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### THE BIOMORPHIC AND BIOPHILIC DESIGN APPROACHES IN REBUILDING PLACE OF HERITAGE SHOPHOUSES

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#### *Abstract*

Heritage shophouses are embedded with unique values such as historical, architectural and cultural values with a strong sense of place. These buildings are known to have many different architectural designs which are based on the natural elements, shapes, and forms known as biomorphic design, and embedded with multi-cultural beliefs. Biomorphic design relates to the forms and patterns inspired by nature. The implication of natural elements in the architecture is beneficial for the well-being of the human. Reconnection of human with the nature can be achieved through the application of biophilic and biomorphic design. There are 14 design patterns in biophilic and classified as Nature in the Space, follows by Natural Analogs as well as Nature of the Space. In the built environment context, these patterns are encouraged to be applied due to the importance in enhancing the quality of life. Hence, this paper aims to analyse the heritage shophouses architecture in the of George Town by using the 14 biophilic design patterns. Five contemporary cafés the Special Zone in this city were selected in this study as they demonstrate the closest forms of biomorphic and biophilic design approaches. Qualitative method was used to obtain the data in the form of building observation and visual and architectural documentation. The results showed that only one heritage shophouse complies the most biomorphic and biophilic design patterns, which can be applied as elements to rebuilding place in shophouses emphasising the occupants' well-being.

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**Keywords:** Biomorphic, biophilic, heritage, shophouse, rebuilding place.



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## 1. Introduction

As a former British trading port, Francis Light listed the settlers on Penang Island according to the ethnic groups, i.e. such as the Southern Chinese, native Malays, Siamese and Burmese, Arab, European, and Bugis. Their cultural and living style markedly influence to the architectural of George Town's landscape. Due to its distinctive cultural and architectural influences, this city was granted the UNESCO World Heritage Site status in 2008 with three statements of the Outstanding Universal Value (OUV) of Criteria (ii), follows by Criteria (iii), Criteria (iv). Penang was ranked in the 8<sup>th</sup> place in the liveable cities index in Asia in 2012 and considered as one of the most urbanised states in Malaysia (Hoo, 2019) (Figure 1). Unfortunately, rapid urbanisation has affected the heritage shophouses to be restored and renovated to meet the current lifestyle and socio-economic needs. The complexity of heritage conservation must comply to the local council's regulations and guidelines. This will affect the plan submission and construction time frame, high cost of materials and skilled labours (Zubir, Hao, Hussain, & Isip, 2018). This becomes a dilemma for the owners to continue their family legacies or to sell to the investors (Loh, 2016). In order to be economical and feasible from the business point of view, the investors will conduct the minimal renovation rather than to enhance and refurbish the authentic architectural fabrics, including the façade carvings, courtyard, floor, and wall tiles.



**Figure 01.** Penang Island, Year 1960 (Left) and Year 2016 (Right)

Source: Sahari, (2017)

Penang heritage shophouses architecture are embedded with unique value such as natural shapes and motifs on building appearing on façades, five-foot ways for shelter usage, and in courtyard that acts as air-well (Wooi, 2015b). Meanwhile, the well-being and health of the building occupants are affected by the environmental design and in the long-term, the quality of life is affected (Steemers, 2015). Previous researchers have addressed the issue regarding the human emotional needs that strongly connected with the architecture (Hashem, Abbas, Akbar, & Nazgol, 2013; Ulrich et al., 1991). It supports the physiological recovery from stress, creates happiness, reduces negative behavioural patterns, and improves cognition.

The heritage shophouses façade are carved with different motifs, forms and shapes represent the nature and multi-cultural beliefs, thus creating a 'Sense of Place' and enhance human well-being known

as biomorphic design approach. Besides that, the authentic design of heritage shophouses allow human to connect with nature and natural elements such as flora and fauna, water, and wind. Based on Wilson (1984), humans have a tendency to give concern, positive responds, and connect with the nature which is known as biophilia. This concept has been further elaborated by Kellert with the term of ‘biophilic design’ to establish a concept for experiencing nature. Whereby, the architecture is significantly affects human well-being and productivity (Kellert & Calabrese, 2015). Hence, this paper aims to analyse the heritage shophouses architecture in this prestigious site with the biomorphic and biophilic design approaches.

