Study of Organism Biomimicry Architecture Approach to Snail-Tent in Asstro Highland Glamping

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INFORMASI ARTIKEL

Abstract: *Although biomimicry has been widely applied in architecture, its use at the organism level remains underexplored and lacks adequate quantitative evaluation. This study aims to examine the implementation of biomimicry in Snail-Tent at Asstro Glamping Resort, Bandung, and determine its percentage of conformity with the imitated organism. A qualitative method was used, employing field surveys and measurements, which were analyzed based on relevant variables within the organism-level biomimicry architectural framework. The results indicate that Snail-Tent successfully adapts the characteristics of a snail with a conformity rate of 60%, reinforcing the potential of biomimicry in sustainable architectural innovation.*

Keywords: *Biomimicry Architecture, Form Exploration, Green Turtle, Glamping Resort, Conservation*

Abstrak: Meskipun biomimikri telah banyak diterapkan dalam arsitektur, penggunaannya pada tingkat organisme masih kurang dieksplorasi dan belum memiliki evaluasi kuantitatif yang memadai. Penelitian ini bertujuan untuk mengkaji penerapan biomimikri pada Snail-Tent di Asstro Glamping Resort, Bandung, serta menentukan persentase kesesuaiannya dengan organisme yang ditiru. Metode kualitatif digunakan dengan teknik survei lapangan dan pengukuran, yang kemudian dianalisis berdasarkan variabel relevan dalam kerangka biomimikri arsitektur tingkat organisme. Hasil penelitian menunjukkan bahwa Snail-Tent berhasil mengadaptasi karakteristik siput dengan tingkat kesesuaian 60%, menegaskan potensi biomimikri dalam inovasi arsitektur berkelanjutan.

Kata Kunci: Arsitektur Biomimikri, Eksplorasi Bentuk, Penyu Hijau, Glamping Resort, Konservasi

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INTRODUCTION

Asstro Highland is a tourist area located in Subang Regency, Bandung, Indonesia. This tourist spot consists of 3 large tourist groups, namely The Ranch Ciater (offroad), Asstro Highland Ciater (food and camping), and Flora Wisata De Castello (educational tourism). One of the facilities of Asstro Highland Ciater is a camping area, which provides accommodation in the form of tents, glamping, camper vans, and villas. Among the glamping offered, one of them is the Snail Tent whose concept adapts the biomimicry architectural approach. As the name implies, the snail-tent or snail tent adapts the snail or slug organism that is often found in Subang, Bandung.

Picture 1. Asstro Highland Ciater, Bandung
(Source: Author's Document, 2024)

Biomimicry has a definition of imitating or mimicking (Benyus, 1997). Biomimicry allows the implementation of a natural system into a design to solve human problems. The biomimicry method is able to create innovations that use ecological standards through an adaptation of natural objects such as animals or plants (Alessandro dkk, 2017). Biomimicry architecture according to Zari is divided into three categories (levels) which is divided into Organisms, Behavior, and Ecosystems (Zari, 2007). The dimension of imitation/mimicking appears at these 3 levels (Azcon in Lopez, 2016).
The nature of biomimicry in a building design can take the concept of nature in the form of form, how it works (process), how the design is made (construction), materials (materials) or what the design can do (function) (Zari, 2007). Zari then developed a framework for applying the biomimicry architectural approach, where the differences between each type of biomimicry are explained in the following table and exemplified by looking at how different aspects of termites, or the ecosystem of which termites are a part, can be imitated (Zari, 2007). The following table presents the biomimicry architecture framework developed by Zari.

Table 1. Framework for Organism-Level Biomimicry Approach

Level of Biomimicry	**Example – a building that mimics termites:**	
Organism Level (Mimicry of a specific organism)	Form	The building looks like termite.
	Material	The building is made from the same material as a termite.
	Construction	The building is made in the same way as a termite.
	Process	The building works in the same way as an individual termite.
	Function	The building functions like a termite in a larger context.

Table 2. Framework for Behavior-Level Biomimicry Approach

Level of Biomimicry	**Example – a building that mimics termites:**	
Behavior Level (Mimicry of how an organism behaves or relates to its larger context)	Form	The building looks like it was made by a termite.
	Material	The building is made from the same materials that a termite builds with.
	Construction	The building is made in the same way that a termite would build in
	Process	The building works in the same way as a termite mound would.

	Function	The building functions in the same way that it would if made by termites.

