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Biophilic Attribute Mapping Across Green Rating Systems for Delhi Housing Adaptation

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Abstract

Biophilic design is associated with restorative and well-being benefits; however, its integration into building rating systems remains uneven. This study aims to map biophilic attributes across 27 international and 2 national rating systems and assess their relevance to Delhi housing, using Kellert’s 72 attributes as a benchmark. It employs a PRISMA-guided systematic review and credit-attribute mapping of official rating-system documents to code explicit and implicit biophilic credits. LBC leads with mandatory "Biophilic Environments" (83 credits, 92% coverage); WELL v2 follows (43 credits, 71% with explicit thresholds), while LEED v4/v5 trails (32% coverage, despite v5's "Connecting Nature" credit). BREEAM-NL HEA 10 offers residential-specific indicators. IGBC India achieves 22% biophilic credits. Environmental Features and Place-based Relationships are most consistently represented, evolved Human-Nature Relationships and Natural Patterns and Processes are rare. The findings reveal a gap between global benchmarks and Delhi’s density-stressed housing context, supporting the need for a climate-responsive biophilic adaptation framework.
Keywords: Biophilic design, LEED, WELL, LBC, IGBC, attribute mapping, Delhi housing, green rating system.

1. Introduction

Biophilic design links exposure to nature to positive impacts, including improved well-being, reduced stress, enhanced cognitive functioning, increased creativity, and restoration within the built environment (Browning et al., 2024). This will become more relevant, as interaction with natural systems may be infrequent due to high housing density in urban areas. There has been a shift towards green building rating systems that incorporate human well-being alongside environmental considerations. However, there are substantial differences across systems in how they integrate biophilic design (Alemrajabi et al., 2025). There are national rating systems for sustainable housing in India, such as IGBC Green Homes and the Green Rating for Integrated Habitat Assessment (GRIHA). The former includes elements of resident well-being, and the latter considers Indian agro-climatic conditions and residential building performance (Indian Green Building Council, 2019; GRIHA Council & TERI, 2019).

What remains unclear is the extent to which biophilic attributes are represented across rating systems when assessed against a common benchmark, and whether these systems are adequate for Indian residential realities. It is also unclear whether contemporary rating criteria recognise the biophilic logic already embedded in Indian domestic architecture through courtyards, Jali screens, natural light, ventilation, water, and vegetation (Pandey, 2024). This gap becomes all the more important in Delhi. Rising heat stress, urban heat island effects, and deteriorating air quality in the city are increasing demand for climate-responsive residential design (Chaudhary, 2024). At the same time, existing rating systems usually treat nature contact as an implicit or secondary attribute rather than a directly measurable residential requirement.

This research was undertaken to address that gap by focusing specifically on residences and on Delhi as a case context. Residences were chosen because housing is the most immediate context in which biophilic design can impact everyday lived experience and because Indian rating systems already include a residential assessment domain that can be enhanced by explicit biophilic criteria (Indian Green Building Council, 2019; GRIHA Council & TERI, 2019). Accordingly, this paper systematically maps green rating systems against Stephen R. Kellert’s 72 biophilic attributes and develops a credit-attribute matrix to examine coverage, structural integration, residential applicability, and climate responsiveness. The purpose is to identify where current systems fall short in Indian housing and to establish a basis for guidance on vernacular, climate-sensitive biophilic design.

