Geografia-Malaysian Journal of Society and Space 22 issue 3 (114-139)
© 2026, e-ISSN 2682-7727 https://doi.org/10.17576/geo-2026-2203-08

Conservation of biodiversity spatial areas in Perdana Botanical Gardens Kuala Lumpur

Muhammad Ridha'i Mahdi, Alamah Misni

Studies for Landscape Architecture, Faculty of Built Environment, Universiti Teknologi MARA

Correspondence: Alamah Misni (email: alamahmisni@gmail.com)

Received: 1 December 2025; Accepted: 25 January 2026; Published: 26 August 2026

Abstract

Urban green spaces in cities face numerous threats due to various challenges. The reduction of these green areas is attributed to inefficient land use, pollution, habitat destruction, and rapid urbanization. These issues undermine the importance of biodiversity in urban settings and negatively impact natural environments. A specific area facing significant ecological challenges is the Perdana Botanical Gardens, located in the heart of Kuala Lumpur. This study focuses on biodiversity and conservation efforts within the Gardens. It examines five landscape attributes form and size, vegetation, artificial materials, surrounding land use, and wildlife activity that contribute to the preservation of biodiversity in an urban park. Visitors to the park were randomly surveyed, with 100 participants contributing to the questionnaire. The data were analysed using SPSS, and PLS-SEM was employed to validate the relationships between landscape parameters and biodiversity. Using a structural model, the study explored connections between biodiversity conservation and the five landscape elements. The findings revealed that these five factors significantly influence the park's efforts to conserve biodiversity. Among these, the types of plants, park configuration, and associated habitats have the most substantial impact on urban park biodiversity. Even in densely populated urban areas, biodiversity can be enhanced through effective ecological design practices, such as introducing artificial habitats, incorporating native vegetation, and implementing thoughtful space planning. The Perdana Botanical Gardens exemplifies how ecological preservation can be maintained amidst urban expansion in the tropical city of Kuala Lumpur.

Keywords: Biodiversity, conservation, ecological design, landscape, Perdana Botanical Gardens, urban green space

Introduction

Urban green areas play a crucial role in sustainable urban development due to their significantecological functions, including habitat provision, carbon sequestration, air purification, temperature regulation, and recreational use. These areas act as essential ecological buffers in rapidly growing cities, where compact development often leads to biodiversity loss and habitat fragmentation (Danneck et al., 2023). In tropical countries like Malaysia, known for their rich biodiversity, urban parks are vital for maintaining ecological integrity. However, the rapid pace of urbanization has resulted in pollution, habitat loss, and the undervaluation of urban parks in the planning processes (Buyadi et al., 2013; Marselle et al., 2021; McDonald et al., 2020; Misni & Basir, 2022).

Perdana Botanical Gardens, a 91.6-hectare urban park located in the centre of Kuala Lumpur, serves as both an ecological and historical landmark. Despite its size and ecological importance, the park faces several anthropogenic pressures, such as land-use encroachment, pollution, and heavy tourist activity. These pressures threaten its potential to serve as a biodiversity refuge within the city. According to Danneck et al. (2023), factors like vegetation structure, park design, and adjacent land use directly affect biodiversity levels. However, there is a lack of empirical studies examining how these variables operate within Malaysia's urban landscape.

There is a significant research gap regarding the impact of incorporating both artificial and natural elements in urban parks like Perdana Botanical Gardens on biodiversity. While global studies have shown the benefits of green infrastructure for protecting urban biodiversity (Dearborn & Kark, 2010; McKinney, 2008; Niemelä, 1999), regional studies in Southeast Asia remain limited. Therefore, comprehensive, context-specific evaluations are necessary to guide sustainable urban planning and conservation efforts. This study addresses these knowledge gaps by analysing the ecological condition and distribution of biodiversity in Perdana Botanical Gardens. It evaluates the effects of five key factors: park shape and size, forest cover, artificial features, wildlife habitats, and the landscape arrangement and land use surrounding the park. By integrating landscape ecology with field assessments, this study aims to determine the effectiveness of dominant biodiversity protection strategies and provide data-driven recommendations for managing urban green spaces in tropical urban environments.

Literature review

Urban green spaces in city areas are crucial for maintaining ecological balance and enhancing biodiversity. This study focuses on conservation initiatives and biodiversity growth within central urban areas, which are identified as the most significant green spaces. We highlight the role of parks as models for urban biodiversity conservation in green urban environments. The study examines various factors, including the richness of flora and fauna, land use, landscape, and other ecological preservation techniques.

Biodiversity conservation of urban green spaces

Biodiversity refers to the variety and variability of living organisms within ecosystems. This includes genetic diversity, species diversity, and ecosystem diversity, all of which contribute to ecological resilience and the functioning of natural systems in the urban green spaces such as Perdana Botanical Gardens. Conserving urban biodiversity requires an interdisciplinary approach that combines ecological science, urban planning, and community engagement. The Perdana Botanical Gardens aligns with Malaysia's National Policy on Biological Diversity (2016–2025), which emphasizes inclusive and evidence-based governance for biodiversity (Yusof et al., 2020). The park currently implements strategies such as habitat enhancement, species monitoring, and public education. However, the conservation agenda must evolve to keep pace with the rapid rate of urbanization. Danneck et al. (2023) identified pollution, fragmentation, and invasive species as significant threats to tropical cities. Furthermore, Ariffin et al. (2023) highlighted the importance of incorporating biodiversity-friendly design into urban planning and engaging the surrounding community in monitoring efforts. These measures are essential for integrating conservation values into everyday urban life.

Shape and size at Perdana Botanical Gardens

Urban green coverage and its configuration play essential roles in driving ecological functions and species diversity. Larger and more geometrically complex parks have a greater capacity to support a variety of flora and fauna. This is primarily because they provide a more diverse range of habitats and reduce edge effects (McGarrigle et al., 2020). The Perdana Botanical Gardens, with its structurally varied but interconnected design, facilitates habitat connectivity, allowing small mammals, reptiles, and birds to move and reproduce effectively. Research has shown that the size of urban parks is directly related to habitat quality and the resilience of biodiversity. For example, Liu et al. (2022) found that urban parks larger than 50 hectares tend to support stable populations of birds and insects. Additionally, complexly shaped patches can create ecotones, which enhance areas of species interaction. However, these complex edges may also introduce edge effects that can degrade the quality of interior habitats if not managed properly (Xie et al., 2023). Therefore, spatial planning must balance compactness and edge complexity to maximize biodiversity gains.

Vegetation composition in botanical gardens

The diversity of indigenous vegetation, vertical stratification, plant architecture, and the presence of native species all play significant roles in shaping urban biodiversity. A variety of native plant species provides essential resources such as nectar, seeds, and nesting materials for both specialist and generalist organisms (Tan & Samsudin, 2022). According to Rahman et al. (2024), the three dimensions of forest vegetation, ornamental gardens, and native tropical species found in Perdana Botanical Gardens create diverse ecological niches. As tree and shrub diversity increases, so does the richness of avian species and pollinators. This effect is particularly pronounced in tropical regions, where the vertical stratification of vegetation can provide refuge for birds, bats, and arboreal mammals simultaneously (Nguyen et al., 2021). Additionally, planting native species helps maintain ecosystem processes and reduces the likelihood of biological invasions (Misni, 2015).

Artificial components for bird habitat

Artificial structures, such as birdhouses, viewing towers, trails, and water bodies, can enhance natural environments when they are well-integrated with ecological design. In Perdana Botanical Gardens, examples of such structures include aviaries, wetlands, and lakes, which aim to maximize microhabitats for urban biodiversity, particularly for birds. These features not only contribute to habitat creation but also serve educational and recreational purposes (Lee et al., 2021). Previous research has indicated that when designed with ecological considerations, artificial infrastructure can boost biodiversity. For instance, Hashim et al. (2023) observed higher bird diversity in artificial wetlands within Southeast Asian urban parks, attributed to increased water and plant resources. However, it is crucial to manage this infrastructure effectively to prevent negative outcomes, such as habitat fragmentation or heightened human disturbance (Xu & Yang, 2020).

Wildlife habitat and landscape patterns

Wildlife habitat and landscape patterns are closely interconnected. The structure, composition, and configuration of landscapes such as patch size, fragmentation, connectivity, and edge characteristics directly influence species distribution, movement, and ecological processes. Changes in land-use patterns can enhance or degrade habitat quality, affecting biodiversity and ecosystem resilience. The Perdana Botanical Gardens feature a mosaic of aquatic, forest, and open lawn communities, which helps maintain ecological connectivity among habitats. However, the edge effects of city roads and surrounding development may limit the mobility of disturbance-sensitive species. Landscape heterogeneity is a key driver of faunal diversity. Nielsen et al. (2021) emphasized that a variety of land covers and well-connected patches of urban green spaces facilitate species movement and gene exchange. Supporting this, Zhou et al. (2024) demonstrated that well-maintained buffer strips and diverse microhabitats in urban parks lead to higher bird species diversity in densely populated cities. To prevent landscape fragmentation, it is essential to preserve or restore ecological corridors and natural edges.

