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### BIOPHILIC DESIGN AND PLANTS APPLICATION IN REBUILDING *KAKI LIMA* OF HERITAGE SHOPHOUSES

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#### *Abstract*

The *kaki lima* or five-foot way is one of the strong architectural characters to shape the identity of George Town World Heritage Site (WHS) heritage shophouses. It is a constantly passageway that links the heritage shophouses frontage to shelter users from hot humid tropical climate. However, it is undeniable that aggressive development to fulfil the demand of modern lifestyles have caused *kaki lima* to be obstructed by man-made structures. It has lost its original uniqueness and functionality. Recent researches on biophilic design stating that this feature can enhance human well-being and support social cohesion by applying plants into built-up environment. This paper is to analyse the biophilic design patterns and types of plant application in *kaki lima* that can be used to revive a liveable space for the city and the country. Observation and documentation of the *kaki lima* was conducted on several shophouses in core zone of George Town, Penang to analyse the biophilic design patterns and type of plants most applicability and suitability. The results of the studies come to surmise that biophilic design patterns and plants are the crucial elements to rebuild a liveable *kaki lima* in World Heritage Site (WHS).

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**Keywords:** Five-foot way, *kaki lima*, biophilic design, plants, heritage shophouses.



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## 1. Introduction

George Town, Penang, Malaysia was well-known as a trading port since 17<sup>th</sup> century and it attracted traders from all around the world. Hence, a unique townscape evolved with the mixture of ethnics' architecture, culture, and belief. As a result, George Town was listed as one of UNESCO's World Heritage Site (WHS) since 2008. Most of the heritage buildings, especially the heritage shophouses of George Town have the most cultural heritage values inherited from their ancestors many generations ago. George Town heritage shophouses are divided into six different styles; Early 'Penang' Style (1790s - 1850s), 'Southern Chinese' Eclectic Style (1840s - 1900s), Early 'Straits' Eclectic Style (1890s - 1910s), Late 'Straits' Eclectic Style (1910s -1940s), Art Deco Style (1930s -1960s) or Early Modernism Style (1950s -1970s) (Wooi, 2015). One of the strongest architecture characteristics can be found in six different heritage shophouses style is *kaki lima* or five-foot way. The corridor named as *kaki lima* in local Malay language, which is common language among local inhabitants including Chinese, Javanese, Bugis and so on. In Penang, *kaki lima* also known as five-foot way in local English, and 'Ngo-Ka-Ki' in local Fukien dialect. The definition of *kaki lima* is a space but not the width of space (Izumida, 2005).

According to (Wooi, 2015), *kaki lima* in George Town is where buildings are set back from the street edge at the ground floor by several feet to provide a sheltered walkway by projecting out a single-storey roof in front of the main façade. It creates a colonnade that links to the *kaki lima* along a row of heritage shophouses. Chinese immigrants built various stalls selling cigarettes, foods and beverages in *kaki lima* (Izumida, 2005). The *kaki lima* in George Town, Penang belongs to heritage shophouse owners and not to the local authority's jurisdiction. Due to the costly maintenance of heritage shophouses, majority of the owners sell their inheritance of shophouses to investors. Hence, most of the *kaki lima* has been fenced up, bricked up and partitioned up to cater for the new urban lifestyle. *kaki lima* becomes a private and quite space, yet lost the original purpose as public pedestrians covered walkway and community space (Figure 1). On the other hand, the usage of impermeable surface materials and heavy motorised vehicles as well as higher concentration of urban pollutants contribute to Urban Heat Island (UHI) phenomenon (Ramakreshnan et al., 2018). The overexposure to man-made built-up environment brings negative impacts such as, tension, anxiety, impatience, irritability, and mood disorder (Olmsted, 1865). According to (Sabah & Samad, 2015), a massive urbanisation leads to fading heritage character, lost its vitality and livability because of visual pollution which eventually affects human well-being. Hence, the alteration of *kaki lima* is not only affecting the aesthetical value of heritage architecture but also seriously impacts the 'Sense of Place', human's well-being, and quality of life in the city.



