

# Biophilic Design Avant la Lettre: Japanese Edo-Period Residential Architecture

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# Abstract

This thesis investigates how Edo-period (1603–1868) Japanese residential architecture intuitively embodies biophilic design principles, centuries before the term was formally defined, offering potential insights for contemporary sustainable and health-supportive housing. Biophilic design, which emphasises the integration of natural elements into built environments, has been shown to support mental well-being by reducing stress, enhancing mood, and improving cognitive function. While the concept has received growing attention in recent decades, traditional architectural styles often incorporated nature in ways that closely aligned with these principles. This study explores that relationship through a comparative analysis of modern biophilic frameworks and Edo-period design.

Using the theoretical framework developed by Zhong et al. (2021), which defines biophilic design through three strategies and eighteen elements, this research applies a visual-analytical method to evaluate two case studies: the Katsura Imperial Villa and the Aizu Samurai Residence. These case studies were selected for their architectural richness and representation of elite social classes, allowing for detailed exploration of material use, spatial organisation, and connection to nature.

The findings reveal a strong alignment between Edo-period residential design and modern biophilic strategies, including features such as open indoor-outdoor transitions, use of natural materials, seasonal responsiveness, and patterns inspired by nature. While certain aspects of contemporary biophilic design, such as technological interventions or explicit biomorphic symbolism, were not present, the core principles were inherently embedded in historical design practices. These findings highlight the relevance of Edo-period architecture as an early example of biophilic design *avant la lettre*, and suggest its continued value as a source of inspiration for contemporary housing strategies that aim to reconnect people with nature in urban contexts.

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# Introduction

Biophilic design is an architectural approach that seeks to enhance human well-being by integrating natural elements into built environments. Research has shown that incorporating nature and greenery into architecture can positively impact mental health, reducing stress and improving overall quality of life (Söderlund & Newman, 2015). As cities become more urbanised and disconnected from nature, architects are increasingly incorporating biophilic design principles, such as natural materials, daylight and vegetation, into their designs to benefit both residents and the environment. However, the concept of integrating nature in architecture is not new. Many traditional architectural styles have long embraced human-nature connections as a core design principle.

Edo-period (1603–1868) Japanese residential architecture is particularly known for its focus on the balance between humans and nature. Characterised by wooden structures, open spaces, natural ventilation, and seamless indoor-outdoor transitions, Edo-period homes appear to reflect biophilic principles long before the term was formally introduced. As such, they exemplify biophilic design *avant la lettre*, intuitively applying nature-based strategies centuries before their formal recognition in architectural theory. This historical parallel prompts a broader question: what can contemporary architecture learn from these early nature-integrated designs?

Previous studies have explored biophilic design principles (Zhong et al., 2021), their relationship to mental health (Alam, 2023), and characteristics of traditional Japanese architecture (Morse, 1885). However, few have examined the connection between Edo-period residential design and biophilic strategies aimed at supporting mental well-being. Addressing this gap, this thesis investigates how historical architectural practices can inform modern biophilic housing. By analysing Edo-period residential architecture, it aims to bridge traditional architectural knowledge with contemporary biophilic design strategies, offering insights into sustainable, health-supportive living environments. In light of growing urban mental health concerns, revisiting traditional housing models may offer fresh perspectives on biophilic design. It suggests that strategies now associated with mental well-being were already embedded in premodern architecture, highlighting that architectural history offers not only cultural insights but also practical solutions to contemporary challenges.

The methodology consists of a literature review and comparative analysis. Research on biophilic design (e.g., Kellert et al., 2008; Zhong et al., 2021) establishes the theoretical framework, while historical sources (e.g., Morse, 1885; Cooper, 2009; Ōkawa, 1975) provide an overview of Edo-period residential architecture. This framework is then used to evaluate the extent to which Edo-period architectural elements reflect biophilic design strategies. The study will also include case studies of the Katsura Imperial Villa and the Aizu Samurai Residence to illustrate the application of biophilic principles in historical architecture. The case studies are analysed through visual-spatial interpretation, focusing on architectural features rather than user-based or psychological data.

This thesis is structured as follows: Chapter 1 introduces the theory of biophilic design, its architectural applications, and its connection to mental well-being. Chapter 2 provides an overview of the architectural elements of Edo-period residences. Chapter 3 analyses biophilic elements within these traditional homes through selected case studies. The final chapters present results, conclusions, and offer recommendations for applying these principles in contemporary architectural practice.

By linking biophilic design and traditional Japanese architecture, this research aims to provide architects with alternative strategies that support mental well-being and promote environmental sustainability in contemporary residential design. It argues that Edo-period homes exemplify biophilic design *avant la lettre*, intuitively applying nature-based principles centuries before their formal definition.

# Chapter 1: Theory of Biophilic Design

Biophilic design is an architectural approach that integrates natural elements into built environments to foster human well-being. This chapter explores the theoretical foundations of biophilic design, beginning with its historical origins and definition before examining its core principles and practical applications. It also addresses the psychological and physiological impacts on human well-being, drawing on scientific theories and empirical research.

## 1.1 History and definition

The concept of biophilic design originates from the term ‘biophilia’, first introduced by social psychologist Erich Fromm in 1964 (Zhong et al., 2021). Fromm described biophilia as the “love of life”, referring to the tendency of living organisms to sustain life by avoiding death threats and positively interacting with each other. However, it was Edward O. Wilson (1984, p. 1) who later popularised the term, defining it as the “innate tendency to focus on life and lifelike processes” and “the innately emotional affiliation of human beings to other living organisms.”

Building on this, social ecologist Stephen Kellert (1993) identified nine biophilic values: utilitarian, naturalistic, scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic, and negativistic. These values provided a structured way to understand human-nature interactions and laid the foundation for the development of biophilic design as a formal architectural approach.

At the beginning of the 21st century, the term ‘biophilic design’ emerged as architects and researchers explored ways to integrate natural elements into the built environment to meet the innate human need for interaction with nature (Zhong et al., 2021). This shift was driven by growing awareness of the psychological, physiological, and environmental benefits of reconnecting people with nature in urban settings. Since then, biophilic design has evolved into a structured architectural approach that aims to enhance well-being, productivity, and sustainability through nature-based strategies.

## 1.2 Principles & practice

Understanding biophilia as a concept is only the first step; integrating it into architectural design requires clear guidelines. Kellert (2018) formalised this transition by establishing principles that define how built environments can effectively foster human-nature interactions, as shown in Figure 1. Based on the concept of biophilia, he identified eight biophilic values: affection, attraction, aversion, control, exploitation, intellect, symbolism and spirituality. Building on these values, Kellert defines the goal of biophilic design as “creating good habitat for people as biological animals” (p.17). He also outlined nine principles to ensure the successful application of biophilic design, emphasising human interaction with authentic, integrated natural environments that promote physical and mental well-being, foster a sense of community and create emotional connections to spaces and landscapes.

