Jurnal KORIDOR
Journal homepage: https://talenta.usu.ac.id/koridor/

A Systematic Procedure for Case Study Research in Biophilic Design: Toward Contextual and Regenerative Inquiry

Pande Putu Dwi Novigga Artha [*1,2], Indah Widiastuti[3], Dewi Larasati[4]
[1]Doctoral Study Program of Architecture, SAPPK, Institut Teknologi Bandung, 40132, Indonesia
[2]Architecture Study Program, Universitas Warmadewa, 20235, Indonesia
[3]Architectural History, Theory and Criticism, SAPPK, Institut Teknologi Bandung, 40132, Indonesia
[4]Building Technology Research Group, SAPPK, Institut Teknologi Bandung, 40132, Indonesia
[*]Corresponding Author: pandeartha69@warmadewa.ac.id

ARTICLE INFO

Article history:
Received 18 September 2025
Revised 17 November 2025
Accepted 01 December 2025
Available online 03 December 2025

E-ISSN: 2721-3463
P-ISSN: 2086-910X

How to cite:
Artha, P. P. D. N., Widiastuti, I., & Larasati, D. (2025). A Systematic Procedure for Case Study Research in Biophilic Design Toward Contextual and Regenerative Inquiry. Jurnal Koridor: 16 (2), 104-118.

http://doi.org/10.32734/koridor.v16i2.21369

ABSTRACT

Biophilic Design is an architectural approach that seeks to restore and strengthen the human connection with nature as a means of enhancing physical and psychological well-being. Over the past two decades, this concept has gained substantial attention across academic and professional fields, yet structured methodologies for investigating its application through case study research remain limited. This study addresses that gap by proposing a systematic and replicable seven-stage procedure for conducting Biophilic Design case studies, grounded in a Systematic Literature Review (SLR) of peer-reviewed publications indexed in Scopus, Web of Science (ESCI), and DOAJ from 2014 to 2024. The seven stages synthesized from the literature include: (1) identification of research problems and objectives, (2) case study selection, (3) multi-method data collection combining observation, interviews, surveys, and secondary sources, (4) development of analytical frameworks based on established Biophilic Design theories, (5) qualitative and/or quantitative data analysis, (6) evaluation and triangulation of findings, and (7) reporting and synthesis into design recommendations. The findings of this study are crucial for the involvement of key stakeholders such as cultural experts, traditional leaders, academics, and anthropologists to ensure an accurate understanding of local ecological and cultural values, particularly within the context of vernacular and traditional architecture. This seven-stage procedure is expected to serve as a methodological reference for conducting context-sensitive, culturally informed, and ecologically regenerative Biophilic Design research that is applicable across diverse built-environment settings.

Keyword: Traditional Architecture, Biophilic Design, Residential, Procedure, Case Study

ABSTRAK

Desain Biofilik adalah pendekatan arsitektur yang berupaya memulihkan dan memperkuat hubungan manusia dengan alam sebagai sarana untuk meningkatkan kesejahteraan fisik dan psikologis. Selama dua dekade terakhir, konsep ini telah mendapatkan perhatian substansial di berbagai bidang akademik dan profesional, namun metodologi terstruktur untuk menyelidiki penerapannya melalui penelitian studi kasus masih terbatas. Studi ini mengatasi kesenjangan tersebut dengan mengusulkan prosedur tujuh tahap yang sistematis dan dapat direplikasi untuk melakukan studi kasus Desain Biofilik, yang didasarkan pada Tinjauan Literatur Sistematis (SLR) dari publikasi peer-review yang terindeks di Scopus, Web of Science (ESCI), dan DOAJ dari tahun 2014 hingga 2024. Tujuh tahap yang disintesis dari literatur meliputi: (1) identifikasi masalah dan tujuan penelitian, (2) pemilihan studi kasus, (3) pengumpulan data multi-metode yang menggabungkan observasi, wawancara, survei, dan sumber sekunder, (4) pengembangan kerangka kerja analitis berdasarkan teori Desain Biofilik yang mapan, (5) analisis data kualitatif dan/atau kuantitatif, (6) evaluasi dan triangulasi temuan, dan (7) pelaporan dan sintesis menjadi rekomendasi desain. Hasil penelitian ini

menekankan pentingnya melibatkan para pemangku kepentingan utama seperti pakar budaya, tokoh adat, sejarawan, dan antropolog untuk memastikan interpretasi yang akurat terhadap nilai-nilai ekologi dan budaya lokal, terutama dalam konteks arsitektur vernakular dan tradisional. Prosedur tujuh tahap ini diharapkan dapat berfungsi sebagai referensi metodologis untuk melakukan penelitian Desain Biophilic yang peka terhadap konteks, berwawasan budaya, dan regeneratif secara ekologis, serta dapat diterapkan di berbagai lingkungan binaan.

Kata Kunci: Arsitektur Tradisional, Desain Biofilik, Hunian, Prosedur, Studi Kasus

1. Introduction

The growing global attention toward human well-being in the built environment has led to the rise of Biophilic Design, an architectural approach that integrates natural elements into buildings and urban spaces to improve physical, psychological, and emotional health (Kellert et al., 2008). Over the past two decades, this approach has evolved significantly, becoming a key topic in interdisciplinary studies and being implemented in various building typologies such as schools, hospitals, workplaces, and public spaces (Niranjika & Arianna, 2021). The theoretical development of Biophilic Design has also progressed, with frameworks such as Browning's *15 Patterns of Biophilic Design (*Browning & Walker, 2020)., Kellert and Calabrese's *3 Experiences and 25 Attributes (*Kellert & Calabrese,2015)., and Zhong's *threefold framework* (Nature Incorporation, Nature Inspiration, and Nature Interaction) providing structured lenses for its practical application (Zhong, et al, 2022).

However, the challenge remains in developing research methodologies that can rigorously and contextually assess Biophilic Design interventions. Much of the current research focuses on quantitative assessments in modern architectural contexts, often overlooking the complex sociocultural dimensions of space. Furthermore, while various design guidelines exist, the methodological clarity in *how* Biophilic Design is examinedparticularly in diverse real-world contextsremains insufficient. According to Ilhami et al. (2024), case study research offers valuable depth in understanding human behavior and perception in context, yet without a standardized procedure, results may lack consistency, repeatability, and reliability.

Within architectural research, the case study method has long been recognized as effective for investigating phenomena embedded in place-based, dynamic, and context-dependent settings (Yin, 2018; Neuman, 2014). It is especially relevant for answering "how" and "why" questions about design interventions. Nonetheless, one of the criticisms of case study research is its limited generalizability. Gerring (2004) argues, however, that intensive case study analysis can produce meaningful explanations that resonate beyond a single instance, especially when applied carefully and transparently.

