Biophilic Design in Sustainable Building Architecture: "Creating Healthy and Comfortable Indoor Environments"

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Abstract

The past decade has witnessed a surge of interest in exploring the relation between biophilic design and sustainable buildings' architecture, with a focus on creating healthy and comfortable indoor environments. Biophilic design, rooted in the principles of ecology and environmental psychology, emphasizes the integration of natural elements into architecture to enhance human well-being, both physically and mentally. This approach aims to foster a connection between humans and nature through architectural design, leading to improved quality of life, reduced stress levels, and increased productivity.

The growing interest in this field stems from numerous studies demonstrating the benefits of being in close proximity to nature, including reduced stress levels, improved mood, and enhanced focus and creativity. These benefits extend beyond individuals to encompass entire communities, as biophilic design contributes to the creation of more sustainable and liveable urban environments.

The research problem lies in the practical application of biophilic design principles to create sustainable buildings that adapt to user needs and provide healthy and comfortable indoor environments. This approach relies on incorporating natural elements such as natural light, plants, and natural materials, along with designs that promote views of outdoor spaces and ensure adequate natural ventilation. The research also highlights the importance of examining the relationship between biophilic design and environmental sustainability, and its role in enhancing architectural styles and urban environments.

The research employs a descriptive-analytical approach, involving the description and analysis of architectural models that implement biophilic design principles within the framework of sustainability. These models are studied to understand how to achieve a balance between architectural aesthetics and the functional and environmental needs of buildings. The study focuses on practical examples of buildings that have successfully integrated biophilic design, providing clear evidence of the possibility of achieving a balance between sustainability and beauty in architectural design.

The study aims to establish a theoretical framework that defines the components of the relationship between biophilic design and sustainable building architecture, and to extract the health, psychological, and environmental benefits of this approach. Biophilic design components include elements such as natural light, natural ventilation, indoor and outdoor

plants, water, natural materials, and shapes and patterns inspired by nature. Integrating these elements into building design is an essential part of comprehensive sustainability, as it contributes to reducing energy consumption, improving indoor air quality, and reducing the need for air conditioning and artificial lighting.

The research yielded several findings, including integration of natural elements into architectural design which enhances the overall well-being of users, and that biophilic design contributes to achieving sustainability goals by improving indoor air quality, reducing energy consumption, and promoting a connection to nature. For instance, large and properly oriented windows can provide ample natural lighting, reducing the need for artificial lighting and creating a more comfortable indoor.

Keywords

Biophilic design - Sustainable architecture - Environmental architecture.

الملخص

شهد العقد الماضي اهتمامًا متزايدًا بالتصميم البيوفيلي، الذي يدمج العناصر الطبيعية في العمارة لتحسين رفاهية الإنسان وبناء مباني مستدامة. يهدف البحث إلى فهم كيفية تطبيق مبادئ التصميم البيوفيلي بشكل فعال لتعزيز البيئات الداخلية، وخفض استهلاك الطاقة، وتحسين صحة ورضا المستفيدين. من خلال تحليل المشاريع الناجحة وإجراء مزيد من الدراسات. تكمن مشكلة البحث في التطبيق العملي لمبادئ التصميم البيوفيلي لإنشاء مباني مستدامة تتكيف مع احتياجات المستخدمين وتوفر بيئات داخلية صحية ومريحة. يعتمد هذا النهج على دمج العناصر الطبيعية، مثل الضوء الطبيعي والنباتات والمواد الطبيعية، بالإضافة إلى التصاميم التي تعزز الرؤية للمساحات الخارجية وتضمن تهوية طبيعية كافية. كما يسلط البحث الضوء على أهمية دراسة العلاقة بين التصميم البيوفيلي والاستدامة البيئية، ودوره في تطوير الأنماط المعمارية والبيئات الحضرية. وقد أسفر البحث عن العديد من النتائج، بما في ذلك تعزيز رفاهية المستخدمين من خلال دمج العناصر الطبيعية في التصميم المعماري، ومساهمة التصميم البيوفيلي في تحقيق أهداف الاستدامة عبر تحسين جودة الهواء الداخلي، وخفض استهلاك الطاقة، وتعزيز التواصل مع الطبيعة. على سبيل المثال، يمكن للنوافذ الكبيرة والموجهة بشكل صحيح توفير إضاءة طبيعية وفيرة، مما يقلل الحاجة للإضاءة الصناعية ويخلق بيئة داخلية أكثر راحة.

الكلمات المفتاحية

التصميم البيوفيلي، العمارة المستدامة، العمارة البيئية.

The importance of research:

This Research plays a crucial role in advancing this field and highlighting its far-reaching benefits and its importance appears in:

1. Fostering Environmental Sustainability by shedding light on specific Biophilic design elements and strategies that effectively minimize energy and resources use, promote natural ventilation and lighting, and incorporate renewable energy sources.

2. Providing Practical and Applicable Solutions through Case studies and examples of successful biophilic projects that can serve as valuable resources for architects, designers, and policymakers. By showcasing real-world applications, research can bridge the gap between theory and practice, enabling the widespread adoption of biophilic design principles.

