CAPITAL UNIVERSITY OF SCIENCE AND TECHNOLOGY, ISLAMABAD

Exploring the Role of Indigenous Construction in Enhancing Sustainable Building Practices

by

Hassan Abbas

A thesis submitted in partial fulfillment for the degree of Master of Science

in the

Faculty of Engineering
Department of Civil Engineering

2025

I want to dedicate this achievement to my beloved parents and wife, honorable teachers, friends, and classmates who always encouraged and supported me in every crucial time during my studies to achieve my tasks and secure this degree.

CERTIFICATE OF APPROVAL

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Hassan Abbas

(MCE233023)

THESIS EXAMINING COMMITTEE

S. No.	Examiner	Name	Organization
(a)	External Examiner	Dr. Muhammad Noman	IIUI, Islamabad
(b)	Internal Examiner	Dr. M. Usman Farooqi	CUST, Islamabad

Dr. Ishtiaq Hassan
Thesis Supervisor
October, 2025

Dr. Majid Ali
Head
Dept. of Civil Engineering
October, 2025

Dr. Imtiaz Ahmed Taj
Dean
Faculty of Engineering
October, 2025

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Acknowledgement

First, thanks to the most powerful and most beneficial Allah Almighty, who inculcated skills, knowledge, and endless effort in me to reach here and accomplish my research work. A special thanks to my thesis supervisor for his help, support, interest, and valuable time. Thanks for supervising and motivating me throughout the way to accomplish this thesis. I am grateful to my institute, Capital University of Science and Technology (CUST) Islamabad. I would like to thank my family for providing me with unfailing support and continuous encouragement. I would like to express my cordial gratitude towards my sweet parents and my beloved wife. I would like to thank my friends for helping and motivating me. Finally, I appreciate all the encouragement I have received from several others who have been involved in some way or another with this research work for the accomplishment of my tasks in hand.

(Hassan Abbas)

Abstract

The construction sector is a major contributor to global environmental degradation, driven by intensive energy consumption, greenhouse gas emissions, and the depletion of non-renewable resources. In Pakistan, these challenges are amplified by rapid urban expansion and widespread adoption of Modern Building Practices (MBP), which often disregard local environmental conditions and socio-cultural relevance. In contrast, Indigenous Building Practices (IBP), derived from centuries of vernacular knowledge, present a sustainable alternative that leverages locally available, climate-responsive materials and construction techniques.

This research evaluates the potential integration of IBP into contemporary construction frameworks, with a particular focus on the diverse climatic, local and traditional contexts of Gilgit-Baltistan and Islamabad. Using a mixed-methods approach comprising literature review, stakeholder consultations through the Delphi method, and structured questionnaires a comprehensive analysis was conducted. Quantitative data from construction professionals were analyzed using IBM SPSS and the Relative Importance Index (RII) with Excel Sheets to assess and prioritize the sustainability attributes of IBP relative to modern practices.

The results indicate that project management teams have a crucial role to play in enhancing indigenous and sustainable building practices (RII = 0.768) as determinants of sustainable development. Their leadership also provides appropriate enforcement and awareness of Indigenous Building Practices (IBP) in current construction. Regarding the environment and economy perspective, indigenous methods contribute to an environmentally sustainable solution and increase tourism-related economic development (RII = 0.777). Building design is powerfully influenced by social, traditional and environmental factors (RII = 0.777) and gives rise to identity and pride among communities. On the whole, IBP has the potential to become really sustainable, and it is indeed demonstrated through the strong leadership of the project, the harmony with the environment, the contribution to the economy, and the preservation of the culture.

The study recommends combining IBP with modern construction to help Pakistan build more sustainable and community-friendly buildings. This could support Sustainable Development Goal 11 (Sustainable Cities and Communities). To achieve this, the study suggests including IBP in building codes, training construction professionals, and launching pilot projects to connect traditional knowledge with modern engineering. This will help create buildings that are better for the environment, cost-effective, and culturally relevant.

Key words: Indigenous Building Practices (IBP), Sustainable Construction, Climate-Responsive Design, Green Building Integration

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Abbreviations

AEC	Architecture, Engineering, and Construction
BREEAM	Building Research Establishment Environmental Assessment Method
GBP	Green Building Practices
IBP	Indigenous Building Practices
LEED	Leadership in Energy and Environmental Design
MBP	Modern Building Practices
MCP	Modern Construction Practices
RII	Relative Importance Index
SDG 11	Sustainable Development Goal 11: Sustainable Cities and Communities
SDG	Sustainable Development Goal
SEED	Smart Energy Efficient Design
SPSS	Statistical Package for the Social Sciences
UN	United Nations

Chapter 1

Introduction

1.1 Background

The construction industry is one of the largest contributors to global environmental pollution and is responsible for significant energy consumption, greenhouse gas emissions, and the depletion of natural resources. As a result, the global climate is deteriorating rapidly, evidenced by extreme heatwaves, irregular rainfall patterns, frequent floods, wildfires, and prolonged droughts forcing populations worldwide to adapt their lifestyles [1]. This situation underscores the urgent need for sustainable construction practices to mitigate the adverse impacts of the construction sector on the environment, economy, and social fabric [2]. Indigenous Building Practices (IBP) are strongly based on the knowledge, culture, and traditions of the local communities and have developed over centuries, in accordance with the local climatic conditions and the environmental factors. These practices provide sustainable solutions which may be more energy saving, resource saving, and weather resilient than most of the Modern Building Practices (MBP) [3]. IBP are an effective way of minimizing carbon footprint of the construction industry. Compared to the contemporary construction methods, which have mainly employed cement, concrete and steel, IBP employs wood, stone, mud and other natural resources that are found locally [4]. In places such as Gilgit-Baltistan in the north of Pakistan, the materials are not only easily available, but also very appropriate to the local environmental and climatic conditions.

The mountainous nature of this region is characterized by severe winters, heavy snowfall and high seismic activity that require construction methods based on energy efficiency, thermal insulation and natural catastrophe resilience like floods, earthquakes [5].

There are different Methods which focus on thermal mass, including the use of stone and mud walls which store heat throughout the day and give it up at night, illustrates how IBP can save energy. Moreover, considerate architectural features such as the positioning and sizing of windows in the maximization of daylight are also indicative of the resource efficient and climate responsive feature of indigenous building styles [6].

Unlike IBP, the growing popularity of modern construction practices in Pakistan, especially the shift to concrete-based construction has resulted in the loss of traditional knowledge. This has brought about an increase in urban temperatures, shortage of water, energy consumption and the rise in social inequalities.

Although the contemporary building could be durable and strong when applied as per standards and codes, it often does not consider the important factors like the climate of the location, the geographical appropriateness, and catastrophe resistance. In addition, concrete and steel material is widely used and highly energy consuming thus contributing to a massive rate of environmental degradation [7].

Although the environmental benefits of IBP are obvious, their application in building contemporary construction is rare. In places such as Islamabad, the wisdom incorporated in the traditional traditions has been shunned in the mod- ern kind of construction. The situation has been aggravated by rapid urbanization and the necessity to provide reasonable housing at a low price, which has frequently focused on speed, beauty, and comfort instead of sustainability and environmental responsibility [8].

Seismic activity in regions such as Gilgit-Baltistan and Islamabad, which are prone to earthquakes, necessitates thoughtful planning in building design. Indigenous

Building Practices (IBP) have naturally evolved to enhance seismic resilience by employing materials and construction techniques that offer superior earthquake resistance compared to many Modern Building Practices (MBP). The use of, timber, and mud in traditional constructions imparts flexibility to structures an essential characteristic for absorbing and dispersing seismic forces. These materials enable buildings to better endure the dynamic loads generated during an earthquake, unlike the rigid and brittle nature of concrete and steel commonly found in modern constructions [9].

The seismic resilience of IBP is particularly significant in the context of low-rise structures (typically ground plus one story), which are prevalent in rural areas. The combination of modest building height and the strategic use of local materials enhances the likelihood of these structures withstanding seismic events with minimal damage. Research has shown that traditional Himalayan buildings often constructed with stone masonry and wooden frameworks exhibit superior seismic performance when compared to modern concrete buildings [10]. However, this advantage tends to diminish in taller structures (those exceeding two stories), where increased height and architectural complexity introduce greater seismic vulnerability. For such multi-story buildings, modern engineering approaches that incorporate reinforced concrete and steel frameworks may provide more robust earthquake resistance [11].

It is essential to evaluate the seismic compatibility of IBP in light of contemporary building codes and regulations in Pakistan. While IBP offer environmentally and culturally sustainable solutions, their seismic performance must be critically analyzed, especially for use in urban contexts like Islamabad, where the seismic threat is considerable. A hybrid approach that integrates the seismic resilience inherent in indigenous methods with modern structural technologies may present an optimal path forward balancing cultural preservation with enhanced safety in the face of natural disasters [12].

Furthermore, the integration of Indigenous Building Practices (IBP) into modern sustainability frameworks, including Green Building Practices (GBP), could address critical gaps in the current construction paradigm. While GBP have emerged to mitigate the environmental consequences of MBP, they often overlook the socio-cultural and contextual relevance of indigenous knowledge.

By embedding sustainable IBP into contemporary green and modern building strategies, the construction sector can become more environmentally responsible, economically viable, and socially and culturally aligned with the needs of local populations.

1.2 Research Motivation & Problem Statement

Climate change and resource depletion are one of the big challenges of the day. Besides modern structures having aesthetics, energy demands and resources' needs are also increasing. So, for small to medium scale building projects, the intelligent architecture is looking back on the revival of Indigenous Building Practices (IBP) and its integration with the modern demands. The IBPs are environmentally friendly, economically viable, and socially acceptable due to their local material availability and cultural identity [13].

In Pakistan, where rapid urbanization is occurring in both capital cities Gilgit and Islamabad there is an increasing demand for construction methods that are energy-efficient, cost- effective, and environmentally sustainable. However, Modern Building Practices (MBP), which are widely adopted, often fail to respond effectively to the unique environmental conditions of Pakistan's diverse climatic zones, particularly in areas like Gilgit-Baltistan where winters are long, cold, and harsh [13].

This challenge also presents a valuable opportunity to revive and integrate IBP with MBP within the construction sector. Indigenous practices from these regions offer sustainable alternatives to address pressing issues such as excessive energy consumption, depletion of natural resources, and environ- mental degradation caused by modern construction materials and methods [13]. Passed down through generations, these traditional techniques have demonstrated long-term viability and provide a climate-responsive, socially inclusive approach to construction especially relevant in regions that maintain natural ecosystems, face economic limitations, or preserve traditional ways of life [14].

Furthermore, the success of initiatives such as the Aga Khan Rural Support Program in the restoration of historical buildings in Gilgit-Baltistan, transforming them into recognized heritage sites and high-end hospitality establishments illustrates the promising potential of integrating sustainable IBP with both Green Building Practices (GBP) and MBP.

This integration not only mitigates environmental impacts but also generates local economic opportunities, fosters community empowerment through circular economies, and preserves invaluable indigenous knowledge and cultural identity [15].

The core motivation of this research is to explore how IBP can be effectively adapted and applied in Pakistan's expanding urban centers, ensuring that all dimensions of sustainability (i.e., environment, economic, & social) and cultural heritage are embedded in MBP.

Despite the proven sustainability of indigenous building practices, their integration into modern building practices remains limited due to several barriers, including policy gaps, technological constraints, and market resistance. The lack of structured research and empirical evidence further hampers their acceptance in mainstream construction.

This study seeks to address these challenges by systematically analyzing indigenous construction practices, identifying obstacles to their adoption, and proposing recommendations for their integration into contemporary construction practices. The research also explores how these methods can contribute to achieving the United Nations Sustainable Development Goal 11, which emphasizes sustainable cities and communities. Through investigation and quantitative analysis, this study will provide insights into the feasibility of incorporating indigenous knowledge into sustainable construction, ultimately contributing to environmentally responsible and culturally inclusive building practices in Pakistan.

1.3 Research Questions

The following research questions have been formulated to guide the study and address its key objectives:

1. How do IBP enhance sustainability?
2. How can IBP be integrated with MBP?
3. To what extent can IBP contribute to achieving UN SDG 11?

1.4 Research Objectives

This section outlines the key objectives formulated to achieve the aims of the study and provide a clear direction for the research.

1. To explore the sustainability (Social, Economic and Environmental) of IBP.
2. To propose practical recommendations for promoting IBP that align with SDG11 (Sustainable Cities and Communities).

1.5 Scope of Work & Research Limitations

This research focus on building projects in Gilgit and Islamabad two regions that represent significant centers of development and urbanization in Pakistan. The selection of these locations is strategically justified by the need for a comparative study that examines Indigenous Building Practices (IBP) within both urban and rural contexts.

Gilgit offers insights into the application of traditional construction methods in a rural, ecologically sensitive setting, while Islamabad provides a contrasting perspective, highlighting the challenges and opportunities. This study does not focus any framework development.

1.5.1 Contrasting Climates

Gilgit represents a mountainous region where Indigenous construction techniques are still widely practiced, especially in traditional housing and the hospitality sector. These methods reflect a deep understanding of local climatic conditions and cultural values. In contrast, Islamabad is a rapidly urbanizing metropolis where modern construction methods dominate the built environment. However, there is a growing interest in sustainable practices within the city, driven by increasing environmental awareness and policy shifts. This contrast between Gilgit and Islamabad provides a unique opportunity to explore the application, relevance, and potential integration of Indigenous Building Practices in both urban contexts.

1.5.2 Availability of Data

The Architecture, Engineering and Construction (AEC) industry is highly represented in Islamabad, providing an important access point to professional knowledge, technical skills and modern design trends. Conversely, Gilgit has become a live example, as native methods of construction have al-ready been applied on a grand scale. This is a true-life example of sustainable construction techniques that are based on local culture.

The juxtaposition of urban wisdom of Islamabad with a sensible, community-oriented prac- tices in Gilgit form a holistic approach to assessing and incorporating Indigenous Building Practices within the contemporary building paradigm.

1.5.3 Addressing Sustainable Development Goals

This study aligns with Sustainable Development Goal 11 (Sustainable Cities and Communities) by investigating how Indigenous Building Practices can be applied across both rural and urban contexts to promote more sustainable construction methods. By examining Gilgit, where such practices are already in use, the research gains valuable insight into existing sustainable approaches that serve as a benchmark. This baseline enables a comparative analysis with urban environments like Islamabad, supporting the development of sustainable strategies for future construction in diverse settings.

1.5.4 Seismic Considerations

Given the seismic significance of Indigenous Building Practices, this study focuses exclusively on structures with a maximum height of ground plus one story. Buildings beyond this height require detailed structural and seismic analysis of individual building components, which falls outside the scope of this thesis.

By limiting the study to low-rise structures, the research remains aligned with the traditional applications of Indigenous techniques while maintaining a feasible and focused analytical framework.

1.6 Research Methodology

An extensive review of existing literature was conducted to identify the most influential factors contributing to sustainability in construction. To ensure the validity and reliability of the research instrument, the Delphi method was employed for the validation of the questionnaire. The questionnaire is structured into five sections: the first gathers general demographic and professional information about the respondents. The second section explores general perceptions of sustainability in relation to the indigenous and modern sustainable practices. The third section focuses on environmental sustainability, while the fourth and fifth sections address economic and social sustainability, respectively. The questionnaire has been distributed to reputable firms and professionals in the construction industry across both Islamabad and Gilgit to obtain credible and context-specific feedback. Upon completion of data collection, both descriptive and statistical analyses have been carried out using SPSS to identify the key indigenous construction factors that contribute to enhancing sustainability.

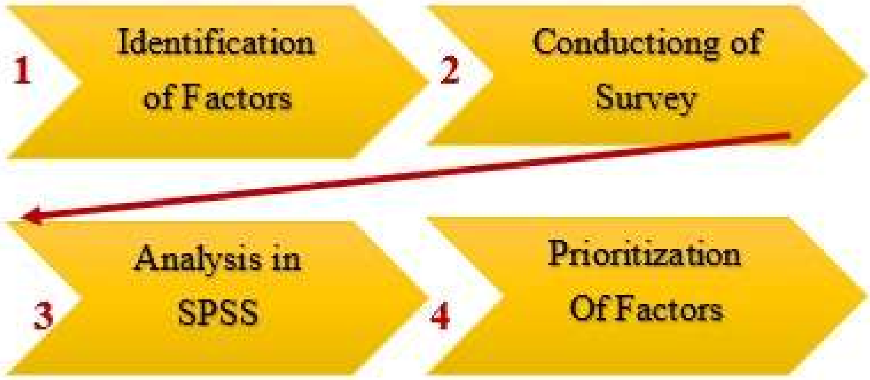


Figure 1.1: Methodology of Research

This study will adopt a quantitative research approach, utilizing structured questionnaires and interrogative methods to gather empirical data. Relevant departments, organizations, and individuals actively engaged in sustainability within the construction sector will be approached to contribute to the research. The aim is to gather insights on the challenges and opportunities associated with integrating Indigenous Building Practices (IBP) and Modern Building Practices (MBP) to enhance overall sustainability in the construction industry. Their feedback will play a critical role in shaping an informed understanding of how traditional and modern methods can be harmonized for more sustainable outcomes.

Following steps have been followed:

1. Data collection and pilot study (literature review & questionnaires).
2. Analysis of data using SPSS (descriptive and statistical analysis).
3. Conclusion and recommendations on the basis of results obtained.

1.7 Thesis Outline

Chapter 1: Introduction

This chapter provides the entire review of the research, including the background and the motivation behind the investigation into Indigenous Building Practices

(IBP) and their role in the modern-day sustainable building. It presents the main research questions, the environmental benefits of IBP, and the difficulties related to the process of implementing these practices in the contemporary construction technique. The chapter further describes the objectives of the study and explains the methodology to be used in the study, which includes a mixed-methods approach to collect both qualitative and quantitative data on the construction industry practitioners.

Chapter 2: Literature Review

The chapter provides a review of the available literature on Indigenous Building Practices (IBP), sustainable construction, and seismic resilience, focusing on indigenous buildings, in particular. It also covers the Sustain- ability certification in the world such as LEED, BREEAM and SEED in Pakistan and comparisons of their various facets of Sustain- ability. It draws the attention to the environmental, economical and social value of IBP, their role in the decrease of energy consumption, and the difficulties that might be encountered in implementing these practices in contemporary construction. It further discusses the SDG 11 role in improving sustainability practices and IBP in the SDG 11 implementation. Additionally, the chapter also analyzes the green building certifications, their importance and compares their efficacy to the conventional construction practices when it comes to promoting the sustainability of the construction practices.

Chapter 3: Materials and Methods

In chapter 3, the design and methodology used to explore the incorporation of Indigenous Building Practices (IBP) into contemporary construction is described. It gives a clear account of how the data was collected, surveys were made with the stakeholders in the industry and how data were to be analyzed using statistical tools, which in this case are SPSS. Also, the chapter introduces buildings built with IBP in Gilgit- Baltistan to assess their performance in terms of environment, economy, and society.

Chapter 4: Results and Discussion

This chapter outlines the research outcomes, highlights the uses of In- digenous Building Practices (IBP) in improving sustainability factors and seismic resilience. It addresses the findings of the quantitative study, the performance of the IBP against the contemporary building practices. The challenges that were observed in the study such as economic, Social and tech- nical barriers to the implementation of IBP, and possibilities of integrating traditional practices with modern practices so as to optimize sustainability construction practices are also discussed in the chapter.

Chapter 5: Conclusion & Recommendations

This chapter summarizes the key findings of the research, highlighting the environmental and economic benefits of integrating Indigenous Building Practices (IBP) with modern construction methods. It offers recommendations for policymakers, construction professionals, and communities to encourage the adoption of IBP in sustainable building initiatives. The chapter concludes with suggestions for future research, including the adaptation of IBP to construction in different regions with consideration of local climatic conditions, as well as further investigation into the long-term performance of hybrid structures.

Chapter 2

Literature Review

2.1 Background

Indigenous building practices are the traditional construction materials and methods that have been developed by the local populations throughout the centuries of interaction with the surrounding environment. These techniques are founded on a thorough knowledge of nature and use of the resources locally available, including clay, stone, timber and agricultural waste [3]. The ultimate goal of such approaches has continuously been to design buildings that are both practical and sustainable as well as congruent to the environmental, economic, social and cultural backdrop of the society in which they are set [4].

Such practices are considered to be sustainable since they have minimum environmental impact. They minimise waste production, use renewable resources and need minimal amounts of energy to be built in comparison with the modern building practices (MBP), and thus they are intrinsically more environmentally friendly [16], [17]. The world's indigenous peoples have developed their methods of construction based on the local climate and using the materials that are available in the area. As an example, mud and clay are typically employed to build houses in Africa, helping to control excessive temperatures by taking in and giving off heat a practice that is quite common in places such as the Sahel [18]. Likewise in Southeast Asia, populations are using bamboo and thatch in the building of houses. materials highly adapted to the conditions in tropical areas and provide a compromise between resilience and versatility [19].

In the last few decades, there has been an increasing interest in the concept of introducing Indigenous Building Practices (IBP) into modern building practices as a sustainable answer to environmental issues that the modern construction industry presents to the environment. Not only are these time-honored approaches of Cultural importance, but also very sustainable because of their low impact on the environment. As an example, IBPs use local and renewable materials that may need a minimum or no transportation, or extensive industrial treatment that leads to carbon emissions in contemporary construction [20][21].

Moreover, the native building methods tend to utilize passive design methods that utilize the natural power like the ventilation, daylight, and thermal mass to improve the energy efficiency [22]. One of the key elements of IBP is the use of local knowledge and experience which is the manifestation of deep knowledge of the local environmental conditions and ecological processes.

The structures have been developed over centuries of trial and error creating structures that are naturally adapted to their particular climatic conditions. Such local construction expertise can play a great role in supporting sustainable development through encouraging the creation of designs that do not rely on non-renewable resources, energy, and water consumption [23].