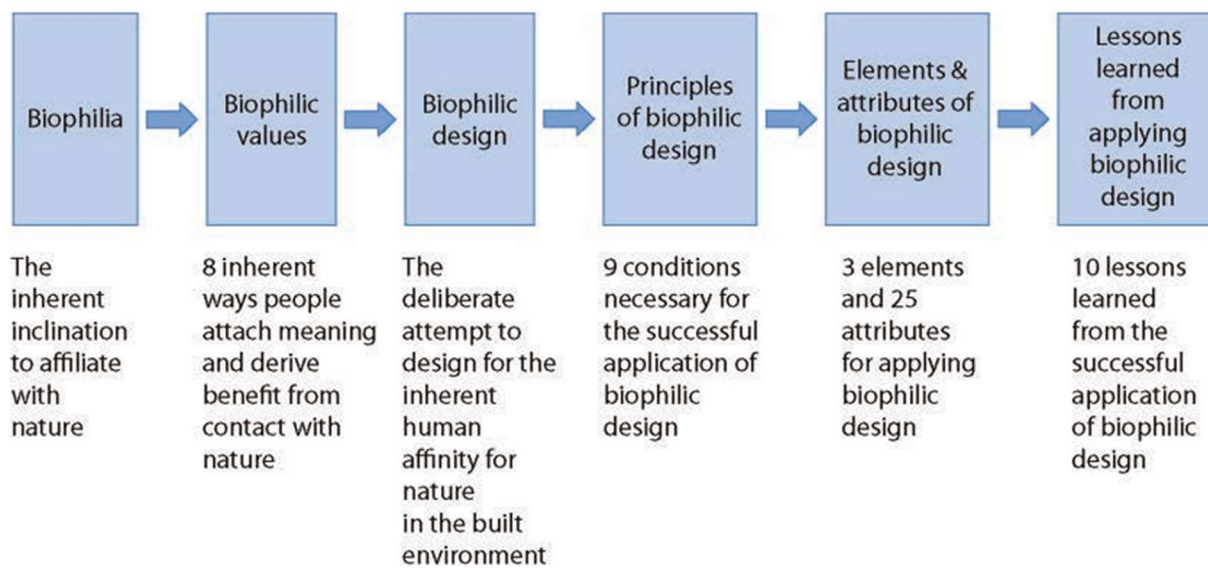


Figure 1: The relation between biophilia and biophilic design (Kellert, 2018)

Since the goal of biophilic design is to create a good habitat for people as biological animals, simply adding natural elements to a built environment is not enough (Kellert, 2018). To achieve this, biophilic design must go beyond superficial additions, embracing a holistic approach that responds to the inherent human inclination to affiliate with the natural world. To translate biophilic design principles into practice, Kellert developed a framework consisting of 3 elements and 25 attributes (Figure 2).

3 Experiences and 25 Attributes of Biophilic Design (Kellert, 2018)		
1. Direct Experience of Nature	2. Indirect Experience of Nature	3. Experience of Space and Place
<ul style="list-style-type: none"> <li>• Light</li> <li>• Air</li> <li>• Water</li> <li>• Plants</li> <li>• Animals</li> <li>• Landscapes</li> <li>• Weather</li> <li>• Views</li> <li>• Fire</li> </ul>	<ul style="list-style-type: none"> <li>• Images</li> <li>• Materials</li> <li>• Texture</li> <li>• Color</li> <li>• Shapes and forms</li> <li>• Information richness</li> <li>• Change, age and the patina of time</li> <li>• Natural geometries</li> <li>• Simulated natural light and air</li> <li>• Biomimicry</li> </ul>	<ul style="list-style-type: none"> <li>• Prospect and refuge</li> <li>• Organized complexity</li> <li>• Mobility</li> <li>• Transitional spaces</li> <li>• Place</li> <li>• Integrating parts to create wholes</li> </ul>

Figure 2: Framework of biophilic design by Kellert 2018 (Zhong et al., 2021)

Later, Zhong et al. (2021) conducted a review of multiple biophilic design frameworks, including the one from Kellert, synthesising them into a unified model comprising three design strategies that together encompass eighteen elements (Figure 3).

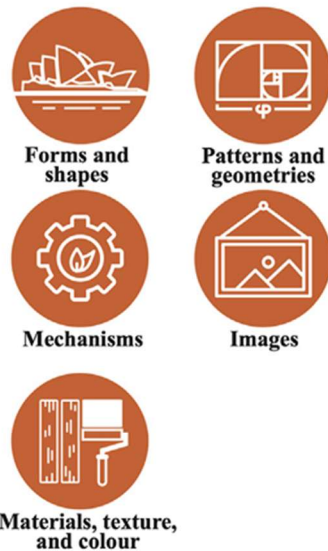
### NATURE INCORPORATION

Bring in or artificially create natural elements, phenomena, and processes, and emphasise them through multi-sensory experiences.



### NATURE INSPIRATION

Imitate nature (often known as 'biomimicry') and evoke the sense of nature through the delicate placement of natural features.



### NATURE INTERACTION

Arrange spaces based on evolved human-nature relationships to experience nature-like environments and establish connections with the natural system or between various spaces.



Figure 3: Biophilic design framework (Zhong et al., 2021)

## 1.3 The psychological basis of biophilic design

Rapid urbanisation has led to built environments that lack natural elements, contributing to stress, anxiety and cognitive fatigue (Söderlund & Newman, 2015). Biophilic design counteracts these effects by integrating natural features such as daylight, greenery, water and organic materials into architecture.

Environmental psychology provides key theories explaining why natural environments benefit cognition and emotional health (Söderlund & Newman, 2015):

- Stress Recovery Theory (SRT): Ulrich (1984) suggests that exposure to nature promotes physiological relaxation, leading to lower cortisol levels (indicating less stress), reduced heart rates and decreased anxiety.
- Attention Restoration Theory (ART): Kaplan & Kaplan (1989) propose that natural settings help restore cognitive resources, reducing mental fatigue and improving focus.

These theories demonstrate the restorative benefits of biophilic environments, which have been applied in architectural design to enhance mental well-being (Söderlund & Newman, 2015). In Edo-period architecture, both theories are relevant, as traditional homes and gardens promoted relaxation (SRT) and attention restoration (ART) through natural elements, visual harmony and sensory engagement.



## 1.4 Biophilic Design Strategies and Their Mental Health Benefits

Numerous studies confirm that specific biophilic strategies—such as the use of natural light, greenery, water features, organic materials, and spatial design—have measurable benefits for human health by reducing stress, enhancing mood, and supporting cognitive function (Söderlund & Newman, 2015; Alam, 2023). The following examples illustrate how various biophilic strategies contribute to measurable mental health benefits.

- **Daylight** regulates circadian rhythms, improving sleep quality and reducing stress and seasonal affective disorder (SAD) (Alam, 2023). Hospitals with abundant daylight show lower rates of depression and pain, along with improved well-being and faster recovery times (Söderlund & Newman, 2015; Ulrich, 1984).
- **Plants and greenery** lower cortisol levels, enhance cognitive performance and improve mood stability (Alam, 2023). Offices with greenery see a 15% rise in productivity, while schools with natural areas report higher student concentration and reduced stress (Söderlund & Newman, 2015).
- **Water elements**, such as fountains and ponds, have a calming effect, reducing anxiety and psychological distress (Söderlund & Newman, 2015). Natural soundscapes, like the sound of water or birds, further enhance cognitive restoration (Alam, 2023).
- **Natural materials** such as wood, stone, and bamboo reduce stress and enhance relaxation (Kellert, 2018). Biomorphic designs—curved, nature-inspired forms—promote positive emotional responses (Kellert, 2018).
- **Prospect and refuge**: Environments balancing open views (prospect) with enclosed, safe areas (refuge) foster psychological security and relaxation (Söderlund & Newman, 2015). According to Appleton's Prospect-Refuge Theory, individuals feel safest when they can observe their surroundings from a secure place, as both elements together create the most comforting experience.