At present, studies on Biophilic Design often emphasize its conceptual benefits but rarely articulate clear research procedures for field-based case studies. In culturally rich contexts such as traditional environments or communities with strong ecological relationships the application of Biophilic principles is often intuitive and embedded, yet not systematically documented. For example, traditional Balinese housing reflects profound harmony between humans and nature (Gelebet, 1981; Suardana, 2015), but its biophilic qualities are seldom studied through formal frameworks. As Browning et al. (2020) and Li et al. (2020) suggest, future research should adopt place-based and community oriented approaches that explore the intersection of nature, culture, and wellbeing.

This article addresses the research gap by proposing a systematic procedure for case study research in Biophilic Design, applicable to a range of architectural and environmental contexts. The procedure is formulated through a Systematic Literature Review (SLR) of peer-reviewed publications indexed in Scopus, Web of Science (ESCI), and DOAJ between 2019 and 2024. It outlines seven structured research stages from case selection and data collection (e.g., field observation and in-depth interviews) to thematic analysis of qualitative data ensuring transparency, coherence, and analytical depth.

The objective of this study is to provide researchers and practitioners with a methodological tool that supports contextual and regenerative inquiry in Biophilic Design. By offering structured guidance, the procedure seeks to strengthen the validity and credibility of case based research, particularly in environments where cultural,

ecological, and social values intersect. It also encourages the active involvement of key local actors such as historians, anthropologists, and cultural practitioners throughout the research process to enrich interpretation and cultural accuracy.

In the long term, this procedure is expected to bridge the gap between theory and practice, facilitate more robust and context aware studies of Biophilic Design, and foster design practices that are ecologically responsive, culturally embedded, and human centered. As environmental and social challenges become increasingly complex, such methodologies will be essential for guiding sustainable and meaningful architectural innovation

2. Method

This research employs the Systematic Literature Review (SLR) method as a foundational strategy to develop a structured and replicable procedure for case study research in Biophilic Design. The SLR method was chosen because it enables a comprehensive, explicit, and reproducible synthesis of academic literature, allowing researchers to critically evaluate existing studies and establish robust methodological guidance (Norlita et al., 2023; Tranfield et al., 2003). As emphasized by Neuman (2014), this type of non-reactive research is suitable for deriving insights from existing data such as published journal articles and case reports without direct interference with research subjects, making it particularly appropriate for constructing method-based frameworks.

The purpose of using SLR in this study is twofold: first, to identify best practices and methodological patterns in Biophilic Design case study research; and second, to formulate a step-by-step procedure that researchers can follow when conducting similar inquiries, especially within culturally embedded architectural contexts.

2.1 Application of the SLR Approach

The research process followed a structured sequence aligned with SLR standards, comprising the following key stages:

1. Formulation of Research Questions and Keywords. The primary research question guiding the review is: *How can a systematic procedure be developed for case study research in Biophilic Design, especially in context-sensitive environments?* Keywords such as "Biophilic Design," "Case Study," "Traditional Housing," "Vernacular Architecture," and "Design Framework" were used in advanced search queries across major databases: Scopus, Web of Science (ESCI), Science Direct, Taylor & Francis, Springer, SINTA, and Google Scholar.

2. Inclusion and Exclusion Criteria. Literature was selected based on relevance to Biophilic Design case study research and publication between 2019 and 2024. Articles that did not employ case study methodology or lacked empirical depth were excluded. Preference was given to studies focusing on natural-cultural integration, including both modern and traditional built environments.

3. Literature Screening and Data Extraction. Articles were screened in multiple stages, beginning with abstract reviews and followed by full-text assessments. Key data such as case characteristics, methodological approaches, data collection tools, analysis strategies, and theoretical frameworks were extracted and categorized.

2.2 Key Analytical Components

The systematic review process generated a five-part analytical structure for the procedure:

1. Case Study Determination. The selection of cases is grounded in thematic relevance. The goal is to identify case studies where Biophilic Design is applied explicitly or implicitly. Articles were chosen if they addressed spatial, ecological, or experiential design qualities aligned with biophilic principles.

2. Case Study Characteristics. Cases included individual buildings or clusters with evident natural integration such as use of natural materials, spatial openness, landscape connectivity, or symbolic nature-cultural narratives. Particular attention was given to projects rooted in local wisdom or ecological consciousness, such as traditional architecture, but also extended to urban green spaces and healing environments.

3. Case Study Categories. Following Rahardjo (2017), cases were categorized as Collective Case Studies to identify methodological patterns across various examples and Instrumental Case Studies to gain

deep insight into selected high-impact examples. This classification allows both horizontal (comparative) and vertical (in-depth) analysis.

4. Sequence and Thematic Analysis. After screening, three representative articles were selected for final synthesis. Thematic analysis was then applied to identify recurring research patterns, challenges, opportunities, and framework applications. Themes such as wellbeing outcomes, cultural integration, environmental strategies, and design methodology were prioritized.

5. Integration of Biophilic Design Theory. The research is guided by Biophilic Design frameworks formulated by Kellert (2008), Browning (2014), and Zhong et al. (2022). These frameworks act as reference models to evaluate and interpret how design elements such as sensory experience, nature analogues, or spatial transitions—are applied and studied in each case. Biophilic Design theory also serves as an analytical lens to assess impact on human experience, ecological regeneration, and cultural continuity.

2.3 Procedure Development and Output

The final output of this research is a comprehensive procedure for conducting Biophilic Design case study research, developed from the synthesis of methodological insights obtained through the literature review. The procedure includes:

- Stage 1, Identification of Problems and Objectives: Define the core research problem, questions, and objectives related to the application of Biophilic Design.
- Stage 2, Case Study Selection: Select case(s) based on design relevance, contextual significance, cultural–ecological value, and research accessibility.
- Stage 3, Multi-Method Data Collection: Collect data through field observation, visual documentation, interviews, surveys, environmental measurements, and supporting secondary sources.
- Stage 4, Development of Analytical Framework: Establish an analytical framework grounded in Biophilic Design theories such as the 14 Patterns, 3 Categories, or other relevant models.
- Stage 5, Data Analysis: Analyze qualitative and/or quantitative data using thematic coding, statistical comparison, matrix evaluation, or mixed-method integration.
- Stage 6, Evaluation and Triangulation: Evaluate findings through triangulation of multiple data sources and validation with literature, experts, and contextual evidence.
- Stage 7, Reporting and Design Synthesis: Formulate research reports and design recommendations based on the interpreted results to guide context-sensitive and regenerative Biophilic Design practices.

This procedure is intended to reduce methodological bias, enhance transparency, and improve research validity, particularly for studies examining Biophilic Design in settings where cultural and ecological values are integral. It also serves as a foundation for replicable and adaptable research that can be implemented across various built environment contexts. The following section (Section 3) illustrates how these procedure stages emerge from and are supported by patterns identified in 20 Biophilic Design case studies across different typologies.

