
Sustainable Spaces: Circularity, Biophilia, and Culture in Expo Osaka 2025 Pavilions

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Abstract

This paper examines how key components within sustainability—circularity, biophilia, and culture—were demonstrated at Expo Osaka 2025. Four national pavilions were carefully selected from attending countries: Switzerland, Germany, China, and Italy, all of which exemplified unique, future-forward approaches to sustainable design through architectural means. The primary focus of this paper was to examine how architects have called for action in addressing the pressing ecological challenges of the 21st century, aligning with Expo Osaka's overarching theme of "Designing a Future Society for Our Lives."

This paper incorporates primary and secondary research to investigate, firstly, how the pavilion's architects attempted to depict the overarching theme of sustainability, and secondly, what the visitors experienced and felt about each selected pavilion. This was achieved through thematic analysis of case studies on selected countries' pavilions, on-site fieldwork, and interviews with visitors.

This research suggests that the future lies in sustainable architecture, where the three subcategories of circularity, biophilia, and cultural identity converge to allow people to build and interact with the world more effectively. This research unpacks the concept of sustainability by analyzing the above subcategories, defining the current and future directions of living.

Keywords: sustainability, Expo 2025, circular economy, biophilic design, culture, sustainable architecture, architectural case studies

1. Introduction

Japan was the host country for the World Expo 2025 in Osaka prefecture. The pavilions showcased the official participants' nations' attitudes on innovations and concepts at the Expo. One of the World Expo's primary purposes is to serve as a global cultural exchange in a single location, inspiring hope worldwide by showcasing progress in addressing global challenges, while fostering a sense of community and collaboration on a worldwide scale (Bureau International des Expositions (BIE), 2025a; "Master Plan," n.d.; Mohajer, 2016).

The Osaka Expo lasted 184 days, from April 13th to October 13th, 2025. An event as large-scale as World Expos holds the power to change behaviors and inspire globally, which sparks anticipation of the event's lasting impact on society, the economy, and the environment (Richards, 2020; Sustainability Bureau, 2025). The urgency for progression in sustainability was particularly heightened at Expo Osaka, as it was the final Expo before the 2030 deadline for achieving the Sustainable Development Goals (SDGs). Therefore, this particular Expo was the materialization of not only the accumulated achievements of the SDGs, but also a leap beyond "SDGs + Beyond", anticipating a larger future beyond 2030 (Sustainability Bureau, 2025).

Additionally, the demand for built urban environments is escalating at an unprecedented pace, as forecasts indicate that by 2060, Earth will have constructed over twice the current total built area (*Why The Built Environment – Architecture 2030*, n.d.). This is raising concerns globally about where and how the resources required will be provided. Visions such as *Japan's Society 5.0* introduced with Expo Osaka 2025, illustrated the importance of sustainable and human-centered architectural solutions that also align ecological well-being with economic development (*Society 5.0*, n.d.).

In addition to *Japan's Society 5.0*, Expo Osaka aimed to bring forward ways of enhancing global quality of life, under its overarching theme of "Designing a Future Society for Our Lives" ("Master Plan," n.d.; Sustainability Bureau, 2024). With the Expo's theme in mind, the architects of national pavilions incorporated circularity, biophilic designs, and a culturally sensitive approach into their practices.

Later in the paper, a clear distinction and description of the three subcategories (circularity, biophilic design, and culture) are presented and discussed.

Another focus of the Expo was on resource management, as many pavilions considered material pollution and the importance of natural restoration and circularity in the larger context of sustainability (Sustainability Bureau, 2024, 2025).

While the technological spectacles at World Expos are likely to capture immediate attention from visitors, this paper argues that equal, if not greater, attention should be paid to how national pavilions utilize architecture to generate discussions and interest in sustainable practices and cultural narratives, thereby promoting a brighter future. In this paper, the highlights are of the fundamental purpose of Expos, which is to serve as blueprints for environments that nurture both humans and the Earth.

2. Literature Review

World Expos are large-scale global gatherings where numerous countries come together every five years to showcase their achievements in multiple fields that all started with the Great Exhibition of London in 1851, and 35 Expos have followed. Within a dedicated physical space, Expos aim to uncover and exchange solutions to contemporary challenges through interactive exhibitions by nations all around the world (Mohajer, 2016). Furthermore, Expos have advanced knowledge-based architecture by fostering collaboration between architects, engineers, and scientists (Mohajer, 2016). As each Expo showcases

impressive advancements in technology, science, economics, and more, each Expo has attracted millions of visitors worldwide, leaving a lasting, unique impact on the host city each time (Richards, 2020; Sustainability Bureau, 2025).

One of the key global challenges in the most recent Expos has been sustainability (Bureau International des Expositions (BIE), 2010; *Expo 2020 Dubai*, n.d.). The United Nations Brundtland Commission's 1987 definition of sustainability provided the foundation that Expos' architects built upon: "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Nations, 2014). With architecture being responsible for approximately 40% of the world's carbon emissions, Expo Osaka's architects gave a large amount of attention to create reflective pavilions, focusing on how to take sustainability a step further.

In this paper, the definition of sustainability extends past environmental commitment. Sustainability in this paper encompasses subcategories of circularity, biophilia, and culture in architectural practices, offering a multifaceted approach that is subjectively interpreted by the architects (Sustainability Bureau, 2024, 2025).

