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A Value-based Assessment and Intervention Framework for ***Dikengyuan*** as Subterranean Vernacular Heritage: Insights from ***Sassi di Matera***

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A Value-based Assessment and Intervention Framework for Dikengyuan as Subterranean Vernacular Heritage: Insights from Sassi di Matera

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Declaration on Generative AI Use:
Generative AI tools were used for limited language-related purposes, including grammar correction and refinement.

ABSTRACT

Abstract

Dikengyuan (Pit Courtyard) is a distinctive type of residential building that originated on the Loess Plateau in China, with the unique construction method of digging into the earth and hidden underground, reflecting the collective wisdom of local communities. It is not an architecture designed by architects, but a result that has evolved over a long period in specific natural and social environments, with multiple typological features of vernacular architecture, earthen architecture, and troglodyte architecture. However, in the context of rapid urbanization and rural depopulation, due to the lack of human use and maintenance, this unique architectural heritage is facing the risk of disappearing.

This thesis first investigated the typological characteristics of Dikengyuan, through the aspects of its formation origin, spatial layout, building materials, construction methods, architectural characteristics, and functional organization, extracted its outstanding heritage value, and then analyzed the key factors that led to its decline from architectural level. Subsequently, researched on the overall use and maintenance status of Dikengyuan, which summarized the conflicts and crises that appear between conservation, use, and renovation in the contemporary development context.

To propose practical conservation and reuse strategies, this thesis selected the case study Sassi di Matera, Italy, which has similar characteristics and evolutionary processes to Dikengyuan, to conduct comparative research. As a UNESCO World Heritage Site, Matera has experienced poverty and depopulation and was once stigmatized, but has successfully completed its identity transformation in recent decades. The thesis summarized the experience based on heritage practice, and discussed its implications for Dikengyuan.

Based on the previous research, this thesis proposed a value-based assessment and classification intervention framework for Dikengyuan. Selected five value dimensions: historical, social, technological, landscape, and economic, levels of which are determined through a multi-factor evaluation and scoring system, corresponding to different intervention strategies: authenticity-oriented conservation, adaptive reuse, and landscape integration. For different intervention categories, proposed possible differentiated construction methods through international heritage renovation case studies.

For the application, a typical Dikengyuan village in Henan Province is selected, and the results indicated that the framework can effectively distinguish targets, match differentiated strategies, and form a path from assessment to intervention. This study provides a replicable and practical procedure for the conservation and reuse of the Dikengyuan typology.

Keywords: Dikengyuan(pit courtyard); Vernacular heritage; Troglodyte settlement; Earthen architecture; Value assessment; Architectural heritage intervention

CONTENTS

01

INTRODUCTION

Fig. 1 *A Photo of Dikengyuan Taken from the Air by a German Pilot.* Wulf-Diether Graf zu Castell-Rüdenhausen. (1938). Cited in *Architecture Without Architects*. Rudofsky, B. (1964).

"What is house,
when the roof is the earth
beneath our feet?"

For thousands of years, the pit courtyards have provided a silent and resilient answer to this question. On the Loess Plateau, millions of people excavate dwellings directly into the earth, creating a unique subtractive architecture, making villages are not visible on the horizon, with only square openings of the courtyards facing the sky. This type of cave dwelling represents one of the most primitive and ecologically resilient survival strategies of human. However, due to the rapid urbanization and modernization process in modern China, the state of these underground villages is being damaged, with the silence of abandoned old pit courtyards contrasting sharply with the thriving new construction next to them. Today, in the context of contemporary life, we are not only asking what these houses used to be, but also how this ancient form of living will be redefined.

The crisis of pit courtyards is not an isolated phenomenon, but a microcosm of the global vernacular heritage dilemma. As Bernard Rudofsky pointed out in his exhibition and book *Architecture Without Architects*, vernacular architecture demonstrates a collective wisdom of the local community that often surpasses meticulously designed schemes in modern times (Rudofsky, 1964). However, despite the gradual recognition of the value of this type of architecture, and the increasing international recognition of *living heritage*, there are still profound contradictions in the practice of conservation and development, even with the issuance of many relevant guidelines such as the *Charter on the Built Vernacular Heritage* (ICOMOS, 1999).

In the public awareness of developing countries, the raw earth is often synonymous with poverty, backwardness, and structural instability. The stigma of poverty drives people's psychological exclusion of this traditional dwelling form. In western Henan, this is manifested as population migration, where the younger generation is abandoning the traditional pit courtyards and moving into the concrete houses on the ground, leaving behind villages in a state of hollowing out and physical decay.

The gap between physical remains and modern life reveals the key deficiency in current conservation methodologies. At present, the main approach towards pit courtyards is wavering between two extremes of museumization and constructive destruction. A few selected pit courtyards are under static preservation and constructed as tourist attractions, different from real local community life but to satisfy the curiosity of tourists. However, the majority of the other ordinary pit courtyards have either lost their original texture due to abandonment, or have undergone rough modernization interventions by the overuse of modern materials, which have erased the original ecological characteristics and aesthetic integrity. These intervention strategies are often driven by benefit or administrative convenience, without the strict value assessment before practice. The lack of scientific guidelines has led to this binary opposition interventions.

There are over 200 pit courtyard villages in Shaanxi County, totaling more than 12000 individual pit courtyards (Henan Provincial Administration of Cultural Heritage, 2023). In such a large number, their current situations are different. Which pit courtyard needs strict preservation, which pit courtyard is suitable for adaptive reuse, and which pit courtyard should return to nature. It is necessary to construct a tool to distinguish, assess, and develop differentiated intervention strategies to achieve sustainable development.

This thesis is based on the lack of this methodology. In order to find the future path of pit courtyards, we must go beyond the local context and engage in experiential learning from a cross-cultural perspective. The Sassi di Matera in Italy provides a powerful mirror for the pit courtyards. Matera was once named as Italy's *National Shame* due to poverty and poor sanitation conditions, which is similar to the current stigmatization of pit courtyards. But today, Matera has successfully changed its image. It was recognized as a UNESCO World Heritage Site in 1993 and a European Capital of Culture in 2019 (UNESCO, 1993; Matera 2019, 2019). The successful transformation of Matera is inside the differentiated intervention strategies during heritage conservation practices, which achieve a balance between conservation and development. This thesis analyzed and summarized the experience of Matera, attempted to translate and adapt it to the specific context of the pit courtyards on the Loess Plateau.

Therefore, the objective of this thesis goes beyond simply recording and proposing a single design project, aims to construct a practical value-based assessment and differentiated intervention framework of pit courtyards. By assessing the values from five dimensions, including historical, social, technological, landscape, and economic and their detailed composition factors, proposed a corresponding differentiated intervention system. As a full process tool, this framework divides pit courtyards mainly into three different intervention paths based on the results of value assessment: authenticity-oriented conservation for high historical value pit courtyards, adaptive reuse for high potential pit courtyards, and landscape integration for pit courtyards that are structurally and ecologically ruined. In addition, a pit courtyard village located in western Henan was selected to verify the practical ability and effectiveness of the framework.

This thesis suggests that the pit courtyard is not only a historical heritage and tourism resource, but also a potential architectural prototype for sustainable living in the future. By bridging the gap between traditional wisdom and modern technology, and translating international heritage theory and practice experiences into the local context, this thesis attempts to prove that Dikengyuan can become a viable, dignified, and resilient house again.

02

THEORETICAL FRAMEWORK AND TYPOLOGICAL ANALYSIS

2.1 International Heritage Conservation Theory

2.1.1 Development of International Heritage Conservation

The history and development of international heritage conservation is a story of how we have expanded our understanding of what **heritage** actually is. Over the past sixty years, the theories has moved from a narrow focus on preservation of single monuments to a much broader and more complex approach that manages entire environments and living settlements. By tracing the key international charters from the 1960s to the present, we can observe two clear trends: the expansion of the protection targets and the methodology transformation of intervention strategies.

The modern era of conservation began with the *Venice Charter* in 1964. At that time, the focus was strictly on **monuments** which are grand, singular structures like cathedrals or palaces. The charter established a strict rule of protecting the physical material of the building as if it were a historical document and witness. It drew a sharp line between **restoration** (fixing based on evidence) and **reconstruction**(rebuilding based on guessing). For a long time, it created a mindset that **authenticity** meant keeping the original bricks and stones exactly as they were, often discouraging any modern changes (International Council on Monuments and Sites, 1964).

The *Convention Concerning the Protection of the World Cultural and Natural Heritage* established the first international legal framework that integrates the protection of both cultural and natural heritage under a single system. It firstly introduced the concept of **Outstanding Universal Value (OUV)**, affirming that heritage of exceptional significance belongs not only to individual nations but to humanity as a whole, thereby justifying international cooperation in its conservation. Furthermore, it emphasized that while international assistance is encouraged, the primary responsibility for safeguarding heritage remains with the States Parties, requiring the establishment of appropriate legal, administrative, and management frameworks. This Convention provided the institutional foundation upon which subsequent operational and technical guidelines for heritage conservation have been developed (UnitedNations Educational, Scientific and Cultural Organization, 1972).

In the late 1970s, the targets began to widen beyond individual monuments to include entire towns and villages. The *Resolution on the Conservation of Small Historic Towns* issued in Rotenburg in 1975 is crucial, which specifically addressed **small historic towns**. This document was one of the first to warn that saving the buildings is useless if the town becomes a museum with no real residents and life. It argued that the goal of conservation is not just to keep the shells of buildings, but to retain the local population and their social structure (ICOMOS, 1975).

The *Australia ICOMOS Charter for the Conservation of Places of Cultural Significance*, also known as the *Burra Charter*, placed cultural significance at the core of heritage conservation, expanded the scope of protection beyond physical fabric to include social, spiritual, and associative **values**. It promoted a systematic, values-based conservation process, which icluding understanding, assessing, planning, and managing. Supported compatible use and community participation, marked a shift from monument-centered restoration toward place-based and management-oriented heritage conservation (Australia ICOMOS, 1979).

By the 1980s, the focus moved deeper into rural and poor areas. The *Tlaxcala Declaration on the Revitalization of Small Settlements*, adopted at the Third Inter-American Symposium on the Conservation of the Building Heritage, explicitly stated that for **small settlements**, government and community are responsible for their conservation and revitalization, and improving the living conditions of the inhabitants is an obligation of conservation. It discussed the point that adding modern infrastructure like plumbing or electricity is not destruction but a necessary step to keep the village alive. Advocated integrated programs that respect local traditions, strengthen socio-economic conditions, promote interdisciplinary collaboration, and support traditional building practices as a foundation for sustainable heritage management (ICOMOS, 1982).

The *Nara Document on Authenticity* redefined **authenticity** as a culturally relative and multidimensional concept, extending its assessment beyond material fabric to include use, traditions, setting, and spirit, and emphasized that judgments of authenticity must be grounded in the cultural values of each heritage context, thereby providing a more inclusive framework for evaluating and conserving diverse forms of cultural heritage (ICOMOS, 1994).

The *Charter on the Built Vernacular Heritage* recognized vernacular architecture as a fundamental expression of cultural identity and environmental adaptation. It stated that **vernacular heritage** is a continuously evolving system, the continuity of the traditional process that how people build and repair their houses is as important as the physical structure itself. It advocated for an integrated, community-based and dynamic approach to conservation, and emphasized that protection should address entire settlements, traditional practices, and socio-economic sustainability rather than isolated buildings or static preservation (ICOMOS, 1999).

Since the early 2000s, heritage conservation theory has increasingly shifted toward a more integrated and people-centered framework. This perspective was further reinforced by the *Xi'an Declaration*, which recognized the setting of heritage sites including landscape, spatial relationships, and social functions is integral to their significance, rather than merely a visual backdrop (ICOMOS, 2005). Subsequently, the Recommendation on the **Historic Urban Landscape (HUL)** promoted the integration of heritage conservation into broader processes of urban planning, socio-economic development, and environmental management, advocating a landscape perspective and a multiple approach to heritage governance (UNESCO, 2011).

Together, these documents reflect a paradigm shift in which heritage is understood as a dynamic cultural process embedded in living communities and development contexts, rather than as a static collection of protected objects.

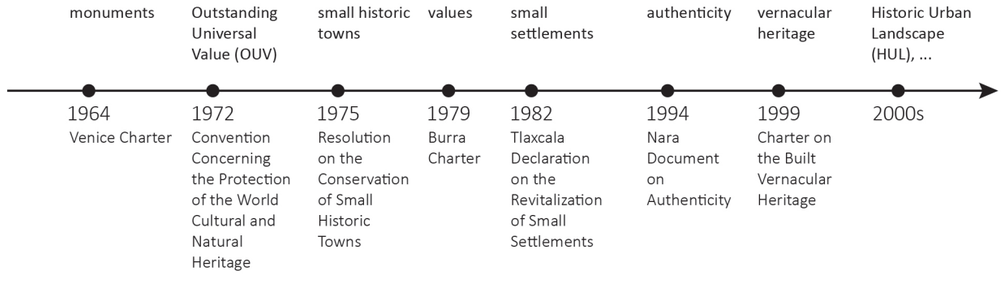


Fig. 2 *Timeline of Heritage Conservation Theory Development.* Drawn by the author.

2.1.2 Expansion and Subdivision of the Value in Heritage

The evolution of conservation theory is fundamentally an evolution of how we define **value**. In the early 20th century, heritage was largely protected for its intrinsic artistic or historical qualities, for instance the age of the stone or the aesthetics of the style. However, the contemporary understanding of heritage has shifted from viewing value as an inherent quality of an object to understanding it as a social construction attributed by people. This shift has expanded the assessment framework from a singular focus on the heritage entity to a diverse inclusion of social, economic, and landscape environment dimensions.

The formal definition of heritage value began with the *Convention Concerning the Protection of the World Cultural and Natural Heritage* in 1972. This document introduced the concept of **Outstanding Universal Value (OUV)**, defining heritage as sites that are "so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity" (UNESCO, 1972).

While the OUV concept successfully elevated heritage protection to a global responsibility, it initially imposed a top-down, Eurocentric perspective. It prioritized the monumental architecture and archaeological sites that could be scientifically measured against a universal standard. As noted by De la Torre (2013), this early approach often ignored the local context, assuming that experts alone could determine what was valuable, often sidelining the communities that actually lived in or near these sites. For vernacular settlements like the Dikengyuan, this universal perspective was often too grand to capture their living, everyday significance.

A critical turning point occurred with the adoption of the *Burra Charter* in 1979. Moving away from the single concept of universal value, the *Burra Charter* introduced the term **Cultural Significance**, which it defined as the sum of "aesthetic, historic, scientific, social, or spiritual value" (Australia ICOMOS, 1979).

The inclusion of **Social Value** was revolutionary. It acknowledged that a place could be significant not because it is a masterpiece of art, but because it holds spiritual or sentimental meaning for a specific community. This shift is vital for understanding vernacular heritage. As argued in the *Charter on the Built Vernacular Heritage*, the value of vernacular architecture lies not just in its physical form, but in the intangible traditions and the continuing way of life of its inhabitants (ICOMOS, 1999).

In the 21st century, the value framework has expanded further to integrate heritage into the broader context of sustainable development. Randall Mason (2002) introduced subdivided value concepts from multiple dimensions, have argued for a holistic typology that includes **Economic Value** as a legitimate dimension of conservation. For city regeneration, cultural heritage acts as a driver that has a use value including tourism, local productions, real estate and other indicators can provide the financial resources necessary for physical maintenance (Nocca, 2017).

Furthermore, the perspectives has widened to include **Landscape and Environmental Values**. It is highlighted that heritage values are often intertwined with natural ecosystems (Azzopardi et al., 2023). The Cultural Values Model proposed by Stephenson (2008) further integrates these tangible and intangible elements, suggesting that landscape values are generated through dynamic interactions between forms, practices, and relationships.

In summary, the theoretical understanding of heritage value has moved from the singular Outstanding Universal Value to a pluralistic, multidimensional framework. It now encompasses not only the historical evidence of the past but also the social connections of the present and the economic potential for the future.

Art History Alois Reigl 1902	ICOMOS Australia Burra Charter 1998	Economics Bruno Frey 1997	English Heritage 1999
Age **Historical** Conmemorative Use Newness	Aesthetic Historic **Scientific** **Social** Spiritual Political National Cultural	Monetary Option Existence Bequest Prestige Educational	Cultural Educational & academic **Economic** Resource Recreational Aesthetic

Table 1 *Classified Heritage Values.* De La Torre, M. (2013). Values and Heritage Conservation. Edited by the author.

2.2 The Multiple Typological Identities of Dikengyuan

2.2.1 As Vernacular Architecture

Dikengyuan can be fundamentally understood as a form of vernacular architecture, shaped through long-term collective experience rather than formal architectural design. As early as 1964, Bernard Rudofsky challenged the academic fixation on elite buildings by introducing the concept of **Non-Pedigreed Architecture** in *Architecture Without Architects*, his book and exhibition in MOMA, Newyork. He argued that these anonymous structures, born from necessity, are produced through continuous adaptation to local climate, available materials, and social organization, exhibit a level of intelligence and adaptability that often surpasses professionally designed buildings (Rudofsky, 1964). Paul Oliver, in his seminal *Encyclopedia of Vernacular Architecture of the World*, further refined this definition. He emphasized that true vernacular architecture are buildings "of the people, not for the people" (Oliver, 1997). This distinction is fundamental to the pit courtyard: it is a dwelling created by the villagers themselves, utilizing their own hands and local materials, without the intervention of professional architects or imported blueprints.

This self-built nature does not imply a lack of rigorous design, it rather represents what Amos Rapoport terms collective wisdom. In *House Form and Culture*, Rapoport (1969) explains that vernacular forms are the result of a long, collaborative process between a community and its environment. Through centuries of trial and error, the builders of Western Henan gradually optimized the spatial logic of the pit courtyards, determined the ideal depth to prevent collapse and the optimal arch curve for stability. This unwritten knowledge, or traditional knowledge system, is transmitted across generations, a value formally recognized by the *Charter on the Built Vernacular Heritage* (ICOMOS, 1999).

In the specific context of China, this vast body of indigenous building wisdom was systematically organized by Liu Dunzhen. In his book *Overview of Chinese Housing*, Liu (2004) shifted the academic focus from imperial palaces to the dwellings of commoners. His research established that Chinese vernacular architecture is not a monolithic style but a diverse set of structural responses to local geography and climate.

Fig. 3 *The Swiss Chalet.*
https://artsandcraftshomes.com/house-styles/the-swiss-chalet

Fig. 4 *Clay House in The Gambia.*
https://artsandcraftshomes.com/house-styles/the-swiss-chalet

While Chinese scholars were establishing the typological foundations, western academia also turned its gaze toward this unique built environment, offering complementary perspectives. Among them, Ronald G. Knapp (Na Zhongliang) offers a critical external perspective. Unlike the structural focus of early Chinese studies, Knapp (2006) expands the discourse into the socio-cultural dimension, arguing that the Chinese house is a "container" for social ethics. He observes that the spatial arrangement of rural dwellings, including the introverted courtyard and the hierarchy of rooms, is a physical manifestation of the Confucian ethical system. Even in the subterranean context of the pit courtyards, the architecture strictly enforces the distinction between public and private, elders and youth. Thus, through the dual lenses of indigenous classification and international cultural anthropology, the pit courtyard is defined not merely as a regional shelter, but as a synthesis of structural rationality and social ethics.

Fig. 6 *Tulou in Fujian, China.*
http://fj.people.com.cn/n2/2021/0718/c181466-34825451.html

Fig. 7 *Diaojiaolou in Hunan, China.*
https://www.seetao.com/details/80307.html

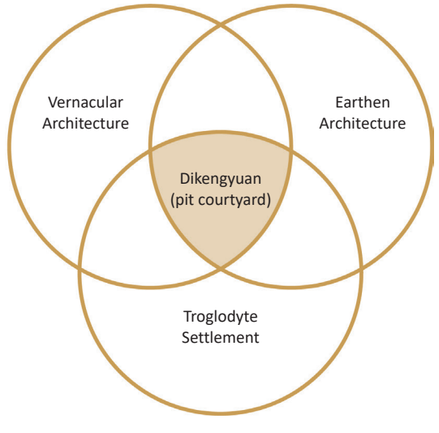


Fig. 5 *Multiple Identities of the Pit Courtyard.*
Drawn by the author.

Fig. 8 *Dai Ethnic Dwellings in Yunnan, China.*
https://www.sohu.com/a/388691200_100020640

2.2.2 As Earthen Architecture

While the vernacular identity defines the social origin of Dikengyuan, its earthen identity situates it within a re-evaluation over the past half century. Historically, earthen architecture has been seen as a symbol of poverty because of its cheap building material, but it began to gain recognition in the 1980s, with Jean Dethier's advocacy. Through landmark exhibitions and publications, *The Art of Earth Architecture: Past, Present, Future* (Dethier, 2020) shifted the narrative, portraying unbaked earth not as a primitive relic but as a sophisticated, eco-friendly solution for the future. Simultaneously, the scientific research led by *International Centre for Earth Construction (CRATerre)* provided the technical validation needed to legitimize earth as a durable building material.

This shifting perception crystallized into formal international institutionalization. The establishment of the *International Scientific Committee on Earthen Architectural Heritage (ICOMOS-ISCEAH)* marked a turning point, creating a specialized platform for experts to develop conservation guidelines specific to soil-based structures. This trend culminated with the launch of the *World Heritage Earthen Architecture Programme (WHEAP)* by World Heritage Centre in 2007. This program officially recognized that earthen heritage which representing 10% of the World Heritage List requires unique management strategies different from stone or brick monuments. Situating the Dikengyuan within this institutional trajectory confirms that its conservation is not a local rural issue, but part of a global agenda to safeguard earthen heritage.

However, the material reality of the raw earth on the Loess Plateau presents two specific characteristics that constitute the core of pit courtyard's modern crisis: **Water Sensitivity** and **High Maintenance Demand**.

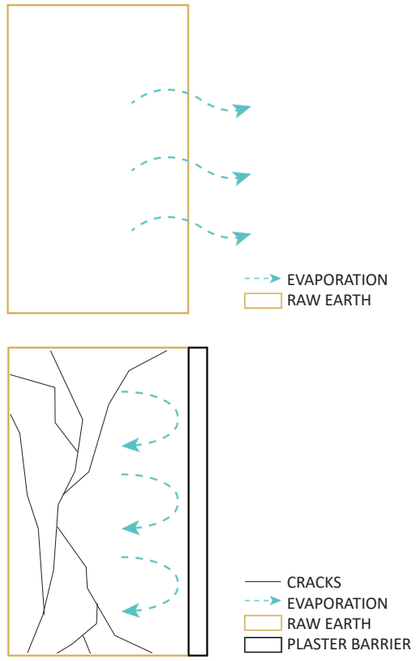


Fig. 9 *Water Crisis of Earthen Architecture Under Inappropriate Intervention.* Drawn by the author.

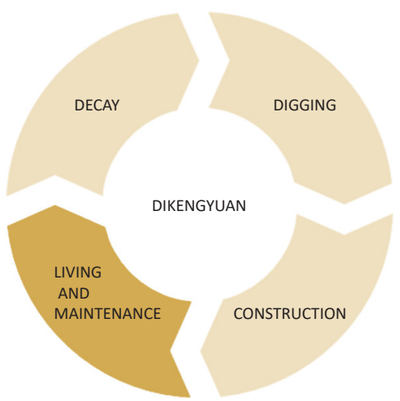


Fig. 10 *Dikengyuan Building Life Cycle.* Drawn by the author.

The primary characteristic of loess soil is its hydrophilic nature. While this allows the walls to breathe and regulate indoor humidity, it also makes the structure extremely vulnerable to water saturation. As noted, raw earth loses its structural cohesion when wet (Avrami, Guillaud, & Mary Hardy, 2008). This inherent sensitivity has led to a disastrous misunderstanding in modern conservation by mistakenly using cement. Villagers and local builders attempting to waterproof the traditional walls often cover them with impermeable cement rendering. This modern intervention disrupts the natural evaporation process, trapping rising damp inside the wall. The result is constructive destruction: the accumulated moisture causes the earthen core to rot and detach behind the cement skin, accelerating the collapse of the very structure it was meant to protect.

The second characteristic is the soil's reliance on continuous maintenance. Unlike fired brick or stone, which can endure decades of neglect, earthen architecture is a living system that erodes naturally under wind and rain. It requires regular care that re-plastering surfaces and rolling roof tops after storms. These practices were once embedded in the annual agricultural calendar. The crisis today is that this material demand clashes with the new social reality. With the depopulation of villages and the migration of the labor force, the social system of maintenance has collapsed. The Dikengyuan is deteriorating not only because the material is flawed, but because the human life of care required to sustain it has been broken.

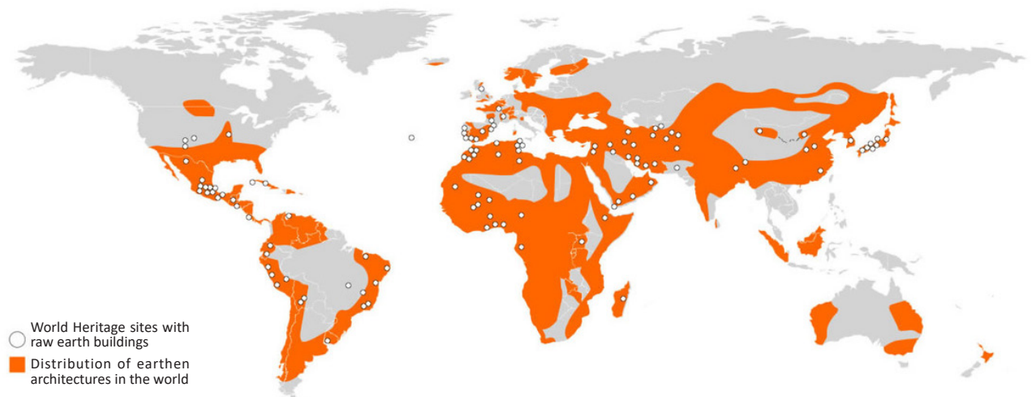


Fig. 11 *Map of Earthen Architectures in the World.* CRATerre. https://craterre.org/en/

2.2.3 As Troglodyte Settlement

The third and defining identity of Dikengyuan is its nature as a troglodyte settlement. While often perceived locally as a unique regional oddity, the pit courtyard is, in fact, part of a vast global lineage of underground dwelling traditions. The ancient Berber village of Matmata in South Tunisia, which has an almost identical vertical pit structure to Dikengyuan. The volcanic tuff cones of Cappadocia in Turkey, the rock-hewn ancient city of Uplistsikhe near Tbilisi in Georgia, and the troglodyte cultural landscape of Maymand in Iran, these examples demonstrate that living underground is a universal human response to harsh semi-arid climates. Despite their geographical distance, these settlements share a common indigenous rationality of utilizing the earth itself as a shield against extreme temperature fluctuations.

What unites these diverse global examples is a fundamental shift in architectural logic: from addition to subtraction. Unlike conventional architecture, where space is defined by adding materials, the Dikengyuan follows a logic of **Subtractive Construction**. It is created by removing matter to carve out a void. This places it within the rare category of negative topography, creating a landscape where the settlement is sunken below the horizon. This subtractive nature implies that the building is not an object on the landscape, but an integral part of the landscape volume itself.

However, this subterranean nature is precisely one of the sources of its modern existential crisis. The primary challenge is the stigmatization of poverty. Historically, living in a cave has been culturally associated with the primitive and the underdeveloped. This phenomenon also occurs in the history of the Sassi di Matera in Italy. Before its recognition as a World Heritage site, Matera was labeled a "national shame" in the 1950s due to the perception that cave living was incompatible with modern civilization (De Togni, 2021).

A similar situation is in Western Henan today. For many villagers, the pit courtyard is a reminder of the past that they wish to escape. The willing of modernization is abstractly translated into the modern architecture, the desire to move up to an above-ground new brick house to reclaim social dignity. This creates a deep psychological barrier to conservation, the villagers themselves often view the preservation of these pits as an attempt to lock them in backwardness. Therefore, the conservation of Dikengyuan faces a dual challenge: the physical invisibility of the negative topography in planning, and the psychological rejection of the cave in the minds of its inhabitants.


Maymand

Cappadocia

Tbilisi


Matmata


Matmata


Mesa Verde

Fig. 12 *Troglodyte Settlements in the World.* Images from online sources. Organized by the author.

03

DIKENGYUAN: FORM, SPACE, AND THE HIDDEN CRISIS

3.1 The Origin and Development of Dikengyuan

On the Loess Plateau in China, there is a unique type of cave dwelling architecture that is hidden beneath the surface of the loess soil. As a continuation of ancient human troglodyte settlements, this distinctive architecture is the result of both natural and human choices. People living on the plateau take advantage of the characteristics of the loess layer and the terrain of the plateau to dig holes and live in them. Adapt to local conditions, climate, use local materials, facilitate construction, and integrate into nature, cave dwellings are widely distributed in provinces on the Loess Plateau such as Shanxi, Shaanxi, Henan, Gansu, and Ningxia. Their history can be traced back over four thousand years (Wang, Du, Zhang, Liu, & Li, 2013).