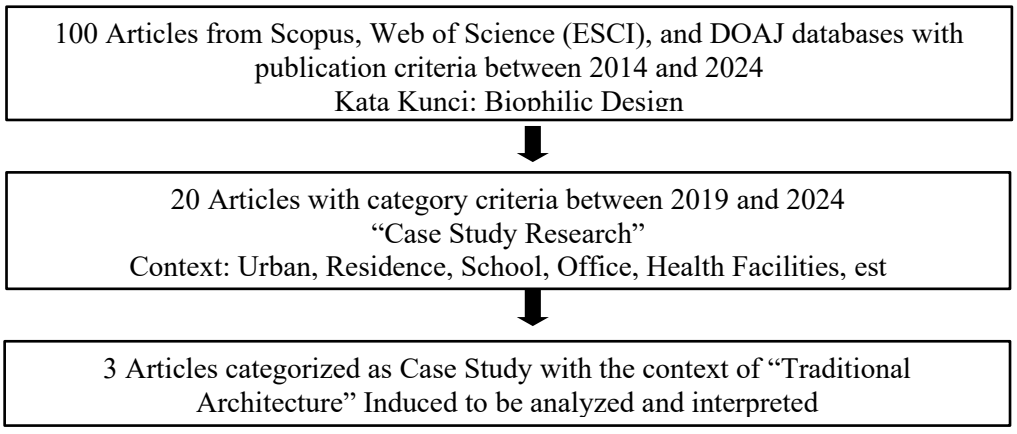

Figure 1. Flowchart Related to Systematic Literature Review Steps
Source: Author, 2024.

2.4 Article Selection Process

The first stage of this research implemented the Systematic Literature Review (SLR) method to identify and evaluate relevant scientific publications related to Biophilic Design. Literature searches were conducted across multiple academic databases, including Scopus, Science Direct, and Google Scholar, which are known for their comprehensive coverage of peer-reviewed research. Using keywords such as "Biophilic Design," "case study," "architecture," and "built environment," a total of 100 articles published over the past ten years were initially retrieved. As shown in Figure 2 (Research Background Pie Chart), the most dominant topics in the literature are the relationship between Biophilic Design and sustainability (34%), the development of Biophilic Design theory (17%), urban context (14%), and its application in facilities such as schools (10%), offices (10%), residential buildings (11%), and healthcare facilities (4%). These findings indicate that Biophilic Design remains closely tied to efforts to achieve sustainability and its application in modern buildings, particularly at the institutional scale. In this study, researchers only focus on articles that discuss case study research on the topic of biophilic design.

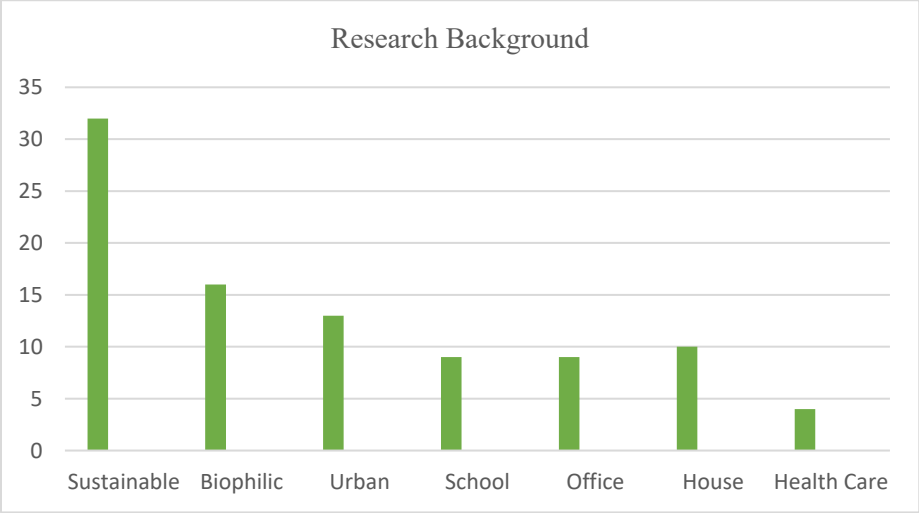

Figure 2. Articles on Various Biophilic Design Research Contexts in the Last 10 Years
Source: Author, 2024.

To narrow the research focus in accordance with the study's objectives, namely, the development of a systematic case study research procedure in Biophilic Design the selection was refined through a set of exclusion criteria. Articles were filtered to include only those that (1) employed a case study methodology, (2) explicitly applied or analyzed Biophilic Design principles, and (3) were published within the last five years (2019–2024). Publications that were theoretical in nature, lacked methodological clarity, or were outside the scope of architectural case study research were excluded from the dataset.

Following this screening process, 20 highly relevant articles were selected for in-depth analysis and synthesis (Figure 3). These articles represent a diverse range of contexts and geographical locations, highlighting the global scope and interdisciplinary nature of Biophilic Design research. For example, "Light Blue: Towards the Application of Biophilic Parameters in Local Buildings: A Case Study of Bilkent School, Erbil City – Iraq" (2019) and "Improving Psychological Well-Being in Urban University Districts Through Biophilic Design: Two Cases in Mexico" (2023) exemplify Biophilic Design implementation in educational settings. Other studies such as "Integrating Biophilic Design Elements into Office Designs" (2024) and "The Impact of Biophilic Design in University Study Areas on Students' Productivity" (2024) highlight its effect on user performance and well-being in indoor environments.

Several articles also focus on residential and traditional architectural contexts, such as "Biophilic Design Features in Vernacular Architecture and Settlements of the Naxi" (2020), "An Evidence-Based Assessment of Biophilic Interior Design in a Traditional Context: The Case of the Kingdom of Saudi Arabia" (2024), and "Investigating the Application of Biophilic Design Principles in the Traditional Pool Houses of Ahmedabad" (2024). These studies are especially relevant for exploring the regenerative potential of Biophilic Design within cultural heritage and community-centered environments.

In addition, studies like “Advancing Three-Dimensional Green Space in Architecture through Frameworks for Biophilic Design and Sustainability” (2023) and “Re-Examining Human Health and User Experience through Direct Experience in Biophilic Architecture Design” (2023) provide conceptual and empirical contributions to understanding how Biophilic principles are operationalized. The inclusion of this wide array of articles ensures that the research procedure developed is both theoretically grounded and methodologically diverse, enabling its application across varied architectural typologies and environmental contexts.These selected articles formed the primary dataset for the synthesis process, which later informed the development of the case study research stages, analytical frameworks, and validation strategies within this study.