In addition, IBPs often incorporate biodegradable or recycled materials, which mean that the amount of construction waste is smaller than that of Modern Building Practices (MBP), which usually creates non-recyclable significant quantities of waste [24].

However, in the recent times, there have been attempts to fill the gap between IBP and MBP. Through these obstacles, one can create construction methods which are not only environmentally friendly, culturally sensitive, but also in line with the current laws and standards of living [19]. Incorporation of indigenous techniques into contemporary design does not only aid environmental agenda, but also reinforces the cultural identity. In most communities, these activities are closely integrated into the local cultures, social ethics and traditional crafts and are a living manifestation of culture [23].

The conservation and implementation of the indigenous practices enables the societies to stay connected to the past and promote sustainable development. With the increasing adoption of sustainable models in the construction industry, including those of Green Building Practices (GBP), indigenous approaches provide a useful contribution and practical solutions to building resilience, energy-efficiency, eco-friendliness, and culturally suitable structures in the global context [19].

2.2 Indigenous Building Practices

IBP in Pakistan, as in most other parts of the globe, has developed centuries over a rich association with the geography, climatic conditions, and available materials of the region. This is located in the north of Pakistan and supports climate adaptable populations who have constructed and maintained building techniques that are uniquely appropriate to the extreme cold of one of the highest mountainous landscapes in the world [25].

Such practices show deep knowledge of the surrounding environment, and they were based on the materials of nature which were easy to access like stone, timber, clay, and mud. These materials have also been chosen based on their accessibility as well as their capacity to withstand the hot climatic conditions and seismic activity of the region that are characteristic of mountainous terrain [26].

Many centuries of indigenous building in the area have been marked by massive stone under carrying, with the top construction of wood and clay. The architecture design is usually characterized by flat roofs that are resistant to heavy snow in the winter season against strong winds and thick walls that offer efficient insulation. These native practices have shown a great success in mitigating the environmental problems of the area, as the people have a close connection to their natural environment [19], [25].

2.2.1 Cultural Significance of Traditional Building Methods

Gilgit-Baltistan has Indigenous Building Practices (IBP) that are closely related to the customs, heritage, and social structures. The architecture of traditional houses and buildings reflects the identity, values and the long-term sustainability praxis of the communities of the area. Such buildings are also very strong icons of community life, culture, and stability [25].

To give an illustration, both the aesthetic preferences and also a demonstration of the culture can be seen through the wooden balconies of Altit Fort, the complex carvings, observed in Shigar and Khaplu forts, which depicts how generations have developed in terms of craftsmanship [27]. These construction practices and the artistic skills were in the past passed on by the master craftsmen to their apprentices to maintain the local knowledge thus ensuring continuity of this knowledge by the community [16].

So, they are not just shelters but physical representations of local culture and history, the stories and experiences of the people who constructed them and lived in them [28].

2.2.2 Case Studies Highlighting Indigenous Restoration and Practices

The restoration of historical forts in Gilgit-Baltistan such as those in Hunza, Shigar, and Ghanche serves as an excellent example of how Indigenous Building Practices (IBP) can be revived and integrated into sustainable conservation efforts. These restoration projects, undertaken by the Aga Khan Rural Support Program (AKRSP), highlight the resilience of traditional architecture and its vital role in promoting both cultural preservation and environmental sustainability in the region [25]. Saidpur is a historic village located near Islamabad, Pakistan, known for its cultural heritage and scenic surroundings. The village has recently seen sustainable development projects iniciated by CDA Capital development authority

[29]. Malik, R. N., & Haiao, Z. (2022).that aim to preserve its traditional charm while adopting eco-friendly practice [30].

2.2.2.1 Altit Village

Among the attractions in the ancient village of Altit in the Hunza Valley are mighty Altit Fort, which has gone through an amazing transformation that epitomizes the fusion of indigenous construction, community renewal and sustainable development. One of the oldest buildings in Gilgit-Baltistan that can serve as a significant reminder of the rich local culture and architecture is the Altit Fort which is thought to be more than 900 years old [25].

The village had, too, prior to its rehabilitation, lost a large part of its area; almost one-third of the houses were already not in use, and new edifices were continually absorbing the little arable land [27].

As an anticipatory measure to the socio-economic compulsions linked with increased tourism content of improvements, the Aga Khan Cultural Service Pakistan (AKCSP) has initiated a village rehabilitation program pre-empting the conservation of the fort. This project brought in es- sential infrastructure such as water supply and sanitation infrastructure that were critical in restoring the village and re-linking the village to its traditional built environment [28].

The restoration of Altit Fort, completed in 2010, was firmly rooted in the use of indigenous materials and traditional construction techniques. The conservation process focused on structural stabilization, repairing walls, selectively replacing roofs, treating wood, and incorporating discreet, energy-efficient lighting. Notably, the project preserved the fort's "empty shell" to showcase its original engineering methods, such as wooden beam structures, mud plastering, and dry-stone masonry techniques designed to endure the region's harsh winters and seismic activity [25], [31].

A defining feature of this restoration effort was its community centered approach. The Kha Basi Café, located in the terraced gardens of the fort, repurposes the

Mir's former colonial-era winter residence and serves traditional local cuisine. This initiative not only enhances cultural interpretation for visitors but also generates economic opportunities for residents. Revenue from entrance fees to both the fort and the rehabilitated village directly supports the Altit Town Management Society, which manages the ongoing maintenance of water and sanitation infrastructure with active community participation [15], [28].

The success of the Altit Fort restoration was internationally recognized when it received the UNESCO Asia-Pacific Award of Distinction in 2011, honoring its sensitive and sustainable conservation model. Like Altit fort Baltit fort centuries year-old structure also restored by AKCSP using indigenous techniques such as timber framing and local stone masonry. Altit Fort today stands not only as a preserved historical monument but also as a model for sustainable heritage conservation. These projects emphasize the value of local craftsmanship, community ownership, and cultural resilience [27], [31].

Figure 2.1: Photographs of Altit Fort restoration

(Source: https://archnet.org/sites/5325/media_contents/42156 (accessed 5 May 2025, AKRSP) (https://the.akdn/en/where-we-work/south-asia/pakistan/cultural-development-pakistan)

2.2.2.2 Shigar Valley

Located in the heart of Baltistan's Shigar Valley, Shigar Fort locally known as Fong Khar, or "the palace on the rock" stands as an example of indigenous architecture, cultural continuity, and sustainable restoration. Stands on a massive boulder at the base of a dramatic cliff and situated along the historic route to K2, this 17th-century fort was originally constructed as the royal residence of the Amacha dynasty, the ruling family of the region [25].

The restoration of the fort was done by the Aga Khan Cultural Service Pakistan (AKCSP-P) under the Aga Khan Historic Cities Program, and the purpose was distinctly important; to preserve the architectural heritage of the site, but to modernize it to use today. It cost approximately USD 1.4 million and the project was designed to remodel the historic building into a five-star heritage hotel and cultural center without destroying the historical character and identity of the building [27].

The unique feature of the restoration was the exclusive use of local materials and the ancient methods of building. The project used the local timber and stone that were used initially to build the fort and retained major wooden components and displayed the traditional Balti craftsmanship. This strategy also provided the assurance that the architectural and cultural heritage of the site were properly maintained [15], [28].

Reflecting AKCSP's broader vision of community-based development, the Shigar Fort restoration project turned a historic monument into a vibrant cultural hub serving both local communities and visitors. Today, the fort is managed by Serena Hotels and functions as a cultural museum and luxury boutique hotel. It offers guests an immersive experience that blends the elegance of Balti royal architecture with modern hospitality [31].

As a model of sustainable heritage preservation, Shigar Fort demonstrates how thoughtful, culturally sensitive restoration can honor historical values, fulfill contemporary needs, and contribute to the cultural and economic vitality of the region [25], [31].

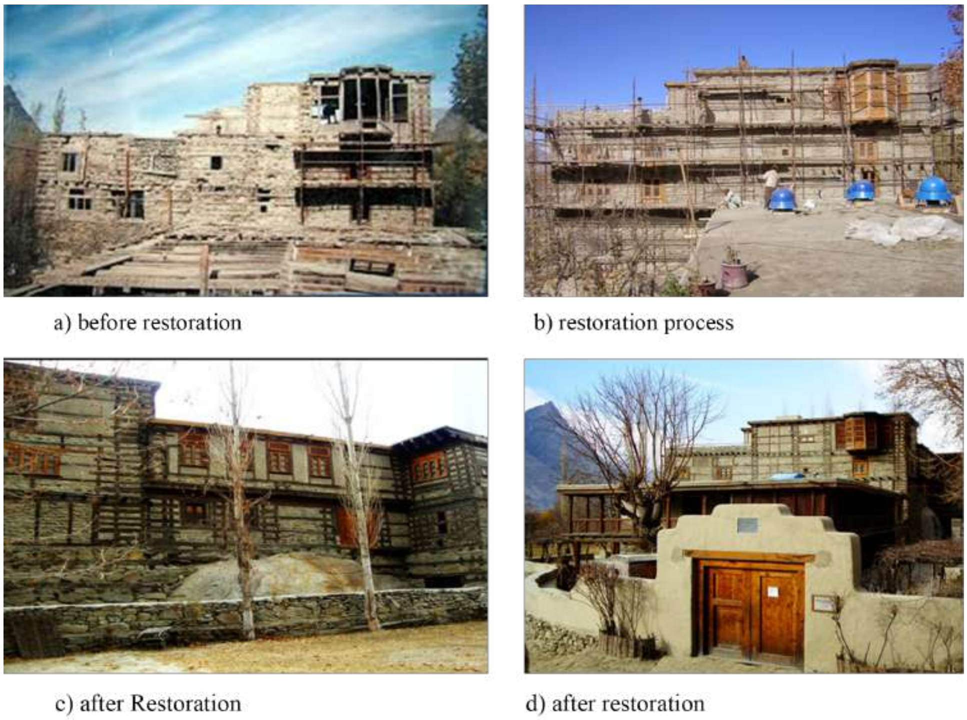


FIGURE 2.2: Photographs of Shigar Fort restoration.

(Source: https://archnet.org/sites/5325/media_contents/42156 (accessed 5 May 2025, AKRSP) (https://the.akdn/en/where-we-work/south-asia/pakistan/cultural-development-pakistan)

2.2.2.3 Khaplu Valley

Located in the scenic Khaplu Valley of Baltistan, Khaplu Palace constructed in 1840 remains one of the finest surviving examples of royal Balti architecture. Originally built as a presidential palace for the Raja of Khaplu, the structure reflects a distinct architectural identity that blends Tibetan, Kashmiri, and indigenous Balti styles. Its construction made extensive use of locally sourced materials, including stone, timber, and clay from the surrounding landscape [25].

By 2005, the palace had deteriorated significantly. Recognizing its cultural and historical importance, the Aga Khan Trust for Culture (AKTC) and the Aga Khan Cultural Service Pakistan (AKCSP) launched an extensive restoration project. This was not a mere effort to preserve the architectural integrity of the palace, but also an attempt to integrate it back into the cultural and economic life of the region [27].

The renovated Khaplu Palace became a 21-room heritage house in July, 2011 as part of Serena Hotels Tourism Promotion Services (TPS) and creates a remarkable combination of exotic hospitality and historical conservation. The restoration placed a special emphasis on use of local materials and old traditional construction techniques such as Balti carpentry and wood joinery, and stone masonry. The active participation of the local artisans and craftsmen was encouraged rejuvenating the traditional skills besides encouraging local employment and local involvement [15], [28].

These efforts demonstrated how community-led, cost-effective improvements using local labor and resources can successfully rehabilitate traditional buildings for modern use without compromising their heritage value. The project's commitment to environmental sustainability, economic inclusiveness, and cultural continuity further enhanced its impact. In recognition of its excellence in conservation, Khaplu Palace was awarded the UNESCO Asia-Pacific Heritage Conservation Award in 2013, underscoring the region's growing reputation for responsible tourism and heritage stewardship [31].

FIGURE 2.3: Photographs show Khaplu Fort restoration.

(Source: https://archnet.org/sites/5325/media_contents/42156 (accessed 5 May 2025, AKRSP) (https://the.akdn/en/where-we-work/south-asia/pakistan/cultural-development-pakistan)

The restoration projects in Hunza, Shigar, and Khaplu demonstrate how indigenous construction practices can play a vital role in the sustainable revival of heritage buildings. By combining traditional building techniques with modern conservation strategies, these historic forts have not only been preserved but have also been reactivated as key contributors to the cultural and environmental sustainability of the region [32].

Central to the success of these initiatives is the use of locally sourced materials, active involvement of local communities, and a strong emphasis on sustainability. These efforts showcase how the integration of indigenous architecture into contemporary practices can offer valuable solutions for sustainable building in today's world.

2.2.2.4 Saidpur Village

Saidpur is an ancient village situated around Islamabad, Pakistan and it is characterized by its cultural background and beautiful environment. Recently, the village has witnessed sustainable development projects that are geared towards maintaining the traditional beauty of the village but in an environmentally friendly posture. Saidpur buildings are built using local construction materials such as the mud bricks, stone, bamboo and recycled wood [29]. Not only are these materials cost-effective, but also they are used to preserve some natural insulation to keep interiors cool in summer and warm in winter. The methods of construction are passive solar de- design, natural ventilation and energy efficient layouts. It uses solar panels and rainwater harvesting systems to minimize the use of non-renewable resources. These are approaches that reduce the effects of environmental degradation and promote sustainable development [30]. Using used material also contributes towards waste reduction and conservation of resources. Local labor is also more beneficial in enhancing the economy of the community. The project shows how tradition and modern sustainability may co-exist. It can be used as a prototype of green rural development in Pakistan. As a whole, Saidpur is an example of a careful compromise between the conservation of heritage and green Innovation [29, 30, 33].

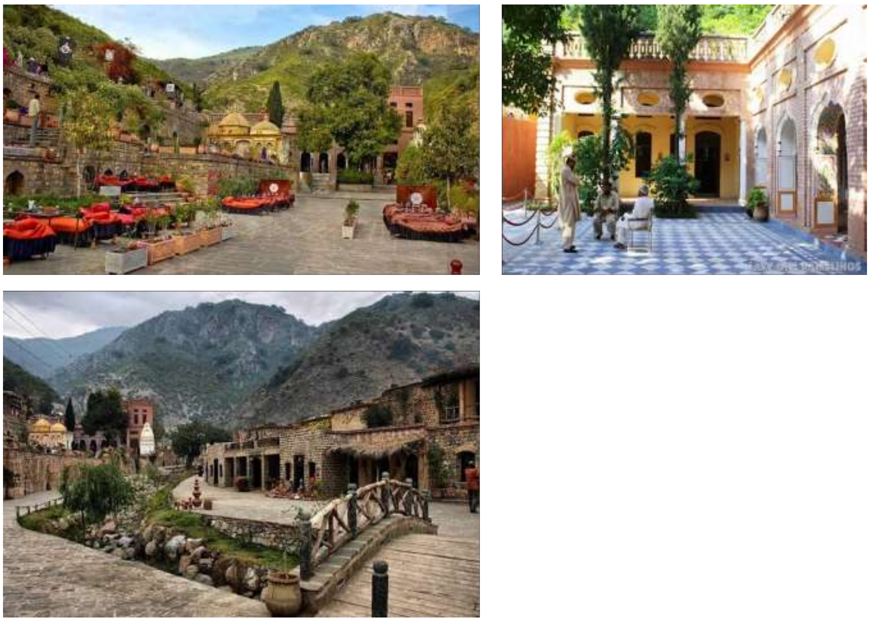


FIGURE 2.4: Photographs show Saidpur Village restoration [29, 30].

2.3 Sustainable Building Practices and Its Pillars

Sustainable building practices (SBP) represent a transformative approach in the construction sector, integrating environmental, economic, and social dimensions to minimize the industry's negative impact on the environment. According to recent studies, SBP focuses on reducing resource consumption while enhancing building efficiency and promoting the health of occupants [34].

Key components of sustainable building practices include energy-efficient design strategies, such as passive solar heating and natural ventilation, which reduce dependence on nonrenewable energy sources [35]. Additionally, conserving natural resources during construction plays a crucial role, emphasizing the use of recycled materials and water-saving techniques like rainwater harvesting [36]. The incorporation of locally grown, fast-growing materials, such as bamboo, further lowers the carbon footprint associated with building projects [37][38].

These interconnected practices collectively aim to create buildings that are environmentally sustainable, economically viable, and socially equitable.

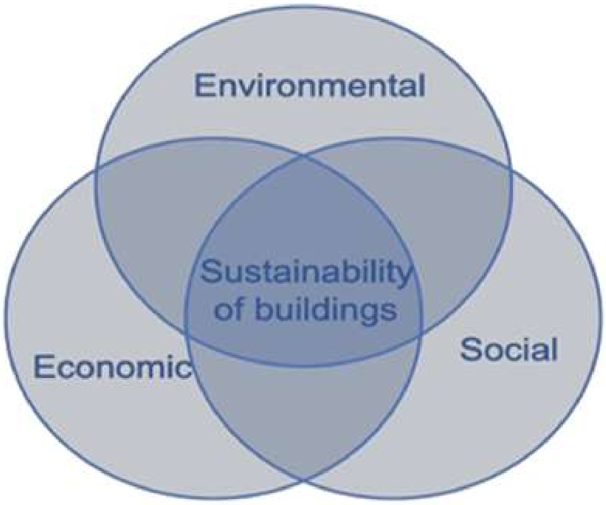


FIGURE 2.5: Three pillars of building sustainability [38]

2.4 Environmental Sustainability

The environmental indicator encompasses integrated development in relation to land use, material selection, climate responsiveness, and water management. It evaluates the energy consumption throughout the entire lifecycle from site preparation and material procurement to the building's operational and maintenance phase [39]. The energy efficient building is critical strategy in reducing environmental effects of buildings and its built environment and addressing the challenges of climate change.

The integration in building process enhances the exploration of different energy saving techniques to optimize building performance which result in reduce environmental concerns [40]. The passive solar design is a best strategy that utilize maximum natural heat gain and loss by window orientation, and door placement. By using solar absorbing materials and position window and building can minimize the need of artificial heating and cooling system [41]. The retrofitting of indigenous structure in Siena Italy with passive solar elements reduces energy consumption by 25% [42]. Another study conducted by [43] investigates that different retrofitting techniques and present effective and feasible method in energy efficiency of existing building is adding insulation layers at the ceiling. Building energy standards play a crucial role in reducing energy consumption and are widely adopted in developed countries as a key instrument for promoting sustainable and energy-efficient building design.

However, their implementation in developing countries remains limited and unclear. Moreover, a significant sustainability gap persists between existing building stock and the growing demand for energy-efficient and sustainable buildings [44].

FIGURE 2.6: Scheme of 5R principle for construction and buildings [38]

2.5 Economic Sustainability

Economic considerations represent another essential dimension of sustainability, with the circular economy (CE) gaining traction within sustainable building practices (SBP). Sustainable construction faces economic challenges at multiple levels. At the macroeconomic scale, industrialized nations actively pursue sustainable construction objectives amid a general decline in construction output. In contrast, construction activity is increasing in less developed and newly industrialized countries, where economic and developmental constraints make sustainable construction more difficult to implement [45].

Despite growing interest, demand for sustainable construction remains relatively low in practice. Barriers include limited awareness of its economic benefits, high upfront capital costs, and perceptions of lower market value compared to conventional buildings, leading to stakeholder hesitance. Many developers view sustainable projects as riskier, costlier, and more difficult to finance. Although life cycle costing effectively illustrates long-term value, it provides limited insight into short-term financial returns. Furthermore, the lack of accurate cost and value data impedes clients' ability to make well-informed sustainability decisions [46].

Sustainable building integrates circular economy principles to enhance resource efficiency by promoting the reuse and recycling of materials. Designing buildings for disassembly facilitates the recovery of components, thereby reducing waste and embodied environmental impacts [47]. However, despite these economic advantages, implementing circular economy practices within the construction industry faces significant challenges. These include design limitations, material selection constraints, supply chain coordination issues, underdeveloped business models, uncertainties and risks, weak stakeholder collaboration, and general knowledge gaps. Additional barriers encompass insufficient policy support, lack of integration with urban planning concepts, and the absence of standardised evaluation methodologies [48][49].

Figure 2.7: Highlight significant reduction of cost of sustainable construction [34]

2.6 Social Sustainability

Social sustainability is a fundamental aspect of residential design, promoting community interaction, cultural identity, and overall social well-being. However, many modern developments often overlook these factors, resulting in fragmented communities. Traditional housing models demonstrate how spatial design can support social cohesion, and integrating such principles can improve the livability and inclusivity of contemporary architecture [50].

Indigenous construction practices contribute significantly to social sustainability by advancing health, safety, equity, cultural continuity, and community cohesion. These practices encourage local participation, preserve traditional knowledge, and strengthen social ties within communities. Empirical studies using structured assessment tools indicate that indigenous settlements often achieve satisfactory levels of social well-being, underscoring the importance of developing context-specific indicators to better capture the social values embedded in indigenous building practices [51]. For example, indigenous wooden houses support stronger social bonds through communal living and shared cultural customs, enhancing residents' sense of belonging and fostering intergenerational connections. In contrast, contemporary masonry houses tend to encourage more individualistic lifestyles, which may weaken community ties [52].

Indigenous building methods play a vital role in preserving cultural identity and reinforcing community cohesion. Traditional construction reflects local values, histories, and social structures, fostering a strong sense of belonging and continuity. Some researcher emphasis that this type of architecture promotes cultural resilience and social inclusion by embedding intangible heritage within physical spaces, thereby enhancing the long-term social sustainability of Indigenous communities [53].

