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DEVELOPING URBAN WALKABILITY MEASURES GROUNDED IN GREEN URBANISM PRINCIPLES USING THE DELPHI SURVEY STUDY

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Abstract

This paper investigates the correlation between Green Urbanism Principles (GUP) and urban walkability. It begins with a Literature Investigation to identify green urbanism components and principles by utilising the Green Urbanism concept by Beatley and Lehmann's Principles of Green Urbanism as a framework. Three-stage Delphi Surveys were conducted to conclude the associated GUP, parameters, potential indicators, and themes of Green Urbanism Quality with urban walkability. The study addresses a literature gap, which is found by linking green urbanism principles to walkability indices and fills it effectively. The outcome is the validated Green Urbanism Walkability Index (GUWI). Moreover, the research emphasises the need for a quality urban environment that stimulates walking in Malaysia. Four main themes of Green Urbanism Quality, namely Nature, Urbanism, Liveability, and Culture and Identity, significantly promote urban walkability. A walkable city triggers positive effects, including lively street-level activities, increased security, and economic stability. Landscapes, greeneries, and well-integrated pedestrian networks further enhance walkability. The results emphasise the crucial link between green urbanism principles and the walkability index, allowing for better identification and measurement of walkability. Implementing the system requires enhancing technical and cultural aspects through training, education, and regulation. This research contributes significantly to the body of walkability studies, particularly in the Malaysian context.

Keywords: Green Urbanism, Urban Walkability, Walkability Index, Delphi Survey

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INTRODUCTION

The speed of urbanisation in developing countries is a major spatial outcome of global capitalism (World Economic Forum, 2023). This uneven process leads to rural-urban imbalance, lopsided city hierarchy and housing segregation, as well as degenerating social and economic inequalities across cities and towns (Lomoro et al., 2017; Todaro, 1997). According to Cardoso (2022), lopsided development can be interpreted as uneven development, uncontrolled urbanisation, and degradation of both the environment and the quality of urban life.

In the Malaysian context, Alor Setar could be referred to in discussing this matter. As a capital city, Alor Setar is a prominent example of a secondary city in Malaysia, historically known for its accessibility to goods and services within walking distance (Jamin, Mohmad Shukri, Taib, & A M R, 2021; Mel'nikova, 2020). However, the city's recent expansions and developments have shifted its focus towards motorised transportation, diminishing its walkability (Ayob, 2020). Studies indicate a decline in active mobility among city dwellers due to a lack of street-level activities and a decrease in dynamic pedestrians (Abdul Latif et al., 2014; Ayob, 2020; Cardoso, 2022). This apparent decline might be associated with population growth, as observed in Kota Setar (Alor Setar city), where the population decreased from 3.25% in 2000 to 2.70% in 2020. Furthermore, the 2020 census revealed that the ageing society in the region reached 8.5% (Department of Statistics Malaysia-Kedah, 2020).

To attract both inhabitants and visitors alike, towns and cities must ensure safety, comfort, and pleasantness in their street environments to experience the town's unique attributes, values, and assets; these are crucial considerations in walkability indices (Samsudin et al., 2022; Rhodes et al., 2022). These factors encompass the three parameters of a walkability index: 1) Safety and Security, 2) Convenience and Attractiveness, and 3) Policy Support. The significance of proximity to goods and services, population dynamics, and street intersection concentration (i.e., connectivity) has become the key factor in typical walkability indices. Further study is needed to understand the magnitude of accessibility and the application of Green Urbanism principles to create a sustainable, safe, comfortable, and high-quality urban life for inhabitants in small towns (Rhodes et al., 2022).

SUSTAINABLE DEVELOPMENT – GREEN URBANISM PRINCIPLES

Malaysia's physical, conceptual and ideologies towards fully sustainable development are still at an initial stage and has yet to be as extensive as other developed countries. However, the visions and missions in that direction are echoed in the policies of both the Federal and Kedah State Governments (MBAS, 2020; Ministry of Science Technology & Environment, 2020). These endeavours

are possible with the application of the Green Urbanism Principles (Beatley, 2001; Lehmann, 2015) and should be applied consecutively to ensure the utmost success. Even so, at this stage, applying all the principles in Malaysia, where urban sustainability is still in its infancy, is unviable. For this research, selective principles (resulting from the three stages of the Delphi Survey) for a specific purpose (measuring urban walkability in the Secondary City in Malaysia) are proposed and tested.

