BIOPHILIC DESIGN IN HERITAGE INDOOR CO-WORKING SPACE IN GEORGE TOWN, PENANG, MALAYSIA

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ABSTRACT

Modern lifestyles do influence Malaysian occupants to work long hours in a day in order to cope with large workloads and to meet a deadline. Majority of the occupants are overstressed, faced with negative emotions that lead to an unhealthy lifestyle. Studies show that nature is able to enhance human well-being by reconnecting human with natural elements in a built environment, which is known as biophilic design. Therefore, this study aims to create a biophilic design guideline to enhance occupants' well-being in heritage adaptive reuse indoor co-working space. This study is conducted in the Heritage World Site (WHS) in George Town, Penang. Mixed method research design was used to collect data from the site. Both qualitative and quantitative data were analysed using the triangulation method to validate the overall data and research by cross verifying the information from multiple methods to gather the data. The results proved that the existing biophilic design patterns do enhance co-workers' emotional well-being significantlyand it can be used as design guideline. In addition, this study also investigated different ways of biophilic design patterns application which can affect the quality of biophilic experiences.

Keywords: *Biophilic design, Heritage indoor, Co-working space, Human well-being*

INTRODUCTION

Background

Penang is listed in the UNESCO World Heritage Site (WHS) since 2008. The heritage buildings are being protected under the National Heritage Act 2005. Any form of conservation works must obtain approval from the Penang local authority. This is to maintain the Outstanding Universal Values (OUVs) as the World Heritage Site status. Majority of the heritage buildings in Penang have been adaptively reused in order to keep it occupied and to accommodate the current lifestyle. This continuous adaptive reuse practice has evolved and conditioned the indoor space to be an unhealthy environment, especially for a co-working space.

Malaysian occupants work an average of 15 hours a day, which exceeded their contracted hours, and has surpassed Singapore, Hong Kong and Australia (Fong, 2017). Studies indicated that majority of the occupants were unhappy with the current working culture where they are required to work extended hours and cope with large workloads while simultaneously meeting production targets and deadlines (Konz & Rys, 2002; Townley, 2000). Occupants' psychology in the workspace today is worse than what was experienced by the past generation (Minter, 1999). When an individual feels stress, his/her psychological, and behavioural will be detracted (Beehr & Newman, 1978; Sutton & Rafaeli, 1987). A newly-released workspace survey conducted by AIA Vitality found that 53% of Malaysian employees are overworked, stressed, negatively emotional, and lead to less concentration and productivity, high level of depression, anxiety, absenteeism, presenteeism, and violence (AIA Vitality, 2017).

Besides, physical work environment has highlighted a concern to promote a healthy workspace to enhance occupants' well-being in term of psychology. Occupant's well-being is an essential element to determine a successful business and country economics. When workers are stressed, they will face a high level of anxiety, depression, presenteeism, and absenteeism. These negative impacts will cause occupants to become less productive, improper behaviour, become violence, and suicide possibility is likely to become higher. A worker's psychology is an indication of his/her environment (Piko, 2006).

To enhance human well-being, nature is the key. Over the millennia, human beings start to evolve and connect with nature. Human has a genetic predisposition for responding to nature positively (Appleton, 1975; Kaplan, 1988; Orians & Heerwagen, 1992; Ulrich et al., 1991). Empirical studies proved nature brings positive impacts on occupants' well-being. There are a growing number of research groups using experimental or quasi-experimental research designs to test the effect of nature on occupants in many factors such as productivity, stress, and discomfort symptoms, mood, emotions, job satisfaction and attitude toward indoor workplace (Adachi, Rohde, & Kendle, 2000; Bringslimark, Hartig, & Patil, 2007; Chang & Chen, 2005; Lohr, Pearsons-Mims, & Goodwin, 1996; Shibata & Suzuki, 2004). Therefore, in order to enhance occupants' well-being in an adaptive reuse of heritage indoor co-working space, the relationship between occupants, nature is an essential aspect to be re-established. This can be established using biophilic design. Biophilic design is the term used to translate an understanding of the inherent human affinity into the design of modern built environment (Kellert, 2008).

