

Balancing Aesthetic and Nature: A Survey on Landscape Visual Quality and Ecosystem Function Among Garden Visitors

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ABSTRACT

This study was conducted at 140 years of Penang Botanical Garden (PBG) which serves as a resource of ecosystem services and landscape visual aesthetics for visitors. This study has been undertaken to i) examine visitors' perception on existing landscape visuals, ii) investigate visitor understanding on visual components and their function in garden's ecosystem, iii) suggest guidelines and management strategies to balance between aesthetic and nature. The study employed structured questionnaire surveys from 330 visitors, and the instrument was adapted from Scenic Beauty Estimation Method introduced by Terry C. Daniel 1976. It is a quantitative measure of aesthetic preference for alternative wildland management system and prediction on the aesthetic consequences of alternative land uses. The data was analysed through descriptive statistical techniques. The analysis revealed that respondents highly preferred visual setting that combined with natural elements and produced sense of calm. They also have deep affection towards provisional services such as water, vegetation and air, but has limitation ability to understand the function of timber and soil towards garden's ecosystem. It is suggested that the gap of understanding can be improved through information sharing and knowledge transfer by experts and PBG's management through series of workshop, campaign, reading material and signage's at the garden.

INTRODUCTION

Landscape visual studies have played an essential role in preserving aesthetical quality, biodiversity, historical and local identity, and the site distinctiveness of a particular place. Visual quality refers to the aesthetic appeal of a landscape and the subjective assessment of a designed outdoor space to observers. It

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is also associated with sensory and experiential aspects perceived by people (Mohamed et al. 2022). Research has shown that the study of landscape visuals has played a significant role in safeguarding the ecosystem function of a garden and helping to achieve a balance between humans and nature (Jamean & Abas, 2023; Mundher et al. 2022; Liu et al. 2010). Penang Botanical Garden (PBG) has served as a sanctuary for plant conservation and a recreational spot for many years. Visitors here are fascinated with the unique site character and captivated by the garden's natural beauty. According to the previous case study, visitors are often influenced by aesthetic factors that produce tranquillity, greenery, attractiveness and safety effects when visiting the garden (Mundher et al. 2022; Mohamed et al. 2022; Wartman et al. 2021). However, climate change and environmental degradation issues have given negative impacts and challenges in sustaining green spaces (Mohammad et al. 2024). The basis of ecosystem services such as vegetation, timber and root, air, water, and slope have faced severe stress due to environmental pollution issues, overused natural resources, and improper planning and management of natural resources. Research has shown that maintaining urban biodiversity in Malaysia can mitigate climate change effects and balance the ecosystem services (Castelo et al. 2024).

As mentioned under Penang Green Agenda 2030, a lack of knowledge and appreciation among the public regarding natural ecosystems and biodiversity has also translated into a need for more interest in protecting greenery in Penang state. It is supported by Mohammad Sabri and Ponrahono (2024) and Jamean and Abas (2023) that the natural elements have a significant relationship between ecosystem structure and function and need further investigation, especially in urban settings where people are isolated from nature. Therefore, through a visual study approach, this study investigates visitors' perception of the relationship between provisional ecosystem services and their functions at PBG. As PBG is known for its naturalistic landscape setting and symbolic of high degree ecosystem services, this study has been undertaken to i) examine visitors' perception of existing landscape visuals, ii) investigate visitor understanding of visual components and their function in garden's ecosystem, iii) suggesting guidelines and management strategies to balance between aesthetic and nature at the historical garden.