Community involvement is a key feature of Indigenous building methods. Johnson and Lee (2023) highlight that engaging local people in design and construction fosters social equity and a sense of ownership [54]. This social engagement encourages shared responsibility and ensures that buildings meet the actual needs of the community, leading to more sustainable and socially cohesive outcomes. Social sustainability in construction also emphasizes community empowerment through inclusive participation and local employment. Utilizing local labor nurtures self-reliance, builds trust, and ensures development aligns with community needs, while also providing meaningful opportunities that help retain youth within the region. This approach strengthens social cohesion and promotes long-term resilience [19].

These eco-friendly strategies support social sustainability by linking physical health with environmental stewardship, thereby contributing to the development of resilient communities.

2.7 Global Sustainable Buildings Certifications

Buildings have significant direct and indirect effects on the environment. Throughout their lifecycle, including construction, occupancy, renovation, repair and demolition, they consume energy, water, and raw materials, produce waste, and release potentially harmful emissions into the atmosphere.

These concerns have led to the development of sustainable b building standards, certifications (Green Building Standards) and rating systems designed to reduce the environmental impact of buildings through sustainable design practices [55].

2.7.1 LEED

The Leadership in Energy and Environmental Design (LEED) certification system was established in the United States in 1998 by the U.S. Green Building Council (USGBC), a non-profit, non-governmental organization dedicated to advancing sustainability in the construction and building industries. Today, the USGBC aims to transform the design, construction, and operation of buildings and communities to promote sustainability, social responsibility, and long-term prosperity throughout their entire lifecycle.

The LEED rating system employs a flexible, point-based approach to evaluate how effectively a building project incorporates sustainable design and environmental performance. Projects can earn up to 110 points based on the green strategies and technologies they implement, with certification awarded at one of four levels reflecting the degree of sustainable performance. A project scoring between 40 and 49 points achieves LEED Certified status, denoted by a green badge. Scores between 50 and 59 points qualify for Silver Certification, represented by a silver or grey badge. Projects earning between 60 and 79 points receive Gold Certification, symbolized by a gold badge. The highest recognition, Platinum Certification, is awarded to projects scoring between 80 and 110 points and is marked by a platinum badge [56].

These points not only determine certification status but also signify a project's overall commitment to sustainability, setting a benchmark for future environmentally responsible developments. LEED v5 builds upon over 25 years of leadership in sustainable building, continuing its mission to foster a healthier, more resilient future. The latest version prioritizes critical global challenges such as reducing carbon emissions, enhancing quality of life, and protecting and restoring ecosystems [57].

While introducing innovative approaches, LEED v5 maintains the rigorous standards that have established it as the world's most trusted and influential green building certification system [58].

2.7.2 BREEAM

The Building Research Establishment Environmental Assessment Method (BREEAM) is one of the world's earliest and most widely recognized green building certification systems. It evaluates buildings across a comprehensive set of categories, including energy efficiency, occupant health and well-being, pollution control, transportation access, sustainable materials, waste management, water use, land use, and ecological impact. BREEAM assigns ratings ranging from Pass to Outstanding, with Pass: 30%-4%. Good: 45%-55%. Very Good: 555-70%. Excellent: 70%-85%. Outstanding: above 85%, providing a clear and accessible measure of a building's overall sustainability performance [59].

Furthermore, the system assesses a building's resilience to climate change and rewards innovative sustainability solutions. Collectively, these criteria ensure a holistic and environmentally responsible approach to building performance.

2.7.3 Green Building Certification in Pakistan

In Pakistan, the design guidelines for green buildings (GBs) are primarily developed by the Pakistan Green Building Council (PGBC). The PGBC plays an active role in shaping local standards and advancing Pakistan's green building movement. Pakistan has been progressively addressing environmental challenges, and today, approximately 18 to 20 buildings in the country are LEED-certified and registered with the U.S. Green Building Council. Notable examples include the British Council Library in Lahore, NCC Mega Corporate Office, Karachi Citi Plan, the Coca-Cola Pakistan Icecap Plant in Multan, and the World Bank's country office in Islamabad [60].

The Pakistan Green Building Guidelines feature four certification levels based on the total points a project earns out of a possible 100. These certification levels reflect the degree to which a building meets sustainability criteria and encourage ongoing improvements in design and performance [60].

1	Integrative Project Management Process
2	Sustainable Transportation & Location
3	SUSTAINABLE SITE DEVELOPMENT
4	WATER MANAGEMENT & EFFICIENCY
5	ENERGY EFFICIENCY & MONITORING
6	NATURAL RESOURCES & MATERIALS
7	INDOOR ENVIRONMENTAL QUALITY
8	INNOVATION & DESIGN PROCESS

FIGURE 2.8: SEED Rating Criteria

Pakistan Green Building Council, "PGBC Guidelines," Pakistan Green Building Council, [online]. Available: https://pakistangbc.org/pgbc-guidelines.php. [Accessed: May 20, 2025].

The certification levels are as follows:

- Silver: 40–49 points
- Gold: 50–59 points
- Platinum: 60–69 points
- Titanium: 70 points and above

2.7.4 Conclusion

Sustainable building is a revolutionary move to the construction industry with consideration of the environment, economic sustainability and social. equity. These practices seek to reduce the environmental impact and maximise the performance and well-being of occupants and buildings by incorporating strategies like passive solar design, resource efficiency and circular economy.

This approach is based on the three pillars of sustainability environmental, economic, and social which help create long-term resiliency and value. Such international certification schemes as LEED and BREEAM offer a holistic system to assess and direct the practice of sustainable construction. The Pakistan Green Building Council (PGBC) is significant in Pakistan in modifying these global norms to the local environments to facilitate green development with clear levels of certification. Despite the financial limitations and lack of awareness, specific policies, and working with communities can speed up the pace of adoption.

Finally, sustainable buildings are not just about the building but rather are initial step to a healthier society and a more sustainable future.

2.8 Hurdles in Adopting Sustainable practices IBP & GBP Practices

Despite the pioneering role of Indigenous Building Practices (IBP) in advancing environmental, economic, and social sustainability for thousands of years, several barriers hinder their adoption within modern building practices (MBP) worldwide. One primary obstacle is limited stakeholder awareness, alongside the limited availability of sustainable materials, as identified by Olawumi and Chan [61].

Stakeholder engagement during the planning phase is also critical; a study [62] found that insufficient collaboration among clients, contractors, and suppliers often detracts from sustainability goals. Therefore, effective communication is essential to align project objectives with sustainability targets.

Shifting public opinion is especially important in underdeveloped countries, where many remain unaware of sustainable building design.

In this context, architects play a vital role as educators and advocates, sharing real-world success stories and emphasizing the broader benefits of sustainability. Buildings must be designed to fit local cultures, climates, and traditions, making sensitivity and adaptability fundamental [63].

Another significant barrier to adopting IBP lies in the limitations of conventional sustainability assessment tools such as LEED and BREEAM. These frameworks, designed primarily for modern construction systems, employ standardized indicators that often fail to capture the environmental and socio-cultural benefits of traditional techniques. Their urban-centric bias and rigid quantification methods tend to undervalue indigenous solutions, particularly regarding passive climate responsiveness, material circularity, and community-embedded sustainability [64].

A study [65] further reveals that the slow construction processes inherent in IBP limit their application in urban contexts, where rapid construction is needed to meet high demand. Conversely, in rural areas where IBP have historically demonstrated sustainability and climate sensitivity the lack of skilled labor, training, and versatile material options constrains wider adoption.

Human factors such as governmental neglect, cultural dynamics, public indifference, and a lack of awareness among property owners about the historical and cultural significance of vernacular architecture further impede the preservation and application of IBP [66].

[67] propose several key measures to overcome these challenges. Foremost is raising public awareness about green initiatives through seminars, workshops, and open discussions. This is complemented by the need for mandatory green building codes and regulations. Additionally, government-backed financial incentives, such as soft loans and tax benefits, can encourage sustainable practices. Comprehensive training programs for engineers, developers, and policymakers in green building technologies are also vital. Finally, respondents emphasize the importance of robust institutional frameworks to ensure effective implementation of these guidelines.

2.9 Comparison of Green Building Practices and Indigenous Building Practices

There are various practices and standards through which sustainability can be promoted among them the major and pioneer practices are Indigenous building practices which has been practiced over centuries by indigenous people evolved through years of connection between environment and people. Meanwhile the green building practices are the result of environmental degradation by modern building practices (MBP) by using industrial materials which have high carbon footprint from initial stage to the final stage of its service. This section will cover the major differences among both practices in achieving sustainability.

TABLE 2.1: Shows Comparison of Indigenous and Green Building Practices

Sr.	Aspect	Indigenous Practices Findings	Green Building Practices Findings	Key Difference	Ref.
1	Energy Efficiency	Traditional courtyard houses reduce cooling loads by 30-40% in hot climates	LEED-certified buildings achieve 20-30% energy savings	Indigenous = passive design; Green = technology-dependent	[50]
2	Social Sustainability	Wooden houses in Munshi Ganj show stronger community ties (satisfaction)	Modern masonry scores lower (62%) on social metrics	higher social sustainability in IBP	[52]
3	Cultural Preservation	heritage values maintained in indigenous techniques	Only 12% cultural relevance in certified green buildings	better cultural preservation	[53]
4	Implementation Costs	IBP cost 40-60% less than conventional	LEED certification adds 15-20% to project costs	more affordable	[55]
5	Certification Process	No formal rating systems for IBP	LEED v5 has 100+ compliance metrics	Indigenous lacks standardization	[58]

Table 2.1 continued from previous page

Sr.	Aspect	Indigenous Practices Findings	Green Building Practices Findings	Key Difference	Ref.
6	Market Perception	Viewed as ”out-dated” by of urban developers	82% of architects prefer green-certified projects	perception gap	[68]
7	Barrier Severity	material sourcing challenges for large scale	high certification costs as main barrier	Indigenous = supply chain issues; Green = financial hurdles	[61]

The comparison between indigenous and green building methods reveals insightful contrasts in approaches to sustainable construction. Traditional techniques excel in naturally regulating indoor temperatures; for instance, studies indicate that courtyard houses can reduce cooling needs by 30–40% in hot climates [50]. They also contribute significantly to social cohesion, with residents of traditional wooden houses reporting an 85% satisfaction rate compared to just 62% among occupants of modern masonry homes [52].

Importantly, indigenous methods preserve approximately 78% of cultural heritage values, far exceeding 12% preservation typically found in certified green buildings [53]. From a financial perspective, vernacular construction is considerably more accessible, costing 40–60% less than conventional building methods [55].

Modern green building practices, however, offer distinct advantages. LEED-certified buildings achieve consistent energy savings of 20–30% [58] and benefit from strong market appeal, with 82% of architects expressing preference for such projects [68]. Yet, these benefits often come at a premium certification process can increase project costs by 15–20% [55], and 76% of builders cite financial constraints as a major barrier to adoption [61].

While traditional methods face challenges in sourcing suitable materials for large scale usage, with 92% of builders reporting difficulties in commercial and market applications [61], green building practices grapple with higher costs and greater complexity.

These findings highlight a promising opportunity for synthesis. By integrating time-tested indigenous building practices with selectively applied modern building practices, can both honor cultural heritage and meet contemporary standards for efficiency and sustainability.

Moving forward, policies are essential to address the unique challenges of integration whether by supporting artisan networks to sustain traditional building skills or by providing financial incentives to sustainable practices adoption.

2.10 The Role of IBP in Achieving SDG 11

The United Nations' 2030 Agenda outlines 17 Sustainable Development Goals (SDGs) and 169 specific targets, providing a comprehensive roadmap for achieving global sustainability. At its core, the agenda recognizes that challenges such as poverty, hunger, health, education, gender inequality, and environmental degradation are deeply interconnected. Addressing these issues in isolation is insufficient; meaningful progress requires a coordinated, integrated approach [69]. The success of the 2030 Agenda depends on how effectively these goals are implemented as a unified framework.

Sustainable Development Goal 11 (SDG 11) targets the achievement of inclusive, safe, resilient and sustainable cities and human settlements. It focuses on affordable housing, efficient transportation, and availability of green urban areas and the goal is to mitigate urban inequities and enhance resistance to climate-related catastrophes. SDG 11 is encouraging city planning that is sustainable to both the environment and the people [69].

In recent years, sustainable development and Indigenous Building Practices (IBP) have gained recognition as vital components for achieving affordable and environmentally friendly housing solutions, especially within the framework of SDG 11 prism [70]. Such an indigenous building method is the core of developing sustainable cities and communities, as it is closely linked to the local culture, the local environment and the resources. Traditional practices are naturally sustainable solutions that offer affordable, socially responsible and inclusive of the environment hous- ing solutions due to their development over centuries to fit particular climates and social requirements [71].

Native building is usually based on the materials locally available, minimizing the use of energy and transportation expenditure and enriching the local economy. Earth, bamboo and other renewable resource-based homes in most parts of Africa and Asia provide natural insulation and toughness.

The strategy does not only respect the environment, but also conforms to the objective of minimizing urban environmental effect and enhancing resource efficiency [19].

These useful building traditions are however on a collision course since the current building practices and rules tend to ignore or devalued them and in consequence, their application is adversely affected. In order to save this valuable information, the policies should not only conserve the indigenous techniques but also encourage their adoption with the adoption of current technologies. Traditional and modern approaches can be used to achieve innovative, sustainable urban development that respects cultural heritage [72].

Architectural education and urban planning play a crucial role in this process. By educating future professionals about indigenous building methods and incorporating them into urban policies, we can ensure these techniques are valued and applied.

This comprehensive approach supports the goals of sustainable development through solutions that are culturally meaningful, environmentally sound, and economically viable ultimately building stronger, more inclusive cities for all [73].

Indigenous building practices offer a powerful pathway to achieving SDG 11 by fostering sustainable, inclusive communities. Their use of local materials, energy-efficient design, and cultural preservation naturally align with sustainable urban development. IBP provide affordable housing solutions while reducing environmental impact, enhancing urban resilience. By blending traditional wisdom with modern innovation, we can create communities that are both sustainable and culturally vibrant. To fully realize this potential, policymakers must support IBP through inclusive planning and education, ensuring these practices remain vital to the urban future.

2.11 Research Gap

The existing literature provides a robust foundation on Indigenous Building Practices (IBP) and their sustainability benefits; however, significant gaps remain regarding their potential role in Pakistan's contemporary construction sector. While previous studies have documented the environmental advantages of indigenous practices such as passive cooling and the use of local materials there is limited research exploring why these practices continue to be marginalized in modern urban construction projects.

Notably, the literature lacks a systematic analysis of the institutional, economic, and perceptional barriers that hinder the broader adoption of IBP within Pakistan's rapidly urbanizing cities. This gap is especially apparent in the insufficient examination of how indigenous knowledge interact with current construction regulations and market dynamics.

A critical research void exists in developing practical frameworks for integrating indigenous methods with modern construction techniques. Although existing studies often compare IBP with green building practices, they rarely propose actionable hybrid models that fuse traditional wisdom with contemporary technologies. There is also minimal exploration of how digital tools such as Building Information Modeling (BIM) might enhance traditional techniques while preserving their cultural authenticity. Furthermore, while heritage restoration projects are documented, research on adapting these approaches for new urban development's remains sparse, particularly in addressing pressing issues such as affordable housing and climate resilience.

The policy dimension represents another significant gap in the literature. Despite acknowledgment of regulatory obstacles to IBP adoption, there is a lack of detailed investigation into how Pakistan's building codes and zoning laws might be reformed to accommodate indigenous techniques. Concrete proposals for financial incentives or mechanisms to improve the competitiveness of traditional construction methods in urban markets are virtually absent. This gap extends to workforce development, where strategies for training builders in both indigenous and modern sustainable construction practices have received little attention.

Urban applications of indigenous practices remain notably understudied. While research tends to focus on rural and heritage contexts, there is limited inquiry into how traditional design principles could be leveraged to address contemporary urban challenges such as heat islands, flooding, and housing shortages. The potential contributions of IBP to achieving Sustainable Development Goal 11 (SDG 11) within Pakistani cities have not been much quantified, leaving policymakers without evidence-based guidance for integrating these practices into urban planning frameworks. Social dimensions also remain underexplored, with few studies examining urban residents' perceptions of traditional architecture or investigating ways to increase the appeal of indigenous designs among modern homeowners.

Economic viability constitutes another crucial area lacking thorough investigation. Although the cost-effectiveness of IBP in rural contexts is recognized, their scalability in urban economies has not been rigorously analyzed. Comparative life-cycle cost assessments between indigenous and conventional building methods are largely missing, as are studies on modernizing and scaling supply chains for traditional materials.

Finally, there is a marked scarcity of community-centered research approaches. Despite frequent references to the cultural significance of IBP, participatory studies involving local communities in preserving and adapting traditional knowledge are rare. Collectively, these gaps underscore the urgent need for detail, context-specific research that can inform practical strategies to integrate Pakistan's rich architectural heritage with current sustainability imperatives.

Chapter 3

Research Methodology

This chapter outlines the systematic approach adopted to address the research problem and achieve the study's objectives, with a particular focus on integrating indigenous building practices to enhance sustainable construction practices. Research methodology serves as a critical foundation for any academic investigation, providing a structured framework to guide data collection, analysis, and interpretation. The chapter begins by justifying the selected research design and identifying the key variables influencing the phenomenon under study, including traditional construction techniques that contribute to sustainability.

The discussion then proceeds to explain the sampling strategy, including the determination of sample size and the demographic characteristics of respondents, ensuring representation from professionals familiar with both modern and indigenous building methods. Additionally, the chapter details the development of the research instrument, describing how the questionnaire was designed to assess the role of indigenous practices such as the use of locally sourced materials (e.g., bamboo, mud bricks, and mud plaster), passive cooling techniques, and vernacular architectural designs in promoting energy efficiency, waste reduction, and cultural sustainability. Furthermore, the chapter elaborates on the data collection and analysis techniques, ensuring their alignment with the research objectives. The chosen methodology not only supports the study's design but also enhances the validity and reliability of the findings. By employing a structured approach, this research enables the examination, interpretation, and prediction of key trends in sustainable construction while maintaining transparency and reproducibility. Given the specific challenges of Pakistan's construction industry, the selected methodologies are tailored to generate meaningful insights into how IBP can complement modern sustainability practices. This includes evaluating cost-effectiveness, environmental impact, and social acceptability of traditional practices compared to conventional construction approaches.

The study thus contributes to both academic knowledge and practical applications by bridging the gap between heritage-based building practices (IBP) and contemporary sustainable building practices and standards.

3.1 Framework of Research Methodology

This study examines the potential of Indigenous Building Practices (IBP) to enhance sustainable building construction by evaluating their environmental, economic, and social contributions.

The research focuses on understanding how indigenous building practices can be integrated with modern sustainable building practices and align the construction sector with UN sustainable development goals.

Through a systematic literature review, the study establishes clear connections between IBP and key sustainability pillars, particularly in the contexts of Gilgit-Baltistan and Islamabad, where both traditional and contemporary building methods coexist.

The research methodology incorporates a structured questionnaire designed to gather professional insights about the performance and applicability of IBP in modern construction scenarios. This survey instrument collects data from architects, engineers, and construction professionals with experience in both indigenous and conventional building methods.

Following comprehensive data collection, statistical analysis is employed to evaluate the relative effectiveness of different indigenous techniques, with the Relative Importance Index (RII) method used to prioritize their sustainability impacts.

The complete research framework, including all methodological approaches, is presented in a detailed flow chart that illustrates the study's progression from theoretical foundation to empirical analysis and conclusion.

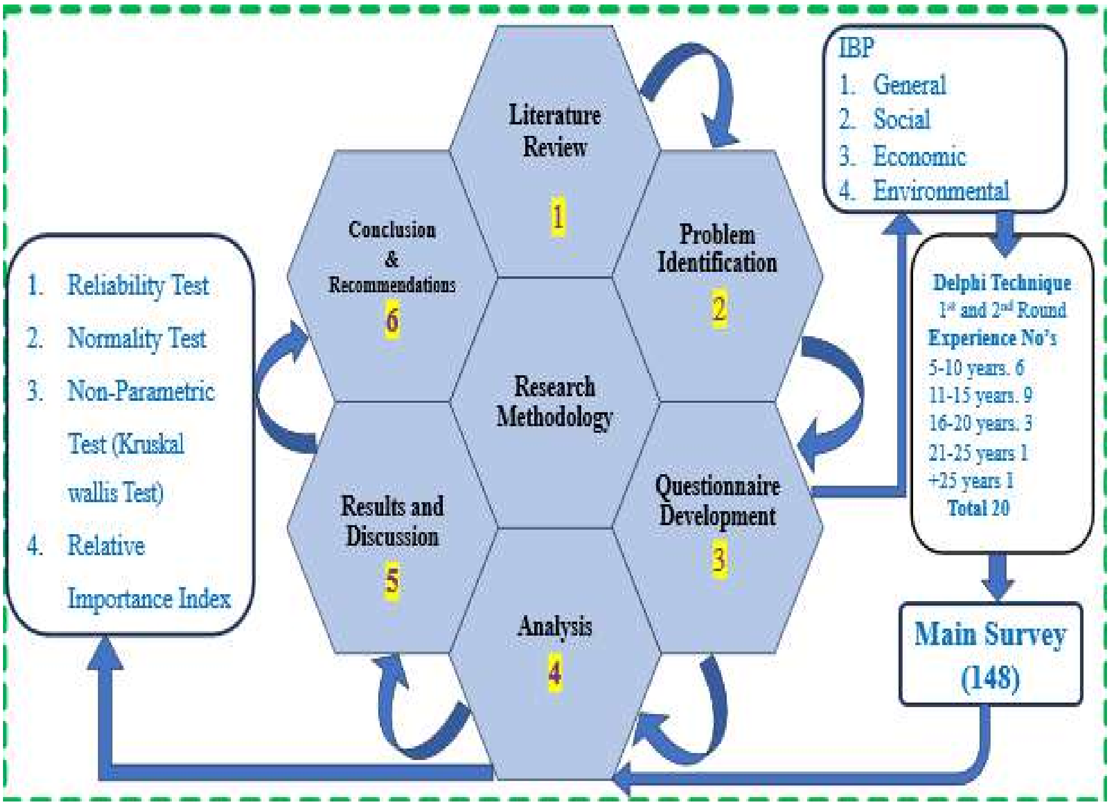


Figure 3.1: Research Methodology

3.1.1 Stage1-Problem Identification

The research began with a preliminary literature review to identify a relevant topic addressing critical challenges in Pakistan's construction industry. The selection criteria focused on finding a research gap that could contribute meaningfully to sustainable building practices through Indigenous Building Practices (IBP). Key issues identified included the industry's environmental impact, resource inefficiency, lack of standardization of indigenous building practices, benefits of IBP, and the marginalization of indigenous building practices knowledge in modern construction.

