

An Overview of Psychological Restoration in Urban Environment: Integration of Pro-Environmental Theory into Neuro-Landscape Study

Noriah Othman¹, Mohd Zahid Mohd Salleh²,
Nurhayati Abdul Malek¹, Leny Suzana Suddin³

¹ Centre of Studies for Landscape Architecture,
Faculty of Architecture, Planning & Surveying,
Universiti Teknologi MARA, Puncak Alam, Selangor, Malaysia.

² Centre of Studies for Postgraduate, Faculty of Architecture, Planning & Surveying,
Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia

³ Department of Public Health Medicine, Faculty of Medicine, Sg. Buloh Campus,
Universiti Teknologi MARA, Sg. Buloh, Selangor, Malaysia

noriaho@yahoo.com, mohdzahidsallehphd20@gmail.com, nurhayati.abdmalek@gmail.com,
lenysuzana@yahoo.com

Abstract

Rapid urbanization has brought changes in life events that impact the psychological problem of mental health. The urban nature serves as a Psychological Restoration (PR) among affected people. Besides, closed attachment with nature leads somebody to react as pro-environmental. Despite many studies on nature and PR, hardly any studied in neuro-landscape (NL) intervene with pro-environment behaviour (PEB) on PR. Thus, this paper explores the potential of PEB to integrate on PR via a systematic mapping review with 23 articles. Hence, these significant arguments were discussed in detail as a basis to support the future study proposition.

Keywords: Neuro-Landscape (NL), Pro-Environmental Behaviour (PEB), Psychological Restoration (PR), Urban Environment (UE)

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1.0 Introduction

Almost 70 per cent of the world's population to be home in the urban area by 2050. (World Urban Forum, 2018). In the circumstance, The New Urban Agenda has indicated the improvement of human health and well-being as a critical priority to achieve the sustainable development goals (The New Urban Agenda, 2017). It is caused by escalating the number of people who have a mental disorder that contributes to 350 million people globally. (Chan, Hutagalung, & Lau, 2017). Rapid urbanization has brought changes in life events that impact the psychological problem of mental health and well-being. A psychological problem comprises depression, anxiety, and stress is a behavioural pattern that should be restrained and treated seriously. It will create distress and a negative impact on daily human life. The burden of having a mental disorder is not only carried by the individual; it is a ripple effect that is felt by the family, the workplace, healthcare systems, the government, communities and economic burden (Razali, S. et al., 2019; Jenkins et al., 2011). Also, the effects of mental disorder, which puts further strain on the government due to loss of productivity and social welfare (Chen, 2017). Nevertheless, the effectiveness of the outdoor environment in urban areas as a natural therapy in fostering mental health has proved light on its benefits.

The first prospect that can be highlighted to combat this issue is psychological restoration (PR) in urban agglomerations. The enhancement of the urban environment is a growing need for restoration in urban surroundings. The urban nature serves as a restorative agent for PR among affected people. It involves co-existence between the neuro-science and landscape is known as neuro-landscape (NL). The human brain shows differential activation patterns in response to the landscape and is associated with emotional states based on psychology. Besides, closed attachment with nature leads somebody to readily protect nature and react as pro-environmental to appreciate its beneficial effects. Despite many studies on nature and PR, hardly any studied in neuroscience and urban nature aspect, its relationship with Pro-Environment Behaviour (PEB) and PR. Thus, this paper aims to explore the potential of PEB to integrate with NL study towards promoting PR via a systematic mapping review. Besides, this paper also answered the following questions,

1. Which urban environment (UE) and significant elements are perceived as restorative potential?
2. What is the prospect of pro-environmental behaviour (PEB) in relation to psychological restoration (PR)?
3. What are the methodological advances in psychological restoration (PR) studies?

2.0 Methodology

This paper employed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) approach to strategising the literature review encompasses identification, evaluation, exclusion, and inclusion. The identification of resources initiated by searching the literature via Google Scholar, Web of Science, Scopus, and Science Direct database. The combination of terms was used to explore the research in accordance with

"Psychological Restoration," "Pro-Environmental Behaviour," "Urban Environment," and "Neuro-Landscape" keywords.