The Definition of Green Urbanism

The term "Green Urbanism" has become prevalent in various media platforms, including newspapers, conferences, and social media, but its exact meaning remains elusive and vague. Despite this ambiguity, there is an inherent and instinctual understanding of its significance. However, the definition of Green Urbanism varies between authors and professionals in the field. Interestingly, most green urbanism definitions by scholars, researchers and professional practitioners revolve around the three (3) pivotal qualities of sustainability (as detailed in Table 1.0 below). Hence, the working definition of Green Urbanism for this research.

i. Natural Qualities - Qualities of the environment with great concern for synergetic co-existence between people and nature (and the management of energy and materials).
ii. Urbanism Qualities – The imprint of geographic, economic, political, social, and cultural environment forces on the built environment.
iii. Liveability Qualities – The Community's quality of life, including the built and natural environments, accessibility, connectivity and walkability, economic prosperity, social stability and equity, educational opportunity, and cultural, entertainment and recreation possibilities.

Table 1: Classification of Green Urbanism Definition Worldwide

No of Author	Years Range	Research Approach	Location	Definition of Green Urbanism		
				Nature	*Urbanism*	*Liveability*
38	2002 – 2017	Sustainability, Urbanism, Landscape,	Global, Asia and Malaysia	34	35	35

Source: Ayob (2020)

Site context

The study was conducted in a medium size city or secondary city of Alor Setar, the capital state of Kedah in Malaysia. The 2010 national census indicated that Alor Setar has a total land area of 666 km^2 with an estimated population of 405,523. The majority of its population dwells at the fringe of the city's boundary,

leaving a very small number of residents residing within the city centre (Jamin et al., 2021; Department of Statistics Malaysia-Kedah, 2020). Alor Setar is known as a secondary city due to its smaller population and medium economic growth, as well as its moderate infrastructure, facilities, and city income (Department of Statistics Malaysia, 2022; The Economic Planning Unit (Malaysia), 2023). Alor Setar City Council is pursuing sustainable development, a healthy lifestyle, and a walkable town, as it aims for a Liveable Township by 2035 (MBAS, 2018).

RESEARCH METHODOLOGY

Identifying Green Urbanism Principles associated with urban walkability in the Secondary city involved two phases of investigation. The first (1) phase was examining extensive literature on both domains of Green Urbanism and Walkability to understand the key concepts and principles. Phase two (2) employed the three-stage Delphi Survey, involving nineteen built environment experts and academicians in Malaysia.

In the first stage - Identification of Green Urbanism Principles that are related to urban walkability - each panel of experts was asked to individually select the most relevant principles associated with urban walkability among the fifteen (15) Green Urbanism Principles.

The second stage of the survey - Examining and discussing the selected principles (from Stage 1) and their detailed content for relevance to walkability**.** To extract and list as many indicators as possible from the detailed content of the selected principles, all panels of experts were asked to deliberate and review the pivotal issues of each principle and to work out the parameters and key attributes of Green Urbanism's association with walkability.

The third stage of the survey - Assessing the selected indicators (from Stage 2) to finally determine a list of Key Indicators that associate Green Urbanism with urban walkability**.** The panel of experts were asked to deliberate and work out the details of indicators based on their knowledge and understanding of Green Urbanism Principles and urban walkability. At the end of stage three, a Green Urbanism Index (ASGUI) set was established to measure urban walkability.

DISCUSSION OF DELPHI SURVEY FINDINGS

i. Delphi Survey-Stage 1- Associated Green Urbanism Principles (GUP) with Urban Walkability

Literature Investigations concluded that 15 GUP were involved in developing a sustainable-zero carbon city. However, not all fifteen principles can be used in measuring urban walkability. Table 2 below showcases the findings. Stage 1 of the Delphi Survey indicated that **Five** principles were selected by the panel of experts during Stage 1.

Table 2: Selection of FIVE GUPs after Stage 1 Delphi Survey by Experts.

