Contextualizing SDGs by the Means of Vernacular Architecture – The Case of Iran

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ABSTRACT

The contemporary world faces urgent challenges in sustainable development due to escalating urbanization and increased pressure on natural resources, encompassing environmental, economic, and socio-cultural dimensions. Addressing these multifaceted challenges requires a comprehensive approach that integrates sustainable techniques derived from rural contexts and references vernacular architecture while aligning with the Sustainable Development Goals (SDGs).

Sustainability, as a concept, acknowledges the interconnectedness of environmental, social, and economic aspects of development. It emphasizes adopting practices that preserve resources, minimize ecological impact, and prioritize community well-being. In rural settings, where reliance on natural resources holds deep cultural significance, tailored sustainable development strategies are imperative.

This research examines sustainability through the lens of the UN Sustainable Development 17 Goals (SDGs), categorizing architectural sustainable techniques taken from houses in rural areas and referencing vernacular architecture. Focusing on socio-cultural challenges associated with SDG achievement, the study investigates global rural housing case studies, utilizing qualitative methodologies and extensive literature surveys using two case studies (Volontariat and Magoda project) from SDGs. Special emphasis is placed on Iranian case studies, providing insights tailored to the local context and identifying techniques to meet social, economic, and cultural needs.

Vernacular architecture, influenced by geography, climate, and cultural traditions, showcases sustainability, resource efficiency, and minimal environmental impact. This

paper analyzes recent literature on vernacular architecture, addressing traditional materials, sustainability, cultural aspects, climate adaptation, and repurposing abandoned structures. It suggests interdisciplinary research and fieldwork in underrepresented regions to integrate contemporary solutions into historic vernacular buildings while meeting modern comfort standards.

Vernacular architecture emerges as a key player in sustainable practices, embodying local solutions and cultural adaptation. Integrating vernacular architecture into urban and rural designs has the potential to create environmentally adaptable and culturally appropriate dwellings, fostering a sense of place and cultural continuity. In summary, this thesis significantly analyses sustainable development goals by exploring the integration of vernacular architecture sustainable techniques in rural designs, particularly in the Iranian context. By investigating local and cultural contexts, it aims to propose practical insights and solutions, fostering a more sustainable and culturally sensitive built environment.

Keywords: Sustainability, Sustainable Development Goals (SDGs), Sustainable Design Techniques, Vernacular Architecture, Rural Design, Iran

ÖZ

Günümüz dünyası, artan kentselleşme ve doğal kaynaklara yönelik artan baskı gibi sürdürülebilir kalkınma konusunda acil zorluklarla karşı karşıya. Bu çok yönlü zorluklara karşı koymak için sürdürülebilir kırsal bağlamdan türetilen teknikleri içeren ve yerel mimariye referans veren kapsamlı bir yaklaşım gereklidir, aynı zamanda Sürdürülebilir Kalkınma Hedefleri (SDG'ler) ile uyumlu olmalıdır.

Kavram olarak sürdürülebilirlik, kalkınmanın çevresel, sosyal ve ekonomik yönlerinin birbirine bağlılığını kabul eder. Kaynakları koruyan, ekolojik etkiyi en aza indiren ve toplum refahını öncelikli kılan uygulamaların benimsenmesini vurgular. Doğal kaynaklara olan bağımlılığın derin kültürel önem taşıdığı kırsal ortamlarda, özel olarak uyarlanmış sürdürülebilir kalkınma stratejileri hayati öneme sahiptir.

Bu araştırma, BM Sürdürülebilir Kalkınma 17 Hedefi (SDG) bakış açısıyla sürdürülebilirliği inceleyerek kırsal kökenli sürdürülebilir teknikleri kategorize eder ve geleneksel mimariye referans verir. SDG başarısıyla ilişkilendirilen sosyo-kültürel zorluklara odaklanarak, çalışma küresel kırsal konut örneklerini araştırır, nitel metodolojileri kullanır ve iki vaka çalışması (Volontariat ve Magoda projesi) üzerinden geniş bir literatür taraması yapar. Özellikle İran vaka çalışmalarına vurgu yaparak, yerel bağlama özgü içgörüler sunar ve sosyal, ekonomik ve kültürel ihtiyaçları karşılamak için kullanılabilecek teknikleri tanımlar.

Coğrafya, iklim ve kültürel geleneklere bağlı olarak şekillenen yerel mimari, sürdürülebilirliği, kaynak verimliliğini ve minimum çevresel etkiyi sergiler. Bu makale, yerel mimari üzerine son literatürü inceleyerek geleneksel malzemeleri,

sürdürülebilirliği, kültürel yönleri, iklim adaptasyonunu ve terk edilmiş yapıları yeniden amaçlama konularını ele alır. İnterd disipliner araştırma ve az temsil edilen bölgelerde saha çalışmalarını önerir, böylece çağdaş çözümlerin tarihi yerel binalara entegre edilmesini ve modern konfor standartlarını karşılamayı amaçlar.

Yerel mimari, sürdürülebilir uygulamalarda önemli bir rol oynar, yerel çözümleri ve kültürel adaptasyonu temsil eder. Yerel mimariyi kentsel ve kırsal tasarımlara entegre etmek, çevresel adapte olabilir ve kültürel olarak uygun konutlar yaratma potansiyeline sahiptir, böylece bir yerin ve kültürel sürekliliğin hissini geliştirir. Özetle, bu tez, İran bağlamında özellikle SDG'lerle uyumlu kırsal tasarımlarda yerel mimarinin entegrasyonunu keşfederek sürdürülebilir kalkınma söylemine önemli bir katkıda bulunur. Yerel ve kültürel bağlamları inceleyerek, pratik içgörüler ve çözümler önermeyi amaçlar, daha sürdürülebilir ve kültürel duyarlı bir yapı ortamını teşvik etmek.

Anahtar kelimeler: Sürdürülebilirlik, Sürdürülebilir Kalkınma Hedefleri (SDG'ler), Sürdürülebilir Tasarım Teknikleri, Yerel Mimari, Kırsal Tasarım, Iran

DEDICATION

To My Family

And My Fiancé

ACKNOWLEDGMENT

I extend my deepest gratitude to my family, whose unwavering support has been my pillar of strength throughout this journey. Your encouragement, understanding, and sacrifices have been my driving force. I am profoundly grateful for the love you've shared, shaping both my personal and academic life.

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Chapter 1

INTRODUCTION

Amidst the heightened awareness surrounding our planet's uncertain future over the past two or three decades, global concern for nature and the environment has taken center stage. Rapid advancements across industries, encompassing manufacturing, transportation, communication, and construction, have triggered substantial environmental transformations. Such changes pose a threat to the delicate ecosystem balance and the depletion of vital natural resources, affecting vegetation and atmospheric components. Within this context, architecture emerges as a significant contributor to the current environmental challenge, given its substantial resource consumption, waste generation, and emission of pollutants. Understanding the role of architecture in this pressing issue is crucial as this research seek to align our built environment with the aspirations outlined in the United Nations Sustainable Development Goals, fostering a more sustainable and ecologically balanced world (Mossin, 2018).

The United Nations Sustainable Development Goals (SDGs) form a comprehensive framework that outlines the world's collective aspirations for a more sustainable and equitable future. As the global community strives to address pressing challenges, such as poverty, climate change, and social inequalities, the role of architecture becomes increasingly crucial in shaping a sustainable built environment. This thesis aims to explore the profound impact of architecture on advancing the SDGs and highlights

how innovative architectural solutions can contribute to achieving these ambitious global objectives. By investigating real-world examples and exploring the intersection of architecture with each SDG, this study seeks to inspire meaningful engagement from architects using locality to create a more sustainable and inclusive world for present and future generations (UNESCO, 2015).

1.1 Research Background

In the contemporary landscape, the urgency of sustainable development has intensified due to unprecedented urbanization trends and escalating strains on natural resources worldwide (UNESCO, 2015). These challenges encompass a wide spectrum, spanning environmental degradation, economic disparities, and intricate socio-cultural complexities. The Sustainable Development Goals (SDGs), as outlined by the United Nations, have emerged as a comprehensive framework to address these multifaceted issues on a global scale. Within this framework, vernacular architecture, shaped by cultural traditions, geographical nuances, and environmental adaptability, presents a repository of sustainable practices rooted in local wisdom and indigenous knowledge systems (Mossin, 2018).

1.2 Problem Statement

The escalating global challenges of rapid urbanization, environmental degradation, economic inequalities, and socio-cultural disruptions demand urgent attention and effective solutions within the framework of sustainable development. Amidst these complex issues, vernacular architecture—rooted in local traditions, materials, and cultural practices—stands as an underutilized yet invaluable resource for addressing contemporary sustainability challenges.

However, despite its inherent sustainability and cultural significance, vernacular architecture faces an existential threat in the wake of modernization and globalization. The erosion of traditional building practices, driven by the widespread adoption of standardized construction methods, poses a substantial risk to the preservation of these architectural treasures.

In the Iranian context specifically, where a rich history of vernacular architectural styles and techniques has evolved over centuries, the collision between modern development aspirations and cultural heritage preservation intensifies. The socio-economic transformations and urbanization pressures often disregard the valuable insights embedded in traditional Iranian architecture, leading to a gradual decline in its practice and application.

The problem is further exacerbated when considering the urgent need to align sustainable development initiatives, encapsulated in the 17 SDGs, with culturally sensitive solutions. Balancing the imperatives of sustainable development while preserving cultural heritage, especially in rural settings where vernacular architecture remains integral to livelihoods and identity, presents a profound challenge.

The critical issue at hand is to navigate this intricate landscape and leverage the inherent sustainability and cultural adaptability of vernacular architecture to craft strategies that not only address contemporary sustainability goals but also safeguard and revitalize these traditional building practices. This calls for an in-depth understanding of the socio-cultural significance of vernacular architecture in Iran, identifying the specific challenges it faces in the context of sustainable development,

and proposing contextually relevant solutions that harmonize traditional wisdom with contemporary needs.

Ultimately, this research aspires to bridge the gap between traditional knowledge and contemporary sustainable practices, aiming to conduct a comprehensive evaluation of sustainable architectural practices inherent in vernacular architecture. Numerous global regions grapple with economic, social, and environmental complexities, and Iran is no stranger to these intricate challenges. Capitalizing on Iran's extensive historical and architectural heritage, this research seeks to present a compelling model for integrating sustainable elements from vernacular architecture. The primary goal is to address prevalent challenges while minimizing environmental repercussions. This will be achieved through a meticulous exploration of Sustainable Development Goals (SDGs) and exemplary cases illustrating effective sustainable practices.

Therefore, this research endeavors to comprehensively examine the intersection of sustainable development goals with vernacular architecture in Iran, aiming to revive vernacular sustainable techniques, preserve cultural values, and propose actionable strategies for the effective integration of vernacular architecture into contemporary sustainable development practices. By addressing this multifaceted challenge, the research seeks to contribute to a more holistic and culturally sensitive approach toward sustainable development in Iran and globally.

1.3 Research Questions

1. How does vernacular architecture in Iran align with the 17 SDGs?
2. What sustainable techniques derived from rural contexts are relevant to vernacular architecture?

3. How can socio-cultural challenges in achieving SDGs be addressed through vernacular architecture?
4. What strategies preserve cultural values while fulfilling social and economic needs in rural areas?

1.4 Aims and Objectives

The aim of this thesis is to investigate the application of Sustainable Development Goals (SDGs) in addressing contemporary challenges faced by communities worldwide, while seeking sustainable architectural solutions that uphold cultural values and foster a better future for generations to come. The focus will be on utilizing SDGs as the primary reference for developing sustainable architectural techniques applicable to vernacular architecture in Iran.

This research also endeavors to deeply investigate the symbiotic relationship between vernacular architecture in Iran and the attainment of Sustainable Development Goals (SDGs). It aims to elucidate the role of vernacular architecture in contributing to sustainable development objectives and proposes contextually relevant and culturally sensitive sustainable techniques for rural development in Iran. To do this the following objectives are developed:

Objectives

- Conduct a comprehensive analysis of the 17 SDGs within the context of vernacular architecture's sustainable practices.
- Categorize and analyze sustainable techniques derived from rural contexts that showcase alignment with and contributions to vernacular architecture.

- Explore and examine a diverse array of global rural housing case studies, to identify socio-cultural challenges in achieving SDGs and the role of vernacular architecture in addressing these challenges.

Identify, assess, and propose sustainable techniques that not only align with the overarching goals of sustainable development but also preserve and promote the cultural heritage embedded in vernacular architecture, while concurrently fulfilling social and economic needs in rural Iranian settings. By achieving these aims and objectives, this research will contribute to a deeper understanding of how the principles of Sustainable Development Goals can be integrated into architectural practices, enabling the creation of culturally sensitive and sustainable solutions for the built environment in Iran and potentially inspiring sustainable practices globally.

1.5 Research Methodology

This research employs a literature-based qualitative approach to explore the role of architectural sustainable techniques derived from vernacular architecture in addressing contemporary societal challenges. Through an extensive literature survey, relevant data on sustainable architecture, vernacular practices, and sustainable design techniques are gathered and filtered based on the research focus. The study employs a qualitative approach involving literature review, case studies, and qualitative analysis. A comprehensive review of recent scholarly works on vernacular architecture and SDGs will inform the research. Global rural housing case studies, with an emphasis on Iran, will be qualitatively analyzed. Data will be gathered through literature surveys, case studies, and qualitative analysis techniques. The study centers on sustainability pillars and their intersections within the context of Sustainable Development Goals (SDGs) to align findings with broader global sustainability agendas. Case studies are

utilized to apply the developed framework, providing practical illustrations of architectural sustainable techniques. Ethical considerations are upheld throughout the research process, ensuring proper citation and acknowledgment of all sources used. This investigation aims to contribute valuable insights to the field of sustainable architecture and its integration with SDGs for a more sustainable built environment.

1.6 Limitations of the Study

While aiming to explore the multifaceted dimensions of sustainability and its alignment with the Sustainable Development Goals (SDGs) through architectural practices, this research is poised to encounter certain limitations inherent to its scope and methodology.

Scope Constraints: The comprehensive nature of sustainability entails a vast spectrum of economic, environmental, and social aspects. However, due to the breadth of these dimensions, the research may encounter limitations in delving deeply into each aspect within the architectural context.

Availability of Data: The availability and accessibility of comprehensive and up-to-date data on sustainable architectural practices, especially concerning specific regions or cultural contexts, might pose a challenge. This limitation could potentially restrict the depth and breadth of the analysis.

Case Study Selection: While case studies play a pivotal role in understanding practical implementations of sustainable architectural solutions, limitations in accessing diverse and representative case studies might impact the comprehensive nature of the research.

Contextual Specificity: Cultural values and regional contexts significantly influence architectural practices. Despite efforts to incorporate cultural considerations, the

research might face challenges in ensuring that the proposed sustainable strategies align effectively with the diverse cultural nuances of various regions.

Research Depth: The depth of the analysis regarding the vernacular case study in Iran might be constrained due to limitations in resources, time, or access to certain areas or communities, potentially affecting the comprehensiveness of insights drawn from this specific context.

Generalizability of Findings: While the research aims to provide valuable insights and recommendations, the applicability and generalizability of the findings to a broader global context might be limited due to the specificity of regional conditions and cultural nuances.

Methodological Limitations: The research's reliance on qualitative analysis, case studies, and literature reviews might present inherent biases or limitations in capturing the complete spectrum of perspectives and experiences related to sustainable architectural practices.

Despite these anticipated limitations, the research endeavors to provide comprehensive insights into sustainable architectural practices' alignment with the SDGs while acknowledging and addressing these potential constraints within its scope and methodology.

1.7 Expected Outcome

Identification of Key Sustainability Challenges: The research aims to identify and articulate the primary economic, environmental, and social sustainability challenges faced by contemporary communities. This comprehensive understanding will serve as a foundational insight for aligning architectural practices with the Sustainable Development Goals (SDGs).

Integration of SDGs in Architectural Practices: Through thorough analysis and synthesis of case studies and existing literature, the research seeks to propose practical and implementable strategies for integrating SDGs into architectural practices. This includes identifying specific SDGs that align with architectural sustainability and proposing innovative approaches for their incorporation.

Tailored Solutions for Contextual Sustainability: By considering regional cultural values and contextual nuances, the research aims to develop tailored and culturally sensitive sustainability solutions. This includes recommendations that respect and integrate local customs, traditions, and societal needs within architectural design and development.

Insights into Practical Implementation: Through the analysis of diverse case studies, the research endeavors to offer insights into the practical implementation of sustainable architectural solutions. This includes elucidating best practices, challenges faced, and lessons learned from real-life examples, thereby providing guidance for architects and stakeholders in the field.

Demonstration through Vernacular Case Study in Iran: The research will conduct an in-depth analysis of a vernacular case study in Iran, showcasing how sustainable architectural principles can be practically applied within the specific cultural and regional context. This demonstration aims to provide a tangible illustration of the integration of sustainability goals within vernacular architecture.

Contributions to Sustainable Development Discourse: The study aspires to contribute significantly to the discourse on sustainable development by offering nuanced insights and practical recommendations for sustainable architectural development. This includes presenting a refined understanding of the role of architecture in achieving global sustainability objectives.

Potential for Future Research and Initiatives: The research outcomes are expected to identify areas warranting further investigation and potential avenues for future research, fostering ongoing discourse and initiatives in sustainable architectural development aligned with SDGs.

1.8 Scope of Research

This thesis focuses on exploring the role of architectural sustainable techniques derived from vernacular architecture in addressing contemporary societal challenges. Focuses on analyzing and synthesizing existing literature on vernacular architecture, rural housing, and SDGs, supplemented by case studies predominantly from Iran, to offer context-specific solutions.

1.9 Significance of the Study

This research seeks to bridge the gap between vernacular architecture, sustainable development, and cultural preservation, providing actionable insights for policymakers, architects, and stakeholders involved in rural development and sustainability initiatives, especially in Iran.

1.10 Structure of the Thesis

The thesis is structured to provide a comprehensive exploration and analysis of the integration between sustainable development goals (SDGs) and sustainable architecture. Commencing with a detailed introductory chapter, the research sets the stage by delineating the problem statement, research questions, aims, methodology, expected outcomes, limitations, scope, and significance of the study. Chapter two meticulously examines the theoretical underpinnings of sustainability and SDGs, drawing from an extensive literature review that encompasses sustainability principles, global challenges, vernacular Architecture, Rural Design, Culture, and Vernacular Architecture in Iran. Following this, chapter three meticulously outlines the

methodological framework, emphasizing case study selection (Rural Vernacular Houses) from SDGs and data collection procedures, especially focusing on sustainable architectural techniques within SDG frameworks, and trying to highlight vernacular architectural sustainable strategies derived from the case studies. The subsequent chapter undertakes an in-depth analysis of key vernacular architecture case studies in Iran, utilizing SDG guidelines as a lens for assessment. This analysis culminates in recommendations for practical applications of sustainable solutions within the vernacular context, paving the way for the study's conclusions. The final chapter synthesizes the findings, discusses their implications, outlines contributions, and recommends directions for future research, thereby providing a holistic understanding of sustainable architectural practices aligned with SDGs, particularly within the Iranian context.

Chapter 2

AN OVERVIEW OF VERNACULAR ARCHITECTURE AND SUSTAINABLE DEVELOPMENTS GOALS (SDGS)

2.1 Sustainable Development

Brundtland Commission (World Commission on Environment and Development): Sustainable development meets the present generation's needs without compromising the ability of future generations to meet their own needs. This definition acknowledges every generation's right to access the same natural resources available to other generations. It emphasizes using natural resources within their replenishment capacity, not depleting them, and ensuring a balance in their utilization to prevent their gradual reduction, which would render development unsustainable (Varmazyar & Saeed, 2016). This is the state often associated with contemporary global development relying on economic growth. World Conservation Union's Definition from 1991: Enhancing the quality of human life while considering the supporting capacities of ecosystems within which we reside (HajiRezaei, 2018).