### 1.1. Biophilic design

Nature influences humans’ health in variety of ways. It can improve and maintain air quality, provides nutritious foods, medicinal substances and vitamin D to humans’ skin, agriculture pollination, and vital infrastructure exposure to intense sunlight, strong winds, and sea waves (Roofs & Associates, 2013; Stutte & Kennedy, 2002). On the other hand, there is a sufficient of evidence to indicate that interaction with nature gives a positive advantage to the human well-being. According to Olmsted, (1865), nature has the ability to restore the spirit of those who are dwelling in the urban. This is also agreed by Ulrich (1979) that stress reduction theory (SRT) and nature elements in built environment can counter physiological stress reaction through visual stimuli.

Previous studies have been conducted regarding the possibility of the nature in reviving exhaustive mental concentration based on Kaplan's Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989; Kaplan, 1995). These theories formed the backbone in the current study to explore and experiment the natural elements beneficial to human well-being in built environment (Bringslimark, Hartig, & Patil, 2007; Fjeld, 2000; Kurazumi et al., 2017; Adachi, Rohde, & Kendle, 2000; Larsen, Adams, Deal, Kweon, & Tyler, 1998; Lee, Lee, Park, & Miyazaki, 2015; Shibata & Suzuki, 2001, 2004; White et al., 2010). Recently, a study conducted by Kellert and Calabrese (2015) has created a new framework known as Biophilic Design. It works on the principle of connecting human with nature in architectural design in order to enhance human well-being. This design is categorised into three as listed on Table 1. In detail, there are 14 patterns in total which have to be applied in order to obtain the connectivity between nature and human (refer to Table 1). However, these patterns are not being emphasised yet in Malaysia, particularly in the heritage shophouses context.

**Table 01.** Biophilic design patterns

Categories	Nature in the Space	Natural Analogs	Nature of the Space
<b>Biophilic Design Patterns</b>	P1. Visual Connection with Nature P2. Non-Visual Connection with Nature P3. Non-Rhythmic Sensory Stimuli P4. Thermal and Airflow Variability P5. Presence of Water P6. Dynamic and Diffuse Light P7. Connection with Natural System	P8. Biomorphic Forms and Patterns P9. Material Connection with Nature P10. Complexity and Order	P11. Prospect P12. Refuge P13. Mystery P14. Risk/Peril

## **1.2. Biomorphic design**

In history, natural elements have become a source of inspirational thought on the history of architecture. In architectural term, the biomorphic design relates to the forms and patterns inspired by nature (Agkathidis, 2017; Feuerstein, 2002). When structural forms and natural context are integrated, it creates a harmony (Agkathidis, 2017). Biomorphic design implication is not only the form-related but the inherent qualities of construction as well (Gruber, 2016). Humans feel more comfortable with elements that could decrease stress, 3 per cent reduction with fractal images showing nature (Salingaros, 2012; Taylor, 2006). According to Joye (2007), architectural designs with biomorphic design elements promote fitness, positive feeling and stress reduction. Indeed, the biomorphic design of heritage shophouses is a study to improve the quality of life.

## **2. Problem Statement**

Most of the buildings have been restored or renovated without complying with the local regional's distinctive characteristics. In this city, the shophouses are embedded with unique values such as historical, architectural and cultural values with a strong sense of place. Hence, rebuilding these places with approaches of biomorphic and biophilic will upgrade the currently deteriorated quality of the shophouses.

## **3. Research Questions**

In this study, the research questions are:

- Can biophilic and biomorphic enhance the living conditions of the shophouses?
- Will biophilic and biomorphic approaches be used to rebuild the place of the shophouses?
- What would be the best application of biophilic and biomorphic in rebuilding place of the shophouses?

## **4. Purpose of the Study**

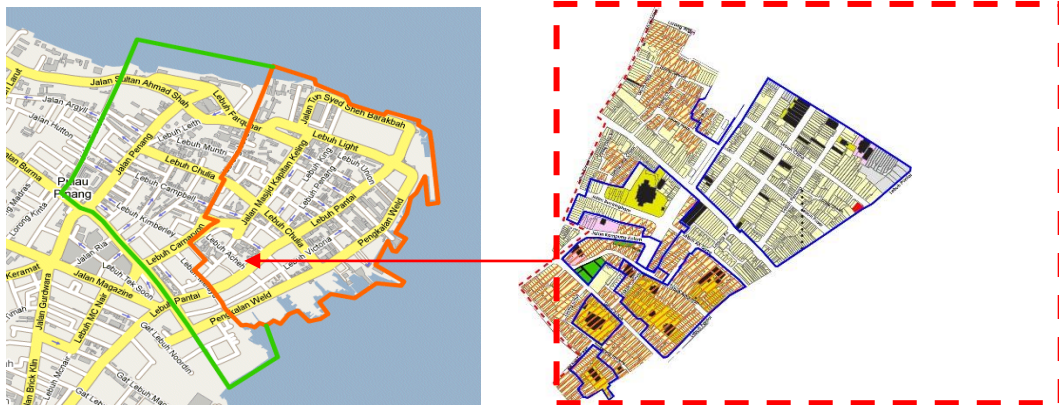
The analysis of the heritage shophouses architecture in George Town heritage site becomes the aim of this study with the biomorphic and biophilic design approaches in rebuilding place.