3. Enhancing Awareness of Nature's Impact on human well-being and overall quality of life. Studies demonstrating the positive effects of biophilic design on stress reduction, productivity, creativity, and physical health, also it can foster a deeper appreciation for the connection between humans and nature. This increased awareness can drive further research and implementation of biophilic design principles, creating healthier and more sustainable spaces.

4. Fostering Interdisciplinary Collaboration that brings together diverse fields such as architecture, psychology, environmental engineering, and biology, by fostering a collaborative spirit, research can accelerate the development of comprehensive and effective biophilic design solutions.

Research Objectives:

1. Understand Biophilic Design Principles.
2. Evaluate Biophilic Design's Impact on Health and Comfort.
3. Identify Strategies for Implementing Biophilic Design in Sustainable Architecture.

Research problem:

Considering these challenges and uncertainties, hence the main research question emerges:

- Can biophilic design principles be effectively implemented in sustainable buildings to enhance indoor air quality and lighting?

Research Methodology:

The research uses a descriptive-analytical methodology, which includes the systematic description and analysis of practical examples of projects applying biophilic design principles. This approach will allow a comprehensive understanding of how biophilic design can be applied in real-world environments and identify effective strategies for its implementation.

Research Hypotheses:

Based on the current understanding of biophilic design and its potential benefits, the research proposes the following hypotheses:

1. Implementing biophilic design principles in buildings will lead to an improvement in users' mental health and overall well-being, contributing to a reduction in stress and anxiety levels.
2. The presence of indoor plants in biophilic buildings will significantly contribute to enhancing indoor air quality and reducing pollutants.
3. Buildings that incorporate biophilic design principles will consume less energy due to increased reliance on natural lighting.
4. Occupants will tend to prefer biophilically designed environments over traditional ones due to a sense of comfort and connection with nature.

1. Introduction:

In recent years, in a world increasingly dominated by technology and urbanization, reconnecting with nature is more important than ever, so the integration of biophilic design principles in sustainable building architecture has garnered significant attention. By understanding and incorporating biophilia into our lives, we can create environments that promote not only our physical health but also our mental and emotional well-being. As Biophilic design, derived from the term "Biophilia," (pronounced bye-oh-FILL-ee-uh) which is a concept that describes the human tendency to connect with nature and living things. It's the idea that we have an innate affinity for the natural world and that this connection is essential for our well-being. It also emphasizes the need to incorporate natural elements into the built environment, aiming to enhance the well-being, health, and comfort of its occupants. Biophilic design is grounded in the understanding that humans have an inherent connection to the natural world. This connection can be fostered by integrating direct and indirect elements of nature into architectural design. Direct elements include natural light, plants, water features, and natural ventilation. Indirect elements might encompass the use of natural materials, colours, shapes, and patterns that evoke nature. Sustainable architecture seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. Biophilic design aligns seamlessly with these goals by promoting the use of sustainable materials and enhancing energy efficiency through natural ventilation and lighting. Moreover, it addresses the psychological and physiological needs of building occupants, contributing to their overall health and productivity.

1.1. A Brief Historical Overview of Nature in Architecture:

The relationship between architecture and nature has been a dynamic and evolving one, shaping the built environment throughout history.

Early Civilizations: Harmony with Nature [1]	
Prehistoric Era:	Human beings initially sought shelter from natural elements, using materials readily available in their surroundings. This early architecture was inherently connected to nature.
Ancient Civilizations:	Civilizations like the Egyptians, Greeks, and Romans demonstrated a deep understanding of natural forces like sunlight, wind, and water. Their structures were often oriented to maximize solar gain and ventilation, reflecting a harmonious coexistence with nature. For instance, the Egyptians aligned their pyramids with celestial bodies, and the Greeks developed architectural orders based on natural proportions.
Industrial Revolution: Disconnection from Nature [2]	
The 19th Century:	The Industrial Revolution marked a significant shift, as cities expanded, and buildings became taller and more enclosed. A focus on functionality and efficiency often overshadowed considerations for nature. Industrial

	architecture was characterized by its use of steel and glass, creating a stark contrast to the organic forms of the past.
Modernism and the Search for Renewal [3]	
The 20th Century:	The Modernist movement sought to break away from historical styles and create architecture that was functional and devoid of ornamentation. While this often led to a disconnection from nature, some architects like Le Corbusier experimented with integrating green spaces into urban environments.
Postmodernism and the Return to Nature [4]	
The end of the 20th Century:	Postmodernism marked a reaction against the rigidity of Modernism, emphasizing contextualism and a renewed interest in history and culture. This period saw a resurgence of interest in incorporating natural elements into architecture.
Contemporary Architecture: Biophilic Design [5]	
The 21st Century:	The growing awareness of climate change and the importance of human well-being has led to a renewed focus on sustainable and biophilic design. Contemporary architects are increasingly integrating nature into their work using natural materials, green roofs, living walls, and biophilic design principles.

Throughout history, the integration of nature in architecture has evolved, reflecting cultural values, technological advancements, and environmental concerns. From ancient civilizations to contemporary designs, the relationship between the built environment and the natural world continues to shape the way we live and interact with our surroundings. As we move forward, this integration becomes increasingly crucial in addressing the challenges of sustainability and enhancing the quality of life for future generations.