3.1.2 Stage 2–Literature Review

A systematic literature review was conducted to establish the theoretical foundation of the study. This phase examined peer-reviewed articles, case studies, on IBP, modern sustainable construction, and their integration. The review highlighted the environmental advantages of indigenous techniques (e.g., thermal efficiency of mud bricks, seismic resilience of timber frames), famous green building certification and identified gaps in their integration into contemporary practices. This devises the research framework and justifies the focus on Gilgit-Baltistan and Islamabad as comparative case studies.

3.1.3 Stage 3- Defining the Problem

Building on the literature review, the study defined its core problem: the underutilization of Indigenous Building Practices in Pakistan's construction sector despite their proven sustainability benefits. Specific challenges included a lack of policy support, technological barriers, and diminishing indigenous knowledge. The problem statement emphasized the need to evaluate IBP's potential to address climate resilience, resource conservation, and cultural preservation.

3.1.4 Stage 4- Aim and Objectives

The study's aim was formulated as to assess the role of Indigenous Building Practices in enhancing sustainable construction in Pakistan. Six objectives were derived:

1. To explore the sustainability (Social, Economic and Environmental) of IBP.
2. To propose practical recommendations for promoting IBP that align with SDG11 (Sustainable Cities and Communities).

3.1.5 Stage 5- Delphi Technique

Initial factors were drawn from academic literature covering environmental, economic, and social dimensions of sustainability in construction. These were then synthesized and refined through expert consultations using the Delphi method. The questionnaire was distributed to professionals in the construction industry via both email and physical handouts in Gilgit and Islamabad. Respondents were asked to assess the importance and relevance of each proposed factor based on their professional experience and understanding of sustainable construction.

To ensure the validity of the selected factors, a pilot study was conducted before finalizing the questionnaire. Expert feedback was used to evaluate the clarity, relevance, and comprehensiveness of the factors according to Delphi techniques [74]. This process helped determine which sustainability components were most critical in the context of IBP integration within current construction practices. The expert panel, comprised of seasoned professionals with deep industry knowledge, contributed significantly to refining and validating the factors under consideration.

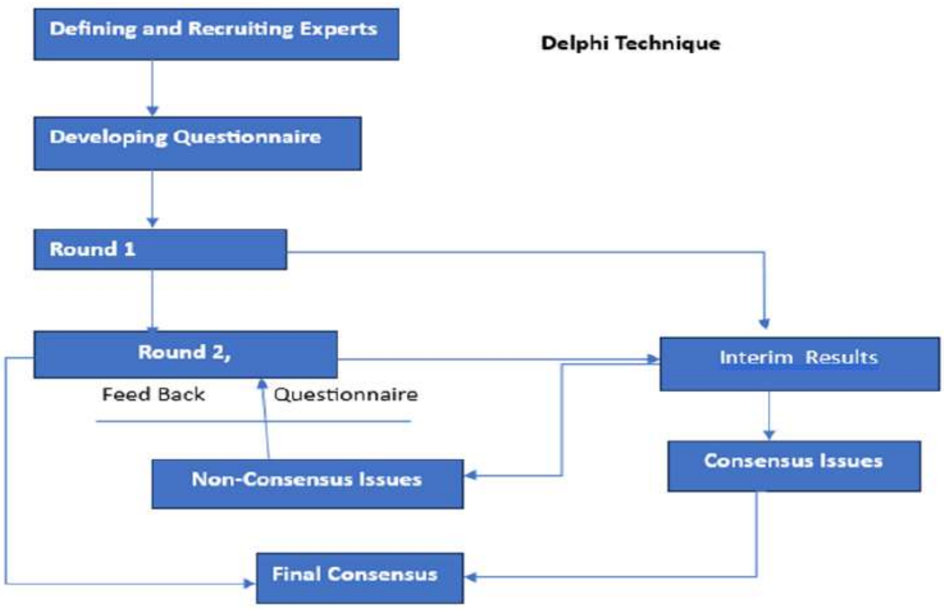


Figure 3.2: Delphi Technique [75]

The questionnaire comprised:

- Section A: Demographics of Respondents.

- Section B: General Sustainability.
- Section C: Environmental Sustainability
- Section D: Economic Sustainability
- Section D: Social Sustainability

The Delphi method validated the questionnaire through iterative feedback from 10 professionals in Islamabad and 10 in Gilgit, all experts in sustainable construction. Respondents were encouraged to suggest other relevant aspects of sustainability principle that may not have been explicitly addressed in the initial questionnaire Their feedback and suggestions were incorporated and included in the main survey for refinement and betterment of the main survey.

3.1.6 Stage 6- Data Collection

The questionnaire was digitized using Google Forms and distributed via professional networks (Architects, Engineers) and snowball sampling. Of 200 invitations, were sent to professionals and 148 responses were received with (74% response rate). After filtering incomplete entries, by responses were retained for analysis (Gilgit: 41.7%; Islamabad: 58,3%) responses.

3.1.7 Stage 7- Data Analysis

To analyze the data collected from the survey, IBM SPSS Statistics was employed due to its efficiency in handling both large and complex datasets. The software is known for its intuitive interface and robust analytical capabilities, making it a preferred choice in construction research for conducting both descriptive and inferential statistical procedures [76].

In the context of this study, SPSS was used to evaluate the effectiveness of different construction practices, including IBP and Modern Building Practices (MBP), based on expert feedback. The software facilitated the computation of frequencies, means, and standard deviations, followed by advanced statistical techniques such as correlation and RII analysis to explore relationships between sustainability principles and sustainability factors.

3.2 Conduct of Survey

A structured questionnaire was distributed to a wide sample of stakeholders working in the construction industry in accordance with the goal of the study that is to research the role of indigenous building practice in fostering sustainable construction. This also covered clients, developers, contractors, consultants, and professionals that have direct or indirect experience with both new and older construction practices. This survey was conducted to elicit an understanding of how indigenous Building Practices (IBP) can be incorporated into Modern Building Practices (MBP), like Green Building Practices (GBP) to enhance sustainability. The survey was prepared using Google Forms, allowing for accessible and efficient data collection. Respondents were drawn from Gilgit and Islamabad, ensuring geographical representation across both Rural and urban regions. The regional distribution of participants is visualized in map 3.3, demonstrating the spatial reach of the study and highlighting the inclusion of diverse professional backgrounds within the built environment.

To evaluate the role of indigenous building practices in sustainable construction practices, especially where indigenous building practices are concerned, a 5-point Likert scale was employed. Participants were asked to rate various sustainability aspects, ranging from "Strongly Disagree" to "Strongly Agree." This scale allowed for standardized responses that could be quantitatively analyzed for trends and consensus.

This open-ended input helped ensure the comprehensiveness of the data and supported the identification of context-specific considerations related to the use of local materials, traditional skills, and community-based labor, social and economic aspects.

The distribution strategy combined both direct outreach and institutional channels. Construction-related organization and networks facilitated the broader circulation of the survey, while a list of practitioners with expertise in sustainable and indigenous construction was contacted directly via email and physical copies.

Follow up reminders were issued periodically to improve response rates and ensure broad stakeholder representation.

3.3 Sample Size Determination When Population is Unknown

Sample size determination is a key methodological concern in quantitative research, especially in construction management where studies often involve multiple variables and complex data environments. Selecting an appropriate sample size ensures the validity and reliability of statistical analysis and supports the generalizability of research findings.

Among the various sample size guidelines available, Harris (1975) provided one of the most direct and widely used rules for regression-based studies. The formula is (equation 3.1):

$$N \geq 50 + m \tag{3.1}$$

Where m is the number of predictor variables.
For the present study
m = 29 variables
$N \geq 50 + 29 = 79$ respondents

So, for this study, a minimum number of 79 responses is enough to back upon the results of this study. However, in actual, 148 responses have been collected.

3.4 Data Measurement Scale

The questionnaire was designed to facilitate statistical data analysis. The survey parameters were evaluated based on their adoption level and effectiveness using a 5-point Likert scale. Different measurement scales were applied to assess various parameters, as summarized in Table 3.1.

The 5-point Likert scale allows respondents to provide precise feedback on the survey questions. This structured approach ensures reliable quantitative data collection. A random sampling technique was used to select respondents, ensuring the sample accurately represents the target population.

TABLE 3.1: Likert-Based Impact Rating Scale

Descriptive Category	**Scale Value**
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

3.5 Data Analysis Methods

To examine the data gathered during the survey, IBM SPSS Statistics was used because it is efficient in processing large as well as complex data. Within the framework of the current research, the effectiveness of various practices of different construction, such as the Indigenous and Modern Building Practices, was assessed using SPSS to gather the feedback of the experts.

The software helped to calculate frequencies, means, and standard deviations and then to use advanced statistical methods, including correlation analysis and regression analysis, to investigate the connections between sustainability principles and sustainability factors.

3.5.1 Reliability Test

A reliability test was conducted to evaluate the consistency of the collected data. The test was performed using **Cronbach's alpha** (α), calculated through **SPSS software**. The reliability was assessed based on the following scale.

- **Excellent**: $\alpha \geq 0.9$
- **Good**: $0.8 \leq \alpha < 0.9$
- **Acceptable**: $0.7 \leq \alpha < 0.8$
- **Questionable**: $0.6 \leq \alpha < 0.7$
- **Poor**: $0.5 \leq \alpha < 0.6$
- **Unacceptable**: $\alpha < 0.5$

This scale ensures that the data's internal consistency is thoroughly validated before further analysis [77].

3.5.2 Normality Test

The Shapiro-Wilk test (1965) was used to assess whether the collected data followed a normal distribution. This test determines if the dataset is parametric (normally distributed) or non-parametric (not normally distributed) based on the p-value:

- **p-value** $> 0.05 \rightarrow$ Data is normally distributed (parametric).
- **p-value** $\leq 0.05 \rightarrow$ Data is not normally distributed (non-parametric).

This test ensures the appropriate selection of statistical methods for further analysis.

3.5.2.1 Parametric and Non-Parametric Evaluation

In statistical analysis, the choice between parametric and non-parametric tests depends on whether the data meet the assumptions of the hypothesis being tested. Parametric tests are appropriate for data that follows a stable, normally distributed pattern with well-defined variances across groups and exhibits linear relationships. In contrast, non-parametric tests are used when analyzing ordinal or ranked data that does not follow a specific distribution, displays non-linear characteristics, or violates normality assumptions. Parametric tests assume normally distributed data, while non-parametric tests do not require this assumption. Non-parametric methods are particularly useful when dealing with non-normally distributed data. Normality is assessed through hypothesis testing, where the null hypothesis (H_0) states that the data follows a normal distribution (if p-value $>$ 0.05), while the alternative hypothesis (H_1) suggests non-normality (if p-value $\leq$ 0.05). This determination guides the selection of the appropriate statistical test for reliable analysis.

3.5.2.2 Kruskal-Wallis Analysis

The Kruskal-Wallis H test was performed using IBM SPSS Statistics as a non-parametric alternative to one-way ANOVA, suitable for comparing median differences across three or more independent groups when data violates normality assumptions. This test was applied after confirming non-normal distribution through prior Shapiro-Wilk or Kolmogorov-Smirnov testing.

The analysis procedure involved ranking all data points collectively, then calculating the Kruskal-Wallis H statistic, which follows a chi-square distribution for significance testing. The output provided the H-statistic value, corresponding degrees of freedom, and exact p-value, with results considered statistically significant at $p < 0.05$. When significant differences were found, post-hoc pairwise comparisons using Dunn's test with Bonferroni adjustment were conducted to identify which specific groups differed [78]. This method offered robust statistical comparisons without requiring normally distributed data, making it particularly valuable for analyzing ordinal data or skewed distributions while maintaining analytical rigor through standardized SPSS computational procedures. The approach ensured reliable identification of group differences while accommodating the non-parametric nature of the dataset.

3.5.2.3 Relative Importance Index Analysis

The research used Relative Importance Index (RII) to determine and rank different factors of indigenous building practices contributing to Sustainability. The ratings of the respondents on a 1-to-5 scale were summed and converted into comparative values of importance of each factor. The RII was calculated using Equation (3.2) to quantify the relative significance of each identified element, enabling systematic prioritization of risk contributors based on their perceived impact [77]. This analytical approach facilitated objective comparison across different categories while accounting for varying degrees of importance indicated by survey participants.

$$RII = \frac{W}{A * N} \tag{3.2}$$

Where: W = Sum of ratings assigned by respondents (scale of 1-5)

A = Maximum possible rating value (5 on Likert scale)

N = Total count of survey participants

3.6 Summary of Research Methodology

This research explores how the native building infrastructure can be used to promote sustainable construction in Pakistan using a holistic research framework. The methodology is developed on the basis of a comprehensive literature review that explores the current issues in the construction industry and the sustainability advantages of the traditional approach to building. The study uses a mixed method approach to assess the role that building practices by indigenous people can play in the building practices of the present in an effort to make them sustainable.

An approach based on surveys was adopted, whereby, structured questionsnaires were issued to the most critical stakeholders such as the architect, engineers, and construction managers, as well as the traditional craftsmen. These tools were to measure the implementation, success, and obstacles to the implementation of indigenous practices contributing to the realisation of the sustainability objectives. Delphi technique was especially useful in this study which made it possible to reach the expert agreement on the most possible IBP to improve sustainable construction practices.

This approach guided the process of research instrumentation and supported the priority of those indigenous approaches that have the highest sustainability potential, including the use of vernacular materials, passive climate control, and construction practices. The quantitative data was used through descriptive statistical analyses to determine significant patterns and relationships. This study also included qualitative measurements using case studies and interviews to give a richer contextual insight into the traditional building procedures. The strong methodological framework has made it possible to gather credible data that can reconcile IBP with modern sustainability Building Practices. The discoveries provide useful information on how the rich history of native con- structions in Pakistan could be successfully applied to the current building activities to attain higher environmental, economical, and social sustainability outcomes. These research findings will be discussed and analyzed in the sub- sequent chapter.

Chapter 4

Results and Analysis

4.1 Background

In this chapter, the data gathered by the means of the structured ques- tionnaire survey is analyzed and the structured questionnaire is designed to measure Exploring the Role of In- digenous Construction in Enhancing Sustainable Building Practices. The survey instrument used a five-point Likert scale (between strongly disagree to strongly agree) to elicit accurate views on four key dimensions of Sustainability, General Sustainability (GnS), Environmental Sustainability (EnS), Economic Sustainability (EcS), and Social Sustainability (SoS). Such methodology allowed quantifying the attitudes of respondents, giving a Sound basis to statistical analysis and interpretation. The chapter reviews the demographic pro- file of people involved in the survey (educational levels, professional positions, the number of years of experience, the geographical distribution) and the extent of their knowledge concerning sustainability and its facets before exhibiting the main study results. These demographic parameters can be considered as critical contextual variables, providing information about possible differences in responses according to professional experience or regional exposure to the indigenous methods of construction. The obtained data were effectively processed through the use of SPSS software and Microsoft Excel, and throughout the process, Precise statistical validation of. results. To improve the readability and ease of interpreting the collected data, the main results are presented in advance with well-constructed tables and graphic images that emphasize key trends, associations and differences in the views of respondents.

The analysis is structured to directly address the study's research objectives, with each section exploring how indigenous practices contribute to distinct aspects of sustainability.

Environmental sustainability is evaluated through metrics such as resource efficiency and carbon footprint reduction, while economic sustainability is assessed in terms of cost-effectiveness and local economic benefits. The social dimension investigates cultural preservation, community engagement, and equity considerations.

By presenting a detailed, evidence-based examination of survey responses, this chapter not only fulfils the immediate objective of data reporting but also sets the stage for the subsequent discussion and conclusion chapters. The insights generated here will inform recommendations for integrating indigenous practices into sustainable construction frameworks, bridging traditional knowledge with modern innovation.

4.2 Development of Questionnaire

As explained in chapter 3 a detailed literature review was done to identify the relevant information ,transformed into questions afterwards. The questions were grouped into 4 categories as under.

1. General Sustainability
2. Environmental Sustainability
3. Economic Sustainability
4. Social Sustainability

4.2.1 Coding of the Questionnaire

The questionnaire was systematically coded to facilitate organized analysis, with each question assigned a unique alphanumeric identifier corresponding to its thematic focus. General sustainability questions received the GnS prefix (e.g, GnS-1 for sustainability promotion, GnS-4 for integration challenges), while environmental aspects were coded EnS (e.g, EnS-2 for carbon footprint, EnS-5 for climate resilience). Economic and social dimensions followed the EcS (e.g, EcS-3 for maintenance costs) and SoS (e.g., SoS-5 for cultural preservation) frameworks respectively. This structured coding enabled precise categorization of responses aligned with the study's sustainability pillars.

The coding scheme served dual purposes: ensuring consistent data referencing during analysis and maintaining thematic coherence with the research objectives. By grouping questions under environmental, economic, and social sustainability headers, the system streamlined both response processing and results interpretation. All coding were documented in the appendix for transparency, with the structure specifically designed to highlight indigenous construction practices' role across each sustainability dimension. This methodological approach supported a rigorous examination of how traditional practices contribute to sustainable building practices.

4.2.2 Pilot Survey Analysis and Delphi

Before the main data collection, a pilot survey was conducted to validate the research instrument and methodology. This preliminary phase aimed to assess the questionnaire's clarity, relevance, and effectiveness in capturing the required data about indigenous construction practices. Twenty industry experts (10 from Gilgit and 10 from Islamabad) representing contractors, architects, civil engineers, consultants and NGOs working in sustainable buildings have participated in the evaluation. The respondents are familiar with both indigenous building construction and modern sustainable practices and provided both rural and urban construction perspectives.

The pilot study yielded critical insights for refining the survey instrument. Participants evaluated question comprehensiveness, appropriate sequencing, and Likert-scale effectiveness through structured feedback sessions. Key modifications included adding new factor Gns-2 General Sustainability and EcS-2 factors in the environmental sustainability section (EnS-2 codes) and SoS-2 factor in Social Sustainability to make the questionnaire clearer and more comprehensive. The demographic balance ensured the tool's applicability across both rural and urban construction contexts. Participant details, including professional backgrounds and regional distribution, are documented in Tables 4.1 through 4.5. This iterative process strengthened the questionnaire's capacity to reliably measure how indigenous methods enhance sustainability across environmental, economic, and social dimensions.

TABLE 4.1: Details of Respondents' Organisation Type of Pilot Survey and Delphi

S. No.	Response	NO'S	Percentage
	Organization Type		
1	Public	8	40%
2	Consultancy	6	30%
3	Contractor	4	20%
4	NGO	2	10%
	Total	20	100%

TABLE 4.2: Details of Education Level of Respondents of Pilot Survey and Delphi

S. No.	Response	NO'S	Percentage
	Educational Level		
1	PhD	1	5%
2	Masters	14	70%
3	Bachelors	4	20%
4	Diploma	1	5%
	Total	20	100%

Table 4.3: Details of Designation of Respondents of Pilot Survey and Delphi

S. No.	**Response**	**NO'S**	**Percentage**
	Designation		
1	Site Engineer	6	30%
2	Construction Manager	4	20%
3	Project Manager	3	15%
4	Planning Engineer	2	10%
5	Architect	2	10%
6	Supervisor	1	5%
7	Quantity Surveyor	1	5%
8	Structural Engineer	1	5%
	Total	20	100%

Table 4.4: Details of Experience of Respondents of Pilot Survey and Delphi

S. No.	**Response**	**NO'S**	**Percentage**
	Experience		
1	5-10 years	6	30%
2	10-15 years	9	45%
3	15-20 years	3	15%
4	20-25 years	1	5%
5	+25	1	5%
	Total	20	100%

Table 4.5: Details of Understanding Level of Respondents on Pilot Survey and Delphi

S. No.	**Response**	**NO'S**	**Percentage**
	Understanding Level		
1	High	9	45%
2	Moderate	8	40%
3	Slight	3	15%
	Total	20	100%

4.2.3 Implementation of Pilot Survey Results

The pilot survey provided valuable insights that guided refinements to the questionnaire, ensuring it effectively evaluates indigenous construction in sustainable building practices. Experts recommended key additions, including recognizing indigenous methods as models for green architecture (GnS-2), their equipment-free advantage in reducing carbon emissions (EnS-2), and their adaptability to community needs (SoS-3). These enhancements strengthened the survey's ability to assess sustainability across environmental, economic, and social dimensions while maintaining the original coding framework.

Technical improvements were made to optimize clarity and accuracy throughout the questionnaire. Complex terminology was simplified, particularly in environmental sustainability sections, and local material examples were added for better contextual understanding. The Likert scale was standardized, and two ambiguous questions were removed based on pilot feedback. These refinements resulted in a more focused instrument that reliably captures the benefits of traditional construction methods while remaining accessible to professionals with varying expertise levels.

The finalized questionnaire successfully balances comprehensive assessment with practical administration, requiring just 15-20 minutes to complete. By incorporating expert recommendations and addressing pilot findings, the survey now provides a robust tool for examining how indigenous practices contribute to modern sustainability goals. The refined instrument is well-positioned to generate meaningful data that advances understanding of sustainable construction approaches.

