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IMPLEMENTATION OF BIOMIMETIC ARCHITECTURAL CONCEPTS ON EQUESTRIAN BUILDINGS

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ABSTRACT

Equestrian sport is one of the efforts to improve human resources and quality. To create good conditions for athletes and the horses themselves, it is therefore necessary to have an open space that is environmentally responsive by making this place their 'home'. To create an open and environmentally responsive space, this equestrian building will use the concept of Biomimetic Architecture, the concept of Biomimetic Architecture to obtain the basic concept of architectural design that minimizes changes to the site. Biomimetic architecture uses nature as a model, reference and guide for solving problems in architecture. This research aims to analyze the points of biomimetic architecture that can be applied to buildings. This research is included in the descriptive qualitative category, especially using synchronic analysis which produces a solution in the form of a design concept. Data collection is obtained from the literature study which is then synthesized and becomes design criteria. From each application point studied, it can answer problems regarding the effect of each criterion on the building itself.

Keywords: Concept, Biomimetic Architecture, Equestrian Buildings

Introduction

The development of the field of sports and its development is part of efforts to improve human quality as indicated by the increasing positive trend in the physical and spiritual health of the community, sportsmanship, and discipline. Equestrian sport is a sport in which humans are able to ride, ride, jump or run using horses. Equestrian sports have four branches, including dressage, show jumping, cross country and eventing. Equestrian sports need a place to support equestrian sports infrastructure to support the physical condition of equestrian athletes and the horses themselves, because equestrian athletes have not been able to meet the needs of good conditions for training and competition. According to (Andri, 2016) to create optimal conditions for both equestrian athletes and the horses themselves, it is therefore necessary to have an open space and be responsive to the environment by making this training place a 'home' for equestrian and horse athletes, so that they can optimize their potential in the field. and able to highlight the nature itself and create buildings that keep up with the times by displaying buildings that can harmonize with nature so as to reduce the intervention of buildings on nature itself. In addition, it can develop spiritually by providing opportunities to mediate and appreciate God's creation.

Then, the term biomimetics was also known by Otto Schmitt in 1982, and rediscovered by Janine Benyus in 1997, an innovation consultant and one of the founders of the Biomimicry Institute. Biomimetics is not a simple imitation of Nature but Biomi-metic is practiced through learning from nature for technological improvement in other words imitating natural systems or processes will affect the shape. Biomimetic architecture uses nature as a model, reference and guide for solving problems in architecture.

Material and Methods

This design study is a combination of qualitative descriptive research, especially using synchronic analysis (Darjosanjoto, 2006) which produces a solution in the form of a design concept. Has the aim of clearly describing and describing each discussion point. The points are in the form of architectural applications of three different principles of Biomimetic Architecture, and are concluded to be one main discussion in the form of architectural applications in frozen buildings. The design concept was generated using the combined metaphor method (Antoniades, 1990) as an approach that was deemed most suitable for representing biomimetics.

Result and Discussion

Biomimetics is also called bionic in European countries (Suryadi, 2018). The terms that have a relationship with biomimetics such as biomorphology, biomechanics, and many more (Eman and Rogi, 2013). Biomimetics is a term that describes something that is made by humans by imitating a system, working method or design from nature (Eman and Rogi, 2013). There are several natural principles that can be learned such as nature that can adjust form and function, and many more (Hartono, Egam, and Sembel, 2018). Biomimetic principles focus in particular on natural attributes; thus implying that humans have much to learn from the billions of years of natural world evolutionary experience. These principles are:

1. Nature only uses the energy it needs
2. Nature recycles everything
3. Nature depends on diversity
4. Nature demands local expertise

According to the Biomimetic Guild, Biomimetic Architecture has three levels that can be applied to a design, namely the level of form, process, and ecosystem. Within these three levels, there are 9 biological criteria that can be applied to the architectural world (Knippers, Nickel, and Speck, 2016), namely:

1. **Openness**
   Openness as a category in architecture, apart from involving physical openness in terms of accessibility, visibility, and permeability, also involves metaphorical openness..
1. **Self-Organisation**
   Self-organization criteria that can be seen from an architectural element that changes or adapts to nature.
2. **Limitation**
   Criteria that describe the capacity of a size in a building, especially in space and time.
3. **Order**
   The use of a pattern on the architectural elements of the building, especially on the structure, the hierarchy between each mass, function and style.
4. **Propagation**
   The distribution criteria in the building can be found according to the function of the space.
5. **Growth**
   The sustainability of the function of the building in meeting the capacity or activities in it.
6. **Energy**
   The ability of buildings to maximize energy efficiency, such as using a building system that is able to suppress used up resources that is able to balance the building system with the natural surroundings (Amma, 2017).
7. **Reaction**
   What was found to be forced to live in and can be used as a benchmark for the sustainability of the function of the space or building (Dewi Wulansari and Wihardyanto, 2017).
8. **Evolution**
   Changes and developments in architectural forms over time.

