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Insights from Past Technological and Intellectual Adaptations in Japanese Traditional Thatch Architecture

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Abstract

Japan's diverse geography and climate have fostered one of the world's most varied styles of thatched roofs, with each region's vernacular architecture being shaped by unique environmental conditions, cultural traditions, and locally available materials. However, contemporary shifts in these factors have led to the near disappearance of thatched houses in rural landscapes and the decline of maintenance knowledge, necessitating significant adaptations in traditional thatching practices. While modifications in vernacular architecture are often seen as threats to authenticity, this study argues that both past and present technological innovations are crucial for ensuring the longevity and sustainability of thatch structures. This paper examines technical adaptations in Japanese thatch architecture as a response to historical environmental, material, and social challenges that have shaped the distinctive regional styles still present today. Data were collected through 15 site visits to Kita thatch village in Miyama, Kyoto (2021–2024) and three Minka architectural parks in Aichi, Osaka, and Kanagawa. The visits involved detailed interviews with a Japanese master thatcher, photographic documentation, and architectural surveys. By analyzing and categorizing adaptations across Japan, this study demonstrates that evolution preserves and enhances authenticity by addressing regional needs and challenges. Guided by skilled local craftspeople, these adaptations ensure vernacular thatch architecture remains relevant while providing sustainable insights for the future of the craft.

Keywords: *traditional thatch technology; vernacular heritage preservation; intellectual resources; technological adaptation; craft sustainability*

1. Introduction

With growing national and international recognition, traditional thatch technology is one of Japan's most valued forms of rural architectural heritage. However, the transmission of this knowledge to future generations of thatch professionals and the preservation of its intellectual resources remains significant challenges that require immediate attention.

The oldest thatched roofs in Japan date back to the Jomon (10,000–1,000 BC), Yayoi (50–200 AD) (Fig. 1), and Kofun (500–600 AD) (Fig. 2) periods (Ando. 1983; ACBECP. 2017). These early dwellings, simple semi-buried structures,

have been preserved in historical parks and can be considered as the origins of thatched architecture in Japan, from which all other forms have stemmed. Given the present diversity of regional thatch roof types across Japan, this study examines two interrelated aspects of technological adaptation in contemporary thatch craft. The central investigation explores: (1) How, considering evolving thatched conservation policies, past and present technological innovations are essential for ensuring the longevity and sustainability of thatch architecture. Historically, thatchers worked locally and developed extensive knowledge specific to their region's thatch types (Ando, 1983). Contemporary circumstances, such as the declining number of active thatchers, now approximately 200 (Ando, 2020), have necessitated an expansion of their work to a national scale, reinforcing the importance of these innovations. (2) Therefore, the study also explores how current thatchers acquire techniques from regions outside their traditional areas of expertise. This aspect provides insight into the transmission of knowledge and adaptation of practices beyond local traditions, further supporting the sustainability of the craft. While changes in vernacular architecture are often viewed as compromising the authenticity of traditional buildings, the Nara Document on Authenticity (ICOMOS, 1994) emphasizes that evaluations of cultural value and authenticity must be conducted with respect to the diversity of cultures and heritage, recognizing their unique contexts and significance. In Japan, authenticity is not an objective explicitly referred to in cultural property legislation (Henrichsen, 2017; Weiler, 2016). This paper seeks to expand upon the relatively recent scholarship on the evolution of Japanese thatch roofs, which have primarily developed since the mid-1950s (Nihon Minkaen, 2007). By examining past adaptations to environmental and socio-economic challenges, this study explores how these factors have driven the evolution of various thatch house forms across Japan and contributed to their authentic regional character. It is well established in Japanese literature that Minka designs are closely tied to the climate and characteristics of each region (Japanese Folk House Museum, 2006; Brown, 2022). To further the corpus of research, this study expands on existing research by sharing findings from studies conducted predominantly in Japanese and highlighting these structures' evolution, emphasizing the need for modifications and adaptations in contemporary conservation.

Fig. 1 – *Higashiune Oita park, Yayoi- period dwelling* (Author, 2025).

Fig. 2 – *Higashiune Oita park, Kofun - period dwelling 2022 conservation work* (Author, 2025).

