Impact of Biophilic Design on Well-being in Residential Spaces

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ABSTRACT

This study investigates how biophilic design elements in residential interiors influence occupant psychological and physiological well-being. Rapid urbanization and prevalent use of artificial materials have reduced everyday contact with nature, potentially harming mental health and indoor environmental quality. Building on established principles of biophilic and nature-integrated design (direct and indirect contact with nature, material authenticity, daylighting, prospect/refuge), and illustrative examples such as the Bangalore "Garden House," this research uses a mixed-methods design to quantify relationships between exposure to biophilic elements and well-being while exploring occupant experiences in depth. Quantitatively, the study collects survey measures of subjective well-being (WHO-5), affect (PANAS), perceived restorativeness (PRS), and perceived indoor environmental quality, combined with objective indoor measures (illuminance, temperature, CO_2, and presence/intensity of vegetation). Physiological indicators (resting heart rate variability and short-term salivary cortisol samples) will be collected for a subsample. Qualitatively, semi-structured interviews and photo-elicitation will document occupants' lived experience. Data will be analyzed using regression models, mediation analysis (testing whether perceived restorativeness mediates the effect of biophilic exposure on well-being), and thematic analysis for qualitative data. Findings are expected to demonstrate positive associations between biophilic exposure and well-being and to identify design features most strongly linked to restorative outcomes. Results will inform practical, climate-sensitive guidelines for implementing biophilic strategies in Indian urban residences

KEYWORDS: biophilic Design, Residential Interiors, Well-Being, Indoor Environmental Quality, Human–Nature Connection, Psychological Health, Sustainable Design, Urban Housing

I. INTRODUCTION

Rapid urbanization and increasing time spent indoors have significantly reduced daily human interaction with natural environments. Residential interiors today are often dominated by artificial lighting, synthetic materials, and sealed spaces, which can negatively impact physical comfort, mental health, and overall well-being. In response to these challenges, biophilic design has emerged as an important approach that integrates natural elements such as daylight, vegetation, natural materials, water features, and nature-inspired forms into built environments.

Biophilic design is grounded in the concept that humans possess an innate connection with nature, and its thoughtful application in residential spaces can support stress reduction, emotional balance, and cognitive restoration. Previous studies have demonstrated that exposure to natural light, indoor plants, and views of nature can enhance mood, improve indoor environmental quality, and promote healthier living conditions. In the Indian context, traditional residential design elements such as courtyards, verandas, and open-to-sky spaces inherently reflect biophilic principles and remain relevant in contemporary housing.

India.

AIM

This research aims to examine the impact of biophilic design strategies on occupant well-being in residential interiors. By evaluating both measurable environmental factors and user perceptions, the study seeks to identify effective biophilic design interventions that contribute to healthier and more sustainable residential environments.

OBJECTIVE

- To examine the impact of biophilic design elements on the psychological well-being of occupants in residential spaces.
- To identify and evaluate key biophilic design strategies that enhance comfort and indoor environmental quality in residential interiors.