1.2. Environmental awareness and emergent sustainable architecture:

Environmental awareness has grown significantly over the past few decades, driven by increasing recognition of the impacts of human activities on the planet. Key events and milestones have shaped this awareness:

1960s-1970s:

The modern environmental movement began, highlighted by the publication of Rachel Carson's "Silent Spring" in 1962, which raised concerns about the use of pesticides. The first Earth Day in 1970 marked a significant moment in environmental activism [6].

1987:

The Brundtland Report, "Our Common Future," introduced the concept of sustainable development, defining it as meeting the needs of the present without compromising the ability of future generations to meet their own needs [7].

1990s-2000s:

International agreements such as the Kyoto Protocol (1997) and the Paris Agreement (2015) highlighted global commitment to addressing climate change and reducing greenhouse gas emissions [8].

1.3. Principles of Sustainable Architecture:

Sustainable architecture aims to minimize the negative environmental impact of buildings through efficiency and moderation in the use of materials, energy, and development space; key principles include [9]:

- **Energy Efficiency**: Designing buildings to reduce energy consumption through passive solar design, high-performance insulation, and energy-efficient systems.
- **Water Conservation**: Implementing water-saving fixtures, rainwater harvesting systems, and greywater recycling.
- **Material Sustainability**: Using renewable, recycled, and locally sourced materials to reduce the carbon footprint associated with transportation and production.
- **Indoor Environmental Quality**: Enhancing indoor air quality, natural lighting, and thermal comfort to promote the health and well-being of occupants.
- **Site Sustainability**: Considering the environmental impact of building sites, promoting biodiversity, and minimizing disruption to natural habitats.

Emergent Trends in Sustainable Architecture:

The evolution of sustainable architecture has led to several innovative trends and practices that address contemporary environmental challenges [10]:

- **Net-Zero and Positive Energy Buildings**: Net-zero buildings produce as much energy as they consume, often through renewable energy sources like solar panels. Positive energy buildings go a step further, generating more energy than they use.
- **Green Roofs and Walls**: These features provide insulation, reduce urban heat island effects, and improve air quality. They also create habitats for wildlife and enhance the aesthetic value of buildings.
- **Adaptive Reuse**: Repurposing existing buildings for new uses, reducing the need for new construction, preserving resources and reducing waste. Adaptive reuse also preserves cultural heritage and revitalizes urban areas.
- **Smart Buildings**: Integrating technology to monitor and optimize energy use, lighting, and HVAC systems. Smart buildings use sensors and automation to enhance efficiency and occupant comfort.
- **Biophilic Design**: Incorporating natural elements into building design to enhance well-being and productivity. This includes the use of natural light, ventilation, plants, and natural materials.
- **Passive House Standard**: A rigorous, voluntary standard for energy efficiency in buildings, reducing their ecological footprint. Passive House buildings use ultra-low energy for heating and cooling.

Case Studies of Sustainable Architecture:

1. **The Edge, Amsterdam**: Known as one of the most sustainable office buildings in the world, The Edge features smart technology, energy-efficient systems, and a design that maximizes natural light and ventilation [11].

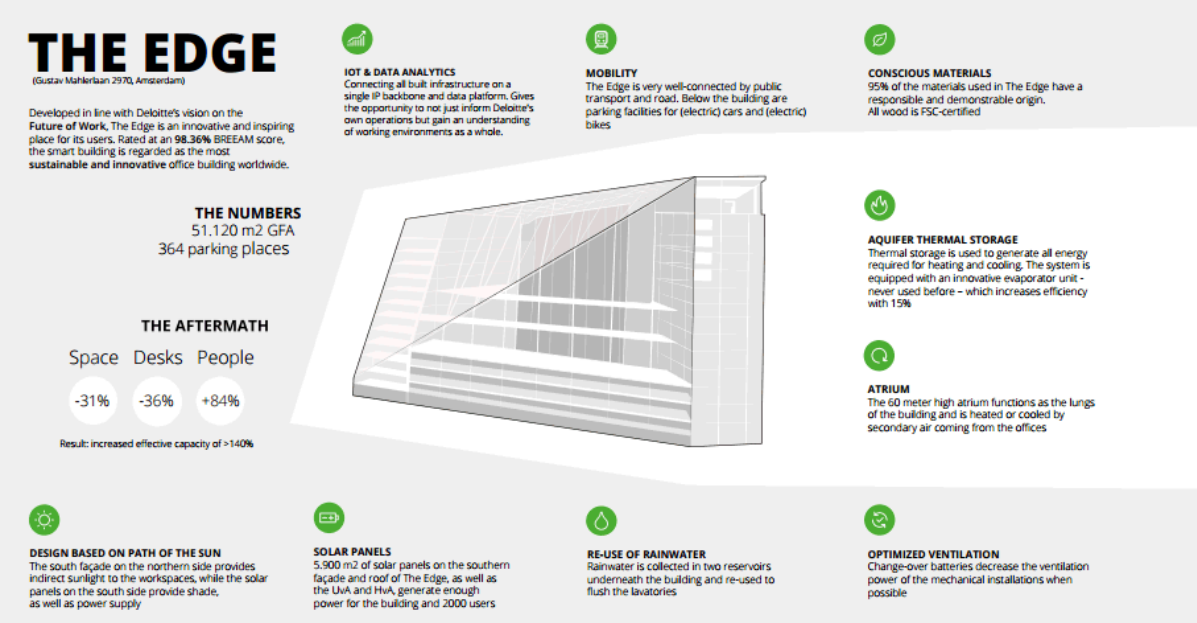


Image No. (1) shows Sustainability principles in the design of The Edge building in Amsterdam.