Surrounding land use

Land use patterns surrounding parks significantly affect biodiversity by introducing external pressures such as noise, pollution, and visual disturbances (Misni & Suran, 2018). The Perdana Botanical Gardens, which is adjacent to civic institutions and urban infrastructure, faces potential conflicts between human activity and ecological integrity. However, its proximity to KL Bird Park and Bukit Tunku offers opportunities for ecological connectivity that can be leveraged through coordinated planning. Karuppannan et al. (2014) recommend incorporating green infrastructure buffers and ecological linkages in high-density areas to reduce negative impacts. Similarly, a study by Rosli et al. (2022) found that green corridors connecting fragmented urban parks led to an increase in wildlife sightings and improved habitat functionality. This indicates that integrative land-use zoning and green infrastructure policies are essential for fostering biodiversity resilience.

Table 1. Study on biodiversity conservation in urban green area

No.	Author	Urban green area	Biodiversity conservation	Method	Finding and gap
1.	McGarrigle et al. (2020)	Urban Park structure in UK cities	Influence of park shape and connectivity on species movement	Spatial landscape analysis (Quantitative)	Irregular and interconnected park shapes improve habitat accessibility and species movement – limited in UK
2.	Tan & Samsudin (2022)	Flora & fauna conservation in Malaysia	Importance of native vegetation in supporting urban biodiversity	Thematic analysis & expert interviews (Qualitative)	High plant diversity enhances pollinator and bird populations – limited to fauna; birds
3.	Rahman et al. (2024)	Tropical parks in Malaysia	Role of plant diversity in delivering	Field assessments & ecological	Diverse tropical vegetation improves air quality,

No.	Author	Urban green area	Biodiversity conservation	Method	Finding and gap
			ecosystem services	evaluation (Quantitative)	cooling, and habitat provision –limited to flora
4.	Lee et al. (2021)	Urban parks with artificial wetlands	Use of artificial structures to boost ecological function	Case study and infrastructure mapping (Mixed-method)	Artificial elements (e.g., wetlands, birdhouses) increase habitat heterogeneity – limited to fauna; birds
5.	Nielsen et al. (2021)	Landscape fragmentatio n & edge effects	Impact of landscape patterns on habitat use and resilience	GIS mapping & ecological modelling	Fragmented landscapes reduce species survival; ecological corridors are crucial – limited for fragmented green areas
6.	Karuppannan et al. (2014)	Urban planning in KL	Land use impact on biodiversity in high-density zones	Policy review & spatial analysis (Qualitative)	Dense development pressures reduce biodiversity; connectivity must be reinforced – limited to flora
7.	Yusof et al. (2020)	Governance of biodiversity in Malaysia	Policy effectiveness and community engagement in conservation	Policy analysis & stakeholder interviews (Qualitative)	Community action is essential for urban biodiversity success under national policies – limited for policy and community
8.	Aronson et al. (2023)	Global tropical city parks	Climate resilience and biodiversity interactions in urban areas	Cross-city comparative study (Quantitative)	Vegetation structure and thermal comfort co-benefit biodiversity and humans – limited for climate resilience
9.	Marselle et al. (2021)	Urban nature and human health	Health outcomes linked to biodiversity exposure	Literature review and framework analysis	Access to biodiverse green areas improves physical and mental health – limited for human health
10.	McDonald et al. (2020)	Urban biodiversity frameworks globally	Strategic biodiversity integration into urban growth	Global data synthesis (Qualitative)	Urban biodiversity must be embedded in planning policies for sustainability – limited for urban biodiversity framework

Table 1 summarizes previous research on urban green areas and the methods employed in these studies. It highlights the various strategies used by researchers and the number of published articles related to urban green areas, with a focus on urban ecological habitats and their biodiversity. However, there is a noticeable gap in understanding the factors that can influence biodiversity conservation in remote green areas within the densely developed and populated central city of Kuala Lumpur.

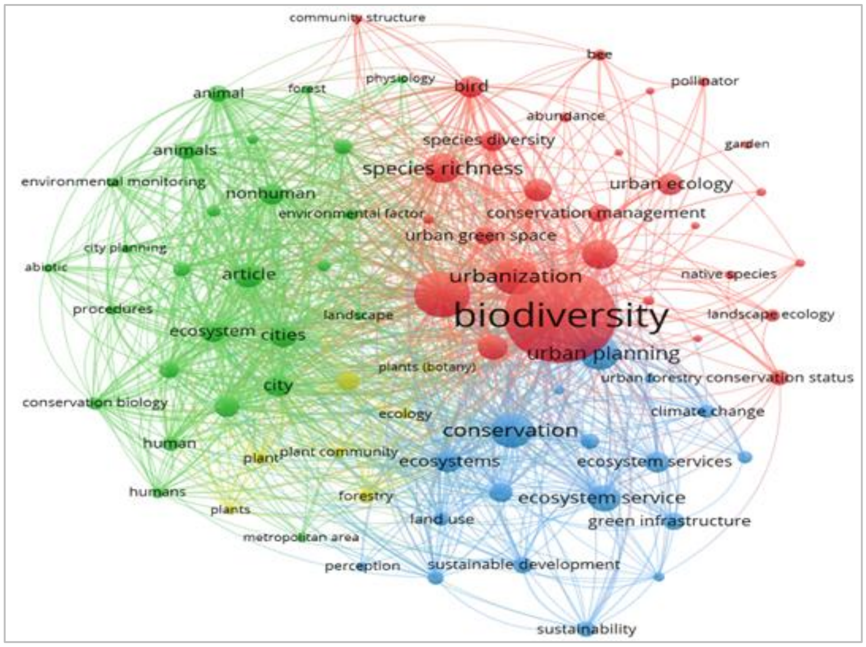


Figure 1. Keywords co-occurrence network related to biodiversity and conservation

VOSviewer is commonly used for analysing scientific literature because it allows users to visualize the connections between different entities, such as keywords, authors, and publications (Bukar et al., 2023). In this visualization, each node represents a term or idea related to the study's subject. The colours in the network indicate various groups or topics (Figure 1). One of the primary findings is the keyword "biodiversity," which highlights its significance within the network in the red cluster. The Blue Cluster represents the second major finding, focusing on conservation and ecological studies, with associated phrases like "urban planning," "land use," and "urban forestry." This cluster emphasizes how biodiversity influences urban green spaces. Finally, the Green Cluster contains terms such as "environmental," "landscape," and "city," which relate to the physical dynamics of urban settings and their effects on urban green spaces. The graphic demonstrates the complex relationships among biodiversity, urban green spaces, and urban ecology, highlighting the diverse nature of research aimed at protecting urban biodiversity.

The research examined agrees that factors such as spatial connectedness, vegetation diversity, and effective governance are crucial for supporting urban biodiversity. However, there are disagreements regarding the importance of park layout compared to park size, the dominance of native species versus overall plant richness, and the ecological value of artificial habitat components, which often benefit only a limited number of species. Additionally, while recent studies have demonstrated that biodiversity, climate resilience, and human health are interconnected and mutually beneficial, the exact mechanisms driving these relationships are not yet fully understood. These inconsistencies highlight the need for a comprehensive framework to explore the biological, spatial, and governance implications for urban biodiversity.

The theoretical hypothesis framework

In response to the limitations identified in previous research, this paper presents an integrated theoretical framework for biodiversity conservation in urban green spaces. Table 1 and Figure 2 summarizes empirical findings and highlights regular patterns that inform the establishment of study hypotheses. Landscape-based studies have shown the significance of shape and size (SS) in urban green spaces, indicating that irregular configurations, reduced fragmentation, and strong connectivity enhance species movement and habitat resilience (McGarrigle et al., 2020; Nielsen et al., 2021). This serves as the basis for Hypothesis 1.

Research in tropical and Malaysian contexts has demonstrated that vegetation composition (VC), particularly a higher variety of plants and the presence of native species, benefits both fauna and ecosystem services, thereby supporting Hypothesis 2 (Rahman et al., 2024; Tan & Samsudin, 2022). On a broader scale, comparative studies indicate that urban green spaces rich in biodiversity for wildlife and landscape patterns (LP) enhance thermal comfort and contribute to human well-being, confirming Hypothesis 3 (Aronson et al., 2023; Marselle et al., 2021). Additionally, mixed-method studies reveal that artificial habitat components (AC), such as wetlands and structures that support birds, increase habitat variability and species presence, particularly for avian populations. This finding supports Hypothesis 4 (Lee et al., 2021). Furthermore, research focusing on governance highlights the importance of surrounding land use (SL), policy integration, and community participation in influencing biodiversity outcomes, which forms the basis for Hypothesis 5 (Karuppannan et al., 2014; McDonald et al., 2020; Yusof et al., 2020).