Circularity

The concept of circularity originated from the field of sustainable development and the theory of the circular economy. Circularity revolutionizes the management and utilization of construction materials by minimizing waste of raw materials and breathing a second life into previously overlooked materials (CONAI, 2016). Circularity challenges the traditional 'take-make-dispose' model and instead promotes regenerative cycles within the built environment (Timm, 2023). Circularity has recently emerged as a cornerstone in sustainable architecture, and thus, has been showcased more explicitly by nations' pavilions in recent Expos, which is why circularity was chosen as one of the focal points in this research.

A prime example is the Netherlands' pavilion at Expo Hannover 2000. The pavilion demonstrated the prospect of circularity through its architecture. With its six-floor structure, which blended various forms of nature, such as water, vegetation, and energy systems, the pavilion highlighted circularity through a unique and distinct architecture that encouraged visitors to open their minds to circularity as a viable component in sustainable architecture (Arquitectura Viva, 2000; MVRDV, 2001). A more recent example was at Expo Milan 2015, with the Italian pavilion. It further advanced the potential of circularity by evolving the 'cradle-to-cradle' approach through its use of structural materials and construction that once again brought circularity to more people (CONAI, 2016; Nemesi, 2015; Nickel, 2025). The Italian pavilion's exterior was made of cutting-edge photocatalytic elements of new concrete and other materials, such as photovoltaic glass, which was also designed to be able to be fully dismantled and be reused afterwards. Through both their forms and function, these pavilions were significant testaments to how sustainable architecture could be circular: adaptable, reversible, and resource-conscious altogether (ArchDaily, 2015; *The_expo_we_learned_en_web-Pdf*, n.d.).

Biophilic Design

Biologist Edward O. Wilson was the first to introduce the concept of biophilia in 1984 in his book 'Biophilia'. It described the innate human affinity for nature and living systems. In architecture, biophilic design seeks to expose people to natural elements, for example, through the integration of daylight, greenery, or sensory flow. It supports psychological well-being beyond environmental impact, yet has been discounted in the context of sustainability (Zhong, 2021). Biophilic design contributes to sustainability as the integration of it reduces energy consumption, enhances indoor environmental quality, and supports biodiversity in various landscapes. It was chosen as the second key component to be explored in this paper as truly sustainable design extends beyond meeting ecological metrics.



In previous Expos, the Japan pavilion at Expo Aichi 2005 introduced biophilic design on a scale that had been rarely witnessed prior (Nomura, 2005). The architecture of the Japan pavilion was primarily composed of recycled paper tubes and bamboo-and-paper membranes, which had an emphasis on natural and renewable materials that served both aesthetic and environmentally friendly purposes (Japan Association, 2005; PDF, n.d.). Following suit, the Singapore pavilion at Expo Dubai 2020 pushed the boundaries of biophilic design by dominating an arid indoor climate with immersive green spaces, including a vertical garden, a forest valley, and a canopy walk framed by hanging gardens (Expo Dubai 2020, 2022; Naidu, 2024). This achieved a net-zero energy and water footprint, serving as a 'living' model of climate-resilient and human-centered architecture and becoming one of the clearest manifestations of biophilia at an Expo. Biophilic design in architecture is not only aesthetically pleasing to the human eye, but it can also serve as a sustainable system that reduces reliance on artificial climate control and contributes to the long-term health of humans (Browning, 2014).

Culture

World Expos, in other words, are an international platform for countries around the globe to showcase their culture, heritage, and values through architectural means (Bureau International des Expositions (BIE), 2025b). Furthermore, culture is integral to Expo pavilions and the Expo itself (Piatkowska, 2013). Sustainability includes culturally preserving and adapting these unique identities in a climate-conscious world, which is becoming increasingly inherent to architecture, according to studies that name this phenomenon as cultural sustainability (Soini & Birkeland, 2014).

In this paper, culture refers to the shared symbolic systems, values, and norms that shape human communities and differentiate them from the natural environment.

At first glance, culture may not appear integral to sustainability, as the origin of sustainability is rooted in ecological concerns. However, culture, alongside environmental components, is increasingly becoming recognized as a vital aspect of sustainability. This is because culture shapes how societies understand, value, and interact with their environments.

Culture is a significant shaper of people's behaviors, consumption patterns, and relationships with natural resources, and consequently impacts the design, applicability, and sustainability of solutions in our society. It fosters a sense of belonging and tradition, and bolsters community resilience in the face of social and environmental change. Cultural heritage is also a reservoir of embodied knowledge and adaptation techniques that can inform innovative and locally suitable methods of sustainability. UNESCO's Culture for Sustainable Development agenda highlights culture as a cross-cutting enabler of the 2030 Agenda and its Sustainable Development Goals through emphasizing that advancement in sustainability cannot be achieved without integrating cultural identity and heritage into practice (UNESCO, 2025). Unless cultural viewpoints are incorporated, sustainability could potentially develop into a generic approach that is disconnected from real-life experiences of the populations it is intended to benefit.

Culture and sustainability are closely intertwined; traditional knowledge allows architecture to remain both environmentally responsive and culturally resonant. When cultural values of community align with values of sustainability and harmony with nature, it transforms into a deeply rooted enduring sustainable design that reflects collective identity rather than a purely technical pursuit.

