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Assessing Biophilic Design, Place Quality, and Sustainability in Commercial Leisure Spaces: Case Studies in Bangkok's CBD

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Abstract

Rapid urbanization has increased the demand for commercial leisure spaces that support human well-being, high-quality public environments, and environmental sustainability. In Bangkok's central business district (CBD), contemporary shopping malls increasingly integrate biophilic design, placemaking strategies, and sustainability initiatives to enhance visitor experience and environmental responsibility. This study investigates how biophilic design, place quality, and sustainability can be jointly achieved and evaluated in commercial leisure spaces.

An integrated biophilic and sustainable place framework was developed through an extensive literature review, synthesizing the 15 Patterns of Biophilic Design, the Twelve Quality Criteria for public spaces, and the United Nations' 17 Sustainable Development Goals (SDGs). The framework was applied as an observational assessment tool to three case studies in Bangkok's CBD: an indoor future-oriented commercial destination, an elevated urban rooftop park, and an outdoor pedestrian walking street. On-site observations were conducted by a multidisciplinary observer team using a three-point scoring system across 44 indices.

The results indicate that all case studies demonstrate strong place quality, while differing in their approaches to biophilic design and sustainability. The rooftop urban park achieves the highest overall performance due to its rich, multi-sensory human-nature interactions. The indoor commercial space excels in sustainability alignment and programmatic innovation, while the outdoor walking street demonstrates strengths in social vitality and enjoyment. Overall, the findings suggest that authentic biophilic environments, diverse activity programming, and visible sustainability initiatives significantly enhance user experience and sustainability awareness. The proposed framework offers a transferable tool for evaluating biophilic and sustainable commercial leisure spaces in dense urban contexts.

Keywords: *biophilic design, placemaking, sustainable design, commercial leisure space, shopping mall*

1. Introduction

Over the past decade, biophilic design has been increasingly incorporated into public architecture through the integration of natural elements into the built environment, fostering stronger connections between people and nature, particularly in commercial buildings in Bangkok. At the same time, contemporary urban lifestyle trends emphasize the creation of high-quality places to support public leisure activities, while environmental sustainability has emerged as a major concern.

In Bangkok, contemporary shopping malls are increasingly embracing biophilic design (integrating nature for well-being), enhancing place quality (creating engaging, multi-functional semi-public spaces with cultural relevance), and pursuing sustainability (circular economy, waste reduction, green tech) to boost visitor experience, health, and environmental responsibility, with key players like Siam Piwat (Siam Paragon and ICONSIAM), Central Pattana (Central Eastville and Dusit Central Park), and TCC Land (One Bangkok) leading with initiatives in green spaces, local partnerships, and futuristic sustainable retail (Aksornnam, 2026). Moreover, mixed-use malls that offer one-stop shopping, convenience, complimentary services, and safe facilities are particularly favored by consumers in Bangkok (Chantarayukol, 2019).

These trends raise the question of how commercial leisure spaces can simultaneously achieve biophilic design, place quality, and sustainability. This research seeks to address this gap by synthesizing multidisciplinary perspectives related to nature, people, and the environment. Accordingly, the following section presents a review of the relevant literature.

Biophilic design is an approach to the built environment that seeks to reconnect people with nature by integrating natural elements, patterns, and processes into architectural design (Kellert & Calabrese, 2015). Rooted in the concept of *biophilia* -- the innate human tendency to seek connections with nature -- this design philosophy recognizes that humans evolved in close relationship with the natural world and continue to benefit from that connection in profound ways (Wilson, 1984). As urbanization and technological advancement increase distance from natural environments, biophilic design offers a framework for creating spaces that support physical health, mental well-being, and emotional comfort (Browning et al., 2014). The *15 Patterns of Biophilic Design*, developed by Terrapin Bright Green, provide a practical design framework for incorporating nature into the built environment (Browning & Ryan, 2020). They are organized into three dimensions, as in Table 1.

Table 1 Design framework of the 15 Patterns of Biophilic Design

Dimensions	Items/Indices	Descriptions
Nature in the space	1. Visual connection with nature	Views of natural elements such as vegetation, water, animals, or landscapes.
	2. Non-visual connection with nature	Sensory experiences of nature through sound, smell, touch, or taste.
	3. Non-rhythmic sensory stimuli	Brief, unpredictable movements or changes in nature (e.g., fluttering leaves, passing clouds).
	4. Thermal and airflow variability	Subtle variations in temperature, humidity, and air movement that mimic natural conditions.
	5. Presence of water	Seeing, hearing, or touching water elements that enhance calm and focus.
	6. Dynamic and diffuse light	Lighting conditions that vary naturally in intensity and direction.
	7. Connection with natural systems	Awareness of natural processes such as seasons, weather, and ecological cycles.
Natural analogues	8. Biomorphic forms and patterns	Shapes, patterns, and textures that mimic natural forms.
	9. Material connection with nature	Use of natural or locally sourced materials that reflect the surrounding environment.
	10. Complexity and order	Organized complexity inspired by nature, such as fractal geometry and layered patterns.
Nature of the space	11. Prospect	Open views and long sightlines that allow surveillance and orientation.
	12. Refuge	Sheltered or enclosed spaces that provide comfort and protection.
	13. Mystery	Partially hidden views that encourage exploration and curiosity.
	14. Risk / peril	A controlled sense of danger, balanced with safety (e.g., glass floors, balconies).
	15. Awe	A feeling of wonder, reverence, and admiration; a sense of vastness (e.g., powerful, or deeply beautiful).