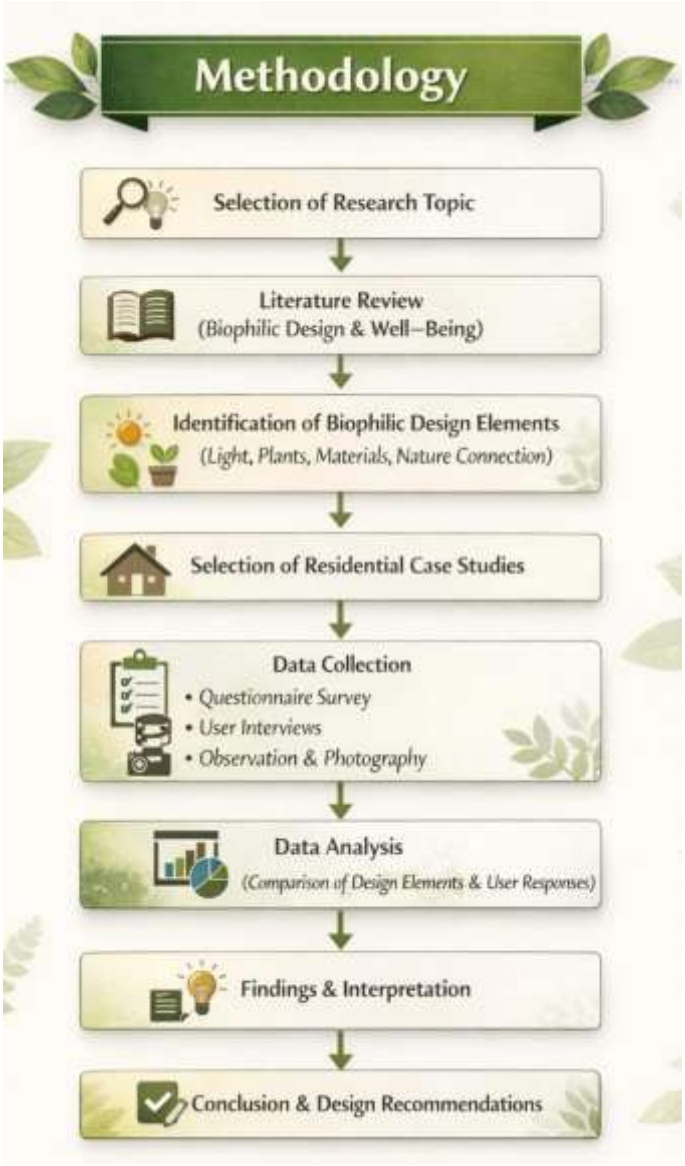
SCOPE

The scope of this research is limited to the study of biophilic design principles applied within residential interior spaces. The research focuses on selected biophilic elements such as natural lighting, indoor vegetation, natural materials, visual connection to nature, and nature-inspired design features. The study evaluates their impact on occupants' psychological well-being and perceived indoor environmental quality.

The research is confined to urban residential settings and considers user perceptions, spatial characteristics, and design strategies rather than structural or construction-related aspects. Data collection is based on case study analysis, user surveys, and observational methods. External factors such as climate variations, long-term physiological health outcomes, and non-residential building types are excluded from the study.

METHODOLOGY

- This research follows a mixed-method approach, combining qualitative and quantitative methods to study the impact of biophilic design on well-being in residential spaces.
- The study includes a literature review and residential case study analysis to understand biophilic design principles such as natural light, indoor plants, natural materials, and visual connection with nature.
- Primary data is collected through questionnaire surveys, user interviews, and on-site observations to assess occupants' comfort, satisfaction, and psychological well-being.
- Secondary data is obtained from books, research papers, journals, and previous studies related to biophilic design and residential well-being. The collected data is analyzed to draw conclusions and design recommendations.



LIMITATIONS

- The study is limited to a small number of residential case studies, which may restrict the generalization of the findings.
- The research is mainly based on user perception and questionnaire responses, which can be subjective in nature.
- Due to time and resource constraints, long-term physical and psychological effects of biophilic design could not be examined.

- Environmental factors such as seasonal changes and maintenance of natural elements were not considered in detail.

II. IMPACT OF BIOPHILIC DESIGN ON WELL-BEING IN RESIDENTIAL SPACES

DEFINITION AND PRINCIPLES

Biophilic design in residential spaces refers to the intentional integration of natural elements and nature-inspired design strategies within homes to enhance occupants' overall well-being. It is based on the concept that regular interaction with nature positively influences human physical, psychological, and emotional health. In residential environments, biophilic design includes the use of natural light, indoor plants, fresh air, natural materials, water elements, and visual connections with nature. These elements contribute to stress reduction, improved mood, better comfort levels, and a healthier living environment, thereby having a direct impact on the well-being of residents

Key Principles Include :

1.Connection with Natural Light:

Natural daylight plays a vital role in regulating human biological rhythms and improving mood. Adequate daylight in residential spaces reduces stress, enhances visual comfort, and supports better sleep patterns. It also minimizes dependence on artificial lighting, creating a healthier indoor environment.