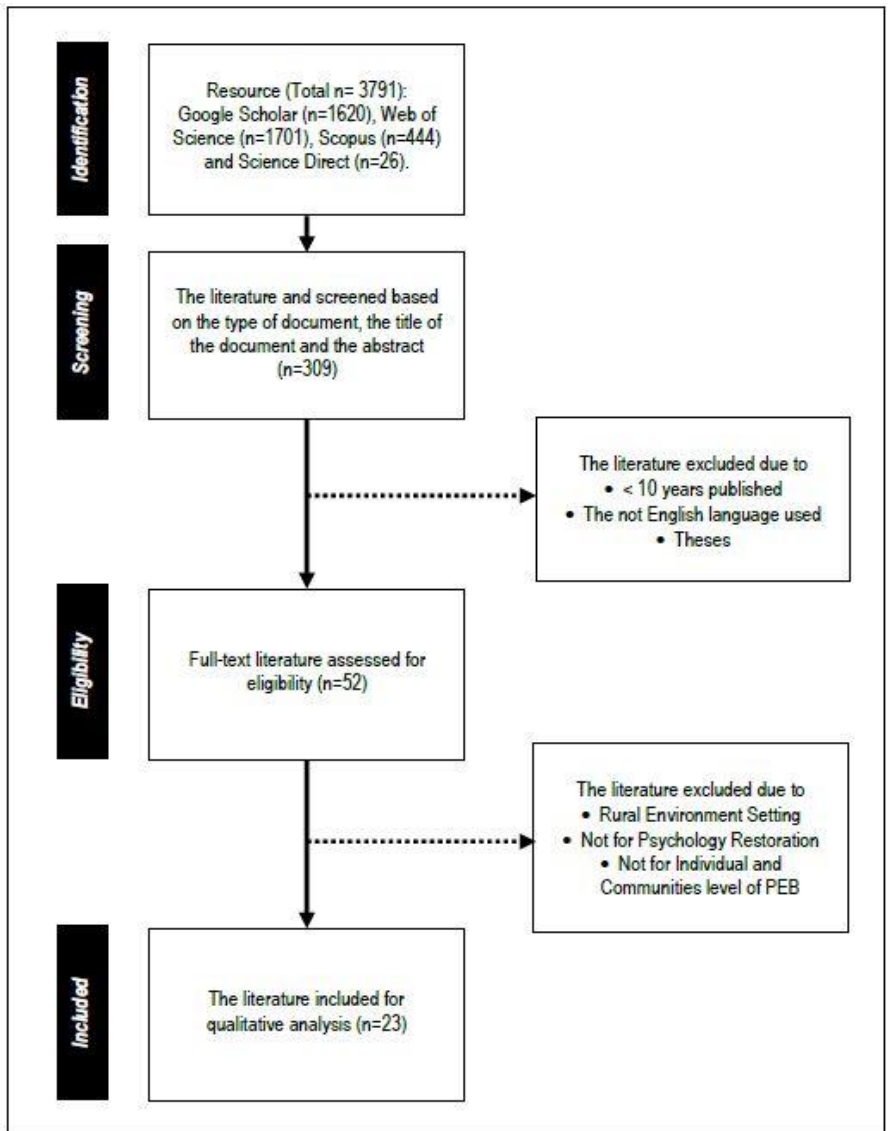


Figure 1: The Flow Diagram of PRISMA
(Source: Moher et al., 2009)

3.0 Results

The total number of 23 articles distinguished into three identical topics, such as the benefits of the natural environment on psychological restoration, the PEB prospect on psychological restoration, and methodologically advanced in psychological restoration studies, which will be described further.