Aim of the study

The aim of this study is to create a biophilic design guideline to enhance occupants' well-being in an adaptive reuse of heritage indoor co-working space.

Objectives of the study

The objective of this study is to examine and analyse biophilic design patterns in heritage indoor co-working space.

LITERATURE REVIEW

Adaptive Reuse Heritage Building

Heritage buildings are the legacy left from the past and they also represent the cultural history and need to be conserved for the next generation (UNESCO, 1972). As stated in Malaysia National Heritage Act 2005, buildings that are 50 years old and above are categorised as heritage buildings. Those buildings are to be preserved, protected, and

enhanced. One of the conservation methods that promotes sustainability is by implementing adaptive reuse heritage buildings. Adaptive reuse can be defined as modifying a place to suit the existing use and compatible in uses, which involves no change to the culturally significant fabric, changes which are significantly reversible, or changes with minimal impact (Charter, 2013). Adaptive reuse heritage building saves energy and resources, reduces new construction, and retains the identity of the local communities (Rashid & Abdullah, 2015)

Rapid urbanisation of the town area and lack of greenery have caused air pollution and escalated the Urban Heat Island (UHI) level especially in Penang Island, Malaysia. This indirectly caused most of the heritage buildings to be enclosed for air-conditioner usage. Human spends more than 90% times in indoor space. The indoor environment is an essential determinant of human well-being. However, the study on human well-being in adaptive reuse heritage indoor space is sparse.

Co-working Space

A report shows that co-working spaces are mushrooming in Asia and currently take up 1% to 5% of total office stock and are foreseen to increase between 20% to 30% by 2030 (Bouncken, Clauß, & Reuschl, 2016; Kay, 2016). Co-working spaces particularly have risen and increased in Asian countries because of the culture such as collectivism, high-context communication, and institutional contexts in Asia. They are given an environment for resources sharing (working desks, printer, meeting rooms, pantry, and Wi-Fi connection) and community (daily routine, social environment and sense of community). Therefore, the indoor built environment is an important element to be considered to enhance the co-workers' well-being and satisfaction.

Biophilic Design

Nature is not only important for physical but also bring positive impacts on human well-being through passive interaction with nature. One of the most investigated aspects is human productivity and supports recovery from mental fatigue (Bringslimark et al., 2007; Larsen, Adams, Deal, Kweon, & Tyler, 1998; Lohr et al., 1996; Shibata & Suzuki, 2001,

2002, 2004). In addition, some studies have investigated that nature is able to reduce stress and discomfort symptoms and improve human mood and emotions (Bringslimark et al., 2007; Lohr et al., 1996; Adachi et al., 2000; Chang & Chen, 2005). Patients in a hospital with plants showed significant impact of well-being resulted in shorter hospitalisation periods, fewer intakes of analgesics, lower ratings of pain, anxiety, and fatigue, more positive feelings and higher satisfaction of their rooms in the hospital.

Biophilia is defined as "the innate tendency to focus on life and lifelike processes" (Wilson, 1984). Kellert (2008) hypothesised nourishment of this innate human connection with nature is important for modern urban human well-being. Biophilic design is to re-establish the relationship between innate human with nature in a built environment. Biophilic design can be studied by using biophilic design patterns. It has evolved from Kellert and originally was with 70 biophilic design attributes the then merged into 14 biophilic design patterns by Browning and his colleagues (Browning, Ryan, & Clancy, 2014a). The 14 biophilic design patterns were divided into 3 categories as shown in Table 1.

Table 1: 14 Biophilic Design Patterns

Categories	Biophilic Design Patterns
Nature in the Space	P1. Visual Connection with Nseature
	P2. Non-Visual Connection with Nature
	P3. Non-Rhythmic Sensory Stimuli
	P4. Thermal and Airflow Variability
	P5. Presence of Water
	P6. Dynamic & 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
	P13. Mystery
	P14. Risk/Peril

(Source: Browning et al., 2014)

Based on the information in Table 1, nature in the Space defines the application of natural elements into the designed indoor space to create a biophilic environment. Natural Analogues indicate a designed feature that is related to nature aspects such as ornamentation, use of natural materials, and biomorphic forms. Natural imagery indicates symbolic value – for example, water element that represents wealth in Chinese belief. Nature of the Space indicates exploring human response to various spatial patterns of the built environment space. However, previous research studies only concentrated on one element pattern.