## **5. Research Methods**

To obtain the objective, qualitative method is applied in this study by using observation and documentation techniques for gathering the data. The data is analysed descriptively based on the site images of the case studies and associate them with the 14 biophilic design patterns in checklist form. In fact, there are total 3,586 of heritage shophouses within the UNESCO World Heritage Site and not every heritage shophouses complies with the heritage conservation guidelines, including the inappropriate and impractical conservation methods.

The case study is selected based on three criteria: (1) the heritage shophouse is located in George Town heritage Special Zone (Figure 2). Special Zone (mixed-use zone) is located inside the Core Zone, it has the highest concentration of Category I Building and with the strictest land use. It involves a complex

layering of cultural, socio-economic, religious and residential morphologies; (2) the proposed case studies have been adaptive reused into a contemporary café; and (3) the original architectural features are well-kept, including the courtyard. Based on the observation conducted, there are a total of 24 contemporary cafés in the Special Zone Area. However, in this paper, five contemporary cafés were selected as the case study as it demonstrates the closest implementation of biomorphic and biophilic design. To prevent any preconception, the case studies were consequently marked as Café A, Café B, Café C, Café D, and Café E.



**Figure 02.** UNESCO World Heritage Special Zone Area

Source: Google Maps, n.d.; Wooi, (2015a)

## 6. Findings

The shophouses studied were deeply observed and documented on its architectural and ornamental elements, including the façade, spatial arrangement, materials embellishments, vegetation and other landscape features. The observation results were listed according to the application of 14 biophilic design patterns and tabulated in Table 2. The result showed that only Café E has the most biophilic design patterns, which is 11 out of 14 patterns. The biomorphic application on Café E was analysed descriptively based on the observation conducted.

**Table 02.** Cafes with biophilic design application

Categories	Biophilic Design Patterns	Café A	Café B	Café C	Café D	Café E
Nature in the Space	P1. Visual Connection with Nature	√	√	√	√	√
	P2. Non-Visual Connection with Nature	-	√	-	√	√
	P3. Non-Rhythmic Sensory Stimuli	-	-	-	-	√
	P4. Thermal and Airflow Variability	-	√	-	√	√
	P5. Presence of Water	-	√	-	√	√
	P6. Dynamic and Diffuse Light	√	√	√	√	√
	P7. Connection with Natural System	-	-	-	√	-
Natural Analogs	P8. Biomorphic Forms and Patterns	√	-	-	-	√
	P9. Material Connection with Nature	√	√	√	√	√
	P10. Complexity and Order	-	-	-	-	√
Nature of the Space	P11. Prospect	√	-	√	-	√
	P12. Refuge	√	-	√	-	-

Categories	Biophilic Design Patterns	Café A	Café B	Café C	Café D	Café E
Nature in the Space	P1. Visual Connection with Nature	√	√	√	√	√
	P2. Non-Visual Connection with Nature	-	√	-	√	√
	P3. Non-Rhythmic Sensory Stimuli	-	-	-	-	√
	P4. Thermal and Airflow Variability	-	√	-	√	√
	P5. Presence of Water	-	√	-	√	√
	P6. Dynamic and Diffuse Light	√	√	√	√	√
	P7. Connection with Natural System	-	-	-	√	-
	P13. Mystery	-	-	-	-	√
	P14. Risk/Peril	-	-	-	-	-

Café E, which has the most patterns, is located on Stewart Lane, George Town, Penang. As illustrated on Figure 3(a), this heritage shophouse is categorised as the Southern Chinese Eclectic Style which was built between the year 1840s to 1910s. There are still many original features which are restored as it was, such as the upper façade. It can be seen from the low brick wall above the bressummer beam, which is sunken and equipped with recessed panel with moulded edges (triple). The original full-width timber louvered shutters, central comb door and solid inner door with two square shutter openings plus air vent were well preserved.