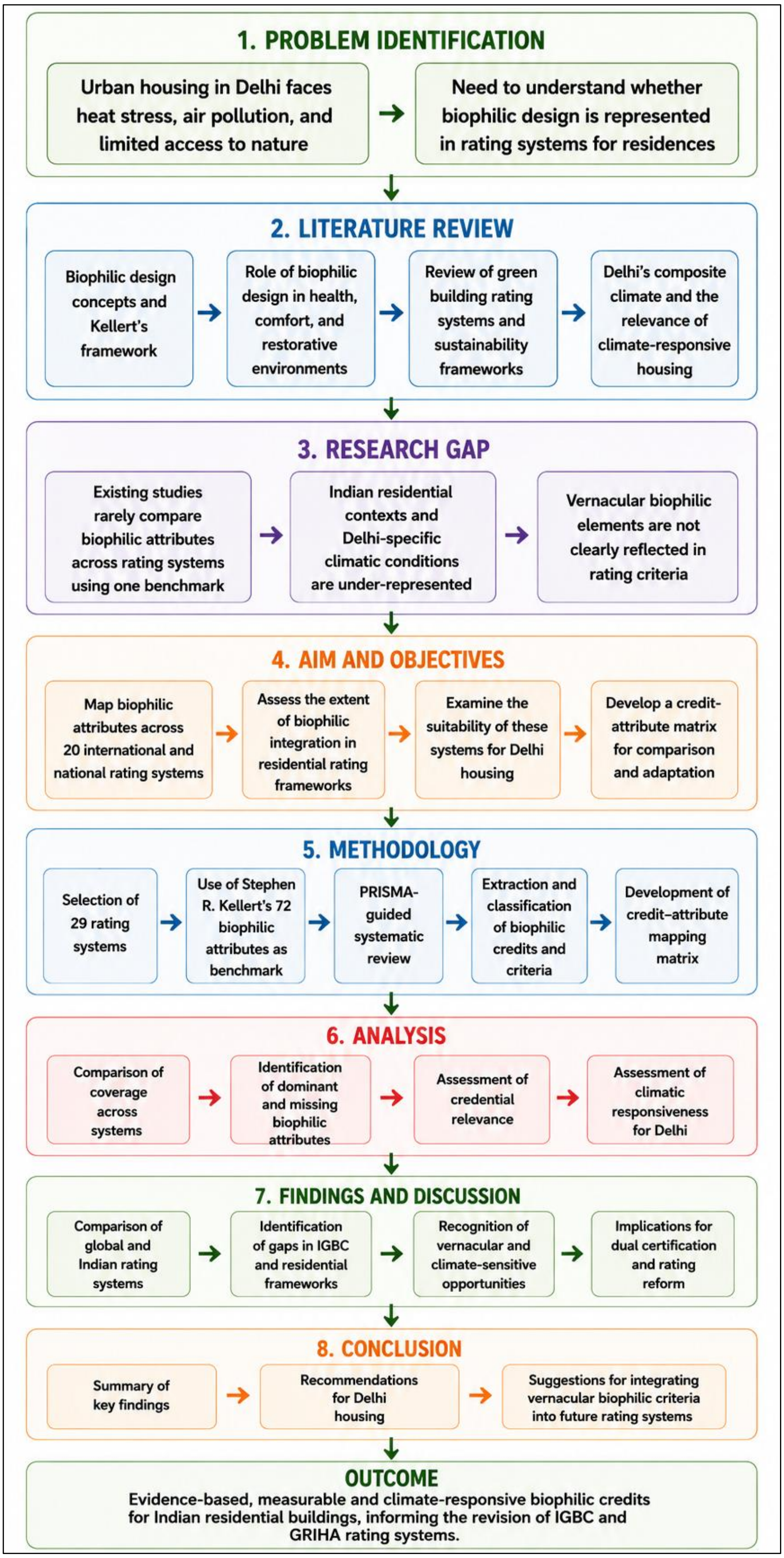

Figure 1. Structure of the Study (Source: Author).

1.1 Biophilic design frameworks

Biophilic design translates human affinity for nature into built-environment principles associated with restoration, comfort, and well-being (Browning et al., 2024). In this study, Stephen R. Kellert's framework serves as the primary analytical basis because it provides a detailed attribute-level structure for systematic comparison across rating systems (Kellert, 2008). It captures direct experiences of nature, such as light, air, water, and plants, as well as indirect and symbolic expressions, such as natural materials, transitional spaces, and place-based relationships. Browning, Ryan, and Clancy's 14 Patterns of Biophilic Design, expanded to 15 patterns with Awe in the 2024 edition, is more practice-oriented and outcome-focused (Browning et al., 2024). It is especially useful for design guidance but less suitable for credit-by-credit comparison because it provides fewer explicit scoring criteria. For this reason, Kellert is used as the main benchmark, while Browning's framework is retained as a complementary interpretive lens.

1.2 Green rating systems and the biophilic spectrum

Green building rating systems have expanded beyond energy and resource efficiency toward comfort, health, and well-being, creating space for biophilic design to become measurable rather than merely aspirational (Alemrajabi et al., 2025). A review of 29 rating systems shows that biophilic integration is uneven. Living Building Challenge is the most explicit, with 83 credits and representation of all 72 Kellert attributes, followed by WELL with 43 credits and LEED BD+C v4.1 with 25 credits. By contrast, 24 of the 29 systems have fewer than 10 biophilic credits, and 15 have fewer than 5.

The literature also shows that rating systems tend to prioritise features that are easy to standardise and score. Environmental Features and Place-Based Relationships are the most consistently represented categories, while Natural Patterns and Processes, Natural Shapes and Forms, and Evolved Human-Nature Relationships are weakly represented. Ecological connection to place, air, plants, and landscape ecology receives much more attention than symbolic or cultural dimensions. This suggests that current standards reward visible proxies of nature more readily than deeper experiential relationships.

Table 1. Comparative analysis of major biophilic design frameworks and rating systems.

Analytical level	Framework or system	Core structure or biophilia expression	Main strength	Main limitation	Relevance to this study	Key Evidence
Framework	Stephen R. Kellert's framework	Two dimensions, six elements, and 72 attributes	Comprehensive, fine-grained taxonomy for systematic analysis	Less direct as a design application tool	Best fit for credit-attribute mapping and cross-system comparison	Kellert, 2008; Kellert et al., 2011
Framework	Browning, Ryan, and Clancy's patterns	Three experiential categories, expanded from 14 to 15 patterns in the 2024 edition.	Clear, intuitive design guidance linked to well-being	Less suitable for detailed attribute-level coding across systems	Useful as a complementary interpretive framework	Browning et al., 2014; Browning & Ryan, 2020
Rating system family	Living Building Challenge (LBC)	Explicit Biophilic Environment imperative with broad alignment to Kellert's attributes	Most comprehensive operationalisation of biophilic design	Less common in mainstream housing practice	Benchmark for the strongest biophilic integration	International Living Future Institute, 2019; Kellert et al., 2011
Rating system family	WELL Building Standard (WELL v2)	Explicit credits and thresholds for nature, light, and occupant well-being	Strong health-oriented integration of biophilic principles	Still selective in coverage	Shows how biophilia can be tied to measurable well-being outcomes	International WELL Building Institute, 2020; Browning et al., 2014
Rating system family	LEED and BREEAM	Indirect integration through daylighting, views, IEQ, and landscape strategies	Widely used and influential	Biophilic principles are present but not fully codified	Demonstrates partial and fragmented biophilic inclusion	USGBC, LEED v4/v5; BRE, BREEAM; Kellert, 2008
Rating system family	Mainstream rating systems	Limited and fragmented references to nature-based strategies	Broad policy and market reach	Selective, partial, and inconsistent integration	Highlights the overall gap in current rating practice	Alemrajabi et al., 2023; Beatley, 2016

1.3 Residential sustainability and the Indian housing context

Residential structures play a critical role in biophilic design, as they govern exposure to light, fresh air, and plants, as well as thermal regulation and healing. Biophilic design in India becomes even more essential because the sustainability of residential spaces is an acknowledged assessment category in IGBC Green Homes and GRIHA. IGBC Green Homes targets residential structures such as multi-family dwellings and high-rise apartment blocks. In contrast, GRIHA suits the Indian climate zones, passive design techniques, life-cycle performance, and indigenous innovations. The architecture of homes in India incorporates strong biophilic design elements. The use of courtyards, jalis, lighting, ventilation, plants, water, and natural building materials does not constitute mere decoration. It serves a functional purpose in providing comfort and regulating the climate. The designs in Delhi and its surroundings demonstrate how courtyards enhance lighting and ventilation.

1.4 Biophilic assessment tools and design-stage evaluation

The literature also points to a need for tools that assess biophilic quality at the design stage, rather than only after completion. The Biophilic Quality Matrix was developed for this purpose and uses 10 criteria and 10 intervention scales. Its validation showed strong reliability, with 92% and 93% inter-rater agreement and Cohen's kappa values of 0.804 and 0.823. A related line of work, the Biophilic Design Matrix and, later, the Biophilic Interior Design Matrix, serves as a structured self-assessment tool for design practice. These tools are useful because they show how biophilic principles can be translated into evaluative structure. In the present study, they demonstrate a middle ground between theory and rating systems, in which design intent becomes measurable.