Architect Mario Cucinella is another advocate for a view of sustainability that goes beyond technical solutions to include a cultural and humanistic understanding of sustainable architecture. He highlights the interconnectedness of ecosystems and disciplines as a model for integrating cultural complexity into design (*BUILDING GREEN FUTURES – Mario Cucinella Architects – Forma Edizioni*, 2020). Sustainable architecture is more than just reducing carbon output or improving efficiency.



Additionally, it requires creating an understanding of environmental challenges as well as including historical and cultural understanding, thus guaranteeing that design in architecture interactively engages human and ecological environments.

In Expo Shanghai 2010, the UAE pavilion drew inspiration from the expansive and streamlined forms of the UAE's sand dunes to echo its natural topography (Foster+Partners, 2010). Not only did its outer shell pay tribute to traditional motifs of the UAE, but by combining traditional customs and methods with innovative, sustainable design principles, it became a tangible metaphorical representation, linking past historical contexts and vignettes of successful integration of cultural identity into a sustainable context.

More recently, at Expo Dubai 2020, the Morocco pavilion showcased a refined view of cultural architecture by drawing upon Morocco's vernacular architecture. Particularly, the incorporation of an earthen facade that utilized traditional construction methods best suited to the host nation, Dubai's hot climate, resulted in a minimized carbon footprint for the pavilion. Such culturally and environmentally aware design choices by the architects demonstrated how a country can leverage its culture to resonate with visitors and bridge information gaps, fostering a sense of community within a contemporary Expo setting (Lewis, 2021; OUALALOU+CHOI, 2021, 2021).

These pavilions exemplified how the architecture of Expo pavilions can serve as vessels to convey cultural narratives while simultaneously addressing environmental challenges.

This paper evaluates two national pavilions from Western and Eastern cultures to present diverse perspectives on how different nations incorporate culture into Expo Osaka 2025's sustainable narrative.

The case studies in this paper push to consider how these themes intersect and reinforce one another: circular systems reduce long-term environmental strain, biophilic strategies ensure those systems support human well-being sustainably, and cultural expression, when sustainable, anchors innovation in continuity and meaning. Revealing how Expo pavilions can inform future architectural practice that not only builds sustainably but also lives sustainably, with empathy, adaptability, and cultural consciousness at its core (Martinsuo & Huemann, 2021).

3. Methodology

After a thorough examination and observation through Expo Osaka's official website and reports, as well as architects' portfolios prior to the Expo, the selected four pavilions and three emerging subcategories from the theme of sustainability were chosen as the focal points of this study to highlight some of the remarkable revolutions in architecture: circularity, biophilic design, and cultural expression. This paper used a mixed-methods approach to gather qualitative data through numerous case studies and thematic analysis.

The fieldwork involved in-person observations and photographic studies of selected pavilions at Expo Osaka, along with brief interviews with a small group of eight Expo visitors conducted in April and May 2025. Five key questions were composed to gain a deeper understanding of visitors' feelings and impressions of the pavilions and how architects attempted to convey specific artistic messages. These conversations strived to capture authentic, ordinary reactions of visitors rather than focus on the technical understanding of the subject. The interviews were conducted with a small group to gather richer qualitative information and helped establish a trusted relationship between the researcher and the interviewees, enabling more genuine responses.

This approach aimed to provide a holistic view of how the three subcategories of sustainability, circularity, biophilic design, and cultural expression are intertwined within the Expo's architectural pavilions, through detailed architectural case studies



of four national pavilions at Expo Osaka: Switzerland, Germany, China, and Italy. In the following sections, each method is described in more detail.

Desk Study

This research was conducted months prior to and the initial months after the opening of Expo Osaka 2025. Diverse sources were systematically consulted for the Literature Review and case studies on the four pavilions. The official Expo 2025 website and reports that were public provided updated information on pavilion themes and design intentions. The architects' official pages offered deep insight into the conceptual frameworks, design philosophies, and material choices. Architecture journals and media outlets provided an insight into how sustainability and architecture are portrayed in the media to the people, and several relevant publications and books in the fields of sustainability, circularity, biophilic design, and culture.

Criteria for the Selection and Categorization of Pavilions

Out of all international pavilions at Expo Osaka 2025, this paper only covers the four most relevant pavilions, as identified in the Methodology: Switzerland, Germany, Italy, and China.

Switzerland's pavilion was chosen to represent biophilia due to its strong focus on natural materials and their sustainable functions, as well as environmental responsibility. Germany's pavilion was selected to represent circularity as it reflected a growing trend toward an architecture that prioritizes fostering a zero-energy circular economy. For culture, the pavilions from Italy and China were selected to compare Eastern and Western cultural expressions through their architectural forms, as both pavilions outwardly present their culture as their focal eye-catching feature.

Table 1: Intensity of Sustainability Subcategories Being Represented Across Selected Expo 2025 Pavilions.

Country:	Circularity	Biophilia	Culture
Switzerland	1	3	2
Germany	3	2	1
China	1	2	3
Italy	2	1	3

Note: This table provides a comparative evaluation of how each selected pavilion, Switzerland, Germany, Italy, and China, prioritized the three identified subcategories of sustainability: circularity, biophilic design, and cultural expression. Each country was rated on a scale of 1 to 3 for all three subcategories (circularity, biophilia, and culture), with 3 indicating the most intense thematic emphasis, based on a qualitative analysis through the Desk Study. A 1 indicates that the sub-theme was minimally present with slight mentions with trivial integration into the design and message. A 2 indicates that the sub-theme was moderately developed and there was evidence of the sub-theme influencing parts of the design or message; however, it was not central or deeply embedded. A 3 indicates that the sub-theme was strongly emphasized through the design and message through the architectural choices and storytelling, with a clear and intentional integration aligned with sustainability.