In recent years, human well-being, satisfaction, and livability have become growing concerns. In the context of increasing urbanization, city residents seek to enhance their quality of life and find their happiness by engaging with places that support relaxation, social interaction, and meaningful experiences (Kourtit et al., 2022). Biophilic shopping malls create more pleasant and restorative environments, encouraging visitors to stay longer, return more frequently, and engage socially. Features such as indoor gardens, green atriums, skylights, and outdoor-indoor transitions (Atthakorn, 2019). Biophilic design features in public spaces help reduce stress, improve mood, create a sense of escape from dense urban surroundings, and create a restorative experience for visitors (Cheng & Marzuki, 2023).

Placemaking is a fundamental concept focused on creating functional and appealing environments that make public spaces more enjoyable places to live and work (Hansasooksin & Tontisirin, 2021). Place quality refers to the extent to which a place enhances positive human experiences, behaviors, and well-being through its physical, social, and environmental attributes. Whyte (1980) emphasized that the success of public spaces depends on how people actually use them, arguing that direct observation in real-life settings provides a more reliable understanding of social behavior. Implementing this approach, Gehl (2010) introduced the *Twelve Quality Criteria* as a framework for evaluating public spaces based on protection, comfort, and enjoyment. This framework enables users to assess, compare, and discuss the observable qualities of urban environments that foster positive human behavior and social interaction. The assessment dimensions, items/indices, and guiding questions are presented in Table 2.

Table 2 Place quality assessment tools: “Twelve Quality Criteria”

Dimensions	Items/ Indices	Questions
Protection	1. Protection against traffic and accidents	Is the pathway safe and separated from roads?
	2. Protection against harm by others	Is it a safe place to spend time without danger?
	3. Protection against unpleasant sensory experiences	Is it protected from pollution/unpleasant climate?
Comfort	4. Options for mobility	Is it easy to access and move around the place?
	5. Options to stand and linger	Is it comfortable to stand and lean against?
	6. Options for sitting	Are the seats available, comfortable, or adjustable?
	7. Options for seeing	Are there interesting things to look at?
	8. Options for talking and listening/hearing	Does the place encourage conversation?
	9. Options for play, exercise, and activities	Is there a playground or activity to participate in?
Enjoyment	10. Human scale	Is the size of public space friendly to humans?
	11. Opportunities to enjoy positive aspects of climate	Does it provide pleasant outdoor conditions?
	12. Aesthetic qualities/positive sensory experiences	Is the public space beautiful and attractive?

In recent developments, biophilic design has played a significant role in promoting sustainability awareness by reconnecting people with nature in public spaces and making environmental responsibility more visible (Zhong et al., 2026). Beyond its well-documented benefits for human health and well-being, biophilic design also has the potential to contribute meaningfully to global sustainable development (Munoz, 2022).

The United Nations (2015) introduced the Sustainable Development Goals (SDGs) to create a better world. These 17 goals serve as a global framework to guide countries toward sustainable development by 2030. Biophilic design has the potential to contribute to the achievement of all 17 SDGs, as supported by existing research, some of which is summarized in Table 3.

Table 3 Examples of biophilic design contributions to the UN’s 17 sustainable development goals

Dimensions	Items/Indices	Biophilic design contributions	References
People	1. No poverty	Promote diversity of community engagement, mutual dependence, and social equity. Reduce energy and material costs.	(Munoz, 2022) (Debertin, 2021) (Lerner & Stopka, 2016)
	2. Zero hunger	Promote sustainable food systems, community agriculture, and a wide variety of food productions.	(Munoz, 2022) (Söderlund, 2019)
	3. Good health and well-being	Reduce stress, improve air quality, promote physical activities, and promote psychological restoration.	(Aydogan & Cerone, 2021) (Sholanke et al., 2026) (Zhong et al., 2022) (Miola et al., 2025)
	4. Quality education	Create a more inspiring and engaging learning environment for better educational outcomes. Improve creativity and problem-solving	(Munoz, 2022) (Browning & Determan, 2024) (Hähn et al., 2021)
	5. Gender equality	Create inclusive and equitable spaces to promote gender diversity. Considering gender in design.	(Munoz, 2022) (Hähn et al., 2021)