Table 3. Framework for Ecosystem-Level Biomimicry Approach

Level of Biomimicry	Example – a building that mimics termites:	
Ecosystem Level (Mimicry of an ecosystem)	Form	The building looks like an ecosystem.
	Material	The building is made from the same kind of materials that a termite ecosystem is made.
	Construction	The building is assembled in the same way as a termite ecosystem.
	Process	The building works in the same way as a termite ecosystem
	Function	The building is able to fuction in the same way that a termite ecosystem would dan form part of a complex system by utilising the relationship between processes.

In this paper, the research focus is limited to developing a framework for applying an organism-level biomimicry architecture approach. The study aims to examine the implementation of this framework in the design of glamping tents. Additionally, it seeks to determine the percentage of implementation by comparing the design object (glamping building) with the organism used as a reference. The analysis explores how closely the glamping structure aligns with the characteristics of the imitated organism.

The novelty of this research lies in developing a framework for applying organism-level biomimicry in glamping tent design. It explores how biomimicry can be systematically implemented, which is still rarely studied. The study also introduces a quantitative evaluation by calculating the percentage of similarity between the design and the imitated organism. Additionally, it connects form, function, and materials to biomimicry principles, offering insights into sustainable architecture. By integrating ecological aspects, this research contributes to environmentally friendly architectural innovations for future designs.

RESEARCH METHODS

This study employs a qualitative research method with a field survey as the data collection technique to conduct observations and measurements of research objects. The collected data is then analyzed based on variables relevant to the framework of the organism-level biomimicry architecture approach. The field survey conducted by the researcher involved a direct visit to Asstro Highland Ciater to observe the shape, color, texture, documentation, and material analysis, as well as to conduct direct measurements of the research object, namely the Snail-Tent type glamping facility. The analysis method used in this study is a direct descriptive analysis of the research object, which is then compared with the variable values of the organism-level biomimicry architecture framework approach.

Picture 2. Snail-tent by Asstro Highland
(Source: Author's Document, 2024)

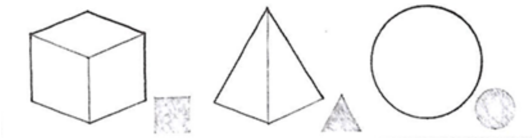
Data and Theory

The framework for the biomimicry architecture approach refers to the application of biomimicry principles in architectural design. According to Zari (2007), there are at least five variables based on natural concepts that can be incorporated into buildings. These variables include form, how it works (process), how the design is made (construction), materials, and what the design can do (function). Each of these aspects plays a crucial role in creating sustainable and efficient architectural solutions inspired by nature.

Variable of Form, The term 'form' in biomimicry architecture means that the building visually looks like the form of the organism being imitated (mimicry). To understand the meaning of form in architecture, the author refers to the meaning of form according to Francis D. K. Ching in his book entitled 'Architecture: Form, Space, and Order'. In the scope of this study, form offers references to both internal and external structures and principles that provide unity to the whole. If form often includes a three-dimensional sense of mass or volume, then basic forms refer more specifically to the most important aspects of form that control its appearance-the configuration or relative disposition of lines or contours that define the boundaries of a figure or form (Ching, 1993). In this case, Ching tries to explain that form is composed of basic forms, has dimensions of size, color and texture.

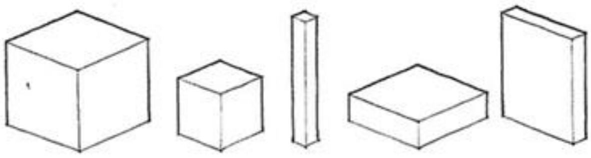
1) Basic Form

   Gestalt psychology states that our minds simplify the visual environment in order to understand it. When faced with a variety of compositions of shapes, we tend to reduce them in our visual field to the simplest and most common forms. The simpler and more regular a basic shape is, the easier it is to recognize and understand. From geometry we know the basic regular shapes, namely the circle, and the infinite series of regular polygons that can be included in it. Of these shapes, the most important are the main basic shapes: the circle, the triangle, and the square (Ching, 1993).



Picture 3. Basic Shape Illustration
(Source: DK. Ching, 2007)

2) Size
The physical dimensions of length, width, and depth of a shape. If these dimensions determine the proportions of a shape, then its scale will be determined by its size relative to other shapes in its environment (Ching, 1993). Additionally, discussions on large city architecture have addressed the quantitative aspects of urban design, focusing on how the size and arrangement of architectural components contribute to the overall coherence and functionality of urban spaces (Köhler, 2017).