Principles (GUP)	% (PCA)
1: Climate and context	68.4
5: Landscape, gardens and urban biodiversity	100.0
6: Sustainable transport & good public space: compact & polycentric cities	100.0
10: Liveability, healthy communities and mixed-use programs	100.0
12: Cultural heritages, identity and sense of place	100.0

Note: PCA = Percentage of Consensus of Agreement

Stage 1 of the survey adopts 66.7% as the cut-off point for the Consensus of Agreement percentage; the calculation for the Percentage of Consensus of Agreement (PCA) is done by a simple percentage formula below;

$$Percentage\ of\ Consensus\ of\ Agreement = \frac{Accumulated\ Given\ rating}{Total\ of\ Maximum\ Rating}\ x\ 100$$

ii. Delphi Survey-Stage 2- Identification of Themes, Parameters and Key Attributes from Identified Associated Principles

Stage 2 was divided into two parts; Part 1 consists of identifying Themes, Parameters and Key Attributes from the five selected principles (from Stage 1). The outcome of the first part is a list of parameters and key attributes based on each selected principle. Part 2 determines the relevancy of all parameters and key attributes for the research and its suitability for Malaysian SC, particularly Alor Setar.

At the end of the Stage 2 session, the panel of experts, upon detailed deliberation of the site context and the nature of research, all agreed to discard GUP 1, citing that GUP 1 was focused on the city's architectural development as the primary reason. This is evident in GUP 1 detail description: "… all buildings will have climate-adapted envelope technologies, with fully climate-responsive facades" (Lehmann, 2010, 2015). The testing on the relevancy of Principle 1 using the four parameters employing Intraclass Correlation Coefficient (ICC) analysis, as in Table 3, indicated 75.5% of participants opted for 'NO' on the relevancy of Principle 1, which is very significant.

Table 3: Intraclass Correlation Coefficient: Principle 1 Relevancy for the Research

Intraclass Correlation Coefficient							
Principle 1: Climate and Context – The Parameters and Key Attributes							
	Intraclass Correlation [b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.436[a]	.207	.681	4.074	18	54	.000
Average Measures	.755	.511	.895	4.074	18	54	.000

Two-way random effects model where both people effects, and measures effects are random.
a. The estimator is the same whether the interaction effect is present or not.
b. Type A interclass correlation coefficient using an absolute agreement definition.

The exclusion of Principle 1 and its parameters was based on three grounds: 1) Redundancy of Parameters and Key Attributes with other Principles; 2) Limitation of information and records on-site/local authority; 3) Not relevant to the local context (especially in Malaysia's small towns and Medium-sized City).

Next, the Frequency Analysis on Principles 5,6,10, and 12 indicated that the majority of the participants opted for 'Yes' on the relevancy of Key Attributes to their Parameters with the Percentage of Consensus of Agreement of above 66.7% cut-off point; thus, validated all Key Attributes to their Parameters. The Intraclass Correlation Coefficient (ICC) calculation of Principles 5, 6, 10 and 12 Key Attributes to its Parameters indicated Sig. Values of 0.002, thus indicating a highly significant, as indicated in Table 4 below.

Table 4: Intraclass Correlation Coefficient: The Relevancy of Principles 5, 6, 10 and 12 for the Research

Intraclass Correlation Coefficient							
Principle 5: Landscape, Gardens and Biodiversity – The Parameters and Key Attributes, Principle 6: Sustainable Transport and Good Public Space; Compact and Poly- Centric Cities – The Parameters and Key Attributes, Principle 10: Liveability, Healthy Communities and Mixed-Use Programmes – The Parameters and Key Attributes, Principle 12: Cultural Heritage, Identity and Sense of Place – The Parameters and Key Attributes.							
	Intraclass Correlation [b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.412[a]	.130	.682	3.077	18	54	.002
Average Measures	.677	.310	.866	3.077	18	54	.002

Two-way random effects model where both people effects, and measures effects are random.
c. The estimator is the same whether the interaction effect is present or not.
d. Type A interclass correlation coefficient using an absolute agreement definition.

Hence, the Stage 2 outcome (Table 5) was a list of Four Principles, 11 Parameters and 28 Key Attributes as follows:

Table 5: Result from Stage 2 Delphi Survey: The identified Themes, Parameters and Key Attributes extracted Green Urbanism Principles associated with Urban Walkability.