Table 3 Cont

Dimensions	Items/Indices	Biophilic design contributions	References
Planet	6. Clean water and sanitation	Provide sustainable management of water and sanitation, and clean water for all.	(Katuk & Koseoglu, 2022) (Munoz, 2022)
Prosperity	7. Affordable and clean energy	Reduce energy consumption, generate clean energy, and support affordable energy.	(Munoz, 2022) (Ibrahim & Al-Chaderchi, 2022)
	8. Decent work and economic growth	Create healthy work environments and promote reusable and renewable resources. Increase work productivity.	(Jude et al., 2024) (Munoz, 2022) (Hähn et al., 2021)
	9. Industry, innovation and infrastructure	Promote innovation and entrepreneurship and enhance sustainable infrastructure.	(Munoz, 2022) (Ibrahim & Al-Chaderchi, 2022)
	10. Reduced inequalities	Create inclusive and sustainable community spaces and foster social interaction.	(European Environment Agency, 2022)
	11. Sustainable cities and communities	Create more sustainable and livable cities and communities by improving urban spaces. Enhance resilience in urban parks.	(Ibrahim & Al-Chaderchi, 2022) (Sholanke et al., 2026) (Ristianti et al., 2024)
Planet	12. Responsible consumption and production	Promote conservation by using more sustainable materials and reducing environmental impacts.	(Munoz, 2022) (Ibrahim & Al-Chaderchi, 2022)
	13. Climate action	Mitigate climate change by reducing energy consumption and creating resilience of buildings. Improve thermal performance.	(Ibrahim & Al-Chaderchi, 2022) (Sholanke et al., 2026) (Wijesooriya & Brambilla, 2021)
	14. Life below water	Conserve use of marine resources and reduce polluted waste. Create senses of waterscape in architecture.	(Munoz, 2022) (Katuk & Koseoglu, 2022)
	15. Life on land	Promote biodiversity and conservation of natural ecosystems by incorporating natural elements into the built environment.	(Ibrahim & Al-Chaderchi, 2022) (Sholanke et al., 2026)
Peace, justice and strong institutions	16. Peace, justice and strong institutions	Promote a sense of calm, relaxation, and well-being by providing comfortable and attractive environments for public space in institutional settings	(Elsadek et al., 2019) (Peters & D'Penna, 2020)
Partnerships for the goals	17. Partnerships for the goals	Promote partnerships between different sectors and organizations by fostering partnerships and collaboration.	(Zong et al., 2024) (Munoz, 2022)

Based on the literature reviews, the creation of biophilic and sustainable places requires consideration of three key aspects: biophilic design, place quality, and sustainability. The indices applied in the framework are derived from relevant theories and practices identified in the literature. Concepts of nature, people, environment, and place are integrated into a single comprehensive framework, which can serve as a universal tool for evaluating biophilic and sustainable places worldwide. In addition to established assessment approaches such as Post-Occupancy Evaluation (POE) and green building standards like LEED or WELL, this new framework is designed to be readily understood and applied by the general public without requiring in-depth expert analysis. The biophilic and sustainable place framework is illustrated in Figure 1.

BIOPHILIC & SUSTAINABLE PLACE FRAMEWORK

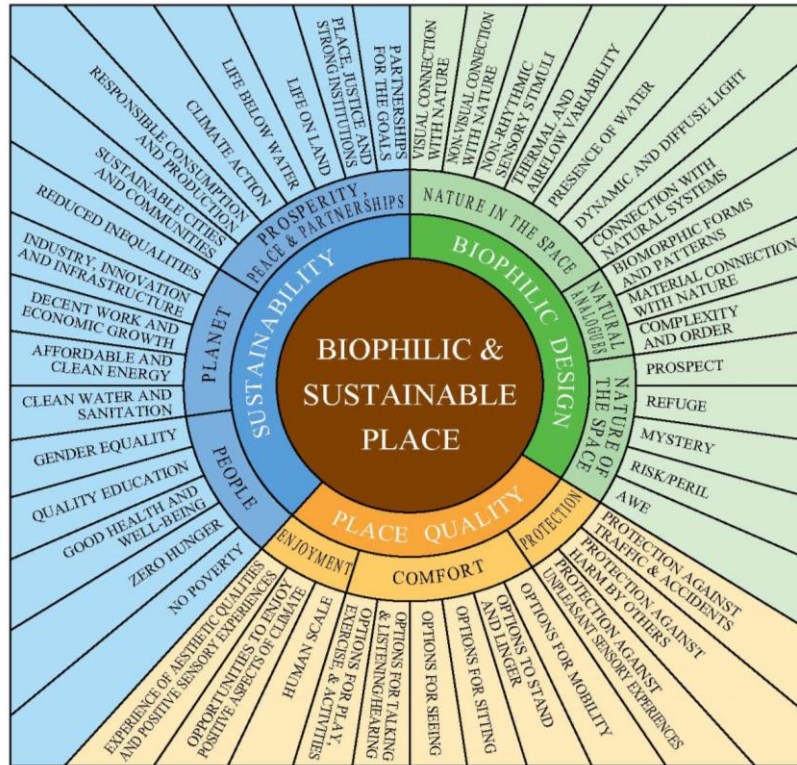


Figure 1 Biophilic and sustainable place framework

2. Objectives

The objectives of the research are as follows:

- 1) To establish a framework integrating biophilic design, place quality, and sustainability.
- 2) To examine three case studies of commercial public spaces in Bangkok by observation.
- 3) To evaluate and compare the observational results using the proposed framework.

3. Materials and Methods

The research methodology consists of five steps: framework development, research tool design, case study selection, on-site observation, and result evaluation and comparison. The details of each step are described below:

First, a framework is developed to integrate the quality criteria of biophilic and sustainable places. These criteria focus on how a commercial leisure space can simultaneously achieve biophilic design, place quality, and sustainability. Relevant literature is reviewed to identify the key factors, dimensions, and indices. Based on this review, the biophilic and sustainable place framework is synthesized and presented in a diagram. This process is described in the introduction section.