METHODOLOGY

Site Parameter

George Town in Penang, Malaysia was selected as the site parameter based on the report from UNESCO site where it faces more negative impacts due to rapid urbanisation compared to other UNESCO sites on the mainland. George Town is divided into two zones, which are the core zone and buffer zone. George Town core zone (109.38 ha.) was selected for this case study because the heritage architecture in the core zone is well-kept if compared to the buffer zone. Core zone is divided into eight different zones (Figure 1); Financial Zone, Waterfront Zone, Special Zone, Open Space/Green Zone, Jetty Zone, and Trade Zone, Institution Zone, and Place of Worship. The financial zone has the most indoor workplaces such as banks, co-working space, law firms, finances firms, and government office whereas occupants have the highest level of stress and negative emotions. However, due to private and confidential issue, special zone is selected as the site because most of the category I buildings are in this zone and are well-kept with the highest tourist concentration area. In addition, co-working space selected has to be an adaptive reuse heritage building.

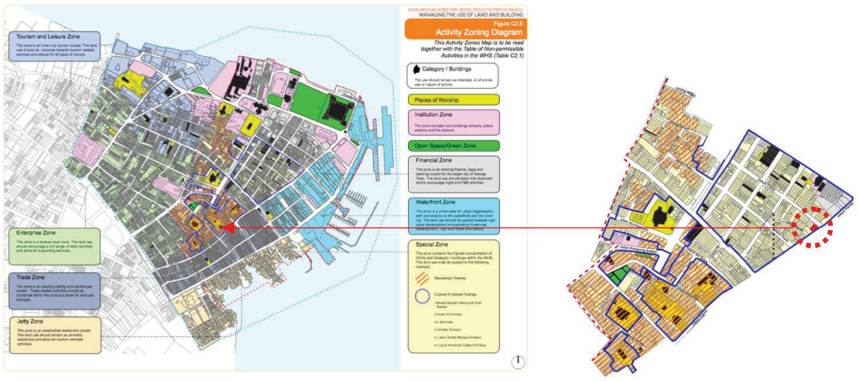

Figure 1: Heritage Zone Plan

(Source: GWTHI, 2013)

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Sampling Selection

The selective co-working space was based on 3 criterias: 1) It has to be a cross-disciplinary unit with different careers; 2) The occupants must work at least 8 hours per day; 3) The workspace is an adaptive reuse heritage commercial building.

Data Collection

This study was conducted in two phases. Firstly, it involved site observation and documentation. The existing architectural of the heritage building and interior layout of the co-workers' space were observed by taking photos and illustrated by using AutoCAD. In order to observe the relationship between occupants with biophilic design patterns, the observation was conducted during working hours. The second phase was the

questionnaire with projection technique. The questionnaire was conducted on selected occupants who worked for a minimum of 8 hours per day. A projection technique was used by editing a selected site photo which was taken from the existing site, by using Adobe Photoshop software to add in biophilic design patterns. This questionnaire is categorised into two parts; in the first part, socio-demographic data, including age, number of children, marital status, monthly income, educational level, and years of work experience. The second part of the questionnaire is ZIPERS (Zuckerman, 1977) measuring the emotional states. ZIPERS consists of 12 items and using 5-point scales (1 = Not at all; 2 = Slightly; 3 = Somewhat; 4 = Definitely; 5 = Very much). Questionnaire and edited site photo were given to the selected occupants to fill in.