2.Integration of Indoor Vegetation:

The presence of plants within residential interiors improves air quality and creates a calming atmosphere. Indoor vegetation helps reduce mental fatigue and promotes emotional well-being by strengthening the human–nature connection in daily living spaces.

3.Use of Natural Materials:

Natural materials such as wood, stone, bamboo, and clay provide tactile comfort and warmth. Their textures and colours create a sense of familiarity and harmony, contributing to psychological comfort and a more relaxing home environment.

4.Visual Connection with Nature:

Providing views of greenery, gardens, courtyards, or natural landscapes helps reduce stress and enhances mental restoration. Even indirect visual connections with nature can positively influence emotional well-being and improve overall residential comfort.

5.Natural Ventilation and Air Quality:

Proper natural ventilation allows the flow of fresh air, improving indoor air quality and thermal comfort. Good ventilation reduces indoor pollutants and supports physical health, leading to a more comfortable and liveable residential space.

6. Sensory Engagement and Comfort:

Biophilic design engages multiple human senses through natural colours, textures, sounds, and thermal variations. This sensory richness creates a soothing environment that supports relaxation, reduces anxiety, and enhances emotional well-being.

7.Creation of Restorative and Calm Spaces:

Residential spaces designed with biophilic principles encourage relaxation and mental recovery from daily stress. Such environments provide a sense of refuge, balance, and comfort, supporting long-term psychological well-being and quality of life.

III. Relationship Between Biophilic Design and Well-Being in Residential Spaces

1. Psychological Well-Being

Biophilic design helps reduce stress, anxiety, and mental fatigue by creating a calming and natural living environment. Exposure to natural elements such as plants and daylight supports emotional balance and improves overall mental health of residents.

2. Physical Comfort and Health

Natural ventilation, daylight, and improved air quality contribute to better physical comfort within residential

spaces. These elements help regulate body rhythms, enhance sleep quality, and support overall physical well-being.

3. Emotional and Social Well-Being

Homes designed with biophilic principles promote a sense of relaxation and comfort, encouraging positive emotions and social interaction. Such environments create a feeling of attachment and satisfaction with living spaces.

IV. Benefits of Biophilic Design for Residential Interiors

1. Improved Indoor Environmental Quality

Biophilic interiors enhance air quality, lighting, and thermal comfort, resulting in healthier living conditions. The use of natural elements reduces dependence on artificial systems and improves overall indoor comfort.

2. Stress Reduction and Mental Relaxation

Natural elements within interiors create soothing environments that help occupants unwind from daily stress. This contributes to improved mood and emotional stability.

3. Enhanced Aesthetic and Living Experience

The use of natural materials, textures, and greenery adds visual interest and warmth to residential interiors. Biophilic design creates spaces that are both functional and visually pleasing.

4. Sustainable and Healthy Lifestyle

Biophilic interiors encourage sustainable living by promoting the use of eco-friendly materials and natural resources. This supports long-term health and environmental responsibility.

V. Relevance of Biophilic Design to Indian Climate and Residential Context

1. Climate-Responsive Residential Design

India's diverse climate conditions require design strategies that support natural ventilation, shading, and daylight. Biophilic design helps create thermally comfortable homes suited to local climate conditions.

2. Traditional Indian Architectural Practices

Elements such as courtyards, veranda's, jalis, and open-to-sky spaces reflect biophilic principles. These traditional features enhance ventilation, daylight, and connection with nature in Indian homes.

4. Urban Residential Well-Being

In densely populated Indian cities, access to nature is limited. Biophilic design helps introduce greenery and natural elements within residential interiors, improving occupants' quality of life.

5. Sustainable Living in Indian Context

Biophilic design promotes the use of locally available materials and passive design strategies, supporting sustainability and reducing environmental impact in Indian residential spaces.