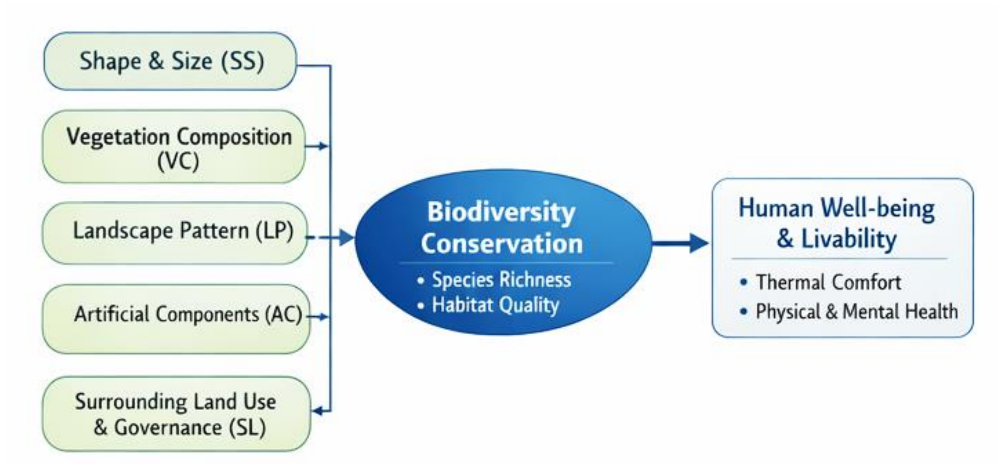


Figure 2. The theoretical hypothesis framework of biodiversity conservation

By proposing an integrative hypothesis framework, these findings collectively address the fragmented approach to ecological, social, and health aspects of biodiversity conservation in urban green areas. This study will focus specifically on biodiversity conservation efforts that directly benefit both the species involved and the surrounding urban environment.

Methodology

Site study

The research was conducted at the Perdana Botanical Gardens, located in the heart of Kuala Lumpur, Malaysia. This urban park spans approximately 91.6 hectares and is one of the most iconic city parks in the area, showcasing high biodiversity and a multi-functional landscape (Figure 3). The park, named Premier Lake Park, features a blend of natural flora, landscaped areas, and constructed elements. It was opened during the British colonial era in 1888 (Gullick, 1955). In

2011, the park was renamed the Perdana Botanical Gardens (Ragu, 2025). The Perdana Botanical Gardens feature several distinct areas, including the Kuala Lumpur Butterfly Park, Kuala Lumpur Bird Park, Hibiscus Garden, Orchid Garden, and Deer Park. This makes it an ideal case study for assessing public perceptions of biodiversity in urban environments. A map of the research area was provided to give spatial context and help participants relate their responses to specific elements of the park.

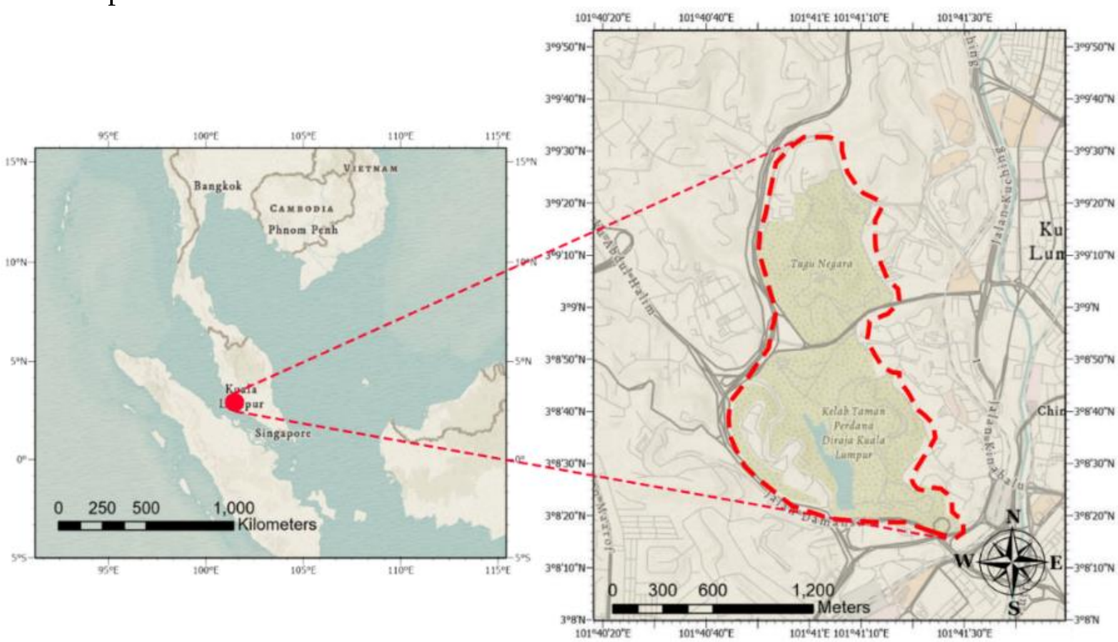


Figure 3. Location of Perdana Botanical Gardens in Kuala Lumpur, Malaysia (Latitude: 3° 8' 38" N, Longitude: 101° 41' 6" E; average elevation of approximately 60 m)

Questionnaire

The survey was conducted with 120 locals, visitors, and tourists to gather a diverse range of responses. A total of 100 valid responses were received, resulting in an effective response rate of 83.3%. Data collection took place during weekends and weekdays in the first and second weeks of June 2025. The questionnaire was divided into seven sections: Part A collected demographic information, while Parts B through G assessed perceptions of various landscape and biodiversity elements using Likert scale questions. The Likert scale employed a 5-point format, with response options including “strongly disagree,” “disagree,” “neutral,” “agree,” and “strongly agree.” This structured format, along with bilingual versions of the questionnaire in Malay and English, improved the readability and inclusivity of the responses, offering a more comprehensive understanding of public attitudes towards biodiversity conservation in the park.

Data analysis

The data from the questionnaire were analysed using the Statistical Package for the Social Sciences (SPSS 30.0) and Partial Least Squares Structural Equation Modelling (PLS-SEM) with Smart-PLS 4.0. Smart-PLS provided descriptive statistics that summarize participant demographics and the overall response patterns (Kapoor, 2025). Inferential statistical tests, including t-tests, were conducted to identify significant differences among demographic groups and their perceptions of landscape features and biodiversity. Additionally, PLS-SEM facilitated an exploration of the complex relationships between variables, allowing for a deeper investigation into how specific landscape elements influence public perceptions of biodiversity in the Perdana Botanical Gardens.

Results and discussion

Table 2 presents the sample data for this study. The demographic distribution of participants was notable, with 57% being female and 43% male. The largest age group represented was 18–25 years, comprising 46% of the participants, followed by the 26–35 years age group at 26%. This reflects a generally young population. Regarding educational attainment, most participants (52%) held a diploma, while others possessed graduate certificates, degrees, master's degrees, or PhDs. In terms of occupation, nearly half of the respondents (48%) were students, while fewer were employed in the public or private sectors or were self-employed. Geographically, most participants were from Kuala Lumpur (31%) and Selangor (20%), with fewer participants coming from other Malaysian states. Additionally, the majority of respondents reported visiting Perdana Botanical Gardens infrequently (56%), indicating a modest yet consistent level of familiarity with the study area.

Table 2. Frequency distribution of sample data

Item	Background variables	Number of people	Percentage (%)
Gender	Male	43	43.0
	Female	57	57.0
Age	18 – 25 years	46	46.0
	26 – 35 years	26	26.0
	36 – 45 years	14	14.0
	46 – 60 years	11	11.0
	Over 60 years	3	3.0
Graduate	Certificate	15	15.0
	Diploma	14	14.0
	Degree	52	52.0
	Master	12	12.0
	PhD	7	7.0
Occupation	Student	48	48.0
	Employed (Public Sector)	20	20.0
	Employed (Private Sector)	12	12.0
	Self-Employed	9	9.0
	Retired	6	6.0
	Unemployed	5	5.0
State	Kuala Lumpur	20	20.0
	Selangor	31	31.0
	Negeri Sembilan	7	7.0
	Melaka	8	8.0
	Kelantan	12	12.0

Item	Background variables	Number of people	Percentage (%)
	Terengganu	5	5.0
	Kedah	3	3.0
	Perlis	3	3.0
	Johor	2	2.0
	Pahang	4	4.0
	Pulau Pinang	4	4.0
	Perak	1	1.0
Frequency of visits to the Perdana Botanical Gardens	Occasionally (1–2 times a year)	56	56.0
	Sometimes (1–2 times a month)	19	19.0
	Regular (weekly or more)	25	25.0

Perdana Botanical Garden is a forest park with important ecological and biodiversity features vital to Kuala Lumpur. This study was conducted to identify the types of biodiversity present in the area and the factors influencing them. It found that various elements play a crucial role in supporting biodiversity. The literature on landscape biodiversity conservation is categorized based on factors such as shape and size, composition of vegetation cover, artificial features, landscape elements and land use within the surrounding area. “Biodiversity Conservation” primarily refers to the parameters that include the garden’s topography, types of vegetation, various artificial components, and the interdependence of these environmental factors in efforts to conserve and restore the rich biodiversity of this city park, which is rapidly urbanizing (Figure 4).

