



HOW DOES THE RESTORATIVE ENVIRONMENT OF GREEN OPEN SPACE AFFECT THE URBAN STRESS IN PALEMBANG, INDONESIA?

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Abstract

Human-nature connectedness has been perceived as an essential pathway for urban well-being and sustainability. Green open spaces are used to reduce urban stress (US) in cities. This paper aims to determine the level of US among the Kambang Iwak Palembang Park's (KIPP) visitors and how its restorative environment (RE) affects US. A questionnaire-based cross-sectional survey was conducted with 147 visitors who had finished their visit to the KIPP. We analysed the visitors' US level by measuring psychological stress and the effect of the RE using partial least squares (PLS) regression analysis. The results showed that the KIPP's visitors experienced "Moderate" levels of US, meaning their stress manifested for a longer duration but was manageable with coping strategies. The analysis of the RE's influence on US showed a positive value, with dominant factors being compatibility, fascination, and being away. This suggests that time spent in the KIPP's RE led to improved mood and well-being. Therefore, it is necessary to further enhance the KIPP's RE to promote human-nature connectedness and contribute to creating a more liveable city.

Keywords: Green Open Space, Restorative Environment, Urban Stress

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INTRODUCTION

Numerous studies have shown a strong link between urban environments and urban stress (US) (Pelgrims et al., 2021; Xu et al., 2023). City life can be a significant stressor for many people due to factors such as sensory overload, social disconnection, environmental factors, and the fast pace of life (Lederbogen et al., 2011; Moghani et al., 2023; Rishi & Khuntia, 2012). Cities must prioritise tackling the issue of US because living in a city exposes residents to a multitude of interactions that have a profound effect on their emotional responses (ER), behavioural responses (BR), and cognitive responses (CR) (Costa et al., 2020; Rishi & Khuntia, 2012). As cities face rapid urbanisation, incorporating green spaces with restorative environment (RE) into city planning is becoming increasingly important for promoting mental health and overall quality of life. This is evidenced by research on urban parks (Chen et al., 2021; Grigoletto et al., 2023; Nath et al., 2018).

Palembang City, with a population exceeding 1.7 million, has a dense urban environment. This can lead to feelings of crowding, competition for resources, and a general sense of being overwhelmed (D Nguyen et al., 2016; Helmi & Wahab, 2023; Marpen et al., 2022). Further adding to these challenges, a 2023 press release by the Ministry of Environment and Forestry stated that Palembang City's pollution exceeds the WHO standard. The standard is $57\mu\text{g}/\text{m}^3/\text{year}$, while Palembang's pollution level is at $30\mu\text{g}/\text{m}^3/\text{year}$. This means residents are breathing in harmful pollutants. Traffic noise also poses a problem. According to the press release, average noise levels along major roads range from 75-85dB(A), significantly exceeding the Indonesian daytime limit of 55dB(A) for residential areas. This noise can increase frustration and hinder concentration. Indonesian Law No. 26 of 2007 on spatial planning mandates that all cities allocate at least 30% of their area for public green space within a 20-year planning period. Palembang aims to achieve this target by providing green open space amounting to 30% of the city area, which translates to roughly 105.76 km^2 , given its total area of 352.52 km^2 . However, achieving this goal presents a challenge. On the same note, massive development is happening. Despite its economic and cultural potential attracting global attention, the city's lack of progress on this RE goal hinders its ability to be promoted as a liveable city.

Limited research on US in Palembang, particularly in relation to urban parks, highlights the potential of these parks to reduce stress through outdoor recreation. By promoting park usage and increasing access to green space, Palembang could enhance its residents' mental health and well-being. Furthermore, limited funding for research on US and mental health, a common challenge in developing countries, is likely a factor in Palembang's situation. Data from the Palembang City Health Department in 2023 reveals that the community satisfaction index of 0.72 falls into the "Pre-Healthy Family" category

(Palembang City Health Service, 2023). This data suggests that Palembang needs to prioritise initiatives that promote better health and an RE for its citizens.