The concept of sustainable development faces the reality of depleting fossil fuels and environmental issues resulting from the rapid industrial growth in human societies, becoming a primary concern in discussions on sustainable development. The term "sustainable development" or "sustainability" was initially introduced by the World Commission on Environment and Development (WCED). In the "Our Common Future" report by the Brundtland Commission, sustainable development was described

as a form of development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The absence of this balance has led to misconceptions about this concept across various fields. For instance, in architecture and urban planning, engineers initially perceived sustainable development as actions taken towards energy efficiency. However, through conferences and numerous articles, the principles and dimensions of sustainable development have become clearer (Varmazyar & Saeed, 2016). Presently, the concept of sustainable development is primarily examined in three domains: environmental sustainability, economic sustainability, and social sustainability. Environmental sustainability involves maintaining an environmentally stable system by conserving and enhancing physical, biological, and ecosystem resources. Development aims to create a framework for strengthening social cohesion, increasing social interactions, and ensuring equality in accessing public amenities such as health, education, transportation, housing, etc. It also addresses minimizing the use of non-renewable resources and transitioning towards renewable resources (HajiRezaei, 2018).

2.1.1 Sustainability

Sustainability has been introduced in three branches: social sustainability, economic sustainability, and environmental sustainability. Architects, in the past two decades, have been pursuing the formulation of methods and principles to achieve environmental sustainability, under various names such as sustainable design, sustainability in architecture. Sustainable design aims to seek architectural solutions that can ensure the well-being and coexistence of these three groups. (Brundtland, 1987) To achieve this objective, nothing is sought other than the formulation of rules and regulations that, if followed by designers, executors, and users, not only lead to the achievement of the defined goal of sustainability mentioned initially but also truly

enhance the appearance of our cities and buildings. Outlining these principles to everyone will help us, instead of resisting nature, embrace it and even utilize its gifts and strengths for the benefit of architectural structures (Erfani, 2023).

When assessing heritage sites for sustainability, it is crucial to employ various techniques and principles that ensure the effectiveness of conservation endeavors while being environmentally friendly, socially equitable, and economically viable. The following sustainable techniques are instrumental in the evaluation process:

1. **Integrated Management Approaches:** Implementing comprehensive management approaches that recognize the interplay of cultural, environmental, and social factors. This entails holistic planning and decision-making involving diverse stakeholders to balance conservation and development objectives.
2. **Sustainability Assessments:** Conducting assessments to evaluate the environmental, social, and economic impacts of conservation interventions. Tools like Environmental Impact Assessments (EIAs) and Social Impact Assessments (SIAs) help identify potential risks and opportunities for sustainable management.
3. **Community Engagement and Participation:** Involving local communities, indigenous peoples, and other stakeholders in the evaluation process to incorporate their perspectives, knowledge, and traditional practices into conservation strategies. Participatory approaches empower communities, fostering long-term sustainability.
4. **Heritage Impact Assessments:** Evaluating potential impacts of development projects on cultural heritage sites. Heritage Impact Assessments (HIAs)

consider factors such as visual integrity, cultural significance, and authenticity to guide decision-making and minimize adverse effects on heritage values.

5. **Adaptive Management Strategies:** Adopting strategies that allow flexibility, experimentation, and learning over time. This involves monitoring, evaluating, and adjusting conservation measures based on feedback and changing circumstances to enhance resilience and effectiveness.
6. **Green Technologies and Practices:** Integrating sustainable technologies and practices into conservation projects to minimize resource consumption, reduce carbon emissions, and mitigate environmental impacts. This includes energy-efficient designs, renewable energy systems, water conservation, and sustainable material sourcing.
7. **Cultural Landscape Approaches:** Applying approaches that recognize dynamic interactions between people and their environments. Cultural landscapes encompass not only physical features but also intangible values, traditional knowledge, and cultural practices shaping human-environment relationships.
8. **Capacity Building and Education:** Investing in capacity building, training, and education programs to enhance local skills, knowledge, and institutional capacity for heritage conservation. Building awareness and fostering a culture of stewardship among stakeholders are essential for long-term sustainability.

By integrating these sustainable techniques into the evaluation process, heritage conservation efforts can effectively balance the preservation of cultural and natural values with the promotion of sustainable development and community well-being (UNESCO, 2015).

2.1.2 Architectural Sustainability

Sustainable architecture is the practice of developing architectural structures that consider environmental impact, resource efficiency, and the well-being of both current and future human life. The objectives of sustainable architecture can be listed as follows (Brundtland, 1987):

- Prioritizing human life and preserving it for the present and future.
- Using materials that are harmonious and sustainable with the environment during production, usage, and even demolition.
- Minimizing the use of fossil fuels and maximizing the utilization of natural energies.
- Reducing environmental degradation and improving the physical and mental well-being of humans and all living organisms.
- Ensuring harmony with the natural environment.

Based on these objectives, the principles employed in sustainable architecture include the following aspects:

- Perception of spatial sense, existential space, and lack of disruption within it.
- Utilization of natural energies such as solar and wind energy.
- Use of natural and indigenous materials that are recyclable and durable.

The goals of sustainable architecture prioritize human life and its preservation for the present and future, employing materials that are environmentally friendly and sustainable in production, usage, and even during demolition. It aims to minimize the use of fossil fuels while maximizing the use of natural energies, reduce environmental damage, improve the physical and mental health of humans and all living organisms, and ensure harmony with the natural environment (Varmazyar & Saeed, 2016).

Sustainable architecture involves principles that consider energy resources and nature. It includes laws and principles of architecture based on the contemporary needs of architecture and limitations in energy resources. Some general indicators of sustainable architecture can be introduced as follows (Aminzadeh, 2003):

- Sensitivity to cultural, environmental, and climatic conditions.
- Coordination and compatibility with nature and the environment.
- Energy efficiency.
- Adequate response to functional needs.
- Clarity and avoidance of ambiguity.
- Emulation of vernacular architecture in a modern context.

Considering the advancement of technology and changes in human needs from architectural spaces, traditional construction methods are no longer sufficient. However, modern technological advancements can translate and transform indigenous architecture into contemporary language. Proper use of materials, both visually and environmentally, resource efficiency, designing for returning to the life cycle, and designing for humans are key aspects of sustainable architecture (Varmazyar & Saeed, 2016).

2.1.3 Architectural Principles of Sustainability

The concept of sustainable architecture, whether considered as the creation of human space and the organization of the relationship between humans and the physical environment or as the product of this process, is always intertwined with a sustainable environment. In a general framework, it can be expressed as 'creating a sustainable human environment' (Farhoudi, 2007). This architecture engages in activities toward the restoration, reconstruction, and renewal of natural systems and land. It also involves the cautious use of resources in the natural life cycle. To create a suitable

environment for human life as another living organism, it must carefully utilize the life cycle resources in nature (Soleimani, 2008). Sustainable architecture follows principles that are referred to in the table below (Table 1). There are several Architectural principles which are categorized as follows:

Table 1: Architectural Principles of Sustainability (Rezaei, Vasigh, Moradi, 2015).

1	Meeting human needs without encroaching upon future natural resources and facilities.
2	Improving the quality of life, physical and mental well-being, social justice, and economic welfare.
3	Establishing security and comfort in architectural spaces.
4	Flexibility and adaptation to environmental conditions and variations in different seasons and times.
5	Intelligent use of land and harmonizing architectural structure with the shape of the land and its surrounding environment.
6	Preventing air and environmental pollution and avoiding the use of pollutants.
7	Using environmentally compatible design methods and considering indigenous patterns in building design and construction.
8	Reducing the consumption of non-renewable resources and energy and increasing the use of renewable energy sources.
9	Using materials and elements compatible with the climate to reduce energy consumption, pollution, and recyclability of materials.
10	Utilizing natural elements and integrating green spaces with residential areas.
11	Maximizing light, warmth, humidity, wind, natural ventilation, and controlling them in indoor spaces.

- **The principles of Sustainable Architecture in Contrast with Vernacular Factors (Table 2):**

First Principle: Energy Conservation Every building should be designed and constructed in a way that minimizes its need for fossil fuels.

Second Principle: Climate Adaptation Buildings should be designed to utilize the local climate and energy resources. The form and arrangement of the building and its interior spaces can be such that it enhances the comfort level within the building while simultaneously reducing fossil fuel consumption through proper insulation.

Third Principle: Reduced Use of New Resources Every building should be designed to minimize the use of new resources and, at the end of its useful life, serve as a source for creating other structures.

Fourth Principle: Respect for Users Sustainable architecture respects all individuals utilizing the building. The form, palette, accesses, etc., should all be based on the needs of users and their usage methods, showcasing utmost functionality and adaptability in the structure.

Fifth Principle: Respect for Site Every building should interact gently and lightly with the land. The formation of structures along the terrain, optimal use of natural resources, and a cohesive structure with the environment can introduce the building as part of nature.

Sixth Principle: Holistic Approach All sustainable principles require participation in a holistic process for constructing an artificial environment (Rahmani,2015).

Table 2: The Sustainable Architecture principles in Contrast with Vernacular Factors

First Principle	Energy Conservation	Every building should be designed and constructed in a way that minimizes its need for fossil fuels.
Second Principle	Climate Adaptation	Buildings should be designed to utilize the local climate and energy resources. The form and arrangement of the building and its interior spaces can be such that it enhances the comfort level within the building while simultaneously reducing fossil fuel consumption through proper insulation.
Third Principle	Reduced Use of New Resources	Every building should be designed to minimize the use of new resources and, at the end of its useful life, serve as a source for creating other structures.
Fourth Principle	Respect for Users	Sustainable architecture respects all individuals utilizing the building. The form, palette, accesses, etc., should all be based on the needs of users and their usage methods, showcasing utmost functionality and adaptability in the structure.
Fifth Principle	Respect for Site	Every building should interact gently and lightly with the land. The formation of structures along the terrain, optimal use of natural resources, and a cohesive structure with the environment can introduce the building as part of nature.
Sixth Principle	Holistic Approach	All sustainable principles require participation in a holistic process for constructing an artificial environment.

2.1.4 Sustainable Development 17 Goals (SDGs)

The Sustainable Development Goals (SDGs) were established by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure prosperity for all by 2030. These 17 interconnected goals were developed to address various global challenges faced by humanity, spanning social, economic, and environmental dimensions (UNESCO, 2015). Here's an overview of the 17 SDGs, their challenges, goals, and solutions (Mossin, 2018):

SDG1-No Poverty: The challenge here is to eliminate extreme poverty, provide social protection systems, and ensure equal rights to economic resources. Solutions involve inclusive economic growth, social support systems, and targeted poverty reduction programs.

SDG2-Zero Hunger: This goal aims to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture. Solutions include investment in agricultural infrastructure, improved yields, and sustainable food production.

SDG3-Good Health and Well-being: Challenges include inadequate healthcare, diseases, and lack of access to essential healthcare services. The goal is to ensure access to quality healthcare services, universal health coverage, and disease prevention through awareness and medical infrastructure.

SDG4-Quality Education: Challenges include inadequate educational infrastructure, lack of access, and quality education. Solutions encompass equitable access to quality education, teacher training, and educational infrastructure development.

SDG5-Gender Equality: The challenge is to eliminate discrimination and violence against women and girls. The goal is to achieve gender equality, empower women, and ensure their equal participation in all spheres of life.

SDG6-Clean Water and Sanitation: Challenges include water scarcity, inadequate sanitation, and lack of clean water access. Solutions involve sustainable water management, sanitation facilities, and access to clean water for all.

SDG7-Affordable and Clean Energy: Challenges include over-reliance on fossil fuels and limited access to clean energy sources. The goal is to promote renewable energy, improve energy efficiency, and ensure access to affordable, reliable, and sustainable energy.

SDG8-Decent Work and Economic Growth: Challenges involve unemployment, underemployment, and lack of decent work opportunities. Solutions include job creation, promoting inclusive economic growth, and protecting labor rights.

SDG9-Industry, Innovation, and Infrastructure: The challenge is to develop sustainable infrastructure and foster innovation. Solutions involve investment in infrastructure, technological innovation, and sustainable industrialization.

SDG10-Reduced Inequality: Challenges include income inequality, discrimination, and unequal access to resources. Solutions include policies and programs that reduce inequalities within and among countries.

SDG11-Sustainable Cities and Communities: Challenges include rapid urbanization and inadequate infrastructure in cities. The goal is to make cities inclusive, safe, resilient, and sustainable through urban planning and infrastructure development.

SDG12-Responsible Consumption and Production: Challenges include overconsumption and unsustainable production patterns. The goal is to promote sustainable consumption and production practices, resource efficiency, and waste reduction.

SDG13-Climate Action: Challenges involve climate change, global warming, and their adverse effects. Solutions include mitigation measures, adaptation strategies, and global cooperation to reduce greenhouse gas emissions.

SDG14-Life Below Water: Challenges include marine pollution, overfishing, and habitat destruction. The goal is to conserve and sustainably use oceans, seas, and marine resources.

SDG15-Life on Land: Challenges include deforestation, biodiversity loss, and land degradation. Solutions involve forest conservation, land restoration, and biodiversity protection.

SDG16-Peace, Justice, and Strong Institutions: Challenges involve violence, corruption, and lack of access to justice. The goal is to promote peaceful and inclusive societies, ensure access to justice, and build effective, accountable, and inclusive institutions.

SDG17-Partnerships for the Goals: The challenge is to mobilize resources and foster global cooperation. The goal is to strengthen partnerships between governments, businesses, and civil society to achieve sustainable development.

Each of these goals represents an ambitious agenda to tackle the most pressing global challenges. Achieving these goals requires collaborative efforts, political will, financial investment, and innovative solutions at local, national, and international levels (Mossin, 2018).

2.1.5 Reviewing the principles of sustainable development by the United Nations by 2030

David Griggs, an Australian theorist, believes that sustainable development, over the past three decades, has three fundamental pillars. Currently, this definition is not as effective; sustainable development should be reviewed socially, economically, and

environmentally. However, Griggs states that the current definition is not as effective. In articles prepared by the United Nations International Strategy for Disaster Reduction, it was emphasized that reducing natural hazards and managing risks are essential for achieving sustainable development (Grix, 2013). Any framework defined for sustainable development requires a clear physical plan against natural hazards and climate risk management. The global incidence of natural hazards is increasing, posing a tangible threat to people, assets, and any efforts toward achieving sustainable development. The tragic events of 2011, particularly the Great East Japan Earthquake and Tsunami, exceeded boundaries (UNISDR, 2011). Therefore, practical plans, policies, financial matters, and technology must work to reduce natural hazards and serve as a crucial shortcut to strengthening sustainable development (Eslami, Majedi, Etesam, 2019).

2.2 Vernacular Architecture

The concept of "vernacular" originates from the Latin term "VERNACULUS," meaning 'native'. Vernacular architecture is recognized within specific social groups and characterized by construction techniques, materials, social rules, and structures. It emerges from the interplay of ecological, economic, material, political, and social factors. This architecture aims to provide solutions to climate challenges, allowing adaptability and versatility, reflecting a cultural identity related to tradition (Rapoport, 1990, 1994, 1998, 2005). Vernacular architecture incorporates various techniques and materials influenced by environmental and geographical factors, such as earth construction used globally for millennia. It embodies the natural, climatic, environmental, economic, and cultural aspects of a place, creating a unique way of life and quality in structures (Brunskill, 1981; Lawrence, 1987). Vernacular architecture showcases compatibility with nature using local materials and resources. Different

scholars and theorists have provided descriptions and classifications of vernacular architecture, seeking to expand its concept. These definitions emphasize characteristics like simplicity, functionality, adaptation to local needs, and cultural relevance. Variations in vernacular architecture exist based on climate changes and cultural contexts, reflecting adaptability over time (Saleh, 2001, 2004).

Vernacular architecture encompasses diverse categories, including domestic, agricultural, and industrial structures. These categories represent different uses and functions, distinguishing various types of vernacular architecture (Rapoport, 1988).

Overall, vernacular architecture represents a synthesis of environmental, cultural, and societal aspects, showcasing a localized approach to construction, materials, and design to meet the needs of a particular community (Hajiloo, 2016).

2.2.1 Tracing the Origins and Formation of Vernacular Architecture

Vernacular architecture is more often sought for reasons that lie beyond it or have roots outside its realm. This trend is observed both in Iran and in countries that focus more on architecture. Nowadays, whenever someone engages in a conversation about vernacular architecture, involuntarily, they leaf through a notebook in which words and forms from the past are inscribed (Falamaki, 2005). Presently, everyone regards vernacular architecture as a heritage from the past, irrespective of any specific part of any land, and they do not even entertain doubts that these very individuals can also contribute to architectural innovation today. Vernacular architecture, in any language and any culture it signifies, refers to the roots of architecture, both distant and near, based on tradition (Bokani & Ghasemi, 2015).

First: Formation of Architectural Products Extends Across Specific Temporal Spaces, Emphasizing the Fusion of Structures with the Inhabitants. It emphasizes the amalgamation of buildings with the people who lived in them as a fundamental principle. The buildings, in pre-industrial eras, prior to humans assigning them specific purposes and before they were standardized, especially in the context of our discussion, evolved within the lives of their creators, who were typically their owners. The creation and arrangement of their structures, perceived in the context of imaginary lives, portrayed the buildings as diverse entities. This primary principle stands out.

Second: Integration with and influence from nature, accompanied by respectful interaction. It encompasses the simplest forms, from the fusion of more than two stones to mimicry of water, vegetation, light, and the sun to revere the structures and exhibit them as symbols of life in this world. This illustrates the dominance of this principle in the constructed environment shaped by humans.

Third: The gap between determining needs and fulfilling them, the Space between envisioning and Realizing a Space with Maximum Adaptation, the Divide between Contemplating Land and Building, and the Moment of Ownership and Possession of Space and Properties—These Are Key Aspects of Traditional or Vernacular Architecture.

Fourth, the reflection of the preferences of architecture creators in the structure, corners, surfaces, decorations, and proportions of the built structures is a matter of representation of both the national culture and individual culture to the extent that it can coexist. If we consider national culture as the primary shaping factor of architectural units and ensembles, individual preferences and insights cannot be

anything other than variables within that cultural domain. This is where we can identify the presence of two traits that complement each other: the first trait endows architectural units and ensembles with uniformity, while the second trait contributes to individual identification within the identity scope of the building owners. In other words, the culture of people, with its various dimensions, influences the colors, sizes, construction techniques, spatial decorations, the way individuals enter, move, and replace others within the building, the external form of the constructed space, and how it replaces the natural environment, directly impacting the surroundings.

Fifth, during the process of shaping a structure, a set of visual features, constructed and expressed intellectual refinements, cultural elegance, and reflections of local customs and traditions, reflecting the history and culture of indigenous peoples, brings both rural areas and urban spaces symbolically closer to the general wealth. What can be added to this concept is dedicated to individual identities, meticulously woven into an organic unity in the fundamental architecture, carefully and delicately crafted and intertwined (Yousefi, 2006).

2.2.2 Identifying Key Characteristics of Vernacular Architecture

Several shared features characterize vernacular architecture, aligning with the principles explored in this thesis:

- **Orientation:** Varied building orientations are strategically employed, optimizing heating and cooling dynamics based on different times of the day and weather conditions.
- **Shading:** To shield buildings from direct sun exposure and precipitation, vernacular architecture incorporates overhanging projections, providing a protective layer to the structure.

- **Ventilation:** Cross-ventilation is integral to regulate the relative humidity within the building. Particularly crucial in hot and humid climates, vernacular designs often incorporate central courtyards, verandahs with openings on both sides, and expansive windows to ensure effective ventilation.
- **Climate Responsiveness:** Vernacular architecture embodies a traditional design ethos that is not only climatically responsive but also holds aesthetic appeal. The interconnectedness of traditional and climate-responsive design is evident. Structures designed with climate responsiveness aim to minimize environmental impact, thereby reducing overall energy consumption (Patel, 2019).

In essence, these characteristics are integral aspects of vernacular architecture, highlighting its emphasis on practical climate considerations, energy efficiency, and a seamless blend of traditional and aesthetically pleasing design elements. Vernacular architecture exhibits distinct features, including:

- **Plinth:** The lowest segment of vernacular houses, the plinth provides a foundational element.
- **Walls:** Predominantly load-bearing, these walls are constructed using materials such as stones, adobe stones, etc.
- **Openings:** Purposeful openings are integrated to regulate thermal balance within vernacular houses.
- **Roofs:** Unlike ending directly at the walls, roofs project outward, forming extensive overhangs that shield walls from sunlight and rain. These roofs typically have a sloping design, with the pitch varying based on the wind speed in the area.