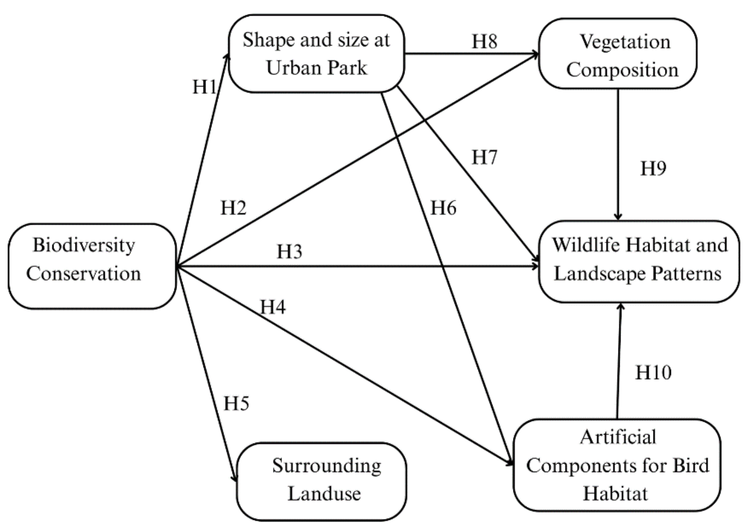


Figure 4. A modified structural equation model depicting the relationship among biodiversity conservation, wildlife, and their habitats in Perdana Botanical Gardens

Geografia-Malaysian Journal of Society and Space 22 issue 3 (114-139)
© 2026, e-ISSN 2682-7727 https://doi.org/10.17576/geo-2026-2203-08

Rewrite this to fit **Results–Hypotheses structure**

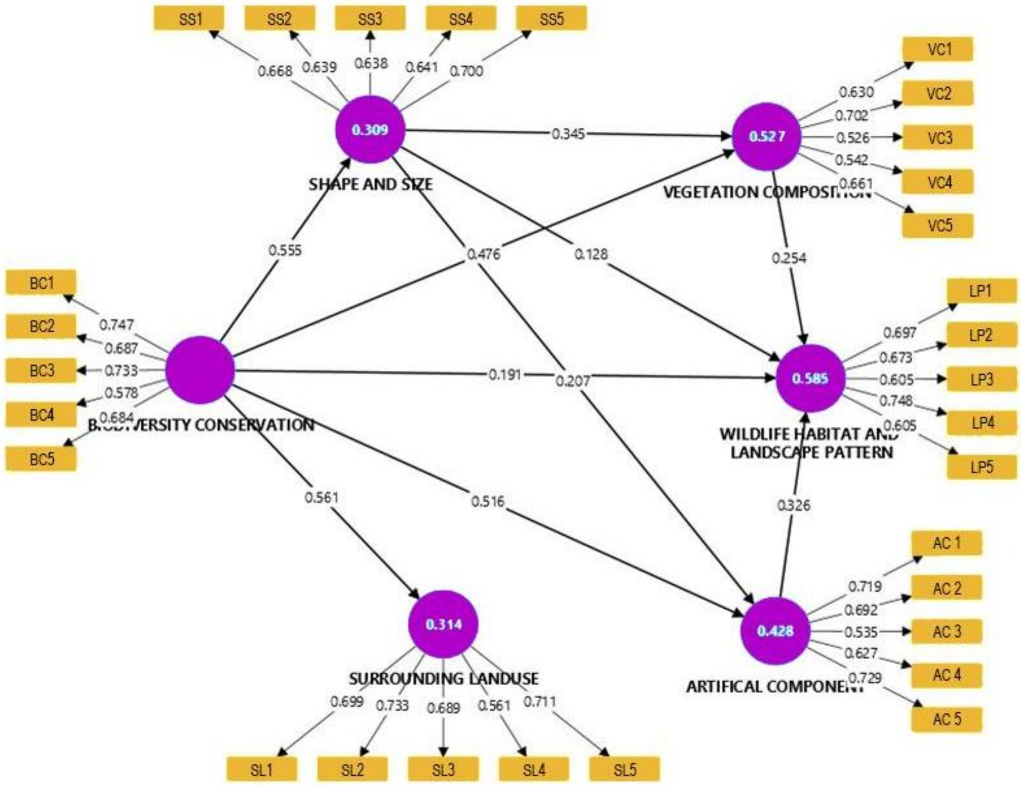


Figure 5. A diagram of the SEM model illustrating the relationships between biodiversity conservation, wildlife, and their habitat in Perdana Botanical Gardens

This study evaluates the ecological condition of plants, animals, and species within the Perdana Botanical Gardens. The organizational framework for this assessment is illustrated in Figures 4 and 5. The primary focus is on the preservation of biodiversity, which is assigned the code BC, with corresponding sub-project codes ranging from BC1 to BC5. In addition to biodiversity, the shape and size of elements in the Perdana Botanical Park are also significant factors, designated by the code SS, with sub-project codes SS1 through SS5. The landscape pattern and wildlife are categorized under the code LP, with sub-codes LP1 to LP5. The landscape pattern includes two components: the vegetation composition, represented by the code VC and sub-codes VC1 to VC5, and the artificial bird habitats, coded as AC, with sub-codes AC1 to AC5. Finally, land use in the surrounding area is included as the last element in Figures 3 and 4, assigned the code SL, with sub-codes SL1 to SL5.

Measurement model parameter estimation

The findings from the measurement model indicated excellent internal consistency, reliability, and convergent validity for all six latent constructs (Table 3). Cronbach's alpha coefficients ranged from 0.728 for the Artificial Component to 0.755 for Biodiversity Conservation, all exceeding the acceptable threshold of 0.7. Additionally, the composite reliability (CR) values were above the 0.8 mark, confirming the internal consistency of the constructs. Average Variance Extracted (AVE) values ranged from 0.442 to 0.538, demonstrating acceptable convergent validity for exploratory studies. Most items had factor loadings greater than 0.6, with the exception of AC3 (0.535) and VC3 (0.526), which were slightly lower but still close to the acceptable range. Overall, the measurement model supports the construct validity necessary for subsequent structural modelling.

Table 3. Measurement model parameter estimation

Dimensions	Question items	Factor loading	Cronbach's α	CR	AVE
Artificial component	AC1	0.719	0.728	0.823	0.538
	AC2	0.692			
	AC3	0.535			
	AC4	0.627			
	AC5	0.729			
Biodiversity conservation	BC1	0.747	0.755	0.831	0.501
	BC2	0.687			
	BC3	0.733			
	BC4	0.578			
	BC5	0.684			
Vegetation composition	VC1	0.630	0.674	0.770	0.442
	VC2	0.702			
	VC3	0.526			
	VC4	0.542			
	VC5	0.661			
Shape and size	SS1	0.668	0.750	0.829	0.497
	SS2	0.639			
	SS3	0.638			
	SS4	0.641			
	SS5	0.700			
Surrounding land use	SL1	0.699	0.741	0.829	0.483
	SL2	0.733			
	SL3	0.689			
	SL4	0.561			
	SL5	0.711			
Wildlife and landscape pattern	LP1	0.697	0.737	0.805	0.456
	LP2	0.673			
	LP3	0.605			
	LP4	0.748			
	LP5	0.605			

The operational definition

Operational definitions of the constructs in this research provide the conceptual foundation for quantifying factors affecting Perdana Botanical Gardens biodiversity conservation (Table 4).

Table 4. The operational definitions

Construct	Dimension/ Indicators	Operational definition
Biodiversity conservation	BC1 – BC5	Represents strategies, actions, and perceptions to preserve biological diversity within the park environment, including plant and animal species.
Shape and size	SS1 – SS5	Captures the spatial configuration of the park area, including geometric form and area extent, which influence ecological connectivity and user access.
Vegetation composition	VC1 – VC5	Describes plant species' variety, abundance, and structural arrangement within a green space, including trees, shrubs, and groundcover.
Artificial component	AC1 – AC5	Refers to artificial elements in the park, such as pathways, signage, built structures, and infrastructure that support or affect ecological and recreational quality.
Wildlife and landscape pattern	LP1 – LP5	Reflects the presence, diversity, and movement of fauna and the arrangement of ecological corridors and landscape elements that support biodiversity.
Surrounding land use	SL1 – SL5	Refers to the types and intensity of land uses adjacent to the park, such as residential, commercial, or industrial, and their potential impact on the park system.