This survey was conducted along a lower 850-meter circular road that functions as a visitor trail, beginning at the main entrance of the garden to the aquatic garden. There are different types of visitor spots along the trail, such as heritage tree and horticulture collections, open lawns and grasses, borrowed landscape view of Penang Hill Forest, semi-natural forest garden, natural pond and stream, vegetation composition, and other garden characteristics that could increase visitor visual experience. This visual setting comprises provisional environment services and natural landscape components that support the ecological function of the garden. For example, heritage trees can provide habitat for wildlife, horticulture collections add variety in plant species, and the borrowed landscape near the garden could provide a sense of continuity with the larger ecosystem and connect users with a broader ecological system perspective. Semi-natural forests rich with native and non-native species increase naturalness and support nature's function; water provides habitat and attracts birds and other species; plant hierarchy such as tall trees, understory shrubs, forest floors, and riparian and aquatic species serve as dynamic functions in an ecosystem cycle. The study employed a structured questionnaire survey from 330 visitors who participated. To assess the visual and ecosystem variables aspects of the site, eight photographs of visual sceneries in the garden were taken and evaluated by the visitors. The structure of questions was explicitly designed to measure visitors' perception and was divided into four: Section A: Respondent's background, Section B: Visual quality analysis, Section C: Botanical Garden as Nature and Product Producer and Section D: Role of Botanical Garden in Ecosystem Function. The instrument was adapted from the Scenic Beauty Estimation Method introduced by Daniel in 1976. It is a quantitative measure of aesthetic preference for alternative wildland management systems and a prediction of the aesthetic consequences of alternative land uses. The author redesigned the method to suit the ecosystem function variables contained at PBG. The data were analysed through simple descriptive statistical techniques. Frequency counts, tables, and

percentages were determined. Hopefully, this study will help us better understand how visitors perceive gardens' beauty and ecological value and provide future PBG conservation guidelines.

Site Background

The PBG was established in 1884 under the supervision of Chalets Curtis. The Penang State Government currently manages the 140-year-old historic garden and is renowned for conserving and protecting plant species in Malaysia. There are four main objectives of the garden: i) conservation and research, ii) garden landscape and management, iii) recreation, education and awareness and iv) centre of excellence (Special Area Plan, Penang Government, 2022). Within the garden are three types of roads: lower circular road, upper circular road, and upper north road. This study occurred on the lower circular road, which visitors frequently use. The visual allure along the road creates physical, mental and spiritual engagement and aesthetic appreciation for those who view the landscape. PBG also attracts hundreds of local visitors as a destination for jogging, hiking, and other recreational facilities. It also offers cultural ecosystem benefits by providing the local community with heritage values, environmental education opportunities, and support for human-nature needs.

There is a wide variety of species to arouse visitors' curiosity along the trail. A remarkable heritage Rain Tree (*Samanea saman*) that was planted in 1887 celebrated the visitors at the garden entrance, and spectacular flowers of the Cannon Ball Tree (*Couroupita guianensis*) can be found along the peaceful and serene trail. Other species such as Ceylon Ironwood (*Mesua ferrea*), Angsana (*Pterocarpus indicus*), Eve's Apple (*Tabernaemontana dichotama*), Umbrella Leafed Palm (*Johannesteijmannia altifrons*), Weeping Bottle Brush (*Callistemon viminalis*) and many more. Plant diversity and hierarchy have increased aesthetic quality and visual attractiveness, and the dramatic visual impact along the trail serves as an open-air museum and provides knowledge for visitors. Vegetation arrangements and natural features that blend with the surroundings have created stunning natural sceneries. During the flower fruiting and flowering season, the visual setting of the garden reaches its peak in terms of visual quality. The vibrant colours of blooming flowers create a picturesque scene, while gentle slopes and dense tropical forest background produce an excellent landscape perspective for the visitors. Also, historic structures like a band stage and a plant collection building from the British era make the trail unique. PBG is also home to animals such as macaques, giant squirrels, lizards, dusky leaf monkeys, and birds that can be seen along the road. In conclusion, PBG's beautiful scenic views and environmental services are an asset to the country and should be preserved for future generations.

LITERATURE REVIEW

Ecosystem Services and Function

The ecosystem is an interconnected community of living organisms such as plants, animals and microorganisms interacting in their physical environment. The scale of the physical environment can be in small or large geographic areas and involves natural processes such as soil and water nutrient cycle, topography, climate, habitat creation and others. Ecosystem benefits can be categorised under four primary types consisting of 'provisioning services' such as food, water, and timber that are consumed and used by humans for their live hoods, 'regulating services' on climate, floods and disease, waste, and water purification processes; 'cultural services' such as recreational, aesthetic, spiritual, and educational experiences that offer to people; and 'supporting services' that involves soil formation, photosynthesis, and nutrient cycling that maintain the environment ability to support life and aesthetic values (Liu et al. 2010; Jamean & Abas, 2023).