- **Loft:** Serving as overhead storage within the structure, the loft creates a separation between the upper hot zone and the lower cool zone of the building. (Ingole,2022)

Elements of Vernacular Architecture

Several key elements define vernacular architecture:

- **Water:** Recognized as a crucial resource, vernacular architecture emphasizes cautious water utilization. Strategies such as water harvesting and recycling are commonly implemented.
- **Structural Longevity:** The materials chosen significantly to impact the building's life cycle. Prioritizing materials with efficient recycling potential, especially those locally abundant, aligns with sustainability principles.
- **Light and Ventilation:** Climate-responsive design reduces reliance on artificial lighting and air conditioning. Vernacular houses are strategically constructed to maximize natural light and airflow.
- **Technology:** Implementation of technologies, including features like jails, fountains, and water systems for building cooling, contributes to sustainable practices at a broader level. (Ingole,2022)

In essence, these features and elements reflect the nuanced and thoughtful approach inherent in vernacular architecture, emphasizing sustainability, climate responsiveness, and the efficient use of resources.

Vernacular architecture centers around the utilization of locally available materials, leading to variations in construction elements based on geographical locations. Common materials include adobe, rammed earth, mud bricks, thatch, cob, bamboo, stone, clay, timber, compressed brick blocks, and clay-fly ash burnt bricks (Kaninika,

2015). This architecture is responsive to climate, culturally embedded in its surroundings, and employs materials sourced locally. Over time, vernacular practices have adapted to local materials and integrated new techniques to meet the community's needs (Patel, 2019).

Climate plays a pivotal role in shaping architectural forms, ensuring the comfort of inhabitants. Buildings designed in response to climate often incorporate features like interior courtyards to provide respite from summer heat. Notably, such structures are generally less load-bearing and cost-effective compared to conventional buildings (Ingole,2022). Here are discussions on some commonly used materials:

- **Timber:** Abundantly available, timber is a natural building material. It is non-toxic, poses no risk of chemical vapor leakage into buildings, is safe to handle, and serves as an excellent insulator. Its ease of workability, renewability, and local availability make it a preferred material.
- **Adobe:** Comprising clay, sand, water, and organic materials like sticks, straw, or manure, adobe is shaped into bricks using molds and sun-dried. It stands as a sustainable building material with cost-effective production.
- **Stone:** A versatile material integral to Indian architecture, stone serves various purposes, providing structural strength and serving decorative roles from foundation to parapet.
- **Clay:** Utilized in sustainable traditional buildings, clay is employed in two main ways. Firstly, walls are constructed directly with a mud mixture. Secondly, walls are built by stacking air-dried building blocks known as mud bricks.

In essence, vernacular architecture's reliance on these materials underscores its commitment to sustainability, responsiveness to local climates, and adherence to cultural contexts. (Ingole,2022)

2.2.3 Vernacular Architecture and its Relation to Sustainability

Over the past thirty years, global awareness of environmental challenges like global warming, land scarcity, pollution, and population growth has significantly increased. Addressing these issues has prompted the concept of sustainability, which involves integrating environmental, social, political, and economic aspects to establish better connections between humans and their habitats for meeting human needs (Salman et al., 2016).

When discussing sustainability, it's essential to understand its core meaning. Sustainability is not just about enhancing life quality or tackling environmental, social, and economic challenges (Thomas, 2007). Its fundamental goal is to ensure that our present actions do not harm future generations while satisfying our current needs. Studying vernacular architecture reinforces the link between policy and culture, ensuring that human activities do not compromise environmental structures. Sustainable design emphasizes accountability, valuing ecological environments, natural resources, human respect, and life cycles (McLennan, 2004).

Vernacular architecture, historically built under resource constraints without modern machinery, often represents unique identities and remarkable structures through the collaboration of communities with limited resources. It inherently embodies sustainable principles, providing pragmatic solutions to harsh environments and human living conditions (Salman, 2018). Reza & Dincyurek (2016) emphasize that vernacular architecture, as an organic form, responds to economic, cultural, and

environmental factors. Sustainable design elements are central to well-established vernacular architectures, developed through local resources, technologies, and long-standing trials and failures (Salman et al., 2016).

2.2.4 Application of Vernacular Architecture Principles towards Sustainable Architecture

If we acknowledge that form, encompassing social or natural phenomena, belongs to the external world and possesses specific characteristics or energy capable of transforming one thing into another, and if we accept that humans, in the provision of constructed spaces using forms within environmental capabilities and limitations in the form of functions, have responded to their needs, both physical and non-physical, and necessities, in that case, it can be claimed that vernacular architecture is practical at any historical period, albeit with the universal concept, physical and non-physical) (Naseri, 2010)

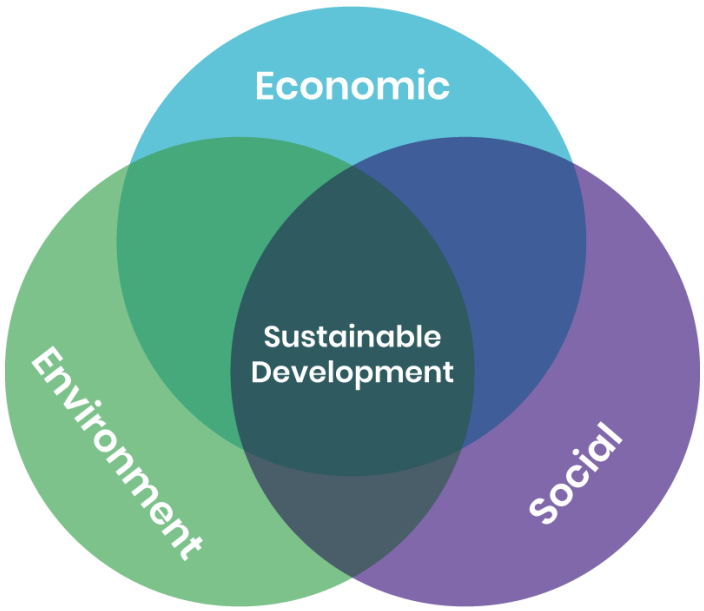

Figure 1: Three Factors of Sustainability architecture.

A concise overview of sustainable architecture will be presented, emphasizing its examination from three primary spheres of impact. The triad of interconnected dimensions in sustainability encompasses the environmental, economic, and social facets of our global context (Figure 1). Ensuring the observance and implementation of all three aspects establishes a robust foundation for development that comprehensively addresses diverse challenges that might emerge. For instance, in the context of sustainable architecture, the thoughtful consideration of natural resources ensures the protection of the environment, safeguards economic interests, and enhances the quality of life (Weihong, 2011).

The repeatable values of vernacular architecture in each of the domains highlighted in sustainable architecture are as follows:

Cultural and Social Aspects (Table 3):

1. **People-oriented**: Vernacular architecture is sensitive to the culture of social members, including introversion considering the user's needs, their privacy, and security.
2. **Adaptability**: Alignment with building inhabitants due to its flexibility.
3. **Nature Significance in Architecture**: Emphasizing nature leads to fostering a culture of proper consumption and contentment.
4. **Reflection of Human Body Proportions in Structures** (Rahmani,2015).

Table 3: Criteria and Means of Cultural and Social Aspects of Sustainability

Element	Criteria	Means
Cultural and Social Aspects	**People-oriented**	Vernacular architecture is sensitive to the culture of social members, including introversion considering the user's needs, their privacy, and security.
	Adaptability	Alignment with building inhabitants due to its flexibility
	Nature Significance in Architecture	Emphasizing nature leads to fostering a culture of proper consumption and contentment.
	Human Body Reflection	Reflection of Human Body Proportions in Structures.

Environmental Aspects (Table 4):

1. **Attention to the meaningful characteristics of nature** leads to respect for nature and contentment, making the built environment more meaningful.
2. **Attention to natural and climate** characteristics, compatibility with the surrounding environment.
3. **Self-sufficiency in the use of local materials**: Using safe, healthy, and local materials, available technology, responsiveness, and feasibility that are the outcomes arranged in today's construction activities. Concentrated energy and outcomes such as sustainability concepts, maintainability, repairability, and simplicity have been considered (Rahmani,2015).

Table 4: Criteria and Means of Environmental Aspects of Sustainability

Element	Criteria	Means
Environmental Aspects	**Attention to the nature**	leads to respect for nature and contentment, making the built environment more meaningful.
	Attention To the climate	Attention to natural and climate characteristics, compatibility with the surrounding environment.
	local materials	Self-sufficiency in the use of local materials: Using safe, healthy, and local materials, available technology, responsiveness, and feasibility that are the outcomes arranged in today's construction activities. Concentrated energy and outcomes such as sustainability concepts, maintainability, repairability, and simplicity have been considered.

Economic Aspects (Table 5):

1. **Avoidance of extravagance and contentment** leads to resource-saving and consequent cost reduction.
2. **Flexibility in structures** leads to an increase in their lifespan, reducing the need for new spaces and reducing the demolition of unused spaces.
3. **Construction of durable buildings** that reduce repair and maintenance costs.

The mentioned characteristics can be considered as repeatable values of vernacular architecture in the process of sustainable architecture for today's constructions (Rahmani,2015).

Table 5: Criteria and Means of Economic Aspects of Sustainability

Element	Criteria	Means
Economic Aspects	**contentment**	Avoidance of extravagance and contentment leads to resource-saving and consequent cost reduction.
	Flexibility	Flexibility in structures leading to an increase in their lifespan, reducing the need for new spaces and reducing the demolition of unused spaces.
	durability	Construction of durable buildings that reduce repair and maintenance costs. The mentioned characteristics can be considered as repeatable values of vernacular architecture in the process of sustainable architecture for today's constructions.

2.2.5 Socio-Cultural Context and Vernacular Architecture

The extensive and intricate concept of culture is pivotal in understanding and contextualizing the design of rural housing. This study delves into the sociocultural dimension, aiming to capture the cultural layers influencing the housing design process. Culture, being a complex accumulation of activities, crafts, habits, beliefs, and thoughts, is interconnected with human affairs. The multifaceted nature of culture includes external representations, activities, practices, and internal or substantial content. These layers, while not rigidly territorialized, act as mediators, influencing behavioral patterns, ethical considerations, and art crafts (Hofstede, Hofstede, & Minkov, 2010). The movement from internal values to external social behaviors is framed through mediator layers (Rapoport, 1980). In the context of vernacular architecture, which is rooted in local origins, culture takes precedence over worldview, and values are seen as generated from worldviews (Schein, 2010). Empirical studies on vernacular settlements reveal the reflection of psychological and sociocultural structures in architectural forms. The sociocultural context is a multilayered

continuum, ranging from deep internal beliefs to external representational activities, interconnected through mediator layers (Holton, 2011). This intricate relationship contributes to the distinguishability of different cultural regions and sociocultural territories, emphasizing the need to explore these layers for a comprehensive understanding of the relations between culture and the built environment (Kamalipour, Zaroudi, 2014).

2.2.6 Contextualizing Vernacular Architecture in IRAN

Iranian vernacular architecture has evolved for thousands of years in response to the challenges posed by the arid climate, limited building materials like stone and wood, and extreme temperature fluctuations on the Iranian Plateau. The primary construction materials used are sun-dried bricks and rammed earth, forming various building types such as wind towers, cisterns, ice houses, among others. If we were to classify vernacular Iranian architecture within the framework and concept recognized globally today as organic architecture, it would fall under this category. In a field of architectural thought where excellence and modesty constitute the primary defining features, the constructed environment, in various scales, shaped itself in the ancient cities and villages of Iran. Iranian architecture has never reached such a state of stagnation that it resorts to a singular style (Falamaki, 2005). Iranian architects have never engaged consistently in experimental, scientific, and educational experiences to condense their building solutions and methods into a reproducible or transferable model. Hence, grand architecture or classic Iranian architecture, which has emerged independently of fixed methodologies, aims to create relations, forms, proportions, and combinations like those found in unit-type structures. We believe that Iranian architecture vividly manifests a spiritual connection, indicating a bond with the living culture of its people. This borderland, without exaggeration, is one of the points where

the Islamic and non-Islamic worlds converge, exhibiting a vast array of diversity and innovations in its architecture. Different methods in architecture have been employed in distinct geographical regions. Exploring the various geographical regions and their architectural differences would be an extensive and deeply intricate subject (Hajhasan, 2016).

2.2.7 Vernacular Architecture in Hot and Dry Climates in Iran

In Iran, vernacular architecture has ingeniously evolved to address the specific climatic characteristics of individual regions over numerous decades. For instance, concerning ecological architecture, the primary consideration in arid and hot climates is the development of an efficient cooling system. The prevalence of extremely hot days throughout a significant portion of Iran for most months of the year necessitates designs that offer maximum shade, minimizing exposure to the sun's rays. Conversely, in the vernacular architecture of the northern region along the Caspian Seas coastline, where the climate is characterized by excess moisture, the principal architectural concern revolves around ensuring proper ventilation (Kazemi, Shirvani, 2011).

In the central parts (Figure 2), marked by hot and arid climates and a scarcity of wood and stone for construction due to the prevalence of sandy lands in the central plains, mudbricks become a pivotal element in vernacular architecture (Burton, et al, 2003). This strategic use of materials is a direct response to the arid conditions of the Iranian Plateau. Iran's traditional architecture not only considers its climatic conditions but also reflects a unique and creatively rich Persian heritage that compensates for apparent limitations in natural resources and aesthetics (Kazemi, Shirvani, 2011). In times past, a vast legacy of charming and often splendid vernacular buildings thrived on the Iranian Plateau, predominantly concentrated in rural areas (Farnian, 2016).

Climate classification in Iran: Iran's climate is divided into four main types: hot arid, hot humid, mild humid, and cold. Due to significantly lower average rainfall compared to many other regions globally, most parts of the country experience hot and dry weather (Farnian, 2016).

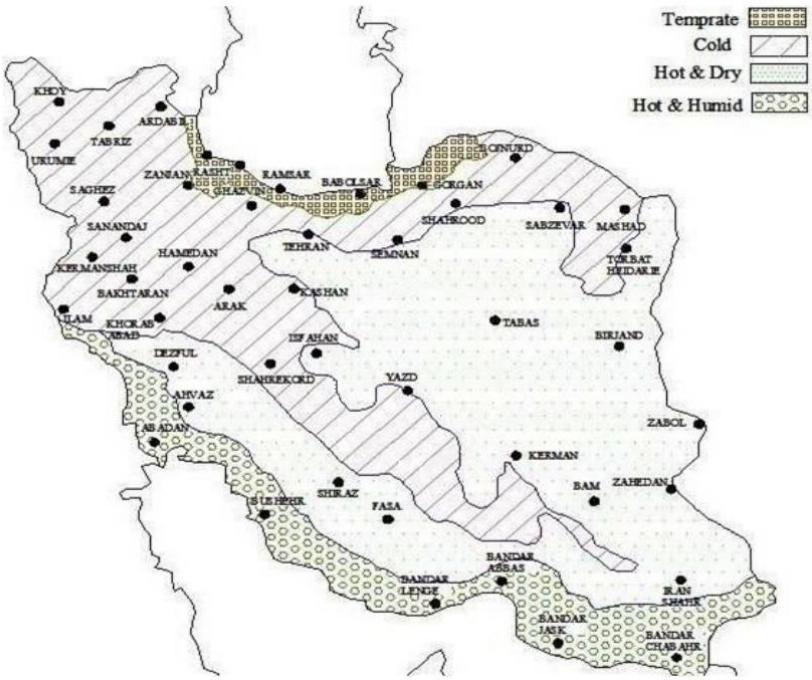

Figure 2: Climatic Regions of Iran (Delfani, 2010)

2.2.8 Rural Vernacular Architecture in Iran: Climate Impacts and Sustainability

Architecture is the outcome of human thought and spirit. It reflects the intellectual and spiritual content of the human designer and builder. A human, as an architect, designs, and constructs with awareness of the natural, social, and cultural environment, as well as insight into existence and nature (Nasr, 2006). They are not merely craftsmen; they exist as artists in essence. They think artistically, craft tools of workmanship, and build their homes artistically (Burkhart, 1997).

Figure3: Rural House texture and Materials Example in Hot and Dry Climate of Vernacular Architecture in Iran (muslim-culture.com)

Harmony with elements and with the surrounding environment are among the secrets of vernacular architecture. Whether in the desert, mountains, or forests, it remains consistently compatible with its environment. It's impossible for vernacular architecture to create something contradictory to itself or to confront the nature of its place and location (Figure 3). The harmony of vernacular architecture originates from the internal coordination of nature. One of the spiritual values of nature is its harmony, making it part of an integrated system. This harmony governs all aspects of nature like a symphony (Rezaei, Vasigh, Moradi,2015).

Simplicity is another key aspect of vernacular architecture. Vernacular architecture starts with a home and ends with a home. The vernacular house architecture is simple and tranquil but incredibly intricate in its simplicity. 'The complexity of vernacular

architecture isn't apparent; rather, what it signifies is simplicity and serenity. Simplicity in its essence is harmonious but visually captivating. The simplicity of vernacular architecture is visual, but its complexity is insightful (Nasr, 2006).

This approach 'adapts easily to specific environmental conditions.' These structures may appear simple and basic at first glance, but they are constructed by individuals who harness all their intelligence and capabilities, utilizing all existing relationships among themselves in their construction (Rezaei, Vasigh, Moradi,2015).

Vernacular architecture in Iran, regarding its functional nature and responsiveness to human needs, the activities of the people, productive elements, and the living environment, forms a cohesive and homogeneous entity with a distinct physical identity. It represents relationships, functions, and multi-functional roles of spaces. 'This identity originates from the essence of dwelling and a specific lifestyle in vernacular settings (Khazari, 2009). Therefore, in addition to addressing the need for residency, security, and the family's privacy, housing in vernacular contexts also encapsulates a circle of vernacular productive systems and coexists with them in mutual connection. The various existing types of vernacular housing are prominent examples of this feature (Rezaei, Vasigh, Moradi,2015).

2.2.9 Rural Architectural Challenges in Iran

Rural architectural challenges in Rural areas are notably influenced by the prevailing features of modernity and modernism in contemporary architecture, manifesting in non-standard structures that often lack compatibility with the rural context. This issue has led to a concerning trend of increased migration of villagers to urban areas due to the neglect of their needs (okhovvat, 2014). The proliferation of non-standard and heterogeneous buildings poses significant threats to the natural and distinctive

environment of Rural areas. There is a critical need to enhance the quality of rural life by developing settlements that align with natural surroundings, emphasizing the incorporation of vernacular architecture and local materials. Moreover, a crucial aspect involves stricter control over construction activities in the village to preserve the natural landscape effectively (Okhovvat, 2016).

In the context of Sustainable Development Goals (SDGs), these interventions align with several key objectives. Firstly, creating compatible and durable rural settlements addresses by promoting inclusive, safe, and resilient environments. Additionally, the emphasis on vernacular architecture and local materials aligns by advocating for sustainable practices and efficient resource use (Okhovvat, 2014). Furthermore, the control of construction to preserve natural landscapes contributes by promoting the sustainable management of ecosystems. Overall, these initiatives aim to foster sustainable rural development in alignment with broader global goals (Okhovvat, 2016).

2.2.10 Aligning Vernacular Architecture in Iran with Sustainable Development Goals (SDGs)

The existence of principles within Iranian architecture allows for a universal language among them. The principles of traditional Iranian architecture manifest through standardized measurement units, modular designs, and proportionality in design. What Iranian architectural principles present is based on attention to stages and levels in design and construction management (Mousavi, 2014). The discussion here doesn't advocate for replicating patterns or forms; rather, it aims to identify the principles of vernacular architecture and identify the challenges that vernacular architecture had proposed to solve (Hajiloo, 2015). Iranian traditional architecture fundamentally focuses on the following:

Reverence for Nature and its Manifestation

An architectural creation, from the moment of inception when it takes its first steps towards materialization, intertwines with the earth: it receives from the earth, transforms its visual and chemical-physical aspects, and gives back in varied proportions (Akef, 2014). It faces the breeze and the winds that disturb it. Its integration with nature is both compliance and utilization. Establishing in the natural environment, whether due to compliance or respect and delicately drawn from the ancient culture and eventful history, occurs with grace and elegance (Hajiloo, 2015).