4.3 Administering Main Survey

Upon the finalisation of the questionnaire, the main survey is carried out. A Google Form was created as a questionnaire and distributed among professionals through soft links (WhatsApp, email, and LinkedIn). The exact population of respondents was not known. Therefore, using Equation (1), the minimum number of respondents is 79. To do further analysis, as a result,148 responses were received, which are considered more than required ones.

4.4 Demographics of Main Survey

This section presents the demographic characteristics of the respondents who participated in the survey. Understanding the background of participants is important, as it helps to interpret their perspectives on indigenous building practices and sustainability. The demographic data includes key variables such as level of understanding, location of respondent, designation, level of education, years of professional experience, and organization type.

4.4.1 Highest Level of Education

Figure 4.1 represents the distribution of respondents in terms of their highest level of education .The educational qualifications of the respondents show a diverse academic background.

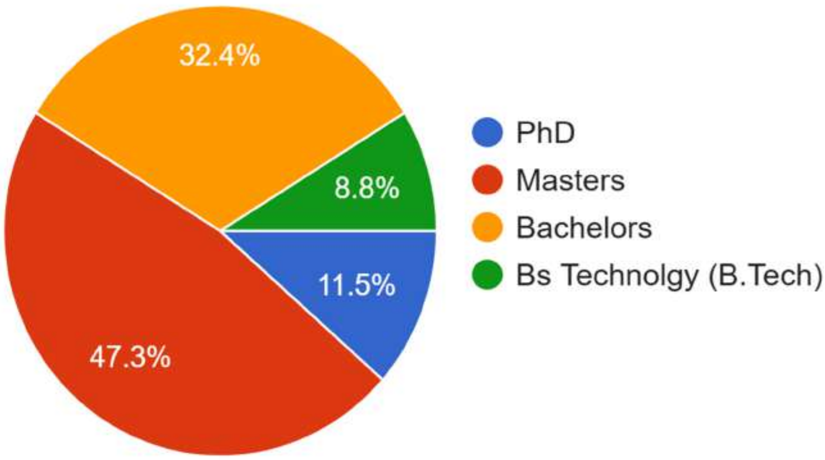


FIGURE 4.1: Education Level of Respondents

Among the participants, 11.5% hold a PhD, reflecting strong research expertise and advanced academic knowledge. The majority, 47.3%, had completed a Master's degree, indicating in-depth understanding of engineering principles and sustainability practices. 32.4% of the respondents hold a Bachelor's degree, representing a relevant foundation in technical and professional skills. Additionally, 8.8% had a qualification in BS Technology (B-Tech), bringing practical, hands-on industry experience. This mix of educational levels provides a well-rounded perspective, combining both academic theory and practical knowledge in sustainable building construction

4.4.2 Respondent Designation

The distribution of the 148 survey respondents by job role is shown below (Figure 4.2) a wide range of professional backgrounds in the construction industry.

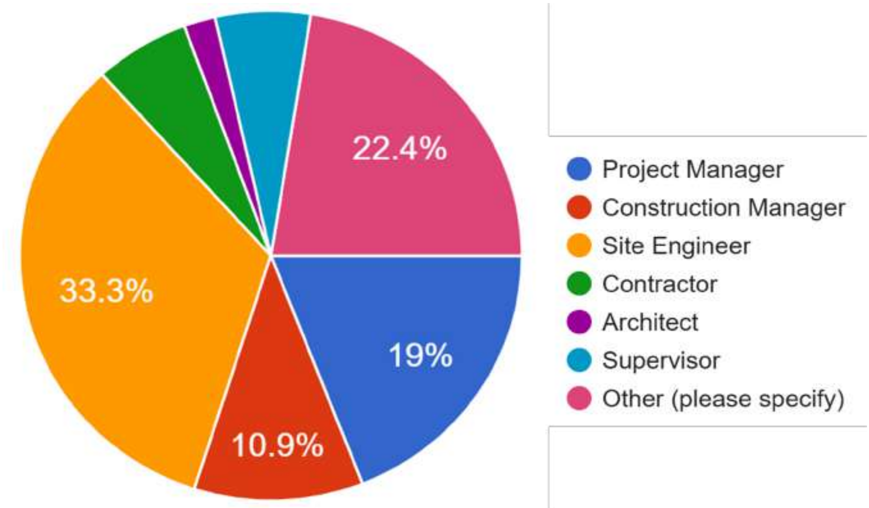


FIGURE 4.2: Designation of Respondents

The largest group was Site Engineers, with (33.3%), respondents reflecting their central role in on-site technical implementation. Other roles, not specifically categorized, included (22.4%), respondents indicating a variety of additional contributions to sustainable construction. Project Managers accounted for (19%), respondents emphasizing their importance in planning and coordination. Construction Managers made up (10.9%), respondents providing insights into site-level operations and management. Contractors were represented by 6.1%), respondents contributing practical knowledge in project execution. Supervisors included (6.1%), respondents focusing on daily monitoring and quality control. Lastly, Architects made up (2%), respondents offering design-oriented perspectives. This mix of roles demonstrates the collaborative effort required to implement sustainable practices effectively across construction projects.

4.4.3 Respondents Experience

Figure 4.3, shown below, represents a diverse range of professional experience within the construction industry.

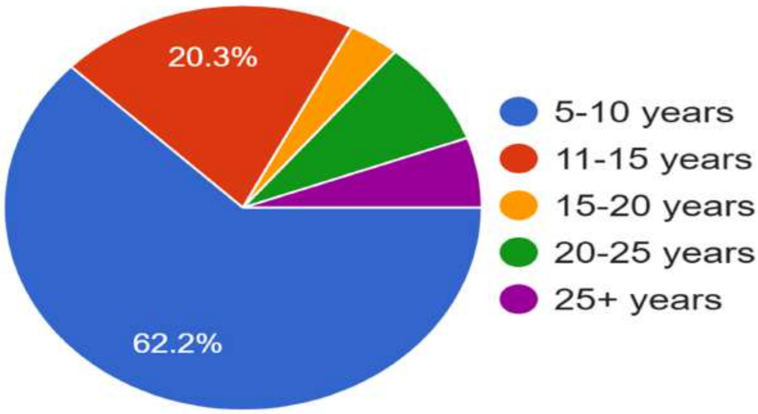


FIGURE 4.3: Respondents Years of Experience

The majority, 62.2% had 5 to 10 years of experience, indicating strong participation from early to mid-career professionals who are actively engaged in current industry practices

A significant portion, 20.3%, had 11 to 15 years of experience, contributing established knowledge and practical understanding of project management and construction processes. Additionally, 3.5% respondents reported (16 to 20 years of experience, offering insights into long-term involvement in the field. 8.4% respondents had (21-25 years) of experience, bringing senior-level expertise and a broad perspective on industry changes over time. Finally, 5.6% respondents had +25 years of experience, bridging late-career stages. This range of experience levels adds value to the survey findings by incorporating both recent trends and long-term observations in sustainable building practices

4.4.4 Organisation of Respondents

Based on the data shown in (Figure 4.4) below, the professional background of the 148 survey respondents demonstrates a diverse mix of roles within the construction industry.

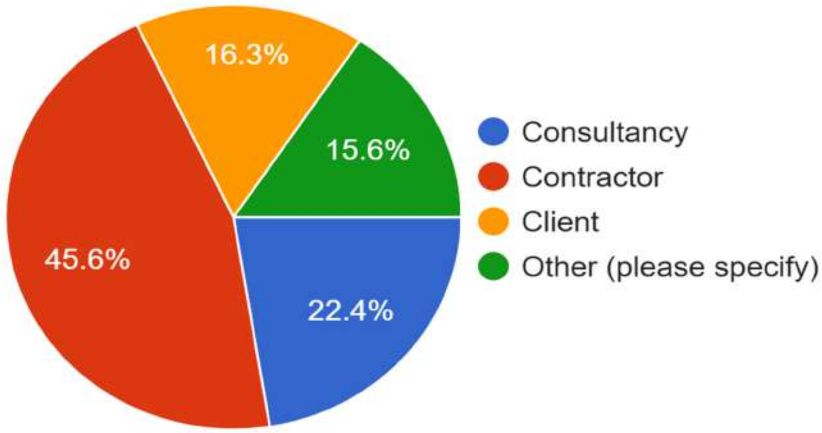


Figure 4.4: Organization Type of Respondent

The largest group, comprising 45.6% respondents, were Contractors, reflecting strong representation from those directly involved in the on-site execution and management of construction projects. Consultants accounted for 22.4% respondents offering expertise in planning, design, and sustainability-focused project management. Clients make up 16.3 % and other professionals made up 15.6% respondents of the total. Clients contributed strategic perspectives on project investment and development, while the "Other" category included various roles not specifically listed, adding further diversity to the respondent pool. These professional representatives ensures a well-rounded understanding of sustainability practices from multiple angles within the construction sector.

4.4.5 Geographical Distribution of Survey Respondents

The finding of this survey in (Figure 4.5) reveal a distinct geographical distribution of respondents, with 41.7% located in Gilgit and 58.3% in Islamabad. The impact on construction industry by breaking the provide valuable insights into regional representation.

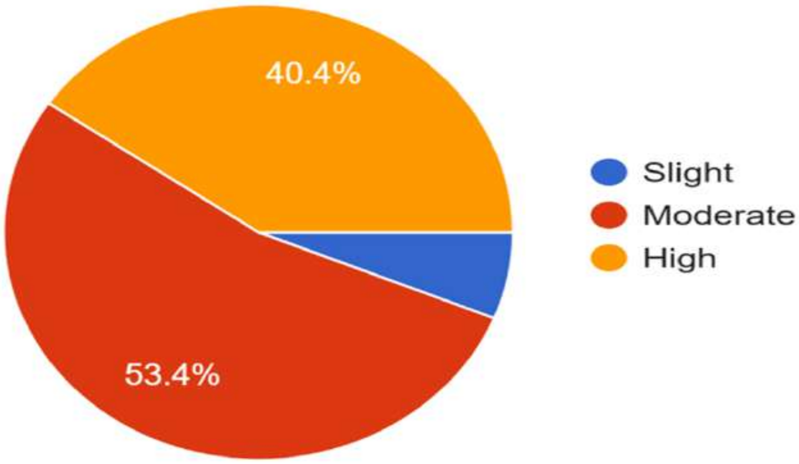


FIGURE 4.5: Understanding of sustainability aspects of respondents

4.4.6 Level of Understanding of Sustainability

The survey results highlight in (Figure 4.6) below shows the current level of awareness and expertise regarding sustainability practices among construction professionals.

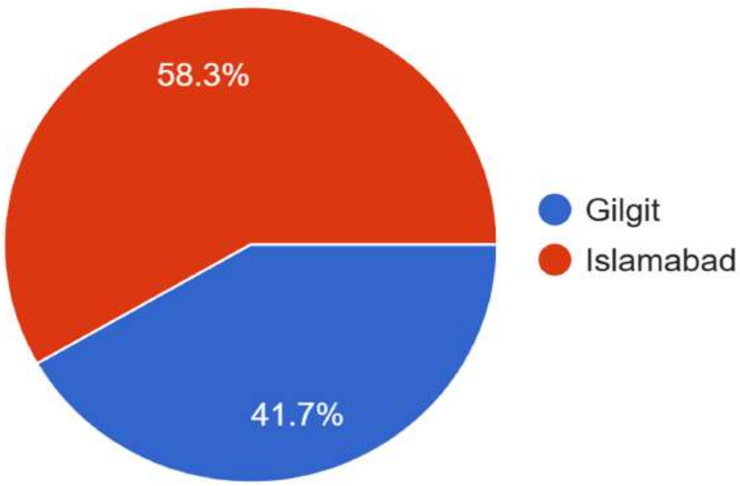


FIGURE 4.6: Understanding of sustainability aspects of respondents

This high level of competency indicates that sustainability is now a central concern in professional growth and project implementation, presumably due to regulatory factors, client need, and industry-wide programs favoring green practices. Very high levels of understanding (40.4) can be attributed to a background understanding of concepts of sustainability.

These experts can be conversant with simple green building practices like reduction of waste or conservation of energy, yet they may need to undergo additional training so as to apply sophisticated practices such as carbon footprint calculation or principles of the circle economy. This population is a potential target of upskilling to address knowledge gaps, which can help in the sustainable delivery of projects.

The lower group 6.2% also has only a modest knowledge of sustainability aspects. This may involve professionals with traditional backgrounds in construction that are yet to fully embrace the modern practice of sustainability or those in positions where sustainability has never been a concern.

4.5 Statistical Analysis

This section describes statistical procedures used in the analysis of the main survey data. Its main goal is to evaluate the reliability, validity, and consistency of the data to be sure that the results obtained after the analysis are valid and credible. This is necessary before any other more advanced statistical processes can be performed because it would ensure quality and credibility of the responses gathered using the questionnaire.

4.5.1 Analysis of Data for Reliability

The reliability analysis began with a preliminary review of the collected data to ensure its integrity. Table 4.6 provides a summary of the total number of cases collected, the number of valid cases retained for analysis, and the number of cases excluded due to missing or incomplete data.

TABLE 4.6: Reliability Analysis

Category	**N**	**Percentage (%)**
Valid Cases	131	88.5
Excluded Cases	17	11.5
Total	148	**100.00**

A total of 148 responses were collected through the main survey. After the initial data screening process, 131 responses were found to be complete and valid, representing 88.5% of the total dataset. The remaining 17 responses (11.5%) were excluded using listwise deletion to eliminate any potential bias that may arise from incomplete or inconsistent data. This step was critical to maintain the accuracy and reliability of the results. The results are presented in table 4.7.

Table 4.7: Reliability Statistics (Cronbach's Alpha) Category-wise

Sr.	**Category**	**Cronbach's Alpha**	**No. of Items**
1	Overall Sustainability	0.984	29
2	General Sustainability	0.946	8
3	Environmental Sustainability	0.947	7
4	Economic Sustainability	0.948	7
5	Social Sustainability	0.946	7

Following data validation, reliability analysis was conducted using SPSS software, employing Cronbach's Alpha as the statistical measure to evaluate the internal consistency of the items within each category. Cronbach's Alpha values range from 0 to 1, where values above 0.7 are considered acceptable, and values above 0.9 indicate excellent reliability.

The Overall Sustainability scale, which includes all 29 items across the four key dimensions, recorded a Cronbach's Alpha of 0.984, indicating exceptional internal consistency. This demonstrates that the overall instrument is highly reliable for evaluating perceptions on the role of indigenous construction practices in sustainable building.

The General Sustainability category, which has 8 items, had a Cronbachs Alpha of 0.946 indicating very good consistency in their perception of wider. sustainability themes, which include integration with current practice, stakeholder engagement, and professional education. Cronbachs Alpha of the 7 items in the Environmental Sustainability dimension was 0.947. The high score indicates that members of the sample were aware of the ecological advantages of indigenous activities (such as lower carbon footprint, use of natural resources, and climate flexibility) all the time. The Econ Sustain category showed a high level of reliability as well with a

Cronbachs Alpha of 948. The 7 questions in this section covered topics like the cost of construction, job creation, utilization of local resources, and boosting the rural economy each of which was rated uniformly by the respondents. Lastly, the Social Sustainability category, consisting of 7 items, had a Cronbachs Alpha of 0.946. This finding indicates that answers to the questions about cultural preservation, community pride, equality, and local involvement in labor were internally consistent and conformed to the overall research goals. Finally, the questionnaire can be deemed a reliable instrument to evaluate the role of in- digenous construction in facilitating sustainable building practices, with all categories in the survey having outstanding reliability. These findings affirm the legitimacy of subsequent analyses, such as Descriptive Statistics and Nor- mality Test, which are discussed in the following chapters in this book.

4.5.2 Descriptive Statistics

Descriptive statistics were used to summarize and interpret the responses collected through the main survey. This analysis provides an overview of participants' perceptions regarding the role of indigenous construction in promoting sustainability across four key aspects: General, Environmental, Economic, and Social Sustainability The statistical measures of mean and standard deviation were calculated for each item to understand the central tendency and the variability in responses. The detailed results of this analysis are presented in Table 4.8.

TABLE 4.8: Descriptive Statistics

Sustainability	**N**	**Mean**	**Std. D**	**Sustainability**	**N**	**Mean**	**Std. D**
General Sustainability				Economic Sustainability			
GnS-1	131	3.75	1.105	EcS-1	131	3.71	1.243
GnS-2	131	3.79	1.121	EcS-2	131	3.76	1.149
GnS-3	131	3.76	1.117	EcS-3	131	3.77	1.262
GnS-4	131	3.84	1.08	EcS-4	131	3.92	1.11
GnS-5	131	3.79	1.181	EcS-5	131	3.73	1.182
GnS-6	131	3.87	1.105	EcS-6	131	3.91	1.147
GnS-7	131	3.73	1.227	EcS-7	131	3.82	1.142
GnS-8	131	3.76	1.129				

Table 4.8 continued from previous page

Environmental Sustainability				Social Sustainability			
EnS-1	131	3.73	1.176	SoS-1	131	3.87	1.105
EnS-2	131	3.55	1.158	SoS-2	131	3.85	1.117
EnS-3	131	3.77	1.106	SoS-3	131	3.85	1.117
EnS-4	131	3.74	1.154	SoS-4	131	3.85	1.117
EnS-5	131	3.56	1.184	SoS-5	131	3.85	1.117
EnS-6	131	3.8	1.112	SoS-6	131	3.85	1.117
EnS-7	131	3.78	1.204	SoS-7	131	3.87	1.105

These values help to identify which sustainability factors are most strongly recognized and agreed upon by construction professionals. The responses under the General Sustainability category show that participants generally agreed with the statements regarding the importance of indigenous construction practices in supporting sustainable development. The mean values for all eight items in this category ranged between 3.73 and 3.87, indicating a consistent positive perception. The highest-rated item was GnS-6 (Mean = 3.87), which reflects a strong belief that "project management teams can play a vital role in promoting indigenous and sustainable building practices".

Similarly, GnS-4 (Mean = 3.91) which indicates the statement "There is a lack of a framework for integrating indigenous construction techniques with modern construction practices". These results suggest that respondents recognize the broader relevance of indigenous knowledge and its integration into modern construction as essential for promoting sustainability. The standard deviations, mostly around (1.08 to 1.23), suggest a slight level of variability in responses, reflecting a generally shared understanding among professionals.

In the Environmental Sustainability category, participant responses were slightly more varied, with mean scores ranging from 3.55 to 3.80. This indicates general agreement with the environmental benefits of indigenous practices, though with slightly lower confidence compared to other categories. The highest-rated item was EnS-6 (Mean = 3.80), suggests that many respondents agree that" Indigenous building practices have vast potential to address modern environmental challenges". On the other hand, EnS-2 (Mean = 3.55) received the lowest agreement, indicating a more mixed opinion about whether "the absence of modern machinery in indigenous practices contributes significantly to reducing the carbon footprint". Despite this, the overall trend still leans positive. The standard deviations across items (around 1.06 to 1.204) indicate a strong level of consensus, although with slightly variation than seen in General Sustainability.

The Economic Sustainability category received the high ratings among categories, with means ranging from (3.71 to 3.92), showing good agreement among respondents regarding the economic advantages of indigenous construction. EcS-4 (Mean = 3.92) was the most agreed-upon statement, reflecting the belief that "indigenous buildings can attract tourism and enhance economic activity in local regions". Other items, such as EcS-6 (Mean = 3.91) and EcS-7 (Mean = 3.82), also received high scores, emphasizing concerns over "the lack of awareness about indigenous materials and the role of such practices in supporting local economies and circular economic goals". These responses clearly indicate that professionals view indigenous methods as cost-effective, resource-efficient, and economically beneficial for communities. The standard deviations deviates moderately (mostly around 1.110 to 1.262), suggesting good agreement across the participant group.

The Social Sustainability category also received the highest agreed feedback, with mean values ranging from 3.85 to 3.87. The highest-rated items were SoS-5 and SoS-1 with equal (Mean = 3.87), reflecting strong agreement that " The Culture, tradition and environment strongly influence the design philosophy of building" and :The indigenous materials and methods strengthen a sense of identity and pride among local communities by preserving historical heritage".

This suggests that respondents recognise the social value of such practices in fostering inclusive development. All other 4 Items (Mean = 3.85 each) were rated slightly lower and had the standard deviations (1.117), indicating similar views, particularly on topics like "gender roles and employment of local labor for cultural preservation and client role for enhancing IBP". The results point to an overall understanding of the importance of cultural identity, social equity, and community well-being in sustainable construction through indigenous methods.

4.5.3 Normality Analysis

To assess the normality of the data, the Shapiro-Wilk and Kolmogorov-Smirnov (K-S) tests were conducted since the sample size (N=131) was below 2000. These tests evaluated whether the collected data followed a normal distribution (parametric) or not (non-parametric). The Table 4.9 presents results from both normality tests for each variable in the dataset, examining whether the data significantly deviates from normality.

For all variables, the significance (Sig.) values for both tests are 0.000, which is well below the standard threshold of 0.05. This indicates that the null hypothesis of normality is rejected for every variable, confirming that none of the datasets follow a normal distribution.