2. **One Central Park, Sydney**: This mixed-use development incorporates green walls, rooftop gardens, and a central park, creating a green oasis in an urban setting. The building also features innovative water and energy management systems [12].

Image No. (2) Shows North facade of one of the towers in central park project in Sydney.

3. **Bullitt Center, Seattle**: Designed to be the greenest commercial building in the world, the Bullitt Center achieves net-zero energy and water use. It features solar panels, rainwater harvesting, composting toilets, and a focus on indoor environmental quality [13].

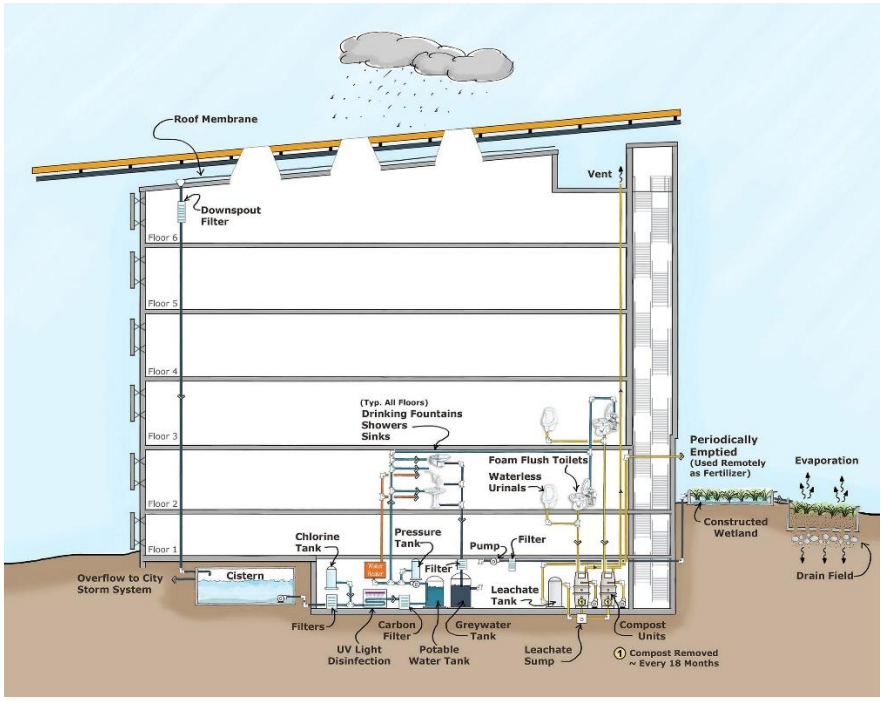


Image No. (3) shows the water management system diagram for the Bullitt Sustainable Center, Seattle.

1.4. From the theory of biophilia to biophilic design:

Origin of the Term:

The term "Biophilia" was first coined by Harvard naturalist E.O. Wilson in his 1984 book of the same name. Wilson proposed that biophilia is a human evolutionary trait that helped us survive and thrive as a species. Our ancestors who were drawn to environments with abundant resources and diverse life forms were more likely to find food, water, and shelter, ultimately increasing their chances of survival and reproduction [14].

Evidence for Biophilia:

There's a growing body of research that supports the concept of biophilia. Studies have shown that exposure to nature can have a range of positive effects on our physical and mental health, including [15]:

- Reduced stress and anxiety
- Improved mood and well-being
- Enhanced creativity and problem-solving
- Boosted immune function
- Faster recovery from illness
- Increased focus and concentration

Biophilia consists of feeling more relaxed when spending time in the garden or by the ocean, finding a houseplant that is calming and aesthetically pleasing, preferring a workplace with

natural lighting and landscaping, and being drawn to natural materials such as wood, stone and water.

Applications of Biophilia:

The concept of biophilia is increasingly being applied in various fields, including:

- **Architecture:** Designing buildings that incorporate natural elements and maximize access to nature.
- **Urban planning:** Creating green spaces and incorporating nature into cityscapes.
- **Interior design:** Using natural materials, plants, and biophilic design principles to create healthy and inviting indoor spaces.
- **Healthcare:** Utilizing nature exposure to promote healing and recovery in patients.

Biophilic Design:

Biophilic design refers to the intentional creation of spaces that integrate elements of nature and natural processes to enhance human well-being and connection with the natural world. It goes beyond simply incorporating plants or nature-themed décor; it's a holistic approach that considers how design features can evoke feelings of calmness, restoration, and connection to the living world, it also should be culturally appropriate and reflect the local environment, its specific principles and strategies employed will vary depending on the project type and intended use of the space **(16)**.