3.1 The Restorative Potential of Urban Environments (UE)

The extensive studies explained the plausibility of Attention-Restoration Theory (Kaplan S 1995), Stress-Reduction Theory (Ulrich et al. 1991), and Biophilia Theory (Kellert, S. R. 1995) on the beneficial effect of natural environment towards mental health is beyond dispute. Various studies have demonstrated that contact with the natural environment can contribute to reduce stress, promote positive states of mood and adequate cognitive function (Kondo et al., 2020; Herranz-Pascual et al., 2019; Kang & Kim, 2019; Machida, 2019; Ojala, Korpela, Tyrväinen, Tiittanen, & Lanki, 2019; Schebella, Weber, Schultz, & Weinstein, 2019; Bakolis et al., 2018; Chiang, Li, & Jane, 2017; Juan, Subiza-Pérez, & Vozmediano, 2017; Soga et al., 2017; Stigsdotter, Corazon, Sidenius, Kristiansen, & Grahn, 2017; Gidlow et al., 2016). However, the terminology of the natural environment is still broad and miscellaneous. The restorative and contemplative effects on mental health for each typology of the natural environment are not identical. For instance, in the urban context, there are two distinct categories of the natural environment, such as natural landscape and landscape garden (Kang & Kim, 2019; Zhang et al., 2019). The natural landscape is natural features that exist naturally, such as forest, woodland, water bodies, and natural reserve. Whereas landscape garden is an artificial landscape that constitutes of architectural and natural element composition.

The contemplative effect of the natural landscape on psychological restoration has been proven predominantly in different settings. For instance, forests with heterogeneous and richness of vegetation are found more physiological recovery. According to Stigsdotter et al. (2017), they revealed that people walking in the forest environment within 15 minutes was evoked a positive emotion. The study is approximately similar to Gidlow et al., (2016) findings indicated that exposure with blue and green elements configuration by walking at least 30 minutes confers high contemplative effects. Besides, the study conducted by Ojala et al. (2019) to test urban-orientedness and noise-sensitivity on psychological restoration in urban woodland found a significant finding. They disclosed that people who were sitting there within 15 minutes felt more vitality and positively perceived restoration. The composition of water and vegetation that have a visual aesthetic and complexity can increase the degree of restorativeness (Kang & Kim, 2019). Furthermore, after 10-minute exposure within a 50-meter distance of the natural outdoor environment contributed a significant effect on evoking a positive mood (Kondo et al., 2020). Nevertheless, the underlying factors of contemplativeness on landscape gardens or urban open spaces also have been proven broadly.

Herranz-Pascual et al. (2019) conducted a study in four different types of urban green spaces such as street (boulevard), public square, community park, and urban park. The result revealed that emotional restoration capacity increased when soundscape was

obtained in urban green spaces. Besides, according to Hashim et al. (2019), they evaluated urban pocket parks via a closed-ended questionnaire to explore the characteristics of contemplative experience. They found that the composition of vegetation and water fountain gives effortless attention, called fascination to people. Furthermore, a set of studies with a sample of 46 respondents that walked and contemplated within two distinguished public squares was conducted. The result indicated that varieties of trees, flowers, grass, and natural elements in the public square are the critical features of contemplative space (Juan, Subiza-Pérez, & Vozmediano, 2017). The community garden and allotment garden also included in the category of urban green space that generates a definite vibe of therapeutic effects. Soga et al. (2017) discovered among 165 residents involved in allotment gardening have improved their mental health. It indicates that having contact with nature by doing gardening also benefits psychological health. Additionally, the people who practice community gardening stimulates a healthy lifestyle via physical exercise, consume a vegetable diet, and reduces stress (Machida, 2019). Consequently, those people who are interacting with nature readily to commit like pro-environmentally and ecological behaviour directly. Thus, pro-environmental behaviour seems to shed light on its potential for PR in an urban area.