Biophilic strategies have been shown to reduce stress, improve cognitive function, and enhance emotional resilience. Given that Europeans and Americans spend approximately 14.0 to 15.8 hours per day indoors at home (Brasche & Bischof, 2005; Schweizer et al., 2006)—not including additional time spent indoors at workplaces or other settings—the integration of these principles into contemporary architectural design holds significant potential for promoting mental well-being.

This chapter outlined the foundations of biophilic design, from its historical origins in the concept of biophilia to its key principles and psychological benefits. The theoretical framework proposed by Zhong et al. offers a structured approach for integrating natural elements into the built environment to support human well-being. These principles form the basis for the following analysis of traditional Japanese residential architecture, enabling an assessment of how Edo-period designs align with biophilic strategies.



## Chapter 2: Residential Japanese Edo-period architecture

While the previous chapter explored the principles of biophilic design and its impact on mental well-being, this chapter examines the architectural characteristics of Edo-period (1603–1868) Japanese residences. These characteristics provide the foundation for the analysis in Chapter 3, where Edo-period residences are evaluated against the biophilic design principles introduced in Chapter 1.

### 2.1 Overview of Edo-period and its architectural context

The Edo period (1603–1868), also known as Tokugawa or "pre-modern" Japan (Kinsei), was a transformative era under the Tokugawa shogunate, marked by peace and stability (Louis-Frédéric, 2002). This stability allowed for urban and economic growth, particularly in cities like Edo (modern Tokyo), Osaka, and Kyoto, where the merchant class flourished and commercial activity contributed to prosperity (Flath, 2000). During this time, a distinctive urban culture emerged, with the merchant and samurai classes coexisting and fostering developments in arts, literature, and entertainment (Nishiyama, 1997). The architecture and urban planning of the period reflected this social stratification, emphasising both functionality and aesthetic simplicity in public and private spaces.

The most common residential architectural style during the Edo period was *Sukiya-zukuri*, which blends elements of the preceding style, *Shoin-zukuri* architecture, and teahouse styles (Itoh & Futagawa, 1972). *Shoin-zukuri* architecture, initially used in the residences of the military elite and monasteries, emphasises formal, elegant design with large, magnificent reception areas suitable for hosting guests and ceremonies. In contrast, *Sukiya-zukuri* architecture is less formal and encompasses various building types, including private dwellings, villas, and restaurants. Known for its refined and elegant aesthetics, *Sukiya-zukuri* focuses on simplicity, modesty, and a deep connection to nature.

### 2.2 Key architectural characteristics of Edo-period residences

Based on the book "Japanese homes and their surroundings" (Morse, 1885), the characteristics of a traditional Japanese house have been established.

Materials & construction:

- **Wood as the primary material:** Edo-period homes were constructed mainly from wood, with minimal use of nails, favouring traditional joinery techniques.
- **Lightweight and flexible structures:** buildings were designed to withstand earthquakes by using a framework of wooden posts and beams.
- **Thatched, tile or wooden shingle roofs:** roofs varied by region and class, with wealthier homes featuring heavier, more durable materials.
- **Paper and bamboo elements:** partitions, sliding doors and windows were often made with bamboo frames and translucent paper.

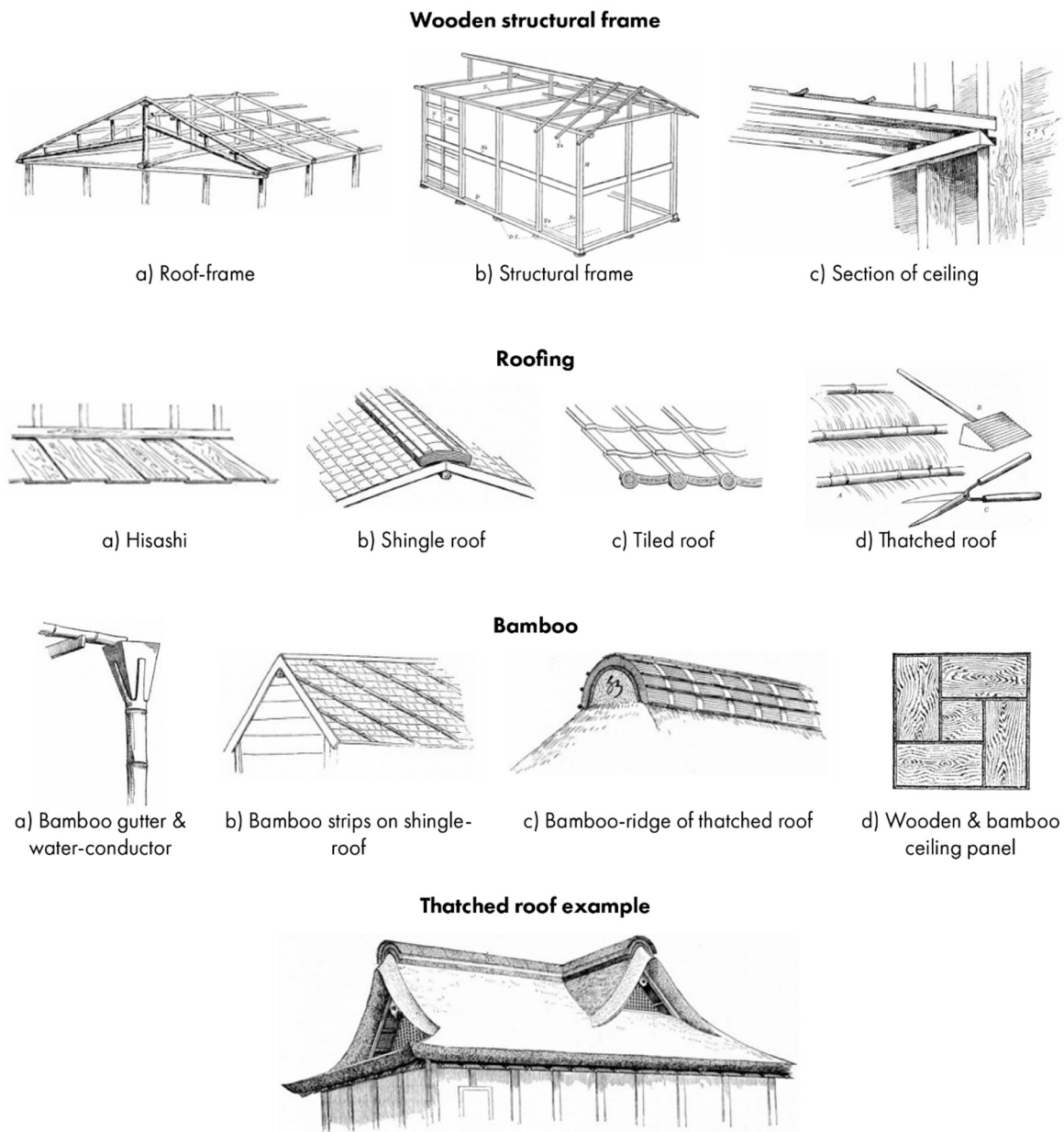


Figure 4: Characteristics of Edo-period residences – materials & construction (Morse, 1885)

#### Structural elements:

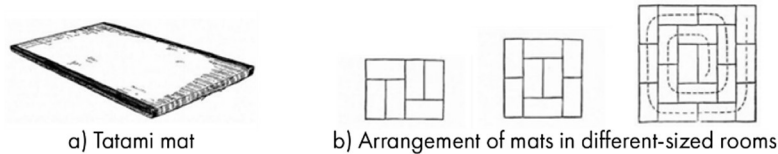
- **Post-and-beam construction:** a flexible structural system allowing for open spaces and earthquake resistance.
- **Raised floors:** houses were elevated to protect against moisture, pests and flooding.
- **Eaves and deep overhangs:** extended roofs provided shade and protection from rain while allowing cool air to circulate.