Benefits of Biophilic Design:

The benefits of implementing biophilic design principles are numerous and can be categorized into several areas:

- **Improved Health and Well-being:** Reduced stress, anxiety, and blood pressure; improved mood, focus, and cognitive function; faster healing and recovery.
- **Enhanced Productivity and Creativity:** Increased employee engagement, productivity, and problem-solving abilities.
- **Increased Occupancy and Property Value:** Creating attractive and desirable spaces that people enjoy occupying.
- **Environmental Sustainability:** Promoting a connection with nature can foster an appreciation for environmental conservation efforts.

Principles of Biophilic Design:

Biophilic design aims to create spaces that integrate elements of nature and natural processes to enhance human well-being and connection with the natural world. Here's a breakdown of some core principles **(17)**:

1. Nature in the Direct View:

This principle focuses on maximizing access to natural elements within the built environment.

- Strategies include:
  - Large windows with views of nature

- Skylights and light shelves for natural light
- Integration of plants and water features
- Access to outdoor spaces like balconies, courtyards, or gardens

2. Natural Materials and Processes:

This principle emphasizes utilizing natural materials and incorporating design elements that mimic natural patterns and processes.

- Strategies include:
  - Using wood, stone, water, and other natural materials
  - Incorporating biomimicry (designing based on nature's solutions)
  - Utilizing natural ventilation and lighting strategies

3. Space and Place Conditions:

This principle focuses on creating spaces that evoke feelings of safety, comfort, and control, similar to those found in nature.

- Strategies include:
  - Design elements that provide refuge (e.g., nooks, alcoves)
  - Prospect and refuge (views of surroundings with a sense of safety)
  - Mystery (elements that spark curiosity and exploration)

4. Non-rhythmic Sensory Stimuli:

This principle focuses on incorporating natural sounds and scents to enhance sensory experiences without overwhelming them.

- Strategies include:
  - Integrating natural sounds like waterfalls or birdsong (through recordings or design features)
  - Using essential oils or natural scents subtly

5. Interconnectedness with Nature:

This principle emphasizes fostering a sense of connection to the larger ecological system.

- Strategies include:
  - Design that offers views of natural ecosystems
  - Integrating natural light cycles and seasonal changes

Biophilic Theory:

Biophilic theory refers to the natural tendency of humans to interact with nature and living systems. This theory is based on the idea that humans have evolved in natural environments and that interaction with nature plays a vital role in our mental and physical health. Biophilic design is based on several key principles [(18)]:

1. Interaction with Nature: This includes direct interaction with nature, such as plants, animals, and water, and indirect interaction, such as natural materials and colors reminiscent of nature.
2. Sensory Elements: Emphasis on elements that stimulate the senses, such as natural light, fresh air, natural scents, and natural sounds.
3. Natural Forms: Using organic shapes and designs that reflect patterns found in nature.

Applying Biophilic Theory in Architecture:

These theoretical principles are translated into specific design practices in architectural environments to achieve tangible benefits for health and well-being. Here's how this can be achieved in biophilic design [18]:

1. Plants and Green Spaces:

- Direct Integration of Plants: Using plants inside and outside buildings to enhance direct contact with nature.
- Green Roofs and Walls: Creating surfaces and walls covered with plants to enhance biodiversity and improve air quality.

2. Natural Light:

- Large Openings and Windows: Designing buildings to allow maximum natural light, reducing reliance on artificial lighting and enhancing well-being.
- Light Wells: Using reflective surfaces and open spaces to transport light to deeper areas inside buildings.

3. Natural Ventilation:

- Cross Ventilation Design: Designing windows and doors to allow fresh air flow and help ventilate buildings naturally.
- Indoor Gardens: Creating indoor gardens or courtyards that allow fresh air renewal inside buildings.

4. Natural Materials:

- Using Organic Materials: Choosing building materials that reflect nature, such as wood, stone, and recycled materials.
- Natural Colors: Using colors that reflect nature, such as green, blue, and earthy tones.

5. Water:

- Fountains and Ponds: Integrating water elements into building designs to improve the overall atmosphere and enhance feelings of calm and relaxation.
- Sustainable Irrigation Systems: Using sustainable irrigation systems to manage water consumption and promote environmental sustainability.

1.4. Bosco vertical analysis of biophilic design and sustainable architecture:

The Bosco Vertical (Vertical Forest) in Milan, designed by Boeri Studio (Stefano Boeri, Gianandrea Barreca, and Giovanni La Varra), is a prime example of biophilic design and sustainable architecture. Here's an analysis of its key features:

Biophilic Design

1. Integration of Nature

- Vegetation:

The towers feature approximately 900 trees, 5,000 shrubs, and 11,000 perennials and ground cover plants. This extensive greenery creates a vertical forest, offering a direct connection to nature for residents [19].

Image No. (4) shows the integration of nature with the building.

Image No. (5) shows Bosco vertical plan.