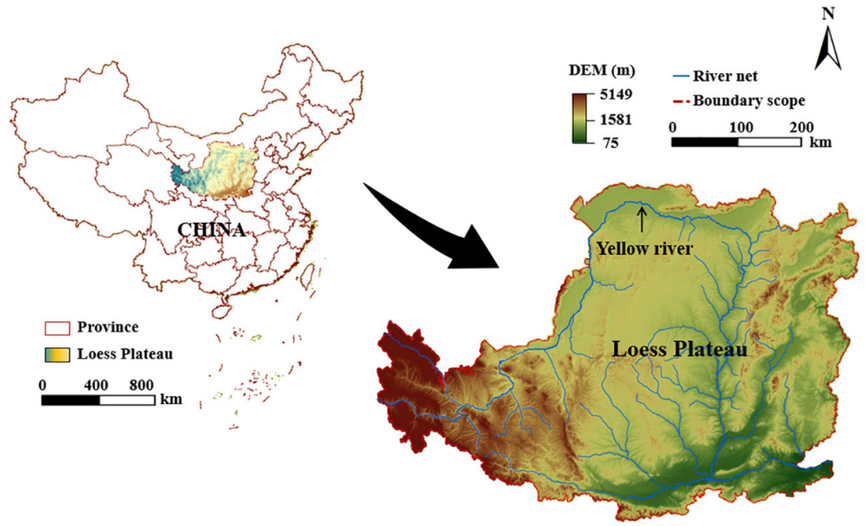


Fig. 13 *Location of the Loess Plateau.* Lyu, J, et al. (2023). Spatiotemporal variations and risk characteristics of potential non-point source pollution driven by LUCC in the Loess Plateau Region, China

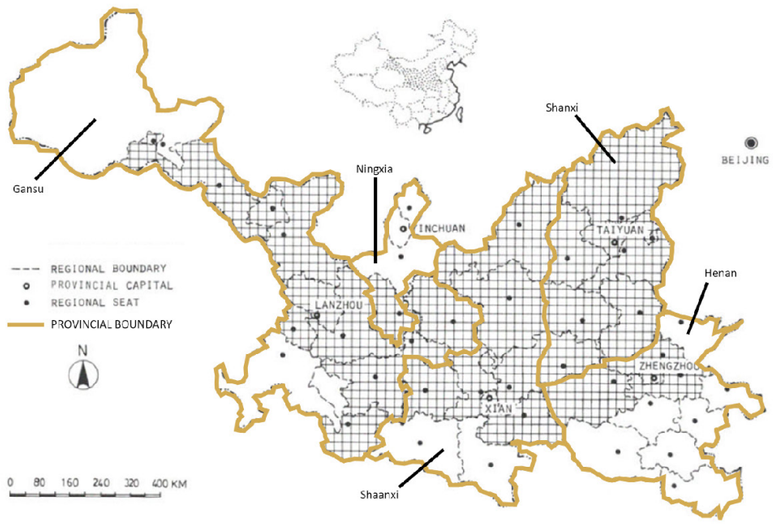


Fig. 14 *Distribution of cave dwellings in Henan, Shaanxi, Shanxi, Ningxia, and Gansu on the Loess Plateau.* Golany, G. (1992). Chinese Earth-Sheltered Dwellings: Indigenous Lessons for Modern Urban Design. Edited by the author.

3.1.1 Factors of Formation

Geological Factors

The areas where the *Yaodong*(cave dwellings) are located are primarily in the Loess Plateau region, where the soil layers are deep, generally reaching depths of 50-150 meters (Golany, 1992). The soil composition is mainly quartz and silt, a very typical type of agricultural soil, with properties between brown soil and loess. The loess layer has a relatively dense overall structure, possessing good earthquake resistance, compressive strength, and alkali resistance, providing a stable and reliable material foundation for the excavation of underground spaces. Therefore, the construction of cave dwellings under these geological conditions offers high durability and safety.

Due to different specific environments, cave dwellings are mainly divided into three types. Above ground level, horizontal excavation along the mountainside creates **cliff cave dwellings**. These cave dwellings are mostly distributed on hillsides or the edges of loess plateaus, carved upwards along the mountain slopes, presenting a stepped layout with relatively open views. There is another type that is added to the ground level using brickwork and rammed earth, forming **independent cave dwellings** with a spatial form similar to traditional cave dwellings. However, in the relatively flat areas of the central Loess Plateau, due to the lack of cliff slopes to rely on, horizontal excavation is not very possible. People then turned to developing below ground level, creating living spaces by digging downwards. This dwelling form is the focus of this thesis: **Dikengyuan, the pit courtyards**, which are the underground cave dwellings.

Climate Factors

The Loess Plateau region has a predominantly temperate continental monsoon climate, characterized by cold winters, hot summers, drought, distinct seasons, and large annual temperature variations. The region receives little rainfall and is arid. This climate helps maintain a firm soil layer, resulting in more stable and durable buildings. Furthermore, the thick loess enclosure effectively insulates against external temperature fluctuations. In summer, the soil blocks heat waves, and in winter, it retains geothermal heat. The average annual rainfall is 500-600 mm, with very few instances of heavy rain or snow (Kimura & Takayama, 2014). Even in cases of sudden increases in rainfall, the surrounding gullies allow rainwater to drain away directly, preventing accumulation in the pit courtyards.

This vernacular architecture, born from the unique geographical and geological conditions of the Loess Plateau and its semi-arid climate, embodies a remarkably simple yet highly efficient concept of Climate-Responsive Design, that leverages locally available natural energy within the built environment to achieve thermal comfort through passive or low-energy strategies (Looman, 2017).

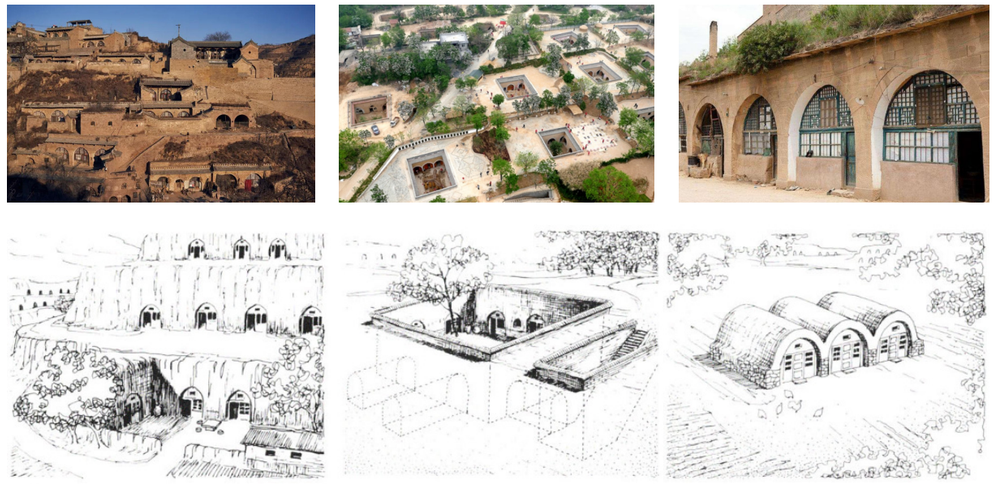


Fig. 15 *Three Types of Cave Dwellings.* Images from online sources; Golany, G. (1992). Chinese Earth-Sheltered Dwellings: Indigenous Lessons for Modern Urban Design. Organized by the author.

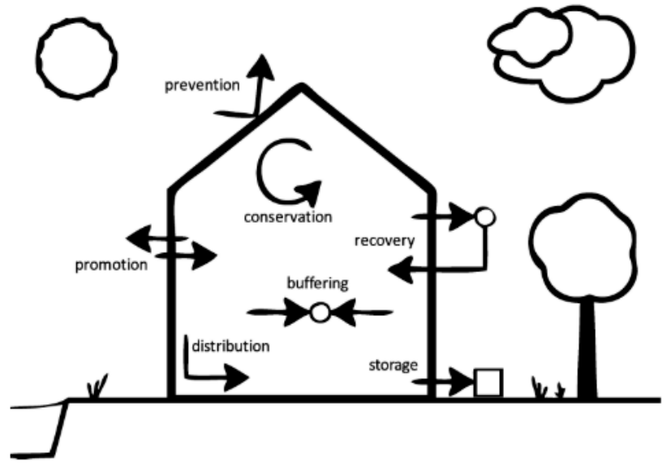


Fig. 16 *A Climate-Responsive Building Manages Natural Energy Flows to Create an Effective Energy Balance.* Looman, R. https://www.climateresponsivedesign.nl/tool/introduction/

3.1.2 The History and Development

Socioeconomic Factors

One of the main reasons why pit courtyards have persisted for thousands of years is economic. For a long time, although the Yellow River basin was the political, economic, and cultural center of the Chinese nation, the surrounding residents actually faced considerable economic difficulties. There are not many trees growing on the Loess Plateau, resulting in a lack of timber resources and the timber needed for beams and pillars in above-ground construction. In the meantime, coal resources are also scarce, making it difficult to fire bricks and tiles for building houses. Pit courtyards, according to local conditions, were inexpensive to construct with extremely low building costs by just digging in the ground. A complete pit courtyard could be built in just six months, which can accommodate up to 3-4 families. Agriculture type is also a contributing factor, the main crops on the Loess Plateau are wheat and corn, which require large areas for drying after harvest. The open space above ground of pit courtyards could meet this need. This architecture was the optimal solution for the poor farmers to solve their housing problems. This origin from poverty is the root of its modern perception as a symbol of backwardness.

The formation of pit courtyards is deeply rooted in China's ancient history. Its origins are often traced back to the semi-subterranean dwellings during the Yangshao culture period (c. 5000–3000 BCE). This type of cave dwelling was already prevalent in the central plains by the Southern Song Dynasty(1127–1279). Specifically, the eleventh-century work *Xi Zheng Dao Li Ji (A Record of the Route to the West)* by Zheng Gangzhong in 1139, noted that "West of Xingyang, all are earthen hills, and people mostly live in caves." and describing the construction process as "First, like digging a hole, three *zhang* (1 *zhang*=3.33m) deep, then digging sideways" (Zheng, 1139/ n.d., as cited in China Intangible Cultural Heritage, n.d.). Large numbers of pit courtyards from the Ming and Qing periods remain in Shan County, where, before the 1980s, approximately 95% of residential buildings were pit courtyards, totaling over ten thousand units (China Intangible Cultural Heritage, n.d.).

After the founding of the People's Republic of China in 1949, it was the peak era for the construction of pit courtyards. Due to the stabilization of society at that time, although the economic level was still relatively low, under the call of the population policy at that time, the population in the village suddenly increased, and the number of children in the family was generally 3-6. Children born during this period also had a sudden increase in housing demand after marriage. The villagers had no funds to build buildings, so the pit courtyard became the best choice. Most of the existing and still inhabited pit courtyards today were built during that time, and such a large number of pit courtyards can also be said to be a result of that specific era.

In the 1980s, it began the period of reform and opening up in China. With the rural revitalization, the improvement of the economy, and the transformation of living concepts, residents of the pit courtyards gradually moved to the ground and lived in the above ground buildings. In the mid 1980s, in order to expand cultivated farmland, most of the pit courtyards were buried, collapsed, or abandoned, resulting in a rapid decrease in the numbers.

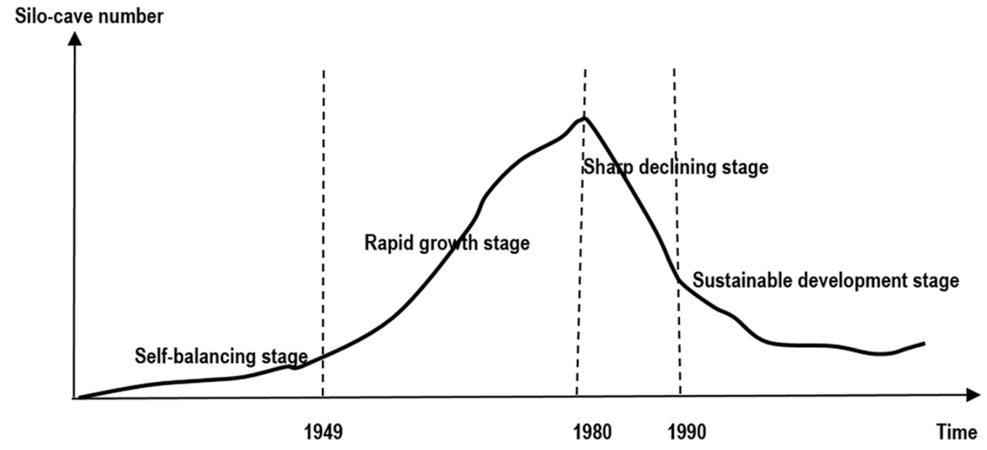


Fig. 17 *Evolution Stages of the Construction of Pit Courtyards.* Zhang, L, et al. (2021). Unique traditional villages on the Loess Plateau of China: historic evolution and challenges to sustainable development of silo-caves

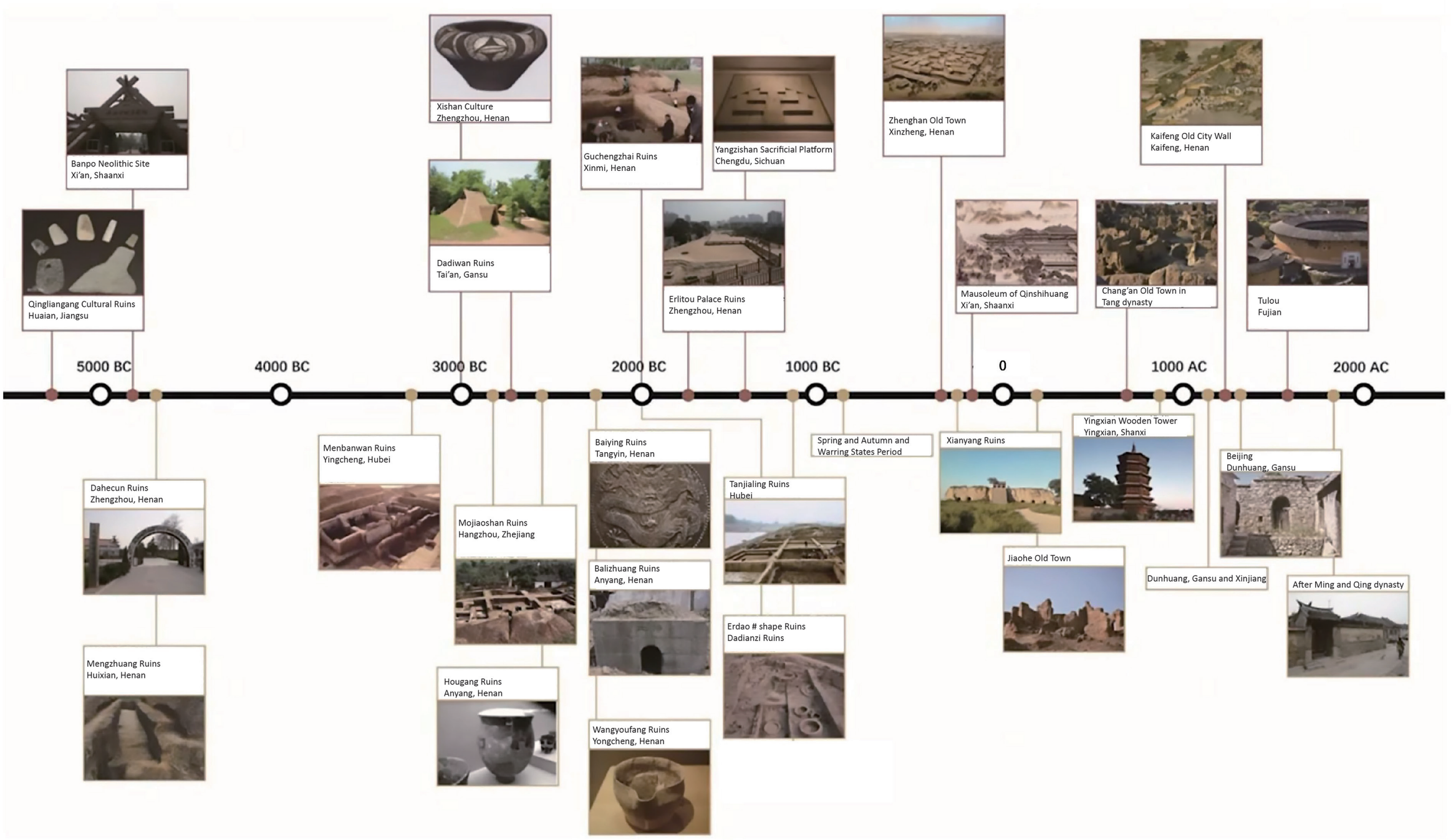


Fig. 18 *The History of Chinese Earthen Architecture.* Mu, J. https://www.archiposition.com/items/20180525112803.
Edited by the author.

3.2 The Architectural Typology and Spatial Organization

Dikengyuan (pit courtyard) is a typical sunken underground residential building, with the layout based on the central courtyard space. The main living space is hidden beneath the ground and is only connected to the external ground space through one slope entrance. The overall shape maintains a high consistency with the surrounding natural terrain. The two main features of the pit courtyard are a sunken central courtyard in the shape of a rectangle or square, and caves with arches excavated laterally on all sides of the courtyard. Compared with traditional courtyard residences on the ground, its horizontal expansion is smaller, but the vertical downward space utilization is significantly higher. This spatial strategy of developing underground not only saves land resources but also provides a more stable thermal environment for residential spaces.

Fig. 19 *Aerial View of a Dikengyuan Unit.* https://www.ourchinastory.com/zh/2684

3.2.1 The Courtyard Layout

The pit courtyard usually takes a sunken courtyard as the space center. The shape of the courtyard can be rectangular or square. The side length is about 9 to 12 meters, and the depth is 6 to 8 meters. There are two common sizes of 9m × 9m *Bagua Style* and 9m × 12m *Shihetou Style* (Wang, 2008). Around the central courtyard, the residential unit cave is excavated horizontally along the four facades. The functional spaces are arranged centripetally around the courtyard and connected by the roads surrounding the courtyard. There is a seepage well in the courtyard for drainage function including rainwater. The ground space in the middle is flat and empty, mainly used for planting trees, flowers, and vegetables. The sunken central courtyard, as the core space element in the pit courtyard, not only plays the role of organizing various cave spaces, but also is an important place for lighting, ventilation and daily life activities.

According to the number of side excavated caves, the scale of pit courtyards are mainly divided into 8-cave courtyards, 10-cave courtyards, and 12-cave courtyards, but there are also a few 6-cave courtyards and 14-cave courtyards. The larger the number of caves, the larger the scale of the pit courtyard, which is related to the economic ability of the owner and the number of family residents.

There are two main types of pit courtyard spatial layout, the layout with caves on all four sides and the layout with caves on only three sides. Based on the number of functional spaces required by the pit courtyards and the consideration of economic optimization, in general, the layout of caves on all four sides has become the primary choice for local inhabitants. The main side of the pit courtyard is also the side where the main cave is located. Generally, there are three caves, and a few have five caves, but there are always singular caves in count. The secondary side of the pit courtyard has side caves, and two or three side caves can be excavated according to the width of the courtyard.

3.2.2 The Cave Function and Layout

The main functional spaces of the pit courtyard rely on caves excavated laterally. According to different functions, it can be divided into the main living cave, the side living cave, the guest cave, the kitchen cave, the storage cave, the livestock cave, the toilet cave, the grain cave, and the entrance cave. The main cave, located directly opposite to the entrance cave, is the part that is used as the living space. It is usually 3-3.5 meters high and equipped with one door and there windows. In the three caves on one side, the central position is the main cave with the highest grade in a pit courtyard, and the width and depth are the largest in the whole courtyard. Usually, the shape and scale are also slightly larger than those on the other sides, where usually the elders of the courtyard family live in, while the young generations live by both sides of the main cave. This functional arrangement based on seniority also reflects the traditional Chinese ethics and order.

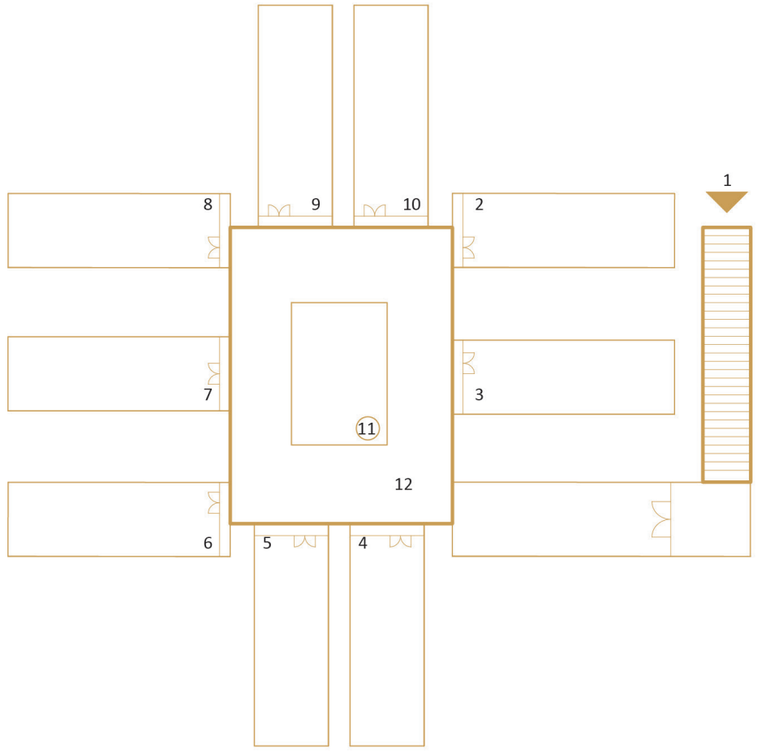
As the living space, every living cave is often equipped with the heated *Kang* bed made of adobe, which is located under the window of the entrance door. Through the heating of the stove, it will continuously provide heat for the *Kang* bed, keep the cave warm and provide a heated seat and living space in winter.

The other auxiliary functional spaces such as the kitchen cave and the storage cave are usually 2.8-3 meters high, with one door and two windows, which are often set on the side of the courtyard. The livestock cave and the toilet cave are usually set on the opposite side of the main cave, and are often located at the corner of the yard.

Fig. 20 *The Living Cave.* Photo by the author.

Fig. 21 *The Kitchen Cave.* Photo by the author.

Fig. 22 *The Entrance Cave.* Photo by the author.



1. Entrance 2. Livestock Cave 3. Living Cave 4. Storage Cave 5. Grain Storage Cave 6. Kitchen Cave 7. Main Living Cave 8. Living Cave 9. Guest Cave 10. Toilet Cave 11. Seepage Well 12. Courtyard

Fig. 23 *Layout of a Typical Dikengyuan (Pit Courtyard).* Drawn by the author.

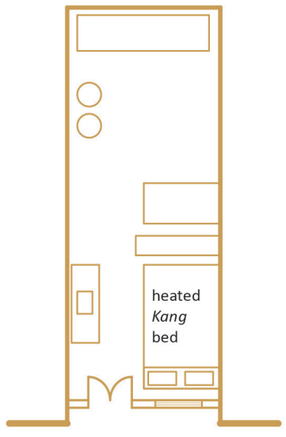


Fig. 24 *Plan of a Typical Living Cave.* Drawn the by the author.

3.2.3 The Facade and "Cave Face" Composition

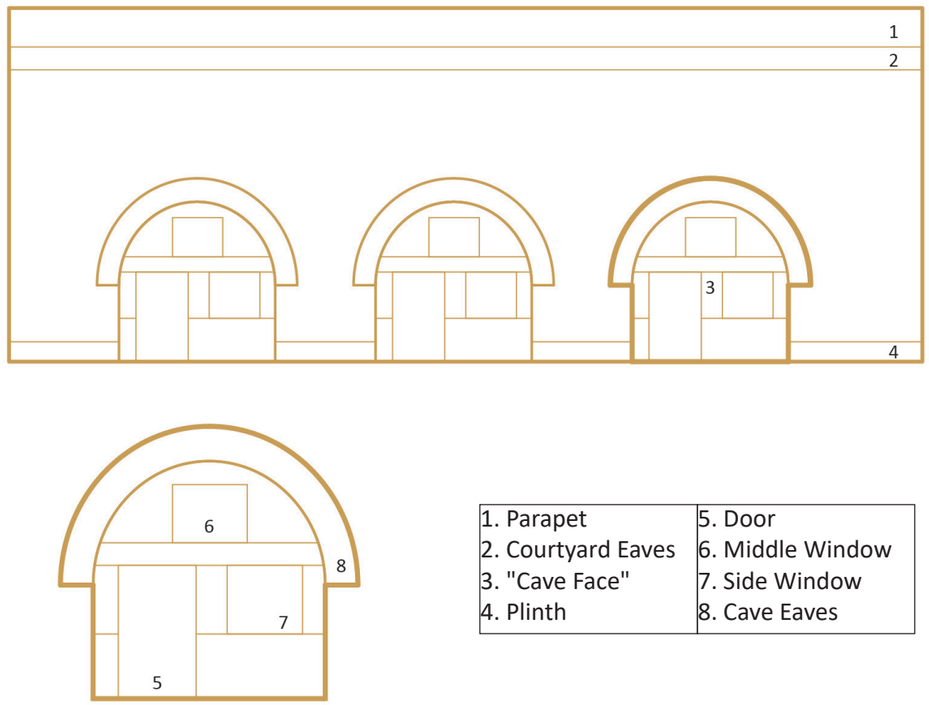
Different from the usual upground architecture, the facade of the pit courtyard means the vertical surface of the sides of the underground courtyard that have the entrance of caves. It is the only vertical wall separating the indoor and outdoor space, the cave and the courtyard. The enclosure structure, filled in the front of the cave, commonly named as the "cave face" by the local inhabitants, includes the door, window, and a cave eaves arch filled in the opening of the cave. The lower plinth, the "cave face" in the middle, the courtyard eaves and parapet on the top constitute the complete facade of the pit courtyard. The curve of the arch forms the basic unit of the facade together with the horizontal straight line of the cave eaves, making the facade of the pit courtyard diverse.

Lanmaqiang (The parapet)
During the construction of the pit courtyard, a parapet wall with a height of about 0.3-0.5 meters, also known as a horse blocking wall by the locals, will be built around the connection between the courtyard and the ground level. It is made of adobe or bricks to prevent people and animals from falling and rainwater from pouring in, and also has a certain decorative function.

Zheyuyan (The Courtyard Eaves)
It is the eaves that surround the top of the pit courtyard facade on all four sides. The eaves protrude about 25cm outward to prevent rainwater from directly washing away the cave face, effectively ensuring that the facade of the pit courtyard is not eroded by rainwater to extend the lifespan.

Yaolian (The cave face)
The *"One Door Two Windows"* and the *"One Door Three Windows"* are the two most typical types of cave faces. The *"One Door Three Windows"* is usually used for the main cave that has a larger scale, referring to one of the windows located above the door, while the other two are symmetrically distributed on both sides of the door. The *"One Door Two Windows"* is usually usedfor the other rest caves in the pit courtyards, referring to one window is above the door, and the other is on the left or right side of the door. The doors of the cave are usually double-layered and double-leaf doors. The inner layer doors are made of solid wood and open inward for protection. The outer layer doors are also called the air door. The air door is divided into upper and lower parts. The upper part is a square wooden grid made of wooden strips, with paper or glass pasted between the grids. The function of the air door is similar to that of a window screen, used for ventilation, lighting, and mosquito prevention. The windows of the cave are the source of light inside the cave, and are mostly finely carved with various shapes and patterns, which are all made of wood structures, and the joints are tight without the use of nails.

Yaotui (The plinth)
This is the base built on the bottom of the wall between two cave faces on the facade, which is covered with bricks and can effectively prevent rainwater from eroding the facade of the pit courtyard.



1. Parapet	5. Door
2. Courtyard Eaves	6. Middle Window
3. "Cave Face"	7. Side Window
4. Plinth	8. Cave Eaves

Fig. 25 *Facade elements of a typical Dikengyuan (pit courtyard).* Drawn by the author.


Lanmaqiang (The parapet)


Yaolian (The cave face)

Fig. 26 *Photos of Facade elements.* Photo by the author.

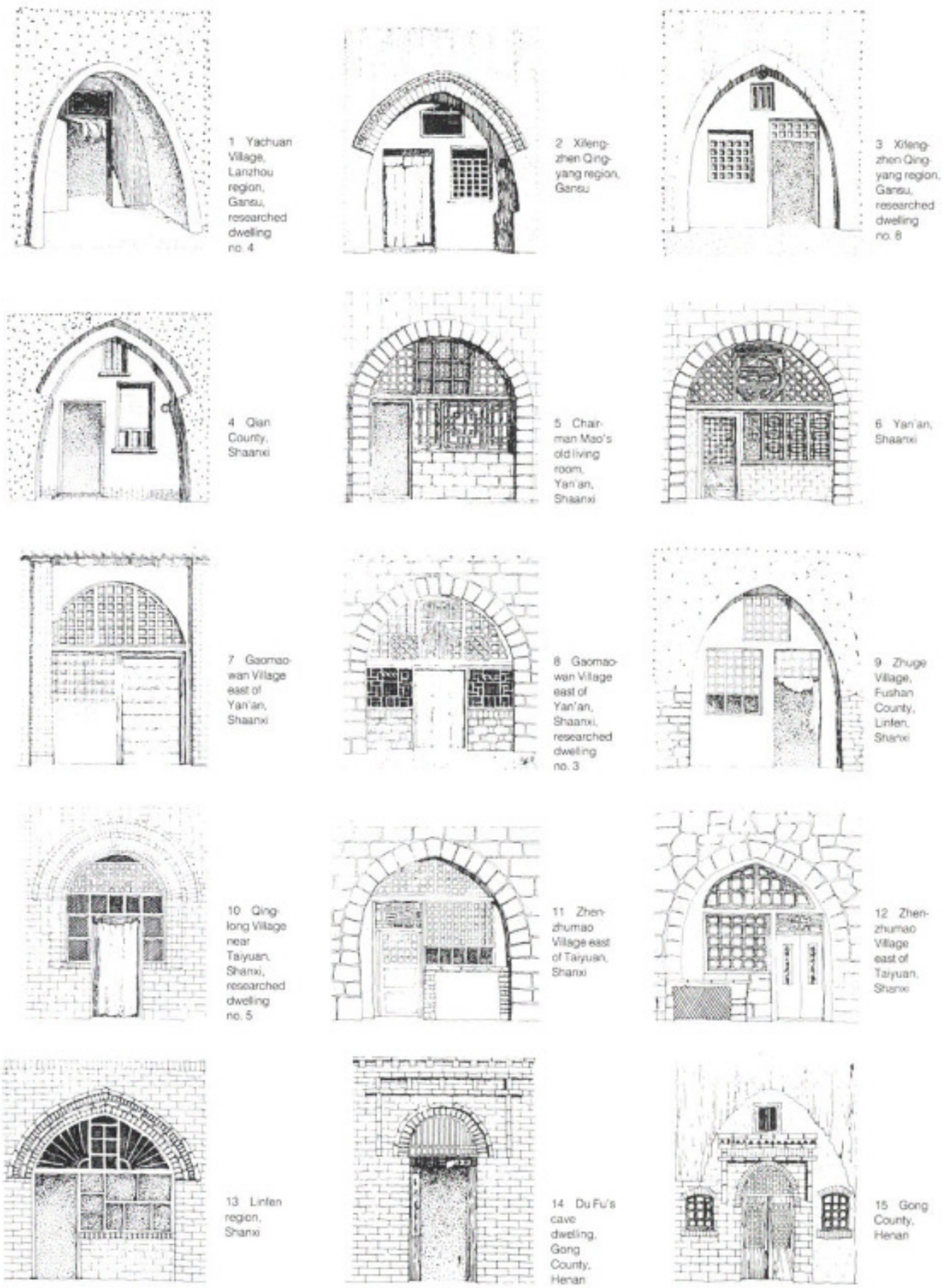


Fig. 27 *Facade design of cave dwellings in different regions.* Golany, G. (1992). Chinese Earth-Sheltered Dwellings: Indigenous Lessons for Modern Urban Design.