2. Methodology

This research was conducted through site visits guided by a master thatcher with over 30 years of professional experience. He leads one of Japan's largest thatching companies and specializes in the Kyoto Miyama style, while also possessing expertise in thatching techniques across all regions of mainland Japan. His direct involvement in the conservation of several

houses in these parks provided key insights into regional building techniques and materials. His knowledge of site-specific techniques and materials offered a unique perspective, especially in cases where he had previously worked on the houses. During these visits, expert interviews focused on the architectural characteristics of each house, supplemented by photographic documentation and structural measurements. These analyses, paired with insights into hidden thatch structures not visible post-conservation, provided valuable context. The case studies were selected to reflect the main thatching zones in Japan, ensuring a representative analysis of regional variations. Field expeditions included 15 visits (2021–2024) to Kita thatch village in the Kyoto region, along with surveys at three Minka architectural parks, specifically chosen for their representation of Japan's three primary thatching zones: The Little World Museum of Man

(LWMM) in March 2021 (Reflecting the North and South styles), the Hattori-Ryokuchi Koen Osaka Museum of Japanese Folk Houses in August 2024 (reflecting the Western style), and the Kawasaki Minkaen, Municipal Japanese Folk House Museum in September 2024 (reflecting the Eastern style). All the houses analyzed were authentic, relocated structures. To further validate the findings collected data were cross-referenced through literature reviews and follow-up expert interviews with representatives from the Japanese Thatch Cultural Association (JTCA) in September 2024, alongside participation in their professional workshop in Miyama in November 2024. This process helped to corroborate the findings and to provide deeper insights into regional variations and conservation challenges. A comparative analysis was conducted to identify key drivers of change, focusing on material availability, environmental factors, and socio-economic conditions. Technological adaptations and shifts in intellectual resources were categorized to understand how thatch architecture has evolved over time. This method enabled a comprehensive assessment of technological solutions and their role in sustaining thatch-building techniques.

3. Threats and catalysis of changes

The consensus within thatch roofing literature identifies weather-related damage such as: High winds, heavy rains, and snowfall, as primary threats to thatch roofs. However, these are not the only risks facing thatch roofs across Japan; several other factors, including sometimes non-threatening catalysts for change, also pose significant challenges (Okawa, 1962; Yoshida, 1985; Tsuda, 1995; Nihon Minkaen, 2014). These catalysts have led thatchers and owners to adapt and optimize their roofs through various thatching modifications which have, in turn, become characteristic of regional designs. The various threats are categorized by issue types in Table 1.

4. Case studies

The selected case study examines the house in response to the coded threats that have led to specific technical transformations. The location of the house is particularly significant, as regional thatching zones influence both roofing techniques and maintenance practices. A map (Fig. 3) has been developed based on data

Table 1 – *Categorization of thatch threats in Japan.*

Issue Type	Threat / Catalyst		
A. Weather-related damage	Heavy rain	Heavy snow	High winds
B. Material-related issues	Weathering, Decay	Fire, Desiccation	
C. Maintenance-related issues	Change in usage	Improper Ventilation	Animal and pest control
D. Structural weaknesses	Weak structural points	Lack of skilled maintenance	
E. Human resources	Knowledge or skills loss	Lack of professionals	
F. Cultural aspects	Taboos	Folklore beliefs and religion	

Table 2 – *Traditional thatch material and Localisation.*

Thatch Kaya 茅	**English terminology *Scientific name***	**Localisation**
Susuki ススキ	Pampas grass *Miscanthus sinensis*	Widespread, especially mountainous areas
Yoshi ヨシ / 葦	Reed *Phragmites australis*	Widespread, especially mountainous areas
Wara 藁	Rice straw *Oryza sativa*	Agricultural zones (rice-producing areas)
Chigaya チガヤ	Cogon grass *Imperata cylindrica*	Widespread across Japan
Mugi-wara 麦藁	Wheat straw *Triticum aestivum*	Grain-farming regions
Ogi 荻	Silvergrass *Miscanthus sacchariflorus*	Riverbanks and moist regions
Kariyasu 刈安	Fine miscanthus *Miscanthus tinctorius*	Chubu region (Shirakawa-gō, Gokayama)
Sasa 笹	Bamboo grass *Sasa veitchii*	Northern, central-west & mountainous regions
Suge 菅	Sedge grass *Cyperaceae*	Wetlands or marshes

collected from the master thatcher, illustrating Japan's thatching practices as divided into ten subzones according to the technical expertise of a leading thatching company. Within the main island, these sub-zones are categorized into three major zones, highlighting a distinct division between the eastern region (case studies 2,3) and the western region (7,8,9). The central zone, or the wider Kanto area, serves as a transitional region, incorporating elements from both eastern and western thatching techniques (4,5,6). This zone can be further divided into two, reflecting a drastic shift in architectural forms (Fig. 3). The Kanto style, characterized by low ridges and gentle slopes, likely evolved as an adaptation to the region's higher population density, whereas the Hokuriku region reflects its historical silk production economy and the need for heavy snow resilience in its roofing forms. This regional classification applies specifically to Japan's main island and excludes Hokkaido (case 1) and Okinawa (case 10), which possess distinct thatching traditions shaped by indigenous Ainu and Ryukyuan cultures, respectively. Therefore, these two regions are automatically regarded as separate zones. The original location of each house is recorded on the map and numbered according to its respective regional classification.