**Figure 01.** *Kaki lima* blocked-out with impermeable materials

Studies showed that application of greenery in urban areas can rejuvenate human well-being in term of psychology, physiology, and cognition. A sufficient of studies have shown significant results human connects with nature can improve human well-being. This relationship can be rebuilt in built up environment through Biophilic Design (Kellert, 2008). Besides that, Malaysian communities such as Malay, Chinese and Indian have a rich and well-documented tradition of using greenery for daily usage such as dietary (food consumption), construction materials, medicinal, dyes and cosmetics, and ritual is abundant (Adnan & Othman, 2012). Hence, this study is to analyse Biophilic Design patterns and greenery application that are the most suitable to revive *kaki lima* into more liveable environment for local communities.

## 2. Problem Statement

Improper alteration of *kaki lima* due to the rapid urbanisation leads to fading heritage character, lost its vitality and livability because of visual pollution, usage of impermeable surface materials and heavy motorised vehicles which eventually affects human well-being. Hence, the alteration of *kaki lima* is not only affecting the aesthetical value of heritage architecture but also seriously impacts the ‘Sense of Place’, human’s health, and quality of life in the city. Studies showed that connection between human and greenery in urban areas can rejuvenate human well-being in term of psychology, physiology, and cognition known as Biophilic Design (Kellert, 2008). However, most of the Biophilic Design application is based on Western culture and environment. There is no study on application of Biophilic Design in Malaysia especially in UNESCO World Heritage Site. In addition, most of the previous study were based on Western available plants but not Malaysia local plants.

## 3. Research Questions

- Is Biophilic Design Patterns applicable in *kaki lima*?
- Which Biophilic Design Patterns is the most suitable application in *kaki lima*?
- Is greenery application in *kaki lima*?
- Which kind of greenery is the most suitable application in *kaki lima*?

## 4. Purpose of the Study

This study was conducted to analyse the biophilic design patterns and types of plant application in *kaki lima*

## 5. Research Methods

This study was held in George Town World Heritage Site (WHS), Penang Malaysia because it is an island which has the higher Urban Heat Island (UHI) compare to the mainland (Figure 2a). George Town is divided into two zones; core zone (109.38 hectares) and buffer zone (150.04 hectares) (Figure 2b). Core zone was selected in this study because it was well-kept and has the most adaptive reuse of heritage shophouses. Qualitative method is used by observation and documentation to collect data of *kaki lima*.

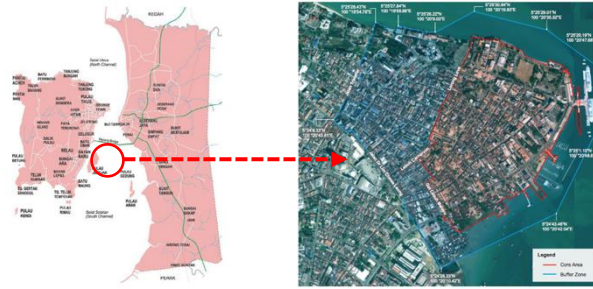


Figure 2a

Figure 2b

**Figure 02.** Penang map and George Town World Heritage Site (WHS) core zone and buffer zone

Source: (Anonymous, 2016)

## 6. Findings

Based on the data collection, there are different types of natural elements found in *kaki lima*. The data collection is divided into two categories for analysis; Plants and Biophilic Design

### 6.1. Plants

There are different types and categories of plants grown in *kaki lima*. Plants are categorised into climbers, ferns and allies, shrubs, cycade and palms, and trees. In these categories, plants can be divided into ornamental plants, herbaceous plants, medicinal plants, fruits plants, and vegetation plants. Based on the site observations, the list of plants in *kaki lima* are being noted listed (Table 1).