Second, the biophilic and sustainable place framework is employed as a research tool to evaluate case studies of commercial leisure spaces in Bangkok's central business district. The three factors, including biophilic design, place quality, and sustainability, are assessment criteria. The forty-four indices are evaluated through on-site observation. Each index is scored by a vote among the observer team, which consists of a senior architect, a middle-aged shopper, and a teenager. The evaluation uses a three-point scale ranging from 0 to 2, where 0 indicates no relationship, 1 indicates a moderate relationship, and 2 indicates a strong relationship with high impact. After all indices are assessed, subtotal scores for each factor are calculated, and total scores for each case study are compiled.

Third, the case studies of commercial leisure spaces are selected based on the following criteria: 1) a substantial presence of green areas or natural elements, high popularity and vitality, and environmentally friendly characteristics; 2) location within Bangkok's central business district; 3) provision of semi-public spaces ranging from approximately 5,000 to 15,000 square meters; and 4) inclusion of diverse spatial types, including indoor, outdoor, and rooftop areas. The selections of the three case studies for this research are shown in Figure 2, and their details are as follows:



Figure 2 Photographs and maps of the case studies

1) Case #1: “Nextopia” is a 15,000-square-meter indoor destination built around the concept of a “prototype for the world of tomorrow.” Designed to seamlessly integrate sustainability into everyday life, it combines lifestyle experiences, retail, and dining within a future-focused urban environment. Located on the top floor at levels 5 and 5A of the Siam Paragon shopping mall, it was developed by Siam Piwat in collaboration with over 50 innovative partners and opened in 2025.

Nextopia showcases cutting-edge green technologies, such as kinetic flooring, solar energy systems, and cooling waterfalls, alongside immersive interactive features, including a globe LED screen and AR experiences. Eco-friendly retail and dining concepts, ranging from vertical farms and plant-forward cuisine to local brands, are complemented by community-driven activities that reward sustainable behaviors. Together, these elements are designed to inspire a joyful, collective journey toward a greener future.

2) Case #2: “Suan Dusit Arun” is the largest elevated urban rooftop park in Bangkok, located across multiple-level rooftops and accessible via the 4th to 7th floor of the Dusit Central Park shopping mall. It is developed by Viman Suriya Co., Ltd., a joint venture between Dusit Thani PLC and Central Pattana PLC, and opened in 2025.

Suan Dusit Arun was designed as a lush green oasis above the city. The rooftop park features tropical gardens, cascading waterfalls, and panoramic urban views. Using native Thai plant species and an inclusive design, it encourages relaxation and meaningful connections with nature. Serving as a “green lung” for the city, Suan Dusit Arun supports biodiversity while offering spaces for walking, jogging, family activities, dining and drinking, and pet-friendly recreation that symbolize renewal and a fresh start for urban life.

3) Case #3: “Siam Square Walking Street” is a 20x400-meter outdoor plaza lined with shophouses. It was upgraded into a vibrant pedestrian destination by the Property Management of Chulalongkorn University (PMCU) in 2022.

Siam Square Walking Street is known for its energetic, youthful atmosphere. The pedestrian-oriented environment blends contemporary trends with local culture through a diverse mix of trendy boutiques, eateries, street food, beauty outlets, and entertainment venues. The human-scaled environment features renovated shophouses and a dynamic combination of old and new shopping experiences, establishing the area as a key hub for fashion, food, and youth culture in Bangkok. The place is celebrated for its unique local discoveries, Instagram-worthy spots, and role as a central meeting place for students and young Thais. Siam Square Walking Street maintains a distinct identity compared to the large-scale malls in the surrounding area.

Next, on-site observations are carried out across the three case studies. Each site is visited at least in two periods, early afternoon (12:00 – 3:00) and late afternoon (4:00 – 7:00), on long vacation days between December 27, 2025, and January 4, 2026. At each location, observers explore both man-made settings and natural elements, as well as on-site human activities. After completing the observations, the evaluation checklist is finalized through team consensus, with each index assigned a score of 0, 1, or 2. However, observers may later revisit the sites, discuss their assessments, and revise scores as necessary. As the assessment relies on observational judgment, a degree of subjectivity is acknowledged. To mitigate potential bias, evaluations are conducted by a multidisciplinary observer team, and final scores are determined through discussion and consensus, enhancing the reliability and consistency of the results. It is noted that this evaluation approach was designed for implementation by a small research team within a limited timeframe, reflecting constraints related to cost, time, and available personnel.

Finally, the results of the on-site observations are reported and analyzed. Comparative evaluations of biophilic and sustainable qualities are conducted across the three case studies using dimensional analysis and aggregate scoring. The strengths and weaknesses of each case study are discussed, and the score rankings are presented. The key findings are summarized in the conclusion section.