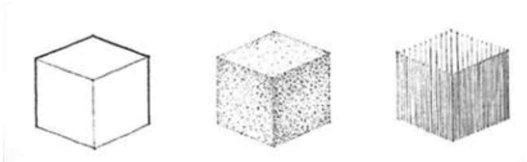
Picture 4. Size Illustration
(Source: DK. Ching, 2007)

3) Color
Color is a phenomenon of light and visual perception based on hue, saturation, and nuance. It helps distinguish a form from its environment and influences its visual impact (Ching, 1993). The Brewster color circle categorizes colors into primary (red, blue, yellow), secondary (mix of primary colors like purple and orange), tertiary (mix of primary and secondary colors), and quarter colors (mix of two tertiary colors) (Nugraha, 2010). Additionally, color in architecture plays a vital role in aesthetics, cultural expression, and historical narratives (Li, 2024).

Picture 5. Brewster's Color Wheel Illustration
(Source: Nugraha, 2010)

4) Texture
The visual and especially tactile qualities imparted to a surface by the size, basic shape, arrangement, and proportions of its parts. Texture also determines the degree to which the surface of a form reflects or absorbs direct light (Ching, 1993). Thus, the analysis of shape variables will identify shapes based on basic shape, size, color, and texture of biomimicry objects. Another investigation delved into the aesthetic

perception of visual textures, modeling the relationship between basic texture features and human aesthetic responses, thereby providing insights into how texture contributes to overall design appeal (Wang, 2020).



Picture 6. Texture Illustration
(Source: Nugraha, 2010)

Variable of Material, In simple terms, Zari defines material in the biomimicry architecture approach as a building to be built that has the same type/material composition as the composition of the material composition of the imitated biomimicry object (Zari, 2007). Materiality in architecture is not limited to theoretical positions on the perceived materiality of images, texts, or other representational objects. Materiality can indicate the materiality of a particular project when considering the various materials used (Harvey, 2014). Materiality has also been described as the state that architecture is realized using building materials and how materials express their properties and specialties, which allow their characteristics or appeal to emerge (Janson, 2014).

Thus, the process of analyzing material variables will translate the material that makes up the organism of the biomimicry object biologically and then compare it with the material that makes up the relevant architecture, which can express the nature and characteristics of the biomimicry object architecturally.

Variable of Construction, In Zari's biomimicry architecture approach, construction follows how the biomimicry object is naturally formed. Organisms go through growth cycles, which can be imitated in the building process (Zari, 2007). Construction in architecture is closely linked to structural systems. Ching (2018) explains that a building's structure must safely support and transfer loads, including roof (upper structure), columns and floors (middle structure), and foundation (lower structure). Therefore, analyzing construction variables involves comparing the structure of biomimicry objects with architectural construction systems.

Variable of Process, Zari (2007) explains that buildings should function like the biomimicry objects they imitate. For example, if a natural object produces oxygen, the building should also be designed to generate oxygen through a specific system. Architectural processes rely on mechanical and electrical systems, which are essential for maintaining comfort, health, and safety (Ching, 2018). The goal is not to dictate design but to highlight key factors for system integration. This analysis identifies the biomimicry object's role in its life cycle and aligns it with relevant building utilities and mechanics.

Variable of Function, Zari (2007) explains that a building's function should reflect the role of the biomimicry object in a broader context. For example, if the imitated organism recycles cellulose or composts, the building should serve a similar purpose in its ecosystem. This function variable emphasizes designing with environmental considerations. The analysis examines how the building's role aligns with the biomimicry object, considering both the environment and user needs.

RESULTS AND DISCUSSION

Based on the survey results, the Snail-Tent developed by Asstro Highland has an oval shape that tapers on one side. In terms of its basic form, this oval shape falls under the category of a basic circular shape. Another geometric form is observed in the design of the glamping tent's entrance opening, which features a rectangular shape. This rectangular form aligns with the basic square shape classification.

Picture 7. Snail-Tent Identification by Asstro Highland
(Source: Author's Document, 2024)

The Snail-Tent covers an area of approximately 50m² (9 × 5.5 m) with a maximum height of 4.2 meters. It is designed to accommodate 3 to 6 people. Ideally, it is suited for 3 occupants to ensure comfortable circulation and interior functionality. However, if needed, the maximum capacity can be extended to 6 people.

Picture 8. Snail-Tent Measurement Results by Asstro Highland
(Source: Author's Document, 2024)

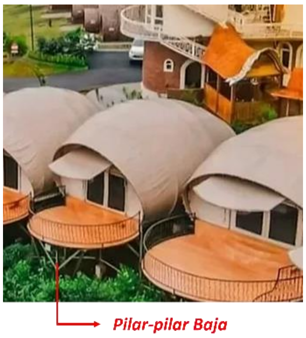
This tent is made of high-quality polyester material in a light brown color, giving it a natural appearance. Its construction consists of a black iron pipe frame coated with duco paint for enhanced rust resistance and durability. According to sources, this structure can last up to 10–15 years. The frame connections are reinforced using a welding system, while the frame and tent membrane are secured with a bolt system. The membranes are joined using adhesive and sewing techniques to prevent gaps and leaks from rain.