3.2.4 Building Structure and Dimensions

The main bays of the cave dwellings range from 2.8m to 4m, while the depth varies flexibly between 6.5m and 10.5m depending on the overall size of the pit courtyard. The height is approximately 3m to 3.5m.

The spatial form of the cave is defined by an arched structural system. Structurally, the arch crown acts as the central point of force transmission, with loads distributed symmetrically to both sides, resulting in a stable center of gravity and high structural stability. To further enhance stability, some caves incorporate timber posts placed above the arch, spanning along the bay direction to support both sides of the vault and resist lateral thrust. According to the geometric characteristics of the arch crown, they can be classified into two main types, the pointed-arch cave (double-centered arches) and the round-arch cave. In the Sanmenxia region, pointed-arch caves are predominant, whereas round-arch caves are more common in the Luoyang and southern Shanxi regions.

Fig. 28 *The Timber Post in Cave.* Photo by the author.

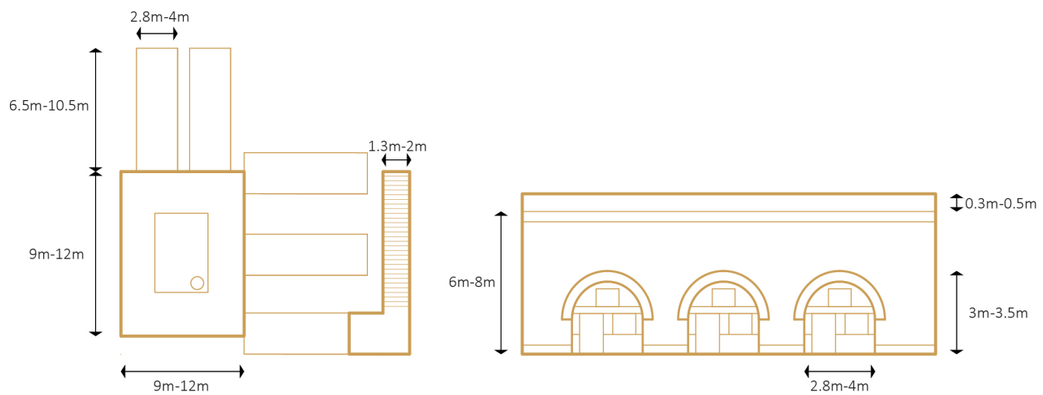


Fig. 29 *Dimensions of the Pit Courtyard.* Drawn by the author.

3.2.5 The Entrances

The entrance cave to a pit courtyard serves as the essential bridge connecting the underground living space with the outside above ground. The constructors of the pit courtyards cleverly utilized the terrain, designing various entrance types. The sunken ramps at the entrances are typically 1.3-2 meters wide. The entrance caves, in terms of their planar form, are mainly categorized as straight-entry, L-shaped, and rotary.

In terms of plan configuration, entrance caves can be classified into four main types: direct access entrance cave, passage entrance cave, ramp entrance cave, and stair entrance. The direct access entrance is primarily determined by topographic conditions. When the ground level on one side of the pit courtyard is relatively low and close to the courtyard floor level, the courtyard can be entered directly through a straight entrance without any elevation change. The passage entrance is the most common form in pit courtyards. It consists of a sloped passage provided with steps, facilitating pedestrian movement. The ramp entrance differs from the passage entrance in that it does not include stepped sections, instead, a relatively gentle ramp surface is used, which greatly facilitates the movement of transportation and animals. The stair entrance is distinct from the other three types. Rather than forming a separate cave passage, it is directly excavated along one side of the pit courtyard wall. Steps are carved following the terrain, allowing direct vertical connection between the ground surface and the underground courtyard, thereby reducing construction work (Wang, 2008).

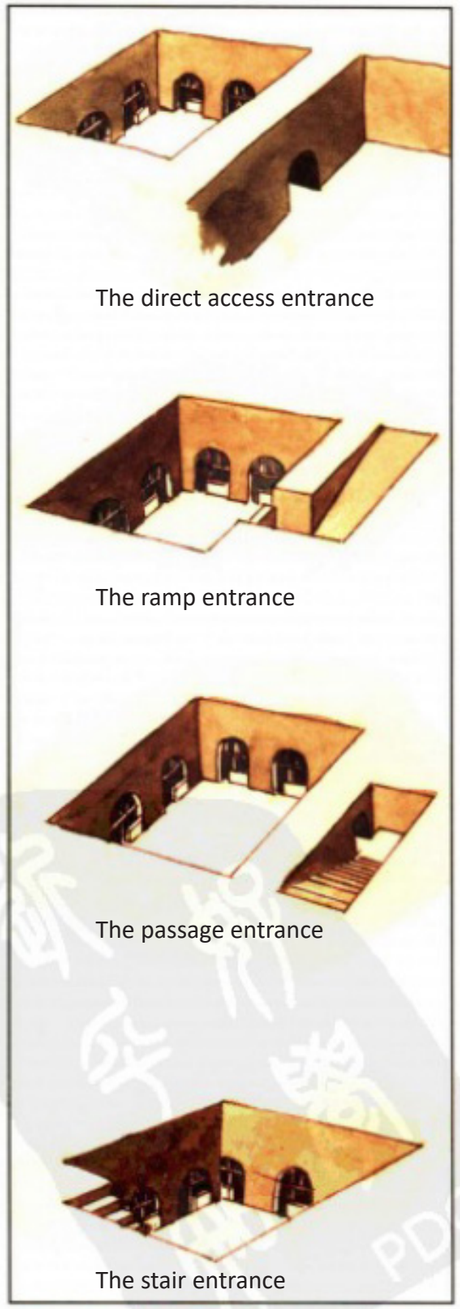


Fig. 30 *Four Types of Entrance Caves.*
Wang, Q. (2008). Illustrated Guide to Chinese Dwellings

3.2.6 The Drainage System

As underground structures built in collapsible loess, the core challenge for the survival of pit courtyards is the management of water. To resist rain erosion and surface runoff, the traditional construction process constructed a comprehensive drainage and defense system, covering the entire process from surface interception to underground absorption.

The ground around the central courtyard of the pit courtyard, which is also the space above the top of the cave, usually needs to be frequently compacted and leveled, and sloped and drained. All vegetation should be removed to prevent downward seepage and reduce the risk of collapse.

On the top of a pit courtyard, to prevent surface runoff from flowing back into the pit and eroding its fragile edges, builders built the *Lanmaqiang* (parapet wall) which is approximately 30 to 50 centimeters high around the four sides of the pit opening connected with the ground. Functionally, the parapet wall was not only a safety barrier to prevent people and livestock from falling, but also to prevent rainwater from flowing in.

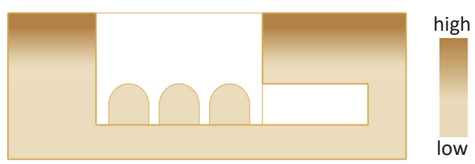


Fig. 31 *Schematic Diagram of Soil Density.*
Drawn by the author.

For the facades, the focus of protection shifts to the construction of a cave face protection system to prevent erosion caused by rainwater flowing along the walls. At the joint of the pit courtyard facade and the cave face, builders typically use protruding bricks or adobe to form an arch cave eave, to deflect rainwater from above away from the wall surface and protect the wooden door and window components and the straw and mud plaster layer below.

As a closed, sunken space, the pit courtyards cannot drain water horizontally like aboveground buildings through ditches. Its core rainwater management relies on a *Shenjing* (seepage well) at the lowest point of the courtyard. The well is typically located in the middle of the courtyard, dug deep through the loess layer to 5 to 10 meters underground, utilizing the pores of the deep loess for natural infiltration. The courtyard ground is sloped inwards towards the seepage wells, allowing rainwater collection and draining directly into the deep underground, preventing it from accumulating in the courtyard.

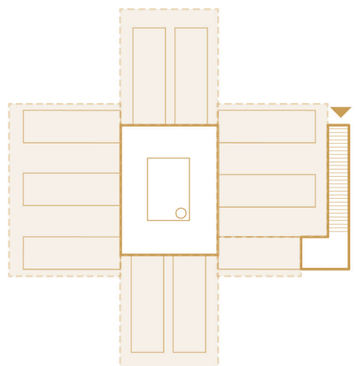
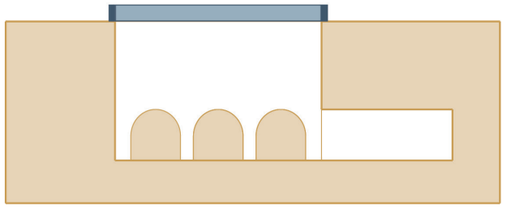
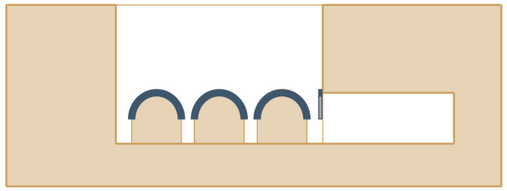


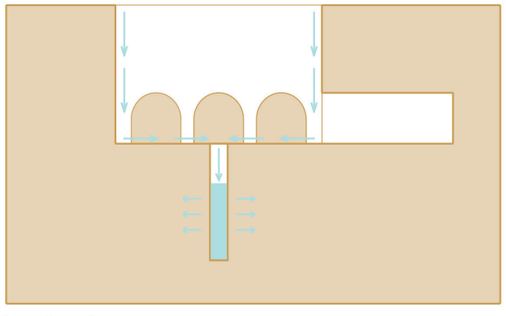
Fig. 32 *The Range of Compacted Ground.*
Drawn by the author.



Lanmaqiang (Parapet)



Cave Eaves



Shenjing (Seepage Well)

Fig. 33 *The Drainage System.* Drawn by the author.

3.3 Materials and Construction Technology

3.3.1 Material Composition and Properties

The material of pit courtyards exhibits an extremely special characteristic, with its main structural system almost entirely dependent on native loess. This native material strategy is not only a passive choice under limited economic conditions, but also reflects the utilization of the physical properties of raw loess in the regional environment. However, the water sensitivity nature of this material becomes the core issue in the preservation and revitalization of pit courtyards.

As the primary material of pit courtyards, the loess is characterized by a distinctive micro-granular structure. The cementation effect associated with clay minerals and calcium carbonate contributes to the metastable fabric and mechanical strength of loess in the dry state (Jian, Kong, Bai, & Sun, 2022). This helps explain why the vertical facade of pit courtyards and the arched vaults of caves can remain stable for long periods under dry conditions.

However, loess is also a typical collapsible soil. It commonly exhibits a loose, metastable structure that can undergo a large reduction in volume upon wetting, together with a marked loss of structural strength (Li, Vanapalli, & Li, 2016). This physical property determines that water is the primary threat to the structural safety of pit courtyards.

To overcome the drawbacks of the loess surface, such as easy peeling and dust generation, traditional artisans developed straw–mud plaster as an early form of composite surface protection for both interior and exterior walls (Knapp, 2000). Laboratory studies on earth plasters show that incorporating natural fibres such as wheat straw can reduce drying shrinkage and suppress shrinkage crack formation (Ashour & Wu, 2010). More importantly, unlike the relatively lower-permeability cement-based finishing layers that can hinder moisture transfer, porous mineral or earthen-based plasters support moisture buffering and moisture transfer across the envelope (Damle, Khatri, Rawal, 2022). This allows moisture within the wall to evaporate and contributes to maintaining a more stable indoor hygrothermal condition.

Compared to the dominant use of raw loess, woods and fired materials such as bricks and tiles were considered luxuries in pit courtyards due to their scarcity, serving only as auxiliary materials and used at key construction details. Grey bricks were mainly used at the parapet, the courtyard eaves, the cave eaves, and the plinth, to resist rain erosion or mechanical wear. Wood is used only for door and window frames and indoor furniture.

Fig. 34 *The Building Materials.* Photo by the author.

3.3.2 Traditional Construction Tools

The construction of the pit courtyards relies heavily on traditional labourers and hand tools that have evolved over generations of local experience and developed in close response to the properties of loess soil. According to their function in the construction process, these tools can be classified into five main categoriesd.

Setting-out tools
Used at the initial stage to define the layout and dimensions of the courtyard and cave entrances. These include *chi* (measuring ruler), *xiansheng* (string line), *futou* (axe), and *mujue*(wooden peg), which together ensure accurate alignment and spatial order before excavation begins.

Digging tools
These are essential for excavating the pit courtyard and the lateral caves. Tools such as *gao* (pickaxe), *juetou* (hoe), and *xian* (shovel) are used to cut and loosen the loess soil, allowing the pit and interior spaces to be shaped directly from the ground.

Transport tools
To remove and redistribute excavated soil, common tools include *biandan* (shoulder pole), *luokuang* (basket), *gulu* (windlass), and *jiaziche* (wheelbarrow), which enable soil to be carried from the pit to the ground surface through coordinated manual labour.

Fig. 35 *Tools Used for Construction.* Wang, H. (2013). Zhong Guo Chuan Tong Jian Zhu Ying Zao Ji Yi Cong Shu

Masonry and finishing tools
These are applied during wall shaping, surface treatment, and detailing. These include *nidou* (mud container), *niban* (mud board), *nimo* (mud trowel), *wadao* (brick knife), *xianzhui* (plumb bob), and *zhuanjia* (brick clamp). These tools are used to shape openings, align masonry elements, and apply loess or straw-mud plaster to protect exposed surfaces.

Compaction tools
These are used to consolidate soil and surface layers where higher density and stability are required. Tools such as *chu* (pestle) and *hang* (rammer) help improve surface durability and structural performance (Wang et al., 2013).

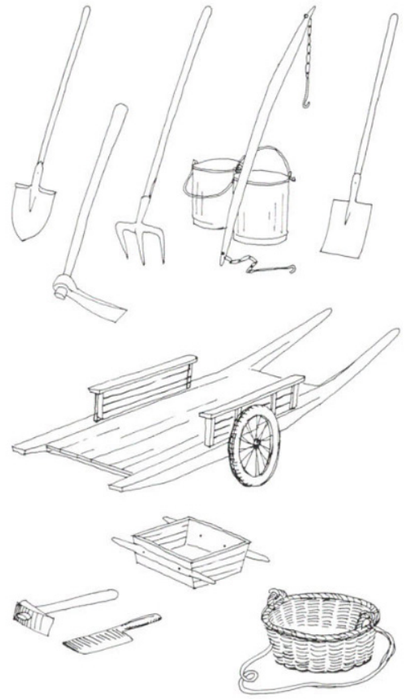


Fig. 36 *Tools Used for Construction.* Golany, G. (1992). Chinese Earth-Sheltered Dwellings: Indigenous Lessons for Modern Urban Design

3.3.3 Traditional Construction Processes

The construction of traditional pit courtyards is a step-by-step process that closely responds to local topography, soil conditions, and everyday living needs. According to traditional practice, the construction follows a clear sequence, beginning from ground-level planning and gradually moving downward into the earth.

Selecting the Site

The construction begins with defining the square courtyard at ground level. Before excavation, builders select a flat area with sufficient loess depth and good drainage conditions. The orientation, size, and position of the courtyard are determined based on sunlight, prevailing winds, and local experience. Simple setting-out methods are used to mark the boundaries of the courtyard and the locations of the main cave rooms. This stage establishes the basic spatial framework of the dwelling.

Excavation of the Courtyard

After the layout is fixed, excavation starts by digging vertically downward to form the pit courtyard. The pit is usually rectangular or square in plan and several meters deep. Soil is removed manually and transported to the ground surface. After the initial excavation, the courtyard walls and floor are carefully trimmed and levelled to form clear edges and stable vertical faces. At this stage, the courtyard becomes a usable open space that organizes circulation and daily activities.

Excavation of the Caves

Once the courtyard is completed, cave rooms are excavated horizontally into the surrounding courtyard walls. The position and number of caves depend on household needs. Excavation usually starts with the main cave and continues with secondary caves. Openings are shaped carefully to ensure structural stability, and the interior space is gradually formed by cutting and smoothing the loess. The depth and height of the caves are controlled by experience rather than precise measurement.

Treatment of Cave Faces and Interior Facilities

After the caves are formed, attention shifts to the treatment of cave faces and interior spaces. The entrances are shaped and reinforced, and simple doors and windows are installed. Interior surfaces are finished with straw and mud mixed plaster. At the same time, a heated *kang* bed used for sleeping and living is constructed inside the caves. The bed is connected to the stove, allowing heat to circulate through internal channels before being discharged, improving indoor thermal comfort during winter.

Rainwater Drainage

The final stage focuses on water management. Because the pit courtyard is located below ground level, drainage is essential for long-term stability. A seepage well is dug within the courtyard to collect rainwater, allowing water to infiltrate into deeper soil layers. This system helps prevent water accumulation and protects the loess walls from erosion.

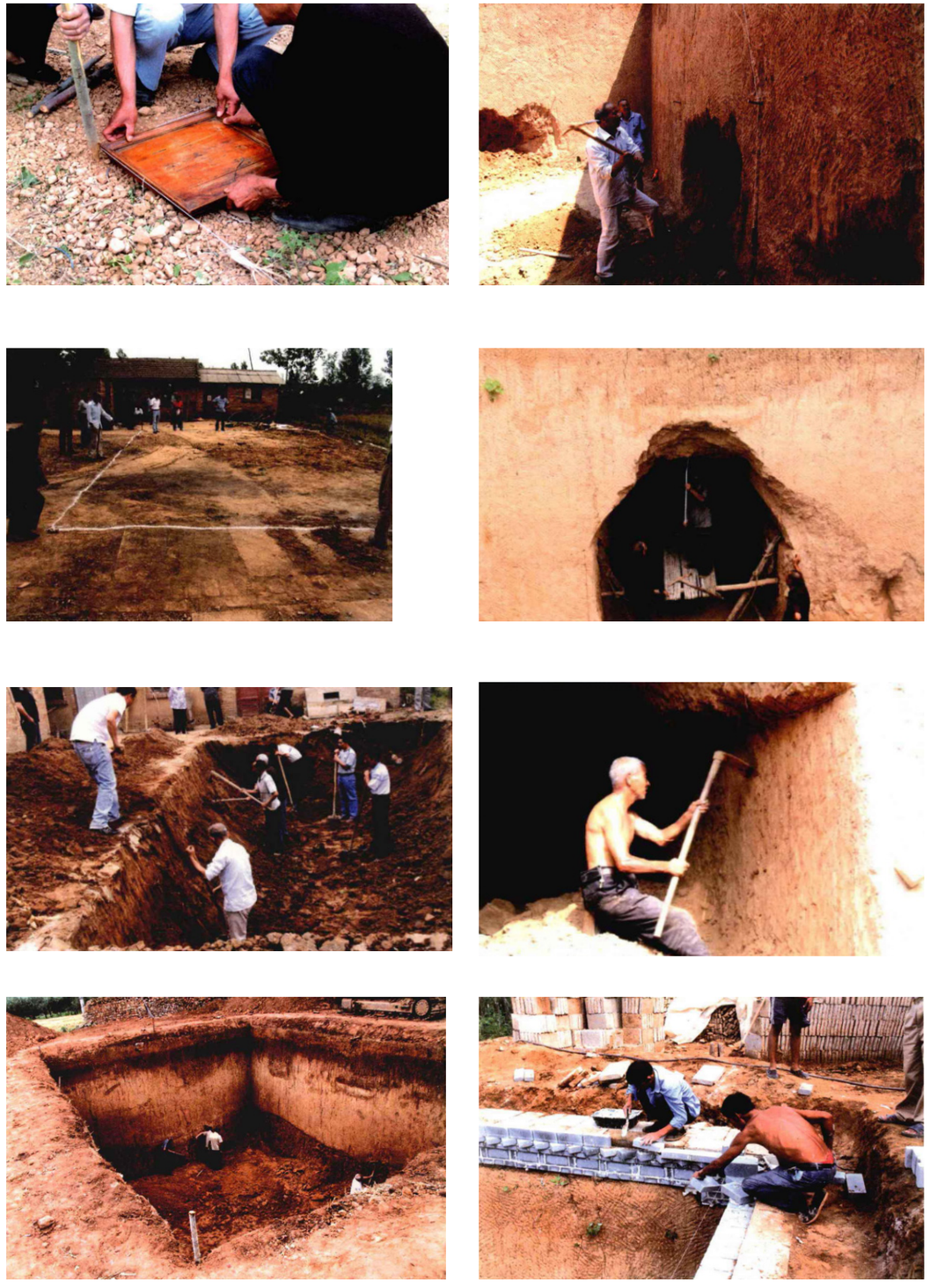


Fig. 37 *The Construction Process.* Wang, Q. (2008). Illustrated Guide to Chinese Dwellings

3.4 Everyday Life in Dikengyuan

3.4.1 The Shared Family Life

The unique negative space form of the pit courtyards shaped the daily lifestyle of their inhabitants. Within this extremely introverted architectural prototype, the living pattern exhibits a significant centripetal characteristic.

Inside a single pit courtyard, the courtyard, as the only lighting space and connection for all lateral cave dwellings, constitutes a public place for family life. In an era without modern partitions and privacy concepts, life inside the pit courtyard was highly transparent. Cooking, laundry, sewing, drying crops, and other household chores are all openly carried out in the courtyard. For example, when a woman cooks on the stove in a corner of the courtyard, her figure is completely within the line of sight of the elders who live in the main cave. The children play in the courtyard and are always under the care of adults. This uninterrupted visual relationship makes there almost no secrets between family members. Although this may seem lacking in privacy in modern times, in traditional agricultural societies, this close sense of spatial distance greatly promotes emotional communication and mutual assistance among family members, forming a close living community.

3.4.2 The Cultural Life in Agricultural Context

As a dwelling form rooted in agriculture, the pit courtyard functions not only as a living space but also as an extension of farming activities. With the progression of agricultural seasons, the use and appearance of the courtyard change accordingly. During the autumn harvest, crops such as corn and chili peppers are commonly dried on the cave facades or spread across the courtyard ground, or also above the surrounding ground. These drying activities temporarily transform the visual character of the space, introducing vivid colors into an environment otherwise dominated by earth tones. At this time, the courtyard serves both as a working area and as a place where household labor and harvest results are visibly displayed, reinforcing the connection between daily life and agricultural production.

Of folk decoration, Western Henan preserves distinctive traditions of local paper cuttings. Unlike the red window decorations commonly seen in other regions of China, black paper cuttings are widely used on windows in this area. Placed against white window paper, black paper cuttings create a strong visual contrast, making windows more legible as openings between interior and exterior spaces. During festival periods, the motifs often depict mythical figures or auspicious symbols and are associated with wishes for protection and well-being (Wang, 2013). These decorative practices enrich the cultural atmosphere of the dwelling, giving the living space greater meaning at specific moments of the year.

Fig. 38 *Life in Dikengyuan.*
Left: http://www1.rmhb.com.cn/chinese/tour/201602/t20160217_800049014.html
Right: https://news.gmw.cn/2020-02/09/content_33537114.htm

Fig. 39 *The Paper Cutting and Life in Dikengyuan.* Photo by the author.

Fig. 40 *Dikengyuan in the Autumn Harvest Season.*
Above: https://sx.ifeng.com/c/8oLk12mtKsY
Below: https://news.gmw.cn/2020-02/09/content_33537114.htm

3.5 Current Situation, Crisis, and Conflicts

3.5.1 Decay of Physical Texture

With the acceleration of urbanization in western Henan, a large number of original inhabitants have moved to modern houses, leading to a severe depopulation trend in the pit courtyard settlements. In the 2000s, there were over 2000 pit courtyards in Shaanxi County, western Henan, but now there are fewer than 1000 left (Ji, 2020). This sociological phenomenon directly led to the destruction of the buildings. Unlike highly durable brick or concrete buildings, the structural integrity of the pit courtyards, as an earthen architecture, highly depends on continuous human maintenance (Correia, 2016). As pointed out in his study of Chinese dwellings, earthen architecture is essentially an organism (Knapp, 2000). Therefore, the daily maintenance by inhabitants, such as compacting the ground after rain, cleaning drainage ditches, and repairing the straw mud mixed plaster on the facade, is the key external force for maintaining its resistance to natural erosion. Once this human intervention comes from residential behavior is lost, the fragile soil is quickly exposed to the disorderly attack of natural forces, leading to irreversible pathological decay of the physical fabric.

It shows that this decline is primarily a chain reaction driven by water erosion. In the traditional space utilization of pit courtyards, the flat ground at the top of the courtyard was often used as an agricultural threshing ground. During the busy harvesting season, farmers would repeatedly roll the grain on the ground with stone rollers. This seemingly purely agricultural activity actually played a crucial role in compacting and waterproofing the soil. The high-intensity rolling damaged the large-pore structure of the loess surface, forming a dense, impermeable crust that effectively blocked the vertical infiltration of rainwater (Hou, Ren, Zhou, & Li, 2018). However, with the relocation of the original inhabitants and changes in agricultural production methods, the soil layer covering the caves gradually loosened, forming micro cracks under rainwater erosion.

The damage to the drainage system of the pit courtyard, especially the parapet and the seepage well, is also catastrophic. The poorly maintained parapet quickly collapsed under wind and rain erosion, losing its water blocking function and causing surface runoff to directly flow into the courtyard, eroding the most fragile vertical cave surface. The siltation of the seepage well causing rainwater to accumulate at the bottom of the courtyard and soften the foundation, and the strength of the structure at the bottom of the cave rapidly decreases. The damage to the foundation and the leakage at the top jointly damaged the structure, leading to the overall collapse of the pit courtyard.

In the meantime, uncontrolled natural vegetation rapidly takes over abandoned pit courtyards. As weeds and shrubs search for moisture, their root systems penetrate the loess layers and cause mechanical damage to the soil. The growth of plant roots not only fractures the original soil structure, but the voids left by decayed roots also become channels for deep rainwater infiltration, further intensifying freeze–thaw damage within the soil mass.

This process of deterioration, driven by the combined effects of soil erosion and biological weathering, has caused many pit courtyards with high historical and cultural value to deteriorate from habitable living spaces into unrecognizable loess ruins within only a few years, resulting in the irreversible physical destruction of this regional architectural heritage.

Fig. 41 *A Farmer Is Compacting the Land with a Roller.*
https://baijiahao.baidu.com/s?id=1673062606814412852&wfr=spider&for=pc

Fig. 42 *A Collapsed Dikengyuan.*
https://baijiahao.baidu.com/s?id=1673062606814412852&wfr=spider&for=pc

3.5.2 Limitations to Modern Living Needs

One of the biggest technological issues to the modernization of pit courtyards is the lack of the modern sanitation system. In the traditional agricultural period, inhabitants relied on outdoor dry toilets and seepage wells to solve their excretion and sewage problems. However, in the context of modern life, independent toilets and shower facilities have become essential living needs.

However, the high collapsibility of loess soil makes the laying of modern pipelines full of risks. Once there is a small leakage in the underground water supply and drainage pipelines, the moisture will quickly soften the foundation soil, leading to structural collapse. This characteristic makes it difficult and costly to simply implant modern pipeline systems in underground pit courtyards. Therefore, most of the pit courtyards that remain in their original state are still using unsanitary dry toilets, which directly leads to the escape of the younger generation due to the lack of basic infrastructure.

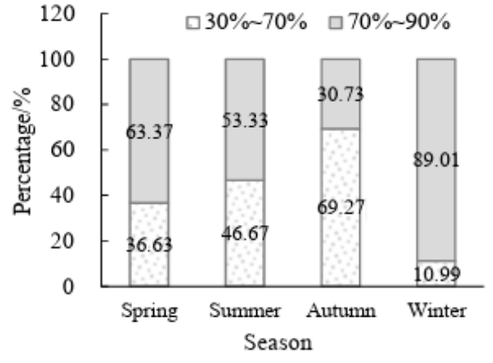


Fig. 43 *Indoor Air Relative Humidity Chart.*
Zhu, J, et al. (2019). Climate Responsive Characteristics of Cliff-side Cave Dwellings in Cold Area of China

Although the pit courtyard is often described as a vernacular architecture that warm in winter and cool in summer, further monitoring of the actual indoor environmental quality reveals its high humidity and weak ventilation, especially in the rainy season. In many cases, caves are ventilated mainly through the single opening facing the courtyard, which limits air exchange and makes it difficult to remove moisture effectively.

Measured data from pit courtyards on the Loess Plateau indicate that summer indoor relative humidity can reach a high range. For example, one monitored study reported that indoor air relative humidity varied from about 68.3% to 87.6% in summer (Zhu, Nie, Li, Tong, & Zhao, 2018). Such long-term damp conditions create a favorable environment for surface mold and microbial growth, and they can worsen moisture-related health discomfort reported in local living experiences.

Daylighting is another structural limitation. Because natural light mainly enters from the courtyard-facing opening, illuminance drops rapidly with increasing room depth. A study on the indoor light environment of traditional pit courtyard shows that even under natural light at 12:00 noon, the indoor illuminance and daylighting coefficient of the cave dwelling are only 150.5 (lx) and 1.35% (Kong et al., 2025). That implies that the middle and rear parts of deep caves cannot meet basic daylighting needs without artificial lighting.

Fig. 44 *Daylighting and Ventilation of the Cave.* Drawn by the author.