Previous research in park and open spaces has reported the value of 'provisional ecosystem' services; for example, by preserving the natural and waterbody system, clean water resources will support the ecological services and benefit the wildlife, insects, underground water storage and support human psychology (Liu et al., 2010). The natural topography and ground forest layer prevent slope erosion and create the natural skyline and background perspective of the garden, the natural boundaries and green buffer have increased visual characteristics, too (Dong et al. 2022). Plant conservation programmes and landscapes have increased garden attraction and vegetation components (Chen & Sun, 2018; Jamean & Abas, 2023). In addition, it supports soil preservation, the recycling of nutrients, carbon sequestration, and oxygen release. It completes the biodiversity function of the garden (Wartmann, 2021), provides aesthetical pleasure (Mohamed et al., 2022) and supports outdoor learning functions (Krisantia. et al. 2021). Extended research has applied the value of cultural ecosystem services in various fields of study, such as preserving the natural environment through conservation efforts (Jamean & Abas, 2023), land use and landscape planning (Tveit et al. 2018), mental and psychological health (Jamean & Abas, 2023), community well-being (Mohamed et al. 2022) and visual preservation (Chen & Sun, 2018). The research findings clearly show that the services were vital for environmental sustainability and provided guidelines for experts involved in designing and planning the natural environment. It offers new opportunities to design an open space that withstands environmental stress and maintains nature and aesthetic function.

Landscape Perception Theory and Contribution in Visual Studies

Previous research has demonstrated that demographic factors have directly influenced how people perceive landscape and rate the environment. Although modern society appreciates landscape visuals in two ways: by viewing images on social media or personally experiencing the view, being in the garden provides a deeper connection with the surrounding environment and multisensory benefits. The result of perception related to identified that young and adult groups are more attracted to designs that have some human intervention landscape scenery (Jamean & Abas, 2023), while senior citizens and retirees preferred lush greenery and quiet setting (Mundher et al. 2022), gender factors also could give different result on landscape perception based on personal feeling and exploration strategies (Mohamed et al. 2019). Males will likely adore landscapes challenging their stamina, and females will likely view beautiful and romantic sceneries (Wartman et al. 2021). Landscape sceneries that symbolise luck, belief and religion are also preferred by specific ethnic and cultural backgrounds (Mohamed et al. 2022). High education level also evaluates the visual landscape more than just aesthetic value.

In contrast, moderate and low education levels perceive landscape as an outdoor space natural setting; the visual components are part of what they like to see daily. Another study revealed that visitors with positive motivation tend to appreciate visual elements and absorb nature's positive energy. In contrast, less motivated visitors appreciate nature less, and visitors seeking psychological and emotional restoration often see the landscape as therapeutic (Mohamed et al. 2022). Survey by the researcher identified sceneries containing natural elements such as plants, streams, lakes, meadows and open lawns as highly preferred by visitors, while unsafe, mysterious and unorganised are less preferred and unattractive. Ancient structures, heritage trees, and buildings are the elements that people tend to focus on to increase their visual preferences (Wartman et al. 2021). Landscape elements and spatial arrangement also give different perceptions and functional values among experts and non-experts (Dong et al. 2022). In conclusion, the interaction between demographic profiles and perception has many intricate factors. By understanding people's choice of landscape, experts and researchers can plan and ensure the garden design aligns with the socio-cultural and socio-economic aspects of the visitors.