Table 1: Urban Environment and Psychological Restoration Studies

Source	Theory	Types of Environment	Elements of Environment	Method and Sample	Outcomes
Kondo et al., 2020	Attention Restoration Theory (ART) and Stress Reduction Theory (SRT)	Natural Outdoor Environment (NOE), Non-natural Outdoor Environment (NNOE)	NOE: Parks, Nature reserve, Playground, Squares, Street trees; NNOE: Woodland, Agricultural land	Ecological Momentary Assessment (EMA) Survey 368 respondents Barcelona	NOE exposure and mental health status have a positive relationship in Stoke-on-Trent and Doetchem.
Hashim et al., 2019	Attention Restoration Theory (ART)	Urban Open Space	Pocket Park	Close-ended questionnaire 385 Respondents Kuala Lumpur	The pocket park has offered restorative benefits in mentally and physically.
Herranz-Pascual et al., 2019	Attention Restoration Theory (ART) and Stress Reduction Theory (SRT)	Four Urban Places	Los Herrán Street, Constitución square, Salinillas de Buradón park and Olarizu	Observational survey 137 respondents Spain	The environmental comfort of urban places can restore the emotion.

			Park		
Kang & Kim, 2019	Attention Restoration Theory (ART) Stress Reduction Theory (SRT) and Visual Characteristic	Natural Environment (NE) and Built Environment (BE)	NE: Trees, Lakes; BE: Buildings, Roads, and Squares.	Experimental study 31 respondents Virginia	Natural scenes had a more substantial positive restorative effect compared to built scenes.
Machida, 2019	-	Urban Gardening	Community Garden, Home Garden	Web-based cross-Sectional Study 1000 Elderly Japan	Both gardenings were positively associated with health.
Ojala, Korpela, Tyrväinen, Tiittanen, & Lanki, 2019	Attention Restoration Theory (ART) and Stress Reduction Theory (SRT)	Natural Environment and Built Environment	City centre, Constructed Urban Park, Urban Woodland	Experimental 83 Adult Women Finland	Forest was found the high capacity of the restorative effect.
Bakolis et al., 2018	Attention Restoration Theory (ART); Stress Reduction Theory (SRT) and Biophilia Theory	Natural Environment	Trees, The Sky, Birdsong, and Water	The Urban Mind Tool 108 individuals United Kingdom	Being outdoors, seeing trees, hearing birds singing and seeing the sky were associated with higher levels of momentary mental well-being.
Juan, Subiza-Pérez, & Vozmediano, 2017	Attention Restoration Theory (ART) and Stress Reduction Theory (SRT)	Public Urban Squares	Natural Elements and Architectural Variation	Experimental 46 University Students University of Basque Country	Better psychological state after spending some time in an urban square. Natural Elements have higher restorative effects.
Soga et al., 2017	-	Urban Allotment Garden	Allotment Garden (AL)	A postal Questionnaire Survey 332 Gardener	AL plays an vital role to maintain the psychological health.

				and Non-gardener	
				Japan	
Stigsdotter et al., 2017	Attention Restoration Theory (ART)	Forest and Urban	The Largest Collection of Trees and Shrubs; Architectonical and Historical Qualities	Experimental 51 Female Students	An improvement in mood was found after the forest walk.
				Denmark	
Gidlow et al., 2016	Attention Restoration Theory (ART) and Stress Reduction Theory (SRT)	Urban, Green, and Blue	Residential street, Country Park, Canal with Natural Vegetation	Self-report of walking experience (30 min) 38 Adult	More significant improvement of mood when exposure to the natural environment.
				Spain	

(Source: Author)

3.2 Pro-Environmental Behaviour (PEB) Prospect in relation to Psychological Restoration (PR)

Pro-Environmental Behaviour (PEB) is generally an action of people to minimise the negative impact on the natural and built environment. Besides, it is known as a protective way to behave and promote an environmentally healthy lifestyle (Rosa, C. D et al., 2018). It involves the psychology, environment, and behaviour interrelationship with pro-environmental attitudes in psychological context (Giusti et al., 2018). The urban nature is often associated with stimulating PEB directly and indirectly. Recently, most of the studies have proved a substantive relationship between connectedness with nature and PEB (Ghazali et al., 2019; Whitburn, Linklater, & Milfont, 2019; Diessner, Genthôs, Praest, & Pohling, 2018; Rosa, Profile, & Collado, 2018; Geiger, Otto, & Schrader, 2018; Geng et al., 2015) as exhibited in Table 2. These restorative experiences influence the way people think, interact, and value of nature to stimulate them for treating the environment wisely (Hartig et al., 2014). However, the PEB of interest could be characterised into few categories, for instance, energy conservation, waste reduction, recycling behaviour, hazardous waste disposal, mobility and transport, social conservation, and consumerism.