Table 2. Residential sustainability, design tools, and Delhi relevance.

Domain	Key evidence	What does it mean for this study
Indian residential rating systems	IGBC Green Homes and GRIHA already assess residential sustainability and climate performance	Biophilic criteria can be inserted into existing residential frameworks.
Traditional Indian housing	Courtyards, jali screens, vegetation, and transitional spaces support comfort and climate control.	Vernacular precedent can be formalised as measurable biophilic criteria.
Design-stage tools	The Biophilic Quality Matrix and the Biophilic Design Matrix support early assessment	The study can use a matrix approach for structured comparison.
Delhi housing context	Delhi faces heat stress, urban heat island effects, and poor air quality	Biophilic design is a climate-response strategy, not only an aesthetic one
Nature-based adaptations	Green roofs and green walls reduce heat stress and improve performance	Delhi provides a strong test case for biophilic housing adaptation

1.5 Delhi as a critical case

This topic becomes relevant because the example of Delhi illustrates the interaction between the environment and housing stress in full force. Heat stress, urban heat island effect, and poor air quality cause thermal discomfort in residents. In this respect, biophilic design becomes environmental buffering, daily comfort, and resilience, rather than an ornamental use of natural motifs. It is also crucial to note that Delhi can serve as a good stress test for rating systems. It is easier to prove the relevance of the proposed framework when it succeeds in promoting biophilic architecture in such complex conditions. Additionally, the study is interesting because of the presence of vernacular devices, such as courtyards and shaded transitions, which enable comparison of the intelligence of traditional architecture with contemporary ratings.

In conclusion, a clear gap between the theory of biophilia and building assessment practices is evident from the literature review conducted. While biophilia is rich in conceptualisation and increasingly scientific in nature, most rating systems include only quantifiable features of nature, omitting more abstract and holistic connections with it. This problem is even more pronounced in the case of Indian housing, as IGBC Green Homes and GRIHA have considered housing quality and climatic factors; however, they failed to fully integrate the biophilia of vernacular architecture through their credit systems. Delhi exacerbates the problem due to its combination of heat, pollution, and high density. This research project attempts to fill the gap by comparing different rating systems, using Kellert's criteria as the basis for evaluation.

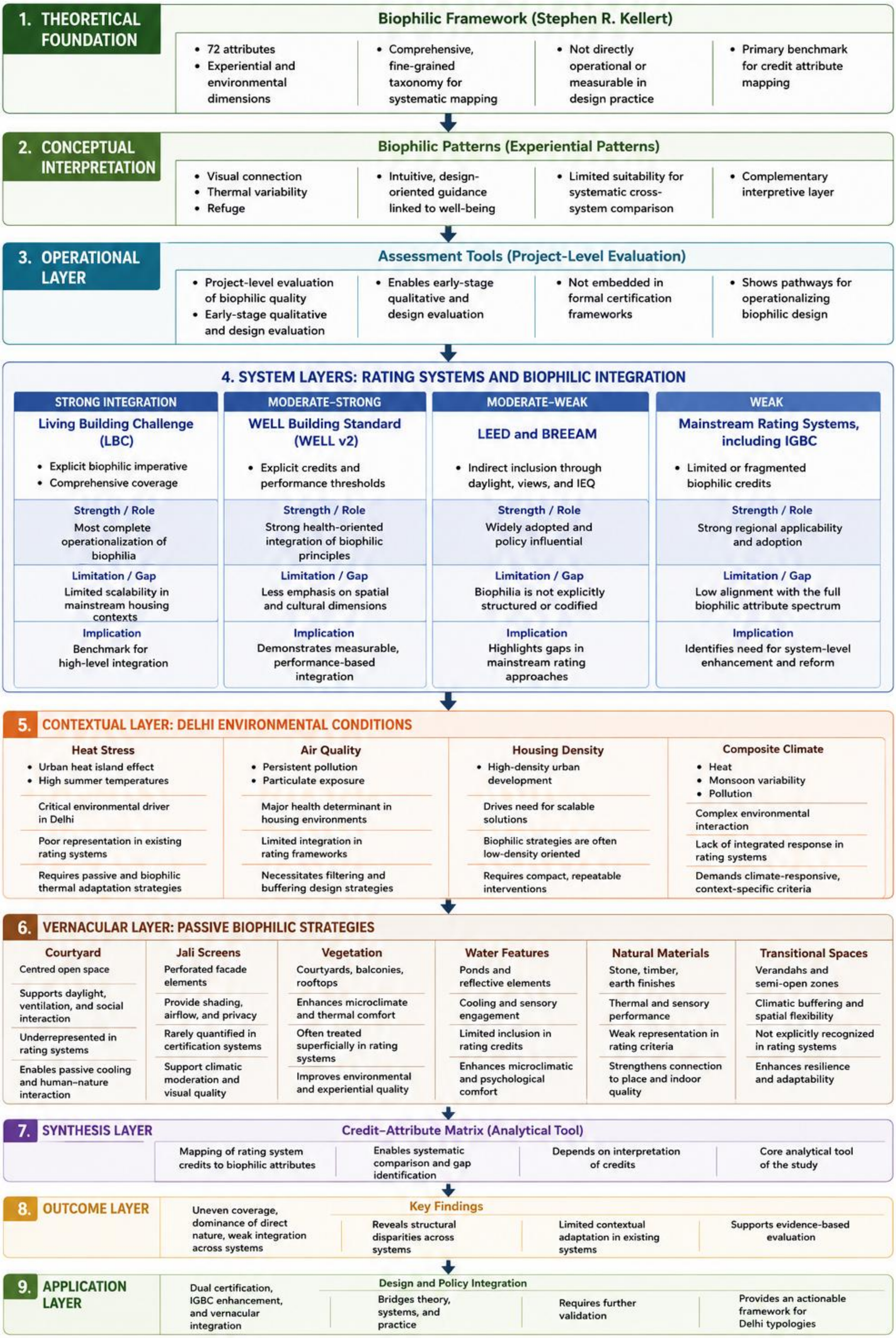

Figure 2. Integrated framework linking biophilic theory, assessment, rating systems, and Indian residential elements (Source: Author).