While numerous studies demonstrate a strong link between urban environments and US (Montanari et al., 2024; Pelgrims et al., 2021; Xu et al., 2023), limited research explores the specific role of a green open RE in mitigating stress within the context of Palembang, Indonesia. This study examines the potential of a green open RE to address US in Palembang. Urban stress (US) was measured using validated scales assessing perceived stress through ER, BR, and CR. Green RE will be evaluated based on Attention Restoration Theory, considering factors like opportunities for being away from stressors, the extent of the space, its capacity to hold attention, and its compatibility with users' needs. This research investigates the relationship between perceived US levels and the qualities of green RE. By doing so, it aims to bridge the knowledge gap on how these spaces can function as stress-reduction tools in cities like Palembang. Such cities face challenges in promoting mental well-being and achieving the psychological benefits necessary for a liveable urban environment.

LITERATURE REVIEW

Urban Stress (US)

Urban environments present a multitude of challenges, particularly related to stress and social sustainability (Israel & Wolf, 2016; Paudel & States, 2023). Studies have consistently shown a correlation between urban living and stress levels (Lederbogen et al., 2011; Montanari et al., 2024; Xu et al., 2023). Urban stress (US) is a prevalent phenomenon affecting city dwellers. It arises from various urban factors, including noise and air pollution, overcrowding, and green space scarcity (Ali Khan et al., 2023; Nguyen & Liou, 2024). Moreover, social and economic challenges such as long commutes, high living costs, social isolation, and safety concerns contribute to US (Dillon & Lee, 2023; Hashim et al., 2019). Chronic exposure to this stress can detrimentally impact physical and mental health, manifesting as reduced productivity, concentration difficulties, anxiety, depression, and other mental health problems (Lederbogen et al., 2011; Yang et al., 2019). Kaplan and Kaplan's (1989) Attention Restoration Theory (ART) posits that exposure to nature replenishes directed attention, enhancing CR and ER. Emotional (ER), BR and CR are key indicators of US (Hashim et al., 2019; Mohamad & Hussein, 2020; Rahmani Jami & Mohammadi, 2023).

Green Open Spaces as Restorative Environments (RE)

Human-nature connectedness and green open spaces are intrinsically linked (Dillon & Lee, 2023; Riechers et al., 2022). Both are crucial for fostering a deeper human-nature relationship. Green open spaces are indispensable for creating thriving, liveable cities (Dillon & Lee, 2023; Nath et al., 2018), offering

numerous benefits for people and the planet. As urbanisation progresses, ensuring equitable access to green space is paramount. Green open spaces inherently possess restorative qualities, contributing to reduced US (Polajnar Horvat & Ribeiro, 2023; Sibarani et al., 2023; Van den Berg et al., 2014). The Restorative Environment Theory posits that specific settings can rejuvenate mental and physical well-being. As a branch of environmental psychology, it investigates how environments can be designed to enhance well-being. Exposure to RE correlates with reduced stress, improved mood, heightened focus, and increased creativity. Key restorative qualities include: 1) being away (escaping daily pressures), 2) fascination (capturing attention), 3) compatibility (comfort and ease), 4) extent (space and solitude), and 5) coherence (order and clarity) (Hashim et al., 2019; Mohamad & Hussein, 2020; Van den Berg et al., 2014). The Attention Restoration Theory (ART) proposes a connection between RE and ER, BR, and CR. These environments are characterised by four core elements: being away (escape from daily pressures), fascination (elements that capture attention), compatibility (feeling comfortable and safe), and extent (sufficient space for exploration and solitude). The ART suggests that these characteristics contribute to positive ER, BR, and CR, ultimately leading to reduced stress and improved well-being.