#### Interior & spatial layout:

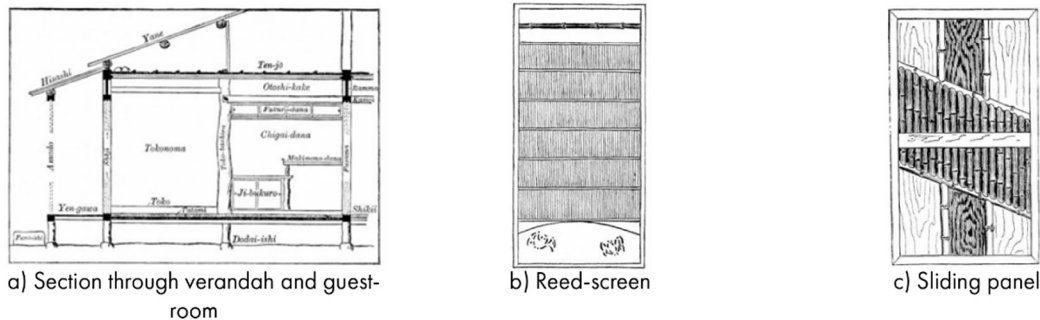
- **Shōji & Fusuma:** these are sliding doors that allow for flexible room arrangements and connection to the outdoors.
  - *Shōji* are the outside screens and windows which are covered with paper to allow diffused light to shine inside the room.
  - *Fusuma* are partitions between rooms which are covered in thick, opaque paper.

- **Tatami flooring:** rooms were covered with woven straw mats (*tatami*) of 0.88x1.76 meter, establishing fixed room proportions and a modular layout. In the arrangement of the mats, it is ensured that four corners never come together in one place.
- **Tokonoma & chigai-dana recesses:** recessed spaces in the main or guest room.
  - *Tokonoma* are open recesses with a higher floor used for displaying art, calligraphy or flower arrangements, emphasising aesthetics and seasonal changes.
  - *Chigai-dana* are low recesses containing variations of shelves and cabinets that can be enclosed by sliding doors.
- **Minimalist furnishings:** interiors were kept simple, with low furniture, floor cushions, and storage spaces integrated into walls.

#### Tatami flooring



#### Shōji & Fusuma



#### Tokonoma & chigai-dana

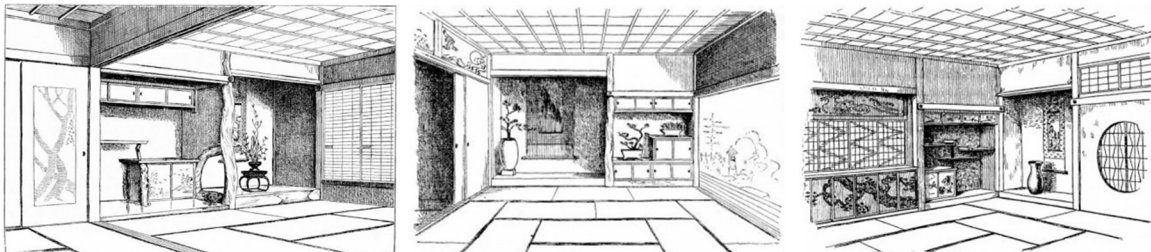
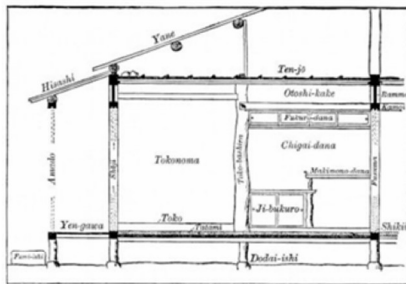


Figure 5: Characteristics of Edo-period residences – interior & spatial layout (Morse, 1885)

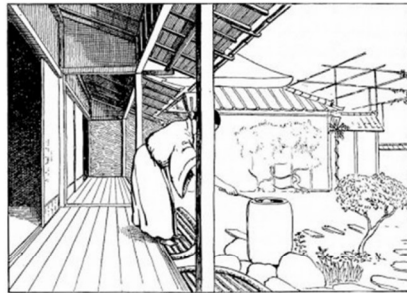
#### Relationship with the outdoors:

- **Engawa (verandah-like corridor):** the *engawa* served as a transitional space between the house and garden, providing shelter from rain and heavy weather. It is almost a continuation of the interior floor, raised above the ground, typically about 1 meter wide, and has no outer rail (except in noble residences).
- **Gardens:** Japanese gardens are designed with artistic precision, emphasising cleanliness, simplicity, and enduring beauty. Even a small ten-foot plot can be arranged with evergreen shrubs, stone lanterns (*ishi-dōrō*), rustic fences, and carefully placed flowers. Larger gardens incorporate ponds, flowing water, small bridges, and miniature hills, creating a tranquil landscape.
- **Arrangement of spaces:** the best rooms of the house face the garden in the rear of the house, while the kitchen is situated on the side of the house that is next to the street.
- **Open and flexible design:** with large windows, sliding doors and removable walls that maximise natural light and ventilation while allowing spaces to adapt to changing seasons.

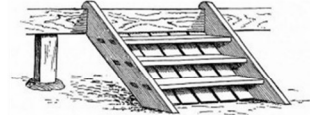
## Verandah



a) Section through verandah and guest-room



b) Verandah example



c) Steps to verandah

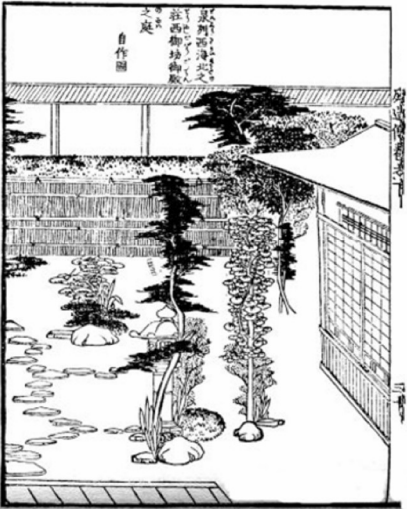
## Gardens



c) Garden of a merchant



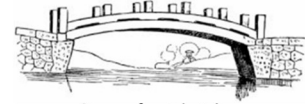
d) Garden of a daimio



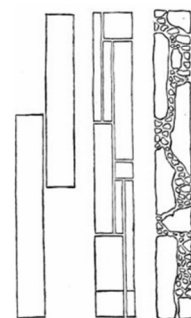
Garden tablet



Ishi-dōrō



Stone foot-bridge



Various forms of garden paths

Figure 6: characteristics of Edo-period residences – relationship with the outdoors (Morse, 1885)

This chapter detailed the architectural characteristics of Edo-period residences, highlighting their materials, structural elements, interior layouts, and relationship with the outdoors. These features reflect a deep connection with nature and a focus on simplicity and functionality. In the next chapter, the inherent biophilic qualities of these traditional designs will be analysed to understand how they align with modern biophilic design principles.

