park, plants on the balcony are not only for the aesthetic but also for ecological purposes which makes the building cool. This balcony also accommodates hotel rooms that are far away at the top level that cannot be directly linked to the park in the lower area. Based on data that has been obtained from observations, the relationship between landscape and buildings is in accordance with Kenneth Yeang's theory. That is because every room is related to the landscape. In addition to providing a cool effect, the park helps the process of O₂ absorption and Co₂ release and can see Figure 16.

H. Passive Shading Devices

At the Novotel Hotel, the use of passive shading is applied to existing vents in the building. The orientation of the ventilation in the building is located towards the north-south. Cross ventilation at Novotel, especially in the lobby area, can increase fresh air and release the heat. With this ventilation, hot air above the building can be flowed out. The hotel

corridors do not use air conditioning as it maximizes natural ventilation from cross ventilation. Usually, in hotels, most closed spaces and corridors use central air conditioning/air conditioners. Based on data that has been obtained from observations, the use of passive shading complies the Kenneth Yeang's theory, in which the passive shading device has an open / ventilation design that can optimize the air-flow and can see Figure 17.

I. Floor Insulation

According to Kenneth Yeang's theory, a good heat insulator on the skin of a building can reduce the heat exchange and heat of the sun with cold air coming from inside a building. In the Novotel hotel building, the building skin uses the regular wall material, without using thermal insulation (double skin façade). Although, there is still special attention on the side of the building which is directly exposed to sunlight, on the east-west side, by using two layers of glass to minimize light and heat from the outside entering the building, as well as to openings which exposed directly to the sun. Based on data that has been obtained from observations, the heat insulation used is in accordance with Kenneth Yeang theory. Even though not all of them use thermal insulation on this element, it is still considered by the Novotel hotel building and can see Figure 18.

V. CONCLUSION

The Novotel Hotel, designed by architect Budiman Hendropurnomo, applies elements of Bioclimatic architecture from Kenneth Yeang. At first Budiman Hendropurnomo only planned the concept to enliven the surrounding architectural patterns. These days, this concept is known as the metaphor inspired by natural formations. The elements of Bioclimatic architecture that have been well applied to hotel buildings are as follows: (1) Core placement at the center of the building; (2) The orientation of buildings that headed East-West; (3) Placement of window openings that lead to North-South; (4) Use and placement of balconies in almost every room; (5) The transitional space at Novotel is very good because the distance is ± 10 m from one another; (6) Design of walls that apply cross ventilation and special treatment to the opening area; (7) The relationship to the landscape is good because each floor has vines in the balcony and corridor area; (8) Passive shading device that is noticed from the cross ventilation opening design; (9) The heat insulation on the Novotel hotel floor does not use protective skin on the entire Hotel building, but there remains special attention on the side of the building which is exposed to direct

sunlight with the use of double glass (two layers of glass).

Novotel Hotel implements eight out of the nine elements of Bioclimatic architecture. Meanwhile, an element is not entirely applied, with this 1 element will get a value of $\frac{1}{2}$ of the overall value in 1 variable which is 5.55%. If presented nine elements $100\% = 1$ element represents 11.1%. So if the Novotel Hotel implements $8\frac{1}{2}$ elements it gets a value of 94.3%. Judging from the results of the observations, the Novotel Hotel successfully applies the concept of bioclimatic architecture. This research found that Novotel has responded to the phenomenon of global warming that has been produced by the building.

Novotel buildings still pay attention to the climate and the environment in order to provide a harmonious relationship with nature. Suggestions for further research are the application of other sustainable architecture, especially bioclimatic architecture in buildings with functions other than hotels, in addition to a more detail discussion to the development and application of sustainable architecture in response to the phenomenon of global warming that occurs in almost all parts of the world.

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