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BIOPHILIC DESIGN IN HERITAGE INDOOR WORKPLACE IN GEORGE TOWN, PENANG, MALAYSIA

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Abstract - Current lifestyle influences Malaysian occupants work more than 8 hours a day in order to cope with large workloads and meeting deadline. Majority of the occupants are facing overstressed, negative emotion and lead to unhealthy lifestyle. Several studies show that elements of nature are able to enhance human well-being by reconnecting human with nature elements in 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 workplace. This study was conducted in Heritage World Site (WHS) in George Town, Penang. Mixed method research design was used to collect data from site. Both qualitative and quantitative data were analysed to validate the overall data and research by cross verifying the information from multiple methods obtained. The results proved that the existing of biophilic design patterns significantly enhance occupants' emotional well-being and it can be used as design guideline in the future. This study also investigated the different ways of biophilic design patterns application that can affect the quality of biophilic experiences.

Keywords - Biophilic design, heritage indoor, workplace, human well-being

1   INTRODUCTION

1.1   Background

Penang was listed under the UNESCO World Heritage Site (WHS) in 2007. 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. The 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 workplace.

Malaysian occupants work an average of 15 hours a day, exceeded their contracted hours, surpassing 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). A newly-released workplace survey conducted by AIA Vitality found that 53% of Malaysian employees are overworked, stressed, being emotionally negative, and lead to unhealthy lifestyles.

Physical workstation environment includes many aspects such as humidity system, lighting effect, and work area design. An occupant's psychology is an indication of his/her environment (Piko, 2006). Occupants' psychology in the workplace 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).

Empirical studies proved elements of nature bring positive impacts on occupants' well-being in term of cognition, psychology and physiology. There are 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 heritage indoor workplace, the relationship between occupants and nature is an essential aspect to be re-established. Biophilic design is the term to translate an understanding of the inherent human affinity into
the design of modern built environment (Kellert, 2008).

1.2 Aim of study

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

1.3 Objectives of the study

The objectives of this study are to examine and analyse biophilic design patterns in heritage indoor workplace.

2 LITERATURE REVIEW

2.1 Adaptive reuse heritage building

Heritage buildings are the legacy from the past and they also represent the cultural history. Thus, they 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 applying the adaptive reuse of heritage buildings. Adaptive reuse can be defined as modifying a place to suit the existing use and be compatible, which involves no change to the culturally significant fabric, changes that are significantly reversible, or changes with minimal impact (Charter, 2013).

George Town is one of the historical port cities in Malacca Straits that is selected by United National Educational, Scientific and Cultural Organisations (UNESCO) as one of the World Heritage Site (WHS) because of its Outstanding Universal Value (OUV) in cultural diversity and living heritage.

2.2 Biophilic Design

Nature is basic human primary needs. Biophilia is defined as "the innate tendency to focus on life and lifelike processes" (Wilson, 1984). It was developed as a part of the evolutionary survival and, thus include certain characteristics that remained within humans until the current time. Wilson (1984) stated that loving a life is for an innate human to explore and affiliate with life. It is a deep and complicated process in mental development (Wilson, 1984). Kellert (2008) hypothesised the nourishment of this innate human connection with nature is important for modern urban human well-being. Humans are biologically responding positively to nature as per Fromm's concept, "this affiliation can assist in humans' intellectual, emotional, and spiritual fulfilment" (Soderlund & Newman, 2015). A conference at Rhode Island, US in 2006, Kellert, Heerwagen, and Mador (2008) established cross-disciplinary foundations for a biophilic design approach in the built environment. Biophilic design is to re-establish relationship between innate human with nature in 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 then merged into 14 biophilic design patterns (Browning, Ryan, & Clancy, 2014). The 14 biophilic design patterns are divided into 3 categories as tabulated in Table 1.