The study conducted by Ghazali et al. (2019) was examined seven categories of PEB respectively in relation to different ethnicity in Malaysia. The seven categories of PEB are activist, avoider, green consumer, green passenger, recycler, and utility saver. They disclosed that Malays are grudgingly engaged in PEB compared to Chinese that lived in an urban area. Similarly, Whitburn, Linklater, & Milfont (2019) investigated seven PEB interests in relation to connection to nature, the use of nature for psychological restoration, and environmental concern. The environmental concern was moderately mediated between PEB and psychological restoration (Whitburn et al. 2018). They concluded that

exposure to urban nature and tree planting is related to PEB and psychological rehabilitation. Besides, the studies on the relationship between nature and PEB found significant positive results. For instance, 224 undergraduate students in northeastern Brazil proved that their PEB was influenced by experience in nature (Rosa, Profile, & Collado, 2018). Also, the experimental study done by Geng et al. (2015) investigated among 113 of Nanjing University students to examine the inherent nature of connectedness and spontaneous environmental behaviour. The finding disclosed that both connections have a strong correlation.

Principally, the sense of connectedness with nature is an indicator to enact PEB. Also, another factor that motivates people to engage PEB is environmental identity and values. According to Diessner et al. (2018) investigated the environmental identity and five PEB among 196 respondents. At the end of the study, they concluded that the engagement with nature's beauty alone without increased environmental identity (thinking, feeling, and believing) to natural environment arduous people to engage PEB. Indeed, a sense of connection to nature also stimulates people by acting with awareness and accepting attitude (mindfulness) to evokes a healthy lifestyle. Based on the study from Geiger, Otto, & Schrader (2018) examined the mindfulness by using 20-items of Kentucky Inventory on Mindfulness Skills (KIMS) on ecological behaviour. They assessed 147 university students to answer the online-questionnaire survey and found that mindfulness and environmental practice have a strong correlation, which supports by favourable external surroundings. In conclusion, the PEB stimulation is a direct consequence of the conducive natural environment existence towards promoting psychological restoration in the urban area. Heretofore, the proliferation of science and technology advancement in psychological studies has implemented broadly.

Table 2: Pro-Environmental Behaviour Studies

Source	Theory	Behaviour Interest	Method	Findings
Ghazali et al., 2019	Value-Belief-Norm (VBN)	Activist, Avoider, Green Consumer, Green Passenger, Recycler and Utility Saver	Survey Questionnaire 581 Participants	Chinese ethnic groups more readily engage in PEB than do Malays.
Whitburn, Linklater, & Milfont, 2019	Connection to Nature and Environmental Attitude	Consumerism, Energy Consumption, Mobility And Transport, Waste Avoidance, Recycling, and Social Conservation	Quasi-experiment 423 respondents	More exposure to nature, more willing to protect the environment (PEB).
Diessner, Genthös, Praest, & Pohling, 2018	Environmental Identity	Conservation, Environmental Citizenship, Food, and Transportation	Questionnaire survey 196 respondents	Feeling connected to nature leads to behaving like pro-environmentally.

Rosa, Profile, & Collado, 2018	Connectedness to Nature	Daily Conservation Actions and Environmental Citizenship Behaviors	Online survey 224 Respondents	Experiences in nature have a positive effect on the PEB.
Geiger, Otto, & Schrader, 2018	Mindfulness And Ecological Behavior	Energy Conservation, Mobility, Waste Avoidance and Recycling, Consumerism, Vicarious, Social Behaviors Toward Conservation	Online-questionnaire 147 Samples	The awareness/observing facet correlated strongest with ecological behaviour.
Geng et al., 2015	Connectedness to Nature	Energy Conservation, Mobility And Transportation, Waste Avoidance, Recycling, Purchasing/Consumerism, Food Consumerism, and Environment Supporting	Experimental study 113 participants	Environmental connectedness and spontaneous pro-environmental behaviour have a substantial effect.