3.5.3 The Stigmatization

Besides its physical limitations, the pit courtyard also faces severe challenges at sociological and psychological levels. In the narrative of rural urbanization over the past few decades, living in a modern apartment has been constructed as a symbol of modernization and wealth, while living in a pit courtyard has gradually become a symbol of poverty, backwardness, and poor sanitation.

This stigmatization of spatial identity means that even families who live in relatively good condition pit courtyards will choose to move away due to their psychological desire to improve their social status. As a result, the pit courtyard has not only become functionally ineffective but has also been abandoned in a symbolic sense by its original inhabitants.

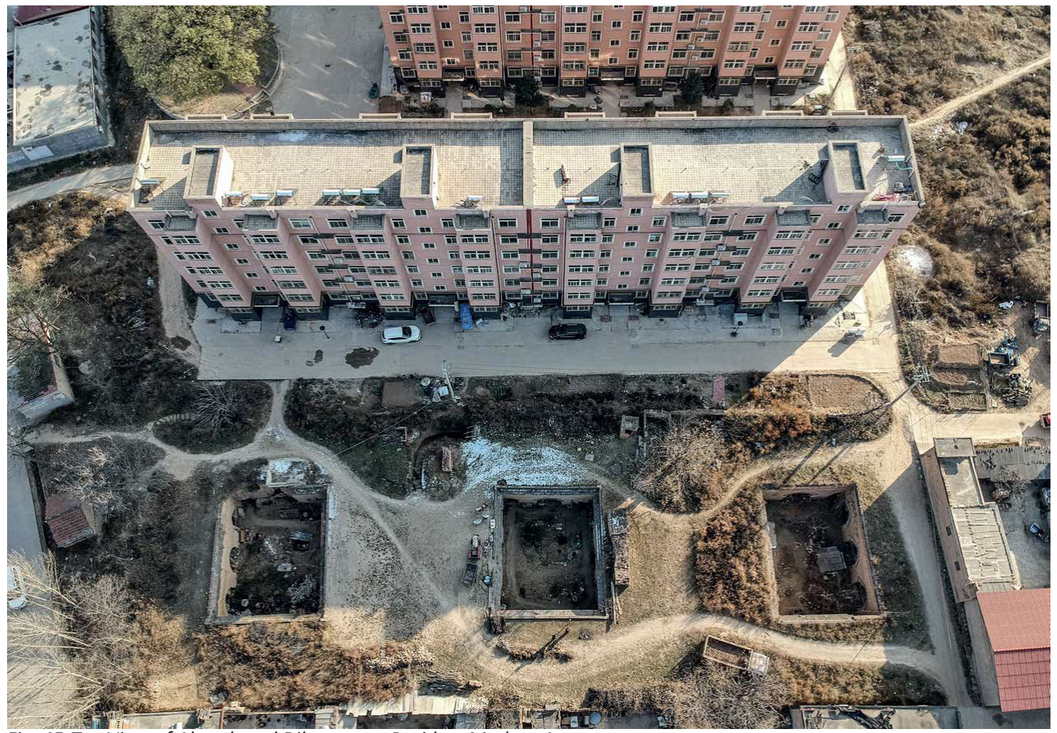


Fig. 45 *Top View of Abandoned Dikengyuan Beside a Modern Apartment.*
Lin, J and Devabhaktuni, S. (2020). AS FOUND HOUSES: Experiments from Self-builders in Rural China.

3.5.4 The "Constructive Destruction"

With the inclusion in the Chinese Traditional Village of some pit courtyard settlements, some regions have initiated an emergency conservation and restoration project without scientific guidance. However, due to ignorance of the physical properties of the earthen material and misinterpretation of the rural landscape, these conservation eff orts often go against the authenticity of heritage.

A common problem lies in the inappropriate use of modern construction materials and techniques. Cement mortar, concrete paving, and impermeable surface coatings are often introduced to reinforce the loess facade, cave interior surfaces, and courtyard floors. These materials, however, are fundamentally incompatible with the hygroscopic and breathable nature of earthen construction. By blocking moisture exchange and natural evaporation, such interventions accelerate internal dampness, salt crystallization, and surface peeling, ultimately increasing the risk of structural deterioration rather than preventing.

In addition, simplified restoration practices reshaped the spatial and visual character of pit courtyards. The facades were rebuilt to uniform heights, and surfaces were smoothed with mortar to create a clean appearance to meet contemporary aesthetic expectations. These actions erased traces of everyday use, repair, and weathering. As a result, the restored environment lost its historical information and material authenticity.

Beyond specific technical issues, some renovation work has also been a problem. On field research, it has been found that economic pressure has led some residents to introduce new structures into traditional pit courtyards. In a pit courtyard in Qu village, a household constructed a lightweight prefabricated shed within the courtyard to support the local agricultural production of persimmon vinegar processing. The new building blocks ventilation, sunlight access, and visually fragments the continuous earthen facade. Although the intervention responds to contemporary economic needs, the inserted structure occupies the central open space of the courtyard and interrupts the pit courtyard's original spatial order.

Fig. 46 *The New Built Structure in the Pit Courtyard for Local Agricultural Product Processing.* Photo by the author.

A more extensive form of transformation can be observed in the large-scale redevelopment of the pit courtyard in Shanxian as a tourist attraction. In this case, conservation is replaced by comprehensive reconstruction and spatial reorganization. The original village layout, characterized by dispersed courtyards embedded within agricultural land, has been replaced by a highly formalized and centralized scenic layout. Newly constructed symbolic elements, such as oversized city gates and axial plazas, bear little relation to the historical settlement pattern or everyday spatial logic of the original community.

Although such projects aim to enhance visibility and tourist appeal, they fundamentally reshape the cultural landscape. The resulting environment no longer reflects the incremental, lived-in character of the pit courtyard settlements, but instead presents a staged and homogenized image of fake heritage. In this process, the physical fabric, spatial hierarchy, and social meaning of the original village are replaced by a designed spectacle, leading to a loss of authenticity that is difficult to reverse.

These forms of constructive destruction reveal a misunderstanding of both loess as the building material and the underground landscape of the settlements. The intervention is transforming living heritage into static displays. In the long term, such practices destroy the integrity and authenticity of the pit courtyards and will produce irreversible loss.

Fig. 47 *Entrance of a Dikengyuan Tourist Attraction.* https://hk.trip.com/travel-guide/attraction/sanmenxia/shan-zhou-silo-cave-30455661/

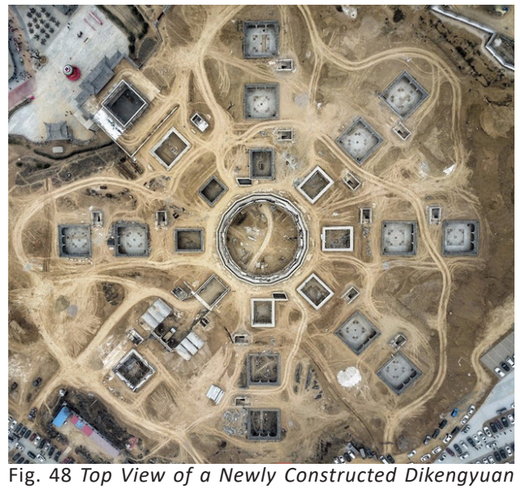


Fig. 48 *Top View of a Newly Constructed Dikengyuan Hotel.* https://www.chinaservicesinfo.com/s/201807/13/WS5b7815bc498e855160e8b24a/shanzhou-cave-dwellings-listed-as-provincial-cultural-industry-demonstration-base.html

Fig. 49 *Aerial Rendering of the Dikengyuan Tourist Attraction Master Plan.* https://www.hebitv.com/news/13375

04

SASSI DI MATERA: PRACTICE OF HERITAGE CONSERVATION AND REUSE

Fig. 50 *The Sassi and the Park of the Rupestrian Churches of Matera.*
https://whc.unesco.org/en/documents/137499

4.1 Case Selection

4.1.1 Spatial Organization of Sassi di Matera

The UNESCO World Heritage Site of Matera comprises two distinct territorial components: *I Sassi* (The Sassi) as the urban settlement, and *Il Parco delle Chiese Rupestri di Matera* (The Park of the Rupestrian Churches of Matera) as the natural archaeological park that is located on the opposite side of the Gravina ravine (UNESCO, 1993).

Within the Sassi, the site configuration is determined by the natural topography of the calcarenite plateau. The settlement is organized around a central vertical promontory named the *Civita*. The urban fabric is divided into two large parts: the *Sasso Barisano* located to the northwest, and the *Sasso Caveoso* located to the south (Laureano, 1993).

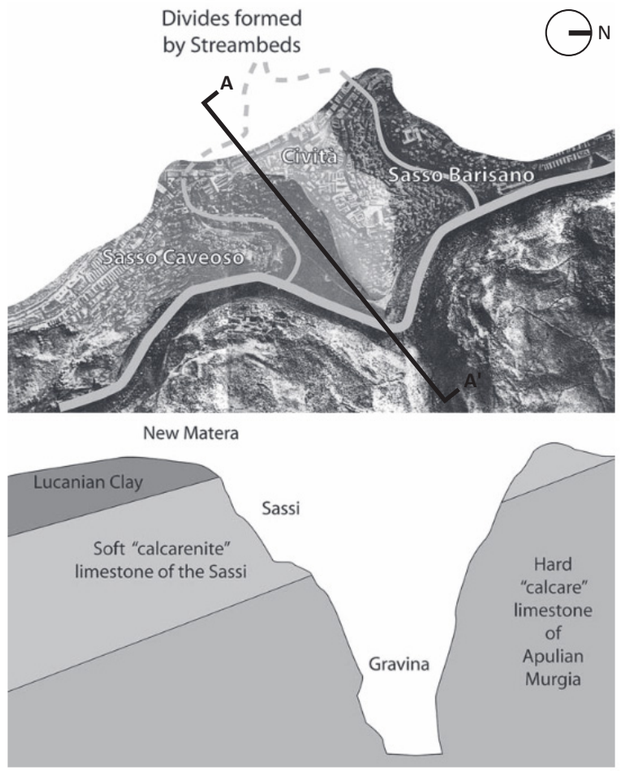


Fig. 51 *Section and Aerial Illustration of the Sassi in Relation to Surrounding Geography.* McMillan, P. (2016). Provincial Capital vs. Peasant Capital: A Subaltern Perspective on Urban Rise and Fall from Grace. Edited by the author.

Il lamione is the structure formed through the gradual transformation of caves. It consists of a single rectangular space covered by a barrel vault, usually constructed in masonry in front of or above the original cave. Structurally, the lamione extends habitation from the excavated interior cave toward the exterior space, creating a clear built facade while maintaining continuity with the rock cave behind. This construction represents a transitional condition between caves and buildings, with the rear and sometimes the sides remaining embedded in the rock, while the front wall and vault are constructed. The lamione allowed the enlargement of living space, improved access to light and air, and supported vertical and horizontal aggregation along the slope.

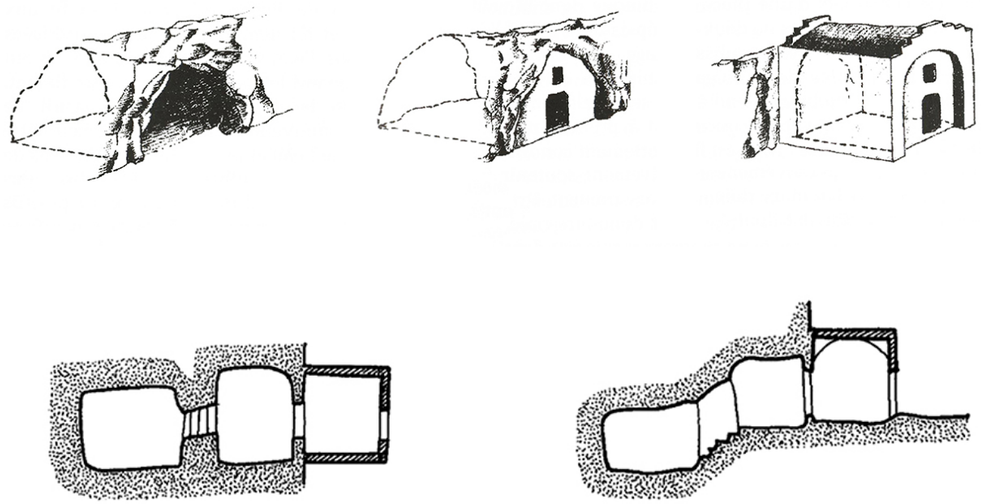


Fig. 52 *Il lamione.* Laureano, P. (1993). Giardini di pietra : i sassi di Matera e la civiltà mediterranea.

4.1.2 The Architectural Typology Similarity

From the perspective of architectural typology, the pit courtyards in the Loess Plateau in China and the ancient town of Sassi di Matera in Italy, though situated in vastly different geological environments, exhibit a high degree of isomorphism in their logic of spatial generation. According to statistics released in 1938 by the Hygiene Office of the Municipality of Matera, out of 2,997 houses recorded, 1,641 are cave dwellings, equal to 54.85% of the total number of houses in the Sassi districts (Fontana, 2018). Both as the troglodyte settlements, they belong to the typical subtractive architecture, that the living space is obtained through excavation and carving into the natural environment as an organic extension of nature.

In the pit courtyards, this continuity is manifested in the integration of the courtyard with the loess soil. In Matera, it is manifested in the symbiotic relationship between the cave facade and the rock walls. This construction method, opposed to the modern main additive architecture that forms solid structures through the addition of materials, determines the deep connection between the two in terms of physical attributes and aesthetic characteristics. This fundamental consistency in construction methods provides a solid typological foundation for the cross-cultural comparative analysis in this thesis.

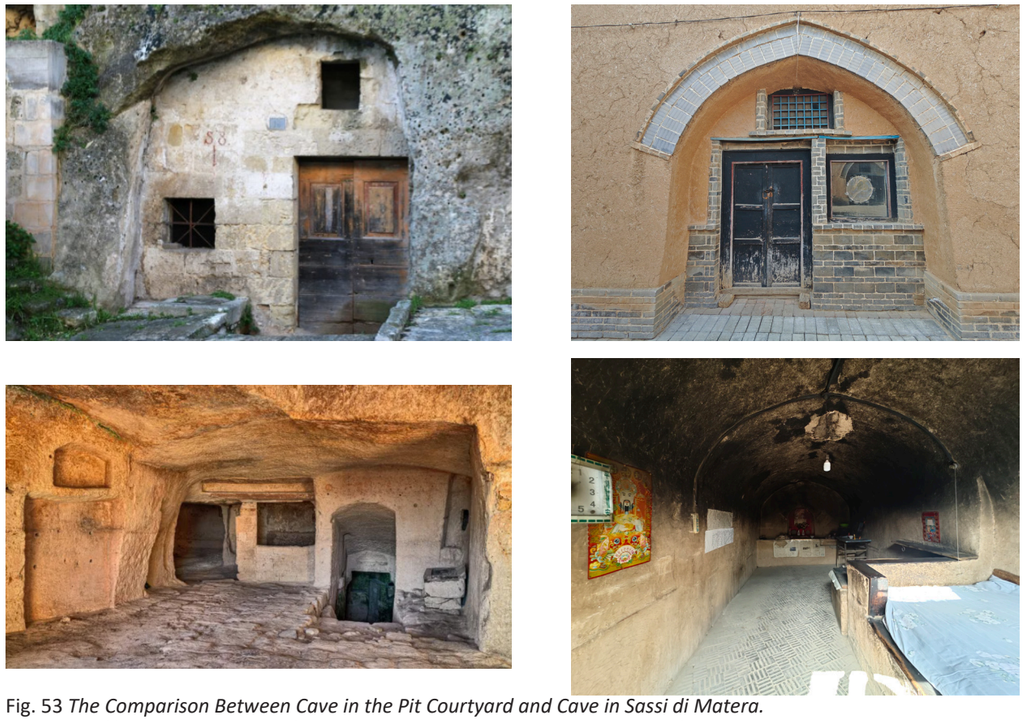


Fig. 53 *The Comparison Between Cave in the Pit Courtyard and Cave in Sassi di Matera.*
Left: https://montenegro-for.me/2019/01/matera-the-city-of-cave-dwellings/
https://aleteia.org/2019/02/27/matera-the-southern-italian-city-where-residents-live-in-prehistoric-caves/
Right: Photo by the author.

Il vicinato is the basic social and spatial unit of Sassi di Matera, formed by a small group of dwellings arranged around a shared open space. This space is usually an irregular courtyard or widened path, directly accessible from the entrances of the houses. It functioned as an extension of domestic space, accommodating everyday activities such as cooking, food processing, childcare, and small-scale work. Because the openings of houses face directly onto the vicinato, daily life took place in constant visual contact, reinforcing close social relations and collective use of space (La Città dell'Uomo. it, n.d.).

In the pit courtyards, the spatial organization of public space is similar. The pit courtyard, although excavated vertically into the earth, performs a similar role by concentrating daily activities within a central, shared, and enclosed courtyard. In both cases, individual cave dwellings are organized around a common open space that acts as the primary interface between private interiors and communal life. This open space enables efficient circulation, mutual visibility, and shared use of resources, demonstrating a common architectural response to collective living based on excavation and spatial proximity rather than formal public infrastructure.

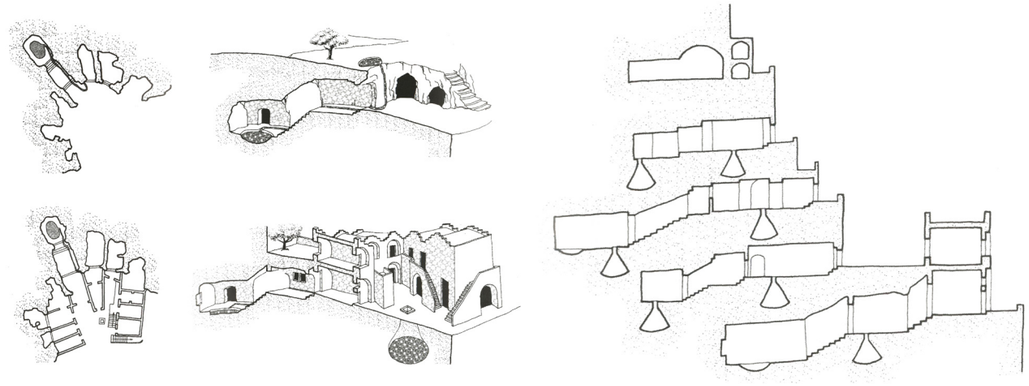


Fig. 54 *Formation of Il vicinato.*
Laureano, P. (1993). Giardini di pietra : i sassi di Matera e la civiltà mediterranea.

From the perspective of heritage categorization, both of them conform to the characteristics of **Underground Built Heritage (UBH)** as defined by Varriale (2021). This typological isomorphism means that both of them are facing similar physical issues and challenges. On the one hand, both rely on the high thermal mass and thermal inertia of thick surrounding materials, exhibiting thermal properties that provide warmth in winter and coolness in summer; on the other hand, they also share the lighting and ventilation problem of having a single opening facade.

Therefore, the experience gained in Matera over the past half-century in addressing negative spaces in rock formations, such as using minimally invasive techniques to solve moisture-proofing, lighting, and the implantation of concealed infrastructure, has direct technological reference for the pit courtyard.

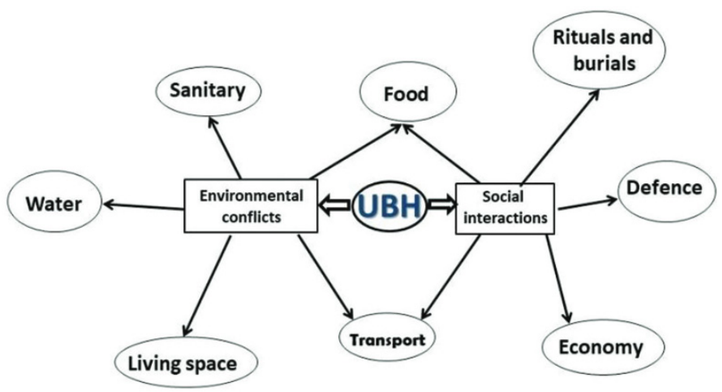


Fig. 55 *The Underground Built Heritage chart.* Varriale, R. (2021). "Underground Built Heritage": A Theoretical Approach for the Definition of an International Class.

4.1.3 The Historical Path Similarity

Besides their similar architectural spatial forms, the pit courtyards and Sassi di Matera also show a similar characteristic in terms of social and historical evolution processes. Both originated as dwelling forms shaped by adaptation to local environmental conditions, later faced decline and functional challenges under the impact of modern lifestyles, and have gradually been recognized for their heritage value. By comparison, the pit courtyards are still in the middle stage of this transformation process.

Fig. 56 *View of the Sassi in the 1960s.* Ranieri, L. (1972). Basilicata.

With the development of modernization, this form of cave dwelling which came from poverty quickly encountered a crisis of stigmatization. For Matera, this crisis peaked in the 1950s. Due to extreme overpopulation and a lack of modern infrastructure, Matera experienced a severe infant mortality wave and malaria crisis. In 1937, the child mortality rate in the Sassi region reached 44.32% (Ivona, A. Rinella, & F. Rinella, 2019), the situation that was described as a *Vergogna Nazionale* (National Shame) by then-Italian Prime Minister Alcide De Gasperi. This dual collapse of the environment and sanitation directly led to the enactment of Law No. 619, of 17 May 1952, *Risanamento dei rioni dei "Sassi" nell'abitato del Comune di Matera* (Renovation of the "Sassi" districts in the municipality of Matera), which initiated a 15-year-long forced relocation, completely moving approximately 17,000 residents from unsanitary old cave dwellings to newly built residential areas. To prevent residents or others from moving into these houses, the government fenced off the blocks and vacant buildings, causing the Sassi area to become a desolate ghost town for a time (Ivona et al.).

This historical context provides a precise parallel to the current situation of the pit courtyards. With the advancement of urbanization in rural China, these cave dwellings that lack of modern infrastructure have also become entrenched as symbols of poverty and backwardness, leading to the abandonment by the original inhabitants and the hollowing out of the village. In a sense, today's Dikengyuan is yesterday's Matera.

4.2 Policy-Driven Transformation of Matera

4.2.1 Top-Down Governance and Policy

Compared to being stuck in the state of abandonment and backwardness, the unique value of the transformation of Sassi di Matera is its successful value reversal through institutional change.

In 1986, facing a vast amount of abandoned heritage and a shortage of government funds for restoration, the Italian government enacted the landmark Law No. 771/86. The Law No. 771, of 11 November 1986, *Conservazione e recupero dei rioni Sassi di Matera* (Conservation and recovery of Matera's Sassi) creatively solved the most intractable problems in heritage protection: ownership and funding.

According to the policy, the law established a governance model of state ownership and concession strategy. The government first reclaimed ownership of the abandoned caves through buyouts, resolving the issue of fragmented ownership. Subsequently, the government leased these cave assets to private investors, artisans, or cultural institutions at symbolic low rents for a long term, to encourage the lessees to make long-term investments and maintenance of the building. In exchange, the lessees and concessionaires were required to take the responsibility for restoration strictly under the government's conservation plans (Varriale, 2019). This system successfully transformed the burden of conservation into operational assets, activating the enthusiasm of social capital and laying a solid material and legal foundation for subsequent revitalization.

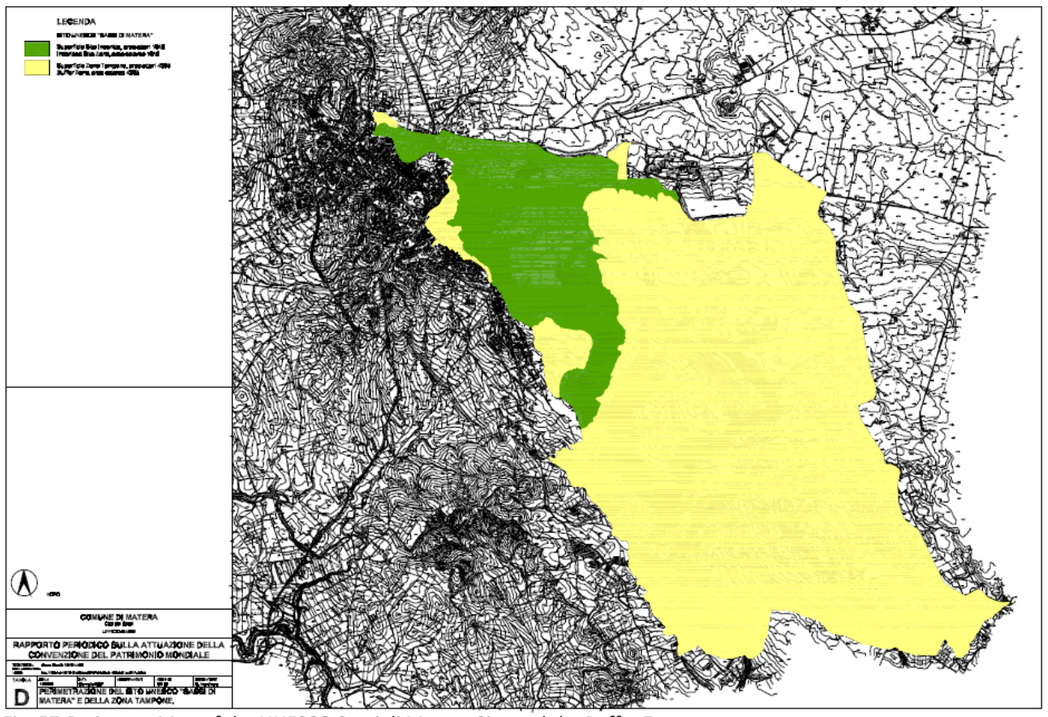


Fig. 57 *Perimeter Map of the UNESCO Sassi di Matera Site and the Buffer Zone.*
https://whc.unesco.org/en/list/670/maps/

4.2.2 Change of Public Awareness

With the physical restoration and population return brought by Law 771, the cultural identity of Sassi di Matera is gradually changing among the public. In the early stages of revitalization, the residents generally held a strong sense of shame about their cave dwelling form. However, following the recognition of **The Sassi and the Park of the Rupestrian Churches of Matera** as a UNESCO World Heritage Site in 1993, and its subsequent exposure as a filming location for Hollywood movies, external recognition and success gradually prompted a shift in local public perception. The community began to realize that this form of dwelling once considered backward actually contained extremely high aesthetic and social value. The narrative gradually shifted from condemning poverty to praising resilience. Matera was redefined as the prototype of an ancient ecological city with its rainwater harvesting system and passive energy-saving system regarded as the model of sustainable development (Girard, Nocca, & Gravagnuolo, 2019). This successful revitalization brought cultural confidence. In 2019, Matera was selected as the **European Capital of Culture**.

This process is described as Re-Signification, which means giving new meaning to old heritage through new social practices (Scardigno, Mininni, Cicirelli, & D'Errico, 2022). This process is not only the restoration of physical space, but also the renewal of community collective memory, the residents are no longer ashamed to acknowledge the history of cave dwelling, but instead see it as a symbol of human resilience.

Fig. 58 *Films Shot in Matera.*
https://www.materaprivatetours.com/matera/matera-and-the-cinema/

4.3 Intervention Practice

In the practice of heritage conservation, instead of adopting homogenized restoration methods, Matera executed a differentiated intervention method based on the assessment of the intrinsic value of heritage. Through an theoritical analysis of the classification of Underground Built Heritage (Varriale, 2023) and the theory of circular regeneration (Girard, Nocca, & Gravagnuolo, 2019), this thesis deconstructs Matera's spatial intervention strategy into three levels: the **Authenticity-Oriented Conservation**, the **Adaptive Reuse**, and the **Landscape Integration**.

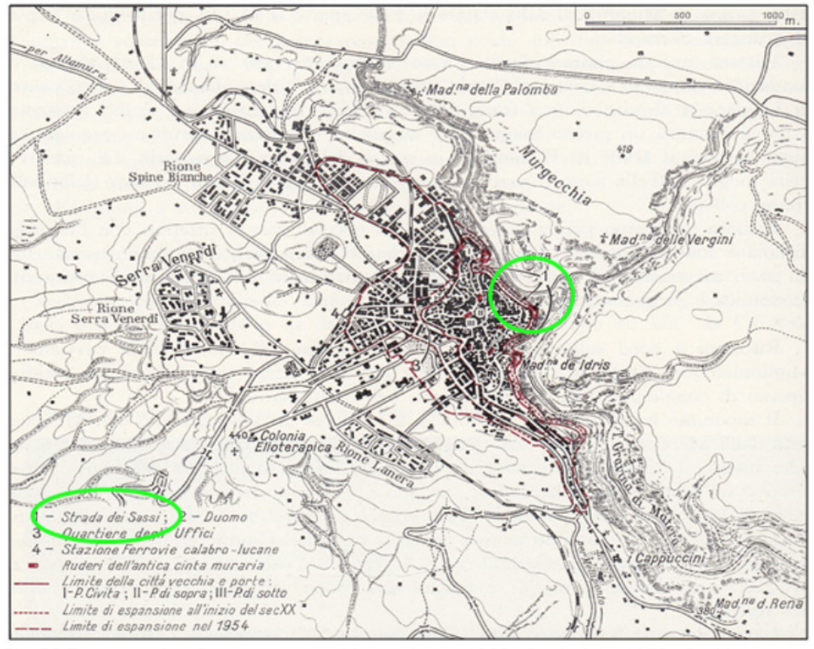


Fig. 59 *Topographical Development of Matera in the 1960s.* Ranieri, L. (1972). Basilicata.

4.3.1 Category I

Authenticity-Oriented Conservation

Based on Historical Value

For the most geologically intact and historically richly layered heritage units in Sassi di Matera, the core intervention strategy is defined as **Authenticity-Oriented Conservation**, implemented through museumization and static preservation. The core concept of this intervention method is to connect and activate the heritage with its historical value, by exhibiting the original spatial pattern within specific historical sections, it transforms the heritage into a tangible, visually recognizable archive, revealing to the public the survival resilience and the technological wisdom behind the cave dwellings.

The *Storica Casa Grotta di Vico Solitario* is one of the best-preserved examples of traditional cave dwellings in the Sassi of Matera, located at Vico Solitario No. 11 in the Sasso Caveoso district. The documented history of the site dates back to the late 16th century, with archival records tracing its existence by 1571. Until the implementation of Law No. 619 of the forced relocation in 1956, this cave remained privately owned by multiple generations and inhabited as a family house (Storica Casa Grotta di Vico Solitario nei Sassi di Matera, n.d.).