## Chapter 3: Biophilic design in residential Edo-period Japanese architecture

This chapter explores the extent to which Japanese residential architecture from the Edo period aligns with the biophilic design principles introduced in Chapter 1. Using the framework developed by Zhong et al. (2021), the architectural characteristics outlined in Chapter 2 are analysed through a visual-analytical method to assess how they reflect biophilic strategies. To support this investigation, two case studies of historical Japanese residences have been selected.

These case studies represent the residences of the two most influential social classes during the Edo period, selected for their architectural richness and cultural significance. As members of the elite, both groups possessed the economic and aesthetic means to commission carefully designed homes that embodied key Edo-period values.

- The imperial family: *Katsura Imperial Villa*, Kyoto
- The samurai class: *Aizu Samurai Residence (Aizu Bukeyashiki)*, Aizuwakamatsu City

The analysis suggests that these historical buildings intuitively employed nature-based strategies that contemporary theory would later formalise, demonstrating *biophilic design avant la lettre*. The findings aim to show how Edo-period design approaches can inform and inspire contemporary residential architecture in ways that may support mental well-being through biophilic design.

### 3.1 Case Study 1: Katsura Imperial Villa

*Katsura Imperial Villa* is an architectural complex in southwestern Kyoto, situated along the Katsura River (Okawa, 1975). Constructed over forty years, beginning in 1620, the villa was built by two generations of the Hachijo family: Prince Hachijo Toshihito and his son, Prince Noritada.

This residence exemplifies the *Sukiya-zukuri* residential architecture style from the Edo period, which emphasises natural elements and a deep connection to nature (Itoh & Futagawa, 1972).

The photographs in Figures 7, 8, and 9 depict architectural features of the Katsura Imperial Villa, showcasing how its exterior, interior, and gardens reflect biophilic design strategies.

Figure 7 illustrates the exterior architecture, highlighting the use of natural materials such as wood and paper, along with extended eaves and the *engawa*. These elements support biophilic features such as *prospect and refuge*, *weather*, *materials*, *texture*, and *colours*, and the *connection of spaces*.

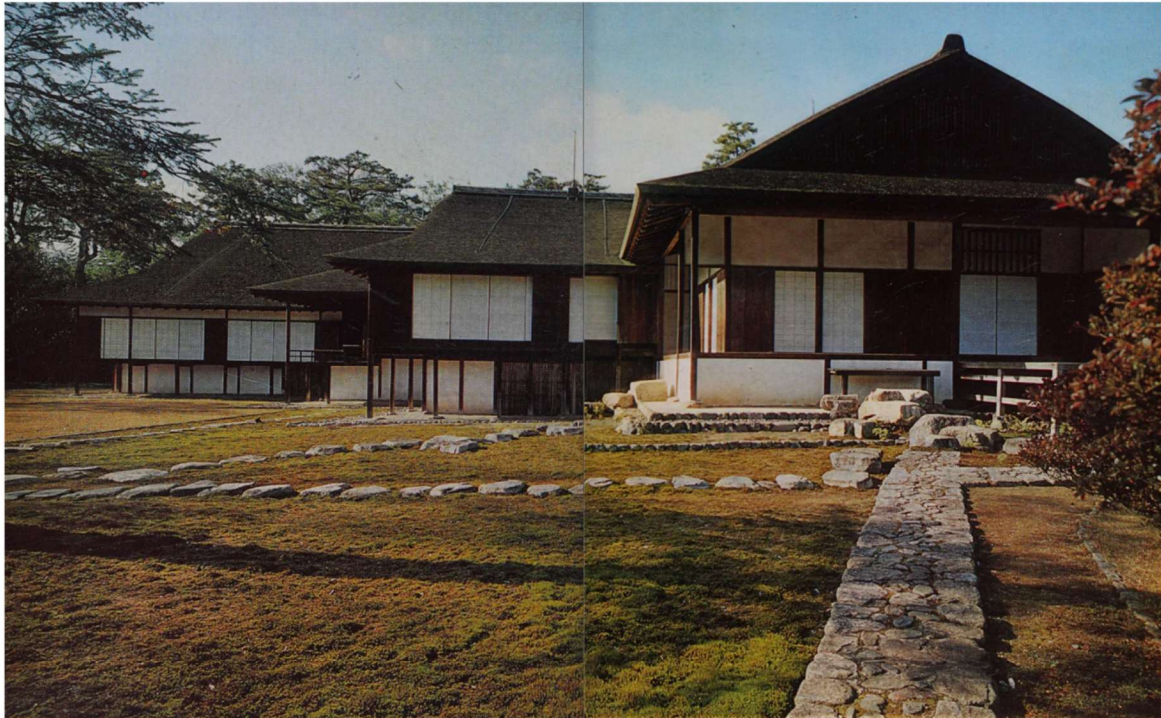
Figure 8 presents the minimalist interior layout, featuring *shōji* and *fusuma* screens made of wood and paper that diffuse natural light, tatami flooring with rhythmic patterns, *tokonoma* and *chigai-dana* recesses with natural ornamented shelves, and open sightlines to the surrounding nature. These features contribute to *daylight*, *materials and textures*, *forms and shapes*, *complexity and order*, and *sensory engagement*.

Figure 9 focuses on the gardens, where water features, stone lanterns, stone arrangements, curated vegetation, and asymmetrical paths exemplify biophilic qualities such as *landscape*, *plants*, *water*, *enticement* and *time and seasonal changes*.

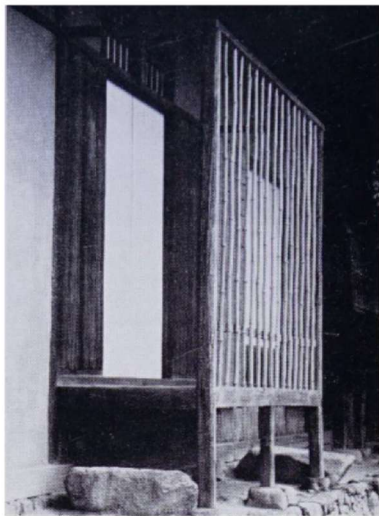
Together, these images show that Katsura Imperial Villa demonstrates several implementations of biophilic design elements.