Two philosophical studies by scholars align with the landscape scenery perception survey. The Scenic Beauty Estimation (SBE) method was designed by Daniel et al. (1976). This method has been explored by Tveit et al. (2018) in landscape perception study and determined relative aesthetic experiences based on

three integrations: i) nature and product, ii) land use decisions for the area and iii) experts' decisions. The study highlighted the interrelationship between the three factors determining the quality and function of scenic beauty and observer judgement depending on landscape assessment criteria. This survey adapted variables under nature and product as producers, and the variables that were selected to be evaluated in the questionnaire were vegetation, timber, soil, water and air. These variables have been used in other social research and recorded dynamic perception amongst users (Abas & Emylia, 2023). For example, a study at red pine vegetation forest identified that linking people's aesthetic evaluations may provide valuable insights for forest management purposes and extend green corridors (Jamean & Abas, 2023), and a survey on eco-tourism found that soil pollution in urban have reduced water index quality for river, stream and underground water. Zhu et al. (2022) addressed the decay of timber as a pile that provides food and shelter for insects, small mammals and fungi. Like waterbody areas, the factors influencing the scenic beauty estimation value include vegetation, water elements, cleanliness, and the aesthetic form of hardscape landscape elements. However, survey dendrology at the park reported a weak relationship when using this method due to the current management and maintenance of the park, which is less preferred by visitors. The second method involves an ecological approach towards visual perception. Gibson's Affordance Theory 1979 underlined that the environment inevitably leads to some course of action and that the human five senses can be an evolved perceptual system. He added that humans prefer physical forms that promise benefits for survival, such as for living and eating, as well as a feeling of safety and potential uses of natural resources, which have helped to shape humans' attitudes and feelings of belonging to a particular space. This research paper uses both theories to understand the environmental systems and human needs at parks associated with scenic quality study.

METHOD

Sample Collection

This survey involved 330 botanic garden visitors selected through stratified random sampling. According to Pallant (2020), stratified random sampling is a probability sampling design that divides the population, overlaps the subset, and randomly chooses the subject from the subgroup. The visitor numbers are about one million visitors per year, and at peak periods, such as during public holidays and weekends, there can be up to one thousand visitors per day (Penang et al. 2021). Since it is a popular spot for the locals, a survey on visitors' visual effectiveness and ecosystem function at 140-year-old gardens is vital to be conducted. A sampling calculation formula was used to identify the sample size. For a 95% confidence level, a margin of error of $\pm 3\%$, the sample size based on the one thousand visitors per day is 1068. It is highlighted that although the initial target sample size was determined as 1068, the actual size collected was reduced to 330 due to several factors. The first factor is the climatic factor. The survey was conducted during specific weather because fewer visitors were seen around the garden on hot and rainy days, and it is challenging to approach them in such weather. The second factor is time constraints. Since time has a significant role in the survey administration process, researchers surveyed Mac and fully utilised eight days at the weekends to complete the sample size. Third is the age factor. Although the garden received a high number of visitors per day, the number of kids, toddlers, and teenagers was equal to that of adults and senior citizens during data collection. It was observed that some groups of respondents came to the garden with family and relatives, too. To reduce the gap in knowledge and understanding of the research questions, respondents below 18 years old were eliminated from the sample size.

Questionnaire Design

The research method in this study consists of a structured research questionnaire design, the collection and selection of photographs, a survey procedure, data analysis, discussion, and suggestions. The

questionnaire consists of four sections that relate to the aim and research objectives: Section A: Respondent's Background, Section B: Rating the Visual Quality, Section C: Botanical Garden as Nature and Product Producer and Section D: Role of Botanical Garden in Ecosystem Function. Under Section A, demographic factors include gender, ethnicity, age, occupation, and the reason for visiting the garden. This section objectively understands respondents' perceptions based on their visiting behaviour and perception towards the variables. Section B used the Likert scale to evaluate respondents' perceptions of landscape visuals. The environmental sampling technique introduced by Kaplan and Kaplan (1989) was applied during the selection of the photographs. The photographs were grouped into several criteria that will be tested in the survey. For example, along the lower circular road, there are several stunning landscapes. However, not all sceneries represent provisional ecosystem services and ecosystem functions as the researcher targets. Pools of photographs were taken and selected carefully by experts in landscape ecology and landscape architecture. Their role in photograph sampling selection is to choose the best distinctive botanical garden characteristics and provisional services for the garden. Eight photographs were selected from the procedure and attached to the questionnaire. Each picture represents a variety types of landscape visuals (LV) along the trail (LV 1- Garden entrance, LV 2- Trail entrance and heritage trees, LV 3- Open lawn and gentle slope, LV 4- Natural stream, LV 5- Forest trail, LV 6- Herbarium and plant houses, LV 7- Formal Garden, and LV 8, Garden's exit), and they were rated by the respondents using 5 Likert scale (5- Very high, 4-High, 3, Moderate, 2- Low, 1-Very Low). Section C comprises a few questions on provisional ecosystem services, and the questions were divided into elements, namely, vegetation, timber, water, soil and air. Respondents were asked to give answers based on their understanding and experience at the garden. Section D tested visitors' knowledge of the ecosystem function based on elements under provisional ecosystem services previously the analysis of data obtained from the study was achieved through descriptive statistical technique. Frequency counts, tables, percentages, and cross-tabulation were determined. Results were presented in pictorial and graphical, followed by a discussion.