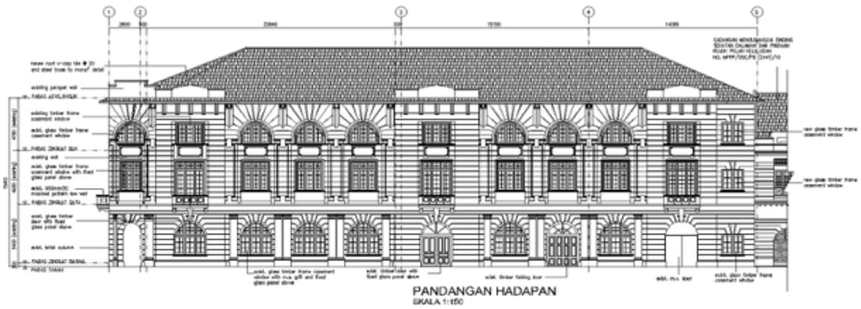
Analysing Tools

In Phase two, Zuckerman Inventory of Personal Reactions (ZIPERS) questionnaire data were analysed using the Statistical Package for the Social Sciences (SPSS). Methodology triangulation method was used to analyse Phase one and Phase two data collection in order to validate and to determine the credibility of the overall data and research by cross verifying the information from multiple methods of data gathering.

FINDINGS

Phase 1 (Observation & Documentation)

Yeap Chor Ee heritage building was built in 1922, was designed by Messrs Stark & McNeil and owned by Mr. Yeap Chow Ee, along China Street Ghaut in World Heritage Site (WHS) core zone in George Town, Penang. The building has served different functions – from warehouses to various of banks (Yeap, n.d.) and today it is adaptively reused as various types of commercial spaces which are café (Ground Floor), Penang Science Cluster Centre (Ground Floor), and co-working space (Second Floor). Co-working space is being selected because it fulfils the site parameter and sampling selection criteria.

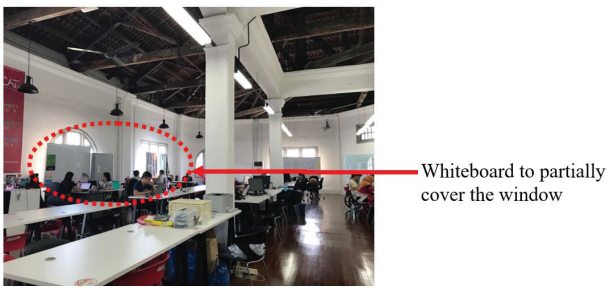


The architecture style is the Art Deco Style (1930s to early 1960s), although Yeap Chor Ee heritage building was built in 1922. It could be proven by the identical art deco style elements such as reinforced concrete structure – beams and columns, clean surfaces, geometric, linear and modern in expression. Its white plain surfaces were highlighted with parallel and bold vertical or horizontal lines and it created sunburst motif on surrounding entrance and windows. There were 'leaf' decoration motifs representing acanthus leaf underneath the first-floor balcony. Acanthus leaf motif can be found in ancient Greek architecture and identified in the capitals of Corinthian orders. The façade of the architectural biomorphic was of the natural forms that have achieved the biophilic design pattern (P8). Natural biomorphic forms created the aesthetic experience and it perceived a strong influence of culture on the way humans see the natural environment (Appleton, 1990). Co-workers of the building could understand the culture and historical of the building indirectly by passive interaction with the building.

(a) **(b)**

In addition, the existing large windows and doors served as security and natural ventilation purposes when it was a warehouse. Today, it

provides sufficient daylighting (P6) into the main atrium staircase, corridor and indoor co-working space. Therefore, the main atrium staircase and corridor's artificial lights are switched off during the day, to save energy and becoming more energy sustainable. On the other hand, passive interaction with natural daylighting can significantly enhance human well-being. According to Kandel et al., (2013), the human body responds to natural lighting transitional colours. Blue light produces serotonin; whereas, the absence of blue light (at night), produces melatonin. The balance of serotonin and melatonin affect human mood, alertness, depression and other health conditions. In the co-working space, there is a combination of artificial light and daylight. Based on the site observation during working hours, the working desks nearby the windows were the most preferable spot for co-workers even though the excessive daylighting through the windows were being block off partially. The second reason was because of biophilic design pattern, Refuge (P12) experience, which achieved partial refuge characteristic with a minimum one side of our surrounding was covered. This can evoke the feeling of protection, private and improved concentration and attention (Browning, Ryan, & Clancy, 2014).