Interviews

Semi-structured interviews were conducted with a small group of eight people through opportunity sampling to obtain richer, qualitative insights and encourage authentic responses. The interviews were semi-structured to allow for comparability among participants, flexibility to explore new ideas, and comfort in optimizing honest responses while ensuring that core questions were asked. The target interviewees were adults and elderly residents in Japan aged 30s to 70s. The demographic was chosen because many Japanese citizens, who have only lived in Japan, view the Expo as an educational facility showcasing global innovations based on the year's theme, rather than a tourist location, with some having attended previous Expos in Japan as a part of their school expeditions. A limitation of these interviews is that they were chosen based on who was available at the time, so the sample may not reflect the broader population.

Interviewing Japanese residents cultivated authentic dialogues between the researcher, a native Japanese speaker, and helped overcome any potential language barriers. It was fascinating to note that most of the interviewees were well-educated and came from diverse backgrounds, including construction, teaching, and business.

Participants 1 and 2 were interviewees at the China pavilion, while participants 3 and 4 were at the Swiss pavilion, participants 5 and 6 were at the German pavilion, and participants 7 and 8 were at the Italian pavilion. These interviews were conducted directly and immediately at the Expo pavilions to allow participants to continuously view and accurately assess the pavilions from their own perspectives without having to rely on potentially erroneous recollections.

Guiding questions were well-developed before the site visits in order to help the conversations flow with the interviews.

4. Analysis

Case Study 1: Switzerland



Figure 1: Swiss Pavilion, “From Heidi to High-Tech.”

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The Swiss pavilion brought much inspiration from the nation's proud, diverse landscapes and traditions. The pavilion embodied a harmonious blend of biophilic design, circularity, and cultural storytelling, with the pavilion having a strong emphasis on "Innovative Switzerland". This was achieved through a powerful showcase of both sustainability and prosperity that highlighted the nation's innovations in its spherical bubble-like structures.

Biophilic Design

The architects aimed to convey their national innovations as being rooted in "a tradition of humanism and a sense of nature" by designing the Swiss pavilion to provide a glimpse into the beautiful nature of Switzerland (Manuel Herz Architects, 2025).

Biophilic elements were clearly physically interwoven with the pavilion's architecture, comprising Swiss local plant species, such as wisteria, sourced from their nurseries, which were then transported and grown directly onto the exterior of the five spherical structures. This 'living' skin of the pavilion's structure was one of the focal points of the pavilion, as each kilogram of plant mass at the Swiss pavilion corresponded to one kilogram of CO₂ absorbed from the environment (Zeitoun, 2024). Participant 3 praised the exterior landscape of the Swiss pavilion, reinforcing its effectiveness in conveying the significance of biophilia, as they stated,

"I found the weaving of plants and flowers on its exterior to be eye-catching and pleasing to the eye. ... Learning about how they exceed the aesthetic appeal and function as sustainable elements later on was a wonderful addition."

The flora elements provided an additional biophilic design factor with local plants being planted across the building's surface and surroundings that reinforced the architects' pride for their nation's natural landscapes (Manuel Herz Architects, 2025). To further engage a biophilic intention, light, ventilation, and color were all scenically manipulated to create a welcoming ambiance and distribute visitors freely throughout the pavilion (EXPO Osaka 2025, 2025b). Not only that, but the one-level plane of the pavilion further enabled accessibility and sustainability by avoiding the use of vertical circulation, of elevators and escalators (Manuel Herz Architects, 2025).

The spheres utilized pneumatic pressure in its ETFE shells instead of walls and eliminated the need for airlocks. This allowed for a subtle permeation of fresh air at all times, enabling the interior of the pavilion to maintain a natural airflow in harmony with the ambient environment (EXPO Osaka 2025, 2025b; Manuel Herz Architects, 2025).

The Swiss pavilion was successful in incorporating innovative biophilic design elements and it was a model example of how biophilic design can be utilized to optimize sustainable architecture in the future.

Circularity

The spherical structure was the pavilion's standout feature; weighing approximately 400 kilograms, it represented one percent of a conventional building and earned the distinction of having the lowest ecological and carbon footprint among all pavilions at the Expo (EXPO Osaka 2025, 2025b; Gent, 2025; Vitality Swiss, 2023).

This impressive lightness of the pavilion stemmed from the external shell, made out of what is known as an ETFE membrane, which replaced traditionally heavy materials such as concrete (Fakharany, 2025b). This membrane allows natural light to pass through whilst offering dual-coloration of surfaces, which saves unnecessary energy, resources and the need for massive machinery (EXPO Osaka 2025, 2025b). The membrane used was a modular and reusable construction material fit for sustainable architecture (Vitality Swiss, 2023). Its high initial cost and temperature-related challenges limit its applicability. However, the Swiss pavilion showcased new potential with the material through its unique plans to repurpose the easily

disassemblable membranes, turning them into furniture (Vitality Swiss, 2023). This upheld sustainability as a core design philosophy and the promotion of the circular economy, extending beyond the Expo. They furthermore collaborated with students and professors from the Kyoto Institute of Technology in their early design stages, which further emphasizes how sustainability had always been at the forefront of the architect's intentions (EXPO Osaka 2025, 2025b; KYOTO Design Lab, 2025).