RESEARCH METHODOLOGY

Studied Area

The Kambang Iwak Park Palembang (KIPP) is one of the parks located in Palembang, Indonesia. Its selection can be attributed to its central location, role in providing green open space, and history of attracting high visitor numbers (figure 1). Built during the early 1900s, the KIPP boasts a rich history that serves as a relic of the colonial era (Sinatra et al., 2021). The KIPP continues to thrive today. Originally constructed for the Dutch community as a sporting venue, the KIPP 's central lake offers not only aesthetic beauty but also a practical function: rainwater collection that helps mitigate flooding. The KIPP has transformed into a vital green public space in Palembang City, acting as the city's "lungs." Spanning an estimated 5 hectares (12.35 acres), the park provides a haven for relaxation and recreation. Visitors enjoy various amenities like a children's playground, seating areas, drinking water fountains, and even free Wi-Fi hotspots, allowing them to connect while basking in the shady garden atmosphere. It bustles with activity, especially on weekends. Diverse communities gather here, from music enthusiasts to roller skaters, cycling groups, and even dance and theatre troupes.

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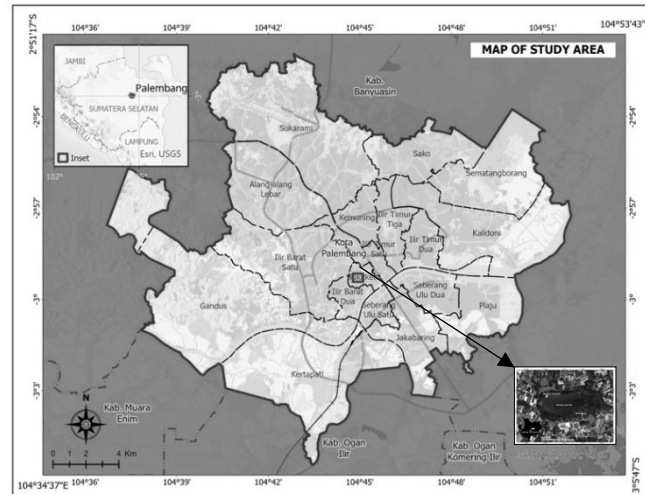


Figure 1. Study Area of Kambang Iwak Palembang Park
Source: Author

The park's jogging track caters to those seeking exercise, offering a scenic path around the lake for joggers and walkers alike. Table 1 presents the soft elements (vegetation) of the KIPP.

Table 1. The Soft Elements (Vegetation) in the KIPP

Type	Condition	Image
Green Cover	Green, uneven, not flowering, and not waterlogged.	
Decorations	There are various types of harmoniously-shaped, healthy ornamental plants. However, the colour of these plants lack diversity.	
Shade	Easy to clean, provides shade for visitors during hot weather, enhances the KIPP's aesthetic appeal, and does not damage the surrounding area.	

Source: Author

Table 2 presents the hard elements (infrastructure) of the KIPP, such as its pedestrian paths, seating, signboards, gazebos, park lighting, rubbish bins, information posts, and drinking water fountains.

Table 2. The Hard Elements (Infrastructure) in the KIPP

Type	Condition	Image
Pedestrian Paths	They are paved with tiles or ceramics and well-maintained.	
		
Seating	Comprises cement and iron garden benches, as well as benches facing the water reservoir. Due to the high number of visitors and limited seating, many visitors resort to sitting on the edges of potted plants.	
		
Gazebo	It is located in the playground area and is well-maintained. Parents often utilise it while watching their children play, while use it for respite.	
Rubbish Bins	They already separate organic and inorganic waste. The condition of the rubbish bins is good and they are evenly distributed at several points throughout the park.	
Information Posts	It is equipped with computers and closed-circuit television (CCTV) cameras located at several points throughout the park to monitor visitor activities.	

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Type	Condition	Image
Ready-to-Drink Water Fountains	Visitors can drink water for free, and it is in good condition.	