- **Visual and Physical Access to Nature:**
  - Large balconies and terraces allow residents to experience the plants up close, fostering a sense of well-being and connection to the natural environment.
  - Spending time in nature is known to reduce stress and improve mental health. Balconies and terraces in Bosco Vertical provide residents with a daily dose of nature, fostering a sense of calm and tranquillity.
  - These outdoor spaces encourage social interaction among residents, creating a stronger sense of community.
  - The balconies and terraces effectively expand the living area of the apartments, providing additional space for relaxation, dining, or gardening.
  - By blurring the boundaries between indoor and outdoor living, Bosco Vertical offers its residents a truly unique and enriching experience.

Image No. (6) shows the Visual and Physical Access to Nature.

2. Health and Well-being

- **Air Quality:**

The plants act as a natural filter, absorbing CO2 and dust, and producing oxygen, thereby improving the air quality around the buildings. This green lung within the urban environment contributes significantly to [20]:

  - **Reduced air pollution**: The plants help to mitigate the effects of urban air pollution, improving the overall health and well-being of residents.
  - **Improved indoor air quality**: By filtering pollutants, the vegetation indirectly contributes to better indoor air quality within the apartments.
  - **Cooler microclimate:** The process of transpiration by plants helps to cool the surrounding air, creating a more comfortable outdoor environment.

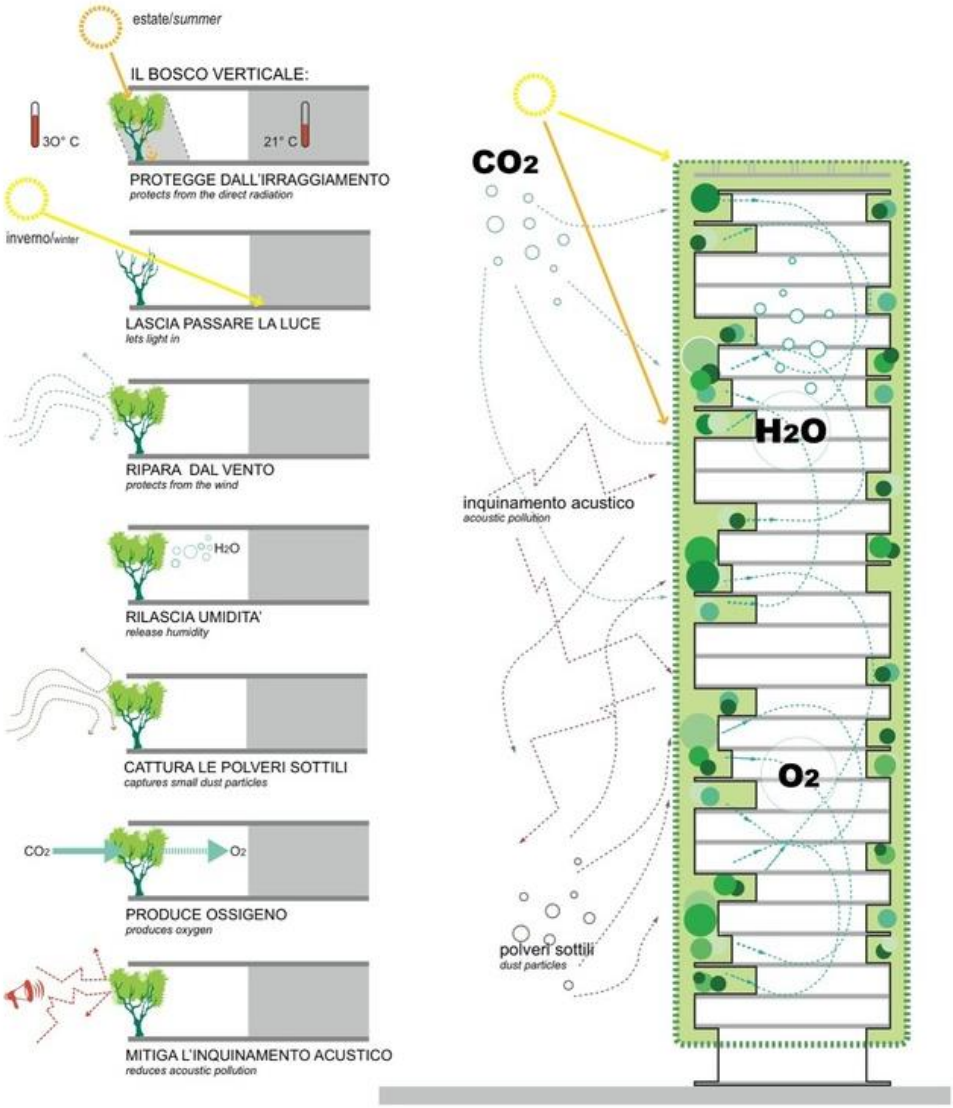
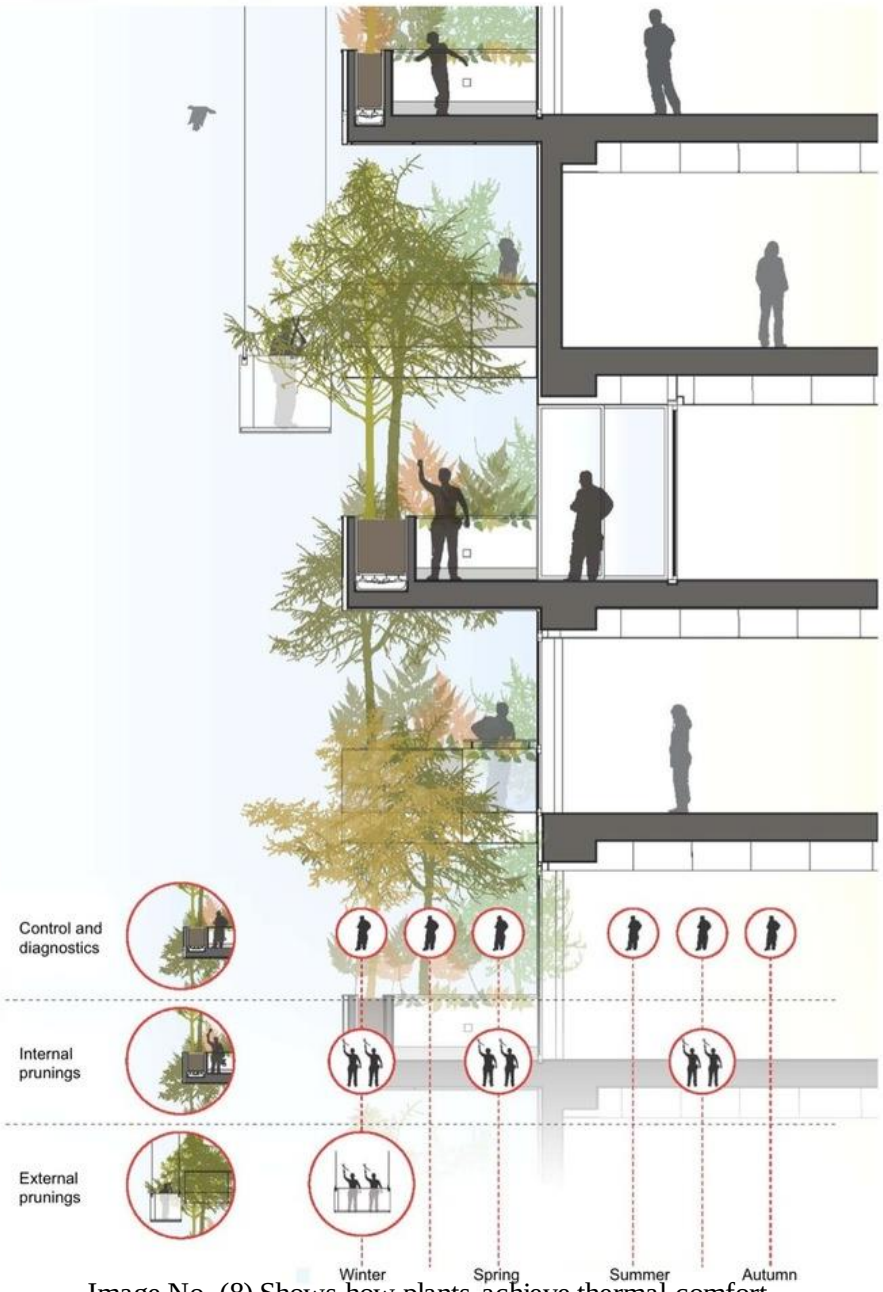