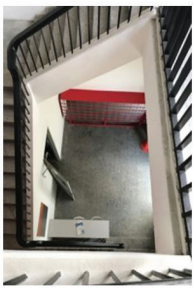


(c)

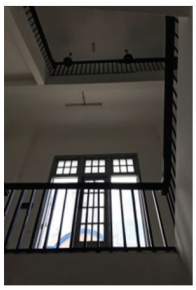
In addition, large windows, doors, and open floor plan of the co-working space without any height divider in between workstation created the biophilic design pattern (P11). Co-workers were able to view the overall space, and feel spacious. The large windows that were surrounding the co-workers' space were closed and the door access was controlled with the card system. These allowed the co-workers to feel safe and secure when working in the space. These statements were supported by Browning, Ryan, and Clancy (2014): 'A strong experience of biophilic design pattern 'Prospect' can be achieved with open and freeing condition, and yet related to sense of

safety and control especially in unfamiliar environment'. Prospect-refuge theory can significantly influence human emotional response in a space by allowing that person to see, but without being seen (Appleton, 1975). For instance, Kaplan and Kaplan (1983) mentioned that an enclosed space will stimulate a feeling of relaxation and safety, while having a view from that space can add levels of excitement.

The main atrium staircase and corridor permitted natural air ventilation (P4) through the opening of windows and balcony door. In the co-working space, the windows were closed and the air ventilation mechanism such as ceiling fan and air cooler stand was operating all the time. Therefore, the biophilic design pattern (P4) experience is weak in the co-working space compared to the common atrium staircase and corridor.



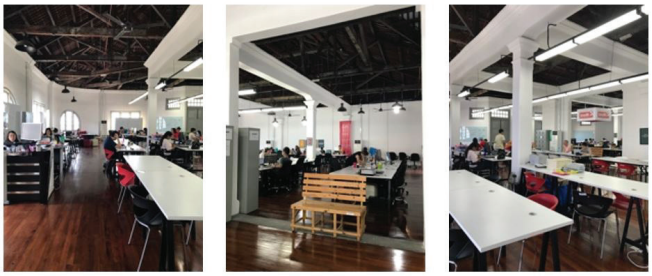
(d)



(e)

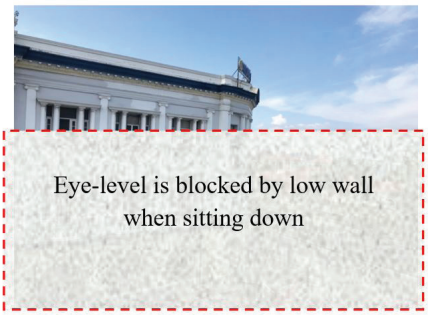
(f)

The interior of the co-workers' space used timber flooring and exposed timber roof structure and roof clay tiles without any ceiling finishes. There was 45% of the total finishing that was covered with timber finishes. This data supported the study of Tsunetsugu, Miyazaki, and Sato (2007) that 45% timber coverage of the room were the most preferred by participants. In addition, timber finishes acts to reduce stress levels, enhance human well-being, and recovery the function of the body (Kelz, Grote, & Moser, 2011; Nyrud & Bringslimark, 2010) Co-workers can enjoy the existing natural materials and understand the culture and structure of the heritage building while working in the workstation. This creates a sense of calm, sense of place and enhance co-workers' well-being in the co-working space. Therefore, the biophilic design pattern (P9) experience was achieved.



(g) (h) (i)

The view throughout the windows has a beautiful and green scenery of sea, trees and surrounded by other heritage buildings. However, certain windows that were facing other heritage buildings that were painted white became very glary towards the co-workers. Some co-workers sat further from the existing windows and some co-workers used white board to cover the window partially as shown above site picture (c). In addition, the window's lowest point is higher than the co-workers' eye level while sitting down (Picture (j)). Hence, biophilic design pattern (P1) existed in the co-workers' space, but co-workers cannot enjoy the scenery except the sky view through the window.