2. Methodology

This study adopted a PRISMA-guided systematic review combined with qualitative content analysis and credit-attribute mapping. The approach was suitable because biophilic design research spans conceptual frameworks, assessment tools, and rating systems, and these are unevenly integrated across systems. Stephen R. Kellert's framework was used as the primary benchmark because it provides a detailed attribute-level taxonomy that can be translated into a systematic codebook for comparing credits across rating systems. Browning, Ryan, and Clancy's patterns were retained as complementary interpretive lenses because they support design-oriented reading of biophilic intent and residential relevance. In contrast, Kellert is better suited to structured mapping across many systems.

Table 3. Methodological stages and outputs.

Stage	Purpose	Main input	Output
Identification	Identify relevant green building rating systems for analysis	Official manuals, technical guides, and reference documentation	Preliminary set of candidate rating systems
Screening	Exclude incomplete, outdated, or contextually irrelevant systems	Scope, version, accessibility, and residential applicability	Finalised sample of rating systems
Benchmarking	Establish a standardised coding framework	Stephen R. Kellert's 72 biophilic attributes	Structured attribute codebook for systematic mapping
Mapping	Assign credits to corresponding biophilic attributes	Extracted credits, criteria, and performance requirements	Credit-attribute mapping matrix
Comparison	Analyse patterns and variations across systems	Completed credit-attribute matrix	Comparative assessment of coverage and integration
Interpretation	Contextualise findings for housing and climate conditions	Comparative analysis results	Delhi-specific insights and design implications

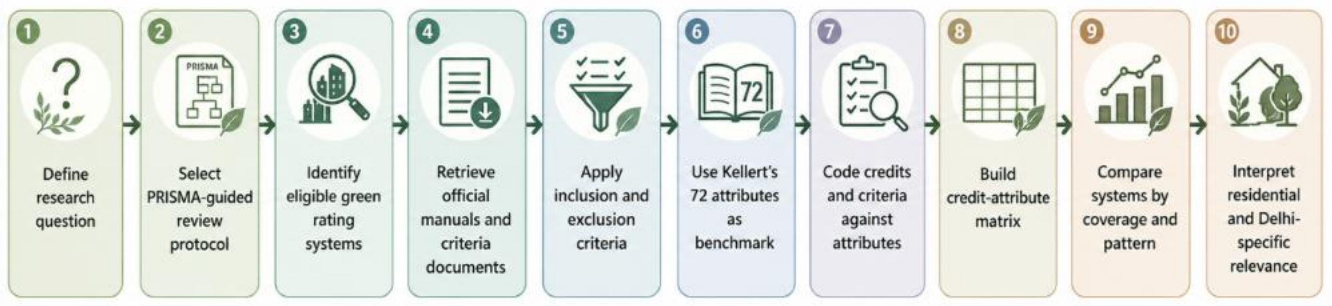

Figure 3. Methodological flow of the study.

2.1 PRISMA-guided review protocol

The review followed a PRISMA-guided structure to ensure transparent and reproducible identification, screening, and inclusion. Only official or authoritative rating-system documents were considered, and only the most relevant versions were retained for coding. This was necessary because rating systems evolve, and their biophilic content is not static. The literature also indicates that systems with broader health and well-being orientations tend to exhibit stronger biophilic integration, whereas mainstream systems often remain fragmented in their nature-based criteria. The final sample included 29 green rating systems, spanning global frameworks such as LBC, WELL, LEED, and BREEAM, as well as Indian systems such as IGBC Green Homes and GRIHA. The reason for including both global and national systems was to compare how biophilic design is formalised across different regulatory and climatic contexts.

The study included systems that were publicly documented, structurally comparable, and relevant to building assessment. Preference was given to the most recent available version because the literature shows that biophilic content varies across revisions and that newer versions often reflect broader health and well-being priorities. Systems were excluded if they lacked sufficient documentation for attribute-level review, were not building rating systems, or were too narrowly focused to permit comparison with the selected benchmark. Drafts, incomplete manuals, and non-building tools were not retained. This kept the sample focused and reduced ambiguity in coding.

2.2 Benchmark and unit of analysis

Kellert's 72 attributes were used as the benchmark because the framework captures both direct and indirect experiences of nature and includes place-based and symbolic dimensions. This makes it more suitable for rating-system analysis than a simple nature checklist because it can distinguish between a system that rewards daylight or plants and one that also recognises cultural connection, ecological place, and spatial refuge. The unit of analysis was the individual credit or criterion within each rating system. Each credit was read in context and compared against the biophilic attribute list. When a credit reflected more than one attribute, it was mapped to all relevant attributes. When biophilic intent was implied, for example, through daylight, views, ventilation, or indoor environmental quality, the credit was coded only if the language clearly supported a connection to nature. This conservative rule reduced overinterpretation and improved comparability across systems.

The analysis distinguished between explicit and implicit biophilic content. Explicit content included credits that directly named nature, biophilia, or ecological relationships. Implicit content included credits that support biophilic outcomes without using the term "biophilic," such as daylight, visual access, and indoor air quality. The literature shows that many systems incorporate biophilic ideas indirectly rather than through dedicated credits.

2.3 Data extraction and coding consistency

To keep the review consistent, each system was extracted into a standard worksheet before coding. This worksheet recorded the system name, version, credit title, category, credit language, and any direct or indirect biophilic content. A structured matrix is appropriate here because biophilic assessment tools work best when criteria are explicit, repeatable, and transparent. When a credit was ambiguous, it was treated conservatively and not forced into a category unless the nature of the connection was clear. This helped maintain internal consistency across systems with very different terminology and scoring logic.