Image No. (7) Shows how plants help improve a building's air quality.

- **Thermal Comfort:**

The vegetation provides natural insulation, helping to regulate temperatures inside the apartments and reducing the need for artificial heating and cooling.

- **Summer**: The dense vegetation provides shade, reducing solar heat gain and keeping the building cooler. Additionally, the process of transpiration by plants helps to cool the surrounding air.
- **Winter**: While the leaves fall during winter, the plant structures still offer a layer of insulation, helping to retain heat within the building and reducing heat loss.



Bosco

Image No. (8) Shows how plants achieve thermal comfort.

Vertical is not merely an aesthetic achievement but also a testament to sustainable architecture. The project incorporates various eco-friendly strategies [19]:

Sustainable Architecture	**Energy Efficiency**	**Microclimate Regulation**	The vegetation helps create a microclimate, reducing energy consumption for heating and cooling. The plants shield the building from direct sunlight in summer and allow sunlight to penetrate in winter.
		Renewable Energy Sources	The design incorporates solar panels and other renewable energy systems to further enhance the building's sustainability.

	Biodiversity	**Urban Habitat**	The towers support a wide range of plant species, promoting biodiversity in an urban setting. This habitat attracts various bird and insect species, contributing to the urban ecosystem.
		Climate Resilience	The diverse plant species are selected to withstand the local climate, ensuring the sustainability of the green façade throughout the year.
	Water Management	**Irrigation System**	The buildings use a sophisticated irrigation system that recycles water from the building, ensuring that the plants receive adequate hydration with minimal waste.
		Rainwater Harvesting	The system collects rainwater, which is used for irrigation, reducing the demand on municipal water supplies.

Table No. (1)shows Bosco's eco-friendly vertical strategies

Architectural Impact

1. Aesthetic Appeal:

- The vertical forest creates a striking visual impact, blending modern architecture with lush greenery, making it a landmark in Milan and a model for future urban design.