RESULTS AND DISCUSSION

Analysis and Discussion of Respondents' Background

The Cronbach's alpha coefficient value is 0.84 for all photographs, confirming that the questionnaire distributed to the respondents was reliable. According to Pallant (2020), a result greater than 0.80 indicates a good reliability level for the instrument. This survey was conducted on weekends, and 330 local respondents participated in this study. From the survey, most respondents were female (66.7%) and male (33.3%). During site observation, female visitors were approachable to answer the questionnaire due to their feeling that the garden was more inviting and peaceful, which encouraged them to participate in surveys compared to males. Even though the number of males answering the questions was fewer than that of females, both males and females showed interest in answering the survey. Ethnic respondents from China (41.0%), Malay (39.0%), India (18.0%) and Javanese (2.0%) were included in the study. For age factors, middle-aged respondents which are 30-39 years old (36.7%) had the highest participation, followed by 40-49 years old (23.3%), above 70 years old (23.3%), below 18 years old (3.3%) and 50-59 years old (3.3%). Middle age group usually comes with family and their kids. Connection with their surroundings and awareness made them choose the garden to relax and recharge after their hectic day. In the survey, senior citizens and retirees showed significant age-related factors. This is due to the pleasant garden settings, which provide passive leisure to them and act as a routine to exercise and strengthen their muscle while viewing the beautiful landscape. During the survey, fewer visitors were 18 years old and below, and it was assumed that this group of people was committed to the study and loved to visit the park with a larger group of friends.

Different occupation categories were reported from the private sector (48.0%), retirees (23.0%), government sector (19.0%), self-employment (7.0%) and student (3.0%). The percentages reflect the ethnic background, where the majority of Chinese ethnic are working in the private sector. The remaining occupation categories consist of mixed ethnic. When were asked about their reason for visiting the garden, the highest answers were for exercise purposes (23.7%), followed by recreational purposes (19.3%), spending time with family (17.3%), viewing the botanical collection (17.0%), get close to nature (16.0%), relaxing (6.7%). The survey showed that visitors prefer engaging in physical activities, such as recreational, over simply relaxing. Another indicator for the garden as a popular spot for nature is when respondents chose their visitation factors to view the plants and get close to nature. Their frequency of being at the park per week reported more than five times/ week (50.0%), 2 to 3 times/week (30.0%), 1 time/week (20.0%) and time spent is 1-2 hours (83.3%) and more than 2 hours (16.7%). In summary, the demographic factors showed mixed responses from the survey. Visitor variety's purposes and intentions when visiting the garden can be guidelines in understanding their perspective about the garden. Based on the descriptive results, it can be concluded that the garden effectively fulfils its role as a recreational botanic garden, a place for the local community to interact with nature and to support their physical, emotional and psychological needs.