(Source: Author)

New scientific and technological advancements in cognitive science have led various disciplines of researchers to employ in their research. A new way to discover human reaction towards the environment is called neuroscience (Banaei et al., 2017; Gianotti, L. R, et al., 2019; Mavros et al., 2016). In recent times, the traditional clinical and neuroscience study has transformed into an advanced technology application known as electroencephalography (EEG) (Mavros et al. 2016). Also, the low-cost implication can be mobilized freely, and open-source analytical tools are the advantages of using this technology. Previously, most of the studies have discovered the neural proses of brain activities by using EEG to explain PEB (Baymgartner et al., 2019), spatial perception, and cognition (Mavros et al. 2016) and strolling on the trails. (Banaei et al. 2017). Moreover, significant evidence has revealed that higher frequencies and amplitude of brain activities when people expose, view, and interact with urban nature directly (Olszewska-Guizzo, A. et al., 2020; Jiang, et al., 2019; Olszewska-Guizzo, A., Paiva, & Barbosa, 2018; Olszewska-Guizzo, A. et al., 2018; Chen, He, & Yu, 2016; Roe et al., 2013)

For instance, Olszewska-Guizzo, A. et al. (2020) assessed six landscape scenes and three urban downtown scenes in relation to the contemplative landscape score (CLS). There are 22 respondents experienced passively virtual scenes incorporated by electroencephalography (EEG) to measure brain activity. Surprisingly, most of the respondents felt happy and calm during viewing landscapes in the residential areas compared to urban parks. It indicates that the left frontal lobe of alpha power is high compared to the right frontal lobe. Likewise, the frontal alpha asymmetry had no significant effect on the twelve contemplative and non-contemplative landscape to generate positive emotion. But, the study found that visual and driven attention has a significant impact on the landscape view from the temporal beta asymmetry result (Olszewska-Guizzo, A., Paiva,

& Barbosa, 2018). These findings were contrary to Jiang, Hassan, Chen, & Liu (2019) study. They found that landscape gardens, natural landscapes, forest landscapes, and urban landscapes have generated high power of alpha in the right hemisphere. It shows that a green environment induces relaxation in relation to stress reduction. Besides, intriguing environmental stimuli of green environment enable to activate a higher meditation (Roe et al., 2013) and higher attention (Chen, He, & Yu, 2016).

Table 3: Neuro-landscape Studies by using an Electroencephalography (EEG)

Source	Stimulation Method	Duration	Sample	Findings
Olszewska-Guizzo, A. et al., 2020	6 Landscape scenes 3 Urban downtown (Actual)	30 and 45 min	22 respondents	Stronger Frontal alpha asymmetry (FAA) in the park compared to Urban downtown.
Jiang et al., 2019	Landscape garden, natural landscape, forest landscape, city landscape (Virtual; 2D)	22 min	50 respondents	Natural landscapes were perceived as more pleasant.
Olszewska-Guizzo, A., Paiva, & Barbosa, 2018	Contemplative landscape (CL) & Non- contemplative Landscape (NCL) (Virtual; 3D)	7-8 min	32 respondents	Significantly increased power in the beta frequency in the viewings of CL.
Olszewska-Guizzo, A., et al, 2018	12 Window view & different floor levels (Virtual; 2D)	23 min	33 participants	The 12th floor, greenest window view significant grater alpha power.
Chen, He, & Yu, 2016	Nature Environment and Urban Environment (Actual)	20 min	32 respondents	High level of attention during nature environment exposure.
Roe et al., 2013	Urban image & Landscape image (Virtual; 2D)	10 min	20 respondents	Landscape scene activated high level of meditation.