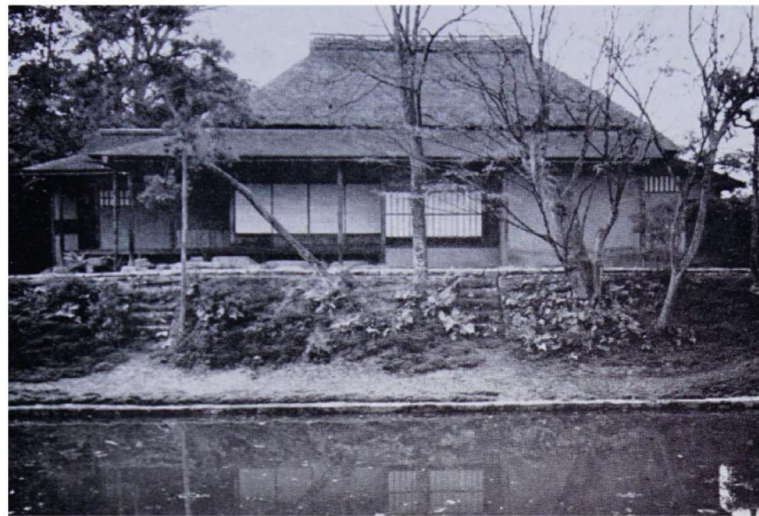
# Katsura Imperial Villa - exterior



Southeastern side of New Shoin, Middle Shoin & Old Shoin (left to right) — with thatched pitched roofs, wooden constructions, paper shōji screens, raised floors, engawas and a garden with grass, stone paths & greenery



Bamboo mullions at edge of veranda

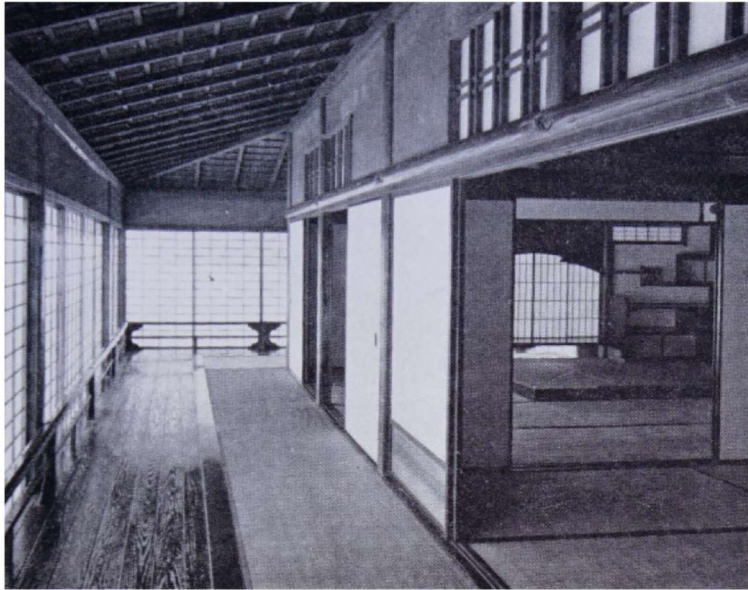


Nothern side of Shoi-ken teahouse — with thatched pitched roof, shōji screens, along the water among greenery

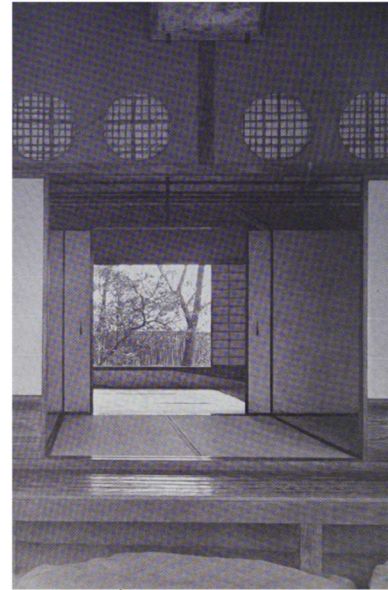
Figure 7: Photos from Katsura Imperial Villa – exterior (Okawa, 1975)



# Katsura Imperial Villa - interior



Interior of New Shoin with enclosed veranda — with wooden structures, tatami flooring, chigai-dana recess (right) & shōji and fusuma screens of paper



Interior of Shoi-ken teahouse — with tatami flooring & fusuma screens



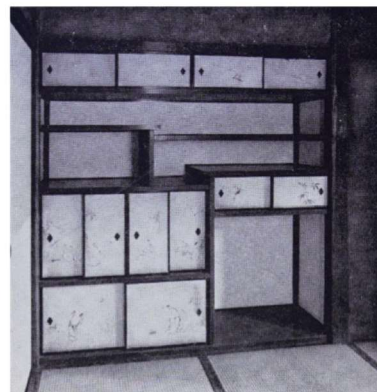
Interior of Old Shoin — with tatami flooring, open tokonoma recess (right) & shōji and fusuma screens of wooden frames and translucent paper



Shōji screens & garden and pond view



Engawa view of Shoka-tei teahouse



Chigai-dana recess with shelf arrangement in dressing room



Ornamental fittings on chigai-dana (shelves)

Figure 8: Photos from Katsura Imperial Villa – interior (Okawa, 1975)



# Katsura Imperial Villa - gardens



Nothern exposure of Shokin-tei teahouse — a landscape with a pond, stone arrangements, gravel, stone lanterns, trees, grass & other greenery



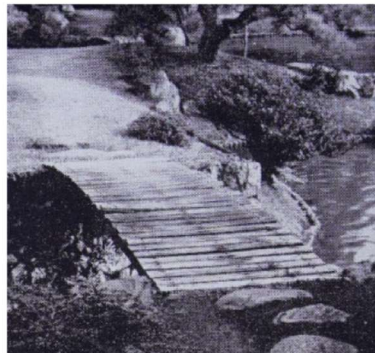
A variety of stone bridges at Kasura



Stone lantern at tip of cobblestone



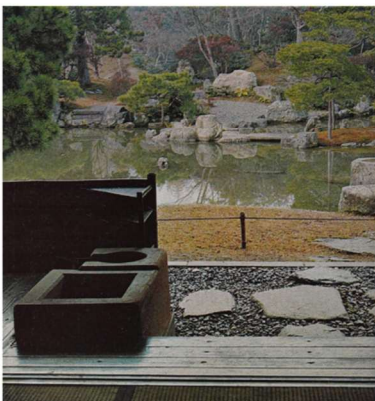
Stone bridge — surrounded by water, stone arrangements & greenery



Plank bridge — surrounded by water, greenery & stepping stones



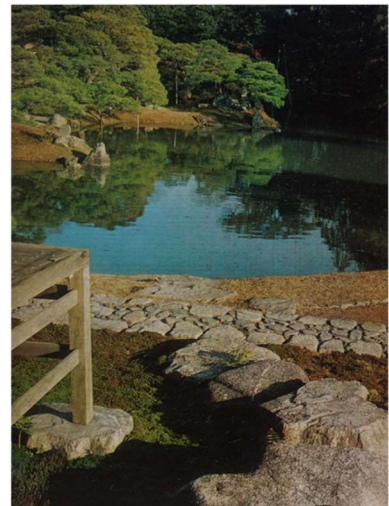
Bamboo hedge surrounding villa grounds



Garden view — with engawa, stepping stones, gravel, greenery, water & stones



Garden view — with raised flooring, greenery, stepping stones & gravel



Stone walkway and steppingstones beside the moon-viewing platform and pond (Old Shoin)

Figure 9: Photos from Katsura Imperial Villa – gardens (Okawa, 1975)



## 3.2 Case Study 2: Aizu Samurai Residence

The *Aizu Samurai Residence (Aizu Bukeyashiki)* is a reconstructed Edo-period mansion located in Aizuwakamatsu City, Fukushima Prefecture. Originally the home of Saigō Tanomo (1830–1903), the chief retainer of the Aizu clan, it served as the residence of a high-ranking samurai family during the late Edo period (Jcastle, 2021; Japan Experience, 2018).