The Kolmogorov-Smirnov test, which measures the maximum distance between the empirical and theoretical normal distribution curves, produced test statistics ranging from (0.283 to 0.186). The Shapiro-Wilk test, which compares the sample distribution to a normal distribution, yielded statistics between (0.827 to 0.891). Although the Shapiro-Wilk values are generally higher, both tests unanimously show significant deviations from normality, as confirmed by their extremely low p-values (all 0.000). Additionally, most variables exhibit negative skewness (exceeding the typical -1 to +1 range), indicating the data is left-skewed with responses clustering toward the higher end of the Likert scale

Table 4.9: Normality Test

Sustainability Aspects	**Kolmogorov Smirnova**			**Shapiro-Wilk**		
(GnS,EnS,EcS,SoS)	**Statistic**	**Df**	**Sig.**	**Statistic**	**Df**	**Sig.**
GnS-1	0.255	129	0.000	0.853	129	0.000
GnS-2	0.224	129	0.000	0.847	129	0.000
GnS-3	0.237	129	0.000	0.853	129	0.000
GnS-4	0.257	129	0.000	0.850	129	0.000
GnS-5	0.224	129	0.000	0.843	129	0.000
GnS-6	0.234	129	0.000	0.841	129	0.000
GnS-7	0.255	129	0.000	0.840	129	0.000

Table 4.9 continued from previous page

Sustainability Aspects	**Kolmogorov Smirnova**			**Shapiro-Wilk**		
(GnS,EnS,EcS,SoS)	**Statistic**	**Df**	**Sig.**	**Statistic**	**Df**	**Sig.**
GnS-8	0.236	129	0.000	0.855	129	0.000
EnS-1	0.211	129	0.000	0.854	129	0.000
EnS-2	0.186	129	0.000	0.887	129	0.000
EnS-3	0.221	129	0.000	0.852	129	0.000
EnS-4	0.257	129	0.000	0.855	129	0.000
EnS-5	0.223	129	0.000	0.881	129	0.000
EnS-6	0.210	129	0.000	0.857	129	0.000
EnS-7	0.268	129	0.000	0.833	129	0.000
EcS-1	0.237	129	0.000	0.839	129	0.000
EcS-2	0.257	129	0.000	0.840	129	0.000
EcS-3	0.219	129	0.000	0.831	129	0.000
EcS-4	0.251	129	0.000	0.813	129	0.000
EcS-5	0.240	129	0.000	0.844	129	0.000
EcS-6	0.242	129	0.000	0.816	129	0.000
EcS-7	0.256	129	0.000	0.838	129	0.000
SoS-1	0.245	129	0.000	0.852	129	0.000
SoS-2	0.205	129	0.000	0.859	129	0.000
SoS-3	0.201	129	0.000	0.860	129	0.000
SoS-4	0.201	129	0.000	0.860	129	0.000
SoS-5	0.242	129	0.000	0.816	129	0.000
SoS-6	0.249	129	0.000	0.831	129	0.000
SoS-7	0.248	129	0.000	0.848	129	0.000

The kurtosis values are predominantly positive, greater than 0, This indicates the distribution is nearly normal but slightly leptokurtic, meaning the distribution has slightly heavier tails than a normal distribution. These characteristics further confirm the non-normal nature of the data.

The results demonstrate that all variables significantly depart from normality. This finding necessitates the use of non-parametric statistical methods for subsequent analyses, as standard parametric tests requiring normal distribution assumptions would be inappropriate

4.5.4 Kruskal-Wallis Test for Analyzing Non-Parametric Data

The Kruskal-Wallis Test was applied to examine whether there are statistically significant differences in perceptions of sustainability aspects across different levels of sustainability understanding, slight, moderate, and high. This non-parametric test is suitable for ordinal data and was used to assess if the distributions of responses differ significantly among the three understanding groups. The significance level was set at $p < 0.05$.

TABLE 4.10: Kruskal-Wallis Test for Analyzing Non-Parametric Data

Kruskal Wallis Test						
Sr. No	**Null Hypothesis**	**Sig.**	**Decision**	**Sr. No**	**Null Hypothesis**	**Sig.**
1	GnS-1	0.9	Retain the null hypothesis	16	EcS-1	0.8
2	GnS-2	0.2		17	EcS-2	0.3
3	GnS-3	0.7		18	EcS-3	0.6
4	GnS-4	0.1		19	EcS-4	0.1
5	GnS-5	0.4		20	EcS-5	0.4
6	GnS-6	0.3		21	EcS-6	0.2
7	GnS-7	0.3		22	EcS-7	0.4
8	GnS-8	0.5		23	SoS-1	0.5
9	EnS-1	0.9		24	SoS-2	0.2
10	EnS-2	0.8		25	SoS-3	0.2
11	EnS-3	0.9		26	SoS-4	0.2
12	EnS-4	0.8		27	SoS-5	0.2
13	EnS-5	0.2		28	SoS-6	0.2
14	EnS-6	0.2		29	SoS-7	0.5
15	EnS-7	0.6				

For all eight items under General Sustainability (GnS-1 to GnS-8), the Asymptotic Significance (p-values) ranged from (0.133 to 0.907), all above the 0.05 threshold. This indicates that there are no statistically significant differences in perceptions among participants with slight, moderate, and high understanding of sustainability. Thus, the null hypothesis was retained for each item. This result suggests a general agreement across all understanding levels regarding the role of indigenous practices in promoting general sustainability, such as stakeholder involvement, climate suitability, and professional training.

All seven items under Environmental Sustainability also showed non-significant results, with p-values ranging from (0.208 to 0.903) since the result remains above the 0.05 threshold, the null hypothesis is retained for all items. This implies that regardless of their level of sustainability awareness, respondents shared a common perception of the environmental benefits of indigenous building practices.

Economic Sustainability items (EcS-1 to EcS-7) also exhibited no statistically significant differences across the understanding levels, with p-values ranging from (0.093 to 0.754).

The indicates some variability in opinions on the economic potential of indigenous, but not enough to reject the null hypothesis. Overall, these results suggest that participants, regardless of their sustainability knowledge level, generally agree on the economic advantages of indigenous construction, including cost-effectiveness, job creation, and local economic support.

Similarly, all seven items under Social Sustainability (SoS-1 to SoS-7) returned non-significant p-values, ranging from (0.243 to 0.499). These findings indicate that participants consistently recognize the social value of indigenous practices, including cultural preservation, community identity, and gender inclusiveness.

The results of the Kruskal-Walli's test confirm that no significant differences exist in sustainability perceptions among respondents with slight, moderate, or high understanding of sustainability across all items. The null hypothesis was retained in each case. This uniformity suggests that the role of indigenous construction in enhancing sustainable building practices is widely acknowledged and consistently valued, regardless of the respondent's level of prior knowledge or familiarity with sustainability concepts.

4.5.5 Factor Prioritization by RII Across Sustainability Aspects

This part explains how the data obtained using a structured questionnaire (which was created to determine how con- struction professionals perceive the incorporation of Indigenous Building Practices, or IBP, in sustainable construction) were analyzed and interpreted. The Relative Im- portance Index (RII) was used in analysing the data to measure the level of significance of each statement in a given four main sustainability dimensions; General, Environmental, Economic, and Social Sustainability. The RII assigns a normalized score (between 0 and 1) that is used to place the responses in order of their perceived significance. According to the category, the rank and the analysis is as shown below.

4.5.5.1 General Sustainability

The analysis of the General Sustainability dimension reveals the respondents' perceptions of how indigenous building practices align with sustainable development goals. The highest-ranked item in this category was GnS-6 "As key players, the project management teams can promote indigenous & sustainable building practices" with a Relative Importance Index (RII) of 0.768. This reflects a strong agreement that"The project managers hold a pivotal role in the adoption and promotion of indigenous practices", given their influence over planning, execution, and policy enforcement in the construction process.

Table 4.11: Ranking of factors of General Sustainability as per RII values

General Sustainability	W	A*N	RII	Overall Rank	Group Rank
GnS-6	507	660	0.768	3	1
GnS-4	503	660	0.762	5	2
GnS-2	497	660	0.753	8	3
GnS-5	497	660	0.753	8	3

The second ranked item GnS-4 with RII of 0.762 indicates that "Past architecture focused on indigenous materials, while modern architecture overlooked them the similar results were conducted in the previous research as the selection of native methods depends on the climate, local cultures, and the materials, which exist in a particular region, which guarantees environmental flexibility and social acceptability enhance sustainable economies and encourage environmental awareness and a sense of place [79].

The third ranked item, GnS-5 "The choice of indigenous techniques depends on climate, tradition, and materials of a specific region", scored an RII of 0.781. GnS-2 also at positioned at third "indigenous building practices as a role model for green architecture and sustainable design", this study were also conducted in the previous research as architectural development in the past was based on indigenous materials that were environmentally adaptive, economical and culturally based to provide sustainable construction practices.

Modern architecture, however, did not consider these solutions but gave preference to industrial materials that represented progress and avoided considering ecological and cultural sustainability [80]. This suggests a need for capacity building and education to bridge the gap between traditional knowledge and contemporary construction practices.

4.5.5.2 Environmental Sustainability

In the Environmental Sustainability category, the highest ranked item was EnS-6 "The unique balance between ecosystem, form, and material found in indigenous practices provides valuable lessons for modern architecture, as it reflects a deep integration of environmental awareness and cultural identity. That this vernacular harmony can inspire contemporary design to adopt more inclusive and sustainable approaches by reconnecting construction with ecological and territorial contexts as this statement is provided by [79].", which scored an RII of 0.755. This underscores the belief that traditional methods could offer innovative solutions to environmental issues if integrated properly into contemporary building systems. The second ranked item was EnS-7 "The unique balance between ecosystem, shape and material in indigenous practices can inspire modern architecture" with an RII value of 0.75, indicating that respondents strongly acknowledge the architectural and ecological synergy of traditional construction. This suggests a growing recognition of indigenous techniques not only for their cultural value but also for their relevance in shaping future green architecture.

Table 4.12: Ranking of factors of Environmental Sustainability as per RII values

Sustainability Factors	**W**	**A*N**	**RII**	**Overall Rank**	**Group Rank**
EnS-6	498	660	0.755	7	1
EnS-7	495	660	0.750	9	2
EnS-3	494	660	0.748	10	3

The Third Rank Factor EnS-3 "The use of industrial wood alongside locally fast-grown trees supports sustainability by reducing pressure on natural forests and lowering environmental degradation.

As [81], such practices in green architecture not only conserve ecosystems but also provide eco-friendly alternatives that align with regional resource management." achieved an RII of 0.748, highlighting importance among professionals about the sustainable resource used in indigenous construction.

The findings in this category reflect a positive outlook towards the environmental potential of indigenous practices, especially in terms of eco-friendly material and resource conservation.

4.5.5.3 Economic Sustainability

Economic Sustainability emerged as a particularly strong area in the survey, with several items scoring high RII values. The top-ranked item in this dimension was EcS-4 "Indigenous buildings serve as cultural assets that attract tourism, thereby boosting the economic activities of the region through heritage-based experiences. The preservation and showcasing of indigenous architecture play a vital role in promoting local livelihoods and strengthening sustainable tourism models" [82].

TABLE 4.13: Ranking of factors of Economic Sustainability as per RII values

Sustainability Factors	W	A*N	RII	Overall Rank	Group Rank
EcS-4	513	660	0.777	1	1
EcS-6	512	660	0.776	2	2
EcS-3	494	660	0.748	10	3

This indicates that respondents see significant economic value in preserving and promoting indigenous construction, particularly through cultural tourism and regional development.

The second highest in this category was EcS-6 “Insufficient information on the native building products can lead to the use of unsustainable and expensive structural materials, which exacerbates structural construction projects in regard to the environmental and monetary expenses.

According [83] sustainable building materials can be promoted through the informed knowledge of cost-effective and eco-friendly building materials” with an RII of 0.776. This result suggests a perceived gap in knowledge and awareness that, if addressed, could reduce costs and promote local economies.

EcS-3, which emphasizes “Native construction methods can be said to cost less to maintain in general as they use materials that are readily available locally and are highly suitable to the climate and the environment, which means that they need less maintenance and replacement over the years.

Their dependency on the traditional knowledge and the use of only basic methods of construction makes them even more durable and less expensive in the long run than industrial options [80]”, ranked third with an RII of 0.748.

This highlights the belief that traditional methods can reduce the high maintenance cost as compared to modern cement Buildings by using local and indigenous material. These findings reflect a clear appreciation of the economic benefits tied to indigenous practices, particularly in terms of cost-effectiveness, job creation, tourism potential, and local empowerment.

4.5.5.4 Social Sustainability

The Social Sustainability category recorded similar RII scores, with SoS-1 and SoS-7 ranking high. SoS-1 The design philosophy of buildings links culture, tradition and environment since the decisions on materials, space arrangement and modes of construction are based on local requirements. This integration makes sure that architecture is capable of not only showing the identity and history of a people but it also effectively responds to the surrounding environment to remain sustainable [80]" and SoS-7 " A sense of identity and pride to local communities is also enhanced through the use of indigenous materials and practices as historical backgrounds and cultural continuity is maintained. According [84] these practices do not only preserve traditions but also improve social cohesion and value of the community as far as modern housing in cities is concerned." both achieved an RII of 0.768, indicating professionals recognize the significant role of cultural and traditional aspects in building design and community identity.

TABLE 4.14: Ranking of factors of Social Sustainability as per RII values

Social Sustainability	W	A*N	RII	Overall Rank	Group Rank
SoS-1	507	660	0.768	3	1
SoS-7	507	660	0.768	3	1
SoS-2	505	660	0.765	4	2
SoS-3	505	660	0.765	4	2
SoS-4	505	660	0.765	4	2
SoS-5	505	660	0.765	4	2
SoS-6	505	660	0.765	4	2

Meanwhile, SoS-2 to SoS-6 scored an RII of 0.765, highlighting One of the most significant contributors to the implementation of indigenous building practices is the role of a client who directly affects the choice of materials and building methods depending on his/her preferences, awareness, and commitment levels. According to Okoye (2021), clients who make sustainability their priority open the demand to indigenous approaches, thus, promoting the development of construction that is environment-conscious and culturally pertinent [85] "client's major role in adoption of IBP and improving quality of life", while also acknowledging challenges like "gender inequality in modern construction". This suggests a strong consensus among professionals on the importance of indigenous practices in economic sustainability.

4.5.5.5 Overall Ranking Based on RII

Among all evaluated factors, the highest-ranked factor was EcS-4 "Indigenous buildings attract Tourism, which enhances economic activities of the region" with an RII of 0.777, reflecting its strong perceived contribution to economic sustainability. EcS-6 (RII = 0.776), showing high importance for social and economic aspects.

TABLE 4.15: RII values of all Factors of Sustainability

Sustainability Aspect	**W**	**A*N**	**RII**	**Rank**	**Sustainability Aspect**	**W**	**A*N**	**RII**	**Rank**
General Sustainability (GnS)					Economic Sustainability (EcS)				
GnS-1	491	660	1	14	EcS-1	486	660	1	16
GnS-2	497	660	1	8	EcS-2	493	660	1	11
GnS-3	492	660	1	13	EcS-3	494	660	1	10
GnS-4	503	660	1	5	EcS-4	513	660	1	1
GnS-5	497	660	1	8	EcS-5	489	660	1	15
GnS-6	507	660	1	3	EcS-6	512	660	1	2
GnS-7	489	660	1	15	EcS-7	500	660	1	6
GnS-8	493	660	1	11					
Environmental Sustainability (EnS)					Social Sustainability (SoS)				
EnS-1	489	660	1	15	SoS-1	507	660	1	3
EnS-2	465	660	1	18	SoS-2	505	660	1	4
EnS-3	494	660	1	10	SoS-3	505	660	1	4
EnS-4	490	660	1	14	SoS-4	505	660	1	4
EnS-5	466	660	1	17	SoS-5	505	660	1	4
EnS-6	498	660	1	7	SoS-6	505	660	1	4
EnS-7	495	660	1	9	SoS-7	507	660	1	3

Notably, factors related to economic sustainability dominated the top five rankings, indicating that respondents perceived "indigenous construction practices as cost-effective, locally empowering, and community-enriching". All factors of social sustainability retain third and fourth position which depicts that the professional have high consensus on the social value of indigenous construction than all other aspects. From the general sustainability category, GnS-6 "Project management teams can promote indigenous & sustainable practices" secured 3rd place with an RII of 0.768, highlighting the strategic role of professionals in promoting sustainability.

Environmental sustainability factors such as EnS-6 and EnS-7 ranked lower (7^{th} and 8^{th} respectively), which may suggest that while environmental contributions are acknowledged, economic and social returns are viewed as more immediate and impactful in practice.

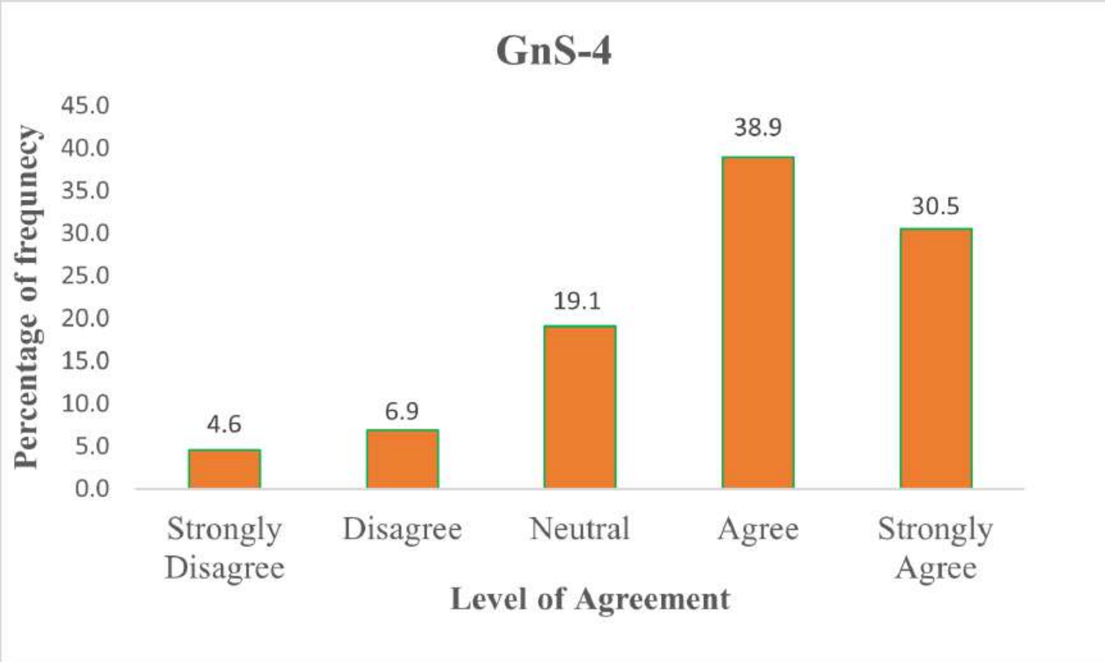
Overall, this ranking pattern aligns with the thematic findings of the questionnaire, where respondents emphasized cost reduction, community development, cultural preservation, and stakeholder involvement over purely environmental considerations. These results reinforce the argument that successful implementation of indigenous sustainable practices requires a balanced integration of all three sustainability pillars, with economic considerations and social inclusion for better integration of both IBP and MBP to enhance sustainable building practices.

4.5.6 Examination of Trends and Opinions Among Respondents

The frequency analysis of survey responses reveals critical stakeholder perceptions regarding indigenous building practices (IBP) across four sustainability dimensions.

4.5.6.1 General Sustainability Impactful Factors as per Frequency

For General Sustainability (GnS), three factors demonstrate strong consensus: 69.46% agree that "There is a lack of a framework for integrating indigenous construction techniques with modern construction practices" and "project management teams are pivotal in promoting IBP", (GnS-4 & GnS-6), 68.7% agree that “Stakeholder management is a critical success factor for the construction of sustainable buildings throughout the project life cycle” (GnS-7), and 67.9% agree that “The indigenous practices promote sustainability” (GnS-1).