(Source: Author)

4.0 Discussion

This paper evaluated 24 articles to extract the elicitation of previous empirical studies about urban environment potential on Psychological Restoration (PR), the prospect of the Pro-Environmental Behaviour (PEB) towards PR, and Neuro-Landscape (NL) studies' methodology. This paper employed a systematic mapping approach and dismantled in detail all the significant excerpts obtained to answer three questions that were highlighted

before. The feature was explained as follows:

4.1 Urban Environment (UE) and Its Elements Potential in Restorative Effect

The urban environment has proved a significant potential effect on PR. Most of the studies authenticate the Attention-Restoration Theory (Kaplan S 1995) to describe the potential of the natural environment towards PR. However, Stress-Reduction Theory introduced by Ulrich et al. (1991) also applied in several studies. It proves that both theories have identical strength until the significant evidence of previous studies were supported. The type of urban environment can be classified into the natural landscape (forest, woodland, natural reserve, and water bodies) and landscape garden (green spaces, parks, squares, and allotments) or can be called urban nature environment. In reliance on the facts, however, the typology of natural landscape and landscape gardens are still indistinct and indistinguishable. For example, Kondo et al. (2020) have to define the natural outdoor environment in their study as all spaces that have a composition of vegetation and water bodies, including parks, civic spaces, and street greenery. Dissimilar to Zhang et al. (2019), stated the natural landscape is the naturalness of landscape, whereas the garden landscape is the artificiality of landscapes. It indicates that landscape gardens also can be defined as a built environment or urban landscape terminology due to the combination of green features and architectural elements existence.

Even though the typology is different, but, it still the green elements and features are consistent to induce PR in the urban environment. Kang & Kim (2019) proved that predominantly natural elements with visual aesthetics and complexity serve restorative effects. Besides, being exposed to the natural environment with a variety of trees and shrubs (Stigsdotter et al., 2017) while enjoying birds singing stimulates high momentary mental well-being (Bakolis et al., 2018). Yet, it is still unclear and untapped which type, size, and quality of urban nature environment have more restorative capacity compared to another. Furthermore, the time spent on urban nature environment exposure that affects psychological recovery also not unanimous. From the previous studies, a range of 10 until 30 minutes of exposure with nature by walking and sitting demonstrated have positive emotion (Kondo et al., 2020; Stigsdotter et al. 2017) and high contemplative effects (Ojala et al. 2019; Gidlow et al. 2016). The interaction and experience of nature by walking or sitting, both activities stimulate attention, relaxation, and positive emotion. These benefits entice people towards preserving nature by promoting a symbiosis action between humans and nature. It is a necessary action to minimise the negative impact of environmental issues with acts as pro-environmentally. Therefore, the relationship between nature and pro-environment cannot be disputed, but it must be expanded with empirical evidence to support that PEB has a positive impact on PB

4.2 Pro-Environmental Behaviour (PEB) Prospect for Future Direction

Previously, the urban nature and PR has a positive relationship that has been proved while the PEB also consistent with the similar findings (Ghazali et al., 2019; Whitburn, Linklater, & Milfont, 2019; Diessner, Genthôis, Praest, & Pohling, 2018; Rosa, Profile, & Collado, 2018; Geiger, Otto, & Schrader, 2018; Geng et al., 2015). It is not surprising that people

are familiar and intimate with nature will behave like a pro-environmentally. It is because the hidden advantages like reducing the stress and economic saving practice can be felt directly for those who practice it. According to Whitburn, Linklater, & Milfont, (2019), revealed that 46% of the variance in PEB come from the amount of vegetation existence in the neighbourhood area and participation of people in tree planting activities. Yet, there is still inadequate empirical evidence to prove the PEB has a positive vibe for psychological restoration directly. Before that, the motivation factors, including internal and external stimuli that drive the PEB, must be thoroughly investigated first. Most of the studies proved that external stimuli, like the urban nature environment, influenced people to engage PEB.