Fig. 60 *Storica Casa Grotta di Vico Solitario.*
https://www.materawelcome.it/en/luogo/casa-grotta-di-vico-solitario/

Architecturally, the Casa Grotta is organized as a single enclosed rock chamber hewn from the hillside, with its front closed by a masonry wall containing a simple wooden door and a single window that once provided both light and ventilation. The interior was arranged to accommodate domestic life through a linear sequence of functional zones, including a central living and sleeping area, a kitchen adjacent to the entrance, and ancillary spaces such as storage recesses and a stable for the family's mule at the rear, commonly separated by low stone partitions. Household tools, furniture, and agricultural implements were stored along the walls, while a subsurface cistern beneath the floor collected rainwater for domestic use. The one-room spatial organization typified the dual use of the cave as both living and working space, with animal husbandry integrated into the household compound (Fontana, 2018).

Casa Grotta's interior environment reflected the realities of peasant life: limited natural illumination, high humidity resulting from cooking and animal presence, and simple finishes such as lime-washed walls and stone floors (Fontana, 2018). As described in historical records, these cave houses were perceived as "cool in summer and warm in winter," but also suffered from minimal ventilation and rudimentary sanitary conditions that contributed to significant health challenges prior to mid-20th-century interventions.

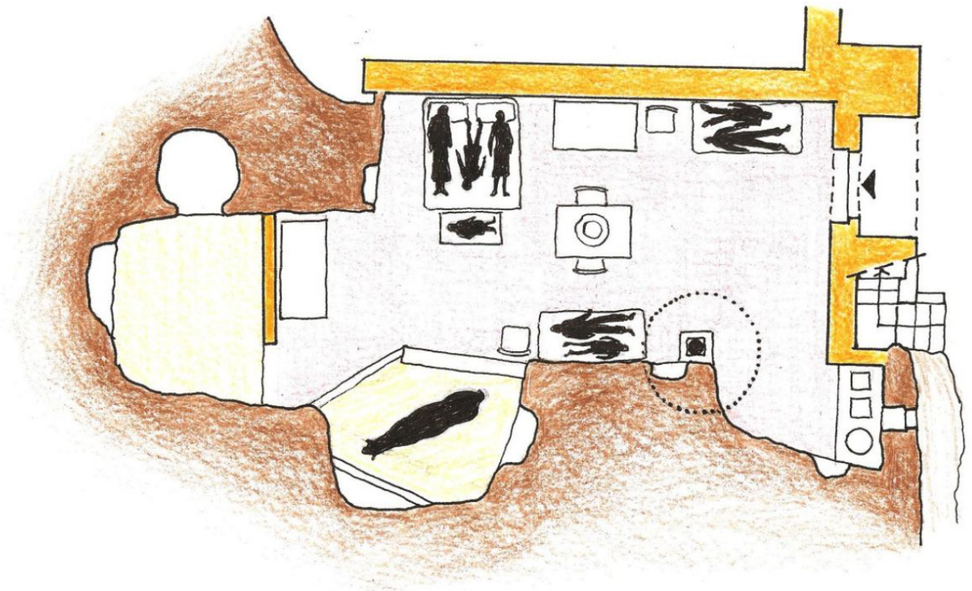


Fig. 61 *Plan of Storica Casa Grotta di Vico Solitario.*
https://www.casagrotta.it/storia-della-casa-grotta/

Today, the Casa Grotta operates as a museum of old family life in Matera, that faithfully reconstructs this domestic environment with period furnishings, authentic household objects, and interpretive material to illustrate the daily life of its former inhabitants. The interior displays include a kitchen with traditional pottery and tools, a bed with seasonal bedding, weaving implements, and other artifacts that demonstrate patterns of work and family routines typical of Matera peasant culture. The museum also provides multilingual descriptions and audiovisual material to support visitor understanding.

Interpreting Casa Grotta as a museum serves both educational and cultural functions. By preserving the original spatial arrangement and outfitting the cave with authentic domestic elements, visitors gain insight into how families lived, worked, and organized their environments in the Sassi before their abandonment in the 1950s. This immersive experience not only highlights the ingenuity of vernacular cave dwelling architecture but also reinforces the human dimension of historic built environments that might otherwise be perceived solely as heritage artifacts. Through material culture and spatial immersion, Casa Grotta bridges past and present, fostering appreciation for the everyday histories embedded in Matera’s ancient urban fabric.

Fig. 62 *Storica Casa Grotta di Vico Solitario.*
http://www.simbdea.it/index.php/musei/tutti-i-musei/1219-storica-casa-grotta-di-vico-solitario

Beyond the static preservation and exhibition of physical life scenes, Matera also strengthens this level of historical cognitive value by introducing non-material narrative methods. *Casa Noha*, operated by *Fondo Ambiente Italiano (FAI)* (Italian Environmental Foundation), represents another narrative-based conservation example.

Casa Noha uses multimedia video mapping technology to project images directly onto the exposed *Tufo* (tuff) walls and vaults, telling a grand historical narrative from the evolution of prehistoric settlements to the mass relocation of the 1950s (FAI, n.d.). This intervention method follows the principle of minimal intervention, using a non-material image layer projected on the material heritage layer. It effectively conveys the sociological meaning and emotional memories hidden behind the rocks without destroying the spatial form of the cave itself. This approach combined the physical objects with digital communication, ensures that Matera's core historical value is well preserved in the tide of tourism commercialization.

Fig. 63 *The Projection in Casa Noha.*
https://www.museimatera.it/casa-noha/
https://www.materawelcome.it/en/luogo/casa-noha/

4.3.2 Category II

Adaptive Reuse

Based on Multidimensional Value

For the largest number of ordinary residential units with average historical information and value in Sassi di Matera, the intervention strategy has shifted from simple static preservation to a more active approach of **Adaptive Reuse**. Faced with the structural contradiction between heritage conservation and tourism development, Matera did not adopt the traditional real estate development model of building the large scale resorts. Instead, it widely promoted the *Albergo Diffuso* (Diffused Hotel) which originated in Italy.

The key to *Albergo Diffuso* is to build an open, horizontal service network to replace the traditional, enclosed, vertical spatial system of hotels. In terms of management, this model emphasizes a spatial organization where rooms are dispersed and services are connected. Its reception and public service facilities are usually embedded in existing large scale caves or squares within the community, while guest rooms are scattered throughout caves and buildings in different streets in the town, with all nodes connected by public streets. *Albergo Diffuso* is an innovative operating model that deeply integrates hotel services with community living (Cucari, Wankowicz, & Esposito De Falco, 2019). It is not only an innovation of the tourist accommodation methodology, but also a regional regeneration strategy based on the combination of local environment and socio-economic value.

This planning strategy has decisive reference value for the protection and development of local heritage, as it directly utilizes existing buildings, avoiding the damage to the texture of the ancient town caused by new constructions. The dispersed spatial layout also leads tourists to experience the public space in the town, sharing streets, cafes, and handicraft workshops with local residents. This design breaks the common Tourist Enclave isolation in traditional tourism development, allowing tourists to be naturally integrated into local communities and achieve symbiosis between foreign consumption and local life.

Ordinary Hotel

Albergo Diffuso (Diffused Hotel)

Fig. 64 *Comparison Between Ordinary Hotel and Albergo Diffuso.* https://www.alberghidiffusi.it/

Sextantio Le Grotte della Civita led by Daniele Kihlgren represents one of the most influential examples of adaptive reuse within the Sassi di Matera and is widely regarded as a reference project for the albergo diffuso model. The project is located in the Civita area and is composed of a series of historic cave dwellings and a former rock-cut church, which were abandoned for decades before being restored and converted into a diffused hotel system (Sextantio, n.d.).

The intervention was based on a conservation-oriented approach that aimed to preserve the original spatial form and material character of the caves. According to the project description, each cave retains its original shape, irregular geometry, and exposed rock surfaces, while new architectural elements are kept to a minimum and clearly subordinated to the existing structure (Sextantio, n.d.). No attempt was made to regularize the spaces or conceal their rough surfaces. Instead, the caves themselves remain the primary spatial and visual feature of the interiors.

Spatially, Sextantio follows the logic of albergo diffuso by distributing guest rooms across multiple cave units rather than concentrating them in a single new building. Shared spaces, including reception and common areas, are integrated into existing historic structures such as the former rock-cut church, reinforcing the relationship between accommodation and the surrounding urban fabric (Sextantio, n.d.). This dispersed organization minimizes the need for new construction and allows the hotel to operate within the scale and morphology of the historic settlement.

A key strategy of the project lies in the careful treatment of materials and finishes. The restoration employed original and reclaimed materials wherever possible, including stone paving, timber elements, and traditional finishes, in order to maintain continuity with the historic fabric of the site (BIG SEE, 2018). Furniture is deliberately simple and, in some cases, built into the cave structure to accommodate uneven floors and walls. This approach avoids introducing freestanding objects that would conflict with the spatial logic of the caves.

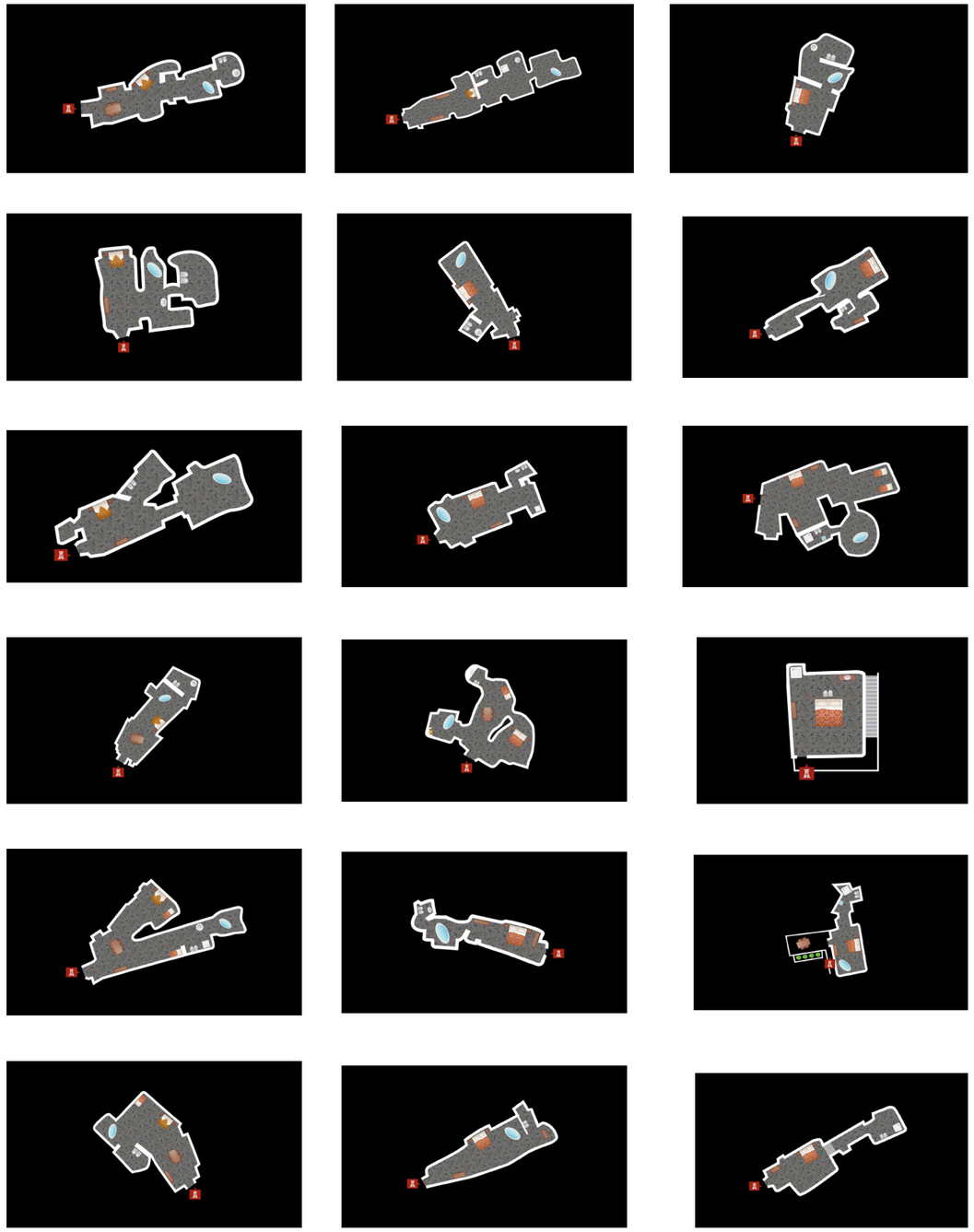


Fig. 65 *Eighteen Guest Rooms of Sextantio Le Grotte Della Civita.*
https://www.sextantio.it/legrottedellacivita/dormire-a-matera-nei-sassi/

One of the main technical challenges of the adaptive reuse was the integration of modern building services required for hotel use. Heating, plumbing, electrical systems, and data connections were installed in a concealed manner to avoid visual intrusion. In particular, the project adopted underfloor radiant heating to ensure thermal comfort while keeping mechanical equipment out of sight (Archilovers, n.d.). To achieve this, existing stone floors were dismantled, numbered, and reinstalled after the heating system was placed beneath them, allowing the original appearance to be restored once construction was completed (Vanity Fair, 2019). Similar principles were applied to lighting and ventilation systems, which were hidden within recesses or secondary layers wherever possible.

As an adaptive reuse project, Sextantio does not seek to modernize the caves through architectural transformation. Instead, it introduces contemporary comfort through hidden technical systems while preserving the physical traces of former domestic life. The project demonstrates how heritage cave dwellings can be reactivated through controlled reuse, maintaining their material authenticity and spatial legibility while accommodating new functions compatible with long-term conservation goals.

Fig. 66 *Interior Space of the Guest Room.* https://www.sextantio.it/en/legrottedellacivita/classic-room/

4.3.3 Category III

Landscape Integration

Based on Landscape Value

For the severely collapsed and structurally unstable caves on the edge area of Matera that are far from the Sassi, it did not adopt the radical reconstruction strategy. Instead, it introduced a **Landscape Integration** approach, incorporating the natural landscape surrounding the old city into the overall heritage preservation framework. *Il Parco delle Chiese Rupestri di Matera* (the Park of the Rupestrian Churches of Matera), as the second component of Matera recognized as the World Heritage site, is the most direct application of this approach. The core logic of this strategy is acknowledging the architecture life cycle. Ruins do not mean failure of operation but rather a critical node in material cycling and ecological restoration.

The cave dwellings and rupestrian churches along the edge of the Gravina canyon are understood as components of a broader cultural landscape shaped by geology, historical land use, paths, and agricultural terraces. As a result, conservation objectives emphasize maintaining the visual continuity between rock formations, caves, and open land(Parco della Murgia Materana, n.d.). This strategy is supported by an institutional framework that combines cultural heritage protection with environmental regulation. The *Parco della Murgia Materana* operates under regional park legislation, which restricts new construction, commercial activities, and infrastructure development within protected areas. At the same time, the caves are recognized as cultural assets subject to heritage protection laws, creating a dual system that limits physical intervention while safeguarding historical features such as carved interiors, wall traces, and rock-cut religious elements (UNESCO, 1993). Through this combined framework, conservation is achieved not by intensive restoration, but by regulating use and preventing transformation.

Cristo Alla Gravinella
Matera (MT)

Cristo la Selva
Matera (MT)

Madonna delle Vergini
Matera (MT)

Madonna di Monte Verde
Matera (MT)

In conservation practices, the main conservation measure applied to these cave systems is controlled utilization. Interventions are limited to basic safety measures, such as stabilizing rock surfaces, securing entrances, and maintaining footpaths for supervised access. Lighting, utilities, and modern building infrastructures are few, allowing the caves to remain in a condition close to their original state. This approach preserves physical evidence of past use, including tool marks, interior niches, and spatial organization, without reconstructing missing elements or introducing new installations (Parco della Murgia Materana, n.d.).

By maintaining the caves as part of a continuous natural and cultural landscape, the city avoids the pressure to convert every heritage space into a functional or economic asset. This practice highlights the value of differentiated intervention strategies based on spatial context. For heritage sites embedded in sensitive natural environments, Matera's approach shows that preserving original conditions and limiting intervention can be an effective and sustainable form of heritage conservation.

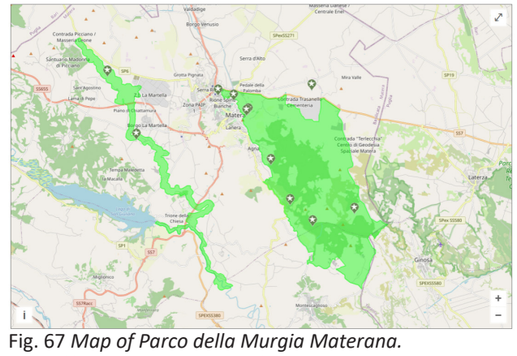


Fig. 67 *Map of Parco della Murgia Materana.* https://www.parcomurgia.it/map.php

Masseria Torre Spagnola
Matera (MT)

San Nicola all'Ofra
Matera (MT)

Santa Maria della Palomba
Matera (MT)

Masseria del Monte
Matera (MT)

Masseria Giudicepietro o "Delle Monacelle"
Matera (MT)

Masseria Selva Malvezzi
Matera (MT)

Masseria Selva Venusio
Matera (MT)

Fig. 68 *Eleven Points of Interest of Parco Della Murgia Materana.* https://www.parcomurgia.it/index.php

05

FRAMEWORK CONSTRUCTION: VALUE ASSESSMENT AND INTERVENTION CATEGORIES

5.1 Necessity of the Framework Proposal

5.1.1 Dikengyuan's Authenticity

Before exploring strategies for the preservation and renovation of pit courtyards, the primary task is to clarify the definition of their core value carrier: authenticity. In the international discourse of heritage protection, based on the *Venice Charter* (ICOMOS, 1964) and The *Nara Document on Authenticity* (ICOMOS, 1994), authenticity typically refers to the original state of materials, craftsmanship, design, and environment. However, for the unique type of earthen dwelling in western Henan's pit courtyards, the connotation of authenticity is often misinterpreted in the contemporary wave of new rural construction and tourism development. Covering earth walls with stone bricks or ceramic tiles, finishing courtyards with cement, or constructing large, fake antique gates above the ground level, prioritizing visual modernization over structural truth, leading to frequent instances of destructive preservation.

Based on the analysis of construction techniques and the comparative research from Matera, the authenticity of pit courtyards should not be viewed as a static historical exhibition, but as a dynamic logic of construction. This definition must encompass three core dimensions. First, regarding material texturality, the exposed raw earth is not merely a building material but the skin of the architecture, regulating thermal performance and defining its aesthetic connection to the landscape. Authenticity requires prioritizing the exposed earth interface. Second, regarding morphological invisibility, the unique negative landscape that the village is unseen from the horizon must be preserved. Any new structure rising above the ground, regardless of its traditional style, destroys this visual order. Third, regarding Technical uniqueness, the pit courtyard is the architecture adapted to the dry climate. Its authenticity is in its operational systems, such as the seepage well for drainage. A yard that relies on electric pumps instead of gravity drainage has lost its technical authenticity.

5.1.2 Framework Proposal

Based on the redefinition of the authenticity of the pit courtyard, existing heritage protection paradigms reveal significant limitations in addressing this unique rural settlement. For a long time, influenced by mainstream heritage discourse Authorized Heritage Discourse (AHD)(Smith, 2006), the protection of vernacular heritage has often fallen into a binary opposition. In the conservation of pit courtyards, courtyards with high-level cultural relic status are subject to frozen, museumization protection, while many unregistered ordinary courtyards with extremely high landscape and technical value face the risk of being filled in or alienated during urban and rural development due to a lack of value assessment criteria. For the completely abandoned pit courtyard that has collapsed, the necessity and cost of restoring it are also worth considering. This singular evaluation perspective, emphasizing the historical period while neglecting active utilization, fails to address the complex attributes of pit courtyards as living heritage.

Facing with the complex current situation of the pit courtyard, to address this issue, this thesis advocates adopting value-based assessment to construct an assessment-intervention framework suitable for the characteristics of pit courtyards. The construction of this framework aims to provide a practical tool for guiding conservation strategies for earth pit courtyards in different conditions.

In the recognition of value elements, it is necessary to expand from a single historical value to multidimensional values. As Randall Mason (2002) pointed out, the value of heritage is not fixed in material entities, but arises from the process of social interaction. The value of the underground pit courtyard is not only reflected in its historical significance (historical value), but also in the unique geomorphic features of the hidden settlement on the plain (landscape value), the thermal adaptability of the cave dwellings (technical value), the living of the community network (social value), and the economic feasibility as a heritage resource (economic value). Therefore, the assessment system must go beyond traditional monument recognition standards and establish a comprehensive framework that covers visible and invisible, material and environmental, in order to provide a solid preservation basis for ordinary pit courtyards that do not have monument identity but have the potential for regeneration.

In terms of intervention strategy, it is necessary to achieve a transition from homogeneous management to differentiated intervention. Due to differences in construction age, preservation status, and location conditions, the pit courtyard settlement objectively presents different life cycle characteristics. If a one size fits all approach is adopted for overall development or style improvement, it will inevitably lead to the loss of authenticity. Intervention strategies should be divided and graded based on the results of value assessment. The core of this differentiated intervention strategy is to recognize the dynamic nature of heritage evolution, which allows some courtyards to participate in contemporary social and economic cycles through functional replacement or controlled ruin treatment while ensuring that core values are well preserved.

5.2 Construction of the Multidimensional Value Assessment Tool

5.2.1 Selection of Assessment Values

Before building an assessment tool for pit courtyards, it is necessary to first examine the logic of selecting assessment dimensions. For a long time, the heritage preservation methodology in China has tended to adopt the age of history and the outstanding artistic form as the core criteria for measuring the value of heritage. However, according to *Principles for the Conservation of Heritage Sites in China* (ICOMOS China, 2015), pit courtyards often struggle to achieve high scores in the traditional value systems of history, art, and science due to the cheap earth building materials, frequent repair processes, and ambiguity of construction dates. If this evaluation standard which is derived from monumental architecture is directly applied to vernacular earthen heritage pit courtyards, it often leads to serious adaptability problems.

Based on the principle of authenticity and the previous analysis of the expression of authenticity in the context of the pit courtyards, this thesis localized and classified the universal value dimensions, and established the following five core value assessment dimensions.

A. Historical Value

Despite frequent repairs, the spatial layout pattern and decorative elements of the pit courtyard remain key to interpreting the evolution of regional culture and construction techniques. This dimension aims to emphasize the recording function of historical information, and is used to screen protected objects with significant architectural typology characteristics.

B. Social Value

Heritage protection should not lead to the passive relocation of original residents. This dimension focuses on the relationship between pit courtyards and community networks, including the living intentions of local residents, the interactions of the neighborhood, and the collective memory carried by the architecture. This corresponds to the definition of social value in the *Burra Charter* (Australia ICOMOS, 1979), which refers to the spiritual, political, or ethnic connections of a place to a specific community.

C. Technical Value

The pit courtyard is not only a residential space, but also an outstanding model of Climate-Responsive Design, with a natural passive energy saving and drainage system. This dimension goes beyond formal aesthetics and instead focuses on physical performance indicators such as the thermal environment of earthen caves and the efficiency of drainage systems such as seepage wells. This is the physical basis for determining whether it has the ability to adapt to contemporary usage needs.

D. Landscape Value

The most distinctive feature of pit courtyards, setting them apart from other vernacular architecture, is their underground form. Amos Rapoport (1969), in *House Form and Culture*, emphasizes that the form of vernacular architecture is a product of both culture and environment. This dimension focuses on assessing the contribution of individual courtyards to the overall hidden landscape of the settlement, as well as the secondary natural landscape features formed by the vegetation along the pit edges as an aspect of the *Genius Loci.*

E. Economic Value

In the context of adaptive reuse, heritage is also an asset. This dimension mainly examines the spatial scale, accessibility, and property rights of the pit courtyards, aiming to objectively measure the feasibility and cost-effectiveness of modern functional implantation, providing a realistic basis for differentiated intervention strategies.

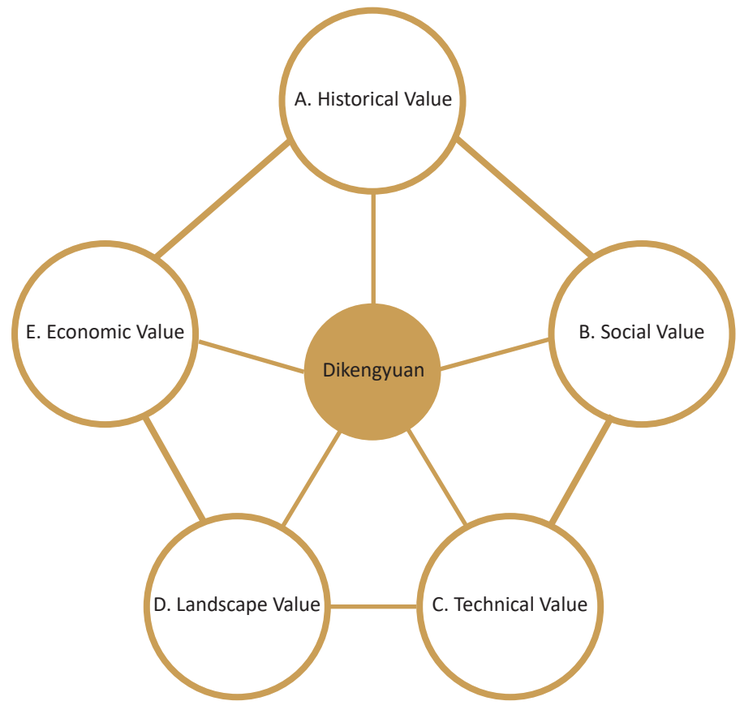


Fig. 69 *Five-dimensional value of Dikengyuan.* Drawn by the author.

5.2.2 Detailed Value Factors and Quantitative Standards

In order to transform the abstract value dimensions into operational quantitative tools, this study further breaks down the five dimensions into several specific secondary factors based on the construction logic and current characteristics of pit courtyards, and constructs a set of scoring systems.

In the specific assessment process, this thesis adopted a direct 0-5 scoring system. For each secondary factor, a score was assigned based on its current status, completeness, or functional effectiveness. The specific scoring logic is as follows.

5 points
Indicates that the factor is in an ideal state. This could be composed of intact historical components, permanent resident inhabitants, or excellent physical situation.

3 points
Indicates that the factor is performing averagely, or has some damage or defects, but has the potential for renovation or functional improvement.

0 point
Indicates that the factor is completely missing, severely damaged, or completely functionally destroyed, and the damage is irreversible.

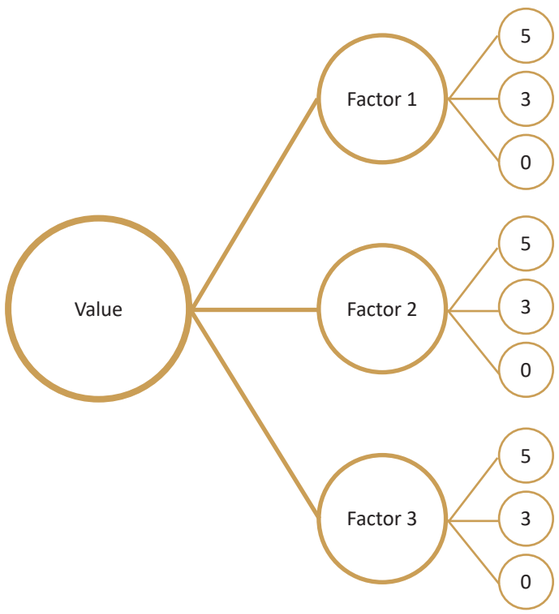


Fig. 70 *Composition of Value Assessment.* Drawn by the author.

A. Historical Value

Since the pit courtyard is a vernacular architecture born for residential needs rather than monumental history, it is rarely associated with grand historical events or famous people. Therefore, the evaluation of historical value has shifted from narratives to considerations of the authenticity of physical remains. This dimension mainly focuses on the verifiability of the construction year, the integrity of the courtyard spatial texture, and the remains of materials and traditional components.

factors/points	5	3	0
A1 Construction Period and Development	Built in the Qing dynasty or earlier. Documentation and historical evolution is clear and verifiable.	Built from the Republican era to the 1970s. Documentation is incomplete.	Built after the 1980s or construction date unknown. Documentation is missing.

factors/points	5	3	0
A2 Layout Integrity	Has complete courtyard layout. All caves are preserved. Has complete facade elements.	Has complete main caves. Partial collapse of side caves or corridors.	Almost all collapsed. The original layout is unclear.

factors/points	5	3	0
A3 Material and Component	Only original earthen building materials are used. Traditional Components are well preserved. Having high craftsmanship value.	Integrated modern building materials after renovation. Components reserved a few. Traces of repair recognizable.	No original materials and traditional components, all covered by modern technology.

Table 2 *Detailed Rules for Historical Value Assessment.* Designed by the author.

B. Social Value

This dimension focuses on the relationship between the pit courtyards and people. Unlike static museum displays, the vitality of the pit courtyards stems from their use as living spaces and their status within the village community network.

factors/points	5	3	0
B1 Residential Status	Residents live in all year-round. Well-maintained.	Residents only return to live during busy farming seasons or holidays. Or only the elderly remain. Moderate-maintainanced.	Vacant for more than 5 years, completely abandoned.

factors/points	5	3	0
B2 Connection with the Community	Located next to the main road of the village.	Located next to the secondary road of the village.	Located on the edge of the village. Or located deep in the fields.

Table 3 *Detailed Rules for Social Value Assessment.* Designed by the author.

