Study of application of bioclimatic architecture strategy at Citraland Residential House in Palu City

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ABSTRACT

Palu City has a fairly hot air temperature, very high intensity of solar radiation, quite high rainfall, and a fairly large wind speed. When reviewing the climatic conditions of Palu City above, the planners in this case the Citraland housing architect team should be able to apply a bioclimatic architecture strategy to be able to respond to the climatic conditions of the city of Palu. Based on this background, it is necessary to conduct a research study on the application of bioclimatic architecture strategies in Citraland's residences. This study uses a rationalistic approach with an exploratory method. Research shows that Citraland Residence has implemented a bioclimatic architectural strategy in several ways, namely the use of shading or shadow effects in the form of roof canopy, eaves, and lattice made of wood, and protective plants, as well as the use of insulating materials such as natural stone affixed to the outer walls. residential home. In addition, the layout of the residence also plays a role in the flow of air circulation to the maximum. Then the strategy of making wind-catching rooms and the use of glass materials on several sides of the building which acts as a place to enter sunlight into the house.

1. Introduction

In the course of time, the science of architecture tried to carry out several residential design ideas that focused on human adaptation to the climate of their dwelling [1]–[3]. One of the architectural movements that carries the concept of adjustment is the bioclimatic concept [4]–[6]. Bioclimatic architecture is defined as an approach that directs architects to obtain a design solution by taking into account the relationship between architectural forms and the climatic environment of the area [7]–[9].

Palu City as the capital of Central Sulawesi Province, is a city that continues to grow. This development has an impact on the increasing population. This then gave rise to several residential plans in Palu City by several property companies, one of which is PT. Ciputra Development Tbk, with the housing being Citraland Waterfront City. The location of Citraland Housing is quite interesting, which is located on the coast of Palu City. Please note that Palu's climate is generally tropical. Palu City's air temperature ranges from 230C - 360C, with an average intensity of sunlight 73.43 percent, and rainfall is recorded between 4.5 - 112.5 mm, where the recorded wind speed reaches 4.53 knots (https://Palukota.go.id, 2022).

Based on the description of Palu City's climatic conditions above, it can be read that Palu City has a fairly hot air temperature, a very high intensity of solar radiation, a fairly high rainfall, and a fairly large wind speed [10]–[13]. When reviewing the climatic conditions of Palu City above, the planners in this case the Citraland housing architect team should be able to apply bioclimatic architectural strategies to be able to respond to the climatic conditions of the city of Palu, especially around the coast. So that the comfort of the occupants of the house will be fulfilled to the maximum. This then encourages researchers to conduct research on the application of bioclimatic architectural strategies in Citraland's residences, so that they will identify what bioclimatic architectural strategies are used in Citraland's homes that are able to respond to the local climate, in order to achieve the comfort of the residents of the dwelling.

2. Method

The research location is in the city of Palu, by taking the object of research, namely the Citraland residential building located on Jalan Trans Sulawesi, Tondo Village. This research uses a rationalistic approach. The rationalistic approach is an approach that sees the truth not only from empirical conditions but also arguments as a part of the construction of thinking [14], [15]. The rationalistic research design departs from a theoretical framework (Grand Theory) which is built from the meaning of known theories, the thoughts of experts, and is constructed into something that contains a number of problems that need further investigation [16]. The source of the Grand Theory that was raised in this study came from the strategy of applying bioclimatic architecture in architectural design [17].

This research is also an exploratory research. According to Gulo [18], exploratory research is research that aims to trace a phenomenon or event through a series of assessments. As previously explained, it is suspected that location factors will lead to several bioclimatic strategies applied to Citraland's residence. This will then be explored as to what its application is to the design of Citraland's residential houses.

3. Results and Discussion

Palu's climate is generally tropical. Palu City's air temperature ranges from 230C - 360C, with an average intensity of sunlight 73.43 percent, and rainfall is recorded between 4.5 - 112.5 mm, where the wind speed is recorded at 4.53 knots. This is of course closely related to the strategy in regulating humidity in Citraland's residence. Of course, the condition of Citraland's housing, which is located in the coastal area of Palu City, is quite hot with the intensity of wind and rain which is quite large, giving rise to several design strategies for its residential houses.