For example, people that many experience with nature is more devotedly protect the environment from destruction and encourages pro-environmental (Rosa, Profice, & Collado, 2018). However, the positive vibe of nature-oriented behaviour does not rely on living in a greener environment alone, but the connectedness to nature should be escalated. (Whitburn, Linklater, & Milfont, 2019). The connectedness proved that exposure and experience in a vast green environment without intimating with nature frequently seems to no avail for stimulating PEB. Another external factor is the social environment, which influences people to behave the PEB. It has proved that recycling activity is influenced by social norms among the Malay community (Ghazali et al. 2019). Furthermore, Ghazali et al. (2019) found that personal norms (internal stimuli) also was influenced by green consumer and utility saver among Chinese. It shows that the personal norm is derived from the association between ascription of responsibility, awareness of consequences, and openness to change (Geiger, Otto, & Schrader, 2018). Besides, both internal and external stimuli need to be integrated into a coexisting to measure the PEB in relation to connectedness to nature. In conclusion, the PEB has a capacity to explore whether it afford to restore mental health concerning to the existence of the urban nature environment by identifying the internal and external stimuli. Besides, an appropriate procedure and methodology will help to attain significant evidence for supporting this argument.

4.3 Proposition of Methodology in Neuro-Landscape Study

Presently, the field of landscape architecture, environmental psychology, and medicine are collective to prove that the natural environment has a positive impact on the restoration of mental health. The consolidation between neuroscience and landscape established a new manifestation of Neuro-Landscape study. Besides, neuroscientific advancement of technology like electroencephalography (EEG) will help to improve the traditional methodology of psychological measures. The previous studies disclosed that indoor and outdoor experiments of viewing nature by using image (2D) and video (3D) on psychological effects are widely explored. Interestingly, the result predominantly proved that the urban natural environment plays vital role in nature therapy. For example, the composition of natural features such vegetation, water bodies, and fauna can be induced stress reduction (Jiang, et al., 2019), high meditation effect (Roe et al., 2013) and more considerable (Chen, He, & Yu, 2016). However, there is room for debate pertaining to 2D and 3D application tools and viewing nature technique (actual or virtual).

Presently, 3D application tools such as Virtual Reality (VR) improve visual quality and

effect to offers realistic visual stimulation compared to 2D. Based on Anderson et al. (2017), they reported that natural environment stimulated relaxation mood after 15 minutes of VR experience. However, the 2D image also generated a high value of alpha power in the right hemisphere (Jiang et al., 2019). The technique of viewing nature using actual and virtual also vary of findings. The study done by Olszewska-Guizzo, A. et al. (2020) found that urban parks did not provide relaxation mood when people expose actually at the site. Interestingly, the neighbourhood landscape makes people felt calm. Whereas the indoor experiment in virtually is consistent findings from have been reached Jiang et al., 2019; Olszewska-Guizzo, A., et al., 2018; Roe et al., 2013). Although the findings vary from each other, but still, brain activity can be measure by different frequencies depends on the intention of individual study. Four types of frequencies that most important are categories into delta (< 3Hz), theta (3.5-7.5Hz), alpha (8 -13Hz), and beta (> 13Hz). (Jiang et al., 2019; Olszewska, Marques, & Barbosa, 2015). The relaxation and positive effect occur when the value of theta and alpha increases. Whereby great visual attention happens when the beta power escalates. Therefore, this review helps the researcher to strategize the NL study direction to understand the psychological restoration effect by viewing, exposing, and connecting with urban nature as well as PEB integration.

5.0 Conclusion

This study demonstrated the systematic mapping review with 23 articles. This review touched three main topics, including urban environment restorative potential of the urban environment (UE), the Pro-Environmental Behaviour (PEB) prospect towards Psychological Restoration (PR), and methodology advancement in Neuro-Landscape (NL) studies. These significant arguments were discussed in detail as a basis to support the future study proposition. Accumulation of scientific evidence from previous empirical data was recognized as a new manifestation for NL studies on PR. This review found that PEB has a new prospect to incorporate with NL and PR as a mediator that is still obscure to prove. Besides, a future study is needed to utilise the electroencephalography (EEG) in measuring the internal activity of the brain. The consolidation of site analysis, interview, and experimental approach offer a greater understanding of NL, PEB, and PR relationship in the urban area. In conclusion, the empirical evidence of this study will support the argument that the urban nature environment fosters mental health as a natural therapy intervention with PEB for urban communities.

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