**Table 01.** List of Plants in *kaki lima*

| Plants Categories                 | Ornamental Plants | Herbaceous Plants | Medicinal Plants | Fruits Plants | Vegetation Plants |
|-----------------------------------|-------------------|-------------------|------------------|---------------|-------------------|
| <b>A. Climbers:</b>               |                   |                   |                  |               |                   |
| 1. <i>Epipremnum aureum</i>       | /                 |                   |                  |               |                   |
| 2. <i>Clitoria ternatea</i>       | /                 | /                 | /                |               |                   |
| 3. <i>Monstera deliciosa</i>      | /                 |                   |                  |               |                   |
| 4. <i>Bougainvillea</i>           | /                 |                   |                  |               |                   |
| <b>B. Ferns and Allies:</b>       |                   |                   |                  |               |                   |
| 1. <i>Asplenium nidus</i>         | /                 |                   |                  |               |                   |
| 2. <i>Nephrolepis exaltata</i>    | /                 |                   |                  |               |                   |
| <b>C. Shrubs:</b>                 |                   |                   |                  |               |                   |
| 1. <i>Dud Unyamanea</i>           | /                 |                   |                  |               |                   |
| 2. <i>Dracaena surculosa</i>      | /                 |                   |                  |               |                   |
| 3. <i>Catharanthus roseus</i>     | /                 |                   | /                |               |                   |
| 4. <i>Plectranthus amboinicus</i> | /                 |                   | /                |               |                   |
| 5. <i>Aloe vera</i>               | /                 | /                 | /                |               |                   |
| 6. <i>Sansevieria trifasciata</i> | /                 |                   |                  |               |                   |
| 7. <i>Pandanus amaryllifolius</i> | /                 | /                 | /                |               |                   |
| 8. <i>Citrus hystrix</i>          |                   | /                 | /                | /             | /                 |
| 9. <i>Citrus microcarpa</i>       |                   |                   |                  | /             |                   |
| 10. <i>Draceana marginata</i>     | /                 |                   |                  |               |                   |
| 11. <i>Zamioculcas zamiifolia</i> | /                 |                   |                  |               |                   |
| 12. <i>Bambusa multiplex</i>      | /                 |                   |                  |               |                   |
| 13. <i>Pistia stratiotes</i>      | /                 |                   |                  |               |                   |
| 14. <i>Ixora</i>                  | /                 |                   |                  |               |                   |
| 15. <i>Heliconia psittacorum</i>  | /                 |                   |                  |               |                   |

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 16. <i>Calathea makoyana</i>                | / |   |   |   |   |
| 17. <i>Codiaeum variegatum</i><br>cultivars | / |   |   |   |   |
| 18. <i>Aglaonema crispum</i>                | / |   |   |   |   |
| 19. <i>Costus woodsonii</i>                 | / |   |   |   |   |
| 20. <i>Schefflera arboricola</i>            | / |   |   |   |   |
| 21. <i>Monachoria elata</i>                 | / |   |   |   |   |
| 22. <i>Caladium bicolor</i>                 | / |   |   |   |   |
| 23. <i>Alocasia x amazonica</i>             | / | / |   |   |   |
| 24. <i>Ruellia simplex</i>                  |   |   |   |   | / |
| 25. <i>Eryngium foetidum</i>                |   |   |   |   |   |
| 26. <i>Lactuca indica</i>                   | / |   |   |   |   |
| 27. <i>Bromeliaceae</i>                     |   |   |   |   |   |
| <b>D. Cycade and Palms:</b>                 |   |   |   |   |   |
| 1. <i>Dypsis lutescens</i>                  | / |   |   |   |   |
| 2. <i>Livistonia chinensis</i>              | / |   |   |   |   |
| 3. <i>Chamaedorea elegans</i>               | / |   |   |   |   |
| <b>E. Trees:</b>                            |   |   |   |   |   |
| 1. <i>Ficus lyrata</i>                      | / |   |   |   |   |
| 2. <i>Ficus robusta</i>                     | / |   |   |   |   |
| 3. <i>Ravenala madagascariensis</i>         | / |   |   |   |   |
| 4. <i>Carica papaya</i>                     |   |   | / | / |   |
| 5. <i>Podocarpus macrophyllus</i>           | / |   |   |   |   |
| 6. <i>Plumeria rubra cultivars</i>          | / |   |   |   |   |