Design Stages and Human-centric Design

In sustainable architecture, meeting the physical and spiritual needs of inhabitants is of particular importance. People's preferences, related to the practicality of a building, are linked; that is, all building users' needs, regardless of their social status, must be met. In vernacular architecture, the goal is to understand the spirit of the place, not the place itself (Hajiloo, 2015).

Structural Stability

One of the characteristics of Iranian architecture is the use of geometry in its designs. Geometric principles in design lead to a better understanding of size, proportion, beauty, and the forces related to the structure, interacting with the construction of the building. An accurate understanding of geometry and related aspects enhances Iranian architecture's ability to provide more sustainable and valuable forms (Hajiloo, 2015).

Measurement Unit in Construction - "Peymon"

The fundamental unit of measurement in a building is called "Peymon," serving as the basis for other measurements. "Peymon" was a uniform and minute measurement used wherever necessary, according to needs. The benefits of employing the principles of Iranian vernacular architecture towards sustainable architecture include:

Accepting that the comprehensive shape, whether social or natural phenomena, belongs to the external world and possesses specific attributes or unique energies that can transform anything into something else (Mousavi, 2014). Acknowledging that humans have addressed their needs within a constructed space using shapes, with capabilities and environmental constraints, in the form of usages for both physical and non-physical necessities and constraints (Robouei, 2005).

Table 6: Sustainability aspects of Vernacular Architecture of Iran

Cultural-social Aspects	**Environmental aspects**	**Economic aspects**
People-centric: Vernacular architecture is sensitive to the culture of community members, including introversion that considers the users' needs in terms of their requirement for personal space and security. **Adaptability:** The adaptability of buildings to residents is due to their flexibility. Signifying nature in architecture leads to the creation of a culture of proper consumption and contentment. **Retrospection (changing bad habits):** Avoiding unnecessary things that decrease efficiency. Our ability and readiness to change our mindset may solve issues even more than finding an absolute solution to a problem.	Attention to the meaningful features of nature that lead to fostering respect for nature, contentment, and meaningfulness within the built environment. Focus on the material aspects of nature, climatic design, and compatibility with the surrounding environment. **Self-sufficiency in using Vernacular materials:** employing harmless, healthy, and vernacular materials, available technology, and performance-oriented adaptability, which are organized outcomes in contemporary construction activities. Concentrated energy and consequences such as enduring concepts, sustainability, repairability, and simplicity have been highlighted.	**Avoidance of extravagance (contentment):** leading to resource conservation and subsequently reducing costs. Structural flexibility that increases its lifespan, thereby reducing the need for creating new spaces and demolishing unused areas. **Durability**: constructing sturdy buildings that reduce maintenance and repair costs.

Chapter 3

ANALYSIS OF SDGS VERNACULAR ARCHITECTURE CASE STUDIES

3.1 Introduction

Sustainable development stands as a beacon of hope in an era marked by global challenges such as climate change, inequality, environmental degradation, and socioeconomic disparities. It encapsulates a visionary approach that seeks to harmonize economic prosperity, social inclusion, and environmental sustainability. Central to this paradigm are the United Nations' Sustainable Development Goals (SDGs), a transformative blueprint encompassing 17 interlinked objectives adopted by all member states in 2015 (UNESCO, 2015).

These 17 SDGs, with their 169 associated targets, constitute a comprehensive roadmap towards a more equitable, resilient, and sustainable world by 2030. Each goal addresses critical global issues, spanning poverty, hunger, health, education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice, and strong institutions, and partnerships for the goals (Mossin, 2018).

In understanding the multifaceted nature of sustainable development, case studies play a pivotal role in elucidating practical strategies, successful interventions, and challenges encountered in diverse geographical, economic, and social contexts. These case studies offer valuable insights into the implementation of the SDGs, showcasing local initiatives, innovative approaches, and lessons learned. They provide tangible examples of how communities, organizations, and governments worldwide are addressing these challenges and working towards achieving the SDGs.

This compilation delves into rural houses case studies aligned with the SDGs, examining successful endeavors, setbacks, and the holistic impact of initiatives across different sectors and regions. By dissecting these real-world applications, we aim to glean lessons, unveil best practices, and inspire collective action toward attaining sustainable development on a global scale.

This chapter delves into a comprehensive exploration of sustainable architectural practices through the lens of two distinctive case studies: "Volontariat: Home for Homeless Children" and "The Magoda Project: Innovating Housing Design to Mitigate Disease Transmission in Rural Tanzania."

"Volontariat: Home for Homeless Children" stands as a testament to architectural compassion and social responsibility. Designed to cater to the needs of homeless children, this innovative housing initiative symbolizes the fusion of sustainable architectural principles with humanitarian efforts. The study of this project offers profound insights into how architectural design can address societal challenges, providing not only shelter but also fostering community and healing environments.

On the other hand, "The Magoda Project" represents a pioneering approach in housing design within rural Tanzania. The project's emphasis on mitigating disease transmission through innovative architectural strategies aligns with the Sustainable Development Goals (SDGs), especially in fostering health and well-being within vulnerable communities. Through meticulous analysis of this project, this chapter aims to explore the nuanced relationship between architectural design, public health, and sustainable development.

By scrutinizing these diverse case studies, this chapter endeavors to draw parallels between sustainable architectural strategies and the SDGs. It aims to showcase how these architectural initiatives align with the broader global agenda of sustainable development, emphasizing the pivotal role of innovative design in addressing social, environmental, and health challenges faced by communities around the world.

Through the lens of these case studies, this chapter aims to underscore the intricate connections between architectural innovation, social impact, and the attainment of sustainable development objectives as outlined by the SDGs. The lessons gleaned from these case studies serve as beacons guiding the integration of sustainable architectural practices into broader developmental frameworks, advocating for a more inclusive, resilient, and sustainable future for communities worldwide.

3.2 SDGs Case Study 1: VOLONTARIAT: HOME FOR HOMELESS CHILDREN

Figure 4: Volontariat Homes for Homeless Children, Anupama Kundoo Architects as Architects (urbanNext, 2024)

3.2.1 Overview of Volontariat

The introduction provides an insightful overview of a groundbreaking project initiated by Volontariat, an NGO in Pondicherry. Aimed at addressing housing challenges for homeless children and foster parents, this innovative endeavor demonstrates a novel approach to sustainable, low-cost housing (Figure 4). The project pioneers a unique construction technique developed by Ray Meeker, utilizing a method that involves baking a mud house in situ to enhance its strength and durability. Notably, the initiative places a strong emphasis on utilizing local labor and unconventional materials, such as repurposed urban waste, to minimize costs and foster sustainability. This socially conscious project underscores a commitment to holistic sustainability, integrating affordability and social responsibility into the design and construction of housing solutions for marginalized communities.

3.2.2 Relevance of Volontariat in relation to SDGs

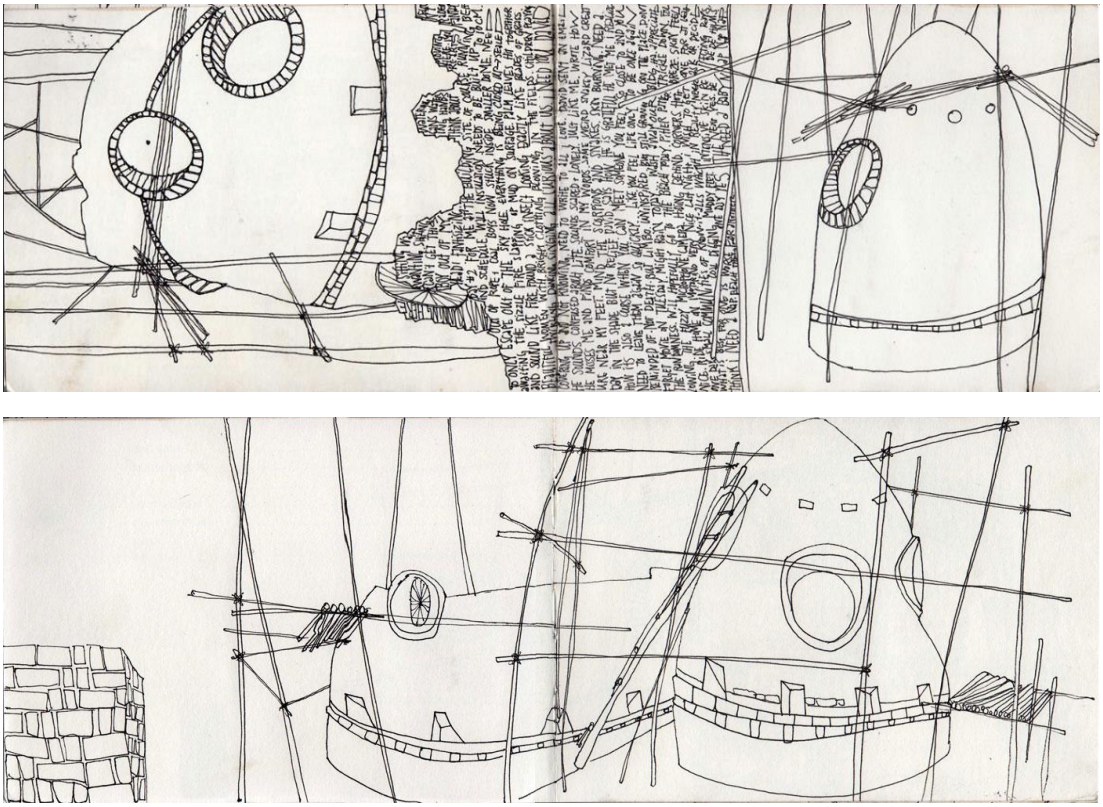

Figure 5: Sketches of Volontariat Case Study (urbanNext, 2024)

The case study is a pioneering initiative aimed at addressing housing challenges through innovative, cost-effective, and sustainable solutions. Focused on providing shelter for homeless children and foster parents, this project integrates traditional construction techniques with contemporary methodologies to create affordable housing in rural areas.

Key elements of the project include utilizing a rare technology developed by Ray Meeker from Golden Bridge Pottery, involving the baking of a mud house on-site after construction. This technique, known as a "fired house," uses local mud bricks and mortar, which are fired to achieve the strength of bricks, thereby creating an energy-

efficient and durable dwelling. The project's emphasis on using locally available resources and upcycling waste materials—such as glass bottles and bicycle wheel frames—demonstrates a commitment to sustainable practices.

Moreover, the case study aligns with various Sustainable Development Goals (SDGs), notably targeting poverty reduction by offering affordable housing solutions. It also prioritizes health and well-being by creating safe living environments and contributes to sustainable urbanization and responsible consumption through its focus on eco-friendly construction methods and material utilization.

Overall, the case study stands as an exemplary model showcasing innovative thinking and experimentation in the realm of affordable housing, intertwining local craftsmanship, sustainable materials, and community-focused approaches to address crucial developmental challenges.

3.2.3 Examination of Key Sustainable Techniques in VOLONTARIAT

The Volontariat Home in Pondicherry, India, showcases several sustainable design elements:

1. **Earth Construction Techniques:**
    - Identification: Utilization of mud bricks, mud mortar, and firing the mud house on-site (Figure 6).
    - Analysis: Earth construction methods reduce the environmental impact by minimizing the use of energy-intensive materials like cement and bricks.

Figure 6: Volontariat Homes for Homeless Children, Anupama Kundoo Architects as Architects (urbanNext, 2024)

2. **Passive Cooling and Ventilation:**

    - Identification: Catenary-shaped domes for improved ventilation and natural cooling (Figure 7).
    - Analysis: Passive design features promote indoor comfort without the need for energy-consuming cooling systems, reducing energy usage.

Figure 7: Catenary-shaped domes for improved ventilation and natural cooling (urbanNext, 2024)

3. **Local Material Utilization:**
    - Identification: Utilization of locally sourced materials (Figure 8).
    - Analysis: Using locally available materials decreases transportation costs and environmental impact associated with long-distance transportation.

Figure 8: Utilization of Mud Bricks for Earth Construction Methods (urbanNext, 2024)

4. **Innovative Upcycling:**
    - Identification: Repurposing waste materials like bicycle wheel frames and glass bottles (Figure 9) (Figure 10).
    - Analysis: Upcycling waste materials reduces landfill waste and contributes to a circular economy approach in construction.

Figure 9: Utilizing of Upcycling Materials (urbanNext, 2024)

Figure 10: Utilizing of Upcycling Materials (urbanNext, 2024)

5. **Community Engagement:**

    - Identification: Engaging local craftsmen and communities in the construction process (Figure 11).
    - Analysis: Involving the local community enhances traditional skills, empowers residents, and fosters a sense of ownership and pride.

Figure 11: Community Involvement during the construction (urbanNext, 2024)

6. **Energy Efficiency Strategies:**
    - Identification: Using the firing process heat for baking other mud bricks or ceramic products.
    - Analysis: Maximizing energy efficiency by reusing firing heat for other purposes reduces energy waste and resource consumption.
7. **Cost-Effectiveness and Affordability:**
    - Identification: Prioritization of low-cost materials and labor.
    - Analysis: Cost-effective construction approaches address housing challenges for poor communities.

Each sustainable design element contributes to the overall goal of providing an affordable, eco-friendly, and comfortable living space for the community while significantly reducing the environmental footprint of construction and operation.

3.2.4 Identification and Categorization of Vernacular Architectural Sustainable Techniques

The sustainable techniques employed in the Volontariat Home case study align with various aspects of vernacular architecture. In this part the analysis of these techniques in the context of vernacular architectural principles will proceed:

Local Materials Usage: The use of unfired bricks, mud mortar, and materials sourced from the immediate environment aligns with the vernacular approach of using locally available resources. This technique ensures a minimal environmental footprint while incorporating indigenous materials into the construction process.

Climate Responsiveness: The construction techniques, particularly the fired-in-situ mud structures, exhibit a response to the local climate. The utilization of catenary-shaped domes for structural stability and energy efficiency during firing showcases adaptation to climatic conditions, a characteristic often seen in vernacular architecture.

Community Involvement and Craftsmanship: Engaging local craftsmen and involving the community aligns with the communal aspect of vernacular architecture. It not only empowers the local populace but also preserves traditional building methods and skills, promoting cultural continuity.

Waste Upcycling and Sustainability: The integration of waste materials, such as glass bottles and bicycle wheel frame, demonstrates resourcefulness and aligns with the sustainable practices often observed in vernacular architecture. Reusing urban waste materials showcases a commitment to sustainability and resource optimization.

Cost-Effectiveness and Affordability: The emphasis on cost-effectiveness resonates with the affordability aspect of vernacular architecture. The use of innovative, low-cost techniques allows for the creation of sustainable housing solutions accessible to

marginalized communities, reflecting the pragmatic approach often seen in vernacular designs.

Adaptation to Context: The project's focus on adapting to local contexts, such as utilizing mud-based technologies and engaging with local craftsmen, resonates with the adaptive nature of vernacular architecture. This technique ensures that the architecture suits the socio-cultural and environmental context.

In summary, the sustainable techniques employed in the Volontariat Home align with many principles inherent in vernacular architecture, including the use of local materials, climate responsiveness, community involvement, waste upcycling, cost-effectiveness, and adaptation to context. These techniques not only contribute to sustainable construction but also encapsulate the essence of traditional building practices within a contemporary context.

Table 7: vernacular Architectural Sustainable Techniques Used in Volontariat Case

Vernacular Architectural Sustainable Techniques	Material Utilization	Local Sourcing	Used mud bricks, mud mortar, and other local materials to minimize transportation and costs.
		Natural Materials	Utilized earth-based construction methods like mud bricks for walls and domes, relying on locally available resources.
		Upcycling and Recycling	Incorporated recycled materials such as bicycle wheel frames for window frames and glass bottles as structural elements in toilet masonry.
	Passive Design and Climate Adaptation	Orientation and Layout	Employed catenary shaped domes for structural stability and energy efficiency before and during firing, considering the local climatic conditions.
		Natural Ventilation	Designed for cross-ventilation and airflow using strategic openings and dome shapes, promoting natural cooling.
	Construction Techniques	Earth Construction	Employed a unique technique by firing the mud house after construction, creating a fired or fire-established mud house for enhanced strength.
		Local Craftsmanship	Collaborated with local artisans and craftsmen to construct the house, supporting local skills and traditional building methods.
	Cultural and Community Integration	Community Participation	Engaged with local communities in the construction process, integrating their knowledge and involving them in the project.

The Volontariat Home exemplifies sustainable techniques (Table 7) by focusing on local materials, utilizing earth-based construction, promoting energy efficiency through passive design, and integrating community involvement and cultural heritage in its construction. The use of recycled materials further showcases an emphasis on upcycling and minimizing waste, aligning with sustainable development objectives.

3.2.5 Evaluation of Sustainable Vernacular building materials and construction techniques

The Volontariat Home's use of mud-based construction, firing techniques, upcycled materials, local sourcing, and community engagement exhibits a commendable effort toward sustainable building practices. While the approach showcases innovation and resourcefulness, ensuring long-term durability and monitoring environmental impact remain critical for sustained success.

1. **Mud-based Construction:**
    - Advantages: The use of mud as a primary construction material offers thermal mass properties, aiding in natural temperature regulation. It's cost-effective, abundant, and locally available, reducing transportation emissions.
    - Challenges: Mud-based structures require proper maintenance and protection from water to prevent erosion or deterioration.
2. **Firing Technique:**
    - Advantages: Firing the mud house on-site to strengthen it mimics the process of brickmaking while minimizing the need for additional materials like cement. It's an innovative method using locally available resources.

- Challenges: The firing process demands careful management to ensure uniform strength and stability throughout the structure.

3. **Upcycled Materials:**
    - Advantages: Reusing waste materials like bicycle wheel frames, glass bottles, and chai cups as structural elements and finishes promotes sustainability, minimizes waste, and reduces the need for new resources.
    - Challenges: While upcycling reduces waste, the structural integrity and longevity of these reused materials may need verification.
4. **Local Sourcing and Craftsmanship:**
    - Advantages: Involving local craftsmen and utilizing locally sourced materials fosters community engagement, preserves traditional knowledge, and supports the local economy.
    - Challenges: Local sourcing might face limitations in terms of quality control and consistency in material supply.
5. **Energy Efficiency and Environmental Impact:**
    - Advantages: The use of locally available materials and the firing process on-site reduces the carbon footprint associated with transportation and production of traditional building materials.
    - Challenges: The assessment of environmental impact could benefit from a lifecycle analysis, considering factors like long-term structural integrity, energy usage, and potential waste generation.

6. **Resilience and Durability:**
    - Advantages: The combination of traditional mud construction techniques and innovative firing methods offers potential for sturdy, environmentally friendly, and cost-effective structures.
    - Challenges: Continuous maintenance and protection against environmental factors are essential to ensure long-term durability and resilience against natural elements.

3.2.6 Significance of Formulated Sustainable Techniques Framework and Vernacular Architecture

The formulated sustainable techniques framework, based on the innovative approach adopted in the Volontariat Home project, stands as a testament to the potential of vernacular architecture in addressing contemporary sustainability challenges. This framework not only showcases the feasibility of utilizing traditional and innovative construction methods but also demonstrates their pivotal role in achieving sustainability goals (Table 8).

3.2.7 Summary of Identified Sustainable Techniques

- Material Innovation and Usage: The project highlighted the efficacy of using unfired bricks, mud mortar, ferrocement components, and integrating local craftsmanship, offering sustainable alternatives to conventional materials.
- Energy Efficiency and Carbon Reduction: The in-situ firing process and reduction in embodied energy through innovative construction methods significantly contributed to lowering the carbon footprint.
- Economic Viability and Cost-effectiveness: By prioritizing local resources and labor, the project showcased how it was not only economically feasible but also contributed to the local economy.

- Space Optimization and Functionality: The design's emphasis on multifunctional elements optimized space usage and enhanced living quality for inhabitants.
- Waste Upcycling and Sustainable Practices: Integrating urban waste materials into construction demonstrated a commitment to sustainability by reducing resource consumption and waste generation.
- Community Engagement and Empowerment: The project's inclusive approach, involving local craftsmen and providing shelter for homeless children, highlighted community engagement and empowerment.