From the 9 biological criteria, they can be grouped into architectural innovations that are responsive to architecture and nature, not necessarily resembling a plant object or an animal. Where architectural inspiration takes the intrinsic form of the function of the organism's object, then the building model that is processed on a life form may also look similar to the object it imitates. The grouping of the principles of Biomimetic Architecture (Raharja, 2018), namely:

1. **Form**
   Biomimetic concept in architecture can be an application of metaphor. Because the basic process of taking ideas taken from forms from nature. In addition, biomimetic architecture with metaphorical processes at present tries to link technology to structural and material systems. In addition, modeling of architectural forms from nature refers to the concept of Biomorphic.
2. **Structure dan Material**
   The concept of mimetics taken on the object of the organism leads to the functional aspects of the building, one of which is structure and material. The intent of Biomimetics is to try to innovate in creating something that is sophisticated or something new, as well as its application to architecture that is inclined to structural and material problems. Most of the case studies of Biomimetic buildings use new structural concepts or are simply modifications of existing structural systems concepts.
3. **Sustainability Principle**

The concept of Biomimetics makes nature a source of inspiration, meaning that architecture must also refer to an ecological approach (The Evolution of Design Biological Analogy in Architecture and Applied Arts, Philip Steadman, 2008). The application of the principle of sustainability in architecture according to (Eugene Tsui, 1999), which uses a minimal amount of material, maximizes the strength of the structure, connects color and texture directly to nature, continuities between interior and exterior and chooses materials that are efficient in demonstrating the previous four principles. The principle of sustainability according to (Brian Edwards, 2001) is like learning from nature.

Biomimetic architecture which is based on nature as an idea and reference in design development is a very complex matter, here is a table of identification of the theory of biomimetic architectural design principles according to experts used in equestrian buildings, namely:

Tabel 1. Identify Design Principles

No.	Design Principle Theory			Application
	Knippers, Nickel, *and* Speck, 2016	**Otto Schmitt, 1982**	**Raharja, 2018**	
1	Openness, physical openness in terms of accessibility, visibility and permeability.	Nature adapts form to function.	The basic process of taking ideas taken from forms from nature.	Have an openness to demanding relationships of accessibility, visibility and permeability.
	Growth, sustainability of building functions in meeting capacity.			Forms of morphology taken from natural forms.
2	Limitation, describes the capacity of a size in the building.	Nature has a standard structure, form and components.	The concept of mimics taken on the object of the organism leads to the functional aspects of the building, one of which is structure and material.	A more functional structure and has standard components.
	Evolution, change and development of architecture along with the times.			The structure follows the times so that the exploration of forms is wider.
4	Energy, the ability of buildings to maximize energy efficiency.	Nature only uses the energy it needs.	The concept of Biomimetics makes nature a source of inspiration, meaning that architecture must also refer to an ecological approach.	Using renewable energy.
	Reactions, reactions can occur in response to various things.	Nature recycles everything.		Can recycle energy by responding to the surrounding environment.
	Self-organization, which is able to live without the help of external factors.	Nature demands local expertise		

5	Spread, in buildings can be found according to the function of the room.	Nature depends on diversity.	-	Distribution of space according to function.
6	Regularity, a pattern in the architectural elements of the building, especially the structure, the hierarchy between each mass, function and style.	-	-	Have a clear repetition rhythm.

There are 8 forms of application that can be applied to equestrian buildings, the application forms include the development of floor plans, development of utilities, and development of the shape and structure of the building. The description of the 8 forms of application, namely:

1. Have an openness to demanding relationships of accessibility, visibility and permeability.

At this point, the form of the accessibility relationship is meant by separating the circulation of each user according to their needs. The visibility relationship has a close relationship with the movement in the configuration of the mass order and in the system (Bafna, 2003). A visible mass will attract people to sign it, the user's position will be a relative location because it is influenced by the location of a visual field environment. The permeability relationship becomes important to create a responsive area. So that the relationship of accessibility, visibility and permeability in the equestrian building area determines the circulation path in general on the site.

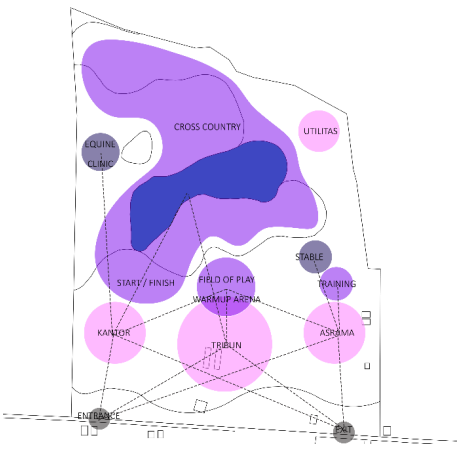


Figure 1. Sketch of the mass spread at the horse riding place

2. The shape of the morphology is taken from the natural form.

the form taken to be able to maximize the system taken, such as taking the form of an ant house mound to produce good ventilation with the coanda effect, this coanda effect is applied in the training field, the principle is to cool the room by removing heat from the roof and walls of the room . So that the wind will enter through the walls and bring out the heat, and the heat will be lifted from the bottom to the roof. This Coanda effect is very suitable to be applied because the heat that

comes out when people exercise is quite large and so is the horse.