4. Results and Discussion

After completing on-site observations, the indices of the three case studies were scored, as presented in Table 4. A score of 0 indicates that the element is not present or not relevant, a score of 1 indicates a moderate level of relevance, and a score of 2 indicates a high level of relevance and impact. Based on these scores, the biophilic design qualities, place quality, and sustainability goals of the case studies are described as follows:

The biophilic design of Case #2 is particularly outstanding, as the site is naturally shaped like a forested hill. The rooftop park, covering approximately 11,200 square meters, extends across the 4th to 7th floors of the retail building. Although surrounded by high-rise buildings, the park visually and spatially connects to Lumpini Park - the largest urban park in Bangkok’s central business district - effectively extending its green landscape into the city center. This semi-public space is recognized as one of the largest green roofs in the area and offers exceptional natural views within the dense urban context.

The biophilic design strategy of Case #2 enhances the human–nature connection through rich multi-sensory experiences, including abundant vegetation, gently cascading waterfalls, soothing natural sounds, the subtle fragrance of carefully selected Thai plant species, tactile engagement with natural materials, and the presence of wildlife such as fish, birds, and butterflies. Visitors are guided along wooden ramped pathways that encourage immersive interaction with the environment, allowing them to experience variations in temperature, airflow, and dynamic, diffused daylight throughout the day. The built elements are thoughtfully designed to

emulate natural forms, featuring bird nest-inspired terraces, wooden flooring, intricately organized handrails, and curved seating made of wood and stone. A diverse sequence of spaces along the pathways evokes feelings of prospect, refuge, mystery, and even a controlled sense of risk. Collectively, these elements culminate in a powerful and memorable experience, with a profound sense of awe as the defining spatial quality.

The biophilic design strategies applied in Cases #1 and #3 can be considered effective, though differing in their approaches. In Case #1, natural elements are entirely constructed within the interior environment, whereas in Case #3, a more conventional arrangement of trees along a pedestrian street is integrated with multi-purpose open spaces. The fifteen patterns of biophilic design in Case #1 are interpreted creatively with advanced digital technologies and media. The public spaces are designed to evoke a range of moods and atmospheres; however, most biophilic elements function as representations or simulations of nature rather than direct encounters with it. The three-story space is envisioned as a futuristic community characterized by fluid, curved forms, nature-inspired artworks and crafts, immersive 3D digital displays of the Earth, a green spiral staircase, a mesh-screen waterfall, skylights providing views of the sky, and diverse organic forms enhanced by LED lighting. While these highly imaginative features create a visually distinctive indoor environment, they also distance the space from authentic natural conditions. As a result, direct perceptions of real nature and the outdoor atmosphere are relatively limited.

In contrast, Case #3 relies strongly on outdoor spaces and tree-lined areas to support the perception of nature. Framed by four-story shophouses, the flat, linear walking street - measuring approximately 12 by 400 meters - is punctuated with rows of trees that create a sense of openness and natural relief between visually striking façades. Natural elements are expressed through the presence of trees, open views of the sky, and the organic patterns embedded in the shophouse façades. Users also experience nature through environmental conditions such as variations in temperature and airflow, dynamic and diffused daylight, expansive sky views, and long prospects across the open pedestrian space. Although the plaza does not include water features or natural objects, several building façades effectively reference nature using natural analogues, including wave-like patterns, wood finishes, raw metal surfaces, and nature-inspired imagery displayed on LED screens. Refuge spaces formed between building blocks and beneath shophouse canopies further enhance the spatial experience. However, while the walking street successfully conveys openness and comfort, it does not strongly evoke deeper biophilic qualities such as mystery, a sense of risk or peril, or feelings of awe.

Overall, all case studies demonstrate strong place qualities, achieving high scores across the twelve place-quality criteria. The public spaces are well protected from traffic-related hazards, as pedestrian pathways are clearly separated from vehicular circulation, and the continuous spatial layouts provide clear visibility that enhances perceived safety. These qualities allow people to comfortably spend time engaging in social interaction and leisure activities within appealing environments.

Among the cases, Case #1 appears to be the most carefully designed in terms of programming and the provision of activities. However, as an indoor environment, it lacks exposure to the positive aspects of outdoor climatic conditions. In contrast, the outdoor spaces in Cases #2 and #3 may present challenges related to environmental discomfort, such as excessive heat, heavy rainfall, or intrusive sounds - such as ambulance sirens - from nearby streets. In terms of *Comfort*, Case #3 is limited by the lack of alternative seating options along the walking street. Regarding *Human Scale*, Case #2 offers the weakest sense of human scale, as the rooftop space is visually enclosed by three surrounding skyscrapers.

The degree to which the three case studies align with sustainability goals varies. Case #1 demonstrates the strongest relationship with the 17 Sustainable Development Goals (SDGs), achieving an outstanding level of alignment, while Cases #2 and #3 are assessed at a high level.