3.2.8 Importance and Application of the Developed Framework for Future Case Studies

The developed framework, derived from the innovative sustainable techniques utilized in the Volontariat Home, offers a robust blueprint for future case studies and architectural endeavors. Its significance lies in:

- **Replicability:** The framework can be replicated in diverse settings, offering adaptable solutions to address housing challenges globally.
- **Sustainability Integration:** It integrates traditional practices with modern innovations, emphasizing the sustainable utilization of local resources and community engagement.
- **Cost-Efficiency:** The framework's focus on affordability and cost-effectiveness serves as a model for creating sustainable housing solutions without compromising quality.

In conclusion, this framework not only fosters sustainable housing but also addresses economic, social, and environmental aspects, making it a pivotal tool in shaping the future of architectural design and sustainable development.

Table 8: Analysis of Vernacular Architectural Sustainable Techniques of Volontariat

Analysis of Vernacular Architectural Sustainable Techniques of Volontariat Case Study				
Sustainable Architectural Techniques	**Sustainable Vernacular Construction/ Material Techniques**	**Sustainable Criteria**	**Socio-Cultural Values**	**Sustainable Development Goal**
Mud-Based Construction	**Local Material Usage** Aligns with the vernacular approach of using locally available resources, ensuring minimal environmental impact. **Adaptation to Context:** Focusing on adapting to local contexts, such as utilizing mud-based technologies and engaging with local craftsmen, resonates with the adaptive nature of vernacular architecture.	**Environmental Impact:** The use of locally available materials and upcycled waste materials reduces the environmental impact associated with long-distance transportation and traditional construction materials. **Community Engagement:** Involving local communities enhances traditional skills, empowers residents, and fosters a sense of ownership and pride. **Cost-Effectiveness:** Prioritization of low-cost materials and labor addresses housing challenges for poor communities.	**Preservation of Traditional Knowledge:** Involvement of local craftsmen and utilization of locally sourced materials preserve traditional building methods and knowledge. **Community Empowerment:** Engaging local communities in the construction process empowers them and fosters a sense of ownership and pride.	**Poverty Reduction (SDG 1):** Offering affordable housing solutions contributes to poverty reduction. **Health and Well-being (SDG 3):** Creating safe living environments prioritizes health and well-being. **Sustainable Cities and Communities (SDG 11):** Focus on eco-friendly construction methods and material utilization contributes to sustainable urbanization. **Responsible Consumption and Production (SDG 12):** Use of upcycled materials demonstrates a commitment to responsible consumption.
Firing Technique	**Climate Responsiveness** Fired mud structures exhibit a response to the local climate, showcasing an adaptation to climatic conditions, a characteristic often seen in vernacular architecture.			
Upcycled Materials	**Waste Upcycling and Sustainability** Integrating waste materials demonstrates resourcefulness and aligns with the sustainable practices often observed in vernacular architecture.			
Local Sourcing and Craftsmanship	**Community Involvement and Craftsmanship** Engaging local craftsmen and involving the community aligns with the communal aspect of vernacular architecture, preserving traditional building methods and skills. **Cost-Effectiveness and Affordability** Emphasis on cost-effectiveness resonates with the affordability aspect of vernacular architecture, reflecting the pragmatic approach often seen in			
Energy Efficiency and Environmental Impact	Reduces the carbon footprint associated with transportation and traditional building materials.			
Resilience and Durability	Combining traditional mud construction techniques with innovative firing methods offers potential for sturdy, environmentally friendly structures.			

3.3 SDG Case Study 2: The Magoda Project: Innovating Housing Design to Mitigate Disease Transmission in Rural Tanzania

Figure 12: The Magoda Project: Innovating Housing Design to Mitigate Disease Transmission in Rural Tanzania

3.3.1 Overview of Magoda Project

The Magoda Project emerges as a response to prevalent health challenges in sub-Saharan Africa, particularly concerning infectious diseases like Malaria, commonly acquired in and around homes (Figure 12). In the quest to enhance the well-being of residents, especially within their primary living space, there's a demand for improvements. In rural African settings, low-cost houses constructed predominantly from mud or brick often lack sufficient windows, resulting in limited airflow. Moreover, essential facilities like cooking spaces, clean water supply, and sanitation are either absent or rudimentary. The project aims to address these challenges through

architectural modifications that target health, hygiene, comfort, and diseases endemic in the region.

Figure 13: Indoor Design of Magoda Project

3.3.2 Relevance of Magoda Project in relation to SDGs

The Magoda Project stands as a testament to innovative architectural solutions aimed at improving health and well-being in sub-Saharan Africa. This initiative, comprising eight prototype houses in Tanzania, addresses the region's health challenges, notably combating diseases such as malaria acquired within households.

Collaborating with local communities, Ingvartsen Architects combined traditional African building techniques with Asian design elements to create homes that foster better living conditions. These houses integrate features optimizing airflow and incorporate materials like timber, bamboo, and shade-net. Additionally, they include semi-outdoor kitchens, water-harvesting tanks, and sanitation facilities.

By focusing on natural ventilation (Figure 13), the project sought to reduce indoor temperatures, create more comfortable living spaces, and decrease reliance on mosquito nets by inhibiting mosquitoes' entry. The prototypes showcased an impressive 2.3°C cooler indoor temperature and an 86% reduction in mosquitoes compared to traditional homes.

Through an evidence-based approach, the team observed significant improvements in indoor climate, along with increased usage of mosquito nets, contributing to a notable decrease in malaria infections.

The Magoda Project has received international acclaim, being shortlisted for prestigious awards, and gaining recognition at exhibitions worldwide. This initiative exemplifies a multifaceted approach, addressing health challenges, promoting sustainable communities, enhancing water and sanitation access, supporting climate-friendly practices, and fostering innovation in rural areas.

Figure 14: Outdoor Design of Magoda Project

3.3.3 Examination of key sustainable techniques in Magoda project

The examination of sustainable techniques employed in the Magoda Project reveals a comprehensive approach aimed at enhancing living conditions while mitigating health risks in sub-Saharan Africa. Through a fusion of traditional African building methods and innovative architectural strategies, the project implemented several sustainable techniques:

Natural Ventilation and Thermal Comfort: The project prioritized natural airflow and ventilation by integrating Asian architectural elements and local building practices (Figure 15). This technique effectively lowered indoor temperatures, making living spaces more comfortable and reducing reliance on mosquito nets by minimizing mosquito entry.

Figure 15: Natural Ventilation and Thermal Comfort of Magoda Project

Building Materials and Design: Utilizing locally sourced materials like timber, bamboo, and shade-net cladding not only provided cost-effective solutions but also

ensured the integration of sustainable elements into the housing prototypes. The design approach optimized materials for thermal comfort and durability, contributing to the home's sustainability.

Water Harvesting and Sanitation Facilities: The inclusion of water-harvesting tanks (Figure 16) and sanitation facilities within the housing prototypes improved water access and sanitation. This sustainable measure addressed fundamental needs while promoting hygiene and health within the community.

Figure 16: Water Harvesting and Sanitation Facilities

Community Engagement and Collaboration: The project's sustainable approach extended beyond physical structures. Collaboration with local engineers, laborers, doctors, and sociologists ensured a holistic understanding of the community's needs and preferences, fostering a sense of ownership and acceptance of the new housing designs.

Evidence-Based Research and Evaluation: An evidence-based approach, involving meticulous measurements of indoor temperatures and mosquito populations, formed

the basis for assessing the project's success. This data-driven evaluation helped validate the effectiveness of the sustainable techniques employed.

The Magoda Project's sustainable techniques not only focused on architectural enhancements but also encompassed broader societal and environmental considerations, aligning with the principles of sustainable development. These initiatives aimed to enhance living conditions, mitigate health risks, promote local engagement, and contribute to a more sustainable and resilient community in sub-Saharan Africa.

3.3.4 Identification and Categorization of Vernacular Architectural Sustainable Techniques

The Magoda Project" stands as a pivotal case study encapsulating the utilization of vernacular architecture in rural Tanzania. This comprehensive analysis aims to identify and categorize sustainable techniques, challenges, and corresponding solutions prevalent within this architectural endeavor.

The project, rooted in the rural landscape of Tanzania, is an innovative housing initiative designed to combat disease transmission through architectural interventions. It underscores the significance of indigenous building methods and community-based solutions, offering insights into how vernacular architecture can address contemporary challenges.The examination delves into various aspects:

Sustainable Techniques: The study meticulously dissects the architectural methods and indigenous practices embedded within "The Magoda Project." It focuses on how local materials, passive design strategies, and community involvement foster sustainable living conditions.

1. **Local Material Utilization:**

- Incorporating regionally available materials like adobe, locally sourced timber, and thatch for construction. These materials offer thermal comfort, are sustainable, and readily accessible within the area.

2. **Climate-Responsive Design:**
    - Adapting architectural designs that respond to the local climate, such as using natural ventilation systems, shaded areas, and suitable building orientations to regulate indoor temperatures.
3. **Community Engagement and Participation:**
    - Involving the local community in the construction process, which not only aids in preserving traditional building techniques but also ensures the designs are culturally sensitive and accepted by the residents.
4. **Hygiene and Disease Mitigation:**
    - Implementing designs to mitigate disease transmission, such as improved ventilation to prevent indoor pollution, incorporating separate spaces for personal hygiene, and emphasizing cleanliness (Figure 17).

Figure 17: Implementing Designs to Mitigate Disease Transmission.

5. **Resource Efficiency and Sustainability:**
    - Emphasizing the use of local resources, reducing waste, and optimizing energy efficiency through passive design strategies like the use of daylight, insulation, and appropriate building orientation.
6. **Adaptation to Local Context:**
    - Integrating architectural designs that are compatible with the local context, considering factors like socio-cultural practices, traditional building techniques, and indigenous knowledge for sustainable living.
7. **Innovative Solutions:**
    - Exploring innovative solutions like the integration of modern technologies where feasible, without compromising the project's vernacular identity and sustainability goals.

Table 9: Vernacular Architectural Sustainable Techniques Used in Magoda Project

vernacular architectural sustainable techniques	Material Utilization	Local Sourcing	Utilizing regionally available materials to minimize transportation and energy costs.
		Natural Materials	Incorporating renewable resources like mud, thatch, bamboo, and timber to reduce environmental impact.
		Upcycling and Recycling	Reusing materials, such as repurposing waste items like glass or tires, promoting resourcefulness and waste reduction.
	Passive Design and Climate Adaptation	Orientation and Layout	Optimal building positioning considering sun path, wind direction, and natural elements for energy efficiency.
		Natural Ventilation	Designing spaces to encourage cross-ventilation, improving indoor air quality without relying on mechanical systems.
		Solar Gain and Shading	Strategic window placement and shading elements to maximize or minimize solar heat gain, adapting to the climate.
	Construction Techniques	Earth Construction	Employed a unique technique by firing the mud house after construction, creating a fired or fire-established mud house for enhanced strength.
		Timber Construction	Using locally sourced timber, supporting sustainable forestry practices and reducing embodied energy.
	Cultural and Community Integration	Local Craftsmanship	Involvement of local artisans and traditional methods, preserving cultural heritage and skills.
		Community Participation	Engaging locals in the design and construction process, fostering ownership and knowledge exchange.

Challenges Faced: Inherent challenges encountered in implementing vernacular architectural solutions within the project's context are identified and scrutinized. Factors such as resource limitations, cultural adaptations, and integration of modern elements present multifaceted challenges.

Proposed Solutions: Addressing these challenges requires innovative solutions. The analysis presents potential strategies to overcome obstacles, offering insights into adaptive measures that blend modern advancements with vernacular strategies.

By categorizing and delineating these sustainable techniques, challenges, and solutions, this examination contributes to a deeper understanding of the role and efficacy of vernacular architecture within the context of sustainable development, specifically emphasizing its application in mitigating disease transmission in rural settings like "The Magoda Project.

The Magoda Project demonstrates a distinctive amalgamation of vernacular architectural techniques and innovative solutions to address health and environmental concerns in rural African housing:

1. **Cross-Cultural Integration:**
    - The project blends vernacular African building methods with Asian architectural elements to create a unique design that combines the advantages of both cultural approaches.
2. **Sustainable Design Integration:**
    - The integration of bamboo, shade nets, timber louvers, and indigenous materials showcases a sustainable approach that balances thermal comfort with improved airflow, minimizing disease transmission risks.
3. **Environmental Impact Assessment:**
    - Continuous research on microclimates resulting from diverse building materials and designs highlights the project's commitment to assessing and enhancing environmental sustainability.
4. **Community-Centric Approach:**
    - Engaging local communities and stakeholders underscores the project's commitment to community participation and acceptance, fostering a sustainable model for disease prevention and improved living conditions.

3.3.5 Evaluation of Sustainable Architectural Building Materials and Construction Techniques in The Magoda Project

The Magoda Project, an initiative by Ingvartsen Architects in Tanzania, exemplifies a fusion of Asian elements with traditional rural African building methods to combat disease transmission while enhancing comfort and well-being. This innovative approach addresses the limitations of traditional rural African homes, primarily the trade-off between thermal comfort and airflow, leading to the potential spread of diseases like Malaria.

1. **Building Materials Evaluation:**
    - **Asian Elements Integration:** Ingvartsen Architects utilized bamboo, shade nets, and timber louvers alongside local materials like brick and concrete. These materials, known for their cross-ventilation properties, were strategically employed to maximize airflow within the buildings while retaining the high thermal mass of local materials.
    - **Thermal Capacity and Airflow Balance:** The combination of materials aimed to maintain a comfortable microclimate by optimizing thermal capacity and promoting adequate airflow. Bamboo, shade nets, and timber louvers facilitate airflow without compromising the buildings' ability to regulate internal temperatures.
    - **Insect Screens:** In addition to these materials, the installation of insect screens on all open windows showcases a conscious effort to prevent the entry of disease-carrying insects while ensuring adequate ventilation.

2. **Construction Techniques Assessment:**
    - **Local Collaboration:** Working closely with local engineers, laborers, doctors, and sociologists, the project integrated indigenous building methods with innovative design solutions. The collaboration focused on maximizing airflow while retaining the thermal benefits of traditional materials.
    - **Elevation and Adaptation:** The use of elevated platforms with materials resistant to flooding illustrates a thoughtful adaptation to the region's environmental challenges, ensuring the buildings remain resilient against potential flooding in the area.
3. **Research and Community Involvement:**
    - **Microclimate Evaluation:** Ingvartsen Architects engage in continuous research to evaluate the effectiveness of different materials and construction designs in creating distinct microclimates. This approach aims to enhance the overall comfort and health of local inhabitants.
    - **Community Participation:** The architects actively involve local community leaders and stakeholders to foster acceptance and understanding of innovative design techniques. The project aims to extend its impact by promoting broader adoption of these architectural solutions to minimize diseases at a community level.

The Magoda Project by Ingvartsen Architects stands as a testament to the potential of cultural exchange architecture in addressing critical health and sustainability challenges within rural African communities. By harmoniously integrating Asian architectural elements with traditional African building techniques, this project has

showcased innovative approaches to mitigate disease transmission while prioritizing comfort and well-being.

3.3.6 Significance of Formulated Sustainable Techniques Framework and Vernacular Architecture

The formulated sustainable techniques framework, derived from the innovative amalgamation of vernacular architectural practices, offers a significant breakthrough in sustainable design paradigms. It underscores the intrinsic potential of merging diverse cultural architectural elements to achieve enhanced livability, disease prevention, and environmental sustainability.

3.3.7 Summary of Identified Sustainable Techniques

The study identified several pivotal sustainable techniques applied within The Magoda Project (Table 10):

1. **Material Integration for Optimal Comfort and Ventilation:** The strategic incorporation of bamboo, shade nets, timber louvers, and traditional African materials ensured a balance between thermal comfort and enhanced airflow, minimizing the risk of diseases while maintaining a comfortable microclimate.
2. **Community-Centric Design Principles:** The project emphasized community engagement, leveraging local knowledge and expertise, thereby fostering acceptance and ownership while fortifying sustainable architectural practices.
3. **Environmental Adaptation and Resilience:** Construction techniques, such as elevated platforms and flood-resistant materials, showcased a proactive approach toward environmental adaptation and resilience against natural challenges like flooding.

3.3.8 Importance and Application of the Developed Framework for Future Case Studies

The framework formulated from the Magoda Project's sustainable techniques offers invaluable insights for future case studies and architectural endeavors:

1. **Replicability and Adaptability:** The adaptability of the developed framework ensures its relevance and applicability across diverse geographical, cultural, and climatic contexts, enabling its replication in similar rural communities facing health and sustainability challenges.
2. **Continued Innovation and Learning:** The application of this framework in future case studies holds promise for continued innovation in sustainable design practices. It presents an opportunity for architects and researchers to build upon existing knowledge, refining techniques, and expanding the repertoire of culturally integrated sustainable solutions.

In conclusion, the Magoda Project's innovative approach not only addresses health challenges but also serves as a beacon guiding the formulation and application of sustainable architectural frameworks rooted in vernacular practices. This project underscores the potential of cultural exchange architecture in shaping healthier, more sustainable, and community-centric living spaces for rural populations, setting a precedent for future endeavors in architectural innovation and social impact

Table 10: Analysis of Vernacular Architectural Sustainable Techniques of Magoda Project Case Study

Analysis of Vernacular Architectural Sustainable Techniques of Magoda Project Case Study				
Sustainable Architectural Techniques	**Sustainable Vernacular Construction/ Material Techniques**	**Sustainable Criteria**	**Socio-Cultural Values**	**Sustainable Development Goal**
Natural Ventilation and Thermal Comfort Implementation of designs to optimize airflow and natural ventilation. Integration of Asian architectural elements and local building practices to reduce indoor	**Climate-Responsive Design:** Adapting designs to respond to the local climate reflects the essence of vernacular architecture.	**Environmental Impact:** The use of locally sourced materials and sustainable practices minimizes the environmental impact of construction. **Community Engagement:** Collaborating with local communities fosters a sense of ownership, contributing to the sustainable development of the community. **Cost-Effectiveness:** Cost-effective solutions address housing challenges, contributing to sustainable development.	**Preservation of Traditional Knowledge:** Involving the local community ensures the preservation of traditional building methods and cultural practices. **Community Empowerment:** Engaging the local community empowers them and fosters a sense of ownership and pride.	**Good Health and Well-being (SDG 3):** Addressing health challenges, particularly combating diseases like malaria, contributes to SDG 3. **Sustainable Cities and Communities (SDG 11):** The project promotes sustainable community development through architectural interventions.
Building Materials and Design Using timber, bamboo, and shade-net for construction	**Local Material Utilization:** Incorporating regionally available materials aligns with vernacular architecture, offering thermal comfort and sustainability. **Resource Efficiency and Sustainability:** Emphasizing the use of local resources and optimizing energy efficiency reflects the resource-conscious nature of vernacular architecture. **Adaptation to Local Context:** Integrating designs compatible with the local context aligns with the adaptive nature of vernacular architecture.			
Water Harvesting and Sanitation Facilities Inclusion of water-harvesting tanks and sanitation facilities within housing prototypes.	**Hygiene and Disease Mitigation:** Implementing designs to mitigate disease transmission aligns with the health and hygiene considerations of vernacular architecture.			
Community Engagement and Collaboration Collaboration with local communities, including local engineers, laborers, doctors, and sociologists.	**Community Engagement and Participation:** Involving the local community ensures the preservation of traditional building techniques and cultural acceptance.			
Evidence-Based Research and Evaluation Meticulous measurements of indoor temperatures and mosquito populations for data-driven evaluation.	**Innovative Solutions:** Exploring innovative solutions while maintaining vernacular identity showcases a blend of tradition and modernity.			