GUP	PRINCIPLE	THEME	PARAMETERS	KEY ATTRIBUTES
5	**Principle 5: Landscape, Gardens and Urban Biodiversity**	Nature and Biodiversity	1. Urban Cooling	a) Presence of Urban Vegetation; b) Inner city garden; c) Urban farming; d) Building greenery
			2. Integrated Urban Landscape	a) Urban landscape; b) Accessibility to parks, gardens & public spaces; c) Leisure & recreation
			3. Local Biodiversity	a) Habitat; b) Ecology; c) Wildlife Rehabilitation; d) Forest Conservation
			4. Conserving Natural Resources	a) Restoring Streams; b) Re-establishing Riverbanks
6	**Principle 6: Sustainable Transport and Good Public Space: Compact and Poly-centric Cities**	Sustainable Urbanism	5. Sustainable Transport System	a) Integrated non-motorized transport (cycling/walking); b) Integrated motorised transport (private/public)
			6. Good Public Space Network	a) Pleasant public spaces; b) Pedestrian network and connectivity
			7. Compact And Polycentric City	a) Land uses; b) Diversity
10	**Principle 10: Liveability, Healthy Communities and Mixed-use Programs**	Liveability	8. Liveability	a) Housing range and users; b) Sense of community
			9. Healthy Community And Mixed-Used Programmes	a) Amenities and facilities b) Healthy communities
12	**Principle 12: Cultural Heritages, Identity And Sense of Place**	Culture, Heritage & Identity	10. Cultural Heritage	a) Local culture b) Heritage
			11. Identity And Sense Of Place	a) Historical elements b) Historical dominance c) Spiritual presence

iii. Delphi Survey-Stage 3 – Identification of Indicators

The Stage 3 objective is to develop a list of indicators for fieldwork. Stage 3 started with the weighing of the definition of Green Urbanism, a detailed description of each Principle, the traverse of key attributes, and finally, arriving at the detailed, measurable indicators for urban walkability established from Green Urbanism principles. The identified indicators were then tabulated for detailed discussion, where the process of addition and omission took place based on mutual and majority agreement for the final register of the Green Urbanism Indicators list.

Delphi Survey-Stage 3 (a) -The Preliminary Listing of Indicators

Apart from their experiences and knowledge on the topic, the participants referred to four publications and a set of current journal articles, namely: 1) Green

Urbanism – Learning from European Cities by Timothy Beatley (2000); 2) Green Urbanism Down Under – Learning from Sustainable Communities in Australia (2009); 3) The Principle of Green Urbanism – Transforming the City for Sustainability by Stephan Lehmann (2010, 2015); 4) Green Urbanism in Asia – The Emerging Green Tigers by Peter Newman and Ann Matan (2013); 5) The currently published journals provided by the author in the form of softcopy. Subsequently, the preliminary listing of Indicators after the first round of discussion has identified 72 indicators, as shown in Table 6 for all Key Attributes.

Table 6: Total Number of Parameters, Key Attributes and Indicators for Each Principle

Principle	Parameters	Key Attributes	Preliminary Indicator
Principle 5	4	13	37
Principle 6	3	6	17
Principle 10	2	4	9
Principle 12	2	5	9
Total	11	28	72

Delphi Survey-Stage 3 (b) -Refining the List of Green Urbanism Indicators

Refining the preliminary list of indicators involved a process of 'omission and addition' to identify the best-suited indicators fit for the research and site context. The second round of rigorous discussion and rationalisation has identified 14 overlapping and redundant indicators that can be merged and will not jeopardise the inclusivity and entirety of the final index. Three indicators were amended by re-wording them for easy understanding. The Key Attribute of Historical Dominance was omitted and merged with the Historical Element, and one Key Attribute (Identity) with Indicator (Showcase Distinct Image and Identity) was added.

Delphi Survey-Stage 3 (c) -The Final List of Green Urbanism Indicators

All participants have reached a consensus on the agreement for an amended list of 58 Indicators. Table 7 below displays the list of indicators for each key attribute, such as the Stage 3 Delphi Survey outcome.