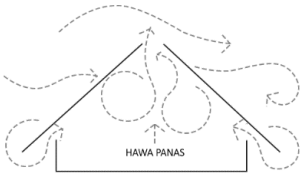


Figure 2. Coanda Effect Sketch Diagram

3. A more functional structure and has standard components.

KSLL foundation (Spider Structure Construction) is one form of application of this application, KSLL foundation is a combination of conventional substructure construction which is a combination of a continuous flat concrete slab foundation underneath which is stiffened by high flat upright ribs and a soil improvement system at the bottom. between the ribs. The KSLL foundation is much more effective at damping earthquakes in the ring of fire area.

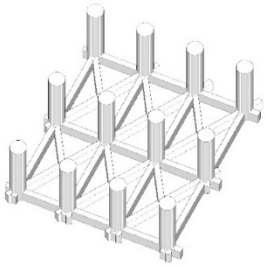


Figure 3. KSLL illustration

4. The structure follows the times so that the exploration of forms is wider.

So that the shape of the building is able to exploit the natural form itself, several technologies that can be combined with nature such as concrete materials using calcium carbonate CaCO3 as the basic material by mixing minerals with CO2, this material is the main raw material in nature.

5. Using renewable energy.

The potential for renewable energy in Indonesia is relatively large. The benefits are still very minimal because the price of electricity production based on renewable energy is still relatively high.

Solar, The potential of solar energy as a new energy source in Indonesia reaches 207.8 GWp. One of the promising microgeneration technologies for processing solar energy into electrical energy is solar panel technology.

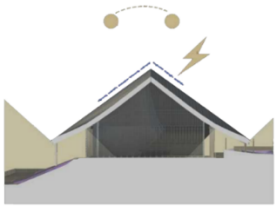


Figure 4. Solar Panel Diagram

Wind, The potential of wind energy for generating electrical energy in Indonesia is indeed smaller than the potential of solar energy. However, the amount is still significant enough to be a substitute for fossil energy, which is 60.6 GW. The most common utilization technology is the use of wind turbines.

Figure 5. Diagram Wind Turbine

Water, The potential of water energy as a renewable energy source in Indonesia is 94.3 GW. In-pipe water technology to produce electrical energy (both on an urban and building scale) is a potential on-site renewable energy tool technology (Casini, 2015). Hydropower is a renewable energy source that is also cost-competitive.

Geothermal, Geothermal potential in Indonesia as a renewable energy source is 28.5 GW. This number is said to be the largest in the world. Geothermal energy can be used directly (integrated with buildings) in the sense that it is used for heating or cooling.

6. Can recycle energy by responding to the surrounding environment

Perform efficiency in water treatment, lighting and air conditioning. Use of non-waste and greywater for site use such as site-irrigation will minimize demands on local aquifers. By processing gray water (used water) and rain water harvesting, it is expected to reduce the use of clean water needed.

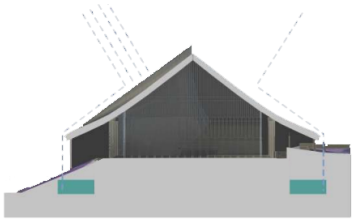
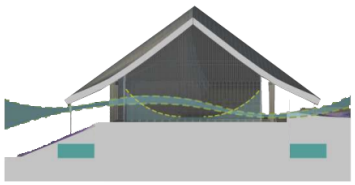


Figure 6. Greywater Diagram

Air flow occurs due to thermal forces, namely the difference in temperature or temperature between the air inside and outside the room and the height difference between the ventilation holes by maximizing openings and natural ventilation systems using asymmetrical cross ventilation where with different air gap dimensions create air flow inside the building. tend to be "sucked" into the building.



Fugure 7. Diagram *cross ventilation*

Factors that affect thermal comfort there are two aspects, namely physically and environmentally and psychologically. Based on SNI 03-6572-2001, the standard of thermal comfort in the humid tropics is 22 oC and humidity is between 40% -70%.

Heat radiation is generated by sunlight that enters the building directly from the hotter surrounding environment. To prevent this can be used shading tools commonly called Sun Shading Device.

7. Distribution of space according to function.

The distribution of space according to function makes it easier to group activities so that the effectiveness of the users is also fulfilled and the flow of activities becomes structured. Inside the equestrian building the grouping of space is based on three categories based on the user inside, namely horses, horses and humans, and humans themselves. This room grouping is also based on user convenience.

8. Have a clear rhythm of repetition.

A clear rhythm of repetition to produce an identity in the building so that it can unite other buildings, the rhythm that is most often used in the appearance of facades and building materials so as to highlight the nature and purpose of the building.

Conclution

Biomimetic architecture can be applied in architecture with several principles in it which require the designer to further explore these principles. Biomimetic architecture is a design concept that is able to create an architectural work with a design that maximizes energy efficiency and the quality of space and buildings adapted from imitation of working methods or criteria. The development of the concept of biomimetic architecture is needed as an answer to research problems concerning how to apply each of the criteria for the application of Biomimetic Architecture. It is hoped that this research can be used as a reference in biomimetic architectural design studies.

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