Picture 9. Identification of Structural Systems and Materials on Snail-Tent by Asstro Highland
(Source: Author's Document, 2024)

For the middle section, the iron pipe frame is bent using a specialized bending technique to create a perfectly curved shape without breaking. This technique ensures structural integrity and maintains the aesthetic appeal of the design. The bending process requires precision to achieve smooth, uniform curves. As a result, the frame remains strong and durable while supporting the overall tent structure. The lower structure, which is on the flat part, is made with a base foundation with the same distance as the curved middle frame which forms the tent into an oval.

Picture 10. Identifying the foundation system on the Snail Tent by Asstro Highland
(Source: Author's Document, 2024)

Picture 11. Identifying the Connection System on the Snail Tent by Asstro Highland
(Source: Author's Document, 2024)



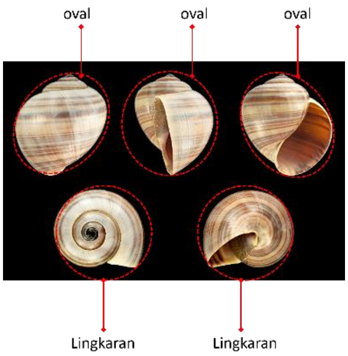
Picture 12. Identification of Foundation System on Snail-Tent by Asstro Highland
(Source: Author's Document, 2024)

Meanwhile, the lower structure, which is positioned on the cliff, is reinforced with steel pillars that support the balcony terrace deck and tent floor. According to sources, the load distribution system is designed to follow the natural contours of the cliff. Before construction, the cliff edge undergoes a soil stabilization treatment using a system called terracing. This method enhances structural stability and minimizes the risk of erosion.

Discuss

Organism Level Biomimicry in Snails / Slugs

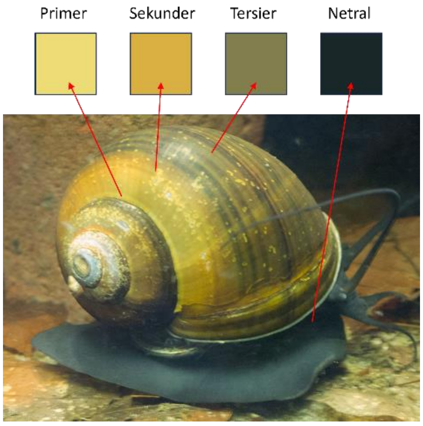
Picture 13. Snail / 'Keong'
(Source: https://asset-a.grid.id//crop/0x0:0x0/700x465/photo/2019/09/25/1726170739)



Picture 14. Shape identification of snail
(Source: Author's Document, 2024)

The *Pila ampullacea*, commonly known as the Gondang snail, rice field snail, water snail, or *tutut*, is a type of freshwater snail found in tropical Asian regions. It typically inhabits rice fields, ditches, and lakes, thriving in freshwater environments. This shelled organism exhibits unique morphological characteristics that distinguish it from other snail species. Its

adaptation to aquatic habitats allows it to play a crucial role in the ecosystem, particularly in maintaining the balance of freshwater biodiversity.
In terms of form, the snail's shape is predominantly organic, though certain geometric elements can be identified. As shown in Picture 13, various views of the snail reveal a form largely dominated by oval and circular geometric shapes. Regarding color, the Brewster color diagram classifies its hues into primary, secondary, tertiary, and neutral levels. The golden snail is characterized by a golden-yellow shell with transparent brown accents, as described by Riyanto (2003), who noted that its shell is thinner than that of other snail species. Additionally, the snail's body exhibits a brownish-cream coloration, further distinguishing its appearance.



Picture 15. Shape identification of snail
(Source: Author's Document, 2024)

The size and texture of the snail shell vary depending on the species. The shell is relatively thin, measuring approximately 0.3 mm–0.5 mm per individual, with a slightly oval shape. It is smaller in size, with a shell length ranging from 10.5 to 14.8 cm and a shell diameter between 7.2 and 8.0 cm (Dharmawati et al., 2016). Based on the image of the snail shell in Figure 2.13, the surface texture appears hard with a relatively smooth finish and a distinct line pattern.