Source: Author

Data Collection and Analysis

This research employed a cross-sectional design using a questionnaire-based survey to investigate visitors' perceived US levels and the RE of the KIPP. Partial least squares (PLS) regression analysis was used to examine the relationship between the KIPP's RE (x) and US (y). The restorative environment construct was measured using the Perceived Restorativeness Scale, encompassing being away, extent, fascination, and compatibility. Urban stress (US) was assessed based on visitors' ER, BR, and CR (Figure 2).

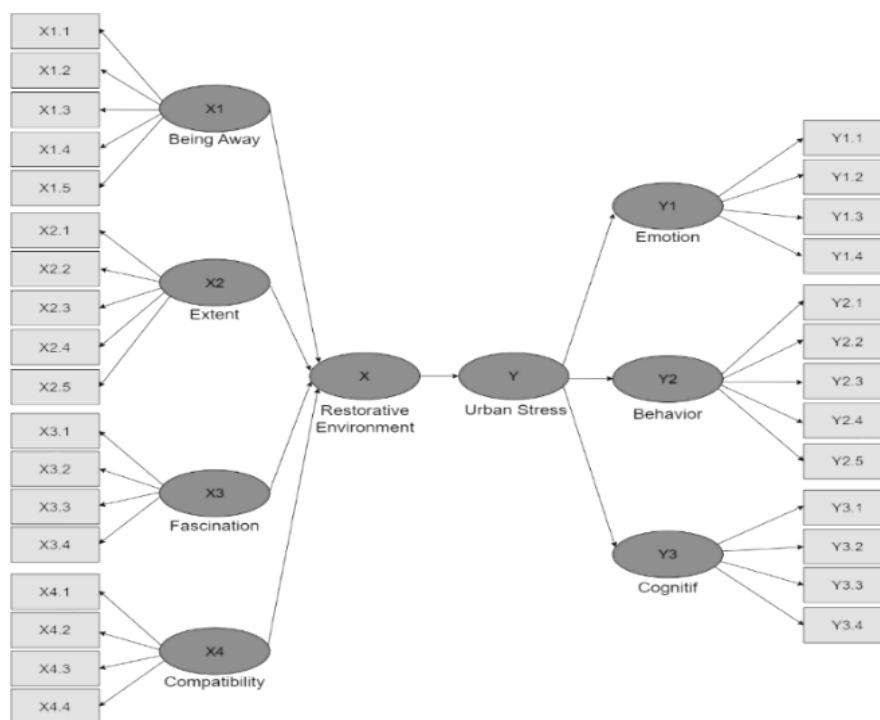


Figure 2. The Structural Equation Models in Partial Least Square

Source: Author

A reflective measurement model was employed for both the RE and US constructs. Partial least squares (PLS) regression analysis was then used to examine the relationship between these latent variables. The RE construct was operationalised using the Perceived Restorativeness Scale, encompassing the dimensions of being away, extent, fascination, and compatibility. Urban stress (US) was assessed based on visitors' ER, BR, and CR.

The study employed a non-probability convenience sampling approach, as described by Rea and Parker (1997). Participants were recruited based on their willingness to participate, presence in the park during data collection, and ability to understand and respond to survey questions. A cross-sectional survey design was used to collect data from 147 visitors who had completed their activities at the KIPP. Secondary information on park profiles and facilities was obtained from relevant agencies and institutions to complement primary data. The respondents' stress levels were assessed by evaluating three variables: ER, BR, and CR (Table 3).

Table 3. The Psychological Variables of Perceived US

Variable	Sub Variable	Indicator	Application in Research
Perceived US	ER	1. Anger 2. Anxiety 3. Disturbances 4. Worry	• ER to US • Feeling anxious due to US • Feeling disturbed due to US • Feeling worried due to US
	BR	1. Social Interactions 2. Socialisations 3. Boredom 4. Negative Behaviours	• Behaviours during social interactions • Behaviours during socialisation • Bored with daily routines • Negative behaviours
	CR	1. Memory Impairment 2. Concentration Impairment	• Frequent forgetfulness due to US • Poor memory or concentration when working or studying

Source: (Rahmani Jami & Mohammadi, 2023)

Four variables; namely, being away, extent, fascination, and compatibility, were used to assess the restorative qualities of green RE (Table 4).