Analysis and Discussion of Landscape Visual Perception

The visitors were requested to focus on visual components that form the perspective views while evaluating the photographs. Landscape Visuals 1 to 8 were standard views that captured their eyes every time they visited the garden. As reported in Table 1, 'Very high' and 'high' mean values were identified for LV 1 (Garden entrance= 4.82), LV 2 (Trail entrance, heritage tree=4.58), LV 5 (Forest trail=4.67) and LV 3 (Open lawn and hills=4.10). It is summarised from respondents' opinions in the open-ended section that i) sceneries that have natural elements and dense vegetation have embraced their attention, ii) gradual visual changes and biodiversity function have captured their eyes and evoked the inner sense and tranquillity feelings, iii) Combination of coherence (uniformity) and legibility (distinctive elements) contributed to their preferences and iv) Their favourite spot in the offers them nice view and activities for recreational. 'Neutral' answers that respondents rated deals with sceneries that contain built structures and less attractive nature elements. LV 4 (Natural stream= 3.55), LV 6 (Herbarium and plant house=3.35), LV 7 (Formal Garden=3.86) and LV 8 (Garden exit=3.25). Among four LVs, the garden exit has the lowest mean value, while the formal garden received the highest. From the respondent's open-ended answers, they stated that i) the garden exit has less vegetation density and impact on visual impression, ii) disconnected access to the stream, no water flow and less coherent from the road, iii) the view can be improved by plants more trees and vegetation and iv) require proper maintenance and attractive access. Respondents have expressed favourable opinions on topiary plant and garden facilities, which offer numerous advantages during their visit.

Analysis of Provisional Ecosystem Services (PES)

From Table 2, there are five Provisional Ecosystem Services (PES) along the trail, namely vegetation, timber, soil, water and air, that were rated by the respondents and were ranked from lowest producer (Likert scale 1) to very high producer (Likert scale 5) as producers. Each PES functioned differently as a garden producer, and for respondents to better understand, the author explained the meaning of 'producer' associated with each PES to the respondents before answering the questions. Out of five PES, *PES 2: timber*, was ranked as the lowest (98) producer, while *PES 4: water*, is the highest (313), followed by *PES 1: vegetation* (319). When comparing cumulative results based on the Likert scale, it clearly shows that the site study has a good reputation as a nature and product producer towards the respondent's point of perspective, with very high producers (867) and high producers (376). Overall, the result analysed that the examination exhibits a notable absence of soil and timber provisioning services. Moderate frequency was recorded under moderate producer (215), which involves *PES 1: Timber*, *PES 2: Soil* and *PES 5: Water*.

This indicates that the respondents appear uncertain about the presence of timber, soil, and air in the garden. The authors concluded that their answers could be influenced by respondents' personal experience and understanding of timber and soil function in supporting ecosystem services. The diversity and quality of timber and soil are essential resources in every garden. By looking at the result, more in-depth studies may be required to understand these services in PBG rated by the respondents comprehensively.

Additionally, collaboration with ecologists and environmental planners can help to ensure strategies to balance its services at PBG. For low producer (53) and lowest producer (38) answers, the cumulative result is 94, representing only 2.3 % of the total result. This reveals that respondents have a deep affection towards PES and for the lowest ranked PES.

Table 1. Analysed Result Based on Landscape Visual Perception

1- Lowest visual quality, 2-Low visual quality, 3-Moderate visual quality, 4-High visual quality, 5-Very high visual quality		
 LV 1- Garden entrance Mean value: 4.82	 LV 2 - Trail entrance, heritage trees Mean value: 4.58	 LV 3- Open lawn and hills Mean value: 4.10
 LV 4- Natural stream Mean value: 3.55	 LV 5- Forest trail Mean value: 4.67	 LV 6- Herbarium and plant houses Mean value: 3.35
 LV 7- Formal garden Mean value: 3.86	 LV 8- Garden's exit Mean value: 3.25	

Source: Authors (2024)

Table 2. Analysed Result Based on Scenic Beauty Estimation (SBE) as Nature and Product Producer

Provisional Ecosystem Services (PES)	Lowest producer	Low producer	Moderate producer	High producer	Very high producer	Cumulative Frequency
PES 1: Vegetation	0	0	0	11	319	330
PES 2: Timber	7	29	75	121	98	330
PES 3: Soil	0	0	71	143	116	330
PES 4: Water	0	0	0	17	313	330
PES 5: Air	31	24	69	84	121	330
Total	38	53	215	376	867	