In terms of material composition, Udomkan and Limsuwan (2008) conducted an EDX analysis on golden snail shell powder. Their findings indicate that the shell is primarily composed of calcium carbonate ($CaCO_3$) at 92.68%, along with magnesium oxide (MgO) at 1.68%, aluminum oxide (Al_2O_3) at 1.04%, and silicon dioxide (SiO_2) at 4.29%. This composition suggests that calcium carbonate and silicon dioxide are the dominant elements in the snail shell material. These properties contribute to the shell's durability and structural integrity.

Analysis Result

Table 4. Comparative analysis of biomimicry approach framework variables towards research objects

No.	Varible	Sub variable	Object of Biomimicry	Object of Design	Value
			Snail	Snail Tent by Asstro Highland	
1.	Form	Basic form	Circle	Circle	1

		Size pxl (ratio)	12,65 x 7,6 (1,66 : 1)	9 x 5,5 1,63 : 1	1
		Colors	Yellow, black, brown	brown	1
		Texture	fine	fine	1
2	Material	Outer covers	calsium carbonat, silicon diokside	Polyester membrane	0
3	Construction	Upper	Carapace	Steel pipe frame with polyester cover	1
		Mid	Body	There is no middle structure	0
		Bottom	leg	Steel pillar foundation supporting terrace deck	1
4	Process	Intern	Producing organic material as nutrients for the soil	There is no imitation in the process aspect	0
5	Function	Extern	Clean moss and dirt by eating it	The function of accommodation is to enjoy the natural atmosphere	0
	Percentage value of conformity of biomimicry objects to design objects				60%

Based on the analysis results, it can be identified that:

(a) From the shape variable, the basic shape of the research object adapts the basic shape of the snail, namely a circle (oval). From the size aspect, the ratio of size to diameter length and diameter width between the research object and the snail is still in a close number, namely 1: 1.66 with 1: 1.63. Furthermore, from the color aspect, there is a match between the research object and the snail, where brown is one of the colors of the snail color variants found. And finally, from the texture aspect, the visual texture quality between the research object and the snail is also equally smooth. It can be concluded that all aspects in the shape variable are in accordance with the approach of the biomimicry architecture framework at the organism level to the snail or slug organism.

(b) From the material variable, there is no conformity between the basic material forming the snail shell structure and the basic material used by the snail-tent in its roof covering. The basic material forming the snail shell is dominated by calcium carbonate and silicon dioxide, while in the development of the snail-tent construction, a polyester membrane is used.

(c) From the construction variables, it can be identified that the snail has at least three parts which include the shell as the upper structure, the body as the middle structure, and the legs as the lower structure. However, in the development of the snail-tent, the middle and upper structures are combined into one construction unit with the upper structure which includes an iron pipe frame forming an oval ball and covered with a roof covering with polyester material.

(d) From the process aspect, there are no internal processes in the snail organism that are adapted. Internal processes that could possibly be adapted from the snail organism as its characteristics include moving slowly, or being able to enter its hard shell when faced with a predator.

(e) From the external function aspect, there is also no conformity, the external function of snails or slugs is to play a role in the environment by digesting organic material and supplying nutrients to the soil. While the function aspect of the research object is as a container for accommodation activities with natural forest views.

CONCLUSION

The primary issue addressed in this research is the absence of a systematic framework for implementing organism-level biomimicry in architectural design, particularly in glamping tent structures. While biomimicry is widely applied in architecture, its use at the organism level remains insufficiently explored and lacks quantitative evaluation. This study aims to assess how closely a glamping tent design aligns with the characteristics of the imitated organism, ensuring that biomimicry is not only conceptually integrated but also measurable and functional in sustainable architecture. Additionally, it seeks to determine the extent of implementation by comparing the design object (glamping building) with the referenced organism.

This research employs a qualitative method, utilizing a field survey as the primary data collection technique to observe and measure the research objects. The gathered data is analyzed based on variables relevant to the organism-level biomimicry architecture framework, providing a structured approach to evaluating biomimicry in architectural design.

This study on the Biomimicry Architectural Framework Approach at the Organism Level for the construction of Snail-Tent glamping tents at Asstro Highland Ciater, West Java, leads to several key conclusions. First, the biomimicry architecture approach at the organism level consists of five research variables: form, construction, material, and function, with form further divided into basic shape, size/dimension, color, and texture. Second, the architectural design adapting this approach is influenced by the organism used as a reference, which can be analyzed through these framework variables. Lastly, the study reveals that the Snail-Tent structure successfully applies biomimicry principles, specifically imitating the snail organism, with a conformity percentage of 60% between the design and the referenced biological form. These findings highlight the potential of biomimicry in sustainable architectural innovations.

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