Shape and Size (SS1–SS5) refer to the spatial arrangement and geometric shape of the park, as well as its overall area. These elements influence ecological connectivity and user accessibility. Vegetation Composition (VC1–VC5) encompasses the diversity of plant species, plant density, and the structural layering of vegetation from ground cover to tree canopy. This variety promotes diverse habitats and enhances ecosystem services. The Artificial Component (AC1–AC5) includes man-made features such as trails, signage, constructed lakes, and observation platforms that contribute to habitat establishment and recreational use. Wildlife and Landscape Pattern (LP1–LP5) refer to the distribution and occurrence of animal species, as well as their movement patterns. These patterns are influenced by ecological corridors, edge effects, and habitat patches. Surrounding Land Use (SL1–SL5) involves the types and intensities of land use adjacent to the park, including cultural developments, residential areas, and institutional land. These factors can pose threats to or create opportunities for biodiversity. Last, Biodiversity Conservation (BC1–BC5) encapsulates the strategies, perceptions, and outcomes related to maintaining biological diversity. This includes aspects such as policy support, ecological resilience, and habitat management within the urban park context.

Questionnaire items and reference

The questionnaire items were designed to measure each construct based on empirical research and ecological literature, ensuring theoretical consistency and construct validity (Table 5). For the constructs of Shape and Size, we borrowed items from Ye et al. (2025) to assess how the spatial layout and shape of parks influence bird populations, habitat area, and species richness. The Vegetation Composition items focused on the importance of plant diversity, shrub layering, and vegetation structure in supporting pollinators and enhancing avian richness (Ye et al., 2025). The Artificial Component dimension examined the ecological roles of built elements, such as water bodies, pedestrian paths, and hard surfaces, in relation to urban wildlife, particularly birds and bats. The Wildlife and Landscape Pattern items measured perceptions of habitat fragmentation, spatial distribution, and ecological resilience, with an emphasis on high-quality patches and multi-scale habitat clumping. The Surrounding Land Use items reflected land use pressures and barriers, including building and road density, proximity to urban infrastructure, and linear development patterns, all of which impact species occurrence and ecosystem integrity (Buyadi et al., 2014). Finally, indicators for Biodiversity Conservation were derived from recent research trends that emphasize the integration of biodiversity considerations in urban design, the application of ecological data, and the effectiveness of landscape patterns in supporting biodiversity outcomes (Ye et al., 2025).

Table 5. Questionnaire items and reference

Dimensions	Code	Questionnaires	Reference
Biodiversity conservation	BC1:	Integrating biodiversity conservation into urban planning and construction became a key trend in sustainable development.	Ariffin et al. (2023)
	BC1:	Lack of sufficient ecological knowledge leads to inconsistent or insufficient implementation of biodiversity-sensitive practices.	
	BC1:	Connectivity among urban green spaces provides habitats and corridors that help conserve biodiversity.	
	BC1:	Natural landscape features contribute to the conservation of biodiversity outcomes.	
	BC1:	Urban parks with larger areas and simple boundary shapes generally exhibit better biodiversity conservation performance.	
Shape and size	SS1:	Small-sized green spaces and limited resources are causing bird populations to decline.	McGarrigle et al. (2020); Liu et al. (2022); Xie et al. (2023)
	SS2:	Urban Park areas significantly predict species diversity and show effects on habitat size.	
	SS3:	Woodland size appears to be the primary factor in bird species richness.	
	SS4:	Larger urban parks usually have more reptiles and amphibians, including rare species.	
	SS5:	Park shape complexity nonlinearly reduces plant richness.	
Vegetation composition	VC2:	More tree coverage is associated with more bird species because trees provide more food and shelter.	Tan & Samsudin (2022); Rahman et al. (2024);
	VC2:	Well-arranged shrub layers promote higher bird species richness and diversity.	
	VC3:	Over-managed lawns reduce the biodiversity value of park grasslands compared to natural grassland.	

Geografia-Malaysian Journal of Society and Space 22 issue 3 (114-139)
© 2026, e-ISSN 2682-7727 https://doi.org/10.17576/geo-2026-2203-08

Dimensions	Code	Questionnaires	Reference
	VC3:	More vegetation layers and vertical structures attract a wider range of bird species.	Nguyen et al. (2021)
	VC3:	Greater plant diversity, particularly trees and flowers, boosts bee populations and diversity.	
Artificial component	AC1:	An impervious surface cover negatively impacts bird and bat populations.	Lee et al., (2021); Hashim et al. (2023); Xu & Yang, (2020)
	AC2:	The water surface is positively correlated with higher bird species richness.	
	AC3:	Most bird species are significantly more likely to be found near water, indicating the importance of water for bird diversity.	
	AC4:	High pedestrian traffic around Perdana Botanical Gardens will reduce the natural habitat during the breeding season.	
	AC5:	The shape of the curving trails limits the variety and number of birds.	
Wildlife and landscape pattern	LP1:	Fragmentation patterns of landscape Habitat encourage Predators to find prey in the biodiversity.	Nielsen et al. (2021); Zhou et al. (2024)
	LP2:	Abiotic conditions drive the microclimate in fragmentation patterns of landscape habitats that are ecologically unstable.	
	LP3:	Inappropriate habitat aggregation and spatial arrangement affect the growth of seeds or offspring of organisms.	
	LP4:	High-quality habitats help stabilize animal populations in isolated areas by maintaining key habitats, even small or isolated ones.	
	LP5:	Multi-scale habitat aggregation enhances birds' biodiversity through broadleaf–conifer gradients and connectivity.	
Surrounding land use	SLI:	Surrounding Land Use and building density oppositely predict bird species richness and densities.	Karuppannan et al. (2014); Rosli et al. (2022)
	SL2:	Attracting birds to Urban parks increases the risk of bird collisions with buildings.	
	SL3:	Road density creates boundaries for insect breeding.	
	SL4:	Distance (≤200 m) of green space in urban areas can encourage bird species to live and breed naturally.	
	SL5:	Parks with linear development will encourage habitat diversity compared to compact spatial development.	

Geografia-Malaysian Journal of Society and Space 22 issue 3 (114-139)
© 2026, e-ISSN 2682-7727 https://doi.org/10.17576/geo-2026-2203-08

Discriminant validity test (Fornell–Larcker criterion)

The discriminant validity of the model constructs was assessed using the Fornell–Larcker criterion, as shown in Table 6. The square root of the Average Variance Extracted (AVE) for each construct (indicated on the diagonal) was greater than its correlations with other constructs, confirming that the discriminant validity is satisfactory. For example, the square root of the AVE for the Artificial Component (0.733) exceeds the correlations with Biodiversity Conservation (0.561) and Vegetation Composition (0.494), demonstrating that these constructs are statistically distinct from one another.

Table 6. Discriminant validity test (Fornell–Larcker)

Dimensions	AVE	AC	BC	VC	SS	SL	LP
Artificial component	0.538	0.733	0.561	0.494	0.472	0.453	0.519
Biodiversity conservation	0.501	0.561	0.708	0.584	0.567	0.566	0.601
Vegetation composition	0.442	0.494	0.584	0.665	0.538	0.495	0.538
Shape and size	0.497	0.472	0.567	0.538	0.705	0.471	0.516
Surrounding land use	0.483	0.453	0.566	0.495	0.471	0.695	0.504
Wildlife and landscape pattern	0.456	0.519	0.601	0.538	0.516	0.504	0.675

Heterotrait–Monotrait Ratio (HTMT)

The HTMT test was conducted once more to evaluate discriminant validity, as shown in Table 7. All HTMT values were below the conservative threshold of 0.90, confirming that each pair of constructs is empirically distinct. The strongest correlation was observed between Wildlife & Landscape Pattern and Biodiversity Conservation, with a value of 0.685. Most inter-construct pairings demonstrated moderate correlations, further supporting the validity of the measurement model.

Table 7. Heterotrait–Monotrait ratio of correlations (HTMT)

Dimensions	AC	BC	VC	SS	SL	LP
Artificial component	—	0.671	0.605	0.583	0.574	0.638
Biodiversity conservation		—	0.678	0.631	0.644	0.685
Vegetation composition			—	0.606	0.594	0.649
Shape and size				—	0.559	0.607
Surrounding land use					—	0.585
Wildlife and landscape pattern						—

Results of hypothesis testing

The results of the hypothesis testing based on Partial Least Squares Structural Equation Modelling (PLS-SEM) indicate statistically significant relationships among the constructs, as shown in Table 8. All proposed hypotheses were validated with p-values less than 0.01, demonstrating strong predictive relationships. Biodiversity Conservation had a substantial influence on all other constructs, including Shape and Size (β = 0.555), Vegetation Composition (β = 0.476), and Wildlife and Landscape Pattern (β = 0.191), Artificial Component (β = 0.516), and Surrounding Land Use (β = 0.561). Furthermore, Shape and Size significantly impacted Artificial Component (β = 0.207), Wildlife and Landscape Pattern (β = 0.128) and Vegetation Composition (β = 0.345). Both Vegetation Composition and Artificial Components and Vegetation Composition also had a significant direct effect on Wildlife and Landscape Patterns (β = 0.345) and (β = 0.326) respectively, confirming the structural stability of the model.