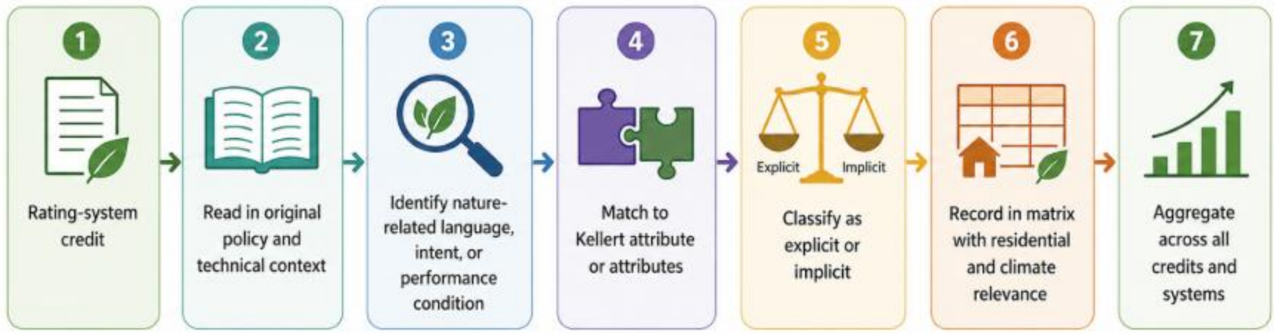

Figure 4. Credit-attribute mapping logic.

2.4 Analysis strategy

The analysis was conducted in three layers. The first layer was descriptive, counting how many biophilic credits appeared in each system and which attributes were represented. The second layer was comparative, examining differences between global frameworks and Indian systems, as well as between explicit and implicit biophilic integration. The third layer was contextual, interpreting the findings through the lens of residential design and Delhi's climate stress. This layered approach was necessary because the study is not only asking whether biophilic design is present in rating systems but also how deeply it is embedded and whether it is relevant to housing in a hot, polluted urban context.

The literature suggests that rating systems often privilege easily measurable items such as daylight, views, and indoor air quality, while deeper cultural or symbolic dimensions are less frequently represented. The study, therefore, also examined the relationship between the framework structure and coverage depth. This was important because systems such as LBC and WELL tend to encode biophilic intent more clearly. In contrast, systems such as LEED and BREEAM often embed it indirectly through environmental performance measures.

2.5 Reliability and coding transparency

To improve transparency, coding decisions were kept conservative and traceable. Each mapping decision was grounded in the language of the system document rather than inferred from design philosophy alone. When a credit could plausibly relate to more than one attribute, it was recorded accordingly, but ambiguous cases were not forced into overly specific categories. This approach was important because biophilic frameworks are conceptually rich but can be interpreted too loosely when coding rules are unclear.

2.6 Methodological limitations

The method is robust for comparison, but it also has limits. First, rating systems differ in structure and terminology, so some interpretative judgment was unavoidable. Second, the analysis depends on the wording of credits and criteria, meaning that a system may support biophilic outcomes even when it does not name them explicitly. Third, because this study focuses on document analysis, it does not test how the credits perform in built projects. These limits do not weaken the study's contribution, but they do define the scope of interpretation.

The chosen method fits the research problem for three reasons. First, a PRISMA-guided review provides structure for selecting systems and limits arbitrary inclusion. Second, Kellert's framework provides a detailed coding benchmark that can be applied to different rating systems without losing comparability. Third, the credit-attribute matrix allows the research to move beyond descriptive review and into systematic evaluation of residential and Delhi-specific relevance. This is especially important because the literature indicates that current rating systems do not uniformly treat biophilic design. The strongest systems integrate a wide range of attributes, while mainstream systems often include only partial or indirect nature-related criteria. A structured mapping method is therefore necessary to reveal not only what is present, but also what is missing.

3. Mapping Analysis and Results

The important insight from this mapping is that many sustainability schemes indirectly incorporate biophilic principles, rather than explicitly crediting biophilic elements within their frameworks. For instance, although LEED and BREEAM may take into account factors such as daylight, views, and air quality, these factors fall under a broad set of criteria related to environmental performance. This implies that although biophilia may be a feature of such a system, it would not appear directly in it. This is evident from the fact that LBC is the only scheme among the five reviewed here that explicitly includes a biophilia requirement in its framework. In addition, LBC mandates each project to develop a Biophilia Framework and Biophilia Plan using Kellert's table. The other sustainability scheme that does a great job regarding biophilia is WELL.

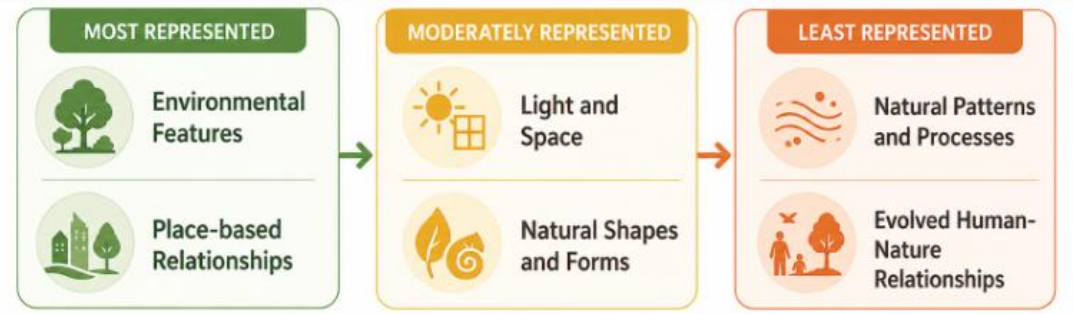

Figure 5. Distribution of biophilic design dimensions across the reviewed systems.

3.1 Explicit versus implicit biophilic integration

This is evident through an analysis of the entire dataset. Systems that adopt a more holistic approach to health and wellness integrate more biophilic features, whereas those that adopt a narrow approach to either the environment or energy do not. The distinction between the two extends beyond quantity, as the best systems place greater significance on place, ecology, and nature-human interaction.

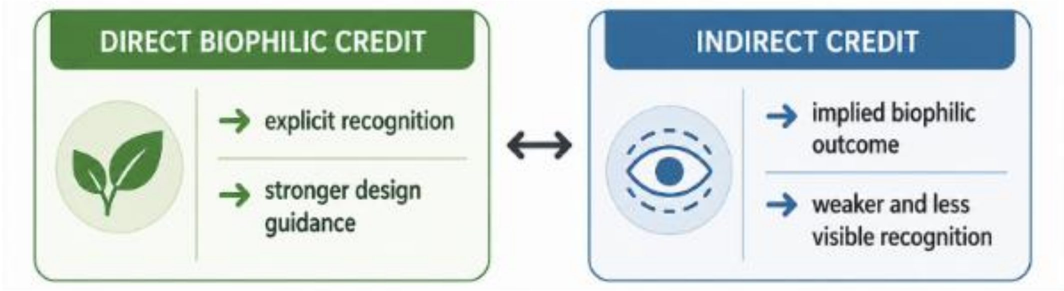

Figure 6. Pathway from credit language to biophilic recognition.