In anticipating climate change that will occur, Citraland's residence is certainly designed with a bioclimatic strategy that is expected to be able to adapt to environmental conditions around the area. Here are some explanations about strategies in dealing with climate that are applied to Citraland's residences.

3.1. Anticipation Against Solar Heat Radiation

In Palu City the average intensity of solar radiation is 73.43 percent, this will cause excessive heat radiation for the environment and will have an impact on living things around it. There are various elements in nature that can absorb or spread this heat radiation. This condition becomes a design consideration in forming the Citraland residential housing system to make it comfortable to live in.

In Citraland's residence, the strategy used to deal with the heat radiation is to create a shading area as a shade, as well as the use of materials that are able to withstand and absorb heat. The strategy in

applying shading to buildings is applied to the application of roof canopies, trellises, and wooden lattices. The goal is to reduce the temperature of hot air due to radiation from outside, when it passes through the shading which then enters the building (see Fig. 1). This is in line with the statement [19], that Sun shading is a damper or barrier to sunlight so that sunlight does not directly enter the room. Not only its function as a protector, the shade is also used as an aesthetic element in the building. The concept is to block the incoming heat by blocking the incoming sunlight.

The eaves that are placed on several sides of the residential building will create a shading or shadowing effect, so that the effect of direct sunlight is avoided by the structure which functions as a sunscreen. Another way is to use plants that protect against direct sunlight. Plants that have a height of 2 – 2.5 meters and thick can be used to make shade so that heat radiation can be reduced. Apart from this, the open area is planted with grass as a water catchment area (see Fig. 1).

The use of materials also has a big influence in absorbing and retaining heat. On the exterior walls of the Citraland house, natural stone is used which is expected to play a major role in absorbing and retaining heat (see Fig. 1). Associated with the use of natural stone material as a wall covering material, natural stone also functions to maintain humidity during the day so that the temperature in the building remains cool. This is in accordance with what Subroto stated in Andiyani [20], that the nature of natural stone is cold and can absorb heat. However, it is necessary to know the shortcomings of this natural stone material, namely in terms of installation and maintenance. This natural stone material every 6-12 months must always be given a protective layer so that the color is maintained and the surface is not mossy. The installation must also be good so that it is not easily separated from the wall or floor.

Fig. 1. Bioclimatic Architecture Strategy to Anticipate Solar Thermal Radiation at Citraland Residential Houses

3.2. Temperature Control In Building

The layout of the Citraland residence plays a very important role in regulating the temperature of the dwelling naturally. On the left and right sides of the residential buildings are arranged close to each other, this is done to maximize the available land area. However, on the front and back of the house, green open space is provided. These green open spaces then reduce heat radiation and regulate air circulation so that the temperature remains comfortable for residents of the house (see Fig. 2).

In addition, on several sides of the residential building, spaces are made to catch the wind and sunlight (see Fig. 2). This Citraland residence is also efficient in terms of the use of electrical energy, this is because on some sides of the building using glass as the construction of the walls of the house (see Fig. 2).

The use of a ceiling in a residential house with a height of about 4 meters is intended to keep the temperature of the dwelling cool even though the house is on the edge of the beach with a fairly high intensity of sunlight (see Fig. 2). All these bioclimatic architectural strategies are carried out to make the residents of the house feel comfortable both in hot conditions and in cold temperatures.