Culture

The architects blended environmental innovation with Swiss' cultural values through iconic imagery featuring Heidi and the Girl of the Alps that emotionally resonated with visitors (Muth, 2025). The character, Heidi was the perfect choice for a cultural symbol, as she embodies the intersection of cultural motif and sustainability, symbolizing Switzerland's abundant nature in a city of technology (Soini & Birkeland, 2014). This was especially evident in the responses of Japanese visitors to question two, as Participant 4 stated,

"Heidi was another key aspect they were promoting heavily, whom I loved since I learned about her in elementary school."

Their reference to Heidi reinforced the notable impact that Switzerland employed through strategic cultural symbolism to make its biophilic message relatable and emotionally impactful, particularly to those familiar with the 1974 animation adaptation. Participant 3 emphasized this by commenting that Heidi

"linked nature and innovation together,"

presenting Switzerland's heritage not as dormant, but as the seed for forward-thinking, sustainable design (Muth, 2025).

Heidi served as a cultural broker to enhance relations between Japan and Switzerland while linking their cultures to a desirable future of innovation (Gent, 2025; Muth, 2025). As suggested by the name of the pavilion, the Swiss exhibition showcased Switzerland's development from its Alpine heritage to a world technology hub. Various zones of the pavilion included an introspective space to allow visitors to ponder Swiss values of openness, sustainability, and innovation (EXPO Osaka 2025, 2025b). The Heidi Café, inside one of the dome-like structures of the pavilion, featured greenery and a glimpse of Osaka Bay, thus stretching the principle of biophilia beyond the boundaries of the exhibition hall (EXPO Osaka 2025, 2025b).

The Swiss pavilion is a compelling model of how innovations truly grounded in humanism and nature can shape built environments to be more sustainable. Specifically, biophilic design was portrayed as being able to achieve sustainability not just visually but structurally, resourcefully, and functionally by the Swiss pavilion. While their approach was specific to their own nation, they brought to light how biophilic design, rooted in one's culture, can elicit a positive ambiance in a space and pass it on to individuals.

Case Study 2: Germany



Figure 2: German Pavilion, “Wa! Germany.”

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The German pavilion was symbolic of circularity in every component, which was intended for a second life beyond the duration of the Expo (230411_PK_Booklet_EN.Indd, n.d.; LAVA, 2025). The coined term “Wa” by the German pavilion signified three different meanings in Japanese: circularity, harmony, and exclamation (EXPO Osaka 2025, 2025a). The term encapsulates its overall focus on circular economy, the harmony and balance between nature and technology, as well as the awe-inspiring potential of sustainable design.

Circularity

The German pavilion architects aimed to answer questions such as, “Are circular cities our future habitats?”, “How will a circular economy succeed in securing our energy supply?”, “What does it mean for each of us as individuals to inhabit a circular society?” (FEDERAL MINISTRY FOR ECONOMIC AFFAIRS AND ENERGY, 2023b).

Firstly, the seven circular wooden structures of the German pavilion visually depicted the theme of circularity through their exterior circular design, utilizing visual elements to convey its focus and dedication to circularity in architecture. The various organic, sustainable materials, including hempcrete, loam, and fungal mycelia panels were specifically chosen for their biodegradability as a key aspect of its circular design by the architects (Kanning, 2025). This was explained to visitors through labeling and thorough explanations provided by their speaking mascot, which they carried around. Visitors of the pavilions noticed this as Participant 6 stated,

“I liked how even the materials of the walls were explained through the talking hand-held mascot. It was immersing, being able to touch the raw materials with the explanation was a factor I deeply appreciated.”

While some inorganic materials were used, materials that would be easily recycled within the industrial sector, such as steel and glulam structures, were chosen. At the same time, rejecting other inorganic materials, such as concrete, that are responsible for over half of the global carbon emissions (BIG SEE, 2025). The architects also incorporated traditional resources of rammed earth to be repurposed after the Expo, which further reinforces Germany's commitment to circularity and reducing waste (LAVA, 2025). The distinction of the materials not only being sustainable but also versatile with long-lasting utility paints a new vision for circularity and circular architecture that's not only eco-friendly but also practical in the meantime (BIG SEE, 2025; FEDERAL MINISTRY FOR ECONOMIC AFFAIRS AND ENERGY, 2023b; Kanning, 2025). All of which mitigated environmental impacts and reinforced the German pavilion's illustrated a clear consciousness to long-term ecological goals.

The fusion of sustainability and innovation stems from tradition, honoring local knowledge, whilst advancing global sustainability goals. Many visitors felt the passion and hopeful outlook for the future of the circular economy through the German pavilion, as Participant 5 stated,

“I feel optimistic about the future. I learned more about how foreign countries are making advances in such fields, and their commitment to circularity was conveyed effectively.”

It confirmed how visitors were able to notice and feel the thematic framing of the circularity in both the exhibition and the space they created. It illustrated sustainability as a humanistic endeavor through architectural storytelling. The German pavilion effectively achieved its goal of educating visitors on the circular economy and cross-cultural sustainability, particularly highlighting European perspectives.