3.2 Delhi-specific implications for residential biophilic design

The importance of the map findings increases significantly when viewed in relation to the context of residences in Delhi. There are several factors causing heat stress, heat islands, and poor air quality in the city, resulting in increased thermal stress and lower quality of living in densely populated areas. Under these circumstances, biophilic design cannot be considered merely as a visual or premium improvement but as an effective way to create comfortable surroundings and improve ventilation and shading.

Rating schemes often reward certain aspects of biophilia, such as daylighting, views, greenery, or indoor air quality. It is important, but the challenges facing residents in Delhi cannot be fully addressed without adopting climatically responsive architecture and spatial solutions embedded in culture. Traditional Indian residential designs already follow this principle, using concepts such as courtyards, jalis, ventilation-friendly layouts, water elements, vegetation, and transition spaces. The significance of the Delhi scenario is thus twofold. Firstly, it will determine whether existing building rating systems can acknowledge biophilia as more than an additional feature. Secondly, it will demonstrate whether local vernacular design strategies can be quantified as valuable criteria for housing policy and design. The Indian Green Building Council's Green Homes and Green Rating for Integrated Habitat Assessment are relevant for their consideration of residential structures and regional climates, but not yet for the intrinsic biophilic and vernacular aspects required by Delhi housing.

Table 4. Delhi-focused interpretation of biophilic gaps.

Delhi issue	Evidence from mapping	Design implication
Heat stress	Most rating systems incorporate only partial or indirect climatic strategies.	Stronger integration of passive cooling and thermally responsive biophilic credits
Air pollution	Limited strategies for air filtration, buffering, or pollution mitigation	Credits for vegetation-based filtration, layered spatial thresholds, and adaptive envelopes
Housing density	Residential contexts are insufficiently addressed across many systems	Compact, scalable, repeatable biophilic strategies are needed
Vernacular knowledge	Courtyards, jali screens, and natural ventilation are weakly codified	Vernacular practices should be translated into measurable performance criteria
Affordability	Biophilic design is often treated as optional or premium	Biophilia should be reframed as essential infrastructure in affordable housing

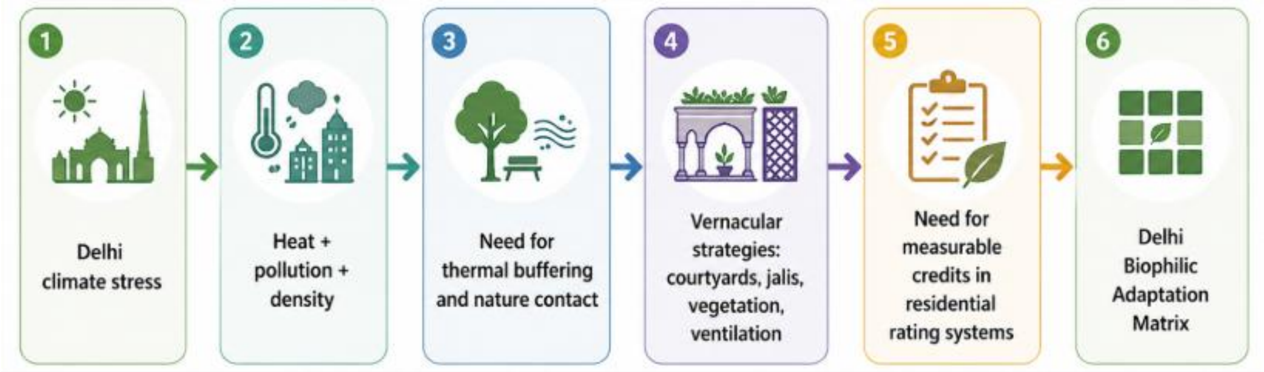

Figure 7. Delhi-specific biophilic adaptation logic.

3.3 India-specific comparison and synthesis

This analysis takes on greater significance in the context of Delhi's climate and India's demand for better housing. IGBC Green Homes is developed specifically for residential buildings and applies to both new construction and major renovations, including multi-dwelling units, gated complexes, and even high-rises; it also includes a category on residents' health and well-being. GRIHA is another tool relevant to our analysis, as it was developed for residential buildings in Indian climates.

On the other hand, both frameworks remain oriented towards sustainable performance rather than explicit biophilic coding. The IGBC emphasises energy efficiency, water usage, material selection, and indoor environment quality, while GRIHA focuses on passive solar architecture and lifecycle performance criteria. Such an approach creates a solid base for the residential evaluation, yet not a complete framework to address courtyards, jalis, landscaping, shading, and multi-sensory contact with nature as measurable credits. Considering Delhi's climatic characteristics, the lack of specific biophilic criteria is especially noticeable, as the city experiences heat stress, urban heat islands, and air pollution. Hence, this approach shows that the rating systems do not neglect residential design but require further refinement regarding biophilia and climate adaptation.

4. Implications for Delhi Housing and Rating-System Adaptation

The maps reveal partial adoption of biophilic design principles across most rating systems; however, this is particularly problematic for Delhi, as the city suffers from heat stress, the urban heat island effect, poor air quality, and a high density of residential settlements. Under these circumstances, biophilic design cannot be considered merely an aesthetic choice but rather a climate-responsive approach to housing that promotes thermal comfort, airflow, mental well-being, and daily living.

India, including Delhi, has a strong vernacular and landscape heritage. Indian homes are already implementing biophilic principles through courtyards, natural lighting, ventilation, water, plantings, and intermediate zones, and studies focused on housing in Delhi reveal that passive cooling, cross-ventilation, orientation, and architectural design will enhance heat resistance in affordable housing. Similarly, landscape-oriented redevelopments demonstrate that the preservation of trees, interconnected open spaces, and ecological linkages will enhance social identity and environmental performance.