Table 8. Results of hypothesis testing

Path	Std beta	Std error	T value	P value	Result
Biodiversity Conservation → Shape and Size	0.555	0.099	5.596	0.000	Supported
Biodiversity Conservation → Vegetation Composition	0.476	0.085	7.887	0.000	Supported
Biodiversity Conservation → Wildlife and Landscape Pattern	0.191	0.073	8.760	0.000	Supported
Biodiversity Conservation → Artificial Component	0.516	0.092	6.844	0.000	Supported
Biodiversity Conservation → Surrounding Land Use	0.561	0.080	7.039	0.000	Supported
Shape and Size → Artificial Component	0.207	0.081	2.556	0.011	Supported
Shape and Size → Wildlife and Landscape Pattern	0.128	0.073	3.877	0.000	Supported
Shape and Size → Vegetation Composition	0.345	0.073	4.730	0.000	Supported
Vegetation Composition → Wildlife and Landscape Pattern	0.254	0.068	3.750	0.000	Supported
Artificial Component → Wildlife and Landscape Pattern	0.326	0.122	2.679	0.009	Supported

R^2 and f^2 value analysis

R^2 and f^2 values were used to assess the explanatory power of the model. The R^2 values ranged from 0.309 to 0.585, indicating that the independent variables explained a moderate to significant amount of the variance (Table 9). For example, Biodiversity Conservation explained 52.7% of the variance in Vegetation Composition and 58.5% in Wildlife and Landscape Pattern. The f^2 effect size test highlighted significant effects in the strongest relationships, such as the impact of Biodiversity Conservation on Vegetation Composition ($f^2 = 0.458$) and Surrounding Land Use ($f^2 = 0.446$). These results indicate a significant effect. In contrast, the relationship between Shape and Size and Vegetation Composition ($f^2 = 0.052$) showed only a small to moderate effect.

Table 9. R^2 value and f^2 value

Path analysis	R^2	R^2 adjusted	f^2
Biodiversity Conservation → Artificial Component	0.428	0.417	0.430
Biodiversity Conservation → Shape and Size	0.309	0.301	0.323
Biodiversity Conservation → Surrounding Land Use	0.314	0.307	0.446
Biodiversity Conservation → Vegetation Composition	0.527	0.518	0.458
Biodiversity Conservation → Wildlife and Landscape Pattern	0.585	0.567	0.331
Shape and Size → Artificial Component	—	—	0.041
Shape and Size → Vegetation Composition	—	—	0.052
Shape and Size → Wildlife and Landscape Pattern	—	—	0.174
Vegetation Composition → Wildlife and Landscape Pattern	—	—	0.023
Artificial Component → Wildlife and Landscape Pattern	—	—	0.064

Biodiversity conservation in Perdana Botanical Gardens

The ecological setting significantly impacts biodiversity and spatial patterns in urban areas, as demonstrated by findings from the Perdana Botanical Gardens in Kuala Lumpur. The PLS-SEM model indicates that biodiversity conservation has a substantial effect on the park's landscape, spatial arrangement, and land use. This influence is particularly evident in improvements to air quality, thermal comfort, and the maintenance of biological diversity. Trees play a crucial role in this ecological environment. They enhance air quality by removing pollutants, help reduce urban heat through shading, and provide habitats for various species. These ecological services contribute to making the park more biodiverse and appealing to visitors, thereby supporting the city's recreational, cultural, and health-related activities.

Perdana Botanical Gardens is located near the Kuala Lumpur city centre, surrounded by cultural sites and urban development. Despite its urban setting, the park features a high degree of vegetation and well-organized space. Numerous large trees provide shade over walkways and activity areas, creating a charming atmosphere with dappled light that enhances thermal comfort (Figures 6 and 7). The presence of birds, invertebrates, and flowering plants indicates a thriving and healthy ecosystem. The park offers more than just opportunities for physical exercise; it also serves as a space for environmental education and social interaction. Tourists often participate in recreational activities such as jogging, bird-watching, and picnics with family, all of which promote mental and physical well-being. The incorporation of ecological planning into the park's landscape exemplifies the characteristics of sustainable urban green spaces.

Perdana Botanical Gardens showcases a rich diversity of plant life, contributing to its ecological, visual, and structural values. The park is home to over 2,000 plant species, including both native and ornamental trees, which gives it a distinctive spatial identity. Notable species include Dipterocarpus, palms, and other types of tropical hardwoods (Table 10). The presence of three forest layers, emergent trees, medium-sized trees, and low shrubs ensures seasonal diversity and provides year-round greenery. The layered structure of the vegetation creates various microhabitats, fostering higher ecological resilience and offering essential ecosystem services, such as carbon sequestration, noise reduction, and habitat connectivity. The conservation-focused management of Perdana Botanical Gardens demonstrates how urban green spaces can thrive as biodiversity hotspots while meeting both human and environmental needs.

Table 10. Several types of flora species in The Perdana Botanical Gardens

No.	Scientific name	Common name	Height (m)	Canopy (m)	Natural/Ornament function
1.	*Araucaria columnaris*	Silhouette plant	2–3	1.5–2	Ornamental, windbreak
2.	*Dipterocarpus caudiferus*	Keruing Putih	2–10	2–4	Ornamental, native species
3.	*Dracaena cochinchinensis*	Dragon blood tree	10–15	8–12	Ornamental, traditional uses
4.	*Heptapleurum actinophyllum*	Octopus tree	4–8	3–5	Ornamental, shade
5.	*Ilex cymosa*	Mensirah	3–10	2–4	Ornamental, traditional uses
6.	*Jacaranda obtusifolia*	Jacaranda	15–25	8–10	Ornamental, shade
7.	*Kigelia Africana*	Sausage tree	15–25	10–12	Ornamental, traditional uses
8.	*Licuala grandiss*	Palas Palm	10–20	10–13	Ornamental, shade
9.	*Magnolia champaca*	Golden Champa	5–15	3–5	Ornamental, fragrant flowers
10.	*Millingtonia hortensis*	Indian cork tree	15–25	10–12	Shade tree, fragrant flowers
11.	*Polyscias diversifolia*	Tumbuh kelapa	40–60	15–25	Ornamental
12.	*Spathodea campanulata*	African tulip	5–15	3–5	Ornamental, bright flower
13.	*Tabebuia rosea*	Rosy trumpet	8–15	6–10	Ornamental, shade
14.	*Trevesia burckii*	Tapak hanuh	30–50	5–10	Ornamental
15.	*Millingtonia hortensis*	Indian cork tree	15–25	10–12	Shade tree, fragrant flowers
16.	*Wrightia religiosa*	Water jasmine	8–15	6–10	Ornamental, fragrant foliage

Source: Hoh, 2020

Figure 6. *Albizia saman* commonly known as the Rain tree, is one of the oldest trees in the Perdana Botanic Gardens. Its girth, measured at a height of 1.30 meters, is 5.74 meters, and its height is approximately 20 meters. This tree was planted around the year 1880, making it approximately 145 years old