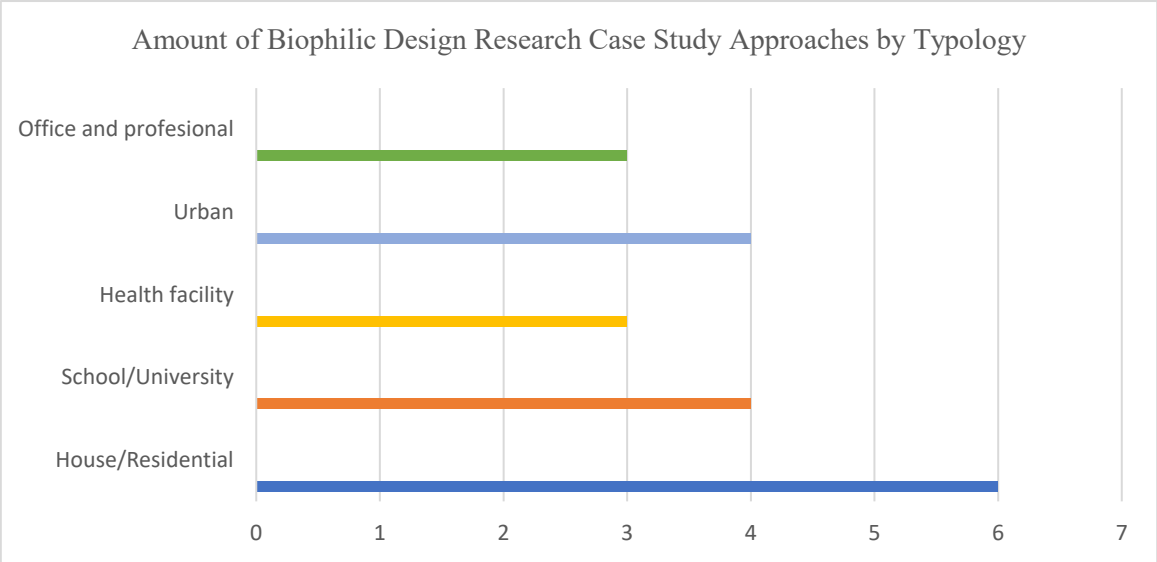

Figure 3. Biophilic Design Research Case Study Approaches in the Last 5 Years Source: Author, 2024.

After the initial analysis stage of 20 Biophilic Design case study articles, this study continued with a focus on the characteristics of certain case studies. The characteristics of the cases selected were modern and traditional housing, schools or universities, health facilities, urban and offices/others. This study was intended as a collective case study, which aims to identify patterns from several relevant articles in the context of Biophilic Design. This approach allows researchers to apply the application of Biophilic Design elements in different cases and contexts. In addition, this study is also classified as an instrumental case study, which aims to explore the application of the Biophilic Design framework specifically in traditional housing. After going through the elimination of the systematic literature review, the articles described were then narrowed down to three articles that specifically discussed the topic of traditional or vernacular propaganda. The purpose of this elimination was to explore in depth how the procedure focused on Biophilic Design case study research was applied in the context of traditional housing. This process provides a new perspective on the relationship between Biophilic Design and traditional architectural elements, which is still rarely explored in architectural research.

3. Discussion

3.1 Analysis of Case Studies based on Typology

Case Study Analysis Based on Typology will discuss in depth how the procedures and stages are found in each article. First, 20 biophilic design case study articles are categorized based on type or category. After that, it was analyzed and concluded based on the stages/procedures, data collection methods and data analysis methods most commonly used in each category. So that in this understanding, a general picture of the stages/procedures of case study research in Biophilic design research is obtained.

Table 1. Case Studies based on Typology

No	Typology of Case Study	Quantity	Procedure	Resource
1	House/Residential	6	● Literature Review & Initial Theory ● Architectural / Visual Observation ● Occupant Survey, Questionnaire, and/or Interview ● Scoring and Assessment Matrix of Biophilic Elements ● Descriptive and Interpretative Analysis ● Validation/Modeling	● Ruang Tekuni Apartments (Christy & Khamdevi, 2022) ● Post-New Normal Residential Home (Wijaya, 2023) ● The Assessment of Biophilic Features in Residential Buildings: A Case from Dubai (Shakhshir & Sheta, 2023) ● Traditional Pol Houses of Ahmedabad (Sheth et al., 2024) ● Biophilic Interior Design in Saudi Traditional Context (Shbaita et al., 2024) ● Biophilic Features in Vernacular Architecture (Naxi) (Li et al., 2020)
2	School/University	4	● Literature Review & Biophilic Design Theory ● Identification of Study Locations / Learning Spaces ● Measurement of Student Perception and Response ● Direct Observation / Environmental Observation ● Use of Measuring Instruments or Supporting Data ● Statistical Analysis / Comparative Tests ● Conclusions and Design Recommendations	● Bilkent School, Erbil City (Mustafa & Yaseen, 2019) ● Attributes of Biophilic Design – Educational Buildings (Taha, 2023) ● University Study Areas – Witwatersrand (Terblanche & Khumalo, 2024) ● Psychological Wellbeing in Urban University Districts (Mexico) (Cobreros et al., 2023)
3	Healthcare/ Rehabilitation	3	● Literature Review on Healing Environment & Biophilic Design ● Development of Conceptual Design Framework ● User Needs Analysis & Context Study ● Design Simulation/Visualization ● Validation of Principles through Narrative or Professional Reflection ● Not Focused on Statistics; More on Conceptual-Qualitative Study	● Chinese Healthcare Spaces (Zhao et al., 2022) ● Biophilic Design in Rehabilitation Buildings (Merylova et al., 2024) ● Human-Centered Health Environments (Tekin & Gutiérrez, 2023)
4	Urban/City	4	● Literature Review on Urban Biophilic Design and Urban Ecosystems ● Selection of Case Studies / Urban Spatial Locations ● Visual Observation & Field Documentation ● Community / Space User Perception Survey ● Spatial Mapping & Evaluation (GIS / Mapping / Pattern Scoring) ● Descriptive, Comparative, or Thematic Analysis ● Recommendations for Biophilic City Design	● Biophilic Urban Design in Italy (Andreucci et al., 2021) ● Biophilic Design & Ecosystem Service Attributes – Australia (Kambo et al., 2019) ● Direct Experience in Urban Public Space (Chetlall, 2023) ● Three-Dimensional Green Space in Architecture (Zhong et al., 2023)

5	Office / Work Space / Professional	3	● Literature Review on Biophilic Office Design & Work Performance ● Selection of Case Studies of Real Offices / Projects / Simulations ● Collection of User Perception Data ● Visual Observation of Office Interiors ● Descriptive & Thematic Analysis ● Results: Design Recommendations & Implementation Strategies	● Integrating Biophilic Design into Office Design (Karci & Kalayci, 2024) ● Enablers of Biophilic Design in Australia (Sadick & Kamardeen, 2024) ● Architecture Learns from Nature – Global Cases (Contreras et al., 2023)