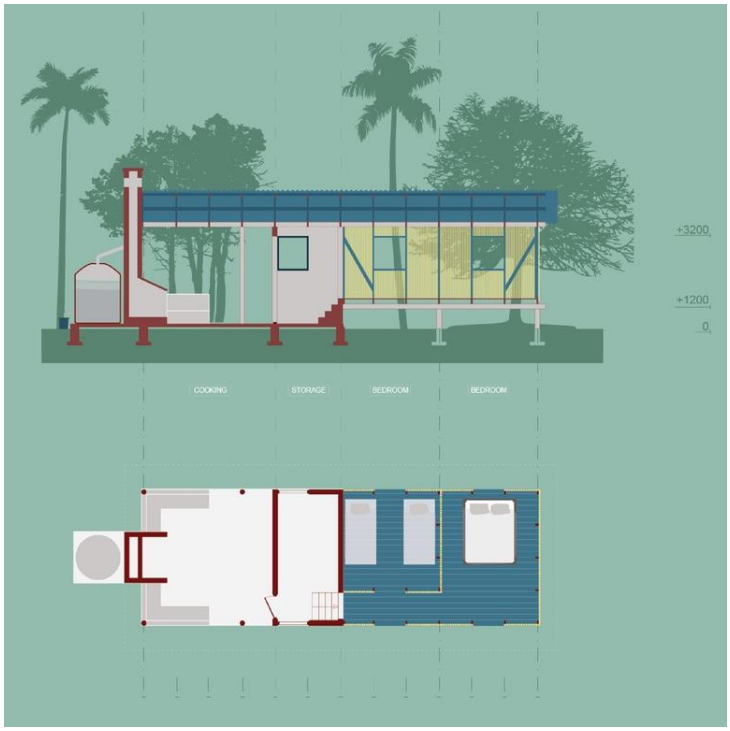

Figure 18: Section and Plan Design of Magoda Project Case Study

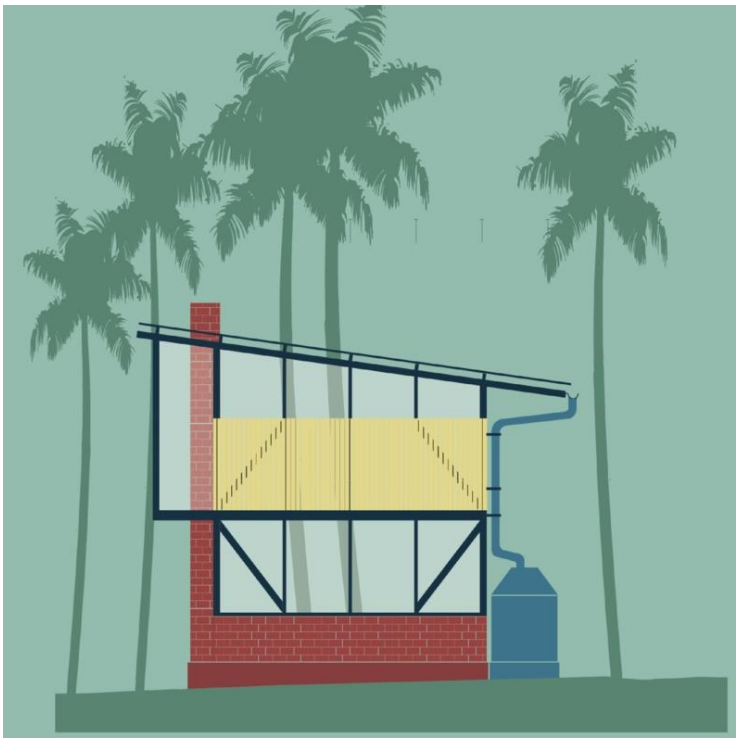
Figure 19: Façade Architectural Design of Magoda Project Case Study

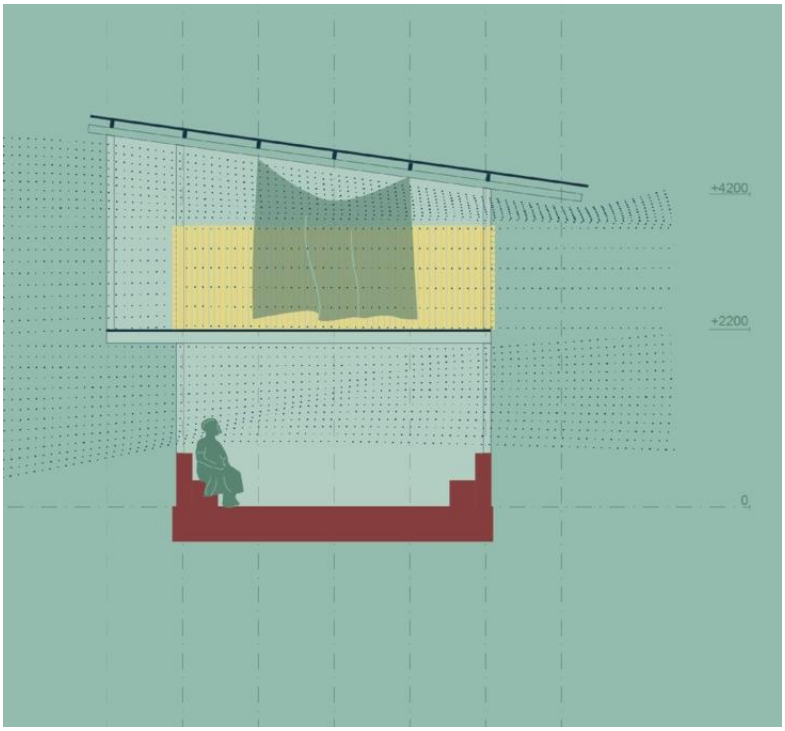

Figure 20: Ventilation Design of Magoda Project Case Study


Figure 21: Façade Design and Material Used in Magoda Project Case Study

Figure 22: First Floor Plan and Section of Magoda Project Case Study

Chapter 4

EXAMINING SUSTAINABLE STRATEGIES IN IRANIAN CASE STUDIES

4.1 Introduction

the study of vernacular design offers invaluable insights into sustainable practices deeply rooted in indigenous cultures. This chapter embarks on an exploration of sustainable architectural strategies within the context of Iranian vernacular architecture. Focusing on case studies that embody rich cultural heritage and ecological mindfulness, this chapter delves into the examination of two distinctive examples: Abyaneh Village's Red Adobe Houses and the vernacular architectural houses of Mehriz.

The architecture of Abyaneh Village stands as a testament to Iran's cultural and historical depth. The vibrant red adobe houses, constructed from locally sourced materials such as red clay and white straw, not only showcase a visually striking aesthetic but also exemplify sustainable construction practices deeply entrenched in the village's heritage. Meanwhile, the vernacular houses in Mehriz present another facet of Iran's architectural prowess, offering a unique perspective on sustainable design principles in response to the region's climatic and cultural demands.

Drawing upon the detailed analysis and insights gathered from these case studies, this chapter aims to evaluate the alignment of these vernacular architectural practices with

the Sustainable Development Goals (SDGs). By dissecting the strategies employed in these architectural forms, ranging from the incorporation of natural elements to the community's adaptive lifestyle, this study seeks to illustrate the convergence between Iran's vernacular architecture and the global agenda of sustainability encapsulated in the SDGs.

Through an in-depth examination of these case studies, this chapter aims to uncover the sustainable architectural strategies embedded within Iran's vernacular architecture. Furthermore, it endeavors to highlight the potential contributions and relevance of these indigenous practices to the broader discourse on sustainable development, thereby underscoring the significance of cultural heritage in shaping environmentally conscious architectural solutions.

4.2 Case Study 3: Vernacular Houses of Mehriz

4.2.1 Overview of Mehriz Vernacular Houses

Mehriz, located in the province of Yazd, Iran, stands as one of the country's desert cities, exhibiting beautiful garden homes attributed to proficient architects. The warm, arid climate of Mehriz and its proximity to the canal networks have led to the creation of residences predominantly constructed along the movement path of these canals. Consequently, these houses possess distinctive attributes that cater to the physical and mental well-being of their occupants.

Architects in this region have intelligently employed specific techniques in creating diverse architectural elements, in some cases, uniquely addressing the comfort and ease of life in the desert. These structures, which have withstood the test of time, have aptly responded to the environmental, cultural, and economic needs of their residents, thus reflecting principles that can embody sustainable architecture.

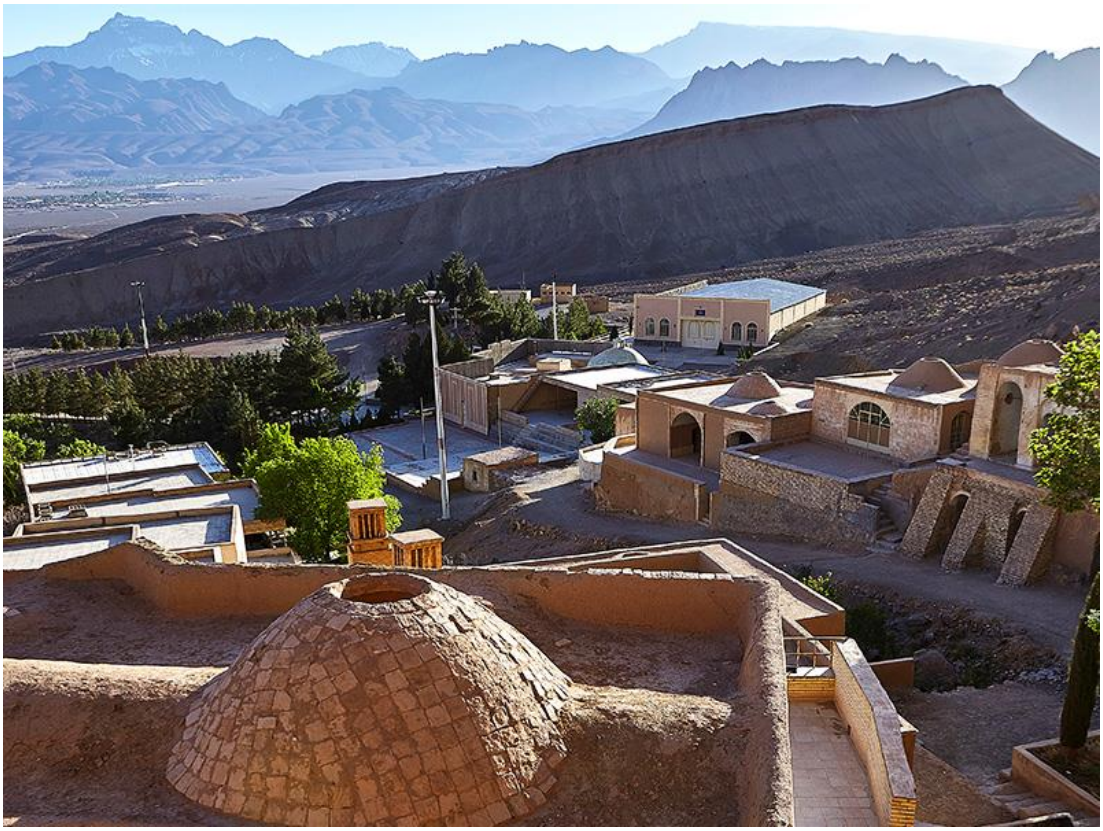

Figure 23: Mehriz Rural Area Perspective

Mehriz City (Figure 23), located in the Yazd Province of the Iranian desert regions, boasts stunning garden homes meticulously designed by adept architects, owing to the presence of qanats in this area. The seasonal residences in this locale, constructed along the course of the qanats, effectively facilitate the well-being of users from both psychological and physical aspects. Architects in this region have ingeniously employed specific techniques in creating various architectural elements, some of which are exceptionally unique, aiming to provide comfort and ease of life in the desert. These structures, remaining intact over time, have admirably catered to the environmental, cultural, and economic needs of inhabitants. Therefore, their governing principles can epitomize the principles of sustainable architecture.

Figure 24: Mehriz Rural Area Perspective

Since the endurance of many deserts vernacular buildings holds substantial cultural (Figure 24), social, economic, and environmental values, these principles can be extrapolated into contemporary architecture, especially in desert homes.

The climate of Mehriz is mountainous and semi-arid, exhibiting a higher degree of moderation compared to Yazd. However, as one moves from north to south and from west to east within this city, rainfall diminishes, and environmental aridity intensifies. Generally, the weather is warm and arid in summers and cold and arid in winters. Low precipitation and relatively low humidity, coupled with a balanced vegetation cover, characterize the climatic conditions of Mehriz.

4.2.2 Buildings Structures Overview of Mehriz Vernacular Houses

In a broad classification, the existing houses in Mehriz can be categorized into introverted and extroverted structures. Introverted houses feature a central courtyard, usually with only one or two sides open as living spaces, while the remaining sides are enclosed by walls. Considering Mehriz's garden city status, notable examples of extroverted (Kushk) houses are present in this city. Kushk houses cater to affluent urban residents and are traditionally used in summer.

This introduction highlights the unique architectural characteristics and regional features of Mehriz, providing a foundational understanding for further exploration in your thesis on vernacular architecture.

4.2.3 Examination of Sustainable Vernacular Buildings of Mehriz Vernacular House Architecture

Exploring Sustainable Patterns in Mehriz Vernacular House Architecture The threefold dimensions of sustainable architecture, encompassing social, environmental, and economic aspects, will be examined within the architecture of vernacular houses in Mehriz. It's important to note that the examined houses include the Za'im House.

Environmental Aspects: Environmental architecture refers to the building's ability to blend environmental and climatic factors, transforming them into spatial qualities, comfort, and a concentrated form. The environmental sustainability in the examined sample focuses on two areas: connection with nature and regional design.

Connection with Nature: An architectural creation from its inception engages with the ground, absorbs water from it, transforms its physical and chemical appearance, and returns it in various measures, interacting with nature. It aligns and benefits from

nature, portraying both compliance and utilization. The use of water in constructing and composing the house's architecture is so intricately intertwined that it's virtually inseparable from the constructed form. This manifestation is prominently observed in the "houdkhaneh" (water reservoir). Water assumes a central role and unity in the architectural depiction of the reservoir, shaping it at the center of the structure. Due to the canal's passage through the house under examination, water primarily enters the reservoir from one side, continuing its path towards the garden from the other side. This continuous flow prevents stagnation. Moreover, the flow of water contributes significantly to cooling the environment and profoundly affects the residents' tranquility. Water's presence in the environment materializes and crystallizes creators' beliefs and perspectives regarding it. It takes on central forms, shaping and being shaped, inviting connection, separation, and serving as a display that embodies and showcases various viewpoints.

The placement of water at the central core of the reservoir has caused various elements of the building to converge around it. The geometry of human presence within space revolves around the central point of the reservoir, which is the very basin itself.

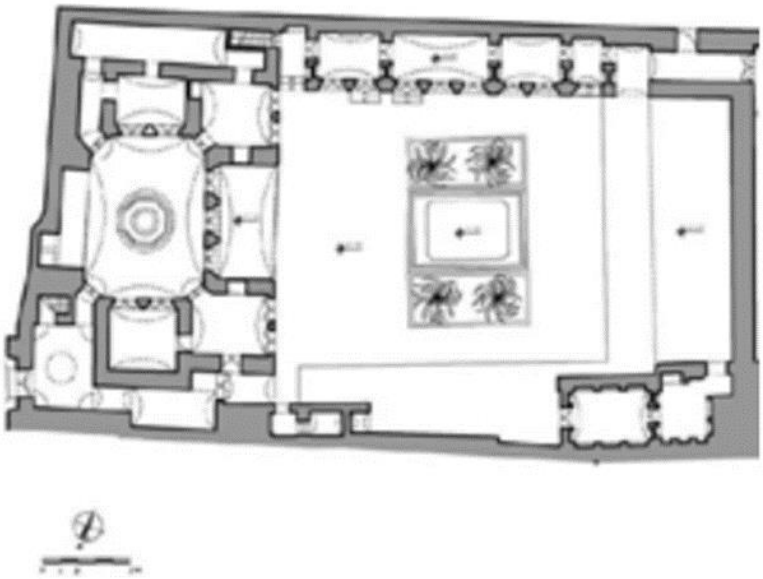

Figure 25: Plan Design Example of Houses in Mehriz Village

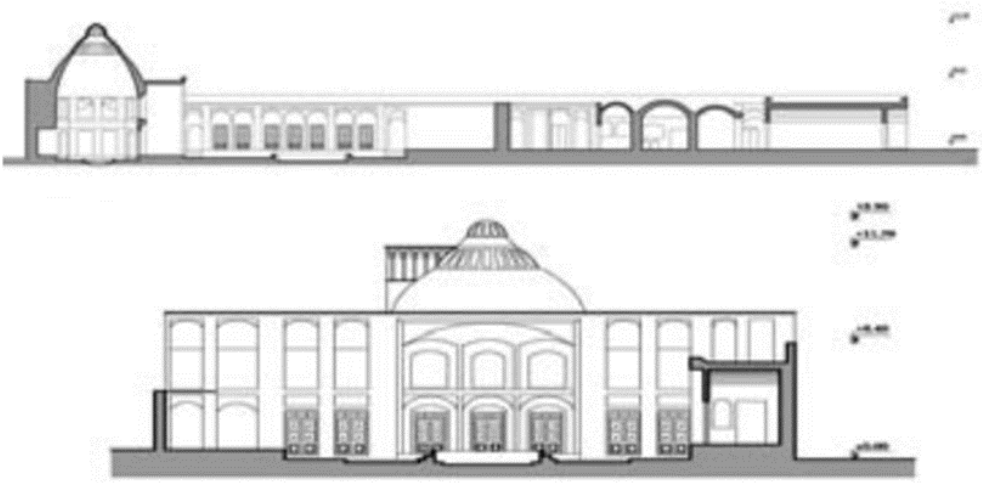

Figure 26: Section and Façade Design Example of Houses in Mehriz Village

The primary source of illumination in the examined house comes from windows or apertures that directly bring light into the environment. However, in the "houdkhaneh" (water reservoir), light manifests in a different manner.

There are two main sources of light in the houdkhaneh: one is a volume of light that emanates from the main hall onto the southwest wall, where the large courtyard

prevents it from spilling onto the southwest facade. The second consists of beams of light that filter through the lattice structure, capturing the interplay of the lattice's twists and turns as the sunlight circulates. Additionally, the presence of wind in the house is further enhanced by the presence of wind-catchers, known as "badgirs."

These elements contribute to the unique lighting conditions within the houdkhaneh, distinguishing it from the conventional sources of natural light in the examined vernacular houses.

Figure 27: Houses and Building Structures in Mehriz Village

Figure 28: Badgir Structure of Vernacular Houses in Mehriz Village

Figure 29: Building Structures and Material usage in Mehriz Village Houses

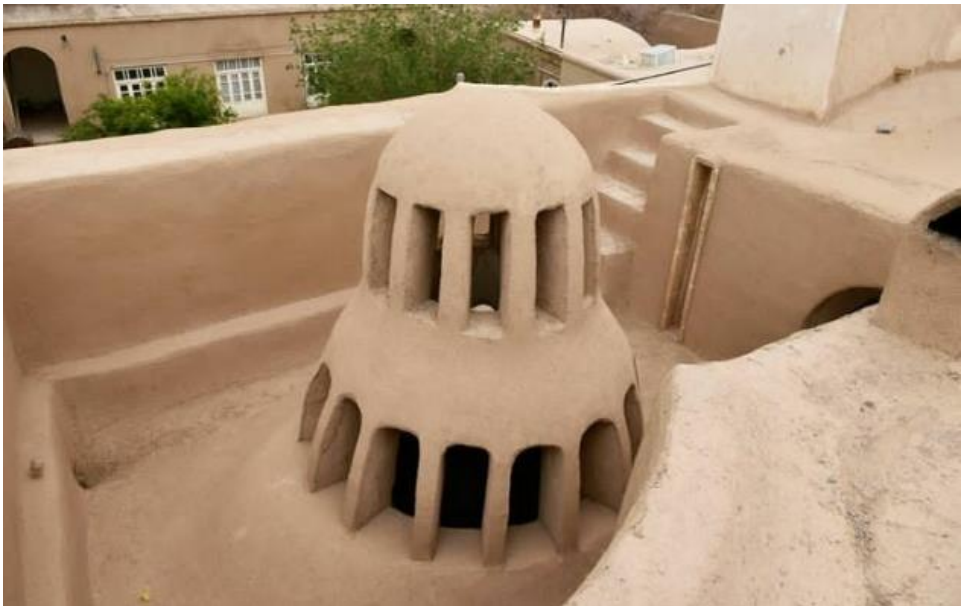

Figure 30: Natural Ventilation Structures of Houses in Mehriz Village

4.2.4 Identification and categorization of vernacular architectural sustainable techniques

These techniques, deeply ingrained in the vernacular architecture of Mehriz, can be classified into several key categories based on their sustainable attributes:

Environmental Adaptation and Integration: This category encompasses techniques that leverage the local environment, climate, and natural resources to create a harmonious living space. It includes aspects like orientation, shading, and natural ventilation, optimizing the building's response to climatic conditions.