Biophilic Design

In the German pavilion, biophilic design was integrated into its central theme of circularity through its architecture and landscape, as the architects predicted that the functions of a biosphere would become a key feature of urban environments in the future (facts and fiction, 2025; *Work - LAVA Laboratory for Visionary Architecture*, n.d.). Out of the seven cylindrical wooden structures that comprised the pavilion, two that seamlessly merged into accessible green spaces and the roof garden paid homage to Expo Osaka 1970, highlighting how the natural world evolved over time alongside architecture (Fakharany, 2025a; Kanning, 2025).

The pavilion featured a diverse array of natural species borrowed from local nurseries in Osaka. These plants enhanced both the aesthetic appeal and biodiversity, as well as ecological balance. The green roofs and vegetation helped facilitate passive cooling in the pavilion, reducing the need for mechanical air conditioning—a key aspect of biophilic design (LAVA, 2025).

Culture

The German pavilion's take on culture was different from the others in two ways. Firstly, instead of embedding culture into the structural elements of the pavilion, culture was represented mainly through the exhibition experience. Secondly, in place of focusing solely on its own national culture and tradition, the German pavilion also highlighted Japanese culture. This was indeed effective in garnering excitement and engagement with the handheld talking circular mascot, “Circulars,” inspired by Japan's *kawaii* culture (FEDERAL MINISTRY FOR ECONOMIC AFFAIRS AND ENERGY, 2023a). This was well accepted by Japanese visitors during the Expo, especially as Japanese visitors made up 90% of the total Expo visitors, as Participant 6 stated,



“It was lovely, having a helpful and cute guide in my hands; it made me feel less alone and made it more comfortable to take my time to take in all the information.”

The German culture was not evident in its architectural form, as Participant Five commented,

“Other than the sign that read 'Germany,' I wasn't sure what other links there were to the country.”

This highlights a limitation in cultural communication that the pavilion had, as it suggests the ecological themes may have overshadowed localized cultural storytelling. Nevertheless, culture was expressed through a sensorial aspect that emerged primarily with the smells, which were not initially considered in the Desk Study but were discovered during on-site research, as Participants Five and Six both commented that the scent of German beer, sausage, and pork knuckle had drawn them in and made it evident of its country of origin.

The German pavilion at Expo Osaka serves as a key testament to the indefinite potential of circularity and the integration of the circular economy into mainstream architecture. It was a powerful prototype for future sustainable design, aligning with Expo Osaka's theme of "Designing Future Society for Our Lives," as it encapsulated the intersection of circularity and biophilic design and culture through diverse innovative means, proving how considerations in all steps, notably from the materials, can make a massive difference.

Case Study 3: China



Figure 3: China Pavilion, “Building a Community of Life for Man and Nature–Future Society of Green Development.”

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The pavilion took profound inspiration from China's cultural heritage, as it presented a powerful architectural narrative drawn from multiple traditional inspirations, embodied a prime example of cultural sustainability (Fakharany, 2023). To reflect the country's intention for a harmonious coexistence of cultural heritage and environmental development.

Culture

At the entrance of the pavilion stood an inscription of classical Chinese poetry on bamboo slips that was indicative of the transmission of knowledge through time and the heritage of China (Fakharany, 2023).

The Chinese pavilion represented China's 5,000-year-old civilization and its current vision of green development, bridging the past and the future through sustainability (Nair, 2024). The Chinese calligraphy and poetry engravings within the pavilion featured over a hundred different classical poems written in five different calligraphy styles, drawn from influential texts such as the Shi Jing and Chu Ci, highlighting how the pavilion took every opportunity to showcase its rich chronology at the Expo (Ruoting, 2025).

One of the distinctive aspects of the Chinese pavilion was its ten-meter calligraphy 'waterfall' demonstration that impressed visitors, as Participants 1 and 2 refer to the 'waterfall' as an impressive aspect of the pavilion. It tells about Chinese writing development spanning three millennia, and combined with interactive touchscreens that delve into ancient scripts and poetry, it allowed national heritage to link contemporary technological presentation so as to support the cultural continuance and innovation that ran through the pavilion's theme (Fakharany, 2023). Visitors in particular enjoyed the creative, engaging pathways in learning, as Participant 1 commented,

“The touch screen with several language options was very accommodating in incentivising visitors to learn.”

A unique initiative showcasing China's culture was that its exhibits and events were routinely rotated to be able to showcase 30 different provinces and regions of China during the six month duration of the Expo to allow visitors to experience a broad cultural narrative and diverse heritage (CCPIT, 2025). Visitors were able to relish in the eclectic, rich history and heritage of China, even with multiple visits, as Participant 2 stated,

“This is my second time here, and I was shocked to find new artifacts being displayed; it drew my attention to how they were different.”

The visitor's response indicated that cultural semiotics were conveyed as intended and effectively embodied, as the pavilion succeeded in effectively showcasing a strong national identity of Chinese culture.

The pavilion also displayed an immersive short film that conveyed China's vision of sustainable development, inspired by traditional Chinese solar terms. This allowed visitors to discover China's cultural concepts through the exhibition, which enabled visitors to partake in the experience instead of passing by unknowingly. This emphasized the cyclical nature of time and the interdependence of humans and nature, conveying the substance of circularity in architecture.