Research in the residential category generally follows an exploratory-descriptive procedure pattern with a focus on occupant experiences of biophilic elements. These studies begin with a literature review referring to Kellert and Browning's Biophilic Design framework, specifically the 14-pattern approach (Christy & Khamdevi, 2022; Li et al., 2020). The main objective is to identify biophilic elements that have or have not been implemented in domestic environments and evaluate their impact on occupant comfort and well-being (Shakhshir & Sheta, 2023; Christy & Khamdevi, 2022).Data collection methods are dominated by visual observation of architecture and surveys of occupant perceptions, through questionnaires or semi-structured interviews (Shbaita et al., 2024; Wijaya, 2023). This approach allows researchers to capture subjective assessments of natural lighting, cross-ventilation, interior vegetation, and natural materials.Data analysis was conducted descriptively and narratively, by juxtaposing visual field findings with theoretical references or literature used (Christy & Khamdevi, 2022). Research in this residential context also highlights the relationship between vernacular architecture and traditionally embedded biophilic principles (Li et al., 2020; Sheth et al., 2024).

Research on educational spaces presents comparative experimental procedures, with the aim of evaluating the effects of biophilic elements on students' learning performance, concentration, and spatial perception (Mustafa & Yaseen, 2019; Taha, 2023; Terblanche & Khumalo, 2024; Cobreros et al., 2023). These studies target university or school environments by comparing the perception and comfort of learning spaces containing and without biophilic elements. Data collection methods include Likert-based perception surveys, direct observation of spatial attributes, and in some cases user performance tests. Cobreros et al. (2023) used questionnaires and perceptual location mapping to assess the relationship between university environments and students' psychological well-being. Mustafa & Yaseen (2019) combined observation and interviews in the context of environmentally conscious school design. The analytical methods used include quantitative descriptive analysis and narrative exploration of survey results and the relationship between biophilic elements and learning outcomes. Terblanche & Khumalo (2024) used a comparative approach to assess the effect of the presence of nature on student productivity.

Studies in this category use a conceptual design approach that aims to create healing spaces based on biophilic principles. The research begins with a literature review on the relationship between the physical environment and psychological recovery (Zhao et al., 2022; Tekin & Gutiérrez, 2023). Elements such as access to nature, natural lighting, and biomorphic forms are the focus of attention. Data collection was carried out through spatial observation, design simulation, and user experience narratives (Merylova et al., 2024). Several studies also validated the design through modular modeling based on multisensory experiences.The analysis was carried out conceptually and spatially-narratively. The study highlights that the biophilic approach is able to design emotionally and functionally restorative spaces (Zhao et al., 2022; Tekin & Gutiérrez, 2023).

In urban studies, research procedures usually include spatial evaluation of biophilic elements and public perception of the quality of urban space. The study begins with mapping of public locations or urban landscapes that reflect the application of biophilic features (Andreucci et al., 2021; Zhong et al., 2023). Data collection methods include surveys of urban space users, field observations, documentation of biophilic elements, and analysis of ecosystem services based on an urban ecology approach (Kambo et al., 2019; Chetlall, 2023). The analysis was carried out using a spatial descriptive approach or visual modeling. The study

emphasized the importance of vegetation, access to green open spaces, and thermal comfort as indicators of urban quality of life (Zhong et al., 2023).

Office case studies use an evaluative procedure that maps users' perceptions of biophilic features in the work environment. The goal is to assess the extent to which these features enhance users' productivity and well-being (Karci & Kalayci, 2024; Sadick & Kamardeen, 2024). Common instruments include Likert-scale surveys, interior visual audits, and interviews with users or professional designers (Contreras et al., 2023). Behavioral observations and spatial documentation reinforce subjective perception findings.The analysis is quantitative and narrative. The results show that natural lighting, interior vegetation, and other natural elements contribute positively to work comfort (Sadick & Kamardeen, 2024; Contreras et al., 2023).

These cross-typology findings reinforce the rationale behind the seven-stage procedure proposed in Section 2.3, demonstrating that it is not an abstract framework, but rather a synthesis of methodological patterns consistently observed across actual Biophilic Design studies. The housing and dwelling cases highlight the importance of problem identification, user-focused inquiry, and purposeful case selection (Stages 1–2), while the education and healthcare studies reinforce the need for multi-method data collection and a structured analytical framework (Stages 3–4) through their experimental and conceptual approaches. The urban studies further validate the importance of analytical rigor and triangulation (Stages 5–6) through spatial mapping, community response, and ecosystem-based evaluation. Across the typologies, the design-focused conclusions align with Stage 7, demonstrating how case studies naturally generate context-sensitive recommendations. Collectively, these parallels confirm that the seven-stage procedure reflects actual research practices used to investigate Biophilic Design and provides a solid foundation for producing healthier, more sustainable, and more nature-connected built environments.

3.2 Analysis specific of Traditional Housing Case Studies

Based on the results of the analysis related to the Biophilic Design Case Study in various contexts, 7 stages of the procedure were found in conducting case study research. Each article has a different pattern but in general it is still the same. This is based on the research objectives and cases discussed in each article. Of the 20 Biophilic Design case study articles, there are 3 articles that have the same research focus, namely looking at the contribution, relationship and correlation between Biophilic Design in a traditional context (Table 1). Traditional architecture is a place to foster and place humans individually and in groups to be in harmony with the universe (Suky, 2023). So that the elements of Biophilic Design have several similarities that contribute to human and environmental health. Traditional Architecture is a part of history that we must preserve. These results support the research of Ramzy (2015) and Movahed (2015) which states that further research and analysis are needed to investigate the quality of Biophilic Design manifested in historic buildings, which can be used as a reference to evaluate biophilic design features in today's architecture. Therefore, the opportunities for developing Biophilic Design research in past contexts such as Traditional Architecture are still very large. By analyzing the Biophilic Case Study Research procedure in Traditional Context, especially housing, it can be a guideline for Biophilic research in similar contexts. The following is an analysis of the case study method in the article Biophilic Design in the context of Traditional Housing.