There are a total of 42 species of plants that can be found in *kaki lima* with 4 types of climbers, 2 types of ferns, 27 types of shrubs, 3 types of palms and 6 types of trees. 70% of the plants are found in contemporary café *kaki lima* and the rest are at convenient stores, souvenir shops, boutique hotel, and residents' heritage shophouses (Figure 3). Based on the plants' list, there are a total of 10 types of multi-purpose plants (Adnan & Othman, 2012). According to discussions with shophouse owners, the plant, *Clitoria ternatea* has a vibrant blue color. It is widely use as natural color dye for local drink and food (Muhammad Ezzudin & Rabeta, 2018). For instance, it is used in Nyonya glutinous rice dumpling, Nyonya 'kuih'(dessert), and 'nasi kerabu' blue.



**Figure 03.** Existing plants in heritage shophouses *kaki lima*

Besides that, it also has medicinal effect such as anti-pyretic, analgesic and anti-inflammatory. *Plectranthus amboinicus* leaves are used for several medicinal purposes (Arumugam, Swamy, & Sinniah, 2016). Aloe vera is a worldwide well-known medicinal plant. Extraction of *Aloe vera* can be used as skin healer (irritation, burned, itching, insects bite and swelling), beauty (slower down appearance of wrinkles), immune-boosting, improve digestion, and contains large range of vitamins (Rajeswari et al., 2012). *Pandanus amaryllifolius* plant used as a flavouring agent for rice, desserts and bread recipe because of its

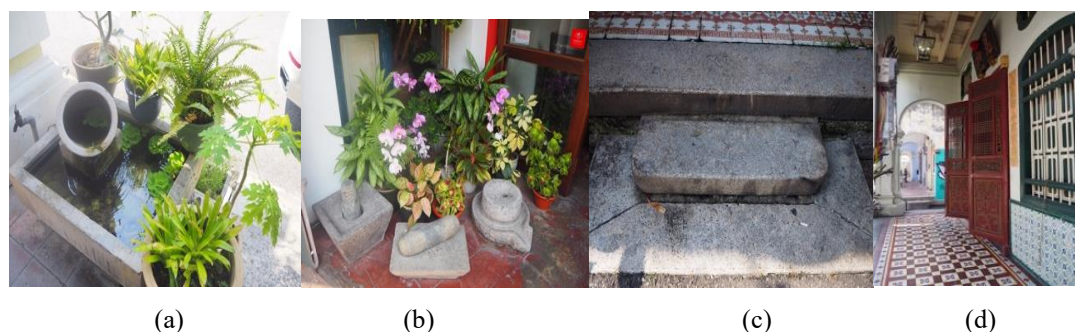
aromatic fragrance (Nor, Mohamed, Idris, & Ismail, 2008) Besides, *Citrus hystrix* (Kaffir lime) plant used as cooking and marinade ingredients, drink ingredient which promotes gum health, natural shampoo, aromatherapeutic agent, mosquito repellent, and antimicrobial activities (Chaisawadi, Thongbutr, & Kulamai, 2008) *Citrus microcarpa* (Calamansi) fruits as a remedy for cough, antiphlogistic, and itching. In addition, it also used for food and beverages, natural shampoo, and bleaching agent (Alinejhad, Asayesh, & Asayesh, 2016). There are two edible plants *Eryngium foetidum* and *Lactuca indica*, which are very rare grown in heritage shophouses. Only one heritage shophouse has these two plants on Beach Street. *Eryngium foetidum* is a type of wild coriander and *Lactuca indica* is a type of vegetation with a little bitterness in taste and normally consume fresh as salad or garnishing according to the owner. *Carica papaya* is the common plant that can be found easily in Malaysia. Its ripe or unripe fruit, leaves, and seeds can be consumed and used as a traditional medicine for wound-healing, anti-fungal, anti-bacterial, anti-tumor, anti-fertility, Diuretic, and Uterotonic (Milind, 2011). *Catharanthus roseus* is the famous medicinal plants extraction for cancer treatment (Nisar, Mamat, Irfan, Mohamed, & Ahmad, 2016) Hence, these multi-purpose plants bring positive impacts towards human health. Ethno Botanic Garden (Adnan & Othman, 2012) bring positive effects to owners' health when they are doing gardening activities. It improves mental health, stress reduction and attentive cognition can be pro-long in the meanwhile it also increase social connection and promote social health (Schmutz, Lennartsson, Williams, Devereaux, & Davies, 2014) Based on the plants list (Table 1), there are a total of 9 species are air purifier plants (A.1, B.2, C.5, C.6, C.16, C.20, D.1, E.1, and E.2) (Wolverton, 1996). Besides that, the different layers of plants can reduce the strong sunshine and temperature of the *kaki lima* and supported by researches (Qin et al., 2014). According to (Thani & Al Junid, 2014), plants acts as passive cooling component through shading and evapotranspiration mechanism.