Water Management and Utilization: Techniques related to water management play a pivotal role. This category focuses on the integration of water systems, such as qanats, and reservoirs, and the strategic utilization of water in cooling and creating comfortable microclimates within the structures.

Passive Heating and Cooling Strategies: The techniques under this category are designed to regulate interior temperatures without active energy consumption. It

includes methods like thermal mass utilization, insulation, and natural ventilation to maintain comfortable temperatures year-round.

Solar and Light Optimization: Techniques that harness natural light and solar energy efficiently. This involves the strategic placement of openings, apertures, and the use of reflective surfaces to optimize natural lighting while minimizing heat gain.

Integration with Surrounding Landscape: Techniques focusing on seamless integration with the surrounding landscape. This includes principles of site selection, material choices, and landscape features that promote sustainability and adaptation to the natural context.

Cultural Adaptation and Heritage Preservation: Techniques preserving local cultural practices, craftsmanship, and indigenous building methods. This category emphasizes the conservation of heritage while adapting to contemporary needs and sustainable practices.

Material Selection and Resource Efficiency: This category involves the selection of locally sourced, sustainable materials and construction methods that minimize resource consumption and waste generation.

By identifying and categorizing these sustainable techniques, it becomes possible to understand their individual and collective contributions to the overarching principles of sustainability in Mehriz's vernacular architecture. This analysis aids in recognizing and potentially applying these time-tested strategies in contemporary architectural practices for sustainable development.

4.2.5 Evaluation of Sustainable Vernacular building materials and construction techniques

Mehriz, situated in the arid region of Yazd, Iran, exhibits a unique vernacular architecture characterized by garden homes aligned with canal networks. This

evaluation focuses on the building materials and construction techniques used, assessing their advantages, sustainability, and challenges within the context of Mehriz's vernacular architecture.

1. **Vernacular Materials**
    - **Adobe and Clay:**
        - Advantages: Abundant, locally sourced, and possess excellent thermal properties suitable for desert climates.
        - Sustainability: Natural, eco-friendly, and readily available, contributing to thermal regulation.
        - Challenges: Vulnerable to water damage in case of flooding or heavy rainfall.
2. **Modern Materials**
    - **Cement and Concrete:**
        - Advantages: Provides structural strength and versatility, aiding in constructing larger or reinforced sections.
        - Sustainability: Efficient for large-scale construction but less environmentally friendly compared to traditional materials.
        - Challenges: Requires energy-intensive production and may lack compatibility with traditional aesthetics.

- **Evaluation of Construction Techniques**

1. **Traditional Techniques**
    - **Adobe Bricklaying:**
        - Advantages: Effective insulation and suitability for the desert climate.

- Sustainability: Utilizes locally sourced materials and contributes to energy efficiency.
- Challenges: Susceptible to erosion and water damage over time without proper maintenance.

2. **Modern Techniques**
    - **Reinforced Concrete:**
        - Advantages: Offers increased structural stability for larger constructions.
        - Sustainability: May pose challenges concerning thermal regulation and energy efficiency.
        - Challenges: Requires skilled labor and has a higher environmental impact during production.

1. **Material Sustainability**
    - **Advantages:** Traditional materials are eco-friendly, locally available, and contribute to thermal comfort.
    - **Sustainability:** Traditional techniques often align better with ecological sustainability due to their natural sourcing.
    - **Challenges:** Modern materials offer structural benefits but may lack environmental compatibility and energy efficiency.
2. **Technique Sustainability**
    - **Advantages:** Traditional techniques often ensure longevity and adaptability to local conditions.
    - **Sustainability:** Preservation of traditional techniques supports cultural heritage and community identity.

- **Challenges:** Modern techniques might compromise the aesthetic and cultural authenticity of the architecture.

Conclusion

- **Balanced Approach:** Recommended integration of traditional materials and techniques with modern practices to preserve cultural heritage while embracing advancements.
- **Sustainability:** Emphasis on eco-friendly practices, locally sourced materials, and adaptive strategies for sustainable architectural development in Mehriz.

4.2.6 Relevance of Mehriz vernacular houses in relation to SDGs

The relevance of Mehriz's vernacular houses in relation to the Sustainable Development Goals (SDGs) lies in their potential contributions to various SDGs. Here's an analysis of their relevance:

SDG 11: Sustainable Cities and Communities:

Mehriz's vernacular houses exemplify sustainable architectural practices suitable for arid regions. They offer insights into building techniques that promote comfortable living conditions, which align to create sustainable and resilient cities.

SDG 13: Climate Action:

These traditional houses showcase passive cooling and heating techniques, which mitigate the impact of extreme temperatures, contributing to climate resilience. Lessons from these structures can inform modern building designs that reduce energy consumption and greenhouse gas emissions.

SDG 9: Industry, Innovation, and Infrastructure:

The adaptation of traditional techniques in construction and the utilization of locally available materials in Mehriz's houses exemplify innovation and sustainable practices in infrastructure development.

SDG 8: Decent Work and Economic Growth:

Studying the craftsmanship and employment of local artisans in the construction of these houses highlights the potential for economic growth and job creation through traditional building practices and local material sourcing.

SDG 12: Responsible Consumption and Production:

The use of locally sourced and renewable materials in construction aligns with the goal of sustainable consumption and production. These techniques minimize waste generation and promote efficient use of resources.

SDG 7: Affordable and Clean Energy:

Insights from Mehriz's houses can contribute to the development of energy-efficient building designs, reducing reliance on conventional energy sources and promoting clean energy solutions.

SDG 3: Good Health and Well-being:

vernacular architectural techniques that naturally regulate indoor temperature contribute to creating healthier living environments, ensuring the well-being of inhabitants.

By analyzing and understanding the sustainable elements inherent in Mehriz's vernacular houses, lessons can be drawn and applied to contemporary construction practices, contributing to the achievement of multiple SDGs related to sustainable living, climate resilience, and inclusive urban development. The insights garnered from the Magoda project and Volontariat case studies can be compared with the sustainable features present in Mehriz's vernacular architecture, enhancing our understanding of holistic approaches to sustainable development.

Table 11: Analysis of Vernacular Architectural Sustainable Techniques of Mehriz

Analysis of Vernacular Architectural Sustainable Techniques of Mehriz Case Study				
Sustainable Architectural Techniques	**Sustainable Vernacular Construction/ Material**	**Sustainable Criteria**	**Socio-Cultural Values**	**Sustainable Development Goal**
Natural Ventilation and Thermal Comfort: Use of architectural elements for optimizing airflow. Incorporation of lattice structures for capturing and filtering sunlight. **Solar and Light Optimization:** Harnessing natural light through strategic placement of openings and lattice structures. Optimization of sunlight for unique lighting conditions in the "houdkhaneh." **Environmental Adaptation and Integration:** Orientation of buildings to respond to climatic conditions. Integration with the landscape and climate for harmonious living. **Water Management and Utilization:** Integration of water systems like qanats and reservoirs. Strategic utilization of water for cooling and creating comfortable microclimates. **Passive Heating and Cooling Strategies:** Utilization of thermal mass, insulation, and natural ventilation for temperature regulation. Techniques designed to maintain comfortable temperatures without **active energy consumption.** **Cultural Adaptation and Heritage Preservation:** Preservation of indigenous building methods. Emphasis on cultural values in the design and construction.	**Use of Vernacular Materials:** Adobe and clay for their thermal properties in a desert climate. Locally sourced materials for sustainability. **Traditional Techniques:** Adobe bricklaying for effective insulation. Traditional techniques for architectural longevity and adaptability. **Balanced Approach with Modern Materials:** Consideration of modern materials for structural benefits. Emphasis on the compatibility of modern materials with traditional aesthetics.	**Environmental Sustainability:** Leveraging local environment, climate, and resources for harmonious living. Sustainable water management and passive heating/cooling strategies. **Cultural Sustainability:** Preservation of indigenous building methods. Integration with local cultural values and heritage. **Resource Efficiency:** Use of locally sourced, sustainable materials. Techniques that minimize resource consumption and waste generation.	**Community Engagement:** Involvement of local communities in construction processes. Preservation of traditional craftsmanship and knowledge. **Cultural Identity:** Adherence to cultural values and practices in construction. Integration with the local context for cultural sustainability.	**SDG 11: Sustainable Cities and Communities:** Contribution to sustainable and resilient urban development. **SDG 13: Climate Action:** Mitigation of climate impact through passive cooling/heating strategies. **SDG 9: Industry, Innovation, and Infrastructure:** Display of innovation and sustainable practices in vernacular construction. **SDG 8: Decent Work and Economic Growth:** Economic growth through local craftsmanship and employment. **SDG 12: Responsible Consumption and Production:** Use of locally sourced and renewable materials for sustainable consumption. **SDG 7: Affordable and Clean Energy:** Potential for contributing to energy-efficient building designs. **SDG 3: Good Health and Well-being:** Contribution to healthier living environments through natural temperature regulation.

4.3 Case study 4: Abyaneh Village's Red Adobe Houses:

The red adobe houses in Abyaneh village, located in Isfahan Province, exemplify sustainable architectural techniques. Constructed from locally available clay and straw, these houses provide excellent insulation against extreme temperatures, showcasing energy-efficient building practices. The materials used are eco-friendly and contribute to carbon sequestration. Additionally, the village's architecture harmonizes with the surrounding landscape, maintaining a balance between human habitation and nature, promoting biodiversity and preservation of natural resources.

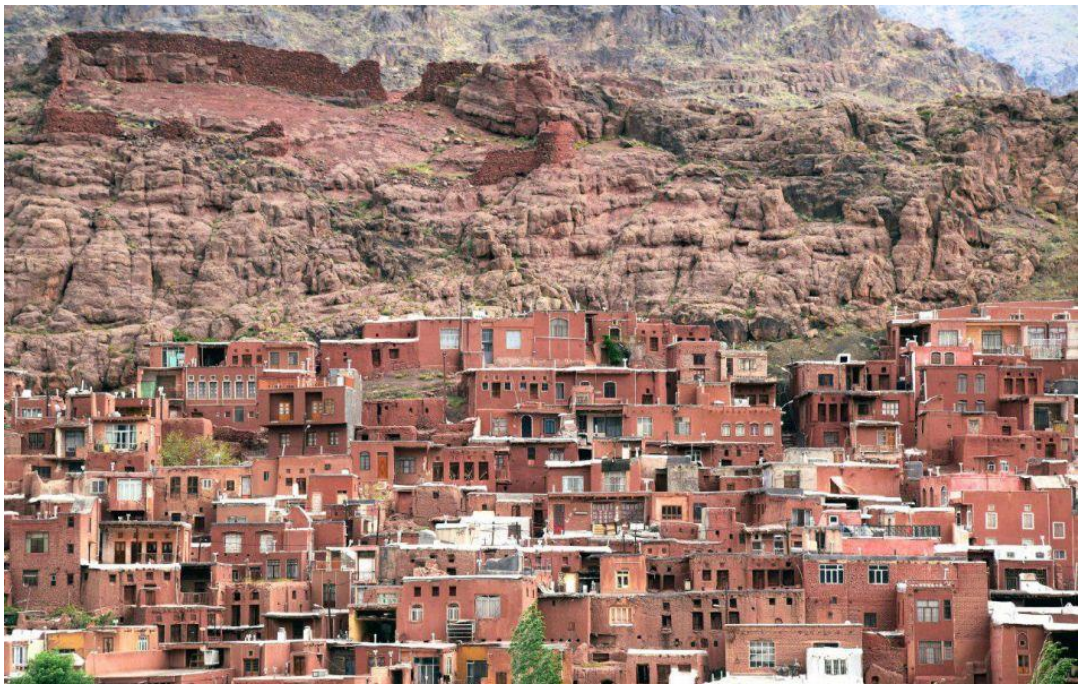

Figure 31: An Overview of Abyaneh Village

4.3.1 An Overview of Abyaneh Vernacular Architecture

The village is linearly structured along the banks of the Barzrud River and takes shape on a steep slope. Abyaneh's location on the mountain slope gives it a semi-staircase structure, creating a multi-story appearance when observed from a distance. From certain angles, one can even discern up to four stories within the village. The flow of

seasonal floods in the valley bed and the mountain torrents surrounding the village significantly influenced its formation. The houses on the northern slope of the valley follow the physical form of the hills.

Abyaneh possesses unique characteristics due to its mountainous setting, among which include:

- Protection against strong winds plays a pivotal role in preserving structures against lateral pressures and managing temperatures.
- Non-absorption of surface water due to stony or clayey soil facilitates water flow in the riverbed for agricultural purposes.
- Construction of two to three-story buildings offering magnificent vistas from the second floor upwards. Sunlight exposure and airflow aid in ventilating and cooling the internal spaces of these structures.

Historically, Abyaneh had two entry gates: the pilgrimage gate in the west, near the current location of the bank, and the "Havdah" gate in the eastern entry of the village's "Havdah" district. Access to the village was solely through these gates, but nowadays, entry can be made from various directions.

Insufficient space for house construction on steep slopes has led each Abyaneh family to maintain a cave-like storage space about a kilometer away from the village, near the road. These serve as winter barns and storage areas for non-essential items, characterized by their small and confined doors. The houses of Gholam Nader Shah and Na'ib Hossein Kashani are considered among Abyaneh's ancient houses, representing significant heritage for the village.

Figure 32: An Overview of Abyaneh Vernacular Houses

Figure 33: An Overview of Abyaneh Vernacular Houses

4.3.2 Building Structure Overview of Abyaneh Vernacular Houses

The Vernacular architecture of Abyaneh, Iran, embodies several key features and building structures that reflect both Vernacular and sustainable Architecture principles:

- **Construction Materials:**

Primarily built with adobe (Khesht) and local stones, offering natural insulation against varying temperatures.

- **Design Elements:**

Includes flat roofs for additional living space, ventilation shafts (Badgirs) for regulating indoor temperature, and ornate wooden balconies (Orsi) for both functionality and aesthetics.

- **Layout and Orientation:**

Houses are compactly clustered, creating interconnected alleys. Most houses are oriented north-south to maximize sunlight and minimize exposure to harsh winds.

- **Spatial Features:**

Houses have separate spaces for summer and winter use and central open courtyards (Hayat) for natural light and ventilation.

- **Decorative Elements:**

Vibrant colors, particularly red hues, and intricate patterns adorn walls, doors, and ceilings, representing cultural significance.

- **Environmental Adaptations:**

Thick adobe walls provide thermal mass, regulating indoor temperatures. The construction materials and design offer natural insulation against extreme weather conditions.

- **Sustainable Features:**

Traditional water reservoirs (Ab-Anbar) and underground cisterns for water storage and conservation. Architectural elements like ventilation shafts and courtyards facilitate passive cooling, reducing reliance on mechanical systems.

Overall, Abyaneh's vernacular architecture showcases a fusion of vernacular and sustainable architectural elements, emphasizing sustainability, adaptation to local climates, and the use of natural resources. These features offer valuable insights for modern green architectural designs by highlighting the significance of vernacular practices in creating environmentally friendly structures.

4.3.3 Examination of Sustainable vernacular Techniques in Abyaneh Vernacular Houses

1. **Local Materials Usage:**
    - Abyaneh's houses predominantly utilize locally sourced materials like adobe (Khesht) and stone. These materials offer natural insulation, minimizing the need for artificial heating or cooling systems.
2. **Passive Cooling and Heating Systems:**
    - The thick adobe walls act as thermal mass, absorbing heat during the day and releasing it at night, maintaining comfortable indoor temperatures.
    - Ventilation shafts (Badgirs) channel airflow, promoting natural ventilation and cooling within the houses.
3. **Optimal Orientation and Layout:**
    - Houses are oriented north-south to maximize sunlight exposure during winters while minimizing direct sunlight during summers, aiding in temperature regulation.
    - Compact clustering of houses creates narrow, interconnected streets, offering shade and reducing direct sunlight exposure.

4. **Functional Design Elements:**
    - The use of flat roofs provides additional living space while serving as a passive heat sink or gathering space.
    - Open courtyards (Hayat) encourage natural light penetration and air circulation within the house, reducing reliance on artificial lighting and cooling systems.
5. **Water Conservation Techniques:**
    - Traditional water reservoirs (Ab-Anbar) and underground cisterns are used for rainwater harvesting and storage, ensuring water availability during dry periods.
6. **Cultural and Sustainable Integration:**
    - The incorporation of traditional decorative elements using vibrant colors and patterns reflects cultural heritage while utilizing locally available materials, merging aesthetics with sustainability.
7. **Adaptation to Local Climate:**
    - The architecture is adapted to the harsh climate conditions of the region, showcasing how the structures are resilient and sustainable within the context of their environment.

In conclusion, the sustainable techniques observed in Abyaneh's vernacular houses architecture emphasize the integration of vernacular strategies, local materials, and environmentally conscious design principles. These sustainable elements offer valuable insights for contemporary architectural practices, highlighting the importance of utilizing vernacular knowledge to create environmentally friendly and culturally relevant structures.

4.3.4 Identification and Categorization of Vernacular Architectural Sustainable Techniques

Abyaneh's vernacular architecture embodies a harmonious fusion of culture, environment, and functionality, showcasing an array of time-honored techniques meticulously crafted to adapt to the region's climatic nuances while preserving the area's rich cultural identity. This study aims to unravel the vernacular sustainable methodologies employed in these structures, offering insights into their relevance in contemporary sustainable architectural practices.

By systematically examining and categorizing the sustainable techniques prevalent in Abyaneh's vernacular houses, this study endeavors to shed light on their intrinsic connection to the environment, community, and cultural heritage. Through this exploration, we seek to showcase the enduring wisdom embedded in Abyaneh's architectural legacy, providing a roadmap for integrating these time-tested sustainable principles into modern architectural discourse.

Table 12: Analysis of Vernacular Architectural Sustainable Techniques of Mehriz

vernacular architectural sustainable techniques	Material Selection and Sourcing	Local Sourcing	The use of indigenous materials such as adobe (Khesht) and stone provide natural insulation, aiding in temperature regulation and reducing reliance on mechanical heating and cooling systems.
		Sustainable Sourcing	Utilization of materials harvested sustainably from the local environment minimizes ecological impact.
	Passive Design Strategies	Thermal Mass	The thick adobe walls and stone structures act as thermal mass, absorbing heat during the day and releasing it at night, contributing to natural temperature regulation.
		Ventilation Systems (Badgirs)	Wind towers or ventilation shafts facilitate passive cooling by directing airflow, enhancing natural ventilation within the buildings.
	Design and Orientation	Optimal Building Orientation	Houses are aligned in a north-south direction to maximize sunlight in winter and reduce direct exposure in summer, enhancing energy efficiency.
		Compact Urban Layout	Dense clustering of houses creates narrow streets and alleys that provide shade, minimizing direct sunlight exposure.
	Functional Elements	Courtyards (Hayat)	Open courtyards encourage natural light penetration and air circulation, reducing reliance on artificial lighting and cooling systems
		Flat Roofs	Flat roofs offer additional living space and can serve as gathering areas while contributing as passive heat sinks.
	Water Management	Rainwater Harvesting	Traditional water reservoirs (Ab-Anbar) and underground cisterns collect and store rainwater for domestic use, supporting water conservation practices
		Efficient Water Use	Design features and systems for efficient water consumption and reuse within the households.
	Cultural Integration	Decorative Elements	The incorporation of local decorative elements and vibrant colors reflects cultural heritage while using natural materials and local craftsmanship.
	Adaptation to Climate	Climate Resilience	Architectural features are designed to withstand and adapt to the region's harsh climate conditions, showcasing resilience and sustainability within the local context.
	Community Participation and Knowledge Transfer:	Inter-generational Knowledge Sharing	Traditional building techniques are passed down through generations, fostering community involvement and preserving sustainable practices.

4.3.5 Evaluation of Sustainable Vernacular Building Material and Construction Techniques

4.3.5.1 Materials Evaluation:

- **Adobe (Khesht):**

Advantages: The use of adobe offers excellent thermal insulation, utilizing locally available earth, straw, and water, reducing the need for mechanical heating or cooling.

Sustainability: Adobe is an eco-friendly material, employing natural resources without causing significant environmental harm.

Challenges: Vulnerable to moisture and erosion, necessitating periodic maintenance.

- **Stone**:

Advantages: Stone provides durability, strength, and acts as thermal mass, aiding in temperature regulation.