Table 2. Case Study Analysis of Traditional Housing

No	Tittle	Method of Collecting Data	Method of Analysis Data
1	*Biophilic Design Features in Vernacular Architecture and Settlements of the Naxi (2020)*	Data Collection ● Fieldwork Observation ● Visual Documentation ● Literature Review and Historical Sources ● Multidisciplinary Approach	● Use of the Three Pillars Matrix (Nature, Place, People) ● Qualitative Analysis: Thematic Coding and Narrative Analysis ● Contextual Analysis ● Data Triangulation: Data from various sources (field observations, visual documentation, and literature) were compared to ensure the validity of the findings. ● Integrative Analysis
2	*An Evidence-Based Assessment of Biophilic Interior Design*	● Field Observation: 12 Traditional buildings ● Visual Documentation ● Literature Analysis: historical, cultural, and anthropological sources	● Quantitative Evaluation with BID-M Matrix ● Thematic and Regional Analysis ● Visual Analysis ● Data Triangulation

	in Traditional Context The Case of the Kingdom of Saudi Arabia (2024)	to understand the relationship between traditional Saudi Arabian design and biophilic elements. ● Use of the Biophilic Interior Design Matrix (BID-M): ● Natural environmental features. ● Natural forms and patterns. ● Ecological processes and systems. ● Place-based relationships. ● Light and space. ● Evolving human-nature relationships.	● Discussion and Generalization of Findings: The results of the analysis are compared with the theoretical framework of biophilic design to explore the potential for adapting traditional Saudi Arabian design in sustainable modern architecture.
3	*Investigating the Application of Biophilic Design Principles in the Traditional Pol Houses of Ahmedabad with a Case Study on Mangaldas Ni Haveli (2024)*	● Direct Observation ● Visual Documentation ● Interviews ● Literature Study: collecting information from existing literature on biophilic design, traditional Pol houses architecture, and relevant design principles.	● Qualitative Analysis ● Application of Biophilic Design Patterns: 14 biophilic design patterns developed by Kellert and Calabrese as a framework for analysis. ● Data Triangulation: Comparison with Literature: compared with findings from literature studies to assess suitability and relevance. ● Organization of Findings: the analysis is organized in a narrative form explaining how the design elements in Mangaldas Ni Haveli contribute to the connection between residents and nature.

In general, the case study procedure for Biophilic Design research in the context of Traditional Housing has similar stages to case studies with other contexts. In addition, based on the stages of case study research according to Neumen (2014) and Creswell (2018), it has almost the same pattern, such as identifying cases and objectives, developing research procedures and data collection, and data analysis to the final report. However, what distinguishes the Biophilic Design case study procedure in the context of Traditional Housing is in stages 3 and 5, namely data collection to data analysis. Data collection in traditional housing case study research has several strategies, including: Observation (Field Observation), Visual Documentation, Interviews and Literature Review

- Observation is essential in case study research as it enables direct understanding of phenomena in their natural setting. It also uncovers non-verbalized information and validates other data sources, leading to a holistic view. For traditional housing, field visits are necessary. No matter how many buildings are studied, it is recommended to go directly to the field or it is not recommended to use samples while other data is only from secondary data. Types of observation in case studies include Participatory Observation: Researchers participate in the daily activities of the subjects being studied, Non-participatory Observation: Researchers observe without being directly involved, Structured Observation: Using certain guidelines or frameworks to direct observations, Unstructured Observation: Flowing without strict guidelines, more flexible to capture spontaneous things (Yin, R,.K 2018), chosen based on research goals and context.
- Visual Documentation captures the connection between design, nature, and humans through sketches, photos, and videos. It records key architectural elements such as facades, spatial layouts, and ornaments tied to nature and culture. This supports qualitative analysis and strengthens findings. This is in line with the opinions of Yin (2018) and Creswell (2018) who emphasized the importance of visual documentation as an additional source of data that enriches qualitative analysis. So researchers are expected to bring camera tools, drones, cellphones, and paper that can help the visual documentation process in Traditional housing.
- Interviews reveal diverse perspectives from community members, homeowners, and cultural stakeholders, especially when knowledge is unwritten. This helps uncover symbolic, religious, and social meanings embedded in architecture. Tools include recorders and notebooks, with the format adjusted to the interviewee's context, whether formal or semi-formal.
- Literature Review provides a theoretical and historical foundation to interpret traditional architecture appropriately. Since this heritage spans generations, it should not be interpreted arbitrarily. Literature study provides a theoretical and historical basis by collecting information from books, journals, books, historical text documents, anthropology, and previous cultures to help researchers understand the historical and

philosophical context of Traditional architecture, especially housing. Literature also helps trace established Biophilic Design principles and assess their presence in traditional settings.

Based on three articles related to the case study of Biophilic Design in Traditional Housing, it has a different approach in analyzing data, the first article uses qualitative analysis with the Three Pillar Matrix. This Three Pillars Matrix is an independent development of researchers resulting from the collaboration between Kellert's Biophilic Framework, namely 3 Experiences and 25 Attributes with Browing, et al, namely 3 Categories and 14 Patterns of Biophilic Design. So it is concluded that the 3 pillars include Nature: Focusing on natural environmental elements such as natural features, natural forms, natural analogies, and ecological processes, Place: Highlighting spatial aspects, local materials, relationships with landscapes, and spatial planning that supports sustainability, People: Analyzing physical connections (such as visual, tactile, and other senses) and psychological connections (prospects, protection, mystery, and security) of users with Biophilic Design elements. The qualitative analysis process was carried out by thematic coding of field documents according to the 3 pillars. The researcher's narrative analysis interpreted the data to describe the relationship between Naxi culture and biophilic elements, such as how the Yulong mountains become spiritual and visual elements in residential design. Contextual Analysis where researchers connect biophilic design elements with local contexts including history, animist beliefs, and Naxi architectural traditions. After that, triangulation of data from various sources (field observations, visual documentation, and literature) was compared to ensure the validity of the research findings.

The second article uses the Biophilic Interior Design-Matrix (BID-M) to evaluate quantitatively. Data collected from field observations totaling 12 buildings and visual documentation were entered into the BID-M matrix. Each feature of the 54 matrix elements is assessed based on its presence in traditional buildings. The scores obtained reflect the level of application of biophilic elements in each building. Furthermore, thematic and regional analysis was conducted where the results of each building were compared based on region (center, west, east, and south) to identify regional patterns in the application of Biophilic Design. Visual Analysis is also used to support the findings of the BID-M matrix. Researchers analyzed architectural patterns, spatial layout, and natural elements based on the results of visual documentation. After that, data triangulation was conducted from various sources such as observation, documentation and literature to ensure the validity and reliability of the findings such as examples of observations on natural ventilation patterns validated with historical records of local architecture that show traditional approaches to climate control in Saudi Arabia. In general, this study provides an evidence-based evaluation of the application of Biophilic Design elements in Traditional Saudi Arabian Architecture.

Meanwhile, in the third article, researchers use 14 Biophilic Design Patterns by Kellert and Calabere (2015). The 14 Biophilic Design Patterns are divided into 3, including: first, Nature in Space consists of Visual Connection with Nature, Non-Visual Connection with Nature, Non-Rhythmic Sensory Stimuli. Thermal & Airflow Variability. Presence of Water, Dynamic & Diffuse Light, Connection with Natural Systems, Second, Natural Analogues consists of Biomorphic Forms & Patterns, Material Connection with Nature, Complexity & Order and third, Nature of Space consists of Prospect, Refuge, Mystery and Risk/Peril. The analysis used is qualitative where data is collected from observation, documentation, and interviews and then the main themes and patterns that emerge from the data are identified, especially those related to the Biophilic Design elements. Furthermore, data triangulation where the results of the analysis of the collected data are compared with the findings of existing literature studies. By comparing the results of the study with previous studies, researchers can assess the consistency and relevance of the findings, and identify possible differences. Triangulation also helps reduce bias that may arise from using only one source or method. So that the results of the study found 12 out of 14 Biophilic Design Patterns in Traditional Dwellings in Ahmedabad, India.