The analysis focuses on specific techniques that thatchers acquire beyond their local expertise, the learning mechanisms they employ, and the challenges associated with adapting to different material and environmental conditions. To avoid redundancy, repeated modifications, such as form evolution, are not duplicated, keeping the focus on original adaptations in the final roofing structure. Case study results are categorized by adaptation issues, highlighting regional differences.

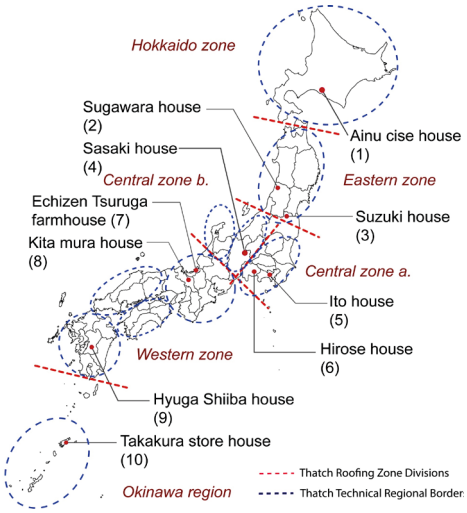

Fig. 3 – *Houses locations within Thatch technical zoning from master thatcher perspective* (Author, 2025).

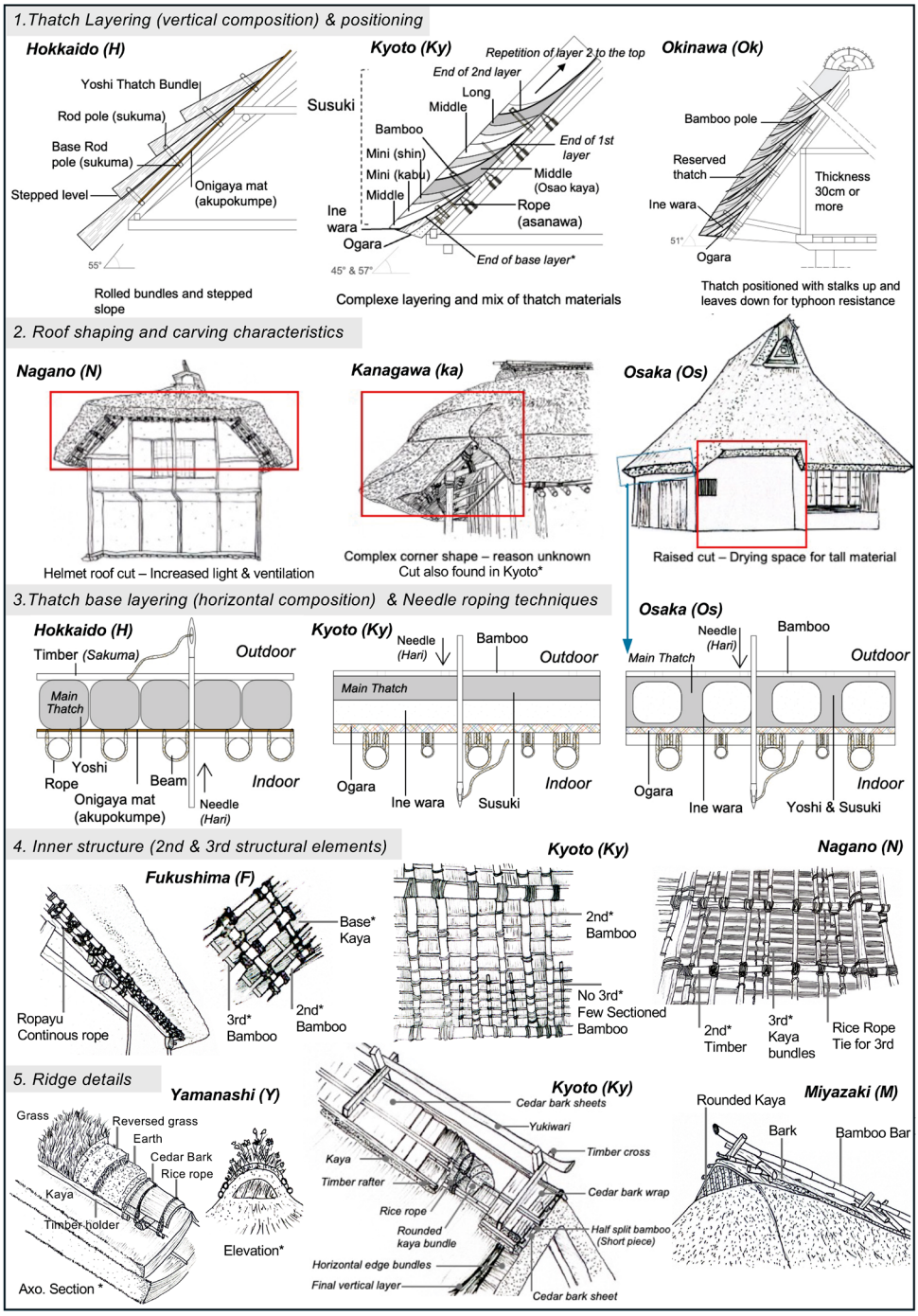

Fig. 4 – *Selected variation in technical characteristics of Japanese Thatch.*

Climatic adaptation: Climatic adaptations in Japanese thatched architecture showcase a deep integration of environmental responsiveness, with roof designs tailored to address climatic challenges, reflecting a clear division between northern/eastern regions and western/southern regions in their approaches to durability and functionality. In Northern Japan (Hokkaido), which is prone to heavy snow and cold weather, *cise* houses feature upside-down fan-shaped thatch bundles to improve water runoff and prevent infiltration (Fig. 4.1.H). Thatch is bundled together to form a thick insulating layer, using an "envelope performance" mechanism to retain heat. In the snowy regions of East Japan (e.g., Nagano, Gifu, Toyama, and Yamagata), thatch roofs are steep and thick to shed snow effectively. In contrast, West and South Japan, especially typhoon-prone areas like Kyushu and Okinawa, feature gentler roof slopes to withstand strong winds, with horizontally layered thatch that reduces the wind impact. The Okinawa region for instance employs reversed thatching that enhances resistance against typhoon impacts (Fig. 4.1. Ok).

Material adaptation: Traditional thatch materials in Japan, *Kaya* were once locally sourced according to regional availability (Table 2). Today, they are often purchased from large kaya-producing fields, marking a shift away from local specificity, though professionals still strive to use varieties best suited to their regional context. In Northern Japan (Hokkaido), *cise* houses use timber as the tertiary structural material. They