C. Technical Value

This dimension is an indicator proposed for the characteristics of earthen buildings. It goes beyond aesthetic form and instead assesses their suitability as green building prototypes from a physical performance perspective, covering three aspects: structural safety, stormwater management, and thermal comfort.

factors/points	5	3	0
C1 Structural Stability	No structural cracks. No reinforcement marks. Good soil verticality.	Has non-structural cracks. Has surface weathering marks.	Has large structural cracks. Has traces of landslides.

factors/points	5	3	0
C2 Drainage Function	Has a complete structure. The drainage is fast. No waterlogging during rainstorm.	Has silt at the bottom. The drainage is slow.	Collapsed or was buried. Water accumulates at the bottom of the well all year-round.

factors/points	5	3	0
C3 Thermal Environment	Indoor humidity is not high. Warm in winter and cool in summer. No mold on the walls.	Visible water droplets are present on interior surfaces occasionally.	Extremely humid. Large areas of plaster have peeled off the walls. Visible mold spots on the wall.

Table 4 *Detailed Rules for Technical Value Assessment.* Designed by the author.

D. Landscape Value

This dimension aims to assess the unique hidden characteristic of the pit courtyards. It focuses on the contribution of individual courtyard houses to maintaining the "village without houses" landscape, and the sense of place in the native vegetation that coexists with them.

factors/points	5	3	0
D1 Visual Invisibility	Courtyard completely invisible on the ground.	Part of structures or vegetation is visible above ground level.	New construction elements on the ground, block the horizon.

factors/points	5	3	0
D2 Vegetation and Greening	The plant species are diverse and growing well.	The plants are scattered and the tree-ages are young.	There are no plants. Or overgrown weeds all around the yard.

factors/points	5	3	0
D3 Visual Purity	No modern buildings within a radius of 20m. The local landscape is unified.	Has utility poles or new constructions at the edges.	Surrounded by multi-story modern buildings.

Table 5 *Detailed Rules for Landscape Value Assessment.* Designed by the author.

E. Economic Value

This dimension primarily assesses the feasibility of intervention. In the context of adaptive reuse, the spatial scale and transportation conditions of the courtyard directly determine the cost of its transformation and the flexibility of its functional replacement.

factors/points	5	3	0
E1 Space Potential	Has a large courtyard area. The cave is tall and deep. Suitable for transforming into public space or guesthouse.	The spatial scale is average. Only suitable for maintaining residential functions.	Courtyard area is small. The spatial scale is average. The cave is low and narrow. Unable to implant modern functions.

factors/points	5	3	0
E2 Accessibility	Can be reached directly by vehicles. Has available parking space.	Needs a short walking distance to reach. With good road conditions.	Only has narrow paths connected to road network. Far from the main road.

Table 6 *Detailed Rules for Economic Value Assessment.* Designed by the author.

5.2.3 Scoring Methods and Visualization

Traditional assessment systems often tend to calculate a comprehensive total score to determine quality, but this fails in the complex context of pit courtyards. A pit courtyard with high historical value but a precarious structure may have the same total score as a pit courtyard with mediocre history but suitable for living, while the required intervention strategies are completely different. Therefore, this thesis does not calculate a comprehensive total score for individual pit courtyards, but instead adopts independent scores for five value dimensions. The final output of the assessment is not a simple grade, such as a level 1 or level 2 courtyard, but a five-dimensional value radar chart that reflects the distribution of its resource characteristics.

For the score calculation, in order to objectively reflect the performance of the pit courtyard in five dimensions, after completing the on-site investigation and scoring of various secondary indicators, this thesis uses the arithmetic mean method to aggregate the factor data.

By visualization, to visually represent the resource characteristics of individual pit courtyards, it maps the final scores of five dimensions onto a five-axis chart, generating a five-dimensional value radar chart. By analyzing the geometric centroid of the radar chart, a typological diagnosis of the pit courtyards can be quickly performed, which directly leads to subsequent differentiated intervention strategies.

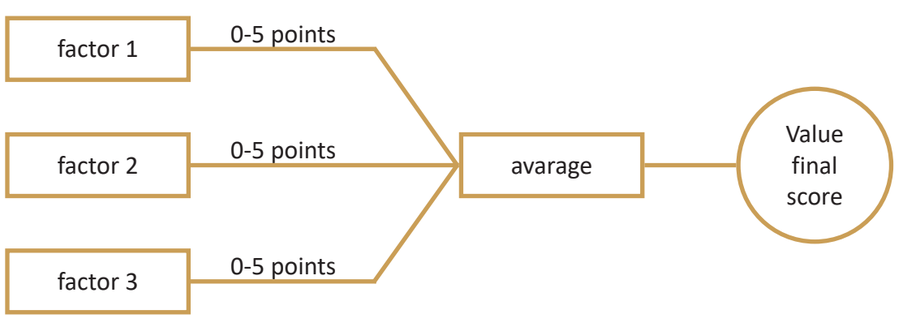


Fig. 71 *Scoring Methods.* Drawn by the author.

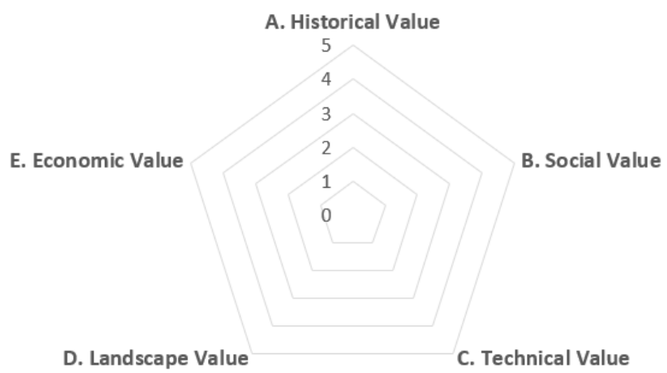


Fig. 72 *Radar Chart Visualization.* Drawn by the author.

5.3 Intervention Category

5.3.1 Decision-Making Model

After completing the multidimensional value quantification assessment of individual pit courtyards, the core task of the research shifted to the method of transforming the assessment data into differentiated intervention strategies. Analyzing the previously identified value dimensions, in order to derive a value-based priority ranking for the conservation of pit courtyards. This thesis constructed a three steps decision-making model based on value scores, establishing a priority level of history, structure, and adaptability, thereby scientifically classifying all assessment subjects into three intervention levels.

The first step of the decision-making model is based on the principle of prioritizing historical value, aiming to identify and rescue historical heritage resources. Regardless of the physical condition or economic situation of the pit courtyard, the historical value (dimension A) is not a renewable scarce attribute. When the assessment results show that the historical or landscape value score of a pit courtyard reaches high value (V≥ 4.0 points), the courtyard is directly classified as category 1: Authenticity-Oriented Conservation. This layer of filter ensures that the pit courtyards with key historical information will be well preserved, preventing them from being damaged in the possible development and utilization.

After separating the strict conservation objects, the second step follows the principle of structural integrity and focuses on examining the technical value (dimension C) of the remaining objects. Earthen architectures have special physical properties. Once there are penetrating cracks on the cave wall or the seepage well system completely fails (score<2.5), their repair often requires large-scale reshaping of the soil, which not only incurs high economic costs but also easily leads to the emergence of fake heritage in authenticity practice. Therefore, for courtyards with structures that have essentially damaged, the decision-making model will classify them as category 3: Landscape Integration. This type of strategy no longer pursues the restoration of residential functions in buildings, but shifts towards controlled ruin treatment and ecological restoration, transforming them into public landscape nodes of settlements.

After the first two steps of filtering, in the third step, the remaining pit courtyards constitute the main body of the existing settlement. These pit courtyards are characterized by a lack of heavy historical background, but have relatively intact cave structures, and have a certain degree of spatial adaptability and economic utilization potential. They normally reach a medium or high score in technical value (dimension C) and economic value (dimension E). Therefore, they are the best carriers for modern rural life and new business models, and are classified into the category 2 adaptive reuse.

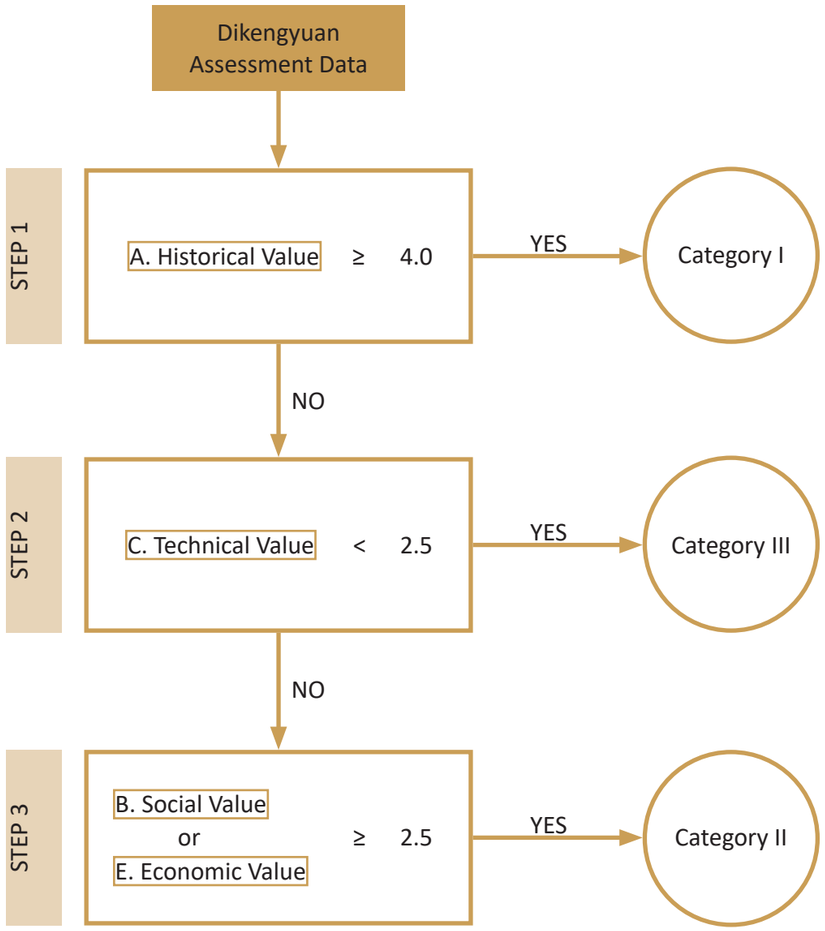


Fig. 73 *Decision-Making Model.* Drawn by the author.

Based on the determined filtering results, the next section will propose specific intervention strategies and technical guidelines through case studies for the three different categories of pit dwellings. The aim is to achieve comprehensive management through differentiated intervention, ensuring that each type of courtyard can receive appropriate and targeted interventions according to its original nature in heritage conservation practice.

5.3.2 Category I: Authenticity-Oriented Conservation

For the category 1 pit courtyard, based on its high historical value, it should be used as a visual display of traditional pit courtyard construction techniques and an archive of settlement history. The intervention strategy for these pit courtyards must adopt the principle of minimal intervention, aiming to prolong the lifespan of physical entities by controlling damage, rather than pursuing a completely new appearance reconstruction. In addition to maintaining its original residential function, when considering the implantation of new functions, considering that modern commercial functions such as boutique hotels and catering often require complex water supply, drainage, and HVAC systems, and their construction process poses a high risk of invasion to soil bodies, it is strictly prohibited to implant such functions.

Its suitable functions are limited to low-intensity cognitive uses, such as museums, rural archive centers, or village community centers, aimed at showcasing the authenticity of historical information and spatial experience. At the level of spatial control, it is necessary to strictly maintain the original centripetal courtyard pattern, prohibit any form of expansion on the ground or excavation of new caves to increase the usable area, and all necessary facilities should follow the principles of reversibility and recognizability, and can be physically separated from the main structure.

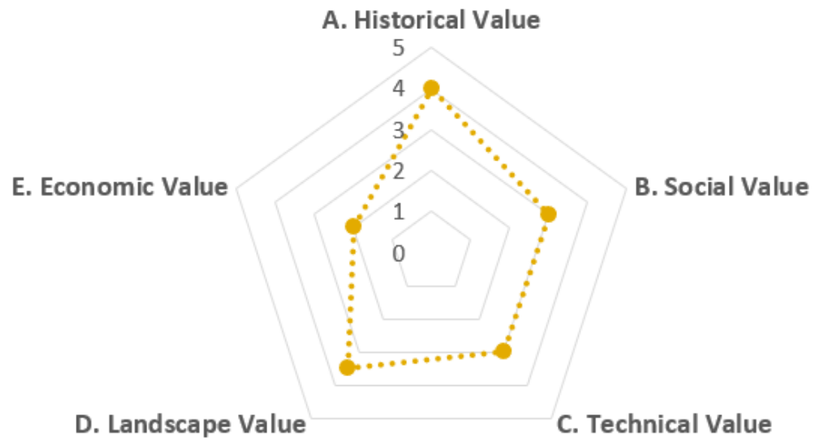


Fig. 74 *Radar Chart Visualization of Category I.* Drawn by the author.

Case Study I

Project Name:
Neues Museum
Location:
Museumsinsel, Berlin, Germany
Architect:
David Chipperfield Architects, Julian Harrap
Completion Date:
2009
Function Before:
Museum
Function After:
Museum

The restoration project of Neues Museum (1997-2009) was completed by David Chipperfield Architects in collaboration with restoration Julian Harrap. The building was originally built in the mid-19th century and was heavily bombed during World War II, leaving it in ruins for over 60 years. Chipperfield's plan did not choose to completely restore the building, nor did it choose a thorough reconstruction that completely erased historical traces. On the contrary, they emphasize the spatial context and material characteristics of the original building, reconstructing the original volume of the remaining parts after World War II. By constructing new building units, the original room sequence has been restored and continuity has been maintained with the existing structure. And only cautiously integrate new materials into existing structures when necessary to maintain overall harmony and unity.

The sense of ruins of the original buildings and the trauma of World War II including bullet marks and burn marks have been fully preserved as part of the heritage, which not only restores the buildings but also restores the continuity of history.

Fig. 75 *Neues Museum Before Restoration.* https://davidchipperfield.com/projects/neues-museum

Fig. 76 *Neues Museum After Restoration.* https://www.archdaily.com/127936/neues-museum-david-chipperfield-architects-in-collaboration-with-julian-harrap

Concept

Recomplete the original building volume while respecting all stages of its architectural history, including its long years as ruins.

Space

For the parts of the Northwest wing and the South Dome that were completely destroyed, the architects reconstructed them strictly according to the original building's volume, but completely removed classical decorative lines from the facade.

Also, the architect inserted a huge, minimalist prefabricated concrete staircase for the insertion of restricted items. It follows the original style in terms of appearance, but adopts a simpler architectural language, which is particularly eye-catching in the grand hall.

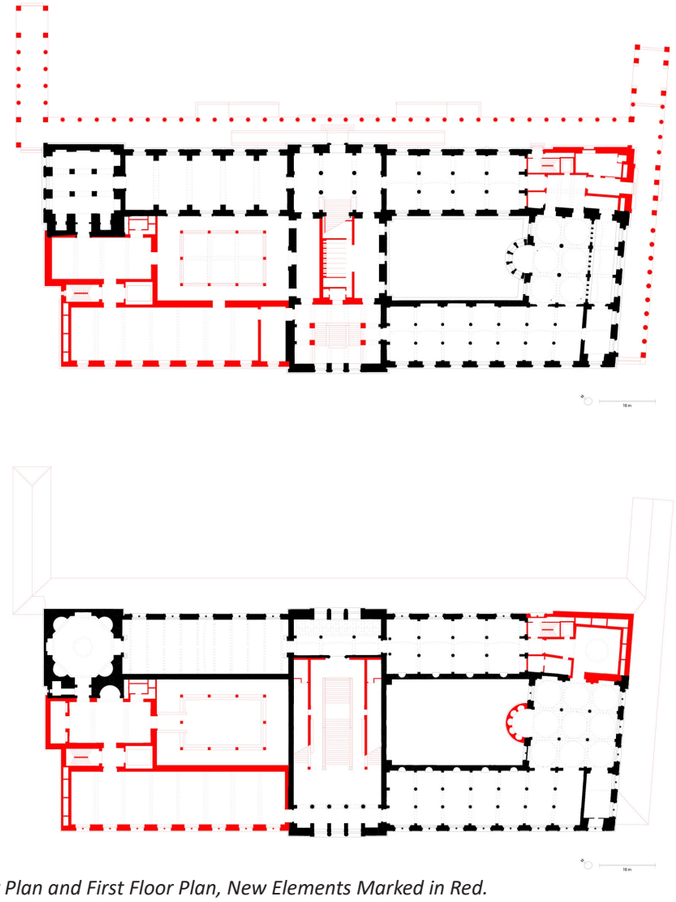


Fig. 77 *Ground Floor Plan and First Floor Plan, New Elements Marked in Red.* https://davidchipperfield.com/projects/neues-museum

Structure

The well preserved colonnades on the east and south sides have been restored and completed, reproducing the pre war urban style.

For the exhibition space in the museum, a new structural framework has been filled in the Egyptian courtyard, supporting a mezzanine gallery.

Material

The newly inserted parts, such as the central staircase and the new exhibition room, are mainly used pre-fabricated concrete elements consisting of white cement mixed with Saxonian marble chips.

And other newly built volumes are made of recycled handmade bricks, cleverly recognizing them from historical parts.

Fig. 78 *Past and New Stairs.* https://davidchipperfield.com/projects/neues-museum

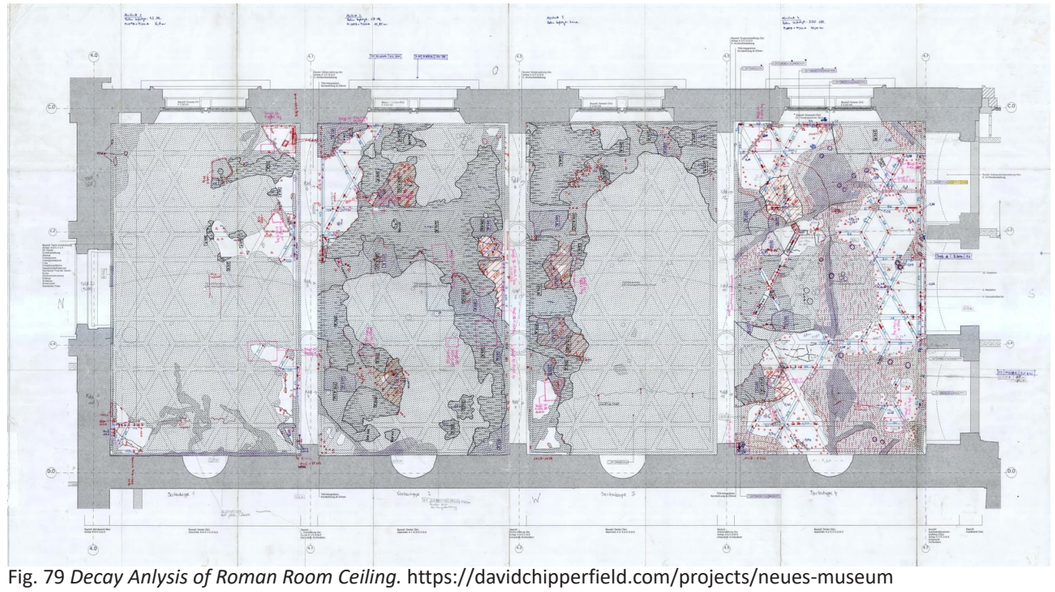


Fig. 79 *Decay Anlysis of Roman Room Ceiling.* https://davidchipperfield.com/projects/neues-museum

The approach of the Neues Museum that healing the wounds of the building without erasing them provides a fundamental theoretical basis for the preservation of category 1. The translation of this philosophy into the Dikengyuan context involves three key aspects.

The Neues Museum validates the aesthetic and documentary value of the ruinous state. In the context of high historical value pit courtyards, natural weathering phenomena such as cliff spalling and parapet erosion constitute an essential historical patina rather than mere defects to be corrected. Consequently, the intervention objective shifts from a restorative reconstruction of a pristine past to the technical arrest of decay. This approach ensures that traces of water erosion and historical habitation remain visible as readable components of the heritage narrative.

Chipperfield's strategy of using pre-cast concrete to fill structural voids offers a methodological template for consolidating collapsed cave legs or walls. The principle of identifiable restoration requires that new interventions achieve chromatic harmony with the local loess soil while maintaining a distinct surface texture. By utilizing modified rammed earth or pigmented concrete with a smoother finish than the original excavation, the intervention secures structural stability while clearly delineating the contemporary repair work from the historical hand-dug substrate.

Just as the museum conserved damaged frescoes without repainting them, the fragile earthen surfaces of the pit courtyard demand a strategy of minimal consolidation. Instead of covering walls with incompatible cementitious renders, the approach employs penetrative consolidants or sacrificial earthen layers. This technique prolongs the lifespan of the soil structure without sealing its surface or altering the inherent visual quality of the invisible landscape.

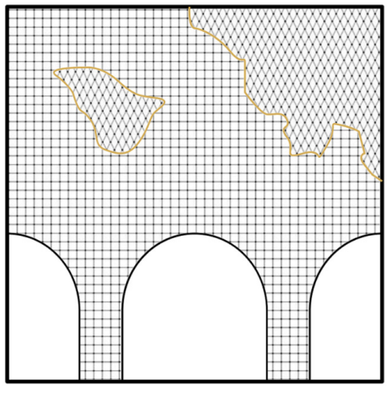


Fig. 80 *Recognizable Intervention on the Pit Courtyard.* Drawn by the author.

5.3.3 Category II: Adaptive Reuse

The intervention strategy for the category 2 pit courtyard, which has the largest existing number, with relatively stable structures and convenient transportation conditions, is to address the physical performance gap between traditional cave dwelling forms and modern living standards. Unlike the strict protection strategy of category 1, the role of these courtyards is positioned as a continuation of the living scene. In addition to the pit courtyards which maintain the original residential function, it is allowed to proceed the adaptive reuse of assessed pit courtyards for sustainable development.

In terms of operation mode, referring to the Italian concept of Albergo Diffuso, integrating separated guest room units into multiple original independent pit courtyards in the settlement, retaining the original living texture of the underground village of the pit courtyard while implanting modern service functions. In terms of functional requirements, in the process of hotel transformation, in order to meet the modern living needs, the setting of bathroom facilities and the control of indoor environment are indispensable, so new designs are needed for lighting, ventilation, and drainage. At the level of spatial intervention, all newly added modern functional modules such as bathrooms and kitchens should be regarded as independent implantations that are structurally separated from the original soil cave body, ensuring that in the future, if better technologies emerge or functional changes occur, these facilities can be dismantled without damage, restoring the courtyard to its initial state.

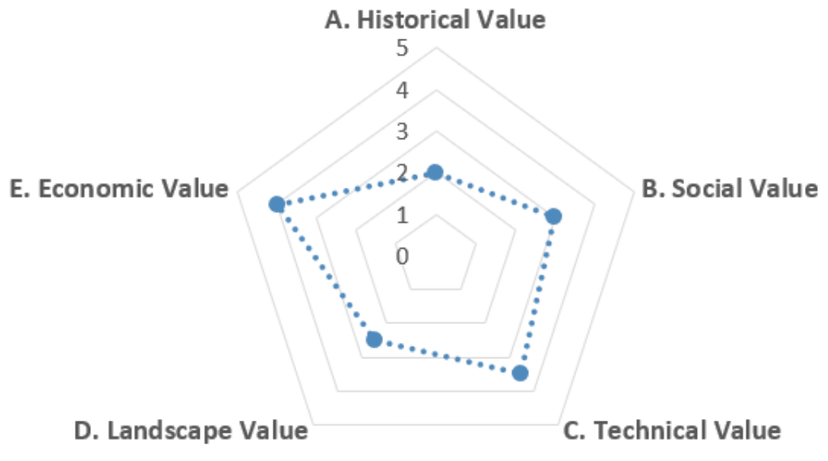


Fig. 81 *Radar Chart Visualization of Category II.* Drawn by the author.

Case Study II

Project Name:
Dovecote Studio
Location:
Snape, Suffolk, UK
Architect:
Haworth Tompkins Studio
Completion Date:
2009
Function Before:
Dovecote
Function After:
Art studio

Located within the internationally renowned Snape Maltings music campus, the project was on the site of an abandoned Victorian dovecote, with only its crumbling red brick facade remaining. Instead of traditional reinforcement, Haworth Tompkins used a box-in-box strategy, inserting a completely freestanding, prefabricated corten steel structure directly into the old brick ruins. This newly implanted core both supports the collapsing old wall and provides a 24/7 modern art studio, achieving a symbiosis between ruin and new architecture.

Fig. 82 *The past Dovecote.*
https://www.archdaily.com/89980/dovecote-studio-haworth-tompkins

Fig. 83 *The New Dovecote Studio.*
https://www.archdaily.com/89980/dovecote-studio-haworth-tompkins

Concept

The new building is conceived as a "lining" inserted into the old shell. The new steel volume is physically independent of the old walls but matches the original form. This approach treats the ruin merely as an external skin, clearly separating the new structure from the historical remains.

Space

The geometry of the steel box strictly follows the original form of the dovecote, including the pitch of the roof. To provide sufficient light for the studio, a large north light is placed in the roof. A mezzanine level is included inside, with specific window placements directing views through existing gaps in the old masonry.

Structure

The main structure is a prefabricated steel frame welded on site. This steel box is completely self-supporting and does not rely on the old walls for load-bearing. Conversely, the steel structure stabilizes the fragile brickwork from the inside, preventing further collapse.

Material

The exterior uses weathering steel COR-TEN, with a rusty red color that blends with the surrounding red brick buildings. The interior walls and floors are fully lined with spruce plywood, creating a bright, warm, and sealed wooden "box" that contrasts with the rough industrial ruin outside.

Fig. 84 *The Implant Process.*

Fig. 85 *The Interior Space.*

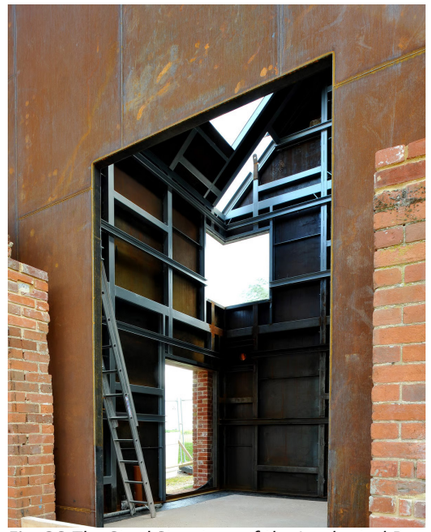


Fig. 86 *The Steel Structure of the Implanted Box.*

Fig. 87 *The Brick Material Pattern.*

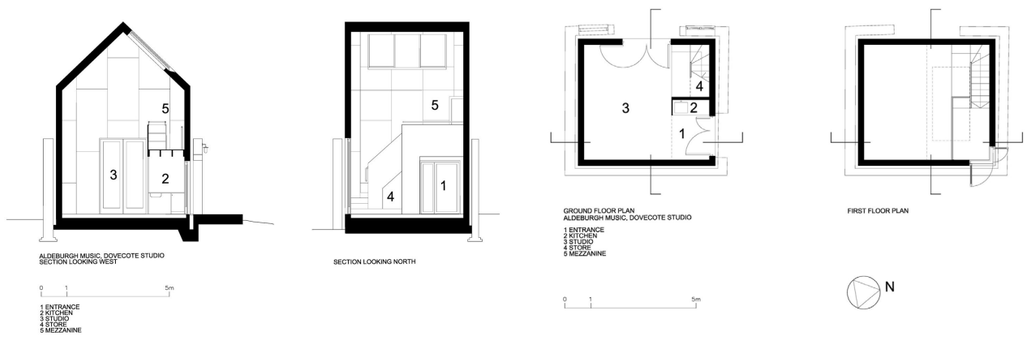


Fig. 88 *Plans and Sections.* https://www.haworthtompkins.com/work/dovecote-studio

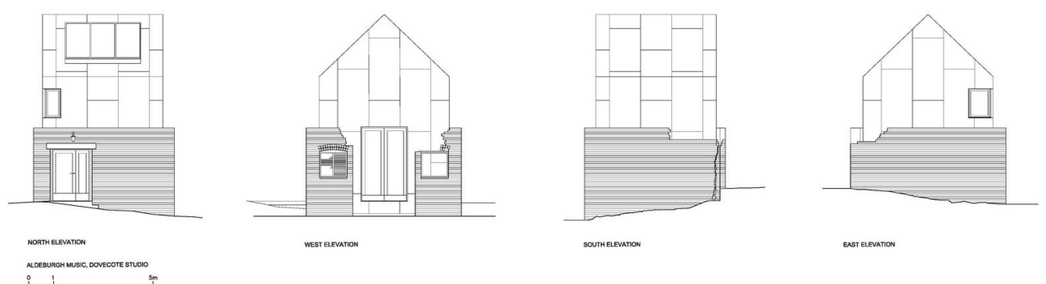


Fig. 89 *Elevations.* https://www.haworthtompkins.com/work/dovecote-studio

The Dovecote Studio demonstrates a paradigm shift from repairing the ruin to inhabiting the ruin, offering a critical reference for the adaptive reuse of category 2. The translation of this strategy into the pit courtyards context involves three key aspects.

The primary pathology of the pit courtyards involves the conflict between the capillary moisture of the loess soil and modern hygiene standards. The Box-in-Box strategy translates into a Box-in-Cave approach for pit courtyard. By inserting a self-supporting light steel or timber unit into the cave, the living space becomes physically decoupled from the damp earthen walls. The interstitial space functions as a ventilation buffer which effectively resolves the issue of rising dampness without chemically altering the original soil structure.

Pit courtyards are typically located deep underground with narrow access paths, rendering traditional wet construction difficult and risky for the fragile cave legs. The logic of prefabricated assembly demonstrated in the Dovecote project is highly applicable here. Manufacturing the lining units off-site and assembling them within the caves minimizes on-site disturbance. This dry construction method ensures the safety of the surrounding earth structure and guarantees the reversibility of the intervention.

Interventions in vernacular settings often risk creating false historical narratives through mimicry. Instead of imitating the yellow earth texture, the design should follow the Dovecote approach of material contrast. Using distinct modern materials such as metal, glass, or plywood for the new insertion creates a clear dialogue with the rough loess texture. This approach respects the authenticity of the heritage site by allowing the historic cave and the modern residential unit to be legible as distinct layers of time.