The estate comprises 38 rooms—including living quarters, offices, and reception spaces—providing insight into the lifestyle and architectural culture of the samurai elite (Japan Experience, 2018). Although the original structure was destroyed during the Boshin War (1868–1869), it was later faithfully rebuilt based on 18th-century records.

This case study was selected for its representation of high-ranking samurai residences, reflecting the political and social influence of this class and their means to construct generous homes.

The photographs in Figures 10, 11, and 12 depict architectural elements of the Aizu Samurai Residence, illustrating how its exterior, interior, and gardens align with biophilic design strategies.

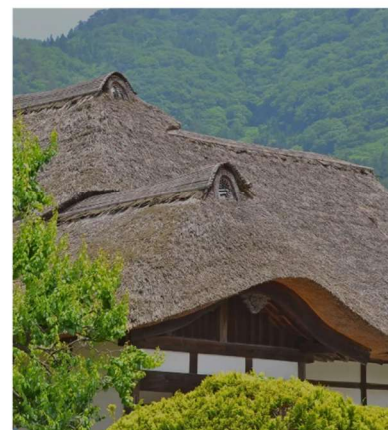
**Aizu Samurai Residence - exterior**



Entrance with tiled pitched roofs & wooden structures



Tiled pitched roofs, wooden structures, shōji screens to garden, raised floors, engawa & garden



Thatched pitched roofs & wooden structures

Figure 10: Photos from Aizu Samurai Residence – exterior (Aizu Samurai Residences, 2025; Jcastle, 2021)

### Aizu Samurai Residence - interior



Room with tatami flooring & shōji screens to garden



Room with minimal furniture, tatami flooring & shōji and fusuma screens of wooden frames and translucent paper



Room with tatami flooring, closed chigai-dana recess (left), open tokonoma recess (right) & decoration of landscape



Room used by people — with tatami flooring, tokonoma recess (right) & chigai-dana recess (left)



Tokonoma recess with open shelves & decoration of nature



Hallway with tatami flooring & wooden construction and roofing



Samurai armor

Figure 11: Photos from Aizu Samurai Residence – interior (Aizu Samurai Residences, 2025; Nori, 2010)



### Aizu Samurai Residence - gardens



Thatched roof, wooden construction, shōji screens, raised floors & engawa



Tiled roof, wooden construction, shōji screens, raised floors & garden with greenery



Connection of engawa with courtyard garden



Garden with various plants, stepping stones & a stone lantern

Figure 12: Photos from Aizu Samurai Residence – gardens (Aizu Samurai Residences, 2025; Nori, 2010)

Figure 10 shows the use of natural materials such as wood and earth-toned finishes, along with deep roof overhangs and a raised wooden platform. These features support biophilic elements, including *natural materials*, *weather responsiveness*, and *connection to place*.

Figure 11 reveals interior features such as *shōji* and *fusuma* sliding screens and tatami flooring, which encourage *spatial flexibility*, *sensory engagement*, and (indirect) exposure to *daylight*. The rhythmic layout of tatami mats and sliding partitions introduces *patterns and geometries*, while the *tokonoma* and *chigai-dana* recesses, often adorned with nature-themed decorations, add visual interest through asymmetry and biomorphic *forms and shapes*. These features collectively contribute to a refined sense of *complexity and order*, rooted in nature-inspired design.

Figure 12 presents a carefully composed garden landscape—featuring plants, stones, and winding paths—that reflects biophilic elements such as *plants*, *landscape*, *enticement*, and

*seasonal awareness*. The open façade and the *engawa* facilitate passive ventilation (*air*) and maintain a visual connection with the surrounding landscape.

Together, these images show that Aizu Samurai Residence demonstrates several implementations of biophilic design elements.

### 3.3 Biophilic Design Elements in Edo-period Residences

Table 1 presents a comparative analysis between the architectural characteristics of Japanese Edo-period residences, as described by Morse (1885) in Chapter 2, and the modern biophilic design elements (BDEs) defined by Zhong et al. (2021) in Chapter 1. The analysis is supported by the two case studies, Katsura Imperial Villa and Aizu Samurai Residence, which serve to illustrate the practical implementation of these elements (Figures 7–9 and Figures 10–12).

Table 1: Implementations of biophilic design strategies (Zhong, et al. 2021) in Japanese Edo-period residential architecture (Morse, 1885)

Biophilic Design Elements (BDEs)	Implementations of the Design Strategies
<b>Water</b>	Edo-period gardens incorporated ponds, bridges, stone basins ( <i>tsukubai</i> ) and controlled water movement.
<b>Air</b>	<i>Shōji</i> and <i>fusuma</i> sliding doors and <i>engawa</i> facilitated natural ventilation.
<b>Daylight</b>	<i>Shōji</i> screens diffused natural light, creating soft, indirect illumination that reduced glare and enhanced visual comfort. Sliding doors created large openings that allowed plenty of natural light to enter.
<b>Plants</b>	The surrounding gardens integrated plants into the built environment. Inside, flowers and plants were displayed in vases.
<b>Animals</b>	The gardens attracted birds and insects, fostering an ecological connection within the residential environment.
<b>Landscape</b>	Carefully curated garden landscapes with miniature hills, stone arrangements, winding paths, and water elements reflected natural landscapes.
<b>Weather</b>	Deep eaves, <i>engawa</i> , and flexible wall openings allowed residents to experience rain, wind, temperatures and seasonal weather changes while remaining sheltered.
<b>Time and seasonal changes</b>	Architecture and gardens emphasized seasonal transitions, using deciduous plants and open layouts to capture shifting light and colours.
<b>Forms and shapes</b>	Curved bridges, asymmetrical garden paths, round windows, and organic spatial layouts mimicked biomorphic forms. Interior elements, such as shelves, door handles, and decorations, were designed in natural forms representing clouds, fog, water, flowers, and plants.
<b>Patterns and geometries</b>	<i>Tatami</i> mat layouts, wooden lattices, and rhythmic <i>shōji</i> panels demonstrated natural proportions and modularity.
<b>Mechanisms</b>	Wooden joinery allowed structures to flex during earthquakes, integrating resilience with natural materials.
<b>Images</b>	Paintings and carvings depicted natural elements and landscapes.