are directly sourced from forests and remain uneven, thereby adding to the uniqueness of the structure (Fig. 3.1.H). Onigaya roof mats, bound with grapevine bark, provide sturdiness and fire resistance. In Eastern Japan's Fukushima region, bamboo is frequently used for rafters, although it requires more frequent repairs than timber, typically every 10 years (Fig. 4.4.F). In snowy Yamagata, areas prone to water accumulation see thatch strengthen with wooden plates along the valleys, resulting in greater durability. In both Eastern and Central regions, Shiba mune, or planted ridges, function as water-resistant features and natural fire indicators (Yamaguchi, 2022), with plant wilting signaling dry air and fire risk (Fig 4.5.Y). In regions like Nagano, while timber is used as the secondary structure, bundles of thatch serve as the tertiary structure, helping to support the weight of snow by bending without breaking (Fig. 4.4.N). West Japan, particularly Kansai, relies on longer-lasting wood rafters, with a lifespan of around 20 years, and Bamboo is used for its secondary structure (Fig. 4.4.ky & 4.5. Ky). Techniques harnessing the material properties, such as layering *Shin,* the upper part with leaves, to absorb moisture and keep *Kabu,* the stalk section, dry, are also used for maintaining roof durability (Fig. 4.1. Ky). In Kyushu, thatch lengths are chosen to match human proportions, making the thatching process efficient and reflective of local practices.

Maintenance and usage: In Northern Japan (Hokkaido), the construction of *cise* houses is notable for its efficiency, requiring minimal manpower while using precise techniques, such as securing thatch bundles with perpendicular needles aligned with the grain, from the inside to the outside (Fig. 4.3.H). Usage patterns show a clear East-West distinction. In East Japan, roofs were carved into new shapes to create additional usable space, serving both to increase storage on outer walls and add light openings inside, aligning with the region's focus on farming and animal raising, particularly silkworms (Fig. 4.2.N & Ka). Across Japan, hearth smoke traditionally preserved thatch by repelling pests. However, lifestyle changes and the shift to modern kitchens have accelerated thatch decay, necessitating alternative preservation methods.