Table 4. The Variables in an RE

Variable	Sub Variable	Concept	Application in Research
RE	Being Away	A feeling of being in a different place than usual and able to forget about everyday burdens.	• Forgetting the burdens of daily activities. • Free of noise. • Free of pollution. • Free of congestion.
	Extent	A place that provides facilities and recreational opportunities that are easily accessible and enjoyable by visitors.	• A variety of activities to be conducted. • Surroundings that can be enjoyed easily and freely.
	Fascination	An element that attracts visitors to return to the place.	• Boasts many interesting things. • Feeling like you want to spend more time there. • Many facilities that make you want to come back. • Choosing the park as a means of recreation/restoration.
	Compatibility	An element that gives visitors the freedom to do anything in the place.	• Fun activities can be conducted there. • Feeling comfortable. • Finding it easy to interact with others.

Source: (Chang et al., 2008; Hashim et al., 2019; Kaplan & Kaplan, 1989)

The data analysis was conducted in a step-by-step manner. The first step involved gathering visitor information, such as their demographics, health conditions, and perceptions of their experiences visiting the KIPP. This information was collected *via* surveys. It was crucial to verify the data to ensure the overall quality and reliability of the information. This involved identifying and correcting errors, missing data, and inconsistencies. The second step involved assessing the level of US among the visitors of the KIPP. This was accomplished by administering a questionnaire that included statements related to stress levels and measuring visitors' responses on a Likert scale. The responses were then categorised into different levels of US (Table 5).

Table 5. The Categories of US Levels

Score	Classification
20 – 36	None
37 – 52	Mild
53 – 68	Moderate
67 – 84	Severe
85 – 100	Very severe

Source: (Alkharusi, 2022; Yang et al., 2019)

Third, to examine the correlations between the RE of the KIPP and US, PLS analysis was employed (Hair et al., 2021). The PLS analysis involved: a) testing the linearity to assess the linearity of the correlations between variables; b) evaluating the measurement model to assess the validity and reliability of the constructs; c) examining the factor loadings to determine the strength of the correlations between constructs and indicators; d) assessing the model's fit via R^2 and Adjusted R^2 ; e) testing the significance of the correlations between the constructs; **f) developing a PLS path diagram** to visualise the correlations; **g) converting the path diagram into a structural equation model (SEM) for further analysis;** and h) identifying the dominant influence of an RE on US via path coefficient analysis.

RESULT AND DISCUSSION

This study examined the correlation between the demographics of the KIPP's visitors, such as their age, gender, and occupation, and their stress levels to understand the impact of green spaces on mental well-being. The dataset comprised the demographic profiles of 147 participants. As seen in Table 6, most of the respondents were women (67%) aged 18-29 (37.4%). Most of the respondents were from Palembang City (83%) and had university degrees (66.7%). Over half (52.4%) were employed and a significant portion (30.6%) had retired by the time of the survey. Of the four income brackets, most of the respondents ($n=36$) earned in the highest income bracket ($>Rp.7500000$), but the distribution was spread relatively evenly across all income brackets.

Table 6. The Characteristics of the Respondents

	n	Mean ($\bar{x}$)
Gender		
Gender	67	45.6
Female	80	54.4
Age (Years)		
18-29	55	37.4
30-39	43	29.3
40-49	24	16.3
50-59	15	10.2
60-65	10	6.8
Address/Place of Origin		
Palembang City	122	83
Outside Palembang City	20	13.6
Outside South Sumatra	5	3.4
Education Level		
University Degree	98	66.7
Lower	49	33.3
Employment Status		
Retired	77	52.4
Student	45	30.6
Unemployed	15	10.2
Other	10	6.8
Income Level		
<Rp.2500000	49	33.3
Rp.2500000-Rp.5000000	34	23.1
Rp.5000000-Rp.7500000	28	19
>Rp.7500000	36	24.5

Source: Author

Figure 3 presents the distribution of the visitors across the different US levels. None of the respondents reported "No" or "Very severe" US levels. Most of the respondents (65.9%) reported feeling "Moderate" levels of US followed by "Mild" (n=35) and "Severe" (n=15) levels of US.