Table 5. Delhi housing priorities emerging from the mapping analysis.

Delhi issue	Evidence from the literature	Implication for biophilic housing
Heat stress	Delhi-NCR experiences extreme summer temperatures and significant thermal stress in residential environments.	Prioritise cooling, shading, and thermal buffering mechanisms
Air quality	Persistent air-quality deterioration affects residential health and comfort.	Integrate vegetation, filtration layers, and transitional buffers.
Affordability	Affordable housing often lacks mechanical cooling and other comfort systems.	Treat passive, low-cost biophilic strategies as essential, not optional
Density	Rapid densification limits space for comfort-enhancing interventions.	Develop compact, scalable, and repeatable biophilic solutions.
Vernacular logic	Courtyards, jali screens, and landscape structures are embedded in Indian domestic architecture.	Translate local precedents into measurable, performance-based criteria.

The mapping shows that most systems reward the easiest biophilic proxies, especially daylight, views, and indoor environmental quality, while deeper cultural, spatial, and relational attributes remain weak. This is important for Delhi because those weaker attributes align more closely with Indian housing traditions and adaptation to hot climates. Systems such as LBC and WELL provide a stronger model because they make biophilic intent explicit, while LEED and BREEAM often embed it indirectly through general environmental performance categories.

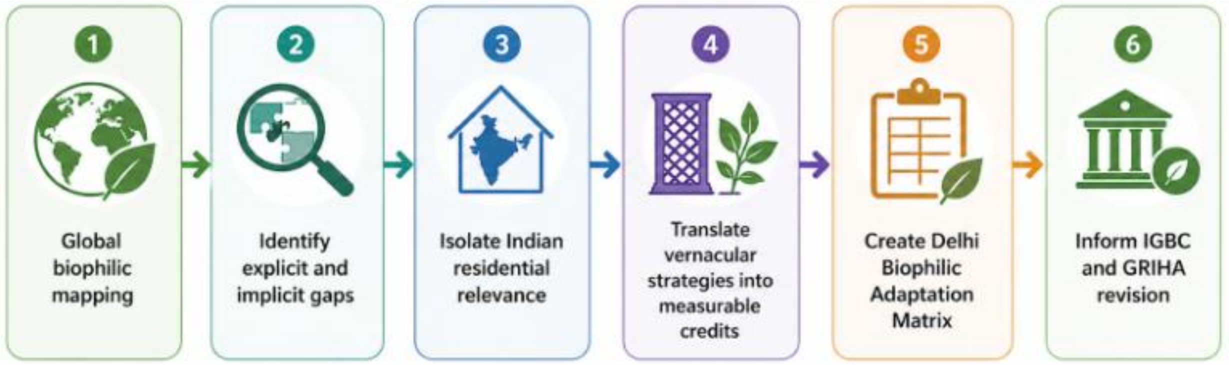

Figure 8. Pathway from mapping results to Delhi adaptation.

For Indian housing, reform should do more than increase the number of green features. It should make biophilic intent legible and measurable. IGBC Green Homes already covers residential buildings and residents' health and well-being. At the same time, GRIHA addresses regional climate, passive design, and indigenous solutions, so both systems have a strong foundation for explicit biophilic credits.

Table 6. From generic biophilic proxies to Delhi-specific rating credits.

Current proxy in rating systems	Limitations of Delhi housing	Delhi-specific credit direction
Daylight	Useful, but insufficient in heat-stressed housing	Credit shade-managed daylight, filtered light, and glare-controlled openings
Views and vistas	Visual access does not ensure thermal comfort or air quality	Combine views with vegetative buffering and shaded outdoor spaces
Indoor environmental quality	Broad category with limited biophilic specificity	Integrate cross ventilation, indoor greenery, and refuge spaces
Site landscaping	Often treated as ornamental.	Develop credits for landscape ecology, tree preservation, and microclimate regulation.
General health and well-being credits	Too generic to capture local climate and vernacular logic	Add credits for courtyards, jali screens, semi-open spaces, and passive cooling

The main implication of the study is that Delhi needs a rating adaptation matrix that converts vernacular and climate-responsive design into explicit credits. This matrix should reward courtyards, jali screens, cross-ventilation, shaded transitional spaces, tree retention, rooftop and ground-level vegetation, and landscape systems that improve air quality, shade, and microclimate.

4.1 Rating-system adaptation priorities

Three key points emerge from the analysis. Firstly, biophilic principles need to be articulated rather than remain implicit, so that designers are incentivised to apply biophilic space-making practices. Secondly, the residential toolkit needs to distinguish between plain landscaping and biophilia that works well in hot and polluted climates. Finally, the Indian rating systems need to utilise vernacular building knowledge as an operational asset.

Table 7. Adaptation priorities for Delhi-focused rating reform.

Priority	Rationale	Suggested action
Make biophilia explicit	Indirect proxies limit integration in housing	Add dedicated biophilic design credits
Link biophilia to climate	Heat stress and air pollution are central Delhi challenges	Include thermal comfort, ventilation, and pollution mitigation criteria
Reward vernacular logic	Courtyards and jali screens are proven climate-responsive strategies	Translate vernacular devices into measurable credits
Support affordability	Passive, low-cost strategies are essential in resource-constrained housing.	Prioritise scalable and repeatable interventions
Integrate landscape systems	Vegetation and ecological networks improve comfort and place identity	Protect and credit tree systems and ecological integration

4.2 Implementation barriers and practical considerations

The implementation process will not be smooth. There could be challenges such as higher costs for certain interventions, the need to maintain vegetation and water features, limited space in dense housing, limited developer understanding, and uncertainties regarding policy endorsement. These obstacles do not undermine the rationale for biophilic adaptation, but they indicate that the recommended credits should emphasise interventions that require minimal investment, low maintenance, and are replicable. For housing in Delhi, the best initial actions would be courtyards, jalis, semi-open, shaded spaces, cross-ventilation, tree conservation, and microclimate modification through landscape design. A definite course of action that emerges from the results. IGBC and GRIHA need to incorporate stronger biophilic criteria in their rating systems—the mate -change adaptation. In essence, biophilic design should be integrated into the housing development process as a pragmatic strategy informed by the proposed matrix.