VI. Case Study: Palmyra House, Maharashtra

Architect: Studio Mumbai Architects

(Founded by Bijoy Jain, an internationally recognized Indian architect known for context-sensitive and craft-based architecture.)

Studio Mumbai is known for designing buildings that respond strongly to local climate, materials, craftsmanship, and nature. Their work emphasizes sustainability, simplicity, and human comfort.

Project Size: Palmyra House is a low-rise private residential house spread across a large site area within a natural landscape of palm trees.

The built form is horizontally planned, allowing close interaction with the surrounding environment rather than vertical stacking of spaces.

Design Intent: The primary design intent of Palmyra House was to create a residential environment that is deeply connected to nature and local context. The architects aimed to design a home that responds to the tropical coastal climate of Maharashtra while ensuring comfort through passive design strategies.

Impact of Palmyra House on Well-Being

1. Open Planning and Indoor–Outdoor Connection

The open planning of Palmyra House allows a seamless connection between indoor spaces and the surrounding landscape. This constant interaction with nature helps reduce stress and mental fatigue, creating a calm and restorative living environment for occupants.

2. Abundant Natural Ventilation

Large openings, verandahs, and shaded transitional spaces promote continuous airflow throughout the house. This natural ventilation improves indoor air quality and thermal comfort, supporting physical health and reducing dependence on mechanical cooling systems.

3. Use of Natural and Local Materials

The extensive use of wood, stone, and natural finishes provides tactile and visual comfort. These materials create a warm and organic atmosphere, which positively influences emotional well-being and enhances residents' connection with their living space.

4. Daylight and Shaded Spaces

Balanced daylight enters the interiors through open courtyards and shaded areas, preventing glare while maintaining visual comfort. Exposure to natural light supports healthy sleep cycles and improves mood and overall mental well-being.

5. Integration with Natural Landscape

The house is designed within a landscape of palm trees, offering constant views of greenery. This visual connection with nature promotes relaxation, reduces anxiety, and enhances psychological comfort.

6. Climate-Responsive Design

The design responds to the local climate by using passive cooling strategies such as shading and ventilation. This ensures comfortable indoor conditions, contributing to physical comfort and long-term residential well-being.

SUSTAINABILITY & WELL – BEING IMPACTS

1.Reduced Dependence on Mechanical Systems

The design of the house minimizes the use of artificial lighting, air-conditioning, and mechanical ventilation. This reduction in energy consumption supports environmental sustainability while creating a quieter and more comfortable living environment, positively affecting occupants' mental well-being.

2. Long-Term Health Benefits Through Passive Living

By relying on natural light, airflow, and thermal regulation, the residence supports a healthier lifestyle over time. Such passive living conditions reduce exposure to artificial systems, contributing to long-term physical comfort and overall well-being.

3. Enhanced Sense of Environmental Awareness

Living in a biophilic and sustainable home increases occupants' awareness of natural cycles such as daylight, seasons, and airflow. This awareness encourages responsible living habits and strengthens the emotional connection between residents and their environment.

4.Stress Reduction Through Simplicity and Natural Living

The simple spatial planning and uncluttered use of natural elements reduce sensory overload. This simplicity creates a peaceful atmosphere that helps occupants disconnect from urban stress and supports psychological restoration.

5.Durability and Low Maintenance Impact

The use of durable natural materials and climate-appropriate design reduces the need for frequent repairs or replacements. This not only supports sustainability but also provides occupants with a sense of stability and long-term comfort.

6.Balanced Relationship Between Built Form and Nature

The house maintains a balance between built spaces and open natural areas. This balanced approach supports ecological sustainability while ensuring residents enjoy continuous access to nature, enhancing emotional and mental well-bei.