(a) Façade



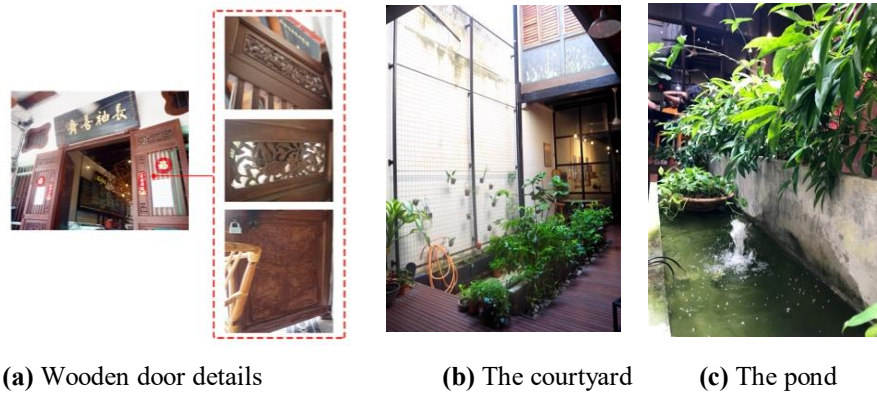
(b) Five-foot walkway



(c) Ceramic majolica tiles

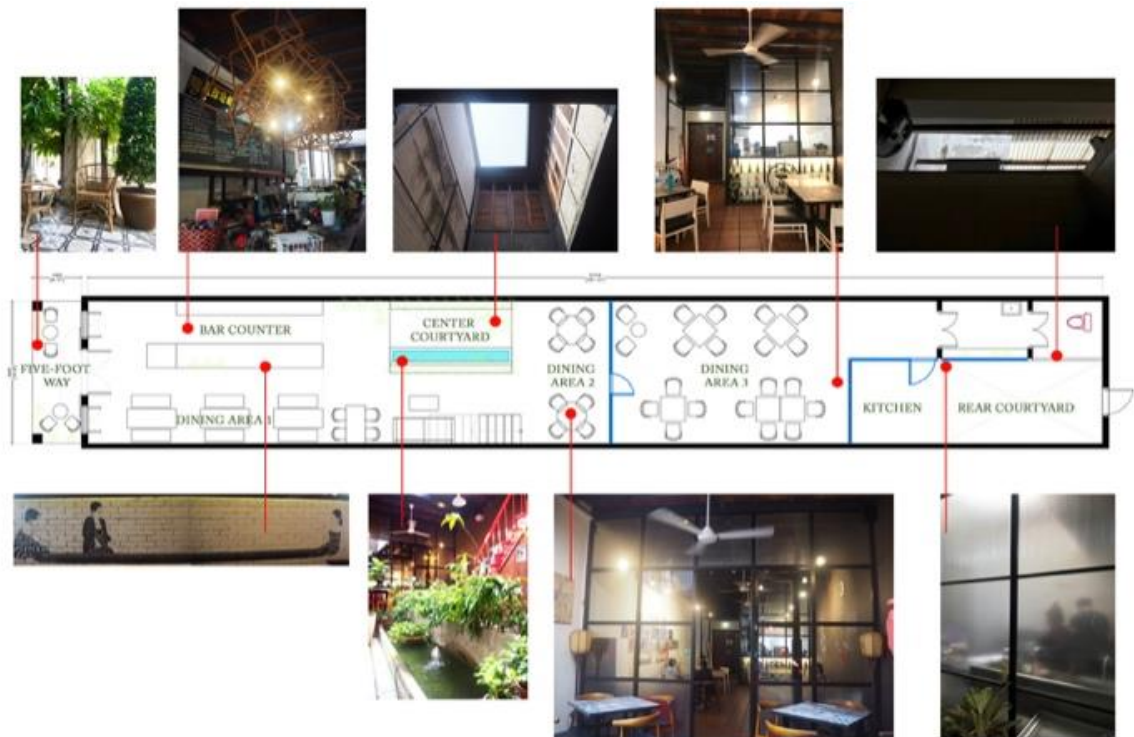
Figure 03. Exterior of the café E

As in Figure 3(a-b), the five-foot way and granite drain bridge were also well-maintained. These observations are supported by a Penang local writer’s statement (Wooi, 2015a). The carving of the central comb door consists of nature motifs such as peony flowers, leaf scrolls, crane, and magpie birds (Figure 4(a)). Based on the Chinese beliefs, these natural motifs bring good fortune, prosperity, and daily happiness (Ming-Yuet, 2009). The ceramic majolica tiles represent floral motifs with vibrant colours (Figure 3 (c)). Evidences show that biomorphic design (biophilic design (P8)) existed in heritage shophouses and indirectly could reduce human stress by shifting focus and enhancing the concentration (Joye, 2006; Ryan, Browning, Clancy, Andrews, & Kallianpurkar, 2014).