Table 4 Results of index scores in case studies

Factors	Dimensions		Indices	Score (0-2 for each item)		
				Case #1	Case #2	Case #3
1. Biophilic Design	Nature in the space	1.1	Visual connection with nature	2	2	2
		1.2	Non-visual connection with nature	2	2	1
		1.3	Non-rhythmic sensory stimuli	2	2	2
		1.4	Thermal and airflow variability	1	2	2
		1.5	Presence of water	1	2	0
		1.6	Dynamic and diffuse light	1	2	2
		1.7	Connection with natural Systems	1	2	1
	Natural analogues	1.8	Biophilic forms and patterns	2	2	2
		1.9	Material connection with nature	2	2	1
		1.10	Complexity and order	2	2	2
	Nature of the space	1.11	Prospect	1	2	2
		1.12	Refuge	2	2	2
		1.13	Mystery	2	2	1
		1.14	Risk / Peril	1	1	1
		1.15	Awe	1	2	1
Subtotal Score				23	29*	22
2. Place Quality	Protection	2.1	Protection against traffic and accidents	2	2	2
		2.2	Protection against harm by others	2	2	2
		2.3	Protection against unpleasant sensory experiences	2	1	1
	Comfort	2.4	Options for mobility	2	2	2
		2.5	Options to stand and linger	2	2	2
		2.6	Options for sitting	2	2	0
		2.7	Options for seeing	2	2	2
		2.8	Options for talking and listening	2	2	2
		2.9	Options for play, exercise and activities	2	2	2
	Enjoyment	2.10	Human scale	2	1	2
		2.11	Positive aspects of climate	1	2	2
		2.12	Aesthetic qualities & positive sensory experiences	2	2	2
Subtotal Score				23*	22	21
3. Sustainability Goals	People	3.1	No poverty	1	1	1
		3.2	Zero hunger	1	1	1
		3.3	Good health and well-being	2	2	2
		3.4	Quality education	2	1	2
		3.5	Gender equality	2	2	2
	Planet	3.6	Clean water and sanitation	2	2	1
	Prosperity	3.7	Affordable and clean energy	2	1	1
		3.8	Decent work and economic growth	2	2	2
		3.9	Industry, innovation and infrastructure	2	2	2
		3.10	Reduced inequalities	1	1	2
		3.11	Sustainable cities and communities	2	2	2
	Planet	3.12	Responsible consumption and production	2	1	2
		3.13	Climate action	2	2	1
		3.14	Life below water	2	2	0
		3.15	Life on land	2	2	1
	Peace	3.16	Peace, justice and strong institutions	1	1	2
	Partnership	3.17	Partnerships for the goals	2	2	1
Subtotal Score				30*	26	25
Grand Total Score				76	77*	68

Remarks: 0 = not existed or related, 1 = some related, 2 = related with a high impact; * = highest ranking of sub/total scores

Within the *People* dimension, none of the cases show strong connections to the goals of *No Poverty* or *Zero Hunger*. Although these inclusive public spaces provide affordable food kiosks and free drinking water, there are limited initiatives aimed at raising public awareness of poverty alleviation or hunger-relief programs. Cases #1 and #3 show greater alignment with *Quality Education*, supported by educational themes and their proximity to academic institutions. It should be noted that some Sustainable Development Goals, particularly *No Poverty* and *Zero Hunger*, are structurally more difficult to manifest through spatial design alone, as they are typically addressed through broader socio-economic policies. This limitation partly explains the lower scores observed for these goals.

In the *Planet* dimension, Case #1 addresses all relevant indicators, whereas Case #2 demonstrates only limited engagement with *Responsible Consumption and Production*. Although Case #3 uniquely offers rotating exhibition spaces with the potential to disseminate sustainability-related information, it shows relatively weak connections to *Clean Water and Sanitation*, *Climate Action*, *Life Below Water*, and *Life on Land*.

Regarding the *Prosperity* dimension, all three cases perform strongly in areas such as *Decent Work and Economic Growth*, *Industry, Innovation, and Infrastructure*, and *Sustainable Cities and Communities*. This strong performance may be attributed to their location within the core of the capital city, where advanced technologies and a highly developed urban environment are evident.

In the dimension of *Peace, Justice, and Strong Institutions*, Case #3 benefits from proximity to the Siam Square community police station and Chulalongkorn University. Additionally, all projects demonstrate substantial collaboration under *Partnerships for the Goals*, with Cases #1 and #3 each engaging in more than 50 partnerships.

In summary, Case #2 demonstrates the strongest overall performance within the framework, achieving the highest total score of 77. Case #1 follows closely in second place with a score of 76, while Case #3 ranks third with a total score of 68. Case #2 performs particularly well in the biophilic design category, attaining the highest subtotal score of 29. In contrast, Case #1 achieves the highest scores in place quality and sustainability goals, with scores of 23 and 30, respectively. Although Case #3 records the lowest scores across all criteria, its overall performance remains at a high level.

The results of the dimensional assessment are illustrated as percentage scores in Figure 3. The nine dimensions derived from the three framework factors are visualized in a spiderweb diagram, including *Nature in the Space*, *Natural Analogues*, *Nature of the Space*, *Protection*, *Comfort*, *Enjoyment*, and the sustainability dimensions of *People*, *Planet*, and *Prosperity–Peace–Partnerships*. The diagram reveals considerable variation in percentage scores across the case studies, clearly highlighting the strengths and weaknesses of each.

Case #1 performs strongly in presenting *Nature in the Space* and *Natural Analogues* within biophilic design, ensuring *Protection* and *Comfort*, and contributing to the *People* and *Planet* dimensions of the Sustainable Development Goals. However, it shows comparatively weaker performance in *Nature of the Space* and *Prosperity–Peace–Partnerships*.