## 6.2. Biophilic Design

Based on the observation, water features are used as display elements in the *kaki lima* (Figure 4a). The existence of water features enhances the biophilic experience of *kaki lima* through sight, hearing experiencing the feel of water, which is Biophilic design patterns – Visual connection with nature (**P1**), Non-visual connection with nature (**P2**), and Presence of Water (**P5**) (Kellert & Calabrese, 2015). An environment contains water features bring positive influence to human psycho-physiology (Alvarsson, Wiens, & Nilsson, 2010; Biederman & Vessel, 2006; White et al., 2010) . In addition, the different height, type, and shape of plants give effects of shading, reduce the surrounding heat, and reduce wind speed almost by 50% compared to open space (Dussadee, Ramaraj, & Sutassanamarlee, 2018). Hence, plants create 'soft fascination' such as light breeze, comfortable and cooling *kaki lima* for users to use (P4) (P6). Biophilic design patterns (**P3**) and (**P7**) are absent because of no stochastic movement and no natural processes especially seasonal are observed in *kaki lima* (Browning, Ryan, & Clancy, 2014)

The natural granite stone bridge, stone mortar and pestle can be found on the floor in *kaki lima* (Figure 4b and 4c). Timber finished structure can be found in the exposed beams above the ceiling, timber doors, window, and air-vents (Figure 4d) (Wooi, 2015). Besides that, the existing floor and wall tiles with vibrant colours gives a vivid imagination of a garden full of flowers in blossom on the ground (**P8**) (Figure 4d). The Material Connection with Nature (**P9**) reflects the local culture and 'Sense of Place' (Browning et al., 2014). These Biophilic design pattern stimulate human emotion and cognitive performance

(Tsunetsugu, Miyazaki, & Sato, 2007). Biophilic design patterns of (P10), (P11), (P12), (P13), and (P14) require a macro scale to measure (Ryan, Browning, Clancy, Andrews, & Kallianpurkar, 2014)



**Figure 04.** Hardscape in kaki lima

## 7. Conclusion

Biophilic design patterns of (P1), (P2), (P4), (P5), (P6), (P8), and (P9) can be found as the most suitable module to revive *kaki lima*. There are a total of 10 multi-purpose plants and 9 air purifier plants found in *kaki lima* which are the most sustainable and enduring types. Based on the result, the presence of biophilic design patterns and greenery can enhance aesthetical value of *kaki lima*, ‘Sense of Place’, human well-being, and quality of life. Owners who are maintaining the plants, not only enhance their physical health but also creating garden activities in *kaki lima*. However, the usage of local multi-purpose plants in *kaki lima* is still minimal even though it preserves the integrity of the local culture and at the same time is preserving local knowledge and heritage. As a consequence, further study is needed to strengthen the concept. In a nutshell, the implementation of biophilic design patterns and greenery applications are crucial elements in creating new liveable *kaki lima* in George Town World Heritage Site (WHS) for local communities to use as a garden activities, enjoyment and fascination away from the hectic urban lifestyle.

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