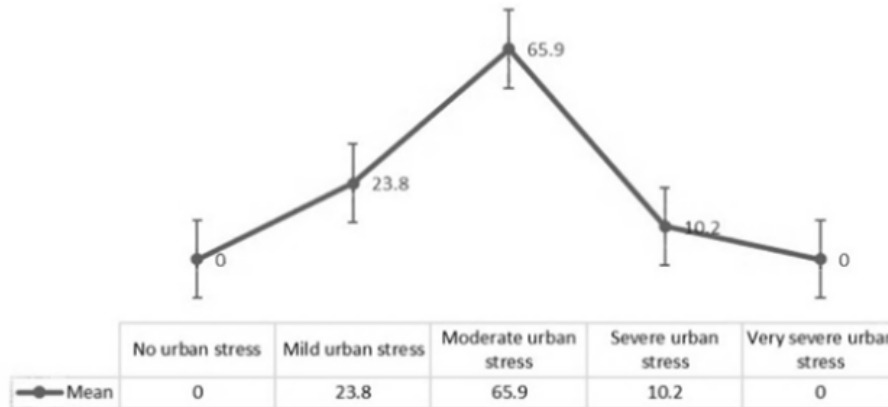


Figure 3. The US Levels of the KIPP's Visitors
Source: Author

A detailed analysis of Table 6 and Figure 3 revealed that the residents of Palembang City exhibit lower average US levels ($\bar{x}=83$) than those residing outside the city ($\bar{x}=13.6$) or South Sumatra ($\bar{x}=3.4$). However, it's crucial to consider the significantly smaller sample size outside Palembang City ($n=25$) relative to the city's population ($n=122$). Individuals with university degrees reported higher average US levels ($\bar{x}=66.7$) than those with lower education ($\bar{x}=33.3$). Retirees experienced the highest average US ($\bar{x}=52.4$), followed by students ($\bar{x}=30.6$), unemployed individuals ($\bar{x}=10.2$), and the "Other" category ($\bar{x}=6.8$). A trend of increasing US with higher income brackets emerged, with the lowest income group ($<Rp.2500000$) reporting the lowest average US ($\bar{x}=33.3$), whereas those with the highest income bracket ($>Rp.7500000$) reported the highest average US ($\bar{x}=24.5$).

This research defined "Moderate" US as a noticeable level of stress that disrupts daily life without being overwhelming or debilitating. This type of stress lasts longer but can be managed with coping strategies. Numerous urban factors contribute to "Moderate" US, including traffic congestion, noise pollution, overcrowding, lack of green space, and work pressure. To address this, prioritising the development and maintenance of green open spaces, such as parks and gardens, is crucial for promoting urban well-being. By creating readily accessible RE, cities can empower residents to manage stress, fostering healthier and more liveable urban communities.

Urban green spaces significantly contribute to overall well-being and quality of life. Research consistently demonstrates that green spaces with restorative qualities reduce stress, mental fatigue, and depression while improving mood. Table 8 presents the correlations between an RE and US using PLS regression analysis. The equation function (x) represented the KIPP's RE,

derived from the Perceived Restorativeness Scale (including being away, extent, fascination, and compatibility), while (y) represented US based on visitors' ER, BR, and CR. First, compatibility, encompassing all three dimensions (ER, BR, and CR), exhibited positive $\bar{x}$ path coefficients with relatively high standard errors. The t-statistics for all three were >1.63 , indicating a statistically significant and positive correlation between compatibility and lower US. This supports the notion that environments aligning with individual needs (ER, BR, and CR) are less stressful. Secondly, while fascination demonstrated positive $\bar{x}$ path coefficients, these had lower magnitudes and higher standard errors than compatibility. The associated t-statistics were <1 , suggesting that correlations may not be statistically significant. Therefore, further research is warranted to confirm or refute this finding.