Source: Authors (2024)

Analysis of Understanding of Ecosystem Services

Table 3 is an analysis of the understanding of ecosystem services that respondents have rated. Reveals. Their levels of perception were denoted by different degrees of functions, from lowest to highest. As shown in the table, the proportion of respondents who ranked very high function and high function on PES 4: Water plays a role in the hydrological cycle, cooling the environment and the basis for living things to grow, carry 328 frequencies, which is the most significant proportion of the total sample of the population. This expresses the highest concern, with 99.4% of respondents agreeing that water is a provisional service supporting the PBG's ecosystem function. Under moderate function, respondents answered PES 3: Soil function provides nutrients for vegetation and stores water with 82 frequencies and PES 2: Timber to absorb carbon dioxide, as habitat and food sources for small mammals, insects and fungi with a total of 162 frequencies. In percentage, both answers represent only 9.8%. Although the percentage is too small compared to the answers to the high and highest function questions, it can be seen that some respondents are likely to think that timber and soil have less essential functions than PBG. This result also aligns with the previous question on visitors' perception of these two natural features as producers. In ecosystem services, respondents were less aware of timber sources in transmitting water and nutrients to the leaves and the root system as anchors for tree stability and retaining the soil structure. Apart from this, the tree canopies and lush greenery of PBG are supported by the timber or the tree trunk. The survey shows that respondents' understanding of timber and soil function needs to be enhanced through information sharing and knowledge transfer by experts and PBG management. This can be achieved through workshops, campaigns, and supporting reading materials and signage in the garden.

Table 3. Analysed Result Based on Ecosystem Function Based and Scenic Beauty Estimation (SBE)

Ecosystem Function Based on Scenic Beauty Estimation Method	Lowest function	Low function	Moderate function	High function	Very high function	Cumulative Frequency
PES 1: Vegetation						
Function: Provide oxygen through photosynthesis, thermal reduction	0	0	0	11	319	330
PES 2: Timber						
Function: Absorb carbon dioxide, as habitat and food sources for small mammals, insect and fungi	0	15	80	109	126	330
PES 3: Soil	0	0	82	106	142	330

Function: Provide nutrient for vegetation and store water						
PES 4: Water						
Function: Hydrological cycle, cooling the environment as basic growth function to all living things	0	0	0	4	326	330
PES 5: Air						
Function: Hydrological cycle, cooling the environment and basis for living things to grow	0	0	0	2	328	330
Total	0	15	162	232	1241	

Source: Authors (2024)

CONCLUSION

Through visual studies, this study suggests three critical suggestions for preserving natural elements and biodiversity in PBG. i) Linking the importance of visual preservation with the reduction in natural environment quality. According to this, planning and design will consider the ecological function and potential of natural resources and build any landscape structures related to the heritage garden concept with eco-friendly material; ii) Visual monitoring and implementation of visual treatment of natural components along the trail and garden. Noticeable degradation of natural resources needs to be treated as soon as possible to reduce visual deterioration in the garden. For example, the current condition of physical soil properties (slope and erosion monitoring and soil nutrients testing), waterbody system (water table and pollution) and plants and vegetation (horticulture assessment and dendrology studies) and iii) Inculcate information exchange and knowledge transfer between expert and community in preserving visual aesthetic. Information and knowledge give people access and opportunities; active participation between the garden officers and visitors will become necessary to preserve PBG. In conclusion, PBG is a country asset that deserves highlighting and preservation for future generations. By understanding and respecting its rich heritage, natural beauty, and ecological functions, PBG can continue to be a heaven of visual attractiveness and biodiversity for visitors and an essential part of Malaysia's landscape legacy.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Noralizawati Mohamed carried out the research, wrote and revised the article, conceptualised the central research idea and provided the theoretical framework. Nurhayati Abd Malek supervised the research methodology progress and approved the article submission. Shazwan Mohamed Shaari conducted data collection and verified data analysis method.

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