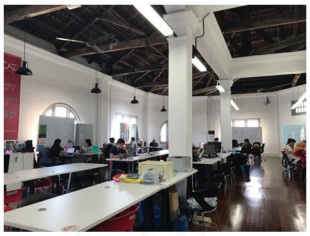
(j)

Phase 2 (Questionnaire and Projection Technique)

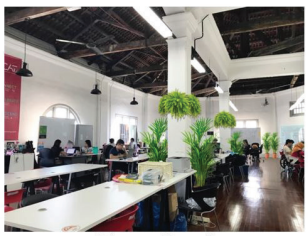
To determine the effectiveness of biophilic design the biophilic design pattern (P1) was used by implementing a technique of editing the existing selected site photo with biophilic design because 1) projection technique by using photo for co-workers to visualise before and after, therefore the

biophilic design patterns (P2, P3, P7, P10, P13, and P14) are not suitable to apply; 2) Biophilic design pattern (P5) is not suitable due to space limitation in the co-working space.

Indoor plants included Boston Fern (Nephrolepis exaltata) and Areca Palm (Chrysalidocarpus lutescens) were used for editing the site photo. The selected indoor plants were the highest toxic gas removers of formaldehyde (from paint, plywood, fabric, varnishes), xylene and benzene (from paint, photocopy printers, and varnishes) (C., 1996). The selection of the indoor plants was not only for visual preference but also for enhancing indoor air quality. These plants were specifically chosen based on the existing condition.



Picture (k) – before



Picture (l) – after

Table 2: Descriptive Statistic for ZIPERS

ZIPERS Questionnaire subscales	Indoor Co-working environment setting (Picture)	
	With indoor plants	Control Room
	M (S.D)	M (S.D)
Positive Affect	**2.61 (1.40)**	1.35 (1.39)
Sadness	2.32 (1.78)	**3.62 (2.17)**
Attentiveness	**2.67 (1.57)**	1.51 (1.70)
Anger/Aggression	1.69 (1.31)	**2.28 (1.81)**
Fear Arousal	1.54 (1.56)	**2.46 (1.99)**

*An item's highest mean is given in bold type

Table 2 shows ZIPERS subscales mean (M) and standard deviation (S.D) of both indoor co-working environment setting. The result showed that Positive Affect subscale and Attentiveness subscale had the highest mean with the appearance of indoor plants in the indoor co-working space compared to the existing indoor conditions which was absence of indoor

plants. This indicates that presence of indoor plants can decrease the value of negative subscales of ZIPERS. Besides that, these findings can support previous studies (Hartig, Korpela, Evans, & Gärling, 1997; Ulrich, 1979). According to Ulrich (2002), views of vegetation and garden-like features can increase positive feelings such as pleasant and calmness. Besides, it reduces negative emotional such as fear, anger, and sadness as shown in Table 2. Besides that, foliage plants green colour brings emotional stability and calmness to human as claim by Adachi et al. (2000) in their study. Therefore, co-workers preferred the presence of indoor plants compared to the existing conditions.

From both results, the total biophilic design patterns achieved 7 patterns out of 14 patterns in Yeap Chor Ee heritage building indoor co-working space. The seven biophilic design patterns combination promote a better indoor environment for co-workers to be healthier, happier, and able to increase focus and concentration. This research supports previous studies documenting the enhancement of human well-being benefits of passive interaction with nature (Adachi et al., 2000; Lohr, 2010; Shibata & Suzuki, 2001). On the other hand, the ZIPERS showed significant result of biophilic design pattern (P1) with indoor plants implementation into the co-working space. The result shows an increase in the quality of biophilic design experience. The co-workers' eye level view has a better biophilic design experience compared to the window view. The results support the objectives of this study.

CONCLUSIONS

In a nutshell, this study, which was done in an adaptive reuse building indoor co-working space, show that biophilic design patterns are significant in enhancing the co-workers' emotional well-being. This study also investigated different ways in the application of biophilic design patterns which would affect the quality of biophilic experiences. Additionally, further study is required to determine the biophilic design patterns in a proper and effective way for built environment in order to create a better biophilic experience. Furthermore, the biophilic design patterns can be used as guideline to design commercial adaptive reuse spaces, to increase workers' performance, satisfaction, and retain workers' loyalty in using the same working space.

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