Table 8. The Results of the PLS Analysis of the Correlation between RE and US

	Original	$\bar{x}$	Std. Error	Perc.025	Per.975	T-Stat
Compatibility → CR	0.4440	0.3350	0.2534	-0.3223	0.7511	1.7519
Compatibility → ER	0.3432	0.2498	0.2099	-0.1680	0.6641	1.6353
Compatibility → BR	0.3506	0.3400	0.1929	-0.0524	0.6962	1.8185
Fascination → CR	0.2153	0.2034	0.2466	-0.3175	0.6282	0.8729
Fascination → ER	0.1212	0.1973	0.2997	-0.3816	0.5435	0.5279
Fascination → BR	0.0610	0.1247	0.2630	-0.4814	0.5355	0.2320
Extent → CR	-0.078	0.0689	0.1683	-0.2630	0.3594	-
						0.4682
Extent → ER	-0.179	0.0654	0.2012	-0.3239	0.4082	-
						0.8927
Extent → BR	-0.328	-	0.3324	-0.4873	0.5099	-0.988
		0.0070				
Being Away → CR	-0.322	-	0.2546	-0.6334	0.3814	-1.265
		0.1954				
Being Away → ER	0.1576	0.2346	0.2406	-0.2984	0.7014	0.6552
Being Away → BR	0.1402	0.1478	0.2011	-0.3012	0.4746	0.6971

Source: Author

Third, the extent of the data revealed mixed results. While the extent of CR showed a negative path coefficient (potentially beneficial), the extent of ER and BR exhibited positive coefficients. The t-statistic for the extent of CR was negative but <1 , indicating no significant correlation. Similarly, the other two t-statistics were insignificant. These mixed findings suggest a complex correlation between the amount of exploration and discovery opportunities and stress. Fourth, being away demonstrated a negative $\bar{x}$ path coefficient and a t-statistic <-1.26 , signifying a statistically significant and negative correlation with stress. This aligns with the notion that environments facilitating daily life can reduce

stress. However, the positive but insignificant correlations between being away and ER and BR require further investigation.

The data suggests that compatibility and the ability to escape from daily life (being away) are most strongly and negatively correlated with US, highlighting their crucial roles in the KIPP's restorative potential. The impact of fascination remains unclear and warrants further investigation. The correlation between exploration opportunities (extent) and stress appears complex and requires additional research. Overall, these findings underscore the significant impact of an RE on US. To enhance urban well-being, cities should prioritise creating and maintaining accessible green spaces, like parks and gardens. Integrating restorative principles into urban design and promoting multifunctional green spaces is essential. By investing in diverse green spaces featuring natural trails, water features, and ample seating, cities can foster relaxation, social interaction, and a general sense of well-being among residents. This approach contributes to creating not only functional but also supportive urban environments, ultimately reducing US and promoting a healthier urban future.

CONCLUSION

This study sheds light on the role of the KIPP in Palembang as an RE for urban residents. Our findings reveal that visitors to the KIPP experience "Moderate" levels of US, potentially indicating manageable chronic stress. Additionally, the analysis aligns with past research by demonstrating a positive association between the KIPP's restorative qualities (compatibility, fascination, and being away) and reduced US levels. This reinforces the established notion that urban green spaces significantly contribute to well-being and quality of life, integrating with residents' daily experiences. In line with these findings, this study supports the creation and maintenance of urban green spaces as a valuable strategy to promote mental well-being and reduce stress in cities. Therefore, further efforts to enhance KIPP's RE and foster a human-nature connection are necessary to contribute to a more liveable Palembang.

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DISCLOSURE STATEMENT

The author has no competing interests to declare.

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