2. Urban Regeneration:

- Bosco Vertical contributes to urban regeneration by transforming a previously neglected area into a vibrant, green space, enhancing the quality of life for residents and the wider community.
-

Case studies of Architectural building in Egypt to show the Potential Benefits of Biophilic Design to Mitigate Identified Deficiencies:

Maspero Building:

Headquarter of the Egyptian Radio and Television Union, is one of the most iconic structures in Cairo, symbolizing the country's media history. However, the building faces several shortcomings and weaknesses that could be addressed through the application of biophilic design principles.

Weaknesses and Shortcomings of Maspero Building:

Image No. (9) Shows Maspero Building.

1. **Lack of Green Spaces:**
   - Analysis: The building lacks any green spaces, both internally and externally. The design relies heavily on concrete and glass structures, with no natural elements incorporated.
   - Biophilic Solution: The internal and external environment of the building could be significantly enhanced by introducing indoor gardens, green walls, and green roofs. These changes would contribute to improving the psychological well-being of employees and visitors.

2. **Insufficient Natural Lighting:**
   - Analysis: Maspero Building suffers from a lack of natural lighting due to its enclosed design and relatively small windows.
   - Biophilic Solution: Improving the window design and increasing their size, along with using glass that allows more natural light to pass through, would help reduce reliance on artificial lighting and improve the overall work environment.

3. **Ventilation Issues:**
   - Analysis: The building often experiences inadequate ventilation, leading to a stuffy atmosphere and an unhealthy environment for the staff.
   - Biophilic Solution: Introducing natural ventilation systems through the design of appropriate ventilation openings or using innovative ventilation techniques to enhance the flow of fresh air can greatly improve indoor air quality.

4. **Temperature Control and Energy Consumption:**
   - Analysis: The building struggles with controlling internal temperatures, leading to high energy consumption, especially during the summer months.

- Biophilic Solution: Utilizing thermal insulation techniques, such as green roofs and insulating building materials, can help improve the building's thermal insulation, thereby reducing the need for extensive use of air conditioning systems.

By applying these biophilic design strategies, Maspero Building could significantly improve its environmental comfort, enhance the well-being of its occupants, and become a model of sustainable and human-centered architecture.

2. The Tahrir Complex building:

one of the largest and oldest administrative buildings in Egypt, playing a vital role in the country's administrative system. Despite its significance, several shortcomings and weaknesses can be identified that could be improved by applying biophilic design principles.

Image No. (10) Shows the Tahrir Complex building.

Image No. (11) Shows the Tahrir Complex building from the inside.

Weaknesses and Shortcomings of the Tahrir Complex Building:

1. **Lack of Green Spaces:**
   - Analysis: The Tahrir Complex lacks green spaces, both inside and outside the building. The heavy reliance on concrete structures and artificial materials has led to a dry and uninspiring work environment.
   - Biophilic Solution: Introducing green spaces within the building, such as indoor gardens or green walls, could significantly enhance the interior environment. Additionally, the surrounding environment can be improved by planting trees and greenery in the nearby plazas.

2. **Insufficient Natural Lighting:**
   - Analysis: The building suffers from a lack of natural lighting due to its enclosed design and the use of small or non-existent windows in some areas.
   - Biophilic Solution: Improving the window design by increasing their size and using transparent glass that allows more natural light to enter can enhance the quality of interior lighting and reduce reliance on artificial lighting.

3. **Ventilation Issues:**
   - Analysis: The building often experiences inadequate ventilation, leading to the accumulation of hot air and pollutants in certain areas, which negatively impacts the comfort and health of employees.
   - Biophilic Solution: Natural ventilation can be improved by designing appropriate ventilation openings or using advanced ventilation techniques to enhance the flow of fresh air within the building.

4. **Temperature Control and Energy Consumption:**
   - Analysis: The building struggles with temperature control, leading to high energy consumption, particularly during the summer months when cooling is needed.
   - Biophilic Solution: Using insulating building materials and thermal insulation techniques, such as green roofs, can help reduce high temperatures inside the building and lower energy consumption.

By applying these biophilic design strategies, the Tahrir Complex can improve environmental comfort, enhance the well-being of its occupants, and become a model of sustainable and human-centered architecture.

Conclusion:

By adopting biophilic design strategies, both Maspero Building and the Tahrir Complex can experience enhanced environmental comfort, improved well-being of occupants, and greater energy efficiency. These changes not only address existing architectural deficiencies but also contribute to the sustainability and resilience of urban environments. Implementing these principles serves as a model for future architectural projects, promoting healthier and more sustainable buildings in Egypt and beyond.

Results:

1. Biophilic design is not merely a theoretical concept, but a practical approach that can be applied to achieve multiple benefits at the environmental, economic, and social levels.
2. Biophilic design achieves a balance between architectural aesthetics, functional needs, and environmental requirements of buildings, thereby enhancing the aesthetic and environmental values of the built environment.
3. Integrating natural elements into architectural design enhances the psychological and physical well-being of users. For example, the presence of plants, natural light, and natural views reduces stress levels, improves mood, and increases feelings of comfort.
4. Spaces based on biophilic design enhance creativity and productivity among workers and students, contributing to improved overall individual performance.

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