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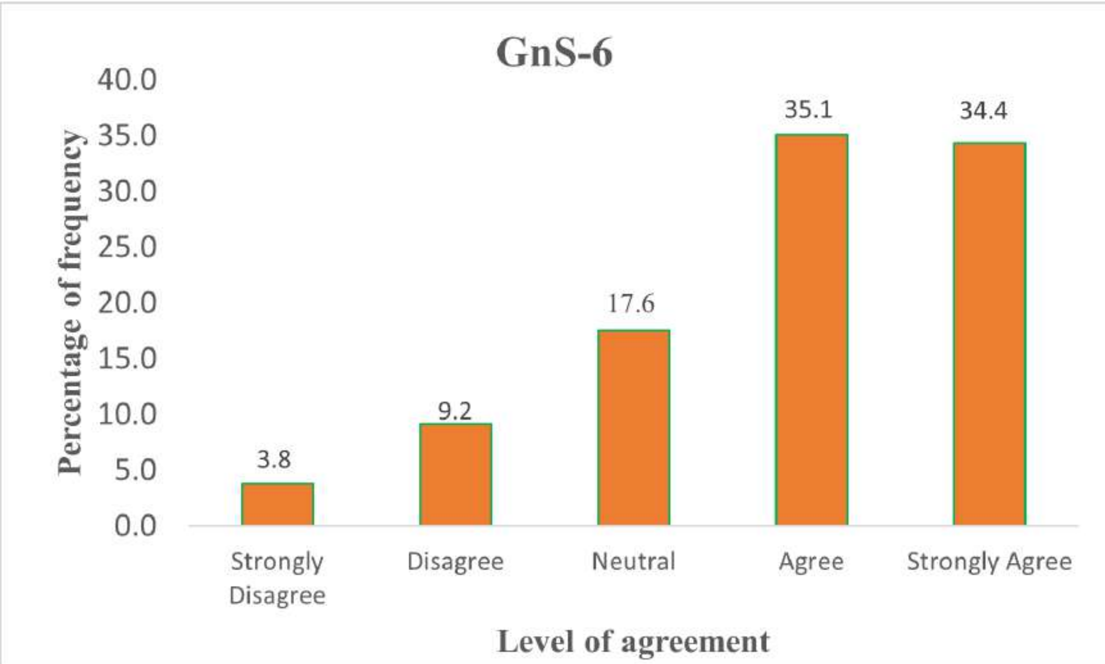

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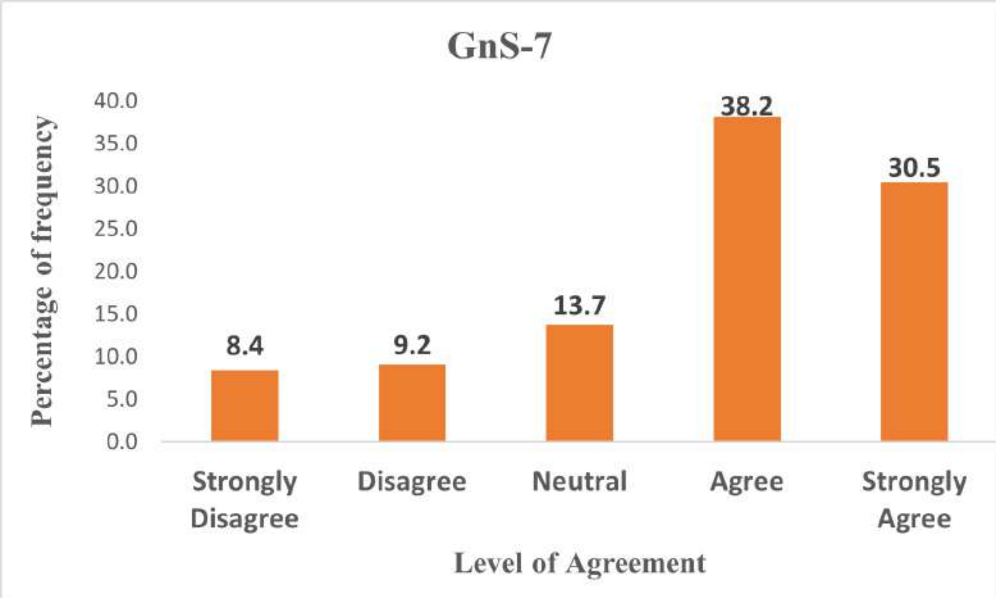

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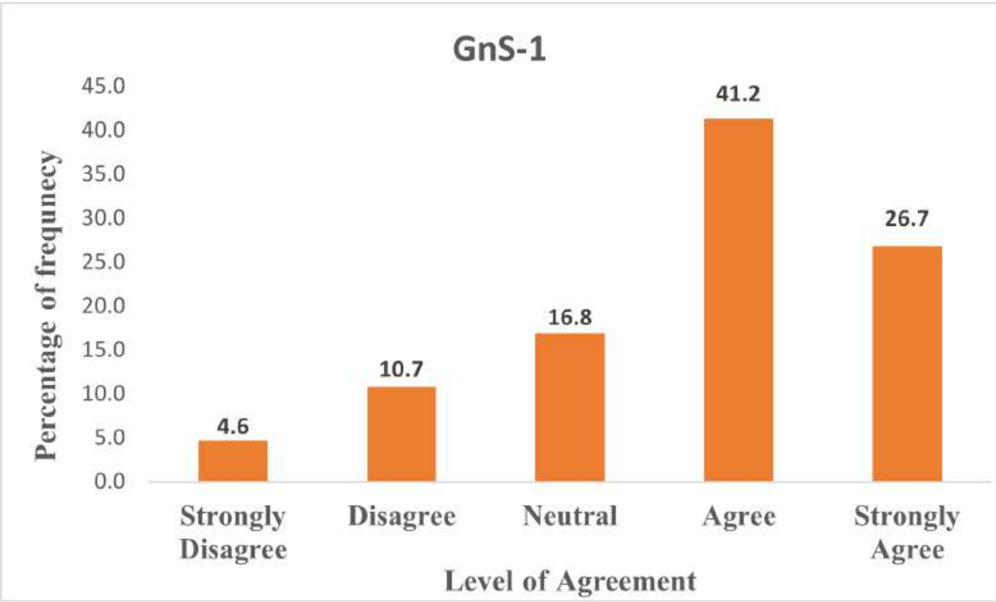
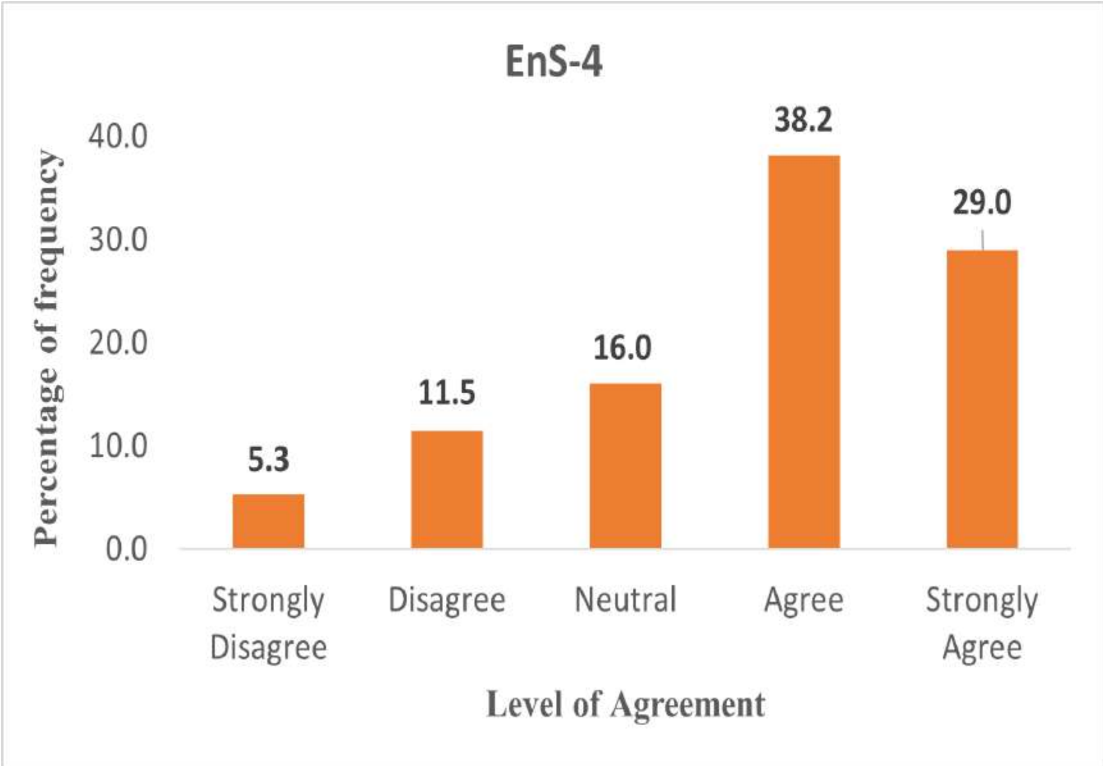


FIGURE 4.7: Frequency Analysis of General Sustainability ((a&b) GnS-6 & GnS-4 at rank- 1, (c) GnS-7 at rank-2, (d) GnS-1 at rank-3)

4.5.6.2 Environmental Sustainability Impactful Factors as per Frequency

In Environmental Sustainability (EnS-7), show that 70.99% agree that "The unique balance between eco-system, shape and material in indigenous practices can inspire modern architecture", (EnS-4), 67.2% "Use of industrial wood and locally fast-grown trees helps to reduce environmental degradation" (EnS-6), and 65.65% recognize "IBP's potential to solve modern environmental challenges" (EnS-6).



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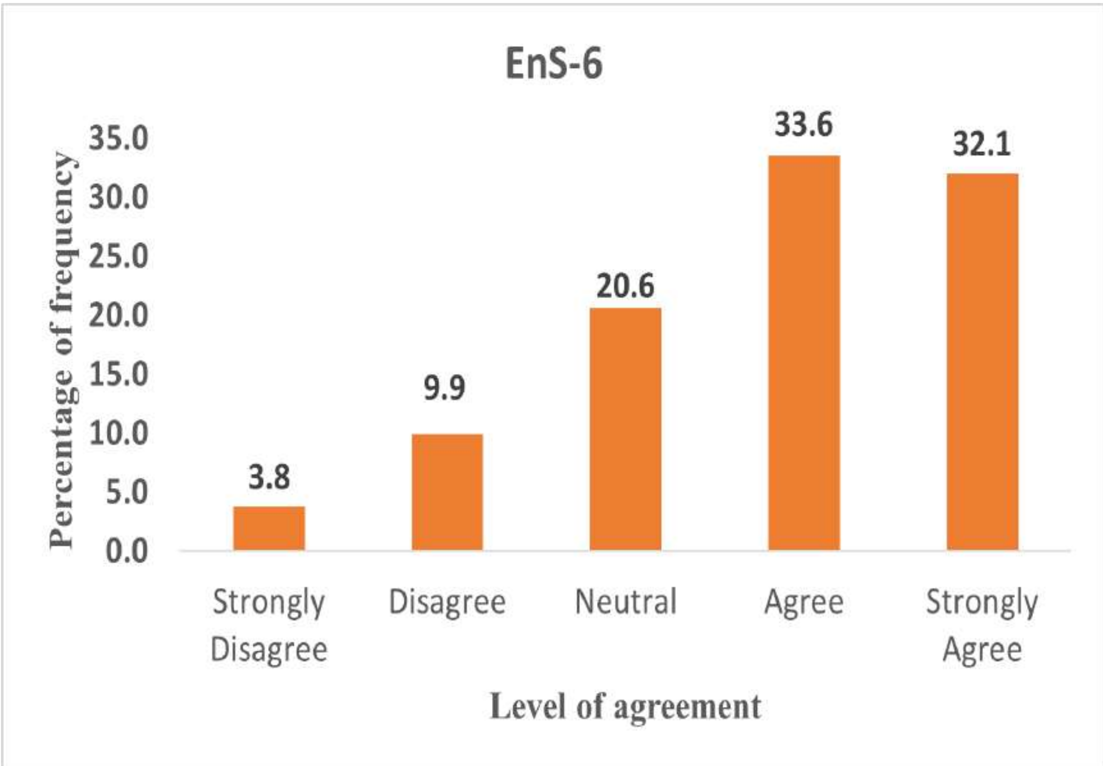

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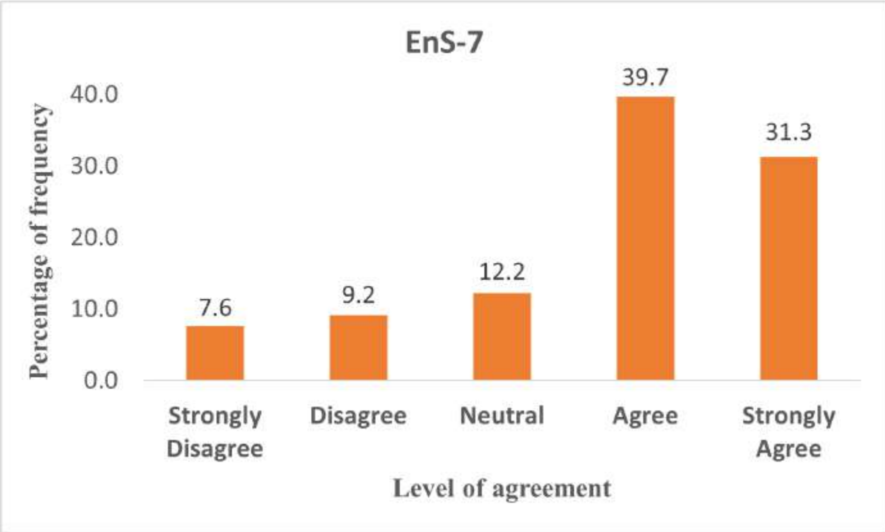
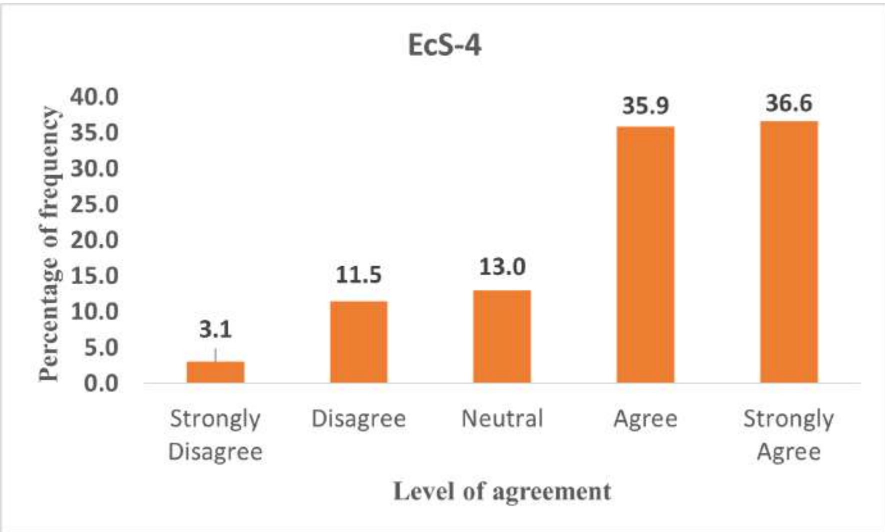


FIGURE 4.8: Frequency Analysis of Environmental Sustainability ((a) EnS-7 at rank- 1, (b) EnS-4 at rank-2, (c) EnS-6 at rank-3)

4.5.6.3 Economic Sustainability Impactful Factors as per Frequency

For Economic Sustainability (EcS), tourism emerges as the strongest driver with 72.52% agreeing "Indigenous buildings attract Tourism, which enhances economic activities of the region" (EcS-4), followed by 70.99% "Lack of information about indigenous buildings products leads to the use of selection of unsustainable and costly materials" (EcS-6), and 70.23% linking "IBP to circular economy goals through local economic flows" (EcS-7).



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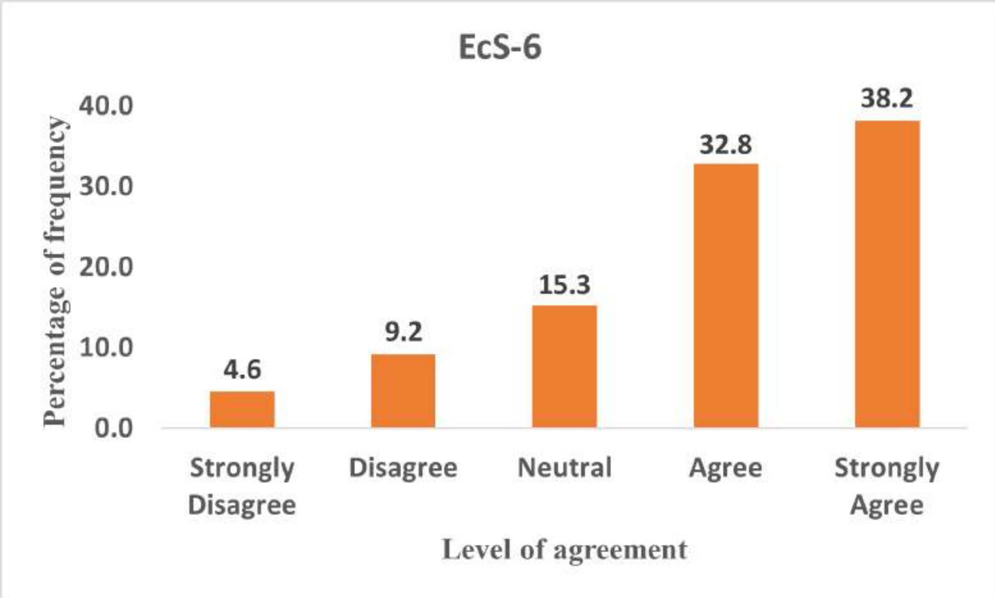

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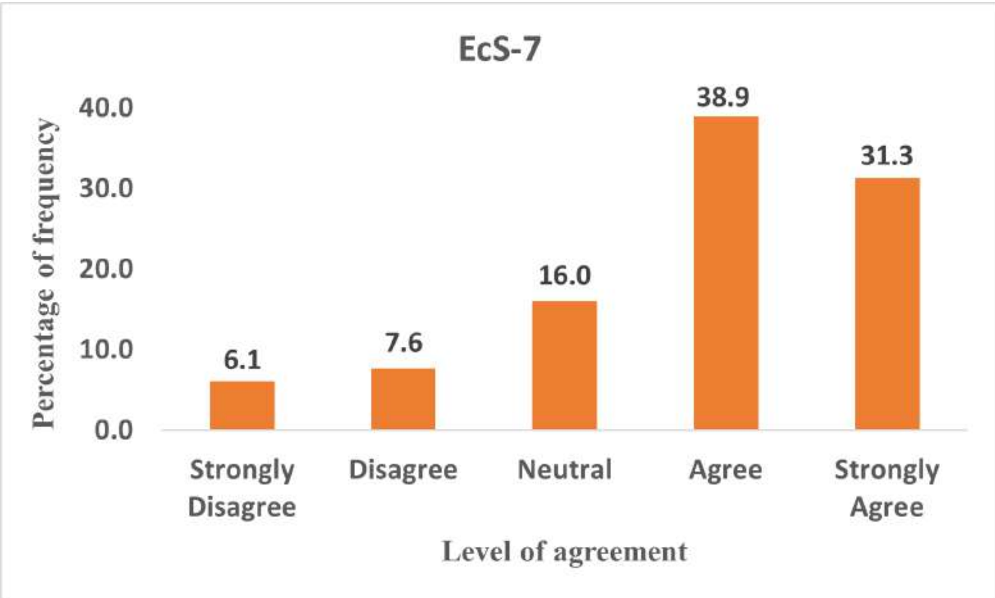
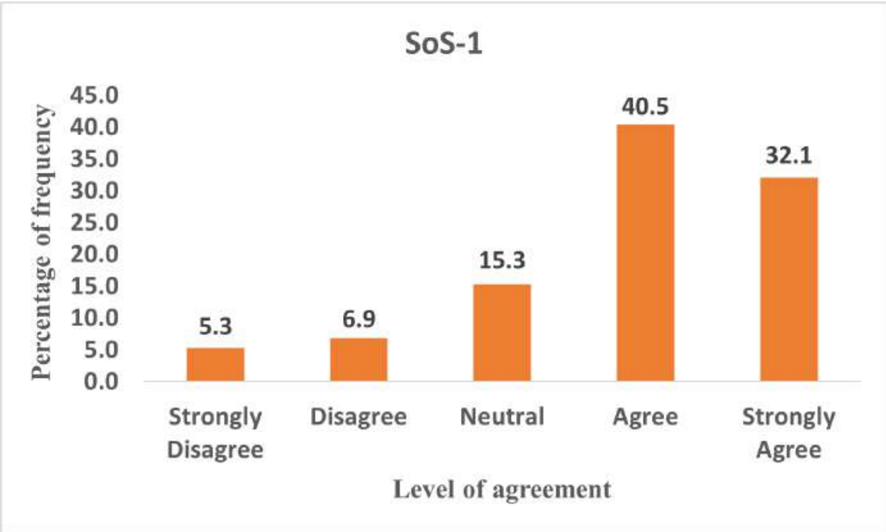


FIGURE 4.9: Frequency Analysis of Economic Sustainability((a) EcS-4at rank-1, (b) EcS-6 at rank-2, (c) EcS-7 at rank-3)

4.5.6.4 Social Sustainability Impactful Factors as per Frequency

In Social Sustainability (SoS), 72.52% "Culture, tradition and environment strongly influence the design philosophy of building "and "The indigenous materials and methods strengthen a sense of identity and pride among local communities by preserving historical heritage" (SoS-1 & SoS-7) both stand first while 71.75% cite

"Indigenous building practices are widely used & highly valued around the world" with "Modern construction methods often exclude women from skilled roles, reinforcing gender inequalities". "The employment of local labour in the construction preserves cultural heritage and contributes to social uplift" also "The indigenous building practices meaningfully improve the quality of life and promote equal benefits for all stakeholders", and t"he Client role is a major factor in adopting Indigenous building practices". These quantified stakeholder perspectives validate indigenous building practices as multidimensional sustainability solutions" (SoS-2-SoS-6) collectively stood second.



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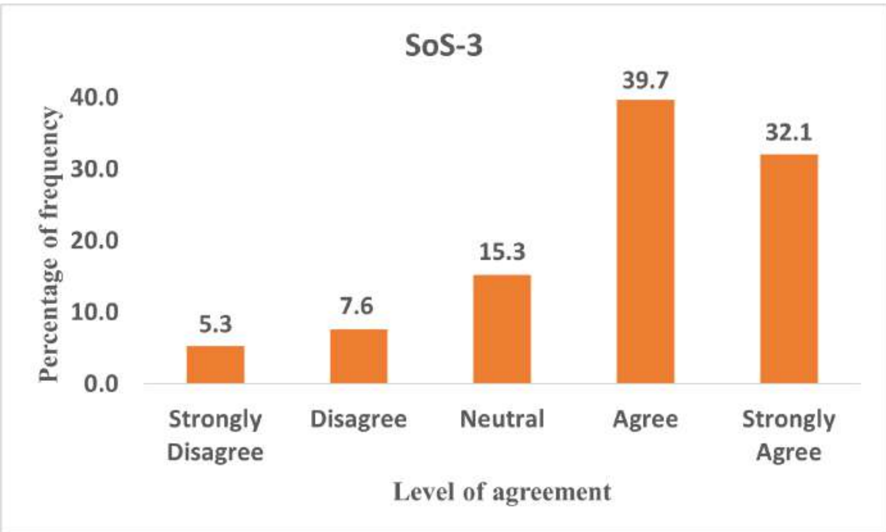

FIGURE 4.10: Frequency Analysis of Social Sustainability((a) SoS-1 & SoS-7at rank- 1, (b) SoS-2 ,Sos-3,SoS-4,SoS-2at rank-2)

These findings collectively underscore that IBP is not only a cultural asset but also a practical framework for sustainable development, offering economic, environmental, and social benefits that modern practices can learn from and integrate.