In relation to the procedures outlined in Section 2.3, traditional housing case studies play a crucial role in refining and validating specific components of the seven-stage procedure, particularly Stage 3 (multi-method data collection) and Stage 5 (context-sensitive analytical process). The Naxi, Saudi, and Ahmedabad studies consistently emphasize the importance of in-situ observation, detailed visual documentation, engagement with cultural experts and traditional stakeholders, and systematic triangulation between field findings and historical or anthropological sources. These methodological requirements incorporate explicit steps dedicated to stakeholder engagement and culturally informed thematic interpretation within the proposed procedure. Thus, traditional housing serves not only as one of the case typologies reviewed, but also as a critical testbed that strengthens the cultural and ecological dimensions of the Biophilic Design case study procedure.

3.3 Analysis of the Utilization of Biophilic Theory as a Framework for Case Study Research

This study uses Biophilic Design theory to explore the integration of nature-based elements in architecture, focusing on the human–nature relationship. Frameworks from Kellert et al. (2015), Browning et al. (2014, 2020), and Zhong et al. (2022) provide structured guidance for analyzing biophilic attributes in the built environment, and their selection must align with research objectives either by adopting a single contemporary model or synthesizing multiple frameworks, as demonstrated in BID-M, which requires prior analytical development. These theoretical foundations support the creation of analytical tools such as matrices, indicators, and evaluative criteria, enabling researchers to systematically identify and assess Biophilic Design features within specific spatial contexts. Their relevance becomes particularly evident in traditional housing studies, where the framework facilitates the examination of how spatial configuration, materiality, and human–nature interaction influence health, well-being, and sustainability. Data obtained through interviews, visual documentation, and field observations help reveal user experience and cultural ecological meanings embedded in space. Biophilic Design theory can also be adapted to local cultural values, such as Kellert's concept of Cultural and Ecological Attachment to Place, making it highly applicable to vernacular settings. These theoretical frameworks also align with Stage 4 of the seven-stage procedure, where researchers determine analytical lenses prior to interpretation, ensuring that the analysis is both theoretically grounded and contextually appropriate. This application not only strengthens academic rigor but also generates practical insights for developing culturally sensitive, sustainable, and human-centered urban housing.

4. Conclusion

Biophilic Design has become a rapidly growing field over the past two decades, with case study-based research emerging as a key approach to understanding its practical applications. This study establishes a systematic, context-based procedure for conducting Biophilic Design case studies, derived from a synthesis of 20 empirical publications. This procedure highlights the need for ecologically sensitive methodological research addressing cultural, social, and local contexts. While each case typology (residential, educational, healthcare, urban, and workspace) exhibits distinctive methodological patterns, they all consistently begin with a theoretical foundation grounded in global frameworks such as Browning's 14 Patterns (2014; 2020) and Kellert's 25 Attributes (2015). Throughout the literature, three primary data collection methods recur: spatial observation, perception-based questionnaires, and in-depth interviews, often combined through mixed-methods designs. In the context of vernacular or traditional housing, effective case studies require deeper engagement through cultural history literature, anthropological interpretation, and direct consultation with traditional stakeholders, underscoring the need for culturally informed inquiry. The procedure proposed in this article offers methodological guidance for researchers and practitioners to conduct more context-sensitive case studies capable of producing regenerative and non-generic architectural outcomes. The primary scholarly contribution of this work is the formulation of a replicable, culturally informed, and context-sensitive seven-stage procedure for Biophilic Design case study research. However, this procedure remains conceptual and is solely derived from the literature, with empirical validation and cross-cultural application testing necessary to strengthen its generalizability and practical robustness.

5. Acknowledgements

As a doctoral student and the first author, I would like to express my deepest gratitude to Dr. Indah Widiastuti and Dr. Dewi Larasati for their invaluable guidance during this research. Their in-depth input and expertise played a major role in shaping this research. Hopefully, this research will be beneficial as we all hope.

References

Andreucci, M. B., Loder, A., Brown, M., & Brajković, J. (2021). Exploring challenges and opportunities of biophilic urban design: Evidence from research and experimentation. Sustainability, 13(8), 4323. https://doi.org/10.3390/su13084323

Beatley, T. (2011). Biophilic cities: Integrating nature into urban design and planning. Island Press.

Buckley, R. (2020). Nature tourism and mental health: Parks, happiness, and causation. Journal of Sustainable Tourism, 1–15. https://doi.org/10.1080/09669582.2020.1742725

Browning, W. D., & Walker, D. B. (2020). Nature inside: A biophilic design guide. RIBA Publishing.

Browning, W., Ryan, C., & Clancy, J. (2014). Fourteen patterns of biophilic design: Improving health & well-being in the built environment. Terrapin Bright Green.

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry and research design: Choosing among five approaches (4th ed.). Sage Publications.

Contreras, G. S., Lezcano, R. A. G., López Fernández, E. J., & Pérez Gutiérrez, M. C. (2023). Architecture learns from nature: The influence of biomimicry and biophilic design in building. Modern Applied Science, 17(1), 58–70. https://doi.org/10.5539/mas.v17n1p58

Chetlall, V. (2023). Re-examining human health and user experience through "direct experience" in biophilic architecture design: Case studies of direct experience biophilic architecture (Master's thesis). Xi'an Jiaotong-Liverpool University. https://doi.org/10.13140/RG.2.2.20569.29283

Christy, I. M., & Khamdevi, M. (2022). Penerapan arsitektur biophilic pada hunian sewa: Studi kasus Ruang Tekuni Apartments DDAP Architect. MARKA: Media Arsitektur dan Kota, 6(2), 23–32. https://doi.org/10.33510/marka.2022.6.1.23-32

Cobreros, C., Medoza-Ruvalcaba, N., Flores-García, M., & Roggema, R. (2023). Improving psychological well-being in urban university districts through biophilic design: Two cases in Mexico. Sustainability, 15(7), 5703. https://doi.org/10.3390/su15075703

Chang, C.-Y., & Cheng, P.-K. (2005). Human response to window views and indoor plants in workplaces. HortScience, 40(5), 1354–1359.

Fagerholm, N., Martin-Lopez, B., Toralba, M., Oteros-Rozas, E., Lechner, A. M., Bieling, C., et al. (2020). Perceived contributions of multifunctional landscapes to human wellbeing: Evidence from 13 European sites. People and Nature, 2(1), 217–234. https://doi.org/10.1002/pan3.10067

Gerring, J. (2004). What is a case study and what is it good for? American Political Science Review, 98(2), 341–354.