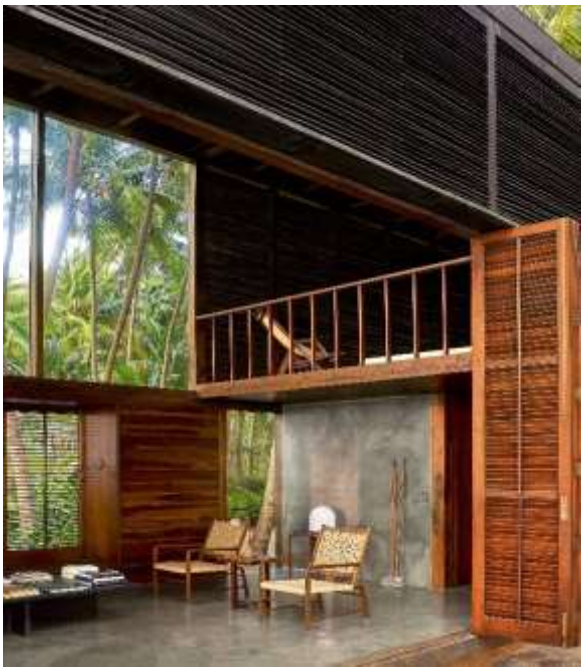
CASE STUDY

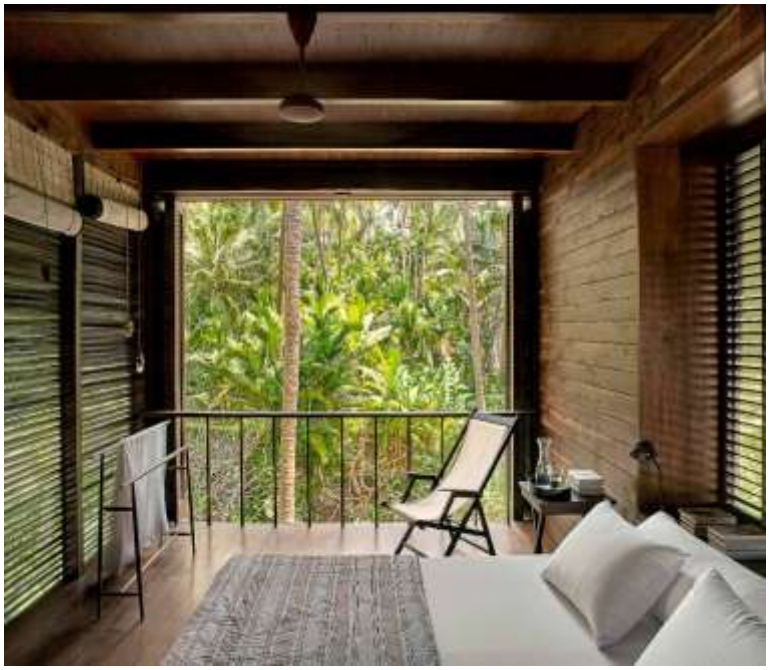
This Palmvra house Is A Great Example Of Biophilic Design

Designed by Bijoy Jain of NNAD Studio, this beautiful Palmvra house is one with nature and is environmentally sustainable

Palmyra House was envisioned as a home that offers peace, simplicity, and a close relationship with nature. The intention was to move away from the noise, stress, and artificial lifestyle of urban living and create a residence that supports calmness and well-being. Rather than a conventional enclosed house, the desire was for a space that feels open, breathable, and connected to the surrounding landscape.

Living in Palmyra House allows daily interaction with natural elements such as light, air, greenery, and changing weather conditions. The open verandahs, shaded spaces, and views of palm trees create a sense of





relaxation and mental clarity. The owner experiences the house not as a static structure, but as a living environment that responds to time, seasons, and daily activitie

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Living room : Palmvra house

The living room is designed as an open and naturally ventilated space with a strong connection to the surrounding landscape. Large openings allow ample daylight and fresh air, creating a comfortable and relaxing environment. The use of natural materials and simple finishes adds warmth and enhances

psychological comfort. Overall, the living room acts as a calm and social space that supports occupant well-being.