4.6 Main Findings from Questionnaire Survey Analysis

In the General Sustainability category, the top three factors based on RII are, GnS-6 "Project management teams can promote IBP" with an RII of 0.768, GnS-5 "Choice of indigenous techniques depends on climate, tradition, and materials" with an RII of 0.753, and GnS-4 "Lack of integration frameworks" with an RII of 0.772. Based on frequency analysis, the top three factors are, GnS-6 & GnS-4 with 70.46% agreement, GnS-7 "Stakeholder management is a critical success factor for the construction of sustainable buildings throughout the project life cycle" with 68.7%, and GnS-1 "IBP promotes sustainability" also with 67.9%. While if we look at the top three factors according to mean and standard deviation, the three highest means and lowest standard deviations are GnsS-2, which comes first with a mean of 3.80, second GnS-5 with a mean of 3.79, and GnS-4 with a mean 3.78 while as per the Standard deviation, the lowest Sd factor is GnS-1 =1.109, GnS-4=1.116 and third ranked factor is GnS-3 =1.27.

In the Environmental Sustainability category, the top three factors as per RII are EnS-6 "IBP addresses modern environmental challenges" with an RII of 0.755, EnS-7 "Ecosystem-material balance inspires modern architecture" with an RII of 0.75, and EnS-3 " use of eco-friendly organic material" with an RII of 0.766. According to frequency, the top three are EnS-7 "indigenous practice can inspire modern architecture" with 70.99%, EnS-4 "Use of local/fast-grown wood" with 67.18%, and EnS-6 again "IBP as solution to environmental challenges" with 65.65%. while in terms of mean and standard deviation top three factors respectively are, EnS-6=3.76, EnS-3=3.72 and EnS-1=3.71, while EnS-3=1.126, EnS-7=1.137 & EnS-4 =1.145 had the lowest Standard deviation.

For Economic Sustainability, the top three factors by RII are EcS-4 "IBP enhances regional economies through tourism" with a high RII of 0.777, EcS-6 "Lack of knowledge leads to unsustainable material choices" with an RII of 0.776, and EcS-3 "The indigenous building practices have a low maintenance cost" with an RII of 0.748. The frequency rankings align exactly EcS-4 ranked highest with 72.99% agreement, followed by EcS-6 with 70.99%, and EcS-7 with 70.23%. while the mean and standard deviation of the top three factors respectively are EnS-6=3.88, EcS-4=3.87 and EcS-7=3.80, while EcS-4=1.139, EcS-6=1.144 & EnS-7 =1.145 had the lowest Standard

In the Social Sustainability category, the RII rankings are led by SoS-1 & S0S-7 "Culture, tradition and environment strongly influence the design philosophy of building" with an RII of 0.777, and SoS-7 "The indigenous materials and methods strengthen a sense of identity and pride among local communities by preserving historical heritage" with 0.777and all other Factors from SoS-2 to SoS-6 have same RII of 0.765 which show similar agreement among respondents. The frequency-based factors are SoS-1 & SoS-7 "IBP strengthens identity and preserves heritage" with 72.52%, SoS-2 to SoS-6 have a frequency of 71.75%, while a similar trend is observed in SoS-1 & SoS-7 with mean of 3.87 while all other factors have same mean of 3.85 with similar pattern for Sd is SoS-1 & SoS-7=1.105 while other factors have same Sd of 1.117. This comparison highlights where stakeholder perception is most aligned across both analysis methods, particularly in the social category and Economic category, and where it diverges slightly in others such as General and Environmental Sustainability.

4.7 Discussion

The discussion of this section reveals consistent and positive trends in how construction professionals perceive the role of Indigenous Building Practices (IBP) across general, environmental, economic, and social dimensions of sustainability. High Cronbach's Alpha values across all categories of value 0.984 confirm excellent internal consistency of the questionnaire, ensuring that responses were coherent and reliable. The study explored how professionals view Indigenous Building Practices (IBP) in supporting sustainability. The focus was on four areas: general, environmental, economic, and social sustainability. To understand the importance of each factor, three methods were used. Relative Importance Index (RII), frequency (how many people agreed), and average scores (mean and standard deviation). The goal was to see if the professionals' opinions matched the statistical results.

In the General Sustainability category, professionals mostly agreed that "The project management teams can help promote IBP" (GnS-6). Other important factors were "the lack of proper systems to support IBP" (GnS-4) and that "the use of IBP depends on climate, tradition, and available materials" (GnS-5). These were the top-ranked factors in RII and frequency.

However, in the average score method, GnS-2 was slightly higher. This shows that while there was strong agreement, some small differences in ranking appeared across methods. Overall, it is seen to believed that good planning and local understanding are very important for the successful use of IBP.

In the Environmental Sustainability category, the top factors were "The use of eco-friendly materials"(EnS-3), "addressing modern environmental challenges" (EnS-6), and "learning from natural systems in design" (EnS-7). These factors were consistently ranked high across all three methods, showing strong agreement. This means that professionals see IBP as a helpful way to deal with current environmental problems.

For Economic Sustainability, the results showed very strong alignment. The top factors were that "IBP supports local economies through tourism" (EcS-4), "lack of knowledge can lead to poor material choices" (EcS-6), and "Integrating indigenous building practices with sustainability aspects supports circular economy goals by fostering local economic flow" (EcS-7).

These were ranked highest in RII, frequency, and average scores. This shows a clear understanding among professionals that IBP offers real financial benefits, especially for local communities.

In the Social Sustainability category, professionals showed the most agreement. "They strongly supported that IBP is shaped by culture, tradition, and the environment" (SoS-1), and that it helps "preserve heritage and builds pride in communities" (SoS-7). These two were the highest in all ranking methods. All other social factors had almost the same scores, showing that professionals had a common view. This suggests that IBP is widely seen as valuable for keeping culture alive and supporting strong communities.

When comparing all the ranking methods and professional perception, most results matched well with professional opinions. The strongest alignment was seen in the economic and social categories. In the general and environmental categories, results were also similar, with only slight differences in order. These small changes are normal in survey-based research, which may be due to perception in understanding of research questions and words used, the level of understanding of the respondent and their experience and working environment of a professional. Overall, the findings show that professionals agree that Indigenous Building Practices are beneficial for sustainability. They help protect the environment, support local economies, preserve culture, and promote responsible building practices.

4.8 Summary

The above analysis highlights construction professionals' views of the role of Indigenous Building Practices (IBP) in supporting sustainability. The study looked at four areas, general, environmental, economic, and social sustainability. Overall, professionals had a positive and consistent opinion about IBP, and the questionnaire showed excellent reliability with a Cronbach's Alpha of 0.984.

Three methods were used to analyze the data, the Relative Importance Index (RII), frequency of agreement, and average scores. In the General Sustainability category, professionals agreed that strong project management and understanding of local needs are key for promoting IBP. In the Environmental category, they supported the use of eco-friendly materials and learning from nature. The Economic category showed the strongest agreement, especially on the role of IBP in supporting tourism, saving costs, and helping local economies. In the Social category, professionals clearly agreed that IBP helps preserve culture and builds community pride.

Across all categories, most rankings from the three methods matched professional opinions, especially in economic and social areas. Some small differences appeared in the general and environmental categories, which is normal in surveys and may be due to differences in understanding the questions.

In conclusion, professionals believe that IBP plays an important role in promoting sustainable building. It supports the environment, economy, and culture. The findings show that with better planning, education, and leadership, IBP can help build stronger, more sustainable, and culturally rich communities, especially in countries like Pakistan.

Chapter 5

Conclusions and Recommendations

This study explored how indigenous construction practices can help make buildings more sustainable. The findings show that these indigenous methods are a good example of green and eco-friendly building. In the past, local materials and traditional techniques were commonly used, but modern construction has mostly ignored them. Today, bringing back these methods can support sustainability in many ways. However, there is no proper system or framework to combine indigenous practices with modern construction. This makes it difficult to apply them widely. Also, not every indigenous technique works everywhere. The choice depends on the local climate, culture, and materials, so each region needs its own approach. The research confirms that Indigenous Building Practices (IBP) are highly valued by construction professionals for their ability to promote sustainability in multiple ways. IBP contributes meaningfully to environmental protection, economic growth, social development, and cultural preservation. It offers a balanced approach that aligns well with the core principles of sustainable development. However, its successful integration into modern construction requires leadership, proper systems, and understanding of local contexts. From a civil engineering viewpoint, the findings highlight the potential of IBP to create buildings that are efficient, affordable, and responsive to community needs. Overall, the study shows that indigenous practices have strong value in today's world, and they should be better included in modern building projects to create more sustainable and locally connected buildings.

5.1 Indigenous Construction - General Perspective

Based on the analysis of responses under the indigenous Construction-General Perspective, the study identifies the most important factors that support the use of Indigenous Building Practices (IBP) in promoting sustainable construction, based on both RII and frequency analysis.

1. As key players, the project management teams can promote indigenous & sustainable building practices also RII=0.768, Frequency=70.46%). This highlights that project managers play a central role in promoting Indigenous Building Practices (IBP), especially when clear systems and support are present.
2. There is a lack of a framework for integrating indigenous construction techniques with modern construction practices which appears at the top in both rankings (RII=0.762 & Frequency=70.46%). This shows that professionals strongly agree that the absence of a proper framework limits the integration of traditional and modern construction methods.
3. The choice of indigenous techniques depends on climate, tradition and materials of a specific region RII= 0.753, meaning professionals recognize the need to Integrate both building methods with local climate and cultural conditions for better sustainability.
4. Stakeholder management is a critical success factor for the construction of sustainable buildings throughout the project life cycle,(RII=0.741 Frequency: 68.7%). This suggests that many respondents believe strong communication and coordination with all stakeholders is also key to success in using indigenous methods.

Overall, these findings show that to apply IBP successfully, there must be a strong project leadership team, an effective framework to combine traditional and modern practices, appropriate selection of local techniques, and active involvement of all project stakeholders.

5.2 Indigenous Construction - Environmental Perspective

The Indigenous building practices offer simple and eco-friendly solutions to today's environmental challenges:

1. Indigenous building practices have vast poten- tial to address modern environmental challenges" (RII = 0.755, Frequency: 65.65%).

2. The unique balance be- tween eco-System, shape and material in indigenous practices can inspire modern architecture" (RII = 0.75, Frequency: 70.99%). These two factors highlight that professionals recognize the strong potential of indigenous practices to deal with current environmental issues while also influencing modern architecture through eco-conscious design and materials.

3. The use of organic and agricultural waste in building construction is more eco-friendly than modern construction materials" (RII = 0.766,). This shows the importance of using organic materials and waste to create more sustainable and environmentally friendly buildings.

This reflects a strong belief among professionals that using locally available renewable materials like fast-growing wood can help reduce environmental harm. This reflects a strong belief among professionals that using locally available renewable materials like fast-growing wood can help reduce environmental harm.

Overall, these practices have great potential to support environmental sustainability in today's building industry.

5.3 Indigenous Construction - Economic Perspective

The study found that indigenous building practices can support economic sustainability, especially when combined with modern sustainable approaches.

1. Indigenous buildings attract Tourism, which enhances economic activities of the region" (RII = 0.777, Frequency: 72.99%).

2. Lack of information about indigenous buildings products leads to the use of selection of unsustainable and costly materials" (RII = 0.776, Frequency: 70.99%). These findings show that professionals believe In- digenous Building Practices (IBP) can directly support the economy by promoting tourism and reducing poor material choices through better awareness.

3. The indigenous building practices have a low maintenance cost" (RII = 0.748)This highlights how IBP helps reduce long-term building expenses, making them more affordable and cost-effective for communities.

4. Integrating indigenous building practices with sustainability aspects supports circular economy goals by fostering local economic flow (RII=0.758 Frequency: 70.23%).

This suggests that many professionals recognize the value of connecting indigenous methods with sustainable systems to boost local economic cycles and support circular economy principles. This suggests that many professionals recognize the value of connecting indigenous methods with sustainable systems to boost local economic cycles and support circular economy principles.

Overall, the findings suggest that integrating indigenous knowledge into construction can lower costs and support sustainable economic growth in communities.

5.4 Indigenous Construction - Social Perspective

The results show that social sustainability is strongly supported by the use of indigenous building practices.

1. Among all the factors, two stood out the most based on RII are SoS-1 "Culture, tradition and environment strongly influence the design philosophy of building" and SoS-7 "The indigenous materials and methods strengthen a sense of identity and pride among local communities by preserving historical heritage", both with an (RII of 0.777 ,Frequency: 72.52%).

   These results highlight that professionals value the cultural and emotional role of IBP in strengthening community identity and preserving heritage through traditional design and materials.

2. SoS-2 to SoS-6 share the same RII value of 0.765 Frequency: 71.75%), indicating a similar level of agreement across multiple aspects of social sustainability. These include the Indigenous building practices are widely used & highly valued around the world (SoS-2), Modern construction methods often exclude women from skilled roles, reinforcing gender inequalities (SoS-3), The employment of local labor in the construction preserves cultural heritage and contributes to social uplift (SoS- 4), The indigenous building practices meaningfully improve the quality of life and promote equal benefits for all stakeholders (SoS-5), and the important role of clients in adopting IBP (SoS-6).

   The consistent rankings show that respondents equally recognize these factors as vital contributors to social well-being.

These findings suggest that indigenous methods not only build structures but also help strengthen community, tradition, and fairness in the building process.

5.5 Supporting UN Sustainable Development Goal 11

The findings of this study clearly support UN SDG 11: Sustainable Cities and Communities, which aims to make cities inclusive, safe, resilient, and sustainable. The use of indigenous building practices helps meet several targets under SDG 11.

1. Target 11.3 (Enhance inclusive and sustainable urbanization)

   Indigenous methods encourage the use of local labor, respect cultural values, and include communities in the design and construction process, which promotes social inclusion and participation.

2. Target 11.4 (Strengthen efforts to protect cultural and natural heritage)

   Findings show that indigenous materials and techniques help preserve local traditions, historical knowledge, and architectural heritage, building a strong sense of identity and pride.

3. Target 11.6 (Reduce the environmental impact of cities)

   Indigenous construction often uses natural or recycled materials, reduces waste, and lowers carbon emissions, especially when industrial waste or fast-growing trees are used.

4. Target 11.a (Support positive links between urban and rural areas)

   Indigenous construction strengthens rural economies by using local resources, skills, and labor, supporting a circular economy and sustainable development in both urban and rural communities.

The study shows that indigenous practices not only improve building quality and sustainability but also support environmental protection, cultural preservation, and social equality, making them highly relevant to achieving the goals of SDG 11

5.6 Recommendations

This section presents recommendations based on the findings and conclusions. The results from the analysis, including average scores, reliability tests, and comparisons of professional opinions, showed a strong agreement among participants on the importance of Indigenous Building Practices (IBP) in supporting sustainable development. However, some differences in how professionals understood and prioritized these ideas also became clear. The following recommendations aim to guide policy decisions, practical actions, and future research based on those findings.

1. There is a need To Integrate Indigenous Construction Methods into Civil Engineering Education
2. To Tailor Building Codes for Indigenous Construction
3. Enforcement of Indigenous Construction Practices
4. Provide Incentives for Indigenous Construction
5. Capacity Building and Training
6. Community Engagement and Participation
7. Integrating modern tools & techniques for Indigenous construction

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Appendix

Questionnaire

Dear participant**,** I am MS civil engineering student at CUST, Islamabad. The questionnaire is intended to assess the factors on **"Exploring the Role of Indigenous Construction in Enhancing Sustainable Building Practices** "The questionnaire is intended for research purpose only. The outcome of this research will contributes to devise strategies to enhance sustainability. I would be grateful if you spend few minutes of your time to fill this questionnaire. you are requested to:

1. Give input regarding appropriateness and clarity of questions asked
2. Add or delete a question
3. Answer on Likert scale (1-5) to give your opinion

Introduction

1. Sustainability and its Pillars

The Sustainability in construction is aim to create Buildings that do not deplete resources or cause harm to the environment by ensuring economic, social, environmental need are satisfied. It involves the integration of environmental, social, equality and economic sustainability through the construction process and building life cycle.

The three main pillars of Sustainability

Environmental	Social	Economic
Energy efficiency	Health and Safety:	Cost effectiveness
Resource conservation	Social equality	Value engineering
Waste reduction	Culture Preservation	Job Creation
Pollution control		

2. Indigenous Building Practices

Indigenous Building practices are the Traditional construction methods developed by indigenous communities by years of relation with surrounding environment using locally available material, Skills and techniques which have been transfer through generations. They are deeply connected to the environment, cultures, and spiritual belief of communities. The Indigenous building practices emphasizes on harmony with nature, sustainability and community wellbeing.

Indigenous Building Practices Sustainability Factors

Environmental	Social	Economic
• Natural Materials	• Local Labor	• Construction Costs
• Climatic Conditions	• Local Technologies	• Maintenance Costs
• Design Suitability	• Cultural Significance	• Local/Rural Economy
• Local Availability		

3.Geeen Building Practices

Green building refers to the practice of creating buildings that are environmentally sustainable, resource efficient and sustainable throughout life cycle. The main aim of green building is minimizing negative environmental impact by maximizing the efficiency of resources, improving human health and reducing operating cost. operating costs.

Key Factors of Green building practices

1. Lifecycle Assessment
2. Health and Well-Being
3. Cost-Effectiveness
4. Regulatory compliance and certifications (LEED, BREEAM, Green Star)

Hassan Abbas
MS Civil Engineering
Capital University of Science and Technology

Questionnaire Part 1: Demographic Details

Pick the appropriate response from the list below.

1. Your highest level of education
   a) PhD
   b) Masters
   c) Bachelors
   d) Bs technology/ B-Tech
2. Please specify your designation
   a) Project Manager
   b) Construction Manager
   c) Site Engineer
   d) Contractor
   e) Architect
   f) Supervisor
   g) Other (please specify) ________________________
3. Please specify your total years of experience
   a) 5-10 years
   b) 11-15 years
   c) 15-20 years
   d) 20-25 years
   e) 25+ years
4. Your organization type
   a) Consultancy
   b) Contractor
   c) Client
   d) Other (please specify) ________________________
5. Your Location
   a) Islamabad
   b) Gilgit
   c)Other (please specify) ________________________
6. Your Understanding of sustainability aspects
   a) Slight
   b) Moderate
   c) High

Questionnaire Part 2: Survey Questions

Category-1	General Sustainability (GnS)					
Scale: 1–Strongly Disagree | 2–Disagree | 3–Neutral | 4–Agree | 5–Strongly Agree						
Code	**Description**	**1**	**2**	**3**	**4**	**5**
GnS-1	Indigenous construction practices promote Sustainability					
GnS-2	IBP is a role model for green architecture and sustainable building design.					
GnS-3	Past architecture focused on indigenous materials, while modern architecture overlooked them					
GnS-4	There is a lack of a framework for integrating indigenous construction techniques with modern construction practices					
GnS-5	The choice of indigenous techniques depends on climate, tradition and materials of a specific region					
GnS-6	As key players, the project management teams can promote indigenous & sustainable building practices					
GnS-7	Stakeholder management is a critical success factor for the construction of sustainable buildings throughout the project life cycle					
GnS-8	Construction professionals lack adequate training in indigenous sustainable construction principles					

Category-02	Environmental Sustainability (EnS)					
Scale: 1–Strongly Disagree | 2–Disagree | 3–Neutral | 4–Agree | 5–Strongly Agree						
code	**Description**	**1**	**2**	**3**	**4**	**5**
EnS-1	There is excessive consumption of natural resources at all phases of building structures.					
EnS-2	IBP requires no moder (heavy) machinery and equipment, so it d not contribute to the carbon footprint					
EnS-3	The use of organic and agricultural waste in building construction is more eco-friendly than modern construction materials					
EnS-4	Use of industrial wood and locally fast grown trees helps to reduce environmental degradation					
EnS-5	The Indigenous building practices are more climate-resilient and seismically resistant compared to concrete Buildings					
EnS-6	Indigenous building practices have vast potential to address modern environmental challenges					
Ens-7	The unique balance between eco-System, shape and material in indigenous practices can inspire modern architecture					

Questionnaire Part 2: Survey Questions

Category-02	Economic Sustainability (EcS)					
Scale: 1–Strongly Disagree | 2–Disagree | 3–Neutral | 4–Agree | 5–Strongly Agree						
code	**Description**	**1**	**2**	**3**	**4**	**5**
EcS-1	Using local construction materials & methods reduces resource wastage and enhances economic sustainability					
EcS-2	Indigenous building practices foster job creation and skill development within the community					
EcS-3	The indigenous building practices have a low maintenance cost					
EcS-4	Indigenous buildings attract Tourism, which enhances economic activities of the region					
EcS-5	The total cost of indigenous buildings is lower as compared to green buildings practices					
EcS-6	Lack of information about indigenous buildings products leads to the use of selection of unsustainable and costly materials					
EcS-7	Integrating indigenous building practices with sustainability aspects supports circular economy goals by fostering local economic flow					

Category-04	Social Sustainability (SoS)					
Scale: 1–Strongly Disagree | 2–Disagree | 3–Neutral | 4–Agree | 5–Strongly Agree						
Code	**Description**	**1**	**2**	**3**	**4**	**5**
SoS-1	Culture, tradition and environment strongly influence the design philosophy of building					
SoS-2	Indigenous building practices are widely used & highly valued around the world					
SoS-3	Modern construction methods often exclude women from skilled roles, reinforcing gender inequalities					
SoS-4	The employment of local labor in the construction preserves cultural heritage and contributes to social uplift					
SoS-5	The indigenous building practices meaningfully improve the quality of life and promote equal benefits for all stakeholders					
SoS-6	Client role is a major factor in the adopting Indigenous building practices					
SoS-7	The indigenous materials and methods strengthen a sense of identity and pride among local communities by preserving historical heritage					