**Figure 04.** Interior of the café E

The symmetrical design of the café façade architecture and the fractal geometric pattern of the five-foot way floor finishes create a visual nourishing entrance. This approach helps to stimulate the mind and stress reduction (Browning, Ryan, & Clancy, 2014). On the other hand, environment complexity defined as viewing environmental information to satisfy basic human needs (Kaplan & Kaplan, 1983) (Figure 5). Exploration and fascination of the environment stimulate further positive plans and actions. Based on the layout plan plotted from site data collection, the space direction is clear and open. The different height of ceiling and roof, daylighting effects, and glass panelling have created different ambience adding mystery to the interior space. Human feels safe, exciting, and fascinated to explore deeper into the cafe to search for new vantage points with additional information. Hence, this café has achieved the biophilic design under category (P10), (P11) and (P13).



**Figure 05.** The internal layout of the café E

Besides that, application of greenery was available in five-foot way, interior middle courtyard, and rear courtyard (Figure 5). There is a total of 10 species of ornamental plants, those are Umbrella Tree (*Schefflera actinophylla*), Curtain Fig Tree (*Ficus microcarpa*), Fiddle Fig (*Ficus lyrata*), Mother-in-law's Tongue (*Sansevieria trifasciata*), Dumb Cane (*Dieffenbachia "Exotica Compacta"*), Boston Fern (*Nephrolepis obliterated*), Money Plants (*Epipremnum aureum*), Philodendron (*Philodendron oxycardium*), Chinese Evergreen (*Aglaonema 'Dud Unyamanae'*), and Gold Dust Dracaena (*Dracaena surculosa*). These greeneries are not only enhancing the aesthetic value but also adding dramatic shadows, act as sun-shading feature, air purifier, and as a component to cool down the air temperature.

The arrangement of the interior layout allows visual connection with nature (Figure 6). Based on the observation conducted during the lunch hour, the dining tables that are surrounded by the greeneries are more preferred by the customers (Figure 6). This contribution reinforces the biophilic design **(P1)**. Secondly, there is water feature in the centre courtyard and creating tranquillity with visual and auditory sound for the interior space (Figure 5). As mentioned by White et al. (2010), the presence of water features has greater restoration level than only greenery. With this, biophilic designs **(P2)** and **(P5)** have been achieved.



**Figure 06.** Visual connection with the nature

In addition, this café uses a ceiling fan to increase the air movement instead of using air conditioning device. The centre courtyard remained as it was. Moreover, the ceiling height is 4 metres high and this air-well allows the warm air to escape. Hence, the cooling effect from the airflow variability becomes more effective resulting a comfortable indoor thermal comfort (Omar & Syed-Fadzil, 2011). The natural process of cooling in heritage shophouses become a component to reduce human stress level (Willem & Tham, 2005), and improve cognitive performance and emotional states (Hartig, Evans, Jamner, Davis, & Gärling, 2003; Parkinson, de Dear, & Candido, 2012). With this, biophilic design **(P4)** is achieved in this café.

The openings such as main door, windows, courtyards (centre and rear) allow sufficient daylighting to enter the interior (Figure 7.0). Daylighting brings sense of openness and freedom, giving positive effects on human psychological and physiological, therefore, biophilic design **(P6)** is achieved. Hence, humans will shift their visual perception toward other thing in short visual focus to relax and regain their focus, known as Non-Rhythmic Sensory Stimuli; Biophilic Design **(P3)**.



According to Ryan (2015), the surrounding natural elements such as interesting daylight's casting shadow, water features with sound, movement, and foliage plants colours bring positive affect towards human's physiology. Natural materials, such as timber, rattan, terracotta tiles and granite stones finishes can be observed in the café (Figure 6). Based on the biophilic design (P9), natural material gives positive effect on physiology response and cognition (Tsunetsugu, Miyazaki, & Sato, 2007).

## 7. Conclusion

The architecture of the selected heritage shophouses have been analysed through biophilic design patterns and biomorphic design approach. By defining these approaches, only one out of five heritage shophouses studied provide a total of 11 out of 14 biophilic design patterns. The result of this study shows that a well-adaptive reused heritage shophouse demonstrates a successful biophilic design by giving a positive impact on human cognition, psychology and physiology. Although the buildings have been adaptively reused into modern properties, the application of biophilic and biomorphic must be maintained according to the conservation guidelines. Hence, building owners, tenants, investors, local councils, and construction professionals could utilise these above approaches to incorporate them into these environments, as a component to rebuild a habitable place in George Town UNESCO World Heritage Site that could improve human well-being, which is a crucial element to human survival.

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