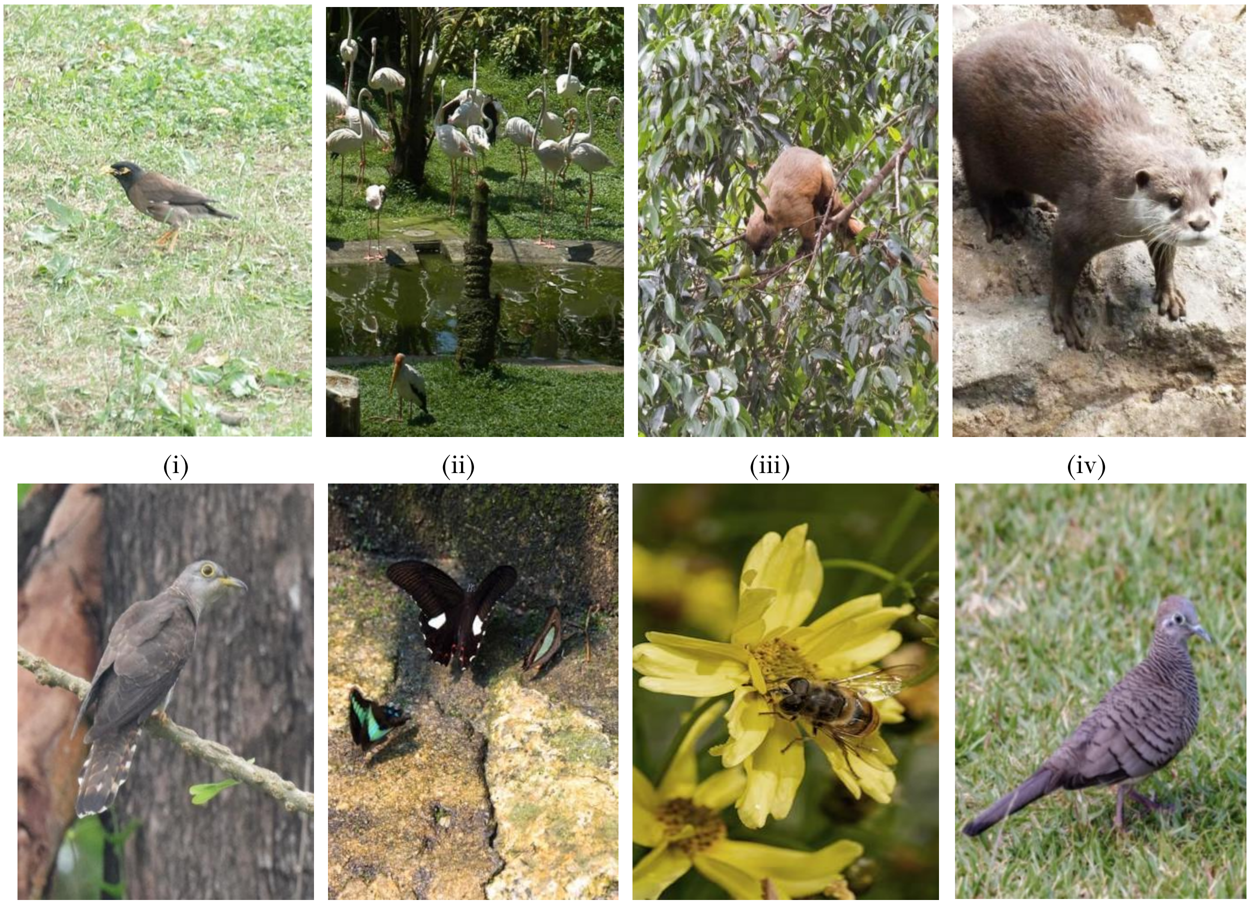
(a) (b) (c) (d)

(e) (f) (g) (h)

Figure 7. (a) *Dipterocarpus caudiferus* (Keruing Putih), (b) *Magnolia champaca* (Golden Champaca), (c) *Spathodea campanulata* (African tulip tree), (d) *Millingtonia hortensis* (Indian cork tree), (e) *Licuala grandis* (Palas Palm), (f) *Jacaranda obtusifolia* (Jacaranda), (g) *Trevesia burckii* (Tapak hanuh), and (h) *Tabebuia rosea* (Rosy trumpet tree)

Table 11. Several types of fauna species in the Perdana Botanical Garden

No	Scientific name	Common name	Family name	Class
1.	*Acridotheres tristis*	Common myna	Sturnidae	Aves
2.	*Alcedinidae*	Kingfisher	Alcedinidae	Aves
3.	*Calotes versicolor*	lizard	Agamidae	Reptilia
4.	*Apis mellifera*	Honeybee	Apidae	Insect
5.	*Callosciurus notatus*	Plantain Squirrel	Sciuridae	Mammalia
6.	*Cuculus micropterus*	Indian Cuckoo	Cuculidae	Aves
7.	*Geopelia striata*	Zebra dove	Columbidae	Aves
8.	*Lepidoptera spp.*	Butterfly	Nymphalidae	Insect
9.	*Lutrinae*	Otter	Mustelidae	Mammalia
10.	*Threskiornithinae*	Ibis	Threskiornithidae	Aves



(i) (ii) (iii) (iv)

(v) (vi) (vii) (viii)

Figure 8. (i) *Acridotheres tristis* (Common myna), (ii) *Threskiornithinae* (Ibis), (iii) *Callosciurus notatus* (Plantain Squirrel), (iv) *Lutrinae* (Otter), (v) *Threskiornithinae* (Indian Cuckoo), (vi) *Lepidoptera spp.* (Butterfly), (vii) *Apis mellifera* (Honeybee), and (viii) *Geopelia striata* (Zebra dove)

Urban parks, such as the Perdana Botanical Gardens, provide essential habitats for many animal species, which play a crucial role in maintaining the park's ecological functions (Table 11 and Figure 8). Notably, species diversity, including the *Callosciurus notatus* (Plantain Squirrel), the *Calotes versicolor* (Oriental Garden Lizard), and various bird species like the *Cuculus micropterus* (Indian Cuckoo) and the *Acridotheres tristis* (Common Myna), contributes to important processes like seed dispersal, insect suppression, and the overall ecological balance. These animals depend on the park's complex vegetation, artificial water bodies, and low-disturbance areas for feeding, reproduction, and shelter. Additionally, *Lepidoptera spp.* (butterflies) and *Apis spp.* (honeybees) demonstrate healthy pollination activity, indicating a strong interaction between flora and fauna elements within the park.

Wild birds, such as the *Threskiornithinae* (Ibis) and *Geopelia striata* (Zebra Dove), highlight the importance of landscape diversity and edge habitats. Adding artificial components like nesting boxes, quiet zones, and corridors of native vegetation can improve habitat quality for these birds. It is essential to balance recreational use by humans and biodiversity protection; therefore, continuous monitoring of biodiversity and implementing adaptive management strategies are necessary to ensure the park remains a sanctuary for both general and endangered wildlife. By doing this, Perdana Botanical Gardens not only protects biodiversity but also promotes ecological literacy and fosters public awareness about the role of urban wildlife in sustainable ecosystems.

Conclusion

This study demonstrated strong validity and reliability, confirming the absence of collinearity among the research facets while assessing the structural model. All the HTMT (Heterotrait-Monotrait Ratio) values fell below the conservative threshold of 0.90, which verifies that every pair of constructs is empirically distinct. The Fornell–Larcker criterion indicated that the square root of the Average Variance Extracted (AVE) for each construct was greater than its correlation with other constructs, further confirming their validity. The R^2 values ranged from 0.309 to 0.585, indicating moderate to significant variances, suggesting an acceptable correlation with all constructs. Overall, the model of the study aligned well with the data.

Statistically significant correlations were found between the constructs, as revealed through hypothesis testing. Hypothesis 1 is valid, demonstrated by the model's path relationship. Biodiversity conservation positively affects shape and size ($\beta = 0.555$, $t = 5.596$, $p < 0.000$). Hypothesis 2 is valid – biodiversity conservation positively affects the vegetation composition ($\beta = 0.476$, $t = 7.887$, $p < 0.000$). Hypothesis 3 is valid – biodiversity conservation positively affects wildlife and landscape pattern ($\beta = 0.191$, $t = 8.760$, $p < 0.000$). Hypothesis 4 is valid – biodiversity conservation positively affects the artificial component ($\beta = 0.516$, $t = 6.844$, $p < 0.000$). Hypothesis 5 is valid – biodiversity conservation positively affects the surrounding land use ($\beta = 0.561$, $t = 7.039$, $p < 0.000$). Hypothesis 6 is valid – shape and size positively affect the artificial components ($\beta = 0.207$, $t = 2.556$, $p < 0.011$). Hypothesis 7 is valid – shape and size were influenced by wildlife habitat and landscape patterns ($\beta = 0.128$, $t = 3.877$, $p < 0.000$). Hypothesis 8 is valid – the shape and size positively affect the vegetation composition influenced ($\beta = 0.345$, $t = 4.730$, $p < 0.000$). Hypothesis 9 is valid – the vegetation composition positively affects wildlife habitat and landscape patterns ($\beta = 0.254$, $t = 3.750$, $p < 0.000$). Hypothesis 10 is valid – the artificial component for bird habitats positively affects wildlife habitat and landscape patterns ($\beta = 0.326$, $t = 2.679$, $p < 0.009$).

This study focuses on a city in a tropical environment, examining the differences in urban green space planning between dense, humid cities and those in temperate regions. It integrates spatial design principles with ecological and social elements to provide a comprehensive view of biodiversity performance in city parks. The preservation of biodiversity in an urban park is influenced by five landscape characteristics: form and size, vegetation, man-made materials, surrounding land use, and wildlife activity. The findings suggest that native vegetation should take precedence, ecological corridors must be maintained, and biodiversity-sensitive infrastructure such as artificial wetlands and bird roosting habitats should be integrated into park design. Continuous and proactive biodiversity monitoring, along with adaptive management techniques, are essential to ensure that the park remains a sanctuary for both common and rare species. It is crucial that human leisure activities and biodiversity preservation coexist harmoniously. In addition to conserving biodiversity, Perdana Botanical Gardens enhances ecological literacy and public understanding of the role urban wildlife plays in maintaining healthy ecosystems. To further boost conservation awareness, increased public involvement through community initiatives and educational programs is necessary.