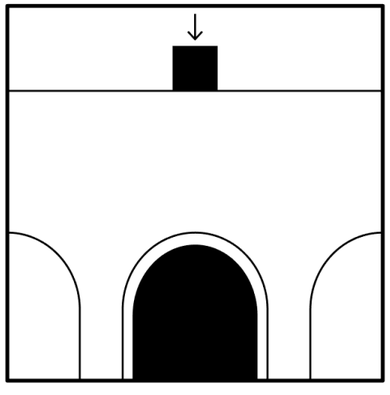


Fig. 90 *Box Implanting in the Pit Courtyard.* Drawn by the author.

5.3.4 Category III: Landscape Integration

For the category 3 pit courtyards selected through step 2, their characteristics are severe instability of the cave structure, complete failure of the drainage system, and under long term abandonment. For spaces that have lost their residential safety, forced restoration not only faces high economic costs, but may also erase their historical authenticity as built sites due to excessive human intervention. Therefore, this study proposes an intervention strategy for landscape integration, which shifts its role from private residential units to ecological nodes and public open landscapes in settlements.

This strategy is inspired by the theory of The Third Landscape, which views abandoned land including neglected, marginal, or unmanaged spaces as a sanctuary for biodiversity and a laboratory for landscape succession (Gilles Clément, 2004). In terms of design methods, the principle of subtractive design is adopted, no longer pursuing the closure and integrity of the building entity, but actively demolishing some endangered building components, cleaning up accumulated waste, and preserving the spatial texture of the ruins. Transforming the originally enclosed underground pit courtyard into an open sunken park, community green space or rain garedn, making it a spiritual place that connects people and nature, past and present, while serving the public supporting needs of the surrounding category 2 residential function.

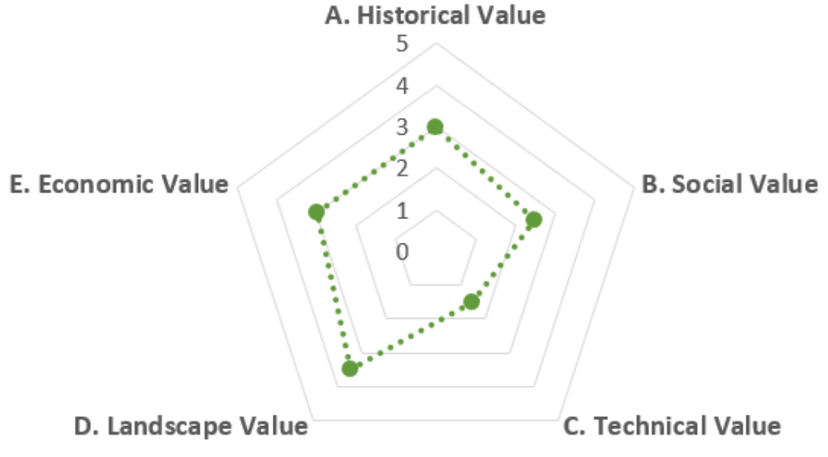


Fig. 91 *Radar Chart Visualization of Category III.* Drawn by the author.

Case Study III

Project Name:
St Dunstan in the East Church Garden
Location:
London, UK
Architect:
/
Completion Date:
1971
Function Before:
Church
Function After:
Public Garden

St Dunstan in the East Church Garden was originally a medieval church that was damaged in the Great Fire of 1666 and subsequently restored by Christopher Wren. During the Blitz of 1941, the church suffered severe bomb damage, leaving only the tower and the exterior walls standing while the roof and interior structure were destroyed. In the post-war period, the City of London Corporation decided against a functional reconstruction of the building. Instead, the site was converted into a public garden in 1971, repurposing the ruinous Gothic shell as a unique container for urban vegetation.

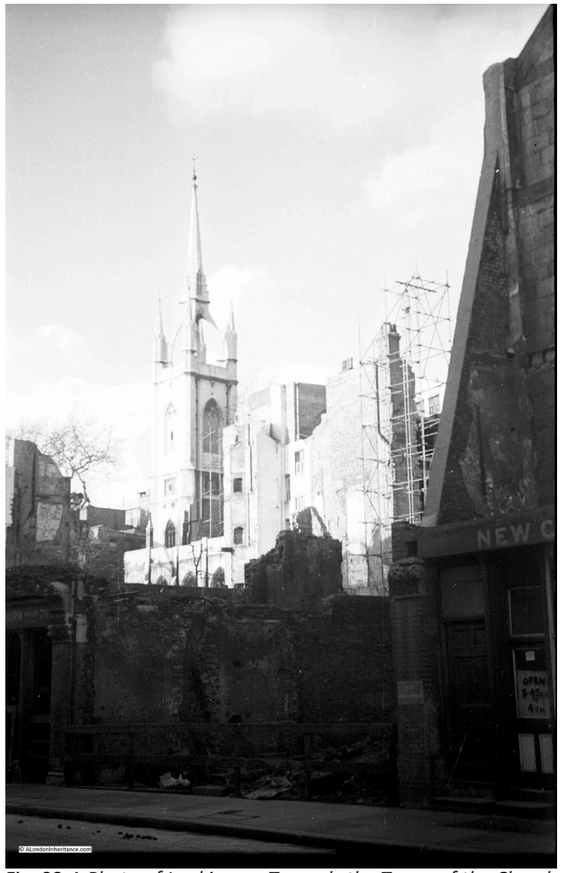


Fig. 92 *A Photo of Looking up Towards the Tower of the Church of St Dunstan in the East, After Being Bombed, Taken in 1948.* https://alondoninheritance.com/london-churches/st-dunstan-in-the-east/

Fig. 93 *A Photo from a Similar View, Taken in 2022.* https://alondoninheritance.com/london-churches/st-dunstan-in-the-east/

Concept

The project adopted a strategy of managed ruin. The design did not attempt to mask the destruction caused by the war or to restore the building's original enclosure. Instead, the roofless state was permanently consolidated. The ruin was redefined not as a defect to be repaired, but as a landscape element with independent aesthetic value, preserving the physical evidence of its history.

Space

The original plan of the church, including the nave and aisles, was preserved, but the nature of the space was inverted: the once sacred interior became an open-air courtyard. The surviving stone walls and window tracery no longer serve as a weather barrier but function as screens that define the garden's boundary. These elements frame views of the surrounding modern skyline, creating a distinct sense of enclosure within the city.

Landscape

Vegetation was strategically introduced into the building's footprint. Lawns cover the area that was formerly the church floor, climbers grow along the remaining limestone walls, and trees are planted within the nave. The interweaving of natural vegetation with the masonry softens the severity of the ruins, utilizing the microclimate created by the high walls to establish a secluded oasis.

Intervention

The architectural intervention was strictly limited to structural stabilization. Dangerous masonry was consolidated to ensure safety without reconstructing the missing elements. The fractured edges and weathered surfaces were retained to maintain the site's character. Apart from the addition of a fountain and necessary seating, no significant modern structures were added to the site.

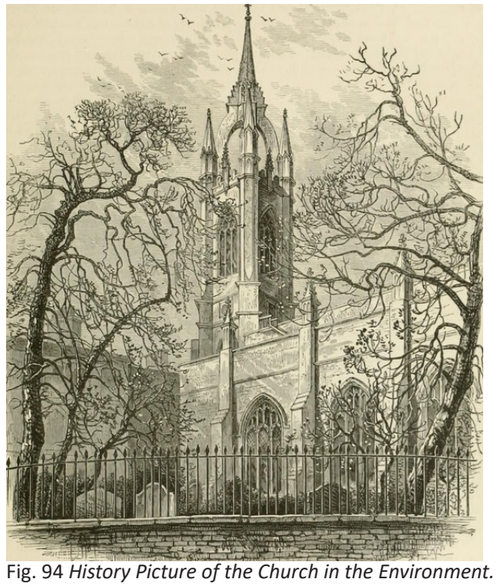


Fig. 94 *History Picture of the Church in the Environment.*
https://en.wikipedia.org/wiki/St_Dunstan-in-the-East

Fig. 95 *Today the Church in the Environment.*
https://historicengland.org.uk/listing/the-list/list-entry/1359173

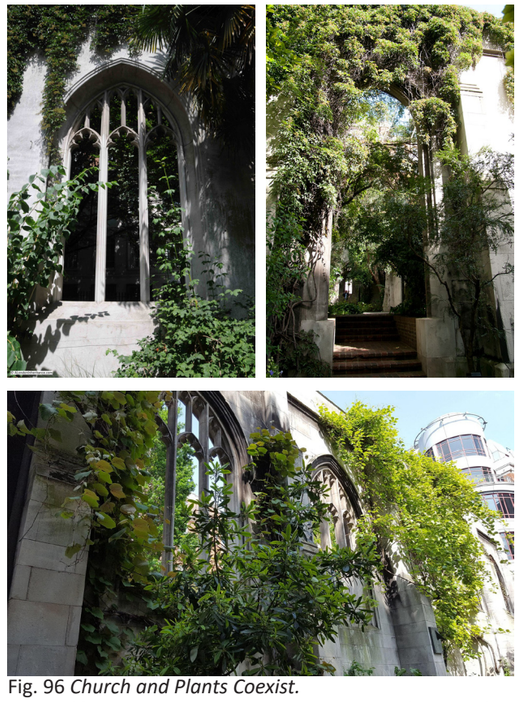


Fig. 96 *Church and Plants Coexist.*
https://www.nationalchurchestrust.org/church/st-dunstan-east-city-london

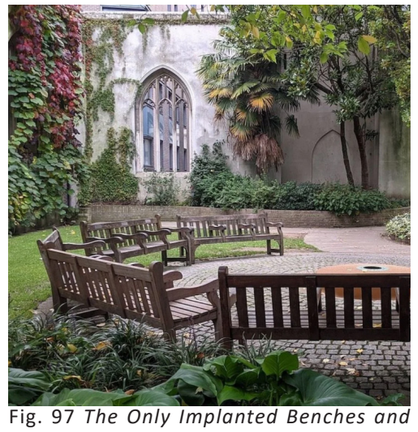


Fig. 97 *The Only Implanted Benches and Fountain.*
https://historicengland.org.uk/listing/the-list/list-entry/1359173

Implication for Dikengyuan

The adaptive reuse of St Dunstan in the East Church Garden offers a direct precedent for the treatment of category 3, specifically those that have suffered structural collapse and are no longer viable for habitation. The translation of this approach into the Dikengyuan context involves three key aspects.

For pit courtyards where the cave roofs have failed and the structure is compromised, the primary function should shift from residential use to a public amenity. Following the St Dunstan model, the remaining earthen walls and courtyard boundaries should be consolidated to serve as the enclosure for a community garden. The collapsed caves, rather than being reconstructed, can be stabilized to function as planting pockets or water retention features, effectively turning the building shell into a container for soft landscaping.

Just as the walls of the church provide a secluded oasis protected from the urban environment, the deep pit courtyards generates a distinct microclimate that is sheltered from wind and temperature extremes. This negative topography allows for the introduction of shade-tolerant plant species that differ from the surrounding surface vegetation. By allowing nature to colonize the void, the intervention enhances local biodiversity while stabilizing the soil through root systems.

The atmosphere of St Dunstan relies on the juxtaposition of the ruined masonry against the open sky. In the context of the pit courtyards, the intervention should respect the existing horizon line of the parapet. By preserving the open-air character of the courtyard and maintaining the visual connection between the subterranean floor and the sky, the design fosters a contemplative atmosphere, respecting the genius loci of the vernacular ruin without attempting a false restoration.

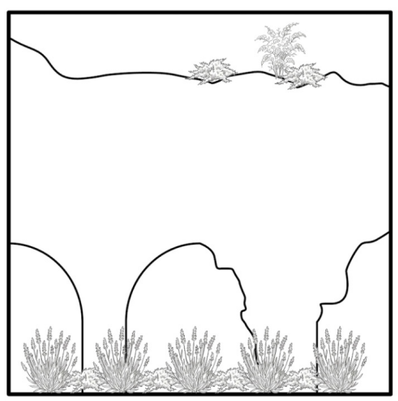


Fig. 98 *The Pit Courtyard and Plants Coexist.* Drawn by the author.

5.4 Summary

This chapter constructs the framework for the Dikengyuan, aiming to address the core issues of unclear value evaluation rules and one size fits all intervention strategies in the protection of traditional local heritage.

Firstly, in terms of establishing assessment tools, this study breaks through the single assessment perspective and incorporates multidimensional factors to construct a comprehensive value evaluation system that includes five dimensions: historical value, social value, technical value, landscape value, and economic value. By assigning scores and visualizing the value radar chart, accurate evaluation of the individual resource attributes of the pit courtyards institute has been achieved.

Secondly, through constructing the decision-making model, a priority ranking approach has been used. Abandoning the simple overall ranking of the whole pit dwelling, the courtyards within the settlement are scientifically divided into three levels: Category 1 Authenticity-Oriented Conservation, Category 2 adaptive reuse, and Category 3 landscape integration based on the scarcity of heritage value and the safety of physical use.

Finally, at the intervention strategy level, differentiated technical guidelines were proposed for different current situations of pit dwellings. Category 1 emphasizes minimal intervention and the preservation of historical information authenticity. Category 2 introduces the "box-in-cave" implantation technology to solve the adaptability problem of modern living. Category 3 draws inspiration from the concept of the third landscape and achieves ecological bridging through controlled naturalization and biotechnology. The establishment of this hierarchical governance framework aims to achieve comprehensive coverage of pit weighting for various current situations, providing a solid theoretical basis and methodological support for the upcoming Qu Village planning and design practice in the next chapter.

06

APPLICATION OF THE FRAMEWORK IN QU VILLAGE

6.1 Case Selection

6.1.1 Site Selection

The site selected for the framework application is Qu Village, Zhangbian Township, Shanzhou District, Sanmenxia City, Henan Province. The village is located in the core area of the Shaanzhou Plateau, about 15 kilometers away from the city center of Sanmenxia. It is a typical Dikengyuan settlement on the Loess Plateau in western Henan. Qu village has a long history and is not only one of the fifth batch of C*hinese traditional villages*, but also preserves the ancient temple customs of Qucun that have been passed down for hundreds of years, with a profound cultural heritage of the clan. In the 1980s, there were more than 300 pit courtyards in Qu Village, and as of 2016, there were still 115 pit courtyards remaining, of which 58 were still inhabited (Wang et al., 2016). The existing Dikengyuan resources in the village are abundant, including well preserved traditional courtyards from the Qing Dynasty, as well as modern Dikengyuan renovated in the 2010s. At the same time, there are a large number of idle and abandoned ruins distributed on the edge of the village, including a complete system of Dikengyuan evolution.

Fig. 99 *Location of Qu Village.* Drawn by the author.

6.1.2 Dikengyuan Selection

Based on the principles of differentiation and typicality, this application identified three courtyards with significant characteristic differences in the Qu village as fixed empirical objects. These three sets of samples represent the typical states of Dikengyuan in three different stages of its lifecycle: traditional preservation, modern renovation, and natural abandonment.

Fig. 100 *Map of Qu Village.* Drawn by the author.

6.2 Case I

Name:

Qu Village Old Yard (Lu Guolan's home)

Category:

I - Authenticity-Oriented Conservation

Location:

In the village center

Current Situation:

This courtyard is one of the earliest existing Dikengyuan buildings in the village. The courtyard has a large scale, with a total of 12 cave dwellings, with the main cave facing north and following the classic shape and scale of Dikengyuan. The exterior of the building retains the most primitive colors of the Shaanzhou Dikengyuan, with walls presenting the original soil yellow color of the loess terrace. The rainwater eaves above the Parapet and kiln cave arches are made of blue gray bricks, creating a clear visual recognition system. At present, the main structure of the building is still in good condition, and the current residents are the family of Lu Guolan.

Fig. 101 *Location of Qu Village Old Yard in Qu Village.* Drawn by the author.

Fig. 102 *Qu Village Old Yard.* Photo by the author.

A. Historical Value

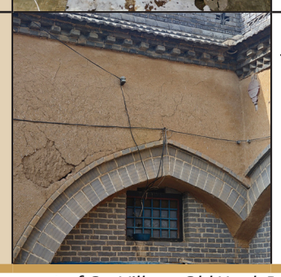
	photo	status	points
A1 Construction Period and Development		One of the earliest built Dikengyuan in Qu Village.	5
A2 Layout Integrity		The courtyard layout is complete. All original caves are preserved and well organized. The facade elements are well preserved after renovation.	5
A3 Material and Component		The renovation project used new materials in some structures, and only part of old components were preserved.	3

Table 7 *Historical Value Assessment of Qu Village Old Yard.* Based on the author's fieldwork.

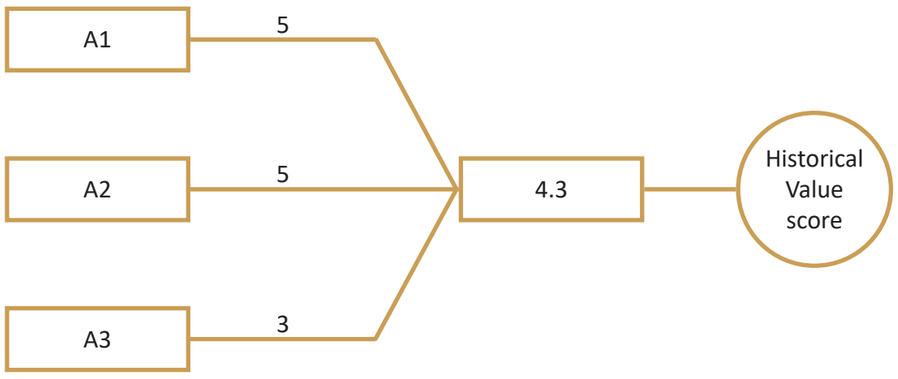


Fig. 103 *Historical Value Scoring of Qu Village Old Yard.* Drawn by the author.

B. Social Value

	photo	status	points
B1 Residential Status		Lu Guolan and her family live in all year round. The living environment is well maintained.	5
B2 Connection with the Community		Located in the center of the village, adjacent to one of the main village roads.	5

Table 8 *Social Value Assessment of Qu Village Old Yard.* Based on the author's fieldwork.

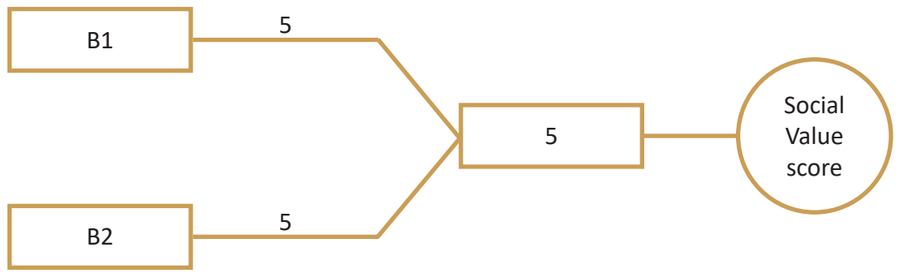


Fig. 104 *Social Value Scoring of Qu Village Old Yard. Drawn by the author.*

C. Technical Value

	photo	status	points
C1 Structural Stability		The cave structure is relatively complete, with only some surface cracks in some corners.	3
C2 Drainage Function		The drainage system operates efficiently, there is no water accumulation in the courtyard on rainy days.	5
C3 Thermal Environment		The indoor thermal environment is comfortable and does not feel damp. The lighting is average, and the deeper parts of the cave are relatively dark.	3

Table 9 *Technical Value Assessment of Qu Village Old Yard.* Based on the author's fieldwork.

D. Landscape Value

	photo	status	points
D1 Visual Invisibility		There are newly built one-story buildings around the courtyard, which has taken on some residential functions, destroyed the original landscape.	0
D2 Vegetation and Greening		There are three persimmon trees planted inside the courtyard, and the central square plot is covered by greenery.	5
D3 Visual Purity		There are light poles and other living infrastructure on the ground around the courtyard.	3

Table 10 *Landscape Value Assessment of Qu Village Old Yard.* Based on the author's fieldwork.

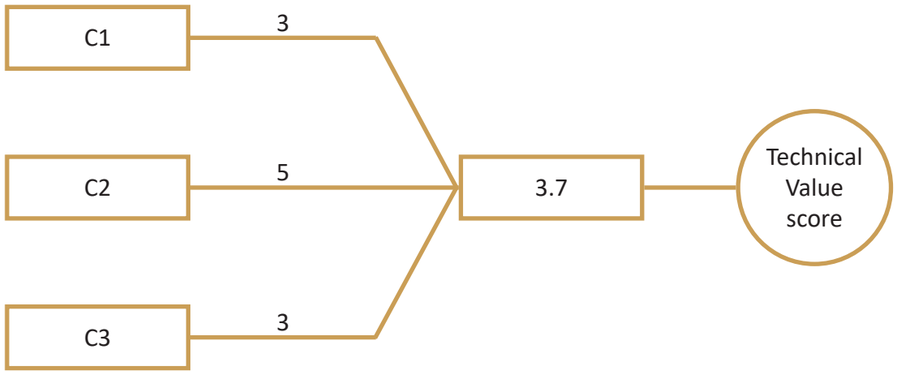


Fig. 105 *Technical Value Scoring of Qu Village Old Yard.* Drawn by the author.

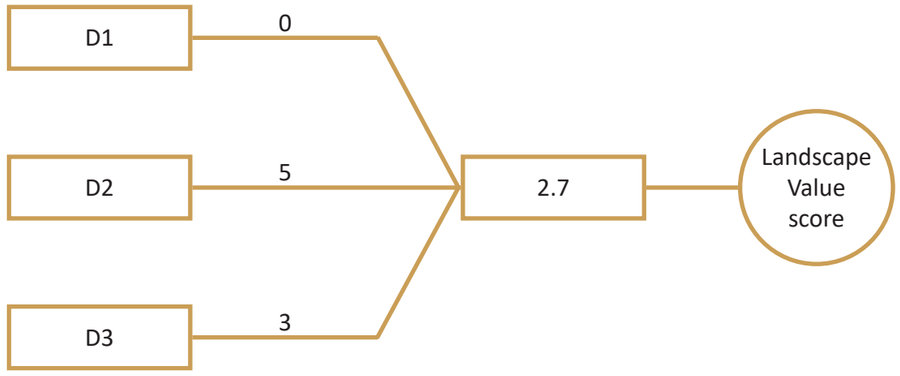


Fig. 106 *Landscape Value Scoring of Qu Village Old Yard.* Drawn by the author.

E. Economic Value

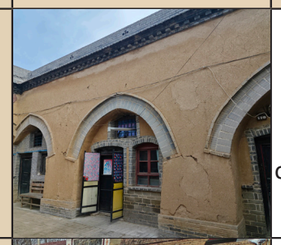
	photo	status	points
E1 Space Potential		The courtyard has a moderate to large scale, but its function is relatively single, it is only used as a residence for the Lu family.	3
E2 Accessibility		Vehicles cannot directly reach the courtyard, needs a short walking distance to reach. Road conditions are good .	3

Table 11 *Economic Value Assessment of Qu Village Old Yard.* Based on the author's fieldwork.

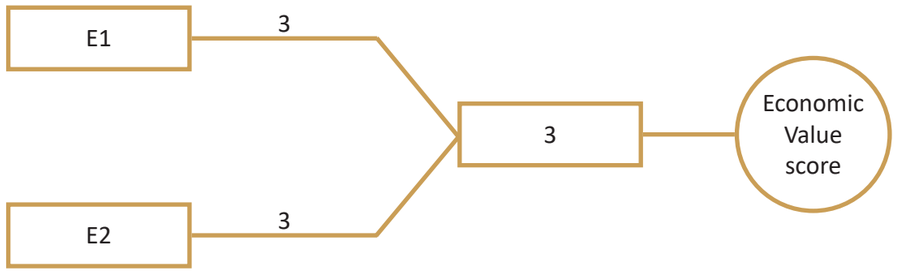


Fig. 107 *Economic Value Scoring of Qu Village Old Yard.* Drawn by the author.

For case I, its category is determined in the first step of the decision path. After analyzing the detailed factors of each value dimension, the score for each value was obtained. Although the economical value (E) score of the courtyard is low, indicating insufficient exploitability as an economic resource, its historical value (A) is as high as 4.3 points, exceeding the judgment threshold of 4.0. By visualizing radar charts, it is very intuitive to see the outstanding historical value. According to the decision model, the priority of retaining historical information is higher than the needs of economic development. Therefore, the sample is locked in the first round of screening and does not need to enter the subsequent evaluation process, and is directly classified as Category I. The corresponding core strategy is not the modernization of functions, but the solidification of historical information and the monitoring of building damage to ensure that the narrative value of spatial carriers is not changed.

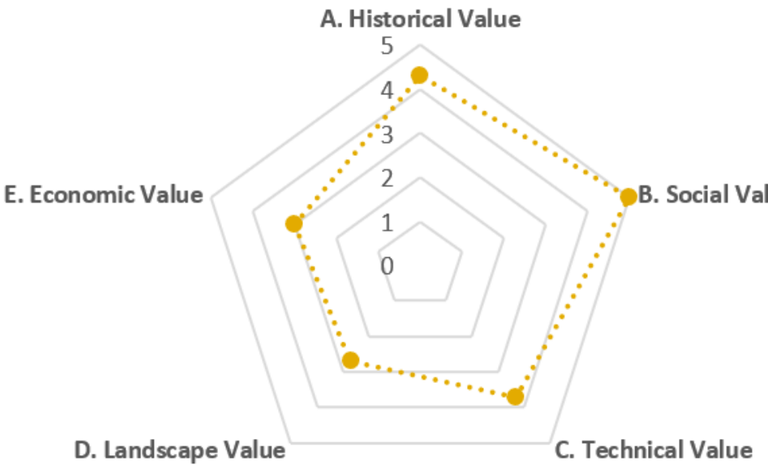


Fig. 108 *Value Radar Chart of Qu Village Old Yard.* Drawn by the author.

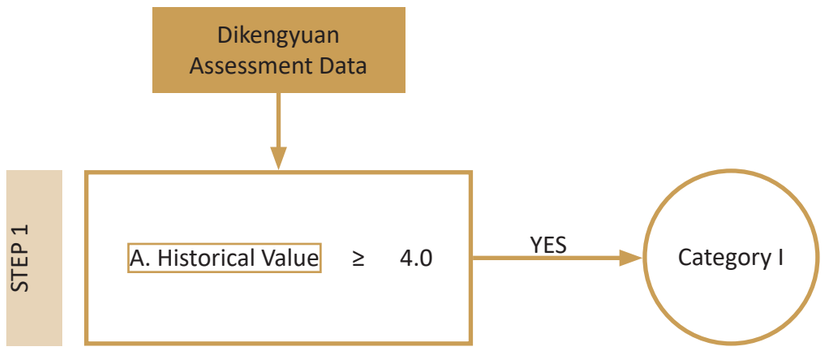


Fig. 109 *Category Classification of Qu Village Old Yard.* Drawn by the author.

Intervention Strategy

Corresponding to the high historical value of Case I, its intervention strategy is defined as *Authenticity - Oriented Conservation*, aimed at freezing the historical status of the courtyard with minimal intervention. The strategy first established an protected area on the current plan, strictly prohibiting any changes to the original layout of the courtyard except for necessary structural reinforcement, and redefining the traffic flow inside the courtyard based on the original context.

In response to the weathering and peeling of loess materials and the damage to structural components such as parapet, the destructive practices of modern cement mortar plastering and the use of prefabricated components have been abandoned. Instead, local original building materials are used for repair while maintaining the recognizability of new and old materials.

For indoor spaces, according to the different functions of the cave, limited repairs can be carried out while maintaining the original layout of the cave, improving the living environment without damaging the most essential indoor composition.

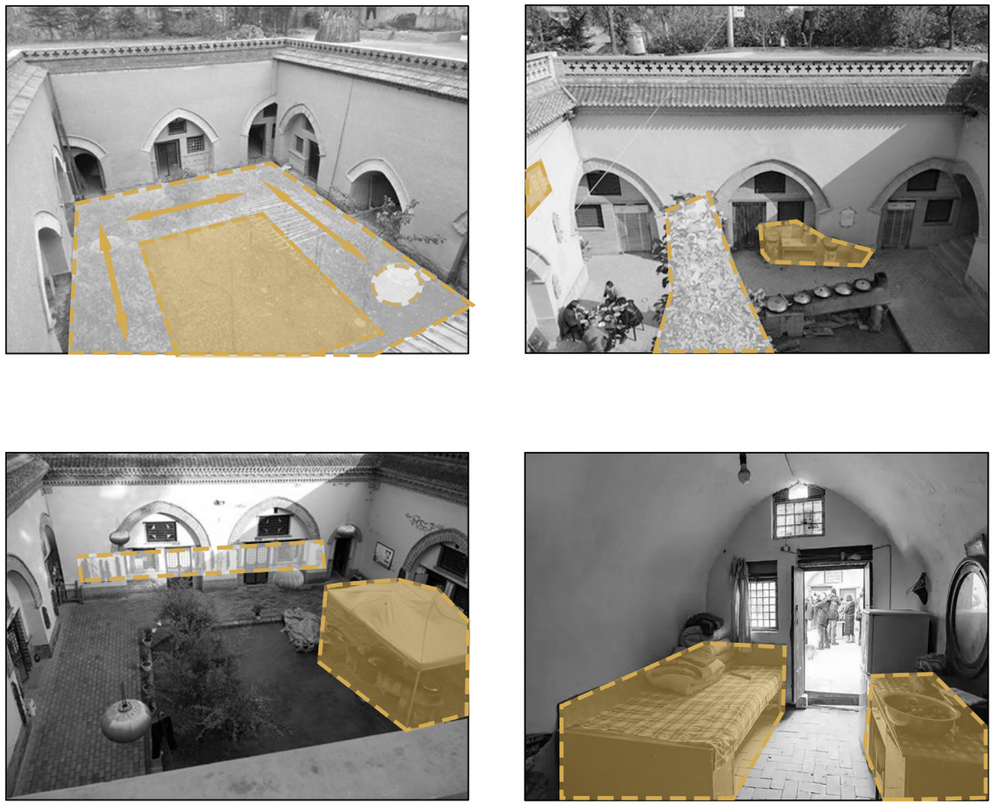


Fig. 110 *Intervention Strategies for Qu Village Old Yard.* Drawn by the author.