Case #2 excels across all three aspects of biophilic design and achieves the highest level of *Comfort*. Its weaker areas include *Protection*, *Enjoyment*, and contributions to the *People* dimension.

In contrast, Case #3 performs best in *Enjoyment* and demonstrates the strongest contributions to *People* and *Prosperity–Peace–Partnerships*. However, it shows limitations across all biophilic design dimensions, as well as in *Protection* and *Comfort*, and makes the least contribution to the *Planet* dimension.

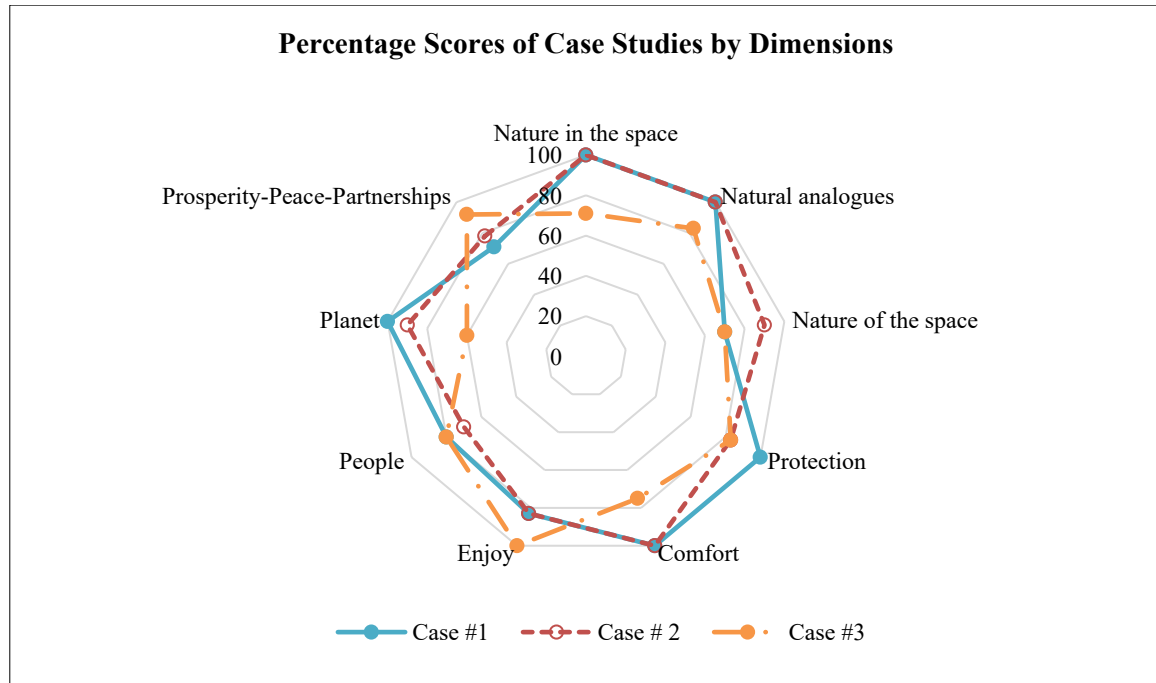


Figure 3 Comparison of percentage scores of case studies by dimensions

The total scores of the case studies were compared and broken down by individual factor scores, as illustrated in Figure 4. Case #2 achieved the highest total score (77), followed closely by Case #1 (76), while Case #3 recorded the lowest total score (68). In Case #1, the SDGs score exerted the greatest influence among the evaluated factors. In Case #2, the biophilic design score was the most influential factor. By contrast, Case #3 showed relatively minimal variation among the factor scores.