These cultural features also reflect ecological principles, such as circularity and interdependence, with their emphasis on time, cycles, and heritage paralleling ideas of resource continuity and environmental responsibility. Integrating culture into sustainable architecture ensures that buildings are environmentally responsible, socially meaningful, and capable of fostering a shared understanding among diverse audiences.

Biophilic Design

The bamboo-like ceiling decorations embodied the growth cycles of nature and agriculture, allowing visitors to feel “the life code” in the exhibition space, where visitors were able to experience all four seasonal transitions in (Jumbo Globe, 2023). The pavilion had also holistically natural lighting for a seamless flow, which enhanced the connection between humans and nature (Nair, 2024). Natural light is one of the most common uses of biophilia in architecture for human well-being purposes,



however, it is not only limited to well-being as it also plays a large role in sustainability by reducing ecological footprints. In the pavilion, the material choice of bamboo, as one of its core materials—a renewable resource—demonstrated both traditional Chinese aesthetics and sustainable design, reinforcing the framework for culturally rooted biophilic design.

Circularity

Whilst the primary focus was on the exhibition and structure, circularity and ecological vision were nonetheless key aspects of the pavilion's architectural approach, shown through the implementation of a zero-waste construction code (Qiange, 2025).

For instance, the China pavilion highlighted future circular materials, such as renewable bamboo-wood panels. They were specially made using advanced 3D and building information modeling (BIM) technologies in China (Qiange, 2025). These panels being prefabricated in China even though the Expo was held in Japan enabled costs to be reduced by 90% and ensured that these panels could be brought back to China to be reclaimed after the completion of the Expo (Qiange, 2025). The China pavilion exemplified circularity in materials through innovative, responsible resource management.

The materials used for the construction of the Chinese pavilion had been designed with energy-saving features to accommodate the hot Japanese weather, which included a centralized cooling system with optimized airflow, bright lighting, and energy-efficient elevators as well (Ruoting, 2025).

The Chinese pavilion presented China's profound engagement with designing a future world and economy that places sustainable design at its core, while incorporating cultural representation. It showcases an example of architectural design that honors history, combining it with new and emerging technologies that give visitors a vision of the future of architecture and built environments.

Case Study 4: Italy



Figure 4: Italy Pavilion, “Art Regenerates Life.”

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The Italian pavilion's theme, "Art Regenerates Life," was largely inspired by the Renaissance concept of the *Ideal City*, a utopian vision of urban design characterized by order and harmony. Accordingly, the pavilion seamlessly merged art, culture, and innovation to present a proactive model of a reimagined *Ideal City*, while simultaneously showcasing Italy's prioritization to environmental responsibility and its cultural heritage.

Culture

The architects of the Italian pavilion aimed to entice visitors to feel as if they were "breathing the air of Italy" through an immersive exhibition of Italy, featuring Renaissance paintings, sculptures, and cultural artifacts (Gonzalez, 2023).

The Italian Pavilion attempted a bold cultural reinterpretation through its theme, *The Ideal City*, a reference to Italy's Renaissance concept of *la città ideale*, famously depicted in 15th-century perspective paintings by artists such as Luciano Laurana (Centrale, 2025; EXPO Osaka 2025, 2025c; Gonzalez, 2023). However, interviewees seem to have misread the architects' reinterpretation presented in the pavilion's entrance, as the arched colonnaded entrance was misunderstood as a nod to the Roman era, rather than recognizing the deeper allusion to the harmonious, rational geometry of Renaissance urban utopias. Participants 7 and 8 both picked out that

"The entrance reminded me of the Colosseum,"

as a significant indicator of the country's culture and origin, confirming the recurring misinterpretation that had been present at the Expo. However, the *Ideal City* that the architects aimed to portray does not utilize arches. The Renaissance is also Greek, where ideals, techniques, and spiritual values were often explored in comparison to the Roman Empire, which was more pragmatic, focused on ownership and imperialism, and the spreading of culture. The architects' intention was to use those historic urban metaphors—the theatre, portico, piazza, and garden—to create a future-oriented "living fabric" that expresses Italy's regional diversity and innovative identity (Mario Cucinella Architects, 2025).

This meant it conveyed a different impression of intentions than it actually intended. The Renaissance era is marked by significant discoveries and a period of rebirth (HISTORY.com Editors, 2018). What the architects of the Italy pavilion sought to convey was more representative of revolutionary cities, as well as the flourishing of inventions inspired by the Renaissance era. Therefore, the execution may have limited clarity for the public and was ineffective.

This misunderstanding prevented visitors from understanding the intended meaning behind the design choices, which were intended to inspire. Socially sustainable architecture allows spaces to be meaningful by understanding how visitors perceive cultural symbolism at these pavilions. The pavilion provides valuable data for architects to design spaces that are both culturally resonant and environmentally sustainable. Analyzing how visitors perceive cultural symbolism at these pavilions provides valuable data for architects to design spaces that are both culturally resonant and supportive of sustainable social practices.

Did the conceptualization rely too heavily on abstract motifs without offering clear interpretive guidance? Or was the execution perhaps overly simplified for the public, who expected more literal and familiar cues?

Whilst the architects aimed to convey Italy's vision of reimagined utopian design through their reinterpretation of the *Ideal City* from the Renaissance era, the conveyed intentions did not align with the visitors' impressions, which raised questions about how abstract concepts could be better executed to provide effortless understanding for visitors. However, it could be considered successful in that the pavilion successfully evoked strong Italian imagery through its architectural form to Expo visitors.



