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Study of Bioclimatic Architecture as A Basis for The Formation of A Sports Center in Batu City

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ABSTRACT

This study examines bioclimatic architecture as the basis for developing a Sport Center in Batu City. The city's mountain climate, moderate temperatures, and favorable natural ventilation potential provide an opportunity to implement climate-responsive design. This research used a descriptive qualitative approach through literature review, climatic analysis, and evaluation of sports facility requirements. The findings indicate that building orientation, cross ventilation, solar control, vegetation integration, daylight utilization, and environmentally friendly materials can significantly improve thermal comfort while reducing energy consumption. The proposed Sport Center concept emphasizes adaptation to local climate conditions and sustainable architectural strategies. The study concludes that bioclimatic architecture can serve as an effective design framework for sports facilities in Batu City because it enhances environmental performance, user comfort, and long-term sustainability. The results provide a reference for planners, architects, and local governments in developing energy-efficient sports infrastructure.

Keywords: *Bioclimatic Architecture, Sport Center, Thermal Comfort*

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INTRODUCTION

Batu City is one of the tourist cities in East Java that has experienced rapid development in the tourism, education, and sports sectors. The growth in population as well as increased community activities has led to a higher demand for representative sports facilities. Sports facilities not only function as a place for athlete training but also as public spaces that support community health and recreational activities. However, the development of sports facilities is often oriented only towards functional aspects without considering local climate conditions, resulting in high building energy consumption (Yeang, 1999).

Bioclimatic architecture is a design approach that places climate as a primary factor in the building design process. This approach aims to create thermal comfort through passive strategies such as building orientation, natural ventilation, natural lighting, solar

heat control, and the use of vegetation (Olgyay, 2015). In the context of sustainable development, these strategies can reduce dependence on mechanical systems and lower energy consumption.

According to Givoni (1998), buildings designed based on local climate characteristics can provide better indoor environmental quality compared to conventional buildings. Hyde's (2008) research also shows that applying bioclimatic principles can increase energy efficiency by more than 30% in some types of public buildings. These findings indicate that climate-responsive design has great potential to be applied in sports facilities.

Batu City has the characteristics of a mountainous climate with an average temperature between 18–28°C, high relative humidity, and fairly good sunlight intensity throughout the year. These conditions allow for the optimal use of natural ventilation and natural lighting. In addition, the presence of green open spaces and a relatively well-preserved natural environment becomes an important potential in the development of bioclimatic design.

Various studies on bioclimatic architecture have been conducted on educational, office, and residential buildings. However, research specifically examining the application of bioclimatic principles as the basis for the formation of a Sports Center in Batu City is still relatively limited. This research gap forms the basis for the need for a more in-depth study.

The purpose of this study is to analyze the application of bioclimatic architecture principles as the basis for the establishment of a Sports Center in Batu City. The study is expected to provide contributions in the form of design recommendations that are adaptive to the local climate, energy-efficient, and support the development of sustainable sports facilities.

METHOD

This study uses a qualitative descriptive method. The descriptive approach is chosen because it is able to explain the relationship between local climate conditions and the design needs of the Sport Center comprehensively (Creswell, 2018).

The research object is the design concept of a Sport Center adapted to the climatic characteristics of Batu City. The research data consists of primary data in the form of observations of environmental characteristics and secondary data in the form of scientific literature, climatology data, regional planning documents, and sports facility standards.

Data collection techniques were carried out through literature review, observation of climate conditions, and document analysis. The literature review was conducted by examining theories of bioclimatic architecture, thermal comfort, sports facility design, and sustainable buildings. Climatology data were analyzed to determine the prevailing wind direction, air temperature, humidity, rainfall, and natural lighting potential.

Data analysis was conducted using a descriptive-comparative method. The climate data of Batu City was compared with the principles of bioclimatic design according to Olgyay (2015), Givoni (1998), and Yeang (1999). The results of the analysis were then used to

formulate the Sport Center design concept that is appropriate for local environmental conditions.

FINDING AND DISCUSSION

RESEARCH RESULT

The analysis results show that Batu City has very good potential for the application of bioclimatic architecture concepts. The relatively cool air temperature allows buildings to utilize natural ventilation as the main strategy for thermal comfort.

Table 1

NO	Bioclimatic Principles and Implementation in Sports Center
1	Building orientation north–south to reduce direct solar radiation.
2	Cross ventilation in the main sports hall.
3	Use of vegetation as shading and wind direction.
4	Bukaan besar dan skylight untuk pencahayaan alami.
5	Materials with low heat absorption.
6	Utilization of green open spaces as thermal transition areas.

Source: Penulis

Orientation analysis shows that placing the building mass along the north–south axis can minimize excessive heat exposure on the east and west facades. This strategy contributes to a reduction in cooling load.

Cross ventilation is obtained by placing openings on opposite sides of the building. This system allows air to flow naturally and improves indoor air quality in the sports room. The use of a high roof also helps release hot air through the chimney effect.

Vegetation has ecological and thermal functions. Shade trees are able to reduce the surrounding environmental temperature, improve air quality, and create comfortable outdoor spaces for users. Green areas can also be used as social interaction spaces.

Natural lighting is obtained through skylights, clerestory windows, and transparent openings. This strategy reduces the need for artificial lighting during the day. In addition, environmentally friendly materials such as lightweight concrete and thermal insulation panels can improve building energy efficiency.

Based on the study results, the concept of a Sports Center in Batu City should integrate indoor courts, multifunctional arenas, fitness centers, public areas, and green open spaces that are interconnected through open corridors.

DISCUSSION

Research findings show that the principles of bioclimatic architecture have a high relevance to the development of a Sports Center in Batu City. These results are in line with Givoni's (1998) research which states that passive design can enhance thermal comfort without excessive reliance on mechanical systems.

The implementation of natural ventilation in sports facilities is very important because physical activity generates high body heat. With good air circulation, user comfort can increase while reducing energy consumption. This finding supports the research of Koenigsberger et al. (1974) regarding the importance of ventilation in tropical buildings.

In addition, the use of vegetation as a design element not only serves an aesthetic function but also plays a role in shaping the microclimate. Vegetation can lower surface temperatures and improve environmental quality. This result is in line with Emmanuel's (2005) research on climate-sensitive design in urban areas.

The use of natural lighting has become an important strategy in improving energy efficiency. Lechner (2015) explains that good natural lighting design can significantly reduce electricity consumption while enhancing the visual quality of a space.

The limitation of this study is that digital energy simulation and thermal simulation have not been carried out. Therefore, future research needs to use building simulation software to measure energy performance quantitatively.

Practically, the research results can be used by local governments, designers, and investors as a basis for developing sustainable sports facilities. The integration of bioclimatic principles not only provides environmental benefits but also enhances the quality of the user experience at the Sport Center.

CONCLUSION

This study shows that bioclimatic architecture can be used as the basis for the development of a Sport Center in Batu City. The characteristics of the local climate support the implementation of proper building orientation, cross ventilation, natural lighting, the use of vegetation, and environmentally friendly materials. These strategies contribute to improved thermal comfort, energy efficiency, and environmental sustainability.

The application of bioclimatic principles in the Sports Center has the potential to create sports facilities that are more adaptive to local climate conditions and provide a better spatial experience for users. Further research is recommended to conduct energy simulations and building performance tests to obtain more comprehensive results.

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