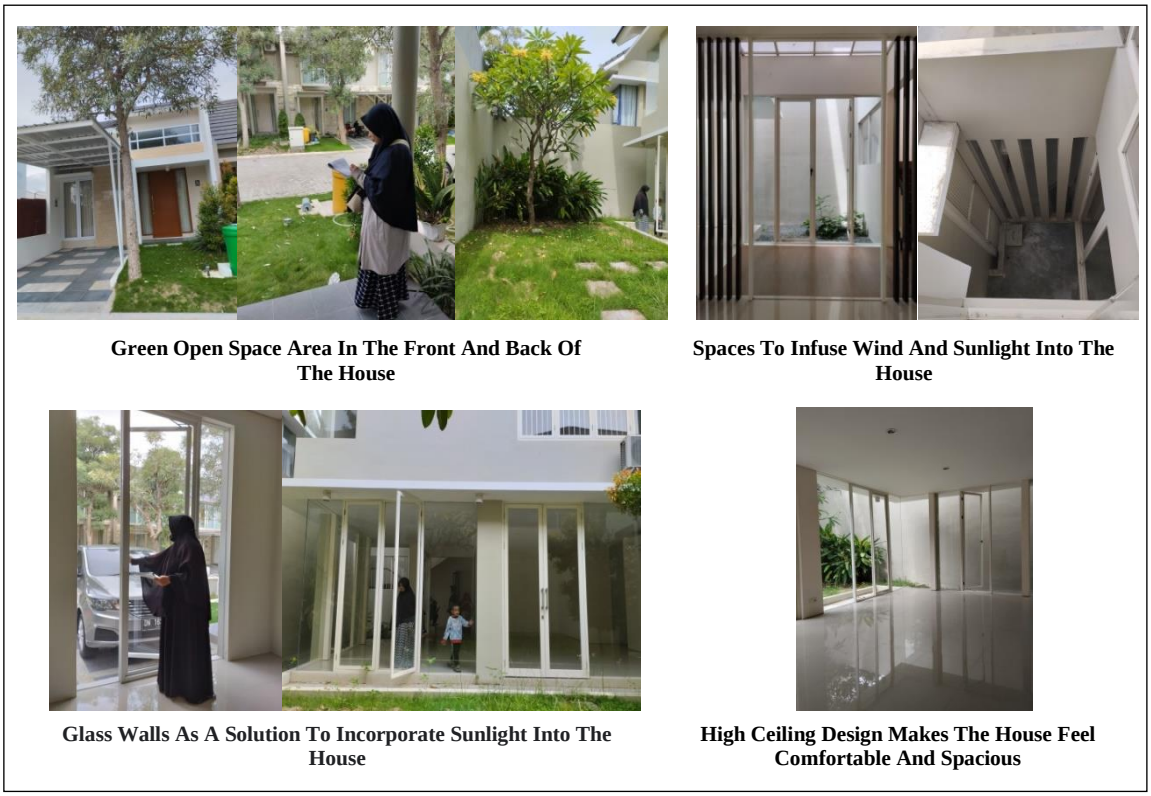

Fig. 2. Bioclimatic Architecture Strategy To Regulate The Temperature In Citraland's Residential House

4. Conclusion

This study uses a rationalistic approach with an exploratory method. Research shows that Citraland Residence has implemented a bioclimatic architectural strategy in several ways, namely the use of shading or shadow effects in the form of roof canopy, eaves, and lattice made of wood, and protective plants, as well as the use of insulating materials such as natural stone affixed to the outer walls. residential home. In addition, the layout of the residence also plays a role in the flow of air circulation to the maximum. Then the strategy of making wind-catching rooms and the use of glass materials on several sides of the building which acts as a place to enter sunlight into the house.

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References

[1] C. Spence, "Senses of place: architectural design for the multisensory mind," *Cogn. Res. Princ. Implic.*, vol. 5, no. 1, p. 46, Dec. 2020, doi: 10.1186/s41235-020-00243-4.

[2] A. Anisa, F. Lissimia, R. D. Nur'aini, A. Ashadi, and M. R. M. Mokhtar, "Transformation of Residential Space as an Adaptation Process during the COVID-19 Pandemic," *Int. J. Built Environ. Sci. Res.*, vol. 5, no. 2, p. 109, Dec. 2021, doi: 10.24853/ijbesr.5.2.109-120.

[3] A. Saifudeen and M. Mani, "Adaptation of buildings to climate change: an overview," *Front. Built Environ.*, vol. 10, p. 1327747, Feb. 2024, doi: 10.3389/fbuil.2024.1327747.

[4] E. I. Aghimien, D. H. W. Li, and E. K.-W. Tsang, "Bioclimatic architecture and its energy-saving potentials: a review and future directions," *Eng. Constr. Archit. Manag.*, vol. 29, no. 2, pp. 961–988, Mar. 2022, doi: 10.1108/ECAM-11-2020-0928.

[5] B. Ozarisoy and H. Altan, "Systematic literature review of bioclimatic design elements: Theories, methodologies and cases in the South-eastern Mediterranean climate," *Energy Build.*, vol. 250, p. 111281, Nov. 2021, doi: 10.1016/j.enbuild.2021.111281.