<b>Materials, texture, and colours</b>	Edo homes used natural materials like wood, bamboo, and paper, with warm, earthy colour tones.
<b>Prospect and refuge</b>	The <i>engawa</i> provided expansive views (prospect), while deep eaves, recessed alcoves ( <i>tokonoma</i> ), and enclosed rooms created intimate, sheltered areas (refuge).
<b>Complexity and order</b>	The interplay of structured interiors (tatami layout, wooden grids) and dynamic outdoor scenery balances complexity with harmony.
<b>Enticement (peril and mystery)</b>	Curved garden paths and translucent <i>shōji</i> screens create a sense of ‘mystery’.
<b>Connection to place</b>	Local materials, craftsmanship, and alignment with the surrounding landscape provided a cultural and ecological connection. Gardens with hills, stones, water, and plants represented complete landscapes.
<b>Connection of spaces</b>	The <i>engawa</i> , without railings, created a seamless transition between indoor and outdoor areas.

This chapter has demonstrated how Edo-period residential architecture embodies biophilic design principles. The case studies of the Katsura Imperial Villa and the Aizu Samurai Residence illustrate how traditional Japanese design intuitively integrated natural elements into the built environment. These examples show that Edo-period architecture incorporated biophilic strategies long before the concept was formally defined, representing an early expression of biophilic design *avant la lettre*. These findings suggest that historical architecture can offer valuable insights for contemporary practice, encouraging the design of health-supportive, nature-connected residential spaces.

## Results

This chapter presents the findings of the comparative analysis between Edo-period residential architecture and biophilic design principles. By examining the case studies, biophilic design elements found in traditional Japanese homes were identified. These findings reveal a strong alignment between Edo-period residences and contemporary biophilic strategies, particularly in their emphasis on natural materials, spatial fluidity, and integration with the surrounding environment.

The analysis of the *Katsura Imperial Villa* and the *Aizu Samurai Residence* confirms that Edo-period residential architecture reflected many biophilic design principles long before the concept was formally defined. Table 1 in Chapter 3 mapped biophilic elements onto specific architectural features. The most prominent themes observed across the case studies include:

- **Seamless Indoor-Outdoor Connection:** Open verandas (*engawa*), sliding doors (*shōji* and *fusuma*), and garden integration create a fluid relationship between indoor and outdoor spaces, potentially supporting mental well-being through increased exposure to natural elements.
- **Use of Natural Materials & Sensory Engagement:** Wood, paper, and bamboo provide a tactile connection to nature, with soft light through *shōji* screens enhancing visual comfort.
- **Seasonal Awareness & Dynamic Spaces:** Adaptable architectural features, such as removable walls and open-air corridors, enable a dynamic layout and enhance the experience of seasonal changes.
- **Water Features & Gardens:** Edo-period residences incorporate ponds, stone basins, and carefully curated gardens, embodying biophilic principles related to water and nature.
- **Prospect & Refuge:** Architectural layouts balance open views with enclosed, protective spaces, providing both visual engagement and psychological security.
- **Patterns, Forms & Shapes:** Rhythmic *tatami* mat layouts and *shōji* panels, geometric latticework, and biomorphic forms in gardens and furniture reflect natural order and complexity.

Although the two case studies were designed for residents of different social classes, they exhibit clear stylistic similarities. Both demonstrate a shared use of natural materials, open spatial layouts, and a strong integration with nature. However, they differ in scale and spatial emphasis: the Katsura Imperial Villa features an expansive, ceremonially oriented layout and a highly curated garden design, whereas the Aizu Samurai Residence presents a more modest architectural scale, characterised by refined detailing and intimate spatial relationships.

While Edo-period homes inherently integrate many biophilic strategies, certain aspects of contemporary biophilic design, such as the explicit application of biomorphic forms or the incorporation of technological systems for air and light regulation, were not present in historical examples.

Overall, the results demonstrate that Edo-period architecture aligns closely with biophilic design principles, particularly in its emphasis on nature integration, sensory engagement, and spatial adaptability. Although contemporary biophilic architecture has advanced through new technologies and materials, its foundational concepts remain evident in these historical precedents.



## Conclusion

This thesis explored how biophilic design principles are reflected in Edo-period residential architecture and their potential relevance for modern architecture and mental well-being. Through a comparative analysis of biophilic design and Edo-period homes—including case studies of the *Katsura Imperial Villa* and the *Aizu Samurai Residence*—this study found that traditional Japanese residences intuitively embodied biophilic design principles long before the concept was formally defined. These findings suggest that Edo-period architecture should be recognised as an early, intuitive form of biophilic design *avant la lettre*, offering potential insights for contemporary sustainable and health-oriented design. Through the use of natural materials, fluid indoor-outdoor transitions, and sensitivity to seasonal change, these historical residences anticipated many of the strategies now associated with enhanced well-being in modern biophilic design.

Key biophilic principles found in Edo-period homes include:

- Integration with nature through gardens, ponds, and open verandas.
- Use of natural materials such as wood, bamboo, and paper, creating tactile richness and visual comfort.
- Passive environmental design for air circulation, daylight control, rain protection and temperature regulation.
- Spatial flexibility with sliding doors and open floor plans allowing for dynamic use of space.
- Patterns, forms, and shapes through rhythmic structures, natural geometries and organic design elements, balancing order and complexity.

Although Edo-period architecture aligns well with biophilic design, some differences remain. Modern biophilic architecture often incorporates technological advancements, such as green roofs, artificial lighting strategies, and advanced ventilation systems, whereas traditional Japanese design relies purely on passive strategies.

These findings underscore the lasting relevance of traditional Japanese residential architecture, demonstrating its potential to inspire biophilic approaches in contemporary housing design. By revisiting historical architectural wisdom, modern practice can create environments that foster stronger connections with nature. Identifying Edo-period residences as examples of biophilic design *avant la lettre* highlights how premodern architecture can inform potentially more sustainable and health-supportive design today.

### Implications for Modern Architecture

Edo-period residences exemplify sustainable, nature-integrated design and offer valuable inspiration for contemporary biophilic architecture. Features such as the *engawa*, the use of natural materials, and adaptable interiors can be reinterpreted in modern housing. These principles can inform contemporary design approaches that aim to reconnect people with nature, potentially promoting sustainability, well-being, and a deeper sense of connection between residents and their environment.

### Limitations

The case studies focus on high-status dwellings, namely imperial villas and samurai homes, which may not reflect the living conditions of ordinary people in the Edo period. Consequently, the findings may overlook the simpler, more utilitarian designs of commoner dwellings.

Additionally, the historical context of Edo-period Japan differs from contemporary urban conditions. While traditional Japanese architecture offers valuable insights, its principles must be thoughtfully adapted to suit the complexities and constraints of modern urban environments.

### **Recommendations**

For future research, it would be valuable to develop practical biophilic design guidelines based on Edo-period principles for implementation in contemporary housing. These guidelines could provide architects and designers with actionable strategies to integrate Edo-based architectural elements into modern residential environments, potentially enhancing mental well-being and sustainability.

Additionally, this research could be further extended by examining a broader range of case studies and investigating additional applications of residential Edo-period architecture. By exploring diverse examples, researchers can gain a deeper understanding of how traditional Japanese design principles can be adapted to various contemporary contexts.

Finally, this type of research could be applied to other *avant la lettre* biophilic architectures, such as Chinese courtyard houses, Swiss chalets, or Scandinavian wooden homes. These architectural styles also emphasise harmony with nature, use of local materials, and climatic responsiveness, offering insights into biophilic design practices across different regions and historical periods. Comparative studies could reveal universal principles of biophilic design and inspire innovative approaches to creating potentially health-supportive, sustainable living environments worldwide.

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