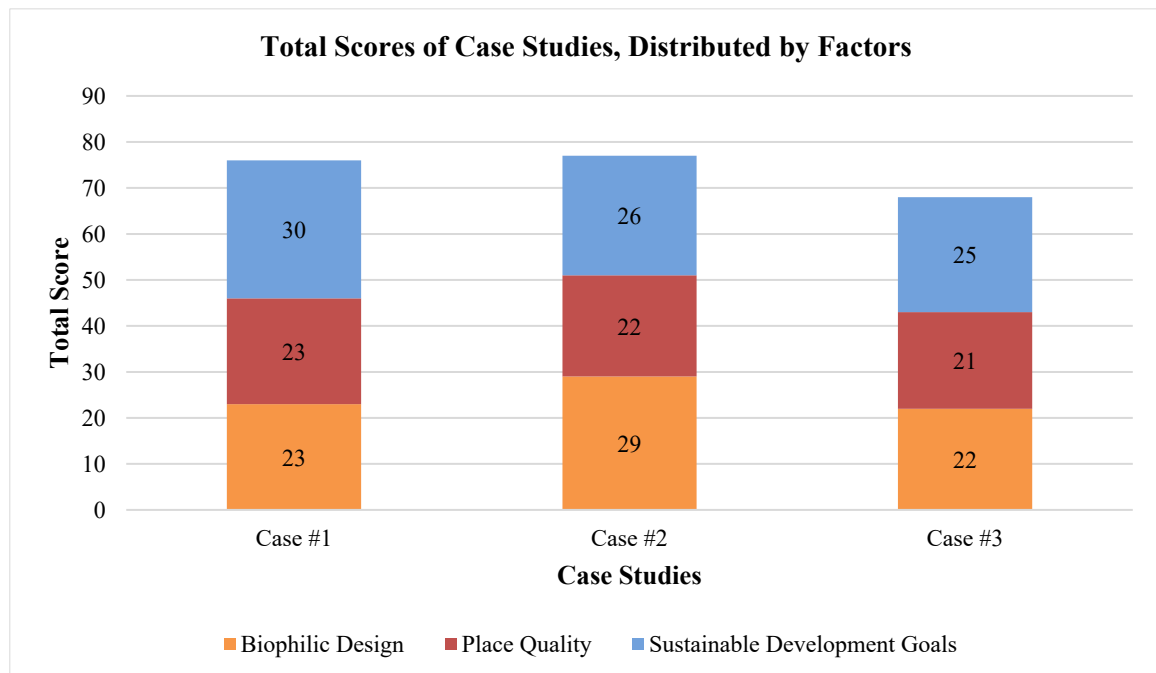


Figure 4 Comparison of total scores of case studies, distributed by factors

The results regarding biophilic design imply that employing more intensive and diverse biophilic design strategies, or situating users in more realistic environments, can strengthen users' perceptions of and experiences with nature. This is supported by the research of Esan-Ojuri and You (2021), which suggested that biophilic design has a positive impact on consumer responses in retail settings. Similarly, Paul (2024) also indicated that the integration of green spaces, natural elements, and biodiversity-friendly design features is likely to be positively received and valued by stakeholders. Moreover, Cheng and Marzuki (2023) suggest that incorporating biophilic design has a positive effect on visitors' landscape preferences, fostering revisit intentions as well as positive word-of-mouth referrals.

The results regarding the quality of place imply that providing choices for desirable activities, whether in enclosed spaces or in areas exposed to natural climatic conditions, can make a place more attractive. This is supported by Burns and Warren (1995), who suggested that consumers engage in outshopping activities partly to fulfill a personal desire, rather than shopping at the closest or a typical location. In Bangkok, increasing optional and social activities in landscape architecture can lead to higher usage density and greater customer traffic in shopping centers (Louvitayanurak & Janpathompong, 2024). In the aspect of climate, Aslantamer and Ilgin (2024) suggested that outdoor and semi-outdoor shopping centers with greater emphasis placed on natural landscape elements are likely to be preferred more often.

The results regarding sustainable design imply that increased visibility of sustainability-related information and greater opportunities for participation within sustainable environments can foster deeper awareness of sustainability. This aligns with Paul (2024), who highlighted the potential of biophilic design to enhance positive effect on environmental sustainability, waste reduction, and energy consumption patterns in the built environment, particularly in Nigeria. Similarly, Claudia Ortiz Jaime et al. (2023) indicated that shopping malls can function as sustainable architectural spaces that promote perceptions of sustainability, quality of life, and social inclusion. Furthermore, integrating Environmental, Social, and Governance (ESG) principles with green loyalty programs offers an effective approach for shopping malls to embed sustainability, respond to rising customer expectations, and strengthen brand engagement (Coniq, 2024).

5. Conclusion

In this research, a framework for commercial leisure spaces was successfully developed by integrating factors of biophilic design, place quality, and sustainability. The biophilic and sustainable place framework was applied to assess three case studies of commercial leisure spaces in Bangkok's CBD through on-site observations. The performance results of the case studies were analyzed and compared across factors, dimensions, and indices. The findings of the research are presented as follows:

- 1) More intensive and diverse integrations of biophilic elements, along with exposure to more realistic natural environments, can enhance users' perceptions and experiences of nature.
- 2) Providing a variety of desirable activities within a place, whether in enclosed spaces or areas exposed to natural climatic conditions, can increase its overall attractiveness.
- 3) Increasing the visibility of sustainability-related information and fostering active, inclusive participation can enhance engagement and understanding of a place's sustainable contributions.
- 4) The success of a biophilic and sustainable place depends on its ability to integrate a diverse range of natural elements, support attractive and meaningful activities, and foster sustainability awareness and active participation.

This research is limited to observational methods within the activity zones of the case studies. Future research should expand the scope by conducting more in-depth investigations of biophilic and sustainable places, such as analyzing building technologies and their contributions to urban sustainability, interviewing and surveying stakeholders, or examining visitors' behavioral responses to these environments. In addition, subsequent studies should apply statistical methods with larger sample sizes to strengthen the validity and reliability of the framework's evaluation.

In conclusion, commercial leisure spaces play a crucial role in enhancing the quality of life for city residents and serving as destinations for visitors. Strengthening biophilic design, placemaking, and sustainability through an integrated biophilic and sustainable framework can foster stronger human-nature connections, promote social cohesion, and support environmental responsibility. It is anticipated that this research will contribute to raising awareness of integrating nature into urban environments, creating higher-quality semi-public

leisure spaces, and fostering greater sustainability among entrepreneurs, city planners, architects, designers, and researchers.

6. References

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