Bedroom:Palmvra house

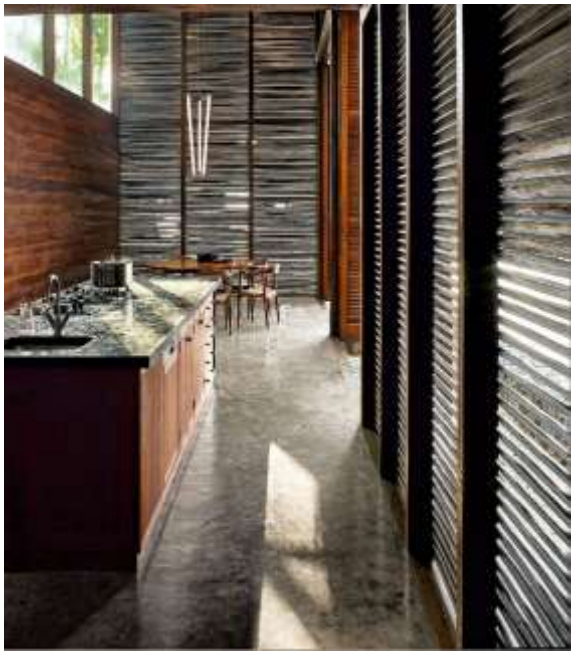
The bedroom is designed as a calm and private space with soft natural lighting and good ventilation. Openings allow fresh air and filtered daylight, creating a comfortable and restful environment. The use of natural materials and muted tones supports relaxation and promotes better sleep, contributing positively to occupant well-being.

Kitchen:Palmvra house

The kitchen is designed as a well-lit and naturally ventilated space to support daily activities comfortably. Openings allow natural light and airflow, reducing heat build-up and maintaining hygiene. The simple layout and use of natural materials create a functional and healthy cooking environment, contributing to the physical well-being of the occupants.

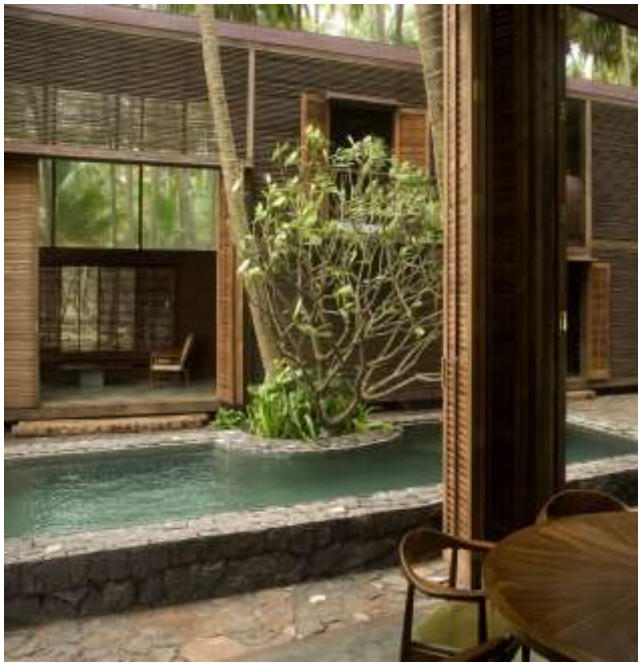
Outdoor area : Palmvra house

The outdoor areas are designed as an extension of the living spaces, surrounded by natural landscape and palm trees. Verandahs and open spaces provide shaded areas for relaxation and social interaction. This strong connection with nature enhances mental calmness, reduces stress, and supports overall well-being of the occupants.



Courtyard: Plamvra house

The courtyard acts as the central open space of the house, allowing natural light and fresh air to penetrate the surrounding interiors. It enhances cross ventilation and helps maintain thermal comfort throughout the house. The presence of greenery in the courtyard creates a calm and refreshing environment, contributing positively to the psychological well-being of the occupants.