Novel/Significant contributions and insights of the study

a) Theoretical

This study advances urban biodiversity research by presenting an integrated theoretical framework that connects spatial design (including shape and size), vegetation composition, artificial habitat components, surrounding land use, and outcomes related to well-being, health, and livability. Unlike previous research that examines these elements in isolation, this framework views biodiversity conservation as a multidimensional system that incorporates ecological, social, and health-related processes, thereby addressing a critical theoretical gap in the existing urban biodiversity literature.

b) Methodological

From a methodological standpoint, the study employs a hypothesis-driven analytical structure to directly evaluate and analyse the combined effects of design, ecological factors, and governance within a single model. It offers a reproducible approach to assess biodiversity performance in urban green spaces, particularly in tropical and high-density urban environments, by translating abstract planning and ecological concepts into measurable indicators (e.g., Spatial Design, Vegetation Composition, Artificial Habitat Components, Surrounding Land Use, Well-being, Health, and Liveability).

c) Empirical

Empirically, the study presents evidence from a tropical metropolitan area for Botanical Gardens (green area) in central city of Kuala Lumpur, which is often underrepresented in global urban biodiversity research. The findings shed light on how various design and governance aspects interact to influence biodiversity outcomes. They suggest that the co-benefits related to biodiversity for climate resilience and human well-being depend on both biological quality and the conditions of surrounding land use. This integrated knowledge extends beyond species- or park-level analysis, providing guidance for more comprehensive urban green space planning and policymaking.

d) Limitation and future research directions

The authors acknowledge that this study is primarily based on perception-based data. As a result, the findings reflect perceived biodiversity and landscape effectiveness rather than direct ecological measurements. These perceptions are still vital, as they capture user experiences and stakeholder assessments that influence the use, management, and long-term sustainability of urban green spaces. The interpretation of the data has been clearly articulated, and claims have been appropriately constrained to perceived rather than actual biodiversity outcomes.

Future research should combine perception-based assessments with direct ecological measurements to validate reported biodiversity. This should also include quantifying species richness, habitat quality, and ecosystem functionality in urban green spaces.

Acknowledgement

The authors would like to express their gratitude to the management of Perdana Botanical Gardens – Landscape Development and Recreation Department, Kuala Lumpur City Hall (DBKL), for permitting the research team to explore and document the park's biodiversity and landscape habitats. Additionally, we appreciate the opportunity to distribute a questionnaire to park visitors.

References

Ariffin, N., Hamid, N. A., & Mohd, S. (2023). Biodiversity-sensitive urban development: A policy integration framework for Malaysian cities. *Urban Ecology Journal, 14*(2), 101–115.

Aronson, M. F. J., Lepczyk, C. A., Evans, K. L., Goddard, M. A., Lerman, S. B., & MacIvor, J. S. (2023). Urban biodiversity and climate resilience in tropical cities: A global comparative analysis. *Environmental Research Letters, 18*(1), 014012.

Bukar, U. A., Sayeed, M. S., Razak, S. F. A., Yogarayan, S., Amodu, O. A., & Mahmood, R. A. R. (2023). A method for analyzing text using VOSviewer. *MethodsX, 11*, 102339.

Buyadi, S. N. A., Mohd, W. M. N. W., & Misni, A. (2014). Quantifying green space cooling effects on the urban microclimate using remote sensing and GIS techniques. *Proceedings of the XXV International Federation of Surveyors*, 1-16.

Buyadi, S. N. A., Mohd, W. M. N. W., & Misni, A. (2013). Impact of land use changes on the surface temperature distribution of area surrounding the National Botanic Garden, Shah Alam. *Procedia-Social and Behavioral Sciences, 101*, 516-525.

Chew, M. Y., Norzielawati, S., Syazwani, A., Yap, J. W., Sam, Y. Y., & Chung, R. C. K. (n.d.). *Wayside Trees: The Nature Pillar and Roofs of The Perdana Botanical Garden*. Kuala Lumpur City Hall.

Danneck, J., Chin Fung Tiang, D., Ngo Duc, K., Azhar, B., Sanusi, R., Campos-Arceiz, A., & Lechner, A. M. (2023). Conserving urban tropical biodiversity by connecting networks of green patches. *Integrative Conservation, 2*(2), 80-94.

Dearborn, D. C., & Kark, S. (2010). Motivations for conserving urban biodiversity. *Conservation Biology, 24*(2), 432–440.

Gullick, J. M. (1955). Kuala Lumpur 1880-1895. *Journal of the Malayan Branch of the Royal Asiatic Society, 24*(4), 10–11.

Hashim, N., Latif, Z. A., & Saad, S. N. M. (2023). Urban artificial wetlands and avian diversity in Southeast Asia. *Journal of Urban Ecology, 9*(3), ueac043.

Hoh, R. (2020). Rain Tree in the area of Perdana Botani Gardens, Kuala Lumpur, Peninsular Malaysia, Malaysia.

Kapoor, S. (2025). The Role of SmartPLS in Optimizing Statistical Analysis: A Case Study Approach. 5th International Conference on Innovative Research in Applied Science, Engineering and Technology (IRASET), Fez, Morocco.

Karuppannan, S., Baharuddin, Z. M., Sivam, A., & Daniels, C. B. (2014). Urban green space and urban biodiversity: Kuala Lumpur, Malaysia. *Journal of Sustainable Development, 7*(1), 1.

Lee, J. H., Tan, P. Y., & Tan, C. L. (2021). Urban artificial elements and ecological integration in public parks. *Ecological Engineering, 169*, 106304.

Liu, Y., Zhang, H., & Wang, J. (2022). Urban park size and its effect on insect and bird populations in Chinese cities. *Urban Forestry & Urban Greening, 70*, 127540.

Marselle, M. R., Stadler, J., Korn, H., Irvine, K. N., & Bonn, A. (2021). Biodiversity and health in the urban Environment. *Current Environmental Health Reports, 8*(2), 146–156.

McDonald, R. I., Mansur, A. V., Ascensão, F., Colbert, M., Crossman, K., Elmqvist, T., & Gonzalez, A. (2020). research gaps in knowledge of the impact of urban growth on biodiversity. *Nature Sustainability, 3*(1), 16–24.

McGarrigle, M., Smith, L., & Brown, R. (2020). Connectivity and park shape influence on species dispersal in urban green spaces: A UK case study. *Landscape and Urban Planning, 196*, 103746.

McKinney, M. L. (2008). Effects of urbanization on species richness: A review of plants and animals. *Urban Ecosystems*, *11*(2), 161–176.

Misni, A., & Basir, A. K. (2022). Sustainable spatial settings of Kuala Kubu Bharu. *Planning Malaysia, 20*.

Misni, A. (2015). Developing criteria and variables for evaluating the effects of vegetation on single-family houses. *Built Environment Journal, 12*(2), 1-11.

Misni, A., & Suran, A. (2018). An integrated public art in Putrajaya urban landscape. *Built Environment Journal, 15*(2), 48-58.

Nguyen, Q. T., Yusoff, M. H., & Rosli, Z. (2021). Vertical vegetation structure and its impact on urban wildlife in tropical parks. *Forest Ecology and Management*, *487*, 118983.

Nielsen, A. B., van den Bosch, M., Maruthaveeran, S., & van den Bosch, C. K. (2021). Species movement in fragmented urban landscapes: The role of habitat connectivity. *Ecological Indicators*, *122*, 107229.

Niemelä, J. (1999). Is there a need for a theory of urban ecology?. *Urban Ecosystems, 3*(1), 57–65.

Ragu, T. (2025). Perdana Botanical Garden, KL’s oldest public park. FMT Newsletter.

Rahman, M. N. A., Hassan, M. I., & Talib, A. A. (2024). Biodiversity services and ecological evaluation of Malaysian tropical urban parks. *Tropical Ecology, 65*(1), 89–104.

Rosli, Z., Norhisham, A. R., & Zulkifli, R. (2022). The role of green corridors in enhancing biodiversity in Malaysian cities. *Urban Forestry & Urban Greening, 67,* 127408.

Tan, P. Y., & Samsudin, R. (2022). Native vegetation and ecological benefits in Malaysian urban parks. *Journal of Tropical Environmental Science, 10*(2), 55–70.

Xu, W., & Yang, W. (2020). Impact of artificial infrastructure on avian species diversity in Asian urban parks. *Urban Ecosystems, 23*(6), 1243–1255.

Xie, B., Lin, Y., & Chen, M. (2023). Edge effects and species diversity in tropical urban green patches. Journal of Applied Ecology, 60(2), 345–358.

Ye, Q., Wang, X., Liang, L., Qiu, J. W., & Tsim, S. T. (2025). A Review on Landscape Factors for Biodiversity Performance Enhancement in Urban Parks. *Diversity*, *17*(4), 262.

Yusof, N., Ali, M., & Fauzi, R. (2020). Governance and community roles in Malaysia’s urban biodiversity conservation policy. *Policy Perspectives in Urban Ecology, 8*(3), 33–45.

Zhou, Y., Chen, D., & Huang, B. (2024). Landscape patterns and bird diversity in high-density urban parks. *Urban Ecology Reports, 12*(2), 65–80.