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

Table 1: 14 Biophilic Design Patterns

Categories	Biophilic Design Patterns
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 & 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)

3   METHODOLOGY

3.1   Site Parameter

George Town core zone (109.38 ha.) was selected for this case study because the heritage architectures in the core zone are well-kept compared to the buffer zone. Core zone is divided into eight different zones (Figure 1). Financial zone has the most indoor workplaces such as banks, co-workers space, lawyer firms, finances firms, and government office whereas occupants have the highest level of stress and negative emotional.
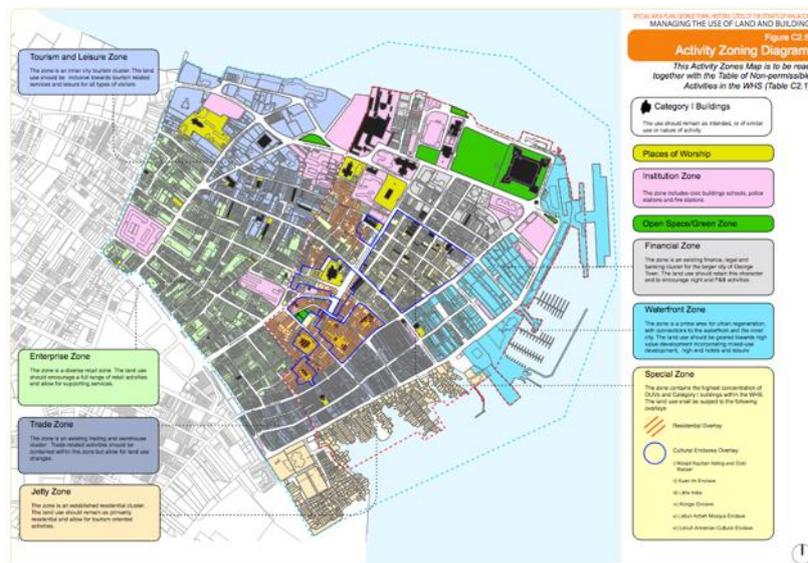

Figure 1: Heritage Zone Plan
(Source: GWTHI, 2013)

3.1   Sampling Selection

The selective workplace is based on criteria: 1) It has to be a cross-disciplinary unit with different departments such as receptionist, administrative staff, and other occupants; 2) The occupants must work at least 8 hours per day and 5 working days per week; 3) The workplace is an adaptive reuse heritage commercial building.

3.2   Data Collection

This study was conducted into two phases. First was site observation and documentation. The existing architectural of the heritage building and interior layout of the workplace was observed by taking photos and was illustrated using AutoCAD. In order to observe the relationship among occupants with biophilic design patterns, the observation was conducted during working hours. The second phase was a set of questionnaire with projection technique. The questionnaire was conducted towards selected occupants who work for **minimum** 8 hours per day and working 5 days per week. A projection technique was used by editing a selected site photo which was taken from the existing site, 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 were posed. The second part of the questionnaire is ZIPERS (Zuckerman, 1977). This is to measure of 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.

3.3   Analysing Tools

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

4   FINDINGS

4.1   Phase 1 (Observation & Documentation)

Yeap Chor Ee heritage building was built in 1922 and 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 in different functions – from warehouses to several banks and today it is adaptively reused as various types of commercial space which are café (Ground Floor), Penang Science Cluster Centre (Ground Floor), and co-workers space (Second Floor). The co-workers space was being selected because it fulfils the sampling selection criteria.
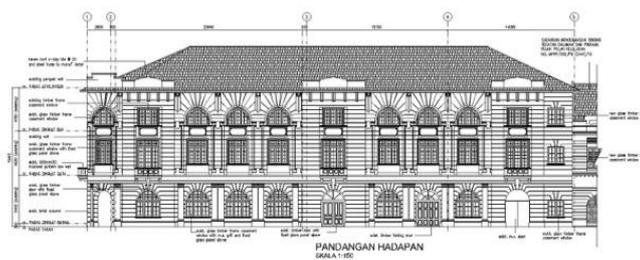

Figure 2: Yeap Chor Ee Building Elevation

Although Yeap Chor Ee heritage building was built in 1922, the architecture style of the building is Art Deco Style (1930s to early 1960s). This is shown by the identical art deco style elements such as reinforced concrete structure – beams and columns, clean surfaces, geometric, linear and modern in expression. Besides, its white plain surfaces that are highlighted with parallel and bold vertical or horizontal lines have created sunburst motif to the surrounding entrance and window. There is 'leaf' decoration motif underneath the first floor balcony. The façade of the architectural has achieved the biophilic design pattern (P8). In addition, the existing large windows and doors provide sufficient daylighting (P6) into the main atrium staircase, corridor and indoor co-workers workplace.