Table 7: The Final List of Principles, Parameters, Key Attributes and Indicators

PRINCIPLE 5: LANDSCAPE, GARDENS AND BIODIVERSITY		
Parameter	**Key Attribute**	**Indicator**
1- Urban Cooling	a) Presence of urban vegetation	1) Functional trees -street planting
		2) Aesthetic & display– palms/shrubberies
	b) Inner-city Garden	3) Pocket park/vertical garden/linear garden/display garden
		4) Mix users and activities
		5) Social interaction and community activities
	c) Urban farming	6) Plot land/bedded/potted
	d) Building greenery	7) Green roof and balcony
2- Integrated urban landscape	a) Urban landscape	8) Image/identity creation
		9) Coverage (continuous throughout the city)
	b) Accessibility to parks, gardens & public spaces	10) Access legibility
		11) Sense of direction (notice board, direction signs, visual linkage)
		12) Connection to public transport
		13) Easy access for pedestrian (connection with primary/secondary roads)
		14) Easy access vehicle (connection with primary/secondary roads/parking)
	c) Leisure & recreation	15) Recreational park -Relaxation/Strolling -Exercise and Jogging
3- Local Biodiversity	a) Habitat	16) Presence of wildlife
		17) Presence of urban wildlife (crows, pigeon, stray cats & dogs)
	b) Ecology	18) Presence of urban peri-landscape
		19) Presence of native vegetation
		20) Inclusion of natural resources in urban development (trees, rivers and wildlife)
	c) Forest Conservation	21) Presence of urban forest
4- Conserving Natural Resources	a) Restoring Streams	22) Reintroducing streams and rivers in the city
		23) Maintenance and management of streams and rivers
	b) Re-establishing Riverbanks	24) Reinstating uses and function of riverbanks
		25) Presence of recreational activities along the river
		26) Presence of community involvement/activities along the riverbanks

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PRINCIPLE 6: SUSTAINABLE TRANSPORT AND GOOD PUBLIC SPACE COMPACT AND POLY - CENTRIC CITIES		
Parameter	**Key Attribute**	**Indicator**
5- Sustainable Transport System	a) Integrated non-motorised transport (cycling/walking)	27) Presence of pedestrian walkways network
		28) Assigned walkways/Paved or Unpaved path
		29) Availability of cycling lanes and Facilities
		30) Safe pedestrian ways
		31) Safe bicycle ways
	b) Pedestrian Network and Connectivity	32) Integrated public and private transport system
		33) Centralised parking spaces (park and ride)
		34) Availability & close proximity of public transport stations/stops along pedestrian routes
6- Good Public Space Network	a) Pleasant public spaces	35) Good legibility and accessibility
		36) Presence of social interaction and community activities
	b) Pedestrian Network and Connectivity	37) Connected pedestrian network
		38) Streetscape that encourage healthy and active life
7- Compact and polycentric city	c) Land uses	39) Close proximity to residential areas
		40) Mix development / land use (residential and business)
	d) Diversity	41) Diverse business types

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PRINCIPLE 10: LIVEABILITY, HEALTHY COMMUNITIES AND MIXED-USE PROGRAMMES		
Parameter	**Key Attribute**	**Indicator**
8- Liveability	a) Housing range and users	42) Mixed users - social status (based on housing type)
		43) Mixed users – age, race, workers/students (city campus)
	b) Sense of community	44) Compact housing and communities
		45) Connected housing areas
9- Healthy community & Mixed-use programmes	a) Amenities and facilities	46) Integrated housing amenities and facilities
		47) Community centres
	b) Healthy communities	48) Facilities for healthy lifestyles
		49) Recreational areas and facilities
		50) Social spaces

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PRINCIPLE 12: CULTURAL HERITAGES, IDENTITY AND SENSE OF PLACE		
Parameter	**Key Attribute**	**Indicator**
10- Cultural Heritage	a) Local culture	51) Cultural significant/values (day to day activity/story)
	b) Heritage	52) Heritage values (areas/buildings/structures/activity)
11- Identity & Sense of place	a) Historical elements	53) Local based history
		54) Foreign influences history
		55) Historical significant structures/artefacts)
	b) Identity	56) Showcase distant image and identity
	c) Spiritual presence	57) Religious based
		58) Cultural and race based

Validation of the Final List of Indicators

Two validators, who were senior academics from distinct local public universities, were assigned to assess and validate the finalised set of indicators. Each validator independently reviewed the completed list and then ranked them based on their relevancy. The ranking ranges from '1' = very low to '5' = very high. The results of the relevancy ranking were then calculated and analysed using the Cohen Kappa Coefficient (k) in SPSS to measure inter-rater agreement between the two validators. Cohen Kappa's analysis is very comprehensive in analysing the inter-rater coefficient or agreement between two raters (Koo, Guhathakurta, & Botchwey, 2022) as it omitted chances (Li, Gao, & Yu, 2023). Table 8 below displays the Level of Agreement between the two validators, which indicates a very high level of agreement.