Circularity

The Italian pavilion's take on circularity was largely seen through its influence with the broader goal of adaptive reuse after the Expo to make the pavilion a model of circular architecture (Al Koshta, 2025).

The pavilion was constructed using certified laminated wood and a dry construction system. This allowed for reconfiguration and disassembly, enabling the materials to be recycled after the Expo, considering its six-month duration (Al Koshta, 2025).

The exterior structure was made from permeable mineral fibres, which could passively regulate temperature, light, and airflow. It acted as both the skin of the pavilion and the interface that connected internal climate to external conditions, symbolizing Italy's transparent approach to sustainable design. The lightweight textile of the outer face reduced energy demands, enabling the pavilion to behave like a living organism, which allowed it to adapt to seasonal rhythms and environmental changes in Japan—a core tenet of circularity (Al Koshta, 2025).

Biophilic Design

Lead architect Mario Cucinella stated, “The Italian Pavilion stands for a new idea of society, and for the city as a living organism where the relationships between people, art, the environment, and history can materialise” (Gonzalez, 2023). The Italian pavilion's integration of biophilic design was intended to reconnect humans with nature through proximity. The rooftop of the pavilion featured an Italian-style garden that served as a contemporary labyrinth, with flowers and small trees that spread various scents, creating sensory dimensions for visitors to weave through inspired by Renaissance harmony and in keeping with the theme of the *Ideal City* (Mario Cucinella Architects, 2025). An organic biophilic ecosystem was designed innovatively, with the garden embodying native plants, fountains, sculptures, alongside winding paths that symbolized both human geometry and natural irregularity (Mario Cucinella Architects, 2025).

Biophilia at the Italian pavilion was multi-sensory and multi-spatial, as the pavilion's exhibition mirrored the rhythms of a day through the use of dappled sunlight filtering through a forest canopy. This enhanced awareness functioned as an antidote to the overstimulation of digital life, connecting Japanese spatial philosophies of impermanence with Italian approaches to beauty and environment.

Key components of the pavilions, such as the theatre, piazza, and rooftop garden, formed a triptych of experimental biophilia that all showcased the Italian pavilion's focus on biophilic design that prioritized empathy and emotion, as much as ecological responsibility.

The pavilion illustrated harmonious integration of cultural and sustainable practices, despite some elements being misinterpreted; the pavilion still encapsulated Italy's dedication to building a future that values ecological balance and cultural richness in urban architecture.

5. Conclusions

The researcher was drawn to the topic of sustainability, and in particular, took the four pavilions as the focal points of this study, analyzing them through the lens of circularity, biophilia, and culture. The architectural innovations displayed by official participants' national pavilions at Expo Osaka demonstrated how sustainability must extend beyond technical performance, environmentally, to encompass broader social considerations. Each national pavilion at the Osaka Expo 2025



exemplified various aspects of sustainability. The Swiss pavilion showcased biophilia, the German pavilion demonstrated circularity, and the Italian and Chinese pavilions conveyed cultural symbolism, all of which evidently resonated with the visitors present. These design approaches can be inspirational for future research and design that focus on the notion of sustainability as a form of biophilia integration, circularity, and culture. The unstructured interviews with pavilion visitors at the Expo highlighted how the clarity of the architectural intentions plays a large part in ensuring they are conveyed effectively. In essence, the clarity of architectural intentions directly impacts and enhances the social effectiveness of sustainable spaces.

However, this study has several limitations: due to time constraints and the ongoing nature of the Expo, information was limited, and only four out of more than fifty pavilions were selected for analysis. Additionally, sustainability encompasses many more potential subcategories, beyond the three explored in this paper. Future research could examine other aspects of sustainability that remain underexplored, for example, neuroarchitecture, innovative applications of technology, or additional social and cultural dimensions. Additionally, the researcher strongly recommends delving deeper into the architectural analysis of the relationships among design, communication, and sustainability in future research highlighted by the findings from the Italian pavilion.

As urban expansion in this century accelerates more and more and the SDGs deadline inches closer, the researcher hopes that the conclusions drawn from this paper's analysis can inform future global efforts to build not just sustainably but meaningfully with empathy and regeneration at the root of architectural practice. The most consequential takeaway from the Osaka Expo's pavilions is one of inspiration.

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Outside of her academic pursuits, she is fascinated by pottery and product design, as evidenced by her capstone project, which created an original board game. She hopes to pursue a career in architecture to design buildings that not only house but also heal those who reside in them.

Mentor Contribution Statement

Dr. Cecilia Zecca is currently an associate lecturer and a research fellow at the Royal College of Art in London, working on inclusive design approaches to implement products, services, and the built environment for marginalised groups such as disabled and older people. Her support primarily consisted of guiding the student through the process of holistic primary and secondary research, providing advice on developing research objectives and subcategories, and aiding in the structuring of the paper as a whole. Nevertheless, her involvement was entirely advisory as the student maintained complete independence in all aspects of the project. Dr. Cecilia Zecca did not contribute directly to the manuscript's writing; rather, she supported the student through regular check-ins, offering mentorship during the initial stage and productive directions during the revision process. This contribution statement acknowledges her role as a mentor while affirming that all research and writing were conducted independently by the student.