Therefore, the main atrium staircase and corridor's artificial lights are switched off during the day, to save energy and be sustainable. In the co-workers' workplace, there is a combination of artificial light and daylighting. However, majority of the occupants preferred to work under artificial lighting rather than working beside windows with daylighting. This is due to over glaring and computer monitor screen reflection. The administration staff used whiteboard stand to block over excessive daylighting. In addition, the large windows, doors, and the openness of the workplace without any height divider in between workstation created biophilic design pattern (P11). Occupants were able to view the overall space. The large windows that surround the workplace are closed and the door access is controlled with the card system. These allowed the occupants to feel safe and secure (P12).

(a)   (b)
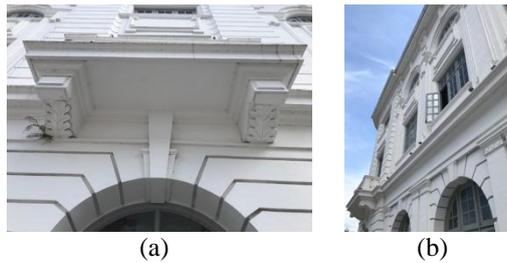
The main atrium staircase and corridor permitted natural air ventilation (P4) through the opening of windows and balcony door. At the workplace the windows are closed and the air ventilation mechanism such as ceiling fan and air cooler stand are operating all the time.

(c)   (d)   (e)

Besides, the interior workplace used timber flooring and exposing timber roof structure and roof clay tiles (P9) without any ceiling finishes. Occupants can enjoy the existing natural materials and understand the culture and structure of the heritage building while working in the workstation. This created a sense of place in the workplace.

(f)   (g)   (h)

The view throughout the windows had a beautiful and green scenery of sea, trees and is surrounded by other heritage buildings. However, certain windows that face other heritage building that was painted white, became very glaring towards the occupants. Most of the occupants sat further from the existing window. In addition, the window's lowest point is higher than the occupant eye level who are sitting down. Hence, biophilic design pattern (P1) existed within the workplace, but occupants cannot enjoy the scenery except of the sky view through the window.

4.2 Phase 2 (Questionnaire and Projection Technique)

Biophilic design pattern (P1) was used to be implemented into existing site photo of workplace because; 1) projection technique by using photo for occupant to visualise before and after. Therefore, the biophilic design patterns (P2, P3, P7, P10, P13 and P14) are not suitable to be applied; 2) Biophilic design pattern (P5) is not suitable due to space limitation in the workplace.

Indoor plants include Boston Fern (*Nephrolepis exaltata*) and Areca Palm (*Chrysalidocarpus lutescens*) and were used for editing the site photo. The selection of the indoor plants was based on the highest toxic gas removal 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.

Table 2: Descriptive Statistic for ZIPERS

ZIPERS Questionnaire subscales	Indoor Workplace 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

The result from Table 2 shows that occupants have more positive emotion and attentiveness with the appearance of indoor plants in the indoor workplace compared to the existing indoor condition which does not have indoor plant. From both results, biophilic design patterns can be achieved up to 8 patterns out of 14 patterns in Yeap Chor Ee heritage building indoor workplace which fulfils the research objective.

The eight biophilic design patterns combination promote a better indoor environment for workers to be healthier, happier, increase focus and concentration. In conjunction, the results significantly showed biophilic design pattern (P1) with indoor plants implementation into the workplace in occupants' eye level views has a better biophilic experience compared to window view.

5 CONCLUSIONS

In a nutshell, this study that has been done in an adaptive reuse building indoor workplace has proven that the existing of biophilic design patterns significantly enhance occupants' emotional well-being. This study also investigated that different way of application of biophilic design patterns do affects the quality of biophilic experiences. Thus, further study is required to determine the biophilic design patterns in a proper and effective way in built environment as to create better biophilic experience. In addition, the biophilic design patterns can be used as a guideline to design commercial adaptive reuse spaces, increase occupants' performance and company socio-economics in the future.

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