Table 8: Level of Agreement Between Two Validators

Validator 2 * Validator 1 Crosstabulation						
			Validator 1			*Total*
			Moderate	*High*	*Very High*	
Validator 2	*Moderate*	*Count*	2	0	0	2
		Expected Count	.1	.3	1.7	2.0
		% within Validator 2	100.0%	0.0%	0.0%	100.0%
		% within Validator 1	100.0%	0.0%	0.0%	3.4%
		% of Total	3.4%	0.0%	0.0%	3.4%
	High	*Count*	0	8	3	11
		Expected Count	.4	1.5	9.1	11.0
		% within Validator 2	0.0%	72.7%	27.3%	100.0%
		% within Validator 1	0.0%	100.0%	6.3%	19.0%
		% of Total	0.0%	13.8%	5.2%	19.0%
	Very	*Count*	0	0	45	45
		Expected Count	1.6	6.2	37.2	45.0
		% within Validator 2	0.0%	0.0%	100.0%	100.0%

Validator 2 * Validator 1 Crosstabulation					
		Validator 1			*Total*
		Moderate	*High*	*Very High*	
y *H* *i* *g* *h*	*% within Validator 1*	0.0%	0.0%	93.8%	77.6%
	% of Total	0.0%	0.0%	77.6%	77.6%
Total	*Count*	2	8	48	58
	Expected Count	2.0	8.0	48.0	58.0
	% within Validator 2	3.4%	13.8%	82.8%	100.0%
	% within Validator 1	100.0%	100.0%	100.0%	100.0%
	% of Total	3.4%	13.8%	82.8%	100.0%

Both validators agreed that 45 out of 58 indicators as very high relevancy, which is higher than the expected count value (by change value) of 37.2; eight indicators were found to have high relevancy, and two were moderate, higher than the expected count of 1.5 and 0.1, respectively.

Table 9: The Kappa Value for the Level of Agreement Between the Two Validators

Symmetric Measures					
		Value	*Asymptotic Standard Error* [a]	*Approximate T* [b]	*Approximate Significance*
Measure of Agreement	*Kappa*	.844	.088	7.537	.000
N of Valid Cases		58			

[a]. Not assuming the null hypothesis.
[b]. Using the asymptotic standard error assuming the null hypothesis.

The Kappa value is 0.844 or (84.4%) with a standard error of 0.088. Table 9 above, indicates the Level of Agreement beyond chance is **Almost Perfect Agreement** with a statistical significance value of 0.000, indicating that it is highly significant (as the interpretation of the Kappa value).

Accordingly, the list of indicators as selected by the participants has been validated with Kappa Value of 'Almost Perfect Agreement' and with a high significance Level of Relevancy related to i) the purpose of the research, ii) the validity of the list of indicators, and iii) the site context. Therefore, as in Table 7 above, the list of indicators was validated and accepted as the Green Urbanism Walkability Index (GUWI) as a tool to measure urban walkability in secondary cities.

CONCLUSION

The study highlights the correlation between Green Urbanism Principles (GUP) and urban walkability. It begins with a Literature Investigation to identify green

urbanism components and principles. Three-stage Delphi Surveys were conducted to conclude the associated GUP, parameters, potential indicators, and themes of Green Urbanism Quality with urban walkability. The outcome is the validated Green Urbanism Walkability Index (GUWI). Thus, the research emphasises the need for a quality urban environment that stimulates walking in Malaysia. Four main themes of Green Urbanism Quality, namely Nature, Urbanism, Liveability, and Culture and Identity, significantly promote urban walkability. A walkable city triggers positive effects such as lively street-level activities, increased security, and economic stability. Landscapes, greeneries, and well-integrated pedestrian networks further enhance walkability. This research contributes significantly to the body of walkability studies, particularly in the Malaysian context.

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