Sustainability: Locally sourced stone minimizes transportation emissions and supports the regional economy.

Challenges: Requires skilled craftsmanship and can be labor-intensive.

- **Timber and Mud Brick:**

Advantages: Timber is used for structural elements, while mud bricks offer flexibility in construction.

Sustainability: Timber from local forests and mud bricks from on-site earth contribute to sustainable practices.

Challenges: Susceptible to decay and pests, necessitating periodic maintenance.

4.3.5.2 Construction Techniques :

- **Adobe Construction :**

Advantages: Utilizes simple construction methods requiring local labor and skills, fostering community involvement.

Sustainability: Low carbon footprint and minimal energy consumption during production and construction.

Challenges: Requires regular upkeep due to susceptibility to erosion and weathering.

- **Stone Masonry:**

Advantages: Stone masonry techniques demonstrate excellent craftsmanship and durability.

Sustainability: Use of local stone minimizes environmental impact and supports traditional skills.

Challenges: Labor-intensive and requires specialized skills.

- **Traditional Joinery:**

Advantages: Interlocking joints and traditional joinery techniques enhance structural integrity.

Sustainability: Reduces reliance on modern construction adhesives and techniques, minimizing environmental impact.

Challenges: Time-consuming and requires skilled craftsmanship.

- **Overall Evaluation:**

Abyaneh's vernacular architecture showcases a commendable use of locally sourced materials and traditional construction techniques that align with the region's environmental conditions. The integration of adobe, stone, timber, and mud bricks reflects a sustainable approach, emphasizing energy efficiency and reduced environmental impact. However, challenges such as maintenance, susceptibility to weathering, and the need for skilled labor remain critical aspects that need consideration for the preservation and adaptation of these techniques in contemporary construction practices

Table 13: Analysis of Vernacular Architectural Sustainable Techniques of Abyaneh

Analysis of Vernacular Architectural Sustainable Technique of Abyaneh Case Study				
Sustainable Architectural Techniques	**Sustainable Vernacular Construction/ Material Techniques**	**Sustainable Criteria**	**Socio-Cultural Values**	**Sustainable Development Goal**
Natural Ventilation and Thermal Comfort: Integration of architectural elements for optimizing airflow. Incorporation of lattice structures for capturing and filtering sunlight. **Solar and Light Optimization:** Harnessing natural light through strategic placement of openings and lattice structures. Optimization of sunlight for unique lighting conditions. **Environmental Adaptation and Integration:** Orientation of buildings to respond to climatic conditions. Integration with the landscape and climate for harmonious living. **Water Management and Utilization:** Integration of water systems like qanats and reservoirs. Strategic utilization of water for cooling and creating comfortable microclimates. **Passive Heating and Cooling Strategies:** Utilization of thermal mass, insulation, and natural ventilation for temperature regulation. Techniques designed to maintain comfortable temperatures without active energy consumption. **Cultural Adaptation and Heritage Preservation:** Preservation of indigenous building methods. Emphasis on cultural values in the design and construction.	**Local Materials Usage:** Utilization of indigenous materials like adobe and stone for natural insulation. **Passive Design Strategies:** Use of locally sourced materials for sustainability. Traditional techniques like adobe bricklaying for effective insulation. **Design and Orientation:** Compact clustering of houses for efficient land use. Orientation of houses to maximize sunlight exposure. **Functional Design Elements:** Use of flat roofs for additional living space. Open courtyards for natural light penetration and air circulation. **Water Conservation Techniques:** Traditional water reservoirs (Ab-Anbar) and underground cisterns for rainwater harvesting. **Cultural and Sustainable Integration:** Incorporation of vibrant colors and patterns reflecting cultural heritage. Adaptation of traditional decorative elements using locally available materials.	**Environmental Sustainability:** Integration with the local environment and climate. Use of vernacular techniques that mitigate environmental impact. **Cultural Sustainability:** Preservation of indigenous building methods. Integration with local cultural values and **practices.** **Resource Efficiency:** Use of locally sourced, sustainable materials. Techniques that minimize resource consumption and waste generation.	**Community Engagement:** Involvement of local communities in construction processes. Preservation of traditional craftsmanship and knowledge. **Cultural Identity:** Adherence to cultural values and practices in construction. Integration with the local context for cultural sustainability.	**SDG 11: Sustainable Cities and Communities:** Contribution to sustainable and resilient urban development. Traditional construction methods fostering community involvement and cultural heritage. **SDG 7: Affordable and Clean Energy:** Design demonstrating efficient thermal insulation for energy efficiency. Use of natural materials contributing to sustainable energy practices. **SDG 13: Climate Action:** Architecture adapting to local climate conditions for climate resilience. Mitigation of environmental impacts through sustainable design elements. **SDG 12: Responsible Consumption and Production:** Emphasis on the use of locally sourced and renewable materials. Traditional construction techniques involve minimal waste. **SDG 9: Industry, Innovation, and Infrastructure:** Preservation and study of vernacular architecture fostering innovation. Potential inspiration for modern sustainable construction practices.

4.3.6 Relevance of Abyaneh Vernacular Houses in Relation to SDGs

The vernacular houses in Abyaneh exhibit various characteristics that align with the Sustainable Development Goals (SDGs) outlined by the United Nations. Here's how Abyaneh's vernacular architecture relates to some of these SDGs:

SDG 11: Sustainable Cities and Communities

Abyaneh's architecture showcases sustainable building techniques that utilize locally available materials, contributing to the creation of resilient and sustainable cities and communities. Traditional construction methods foster community involvement and knowledge sharing, promoting cultural heritage and a sense of belonging.

SDG 7: Affordable and Clean Energy

The design of Abyaneh's houses demonstrates efficient thermal insulation, reducing the need for external heating or cooling, and thereby promoting energy efficiency.

The use of natural materials like adobe helps in maintaining comfortable indoor temperatures without excessive energy consumption.

SDG 13: Climate Action

Abyaneh's architecture adapts to local climate conditions, showcasing sustainable design elements that naturally regulate temperatures and reduce reliance on energy-intensive systems. These houses illustrate how traditional architecture can respond to climate challenges, promoting climate resilience and mitigating environmental impacts.

SDG 12: Responsible Consumption and Production

Vernacular architecture in Abyaneh emphasizes the use of locally sourced and renewable materials, reducing the environmental footprint associated with construction and supporting sustainable production practices.

Traditional construction techniques often involve minimal waste and demonstrate efficient use of resources, aligning with responsible consumption practices.

SDG 9: Industry, Innovation, and Infrastructure

The preservation and study of Abyaneh's vernacular architecture offer insights into traditional building methods, fostering innovation and potentially inspiring modern sustainable construction practices.

These traditional techniques can contribute to the development of innovative, environmentally friendly construction approaches that are in harmony with nature.

By preserving and learning from the sustainable practices evident in Abyaneh's vernacular houses, there's an opportunity to leverage this knowledge to address contemporary challenges outlined in the SDGs, promoting sustainability, resilience, and community well-being.

Figure 34: Abyaneh Buildings Materials and Structure Overview

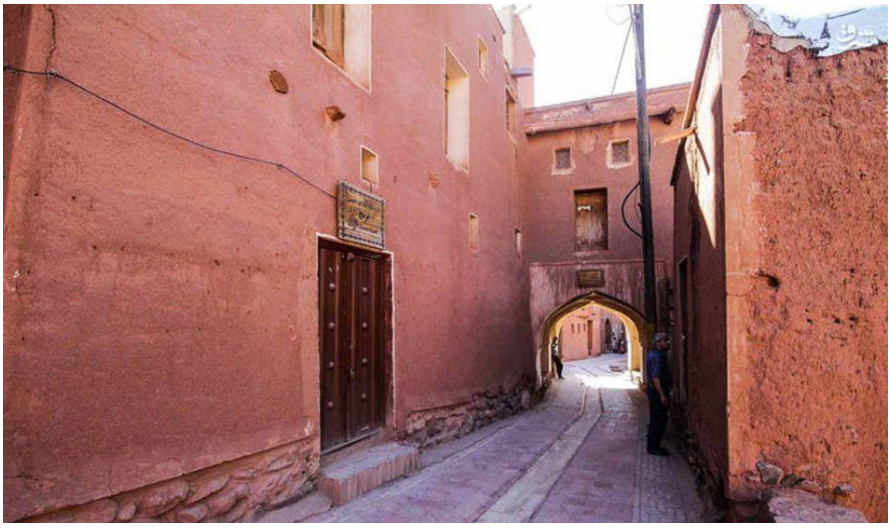

Figure 35: Abyaneh Buildings Materials and Structure Overview

Figure 36: Abyaneh Buildings Materials and Structure Overview

4.4 Summary

The study of vernacular architecture in Iran, particularly in Mehriz and Abyaneh, provides valuable insights into the alignment of these architectural practices with the 17 Sustainable Development Goals (SDGs). The vernacular architecture in Iran reflects a harmonious integration with its natural environment, cultural values, and socio-economic context.

4.4.1 Alignment with SDGs

SDG 11: Sustainable Cities and Communities: Iranian vernacular architecture, as seen in Mehriz and Abyaneh, contributes to sustainable and resilient urban development. It emphasizes local materials, cultural identity, and community engagement.

SDG 7: Affordable and Clean Energy: Techniques like natural ventilation, passive heating/cooling, and efficient use of resources in vernacular architecture contribute to energy efficiency and align with the goal of clean energy.

SDG 13: Climate Action: The design elements and construction techniques in Iranian vernacular architecture showcase adaptation to local climate conditions, promoting climate resilience and mitigating environmental impacts.

SDG 12: Responsible Consumption and Production: The use of locally sourced, sustainable materials and traditional construction techniques aligns with responsible consumption and production practices, minimizing environmental impact.

Relevant Sustainable Techniques

Local Materials Usage: Both Mehriz and Abyaneh emphasize the use of indigenous materials like adobe and stone, providing natural insulation and minimizing the environmental footprint.

Passive Design Strategies: Techniques such as thermal mass utilization, natural ventilation, and optimal orientation contribute to energy-efficient and sustainable designs.

Cultural Integration: Preservation of indigenous building methods and incorporation of cultural values in design elements reflect a sustainable approach rooted in local context.

4.4.2 Deriving Sustainable Techniques from Rural Context

Deriving Sustainable Techniques from Rural Context: Case Studies of Mehriz and Abyaneh Vernacular Architecture

Mehriz Vernacular Architecture

Mehriz, situated in the desert region of Iran, showcases sustainable techniques within its vernacular architecture that are deeply rooted in the rural context.

1. Adobe and Clay Utilization

Local Material Sourcing: Abundant clay resources utilized in adobe construction, minimizing transportation.

Thermal Regulation: Efficient insulation against desert heat due to clay's natural properties.

Sustainability: Low carbon footprint and environmentally friendly.

2. Earth and Stone Construction

Durability and Stability: Stone foundations and earth walls offer long-term structural strength.

Thermal Mass: Excellent for retaining heat during cooler desert nights.

Cultural Identity: Reflects local heritage and traditional building practices.

3. Utilization of Natural Elements

Water Management: Incorporates qanats and water reservoirs for cooling and life sustainability.

Natural Lighting and Ventilation: Employing wind-catchers (badgirs) and strategic window placements for ventilation and illumination.

Abyaneh Vernacular Architecture

Abyaneh, an ancient village in Iran's mountainous region, showcases sustainable practices ingrained in its rural context.

1. Utilization of Local Materials

Straw and Timber Roofing: Traditional roofing materials for insulation and temperature regulation.

Stone Foundations: Stability and longevity through locally sourced stone.

2. Thermal Adaptation

Building Orientation: Structures oriented to optimize natural light and heat gain/loss.

Terraced Construction: Houses built in terraced layers to adapt to mountainous terrain and climate.

3. Cultural Significance

Preservation of Tradition: Retention of traditional building techniques and architectural aesthetics.

Community Engagement: Collective efforts in maintaining and preserving cultural heritage.

4.4.3 Deriving Sustainable Techniques

1. Material Adaptation and Local Sourcing

Local Materials: Emphasis on using materials abundant in the region to reduce environmental impact.

Traditional Techniques: Leveraging time-tested construction methods aligned with local resources.

2. Climate-Responsive Design

Thermal Comfort: Employing design strategies for natural temperature regulation and energy efficiency.

Natural Elements Integration: Incorporating water management, natural lighting, and ventilation systems.

3. Cultural Preservation and Community Involvement

Cultural Conservation: Balancing modern advancements with preservation of cultural identity.

Community Participation: Engaging locals in sustainable practices for mutual benefit and heritage conservation.

The vernacular architecture of Mehriz and Abyaneh exemplifies how rural contexts foster sustainable techniques. Deriving from these case studies, integrating local materials, climate-responsive design, cultural preservation, and community involvement can serve as a blueprint for sustainable architecture rooted in rural contexts, preserving heritage while addressing modern sustainability challenges.

1. **Addressing Socio-Cultural Challenges:**
    - Community Engagement: Vernacular architecture inherently involves community participation, preserving traditional craftsmanship, and fostering knowledge sharing. This addresses socio-cultural challenges by involving locals in the construction process.
    - Cultural Identity: By adhering to cultural values in construction, vernacular architecture ensures that development aligns with local identity, fostering a sense of belonging and preventing cultural erosion.

4.4.4 Recommendations:

1. **Strategies for Preserving Cultural Values:**
    - Encourage community-led initiatives that involve locals in decision-making processes related to architectural developments.
    - Establish guidelines and policies that prioritize the preservation of cultural elements in construction practices.
2. **Sustainable Development and Vernacular Architecture:**
    - Integrate vernacular architectural techniques into modern sustainable development practices, emphasizing the use of local materials and traditional construction methods.
    - Develop educational programs to promote awareness about the environmental and cultural significance of vernacular architecture.
3. **Cross-Cultural Learning:**
    - Facilitate knowledge exchange between different vernacular architectural practices globally, such as the Iranian case studies, Volontariat, and Magoda Project. Cross-cultural learning can inform more holistic and inclusive sustainable development strategies.
4. **Addressing Socio-Economic Needs:**
    - Implement strategies that balance economic development with cultural preservation, ensuring that the benefits of development are distributed equitably among the community.
    - Explore innovative funding mechanisms that support sustainable architectural projects in rural areas.

Comparison with Volontariat and Magoda Project:

- **Similarities**:

- All case studies emphasize the importance of cultural identity in architectural practices.
- Sustainable techniques such as the use of local materials, community engagement, and adaptation to local climate conditions are common across the studies.

- **Differences:**
  - While Iranian vernacular architecture heavily relies on traditional materials like adobe and stone, Volontariat and Magoda Project may incorporate a broader range of materials due to regional variations.
  - Socio-cultural challenges in achieving SDGs might differ; for instance, the challenges faced by Iranian villages may differ from those in African contexts.

Overall, these case studies collectively underscore the importance of integrating vernacular architecture into the global discourse on sustainable development, recognizing its potential to address socio-cultural, economic, and environmental challenges.

Chapter 5

CONCLUSION

In the face of escalating global challenges related to rapid urbanization, environmental degradation, economic inequalities, and socio-cultural disruptions, this research delved into the underutilized yet invaluable resource of vernacular architecture. Rooted in local traditions, materials, and cultural practices, vernacular architecture presents a unique avenue for addressing contemporary sustainability challenges. The specific focus was on the Iranian context, where a rich history of vernacular architectural styles faces the risk of erosion in the wake of modernization and globalization.

The collision between modern development aspirations and the preservation of cultural heritage poses a substantial threat to traditional architecture. This is particularly critical given the urgent need to align sustainable development initiatives, encapsulated in the 17 Sustainable Development Goals (SDGs), with culturally sensitive solutions. The erosion of traditional building practices driven by the widespread adoption of standardized construction methods exacerbates the challenge.

The study illuminated the multifaceted relationship between vernacular architecture and the 17 SDGs. It identified sustainable techniques from rural contexts that align with and contribute to vernacular architecture, showcasing a potential bridge between tradition and contemporary sustainability. The examination of global rural housing

case studies, especially in Iran, unveiled socio-cultural challenges and highlighted the pivotal role of vernacular architecture in addressing these challenges.

This research contributes valuable insights to the integration of Sustainable Development Goals into architectural practices, emphasizing culturally sensitive and sustainable solutions. The proposed sustainable techniques aim to preserve and promote cultural values while meeting social and economic needs in rural context. The findings not only enrich the understanding of sustainable architecture but also provide a foundation for potentially inspiring sustainable practices globally.

While this research sheds light on the potential of vernacular architecture in sustainable development, it acknowledges certain limitations. The scope was primarily focused on Iran, and future research could expand the geographic scope for a more comprehensive understanding. Additionally, ongoing exploration of innovative sustainable techniques and continuous engagement with local communities are recommended for sustained impact.

In conclusion, this research serves as a step toward bridging the gap between traditional knowledge and contemporary sustainable practices. By unraveling the intricate relationship between vernacular architecture and the SDGs, it provides a roadmap for architects, policymakers, and communities to craft strategies that address contemporary challenges while safeguarding and revitalizing traditional building practices. Ultimately, the integration of vernacular architecture into sustainable development practices holds the potential to contribute to a more holistic and culturally sensitive approach to sustainable development in Iran and beyond.

How does vernacular architecture in Iran align with the 17 SDGs?

Vernacular architecture in Iran exhibits alignment with several Sustainable Development Goals (SDGs). For instance, the use of locally-sourced and eco-friendly materials contributes to SDG 12 (Responsible Consumption and Production). The emphasis on energy-efficient designs and natural ventilation supports SDG 7 (Affordable and Clean Energy). Additionally, the preservation of cultural heritage within vernacular architecture corresponds to SDG 11 (Sustainable Cities and Communities). Overall, the sustainable and community-focused aspects of vernacular architecture in Iran contribute to a range of SDGs related to environmental sustainability, cultural preservation, and community well-being.

What sustainable techniques derived from rural contexts are relevant to vernacular architecture?

Sustainable techniques derived from rural contexts that are relevant to vernacular architecture include:

1. **Natural Materials:** The use of locally sourced, natural materials that are abundant in rural areas.
2. **Passive Design:** Incorporating design elements that utilize natural resources, such as sunlight and wind, to reduce energy consumption.
3. **Water Harvesting:** Designing structures to capture and utilize rainwater for various purposes.
4. **Integration with Landscape:** Ensuring that architectural designs harmonize with the natural surroundings.
5. **Adaptation to Climate:** Designing structures that respond to the specific climatic conditions of the region.

How can socio-cultural challenges in achieving SDGs be addressed through vernacular architecture?

Vernacular architecture, deeply rooted in local cultures, can address socio-cultural challenges in achieving SDGs in the following ways:

1. **Community Engagement:** Involving local communities in the design and construction process fosters a sense of ownership and addresses cultural considerations.
2. **Preservation of Identity:** Incorporating cultural elements in architecture helps preserve local identity and traditions.
3. **Social Inclusivity:** Designing spaces that promote social interaction and inclusivity, addressing challenges related to community well-being.
4. **Education and Awareness:** Integrating educational components within architectural designs to promote sustainable practices and awareness among communities.

What strategies preserve cultural values while fulfilling social and economic needs in rural areas?

Preserving cultural values while fulfilling social and economic needs involves:

1. **Cultural Sensitivity in Design:** Integrating architectural elements that reflect local traditions and cultural aesthetics.
2. **Inclusive Development:** Ensuring that economic development initiatives include and benefit the local community.
3. **Skill Empowerment:** Supporting local craftsmanship and traditional skills to enhance economic opportunities.

4. **Heritage Conservation:** Incorporating strategies to conserve and showcase cultural heritage within architectural designs.
5. **Balancing Modernity and Tradition:** Striking a balance between modern amenities and preserving traditional ways of life.

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APPENDIX

List of Local Terminology

1	Badgir	Wind Catcher
2	Hayat	Courtyard
3	Eivan	Semi-Closed Space that is Blocked on Three Sides with an Opening to the 4th Side that is Located on the Edge of the Courtyard
4	Seh Dari Room	Seh Dari Room
5	Hashti	Entrance, Vestibule
6	Talar	Balcony, Semi Open Space which is in South Part of Courtyard
7	Godal-Baghcheh	Deep yard Located at the Center of the Main Courtyard of the House. Its Depth Usually One Story
8	Shabestan &Sardab	Basement Spaces which are Equipped with Small Pool in the Middle