CONCEPTUAL DESIGN GUIDELINES FOR SUSTAINABLE INTERIOR AESTHETIC IN INDIAN CLIMATE

a) SITE / SPATIAL STRATERGIES

- Prioritise daylight: place living areas or work zones adjacent to glazing facing favourable orientation (north/east in India for less harsh solar gain).
- Facilitate natural ventilation: openable windows, cross – ventilation, internal courtyards or light shafts.
- Link interior to exterior : balconies, terraces, internal courtyards or green walls, allow the nature – interface.
- Use transitional spaces : semi – open verandas or buffer zones can moderate interior climate and connect with nature.

b) MATERIALITY & FINISHES

- Use natural materials : wood, bamboo, stone, terracotta – preferably locally sourced, low embodied energy.
- Select finishes with tactile warmth and natural textures rather than cold synthetic surfaces.
- Consider finishes that moderate indoor environment : e.g., lighter colours to reflect light/ heat, stone floors for cooling in hot climate.
- Incorporate patterns/analogues from nature/; biomorphic shapes, organic forms, green colour accents – to evoke nature even where planting is limited.

c) VEGETATION & GREEN ELEMENTS

- Indoor plants and green walls: Even in small interiors, vertical greenery or plant clusters enhances connection to nature, improve air quality.
- Use planters, pots, terrariums, vine plants near windows or balconies to blur inside/outside boundary.
- Water features (small fountains, indoor ponds) if feasible : sounds of water support calmness and better experience.

d) LIGHTING, AIR & ACOUSTICS

- Maximise natural light : avoid deep dark rooms; use skylights or clerestory windows where feasible.
- Use shading devices to reduce glare/heat gain (especially for Indian Sun).
- Ensure good indoor air quality : natural ventilation and / or air – purifying plants.
- Soundscape : include natural textures and greenery to absorb noise; where possible, water sounds or vegetation can soften acoustic harshness.

e)AESTHETIC INTEGRATION & SUSTAINABILITY

- Choose a colour palette reflecting nature: greens, browns, muted earth tones, warm neutrals.
- Combine sustainable practices: local materials, passive climate control, efficient lighting & appliances.
- Visual coherence: the interior aesthetic should be seamless – nature elements should not add – on but integrated.
- Maintenance & adaptability : in India, heavy dust, monsoon humidity and seasonal shifts demand materials that age well, plants that can thrive indoors, and design flexibility to adapt (e.g., shading in summer, open in winter).

DISCUSSION

Implementing biophilic design in Indian contexts presents both opportunities and challenges. On the opportunity side improving occupant well – being, creating visually calm and sustainable interiors, leveraging traditional Indian architecture (courtyards, verandas) in new ways. The literature emphasises that local climate, culture and materials Matter strongly for biophilic design to succeed.

Challenges include: space constrains in Indian apartments; budget limitations; maintenance of indoor plants/green walls; ensuring sufficient daylight without overheating; balancing the need for cooling and ventilation in hot/humid climates; and educating clients about long – term benefits (well – being , sustainability) rather than short – term aesthetics.

From a research perspective, more empirical data is needed in Indian interiors on how biophilic elements quantitatively impact thermal comfort, energy use, occupant health and productivity. However, early indicators and global studies suggest a strong benefit.

Aesthetically, biophilic interiors need to avoid becoming purely " green décor" or "trend – based" and instead embed nature meaningfully – so that

vegetation, materiality and spatial design work together as an ecosystem within the interior.

CONCLUSION

In an era of dense urbanization of biophilic and nature – based design into interior spaces in India is both timely and necessary. By bringing nature in, maximizing daylight and ventilation, using natural materials, and creating aesthetic interiors that support well – being and sustainability, designers can create spaces that are not only visually attractive but also healthier and more sustainable. The case study illustrates how Indian climate and cultural context can be harnessed. The guidelines presented offer a practical framework for designers, architects and interior professionals. As biophilic design moves from trend to norm, especially in the India interior design practice, the future looks green, calm and connected to nature.

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