Ilhami, M. W., Nurfajriani, W. V., Mahendra, A., Sirodj, R. A., & Afgani, M. W. (2024). Penerapan metode studi kasus dalam penelitian kualitatif. Jurnal Ilmiah Wahana Pendidikan, 10(9), 462–469. https://doi.org/10.5281/zenodo.11180129

Karci Demirkol, A., & Kalayci Onaç, A. (2024). Integrating biophilic design elements into office designs. Ain Shams Engineering Journal, 15(1), 102962. https://doi.org/10.1016/j.asej.2024.102962

Kambo, A., Drogemuller, R., & Yarlagadda, P. K. D. V. (2019). Assessing biophilic design elements for ecosystem service attributes: A subtropical Australian case. Ecosystem Services, 39, 100977. https://doi.org/10.1016/j.ecoser.2019.100977

Keniger, L. E., Gaston, K. J., Irvine, K. N., & Fuller, R. A. (2013). What are the benefits of interacting with nature? International Journal of Environmental Research and Public Health, 10(3), 913–935. https://doi.org/10.3390/ijerph10030913

Kellert, S. R., Heerwagen, J., & Mador, M. (2008). Biophilic design: The theory, science, and practice of bringing buildings to life. John Wiley & Sons.

Kellert, S. R., & Calabrese, E. F. (2015). The practice of biophilic design. http://www.biophilic-design.com

Kellert, S. R. (2018). Nature by design: The practice of biophilic design. Yale University Press.

Li, M., Chau, H.-W., & Aye, L. (2020). Biophilic design features in vernacular architecture and settlements of the Naxi. Journal of Architecture and Urbanism, 44(4), 196–211. https://doi.org/10.3846/jau.2020.13266

Mustafa, F. A., & Yaseen, F. R. (2019). Towards the application of biophilic parameters in local buildings: A case study of Bilkent School, Erbil City–Iraq. International Journal of Technology, 10(2), 363–375. https://doi.org/10.14716/ijtech.v10i2.2416

Merylova, I., Shekhorkina, S., Panchenko, T., Zakharov, M., & Talash, A. (2024). Methodological approaches to designing biophilic rehabilitation buildings. E3S Web of Conferences, 534, 01014. https://doi.org/10.1051/e3sconf/202453401014

Movahed, K. (2015). Study on people–nature connection in built environments to verify Aqa-Bozorg Mosque as biophilic design. Urban Management, 40, 241–252.

Neuman, L. W. (2014). Social research methods: Qualitative and quantitative approaches (7th ed.). Pearson Education.

Niranjika, W., & Arianna, B. (2021). Bridging biophilic design and environmentally sustainable design: A critical review. Journal of Cleaner Production. Elsevier.

Norlita, D., Nageta, P. W., Faradhila, S. A., Aryanti, M. P., Fakhriyah, F., & Ismayam, E. A. (2023). Sistematis literature review (SLR): Pendidikan karakter di sekolah dasar. Jurnal JISPENDIORA, 2(1), 1–20.

Sadick, A.-M., & Kamardeen, I. (2024). Enablers for accelerating biophilic design adoption in Australian buildings. Journal of Building Engineering, 83, 108464. https://doi.org/10.1016/j.jobe.2024.108464

Shbaita, A. S., Denerel, S. B., & Asilsoy, B. (2024). An evidence-based assessment of biophilic interior design in a traditional context: The case of the Kingdom of Saudi Arabia. Sustainability, 16(7), 7979. https://doi.org/10.3390/su16079779

Shakhshir, K., & Sheta, W. (2023). The assessment of biophilic features in residential buildings: A case from Dubai. Archnet-IJAR: International Journal of Architectural Research, 18(2), 247–267. https://doi.org/10.1108/ARCH-03-2023-0064

Sheth, C., Pandey, S., & Sinha, A. (2024). Investigating the application of biophilic design principles in the traditional Pol houses of Ahmedabad: Case study Mangaldas Ni Haveli. ShodhKosh: Journal of Visual and Performing Arts, 5(ICETDA24), 80–94. https://doi.org/10.29121/shodhkosh.v5.iICETDA24.2024.1304

Suky Luxiana, I. W., Runa, I. W., Parwata, I. W., & Kurniawan, A. (2023). Implementasi arsitektur tradisional Bali berbasis ekowisata di Desa Bukian. Wicaksana: Jurnal Lingkungan dan Pembangunan, 7(2), 61–68.

Rahardjo, M. H. (2017). Studi kasus dalam penelitian kualitatif: Konsep dan prosedurnya. Pascasarjana UIN Maulana Malik Ibrahim.

Ramzy, N. S. (2015). Biophilic qualities of historical architecture: In quest of timeless terminologies of "life" in architectural expression. Sustainable Cities and Society, 15, 42–56. https://doi.org/10.1016/j.scs.2014.11.006

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. British Journal of Management, 14(3), 207–222.

Terblanche, R., & Khumalo, D. (2024). The impact of biophilic design in university study areas on students' productivity. Archnet-IJAR: International Journal of Architectural Research, 18(1), 1–20. https://doi.org/10.1108/ARCH-10-2023-0288

Taha, H. S. (2023). The attributes of biophilic design: Educational buildings case study. Al-Nahrain Journal for Engineering Sciences, 26(3), 167–174. https://doi.org/10.29194/NJES.26030167

Tekin, B. H., & Gutiérrez, R. U. (2023). Human-centred healthcare environments: A new framework for biophilic design. Frontiers in Medical Technology, 5, Article 1219897. https://doi.org/10.3389/fmedt.2023.1219897

Wijaya, I. B. A. (2023). Biophilic concept analysis in the interior of a post-new normal residential home. IOP Conference Series: Earth and Environmental Science, 1169, 012055. https://doi.org/10.1088/1755-1315/1169/1/012055

Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). Sage Publications.

Zhong, W., Schroeder, T., & Bekkering, J. (2023). Advancing three-dimensional green space in architecture through frameworks for biophilic design and sustainability. Frontiers of Architectural Research, 12(1), 732–753. https://doi.org/10.1016/j.foar.2023.03.001

Zhao, Y., Zhan, Q., & Xu, T. (2022). Biophilic design as an important bridge for sustainable interaction between humans and the environment: Based on practice in Chinese healthcare space. Computational and Mathematical Methods in Medicine, 2022, Article 8184534. https://doi.org/10.1155/2022/8184534

Zhong, W., Schröder, T., & Bekkering, J. (2022). Biophilic design in architecture and its contributions to health, well-being, and sustainability: A critical review. Frontiers of Architectural Research, 11(1), 114–141. https://doi.org/10.1016/j.foar.2021.07.006