5. Conclusion

This paper examined how biophilic principles are represented in green rating systems and how relevant they are to Delhi's residential context. The findings show a highly uneven integration of biophilia: the Living Building Challenge offers the strongest coverage with 83 biophilic credits and all 72 Kellert attributes, followed by WELL and LEED BD+C v4.1. Across systems, Environmental Features and Place-Based Relationships are most common, whereas deeper dimensions, such as Evolved Human-Nature Relationships and Natural Patterns and Processes, are rarely included. Most systems recognise biophilia indirectly through daylight, views, and indoor environmental quality rather than through explicit biophilic credits, which limits their usefulness as direct design guidance in housing.

The Delhi case highlights a major gap between global rating frameworks and local environmental realities. In a city shaped by heat stress, urban heat islands, air pollution, and high density, biophilic design should function not as decoration but as a climate-responsive strategy that supports thermal comfort, ventilation, shading, and resilience. Indian residential traditions already demonstrate this through courtyards, Jali screens, vegetation, water, daylight, and transitional spaces, showing that biophilic logic is deeply rooted in vernacular architecture.

The main contribution of the study is the credit-attribute mapping framework, which clarifies where biophilic design is present, where it is absent, and how it can be adapted to Delhi housing through the proposed Delhi Biophilic Adaptation Matrix. This matrix is intended as a scholarly analytical tool rather than a ready-made rating system, but it can help connect theory with residential application and inform future rating reform. Although Indian systems such as IGBC Green Homes and GRIHA already address residential performance and climate sensitivity, the challenge lies in making biophilic qualities more explicit and measurable within them.

The study is limited by its document-based method, interpretive coding challenges, and the fact that the proposed matrix has not yet been tested in practice. Future research should convert the matrix into a weighted, testable framework and extend the analysis to shared biophilic spaces in residential developments.

References

Alemrajabi, H., Zhang, R., Bulbul, T., & Pearce, A. (2025). Integrating nature into norms: Evaluating biophilic design attributes in building rating systems. *Proceedings of the 23rd CIB World Building Congress*. https://doi.org/10.7771/3067-4883.1857

Babbu, A. H., & Anwar, A. M. F. (n.d.). *Bio-climatic design strategies for buildings in Delhi, India*.

Browning, W. D., Ryan, C. O., & Clancy, J. O. (2024). *14 patterns of biophilic design: Improving health and well-being in the built environment* (10th anniversary ed.). Terrapin Bright Green.

Chaudhury, S. (2024). *Green roofs and green walls as heat stress mitigation strategies for New Delhi, India* [Master's thesis]. HafenCity University.

GRIHA Council, & TERI. (n.d.). *GRIHA v.2019, volume 1: Introduction to national rating system - GRIHA*.

Hung, S.-H., & Chang, C.-Y. (2024). Designing for harmony in urban green space: Linking the concepts of biophilic design, environmental Qi, restorative environment, and landscape preference. *Journal of Environmental Psychology, 96*, 102294. https://doi.org/10.1016/j.jenvp.2024.102294

Indian Green Building Council. (n.d.). *IGBC Green homes rating system*.

Indian Green Building Council. (n.d.). *IGBC Green Homes rating system: Version 3.0 for multi-dwelling residential units, abridged reference guide*.

Jiang, B., Song, Y., Li, H. X., Lau, S. S.-Y., & Lei, Q. (2020). Incorporating biophilic criteria into green building rating tools: Case study of Green Mark and LEED. *Environmental Impact Assessment Review, 82*, 106380. https://doi.org/10.1016/j.eiar.2020.106380

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

Kellert, S., & Calabrese, E. (2015). *The practice of biophilic design*. Terrapin Bright Green.

Khairoowala, Z., Aslam, M. F., Ali, U., Haq, S., & Ansari, M. A. A. (2025). Biophilic design and its implications for human health and well-being. *African Journal of Biomedical Research*. https://doi.org/10.53555/AJBR.v28i1S.6408

Lee, S., & Kim, Y. (2021). A framework for biophilic urbanism to improve climate change adaptability in urban environments. *Urban Forestry & Urban Greening, 61*, 127104. https://doi.org/10.1016/j.ufug.2021.127104

McGee, B. L. S. (n.d.). *Designing biophilia into interior environmental practice: A biophilic design assessment tool development*.

Pandey, A. A. (n.d.). *Biophilic architecture and Indian residences*.

Raje, A. R. (2020). Value of landscape design in creating a sustainable urban transformation model for the Sarojini Nagar housing community, New Delhi. *IOP Conference Series: Earth and Environmental Science, 588*(5), 052045. https://doi.org/10.1088/1755-1315/588/5/052045

Tekin, B. H., Corcoran, R., & Gutiérrez, R. U. (2022). The impact of biophilic design in Maggie's Centres: A meta-synthesis analysis. *Frontiers of Architectural Research, 12*(1), 188-207. https://doi.org/10.1016/j.foar.2022.06.013

Vij, A., Shorey, G., Zia, H., Majumdar, M., Shukla, P., Kumar, P., Kochhar, P., Chauhan, R., Poddar, R. P., Rajkumar, S., Singh, S., Garg, T., Bandyopadhyay, B. D., Kumar, A. K., & Tripathi, A. K. (n.d.). *GRIHA manual, volume 1: Introduction to national rating system - GRIHA*.

Wijesooriya, N., Brambilla, A., & Markauskaite, L. (2023). Biophilic design frameworks: A review of structure, development techniques and their compatibility with LEED sustainable design criteria. *Cleaner Production Letters, 4*, 100033. https://doi.org/10.1016/j.clpl.2023.100033

Wijesooriya, N., Brambilla, A., & Markauskaite, L. (2025). Biophilic quality matrix: A tool to evaluate the biophilic quality of a building during the early design stage. *Cleaner Production Letters, 8*, 100094. https://doi.org/10.1016/j.clpl.2025.100094

Xue, F., Lau, S. S.-Y., Gou, Z., Song, Y., & Jiang, B. (2019). Incorporating biophilia into green building rating tools for promoting health and well-being. *Environmental Impact Assessment Review, 76*, 98-112. https://doi.org/10.1016/j.eiar.2019.02.004

Zhong, W., Schröder, T., & Bekkering, J. (2021). 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