[6] F. Sommese, L. Badarnah, and G. Ausiello, "A critical review of biomimetic building envelopes: towards a bio-adaptive model from nature to architecture," *Renew. Sustain. Energy Rev.*, vol. 169, p. 112850, Nov. 2022, doi: 10.1016/j.rser.2022.112850.

[7] A. K. Bestara, "Bioclimatic Architecture as a Design Approach for High School in Gedebage, Bandung City," in *Proceedings of the International Webinar on Digital Architecture 2021 (IWEDA 2021)*, 2022, vol. 671, no. Iweda 2021, pp. 270–273, doi: 10.2991/assehr.k.220703.048.

[8] L. Balaguer, C. Mileto, F. Vegas López-Manzanares, and L. García-Soriano, "Bioclimatic strategies of traditional earthen architecture," *J. Cult. Herit. Manag. Sustain. Dev.*, vol. 9, no. 2, pp. 227–246, May 2019, doi: 10.1108/JCHMSD-07-2018-0054.

[9] S. Attia, T. Lacombe, H. T. Rakotondramiarana, F. Garde, and G. Roshan, "Analysis tool for bioclimatic design strategies in hot humid climates," *Sustain. Cities Soc.*, vol. 45, pp. 8–24, Feb. 2019, doi: 10.1016/j.scs.2018.11.025.

[10] A. Jiba Rifai Bassaleng, P. Fitriaty, N. Rahmanina Burhany, F. Zubaidi, and R. Arifin, "Thermal Performance of Vernacular Stilt House in Palu City," *Interdiciplinary J. Hummanity*, vol. 3, no. 2, pp. 185–195, Feb. 2024, doi: 10.58631/injurity.v3i2.180.

[11] P. Fitriaty *et al.*, "Energy Efficient Features of Vernacular Houses in Tropical Hilly Area of Indonesia," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 1157, no. 1, p. 012010, Apr. 2023, doi: 10.1088/1755-1315/1157/1/012010.

[12] J. S. Younger, "Factors, Including Disasters, Affecting Sustainable Development- Focus on Indonesia," in *2019 International Conference on Sustainable Engineering and Creative Computing (ICSECC)*, Aug. 2019, pp. 1–8, doi: 10.1109/ICSECC.2019.8907189.

[13] B. Paramita and A. Matzarakis, "Urban Biometeorology of Tropical Climate: Af, Am, Aw, a Propensity of 34 Provincial Cities in Indonesia," Springer, Singapore, 2023, pp. 283–296, doi: 10.1007/978-981-99-3675-5_16.

[14] D. B. Garancini, "Experiment-driven rationalism," *Synthese*, vol. 203, no. 4, p. 109, Mar. 2024, doi: 10.1007/s11229-024-04513-2.

[15] M. Ghajargar and J. Bardzell, "Synthesizing Opposites: Technical Rationality and Pragmatism in Design," *Des. J.*, vol. 22, no. sup1, pp. 2031–2044, Apr. 2019, doi: 10.1080/14606925.2019.1594927.

[16] N. Muhadjir, *Qualitative research methodology*. Yogyakarta: Rake Sarasin, 2000.

[17] M. S. Ferwati, M. AlSuwaidi, A. Shafaghat, and A. Keyvanfar, "Employing biomimicry in urban metamorphosis seeking for sustainability: case studies," *ACE Archit. City Environ.*, vol. 14, no. 40, pp. 133–162, Jun. 2019, doi: 10.5821/ace.14.40.6460.

[18] G. W, *Research methodology*. Jakarta: Grasindo, 2002.

[19] S. Purnama, "Analysis Of Shade Form On Solar Radiation Obtainment In High-Rise Buildings," *Lakar J. Arsit.*, vol. 3, no. 01, pp. 45–49, Mar. 2020, doi: 10.30998/lja.v3i01.5914.

[20] S. Andiyani, "Changes In The Use Of Building Materials In The Weleri Griya Harapan Housing Housing, Weleri District, Kendal Regency," pp. 1-62, 2016. [Online]. Available at: https://lib.unnes.ac.id/27251/.