Structural improvements: Structural improvements in traditional Japanese architecture demonstrate region-specific innovations that prioritize safety, resilience, and efficiency, addressing environmental challenges In Northern Japan (Hokkaido), *cise* houses are constructed with roofs built on the ground first, improving safety and enabling precise weight management during assembly. In East Japan, unique rope-tying

methods like Roppayui secure bamboo rafters tightly, essential in snowy conditions (Fig. 4.4.F). Complex roof features such as valleys and ridges are reinforced with bark layers between thatch to prevent erosion or sagging. In Okinawa, reverse thatching is used to quickly restore roofs in disaster-prone regions.

Human Resources: In the worst cases, the inability to perform re-thatching due to a shortage of skilled or knowledgeable thatchers has led to the disappearance of minka structures in certain regions, highlighting once more the critical need for knowledge preservation and craft transmission. In Northern Japan (Hokkaido), traditional *cise* houses are no longer used as residences but have been repurposed for ceremonial and public cultural purposes, ensuring their continued relevance and value. East Japan, notably Gokayama, has turned to forestry associations for thatch management due to the scarcity of skilled thatchers. Nationwide, training for thatching has extended from five to eight years to account for regional diversity in techniques and materials, reflecting the differing demands across regions. When working outside their zone of expertise, professional thatchers gather information on roof details and re-roofing procedures by consulting local or retired thatchers, reviewing archives and, as a last resort, taking inspiration from old photographic records and documenting the roof's layers and details during the dismantling work. Despite these efforts, accurately restoring the exact slope shapes and details can remain challenging (Fig. 4.2. Ka). Beyond the clear indigenous distinctions between the North, South, and main island, this analysis reveals a striking East-West divide within Japan's main island, as well as an integration of both sides within the central region, shaped by economic and cultural activities. This distinction highlights the profound interaction between local environmental challenges, technical regional specificities, and the ingenuity of traditional craftsmanship to adapt and expand their technical knowledge, ensuring resilience and continuity in the face of diverse needs.

5. Conclusions

Despite its simple appearance, the thatch roof is a highly specialized architectural element, deeply embedded in Japan's vernacular heritage. This study reveals that innovation within traditional thatch craft is essential for its longevity, demonstrating that the evolution of Japanese thatched architecture is not merely a response to environmental constraints but a dynamic process shaped by socio-economic shifts, material availability, and knowledge transmission. Rather than threatening authenticity, technological adaptations, past and present, have sustained regional thatching by integrating symbolic heritage with essential architectural performance. By examining historical and contemporary modifications, this study highlights key technological solutions tailored to Japan's diverse climate zones. The expansion of thatchers' expertise beyond their local regions marks a shift where contemporary practitioners now have to rely on archival documentation, expert networks, and intergenerational exchanges to adapt their skills. When no other options are available, they depend on their own knowledge and expertise to document the roof themselves, learning from its structure as they dismantle it during conservation work. This process allows the craftsmen to analyze past techniques before beginning the re-roofing conservation work. Extending Kobayashi's (2014) framework, this study underscores the importance of natural, human, and intellectual resources in sustaining thatched heritage. The decline of high-quality domestic materials and shifts in usage patterns, such as the loss of hearth smoke as a natural preservative, have accelerated thatch decay cycles. Addressing these challenges requires improved maintenance strategies, stronger material production, and documentation of expert knowledge, particularly by engaging and recording the knowledge of retired master thatchers. This study further argues that authenticity in Japanese thatched architecture, as a living tradition, is fluid and shaped by necessity rather than rigid conservation principles. Looking forward, revitalizing the craft depends

on expanding adaptive techniques, strengthening professional training, and re-establishing traditional and local material sourcing to meet the ecological and cultural demands of our time. Guided adaptations contribute to resilience, allowing thatched architecture to respond meaningfully to present-day challenges. These findings provide insights for policymakers, craftspeople, and conservationists working to sustain vernacular thatch architecture where forward-oriented strategies ensure thatched architecture remains both resilient and relevant in the face of ongoing socio-environmental change. A holistic approach integrating material innovation, skill transmission, and adaptive maintenance is essential to sustain this living heritage in meaningful and sustainable ways. While the complexities of these dimensions go beyond the scope of this article and are the focus of ongoing parallel research by the authors, they also offer valuable directions for future studies.

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