6.3 Case II

Name:
Starlight B&B
Category:
II - Adaptive Reuse
Location:
Adjacent to the main village road
Current Situation:
This courtyard is a typical representative of Qu Village's rural tourism development in recent years, transformed into a family run B&B. It is located in the center of the village, adjacent to one of the main roads, and vehicles can directly reach the courtyard roof. The building has undergone a comprehensive modernization renovation, with some of the cave facades using green brick finishes, the ground hardened and paved, and independent bathroom facilities and air conditioning systems embedded inside. The doors and windows have also been replaced with modern glass windows with better air tightness.

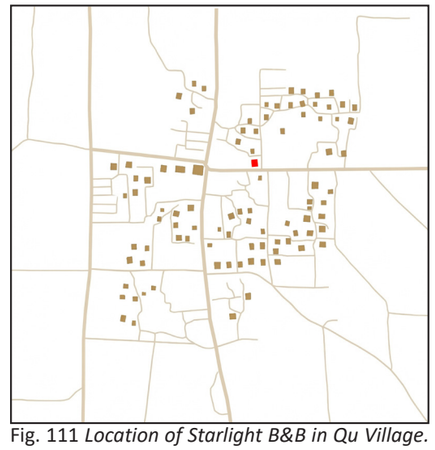


Fig. 111 *Location of Starlight B&B in Qu Village.* Drawn by the author.

Fig. 112 *Starlight B&B.* Photo by the author.

A. Historical Value

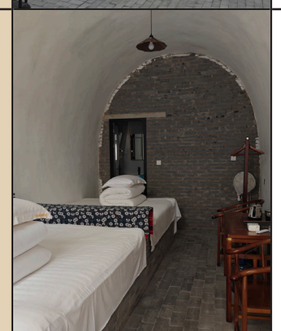
	photo	status	points
A1 Construction Period and Development		It was built in the 1980s and has been used as a residential area for villagers all the time.	3
A2 Layout Integrity		The courtyard layout is complete. But the original functions of the cave have been changed, all of which have become guest rooms. After renovation, the facade elements are well preserved.	5
A3 Material and Component		After the modern renovation of B&B, the original component materials have been completely replaced, and the facade is covered with plaster.	0

Table 12 *Historical Value Assessment of Starlight B&B.* Based on the author's fieldwork.

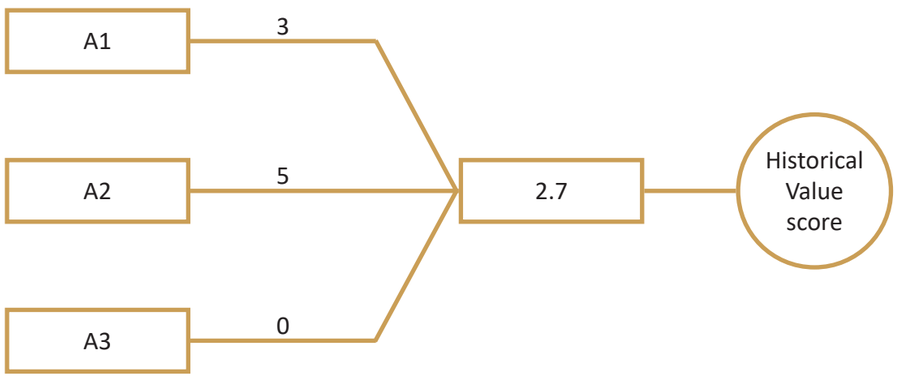


Fig. 113 *Historical Value Scoring of Starlight B&B.* Drawn by the author.

B. Social Value

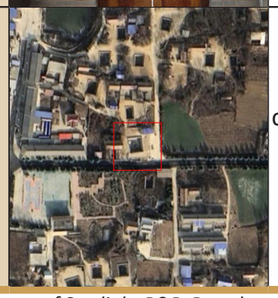
	photo	status	points
B1 Residential Status		The host of B&B resides here year-round, with both tourists and guests come to stay throughout the year.	5
B2 Connection with the Community		Located in the central area of the village, close to the intersection of two main village roads, adjacent to one of the main road and a secondary road.	5

Table 13 *Social Value Assessment of Starlight B&B.* Based on the author's fieldwork.

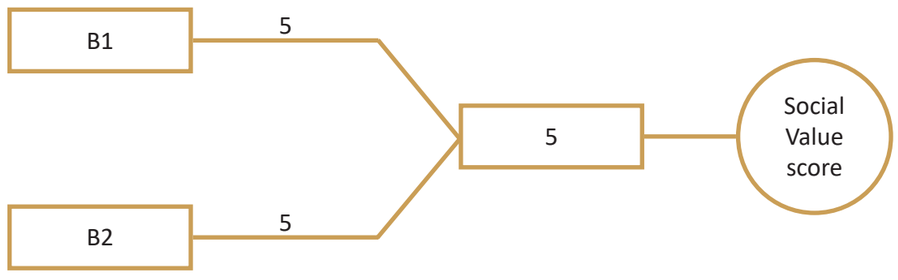


Fig. 114 *Social Value Scoring of Starlight B&B.* Drawn by the author.

C. Technical Value

	photo	status	points
C1 Structural Stability		No structural cracks. No reinforcement marks. Good soil verticality.	5
C2 Drainage Function		The courtyard drainage system operates efficiently, there is no water accumulation in the courtyard on rainy days. The bathroom in the guest room is equipped with a new modern drainage system.	5
C3 Thermal Environment		The indoor thermal environment is comfortable and does not feel damp. But the indoor temperature is still low in winter.	3

Table 14 *Technical Value Assessment of Starlight B&B.* Based on the author's fieldwork.

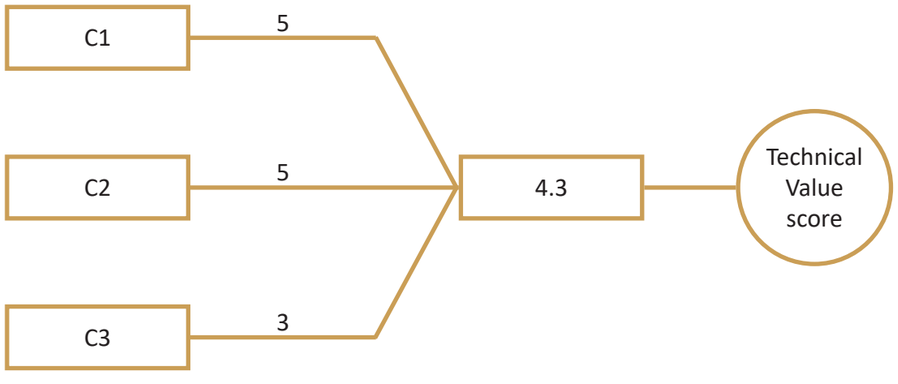


Fig. 115 *Technical Value Scoring of Starlight B&B.* Drawn by the author.

D. Landscape Value

	photo	status	points
D1 Visual Invisibility		A newly built single-layer ancillary facility is located on the north side of the courtyard above ground level.	3
D2 Vegetation and Greening		A greenery landscape design has been carried out in the center of the courtyard, with diverse vegetation types.	5
D3 Visual Purity		A new pavilion has been built to highlight the entrance.	3

Table 15 *Landscape Value Assessment of Starlight B&B.* Based on the author's fieldwork.

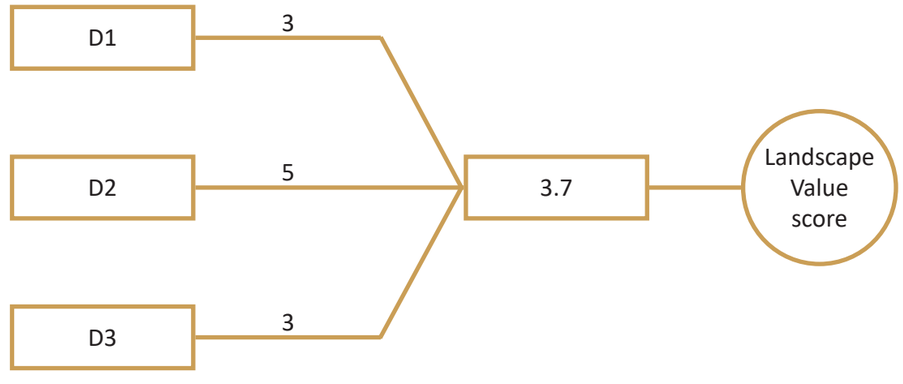


Fig. 116 *Landscape Value Scoring of Starlight B&B.* Drawn by the author.

E. Economic Value

	photo	status	points
E1 Space Potential		The central space of the courtyard is large, with a total of 12 caves in the courtyard, of which 10 are used as guest rooms.	5
E2 Accessibility		Adjacent to the village main road, vehicles can directly drive to the entrance of the courtyard. There is open space for parking on the ground around the courtyard.	5

Table 16 *Economic Value Assessment of Starlight B&B.* Based on the author's fieldwork.

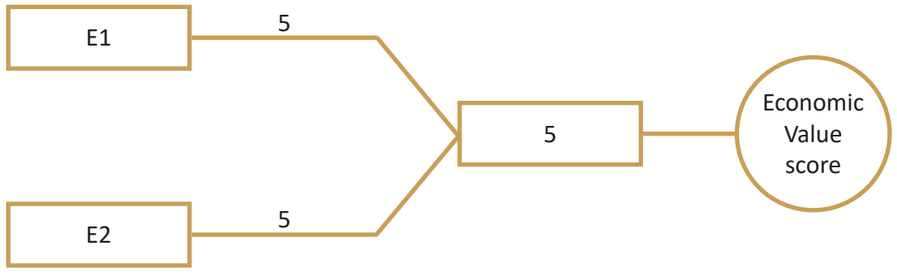


Fig. 117 *Economic Value Scoring of Starlight B&B.* Drawn by the author.

For case II, it successfully passed the first two levels of screening and entered the final stage. This case does not possess high historical attributes that cannot be easily changed (value A<4.0), nor does it have serious structural safety hazards (value C>2.5). On the contrary, its dual high scores in technical value and economical value give it the characteristics of low historical burden and high utilization potential. This indicates that the courtyard is the best container for carrying modern functions, and its core contradiction lies in how to balance the relationship between modern transformation and local style. Therefore, the sample was ultimately classified as Category II, with an intervention focus on improving residential performance through techniques such as implanting box and recovering damaged landscape textures caused by over renovation.

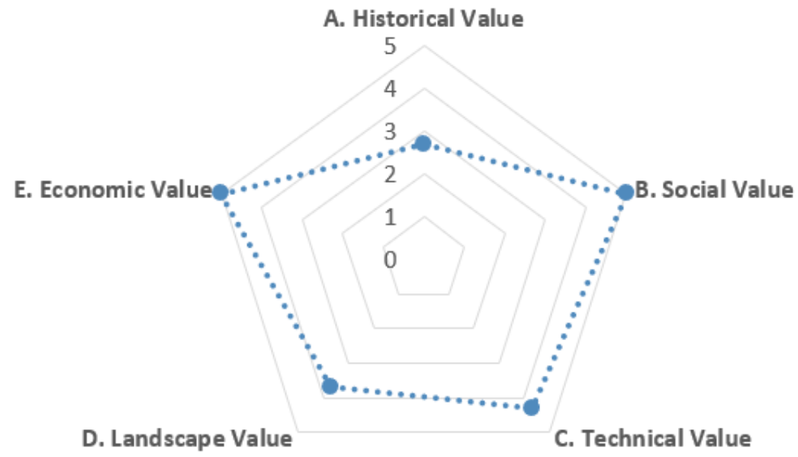


Fig. 118 *Value Radar Chart of Starlight B&B.* Drawn by the author.

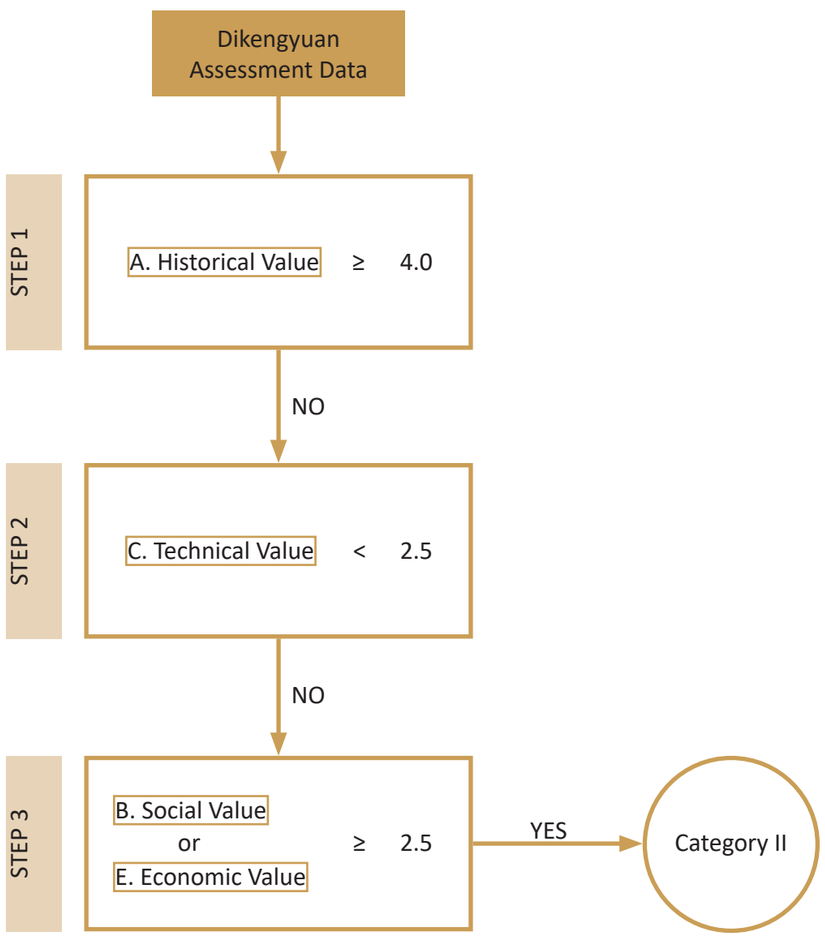


Fig. 119 *Category Classification of Starlight B&B.* Drawn by the author.

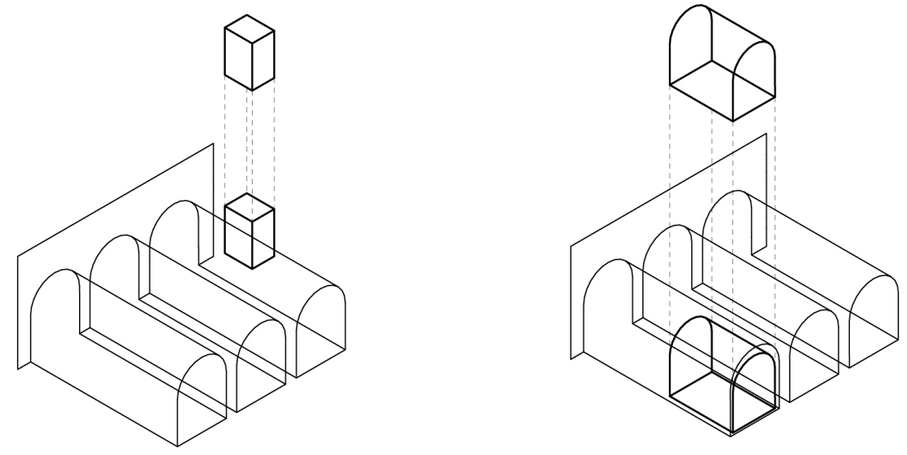
Intervention Strategy

The intervention strategy for case II of the high utilization needs of transformation into a B&B is defined as *Adaptive Reuse*, whose core logic is to address modern functional requirements through technological implantation while ensuring the reversibility of the cave itself.

In response to the demand for bathroom space, independent lightweight steel prefabricated cabins are implanted inside traditional caves, and the *Box in Cave* model is used to achieve symbiosis between old and new. A buffer zone is reserved between the box wall panels and the originally surface of the soil cave, which physically blocks the infiltration of underground capillary water into the interior and also serves as insulation.

This separated structure ensures that the implant does not rely on the original cave surface. In the future, if the function is adjusted, the box can be removed without damage, restoring the original state of the pit courtyard and effectively balancing modern living comfort with local style protection.

For ventilation issues, solar powered ventilation shafts are implanted above the cave wall, utilizing the principle of thermal pressure to enhance passive ventilation.



Implantation of lighting and ventilation well

Implantation of function box

Fig. 120 *Intervention Strategies for Starlight B&B.* Drawn by the author.

6.4 Case III

Name:

Unnamed Abandoned Pit Courtyard

Category:

III - Landscape Integration

Location:

At the edge of the village

Current Situation:

This pit courtyard is located on the southwest edge of the village, adjacent to a large area of farmland on the west side, with poor accessibility. It has been abandoned for more than 5 years, and due to long-term lack of maintenance, the facade finishing has been peeled off, and the original building structures such as parapet no longer exist. Part of the cave in the courtyard has collapsed, exposing the yellow soil inside. The original drainage system failed and the seepage well was severely blocked, resulting in water accumulation inside the yard during the rainy season and the growth of dense plants.

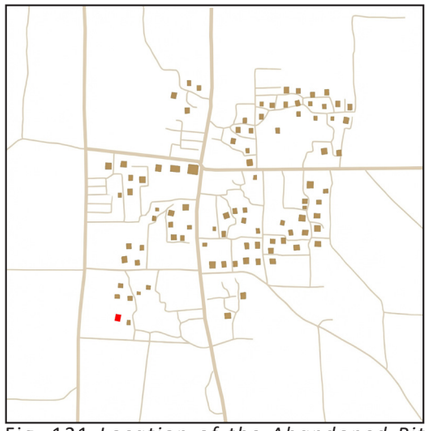


Fig. 121 *Location of the Abandoned Pit Courtyard in Qu Village.* Drawn by the author.

Fig. 122 *The Abandoned Pit Courtyard.* Photo by the author.

A. Historical Value

	photo	status	points
A1 Construction Period and Development		It was built in the 1980s and has been used as a residential area for villagers, but it has been abandoned for more than 5 years.	3
A2 Layout Integrity		Half of the cave in the courtyard has collapsed. The original layout is unclear.	0
A3 Material and Component		The original structure and components are missing, leaving only the collapsed soil slopes.	0

Table 17 *Historical Value Assessment of the Abandoned Pit Courtyard.* Based on the author's fieldwork.

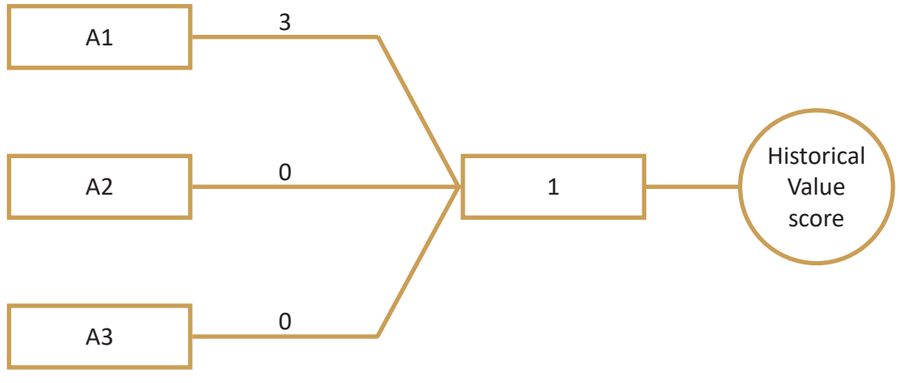


Fig. 123 *Historical Value Scoring of the Abandoned Pit Courtyard.* Drawn by the author.

B. Social Value

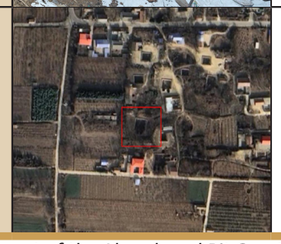
	photo	status	points
B1 Residential Status		The original residents have moved out and there has been no one living there for over 5 years.	0
B2 Connection with the Community		Located on the southwestern edge of the village, separated from the cultivated field by a road.	0

Table 18 *Social Value Assessment of the Abandoned Pit Courtyard.* Based on the author's fieldwork.

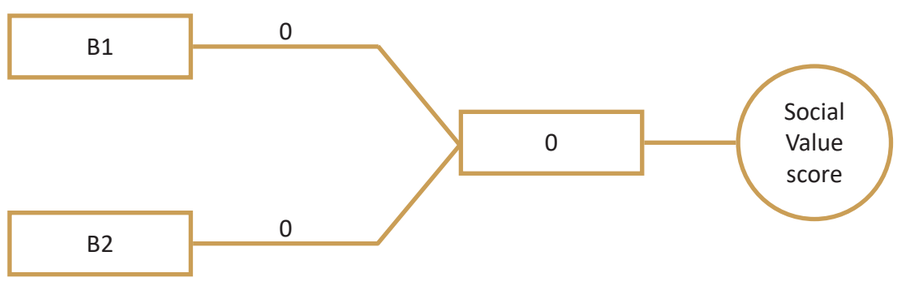


Fig. 124 *Social Value Scoring of the Abandoned Pit Courtyard.* Drawn by the author.

C. Technical Value

	photo	status	points
C1 Structural Stability		More than half of the caves have collapsed, and some caves that have not yet collapsed also have huge structural cracks.	0
C2 Drainage Function		Parapet structure is missing, causing rainwater from the ground to flow back into the courtyard. The seepage well in the courtyard is blocked, and there is severe water accumulation on rainy days.	3
C3 Thermal Environment		The building envelope is damaged, the indoor thermal environment is basically the same as the outdoor environment.	0

Table 19 *Technical Value Assessment of the Abandoned Pit Courtyard.* Based on the author's fieldwork.

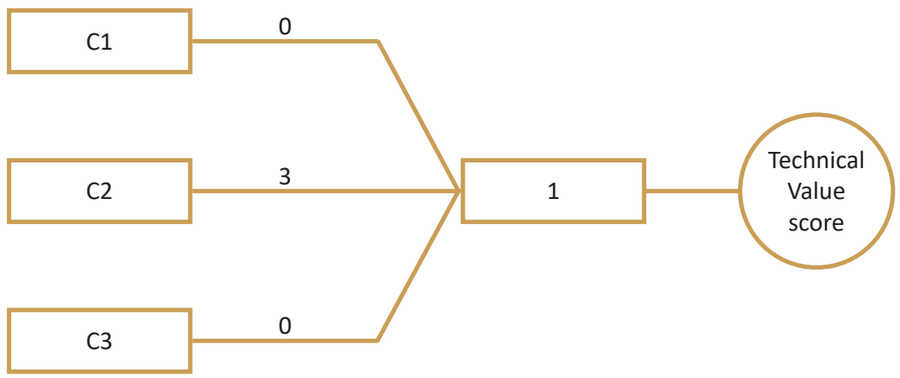


Fig. 125 *Technical Value Scoring of the Abandoned Pit Courtyard.* Drawn by the author.

D. Landscape Value

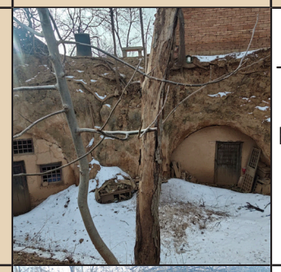
	photo	status	points
D1 Visual Invisibility		The vegetation growing inside the courtyard is higher than the ground level and can be seen from a distance.	3
D2 Vegetation and Greening		The landscape is messy, with vegetation growing freely without any planning.	0
D3 Visual Purity		There are newly built single story brick houses in the surrounding used as warehouses.	3

Table 20 *Landscape Value Assessment of the Abandoned Pit Courtyard.* Based on the author's fieldwork.

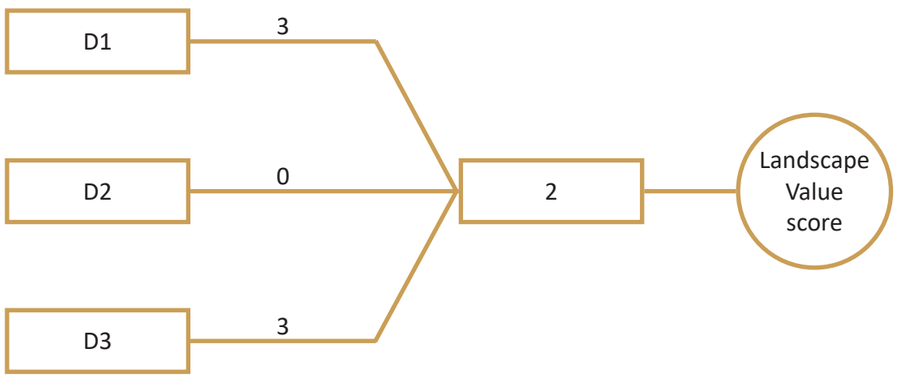


Fig. 126 *Landscape Value Scoring of the Abandoned Pit Courtyard.* Drawn by the author.

E. Economic Value

	photo	status	points
E1 Space Potential		The courtyard has a medium scale and there is sufficient free space around it for future design purposes.	3
E2 Accessibility		There is a small path within the village that leads directly to it, not far from the main road connecting the field and the village.	3

Table 21 *Economic Value Assessment of the Abandoned Pit Courtyard.* Based on the author's fieldwork.

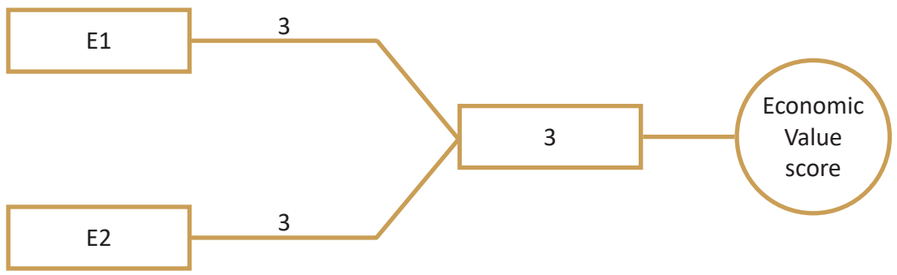


Fig. 127 *Economic Value Scoring of the Abandoned Pit Courtyard.* Drawn by the author.

For case III, it is classified in the second step of the decision-making process. After failing the first level selection with historical value as the primary consideration factor, the courtyard entered the structural safety assessment step. Through field research, it was found that there were multiple collapses in the cave of the courtyard, the seepage well was blocked, and the original enclosure structure was missing, resulting in the failure of the drainage system. Its technical value (C) is only 1 point, which is below the minimum limit of 2.5. This data indicates that the courtyard can no longer be considered as a building in terms of functionality, and forced restoration is not only costly but also carries uncontrollable risks. Therefore, it is excluded from residential or commercial use and directly leads to Category III. Subsequent interventions will consider undertaking functions beyond the building.

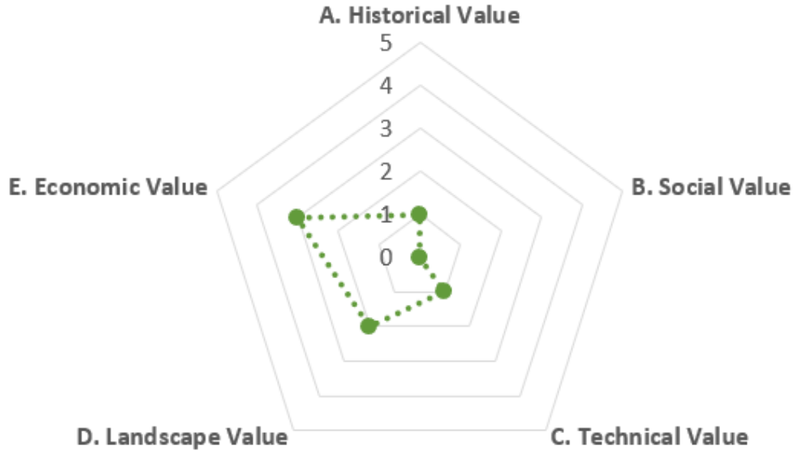


Fig. 128 *Value Radar Chart of the Abandoned Pit Courtyard.* Drawn by the author.

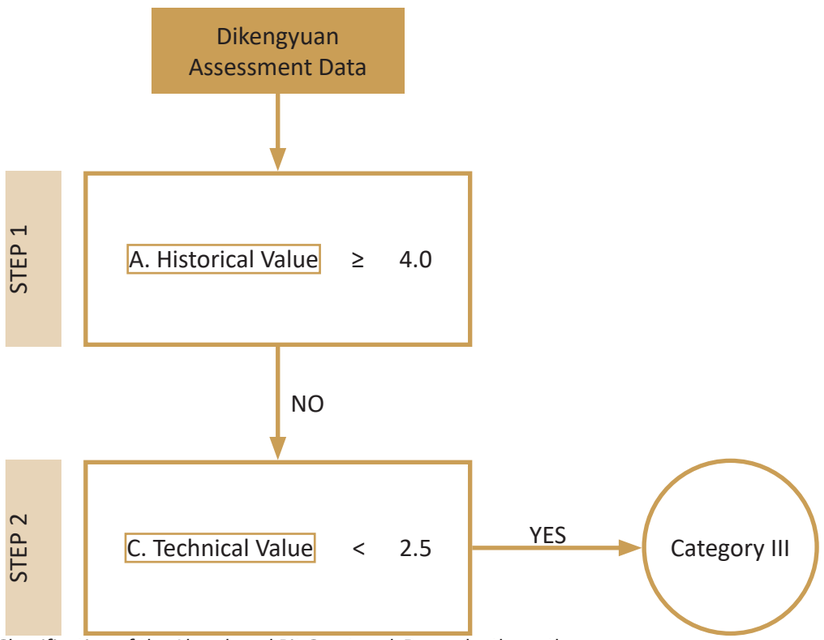


Fig. 129 *Category Classification of the Abandoned Pit Courtyard.* Drawn by the author.

Intervention Strategy

In response to the hazardous property and ruins characteristics of Case III, the intervention strategy no longer pursues functional restoration at the architectural level, but transforms it into landscape infrastructure at the edge of the settlement, adopting the *Landscape Integration* strategy. Firstly, accept its aesthetic value as ruins, and only use biological methods to reinforce the collapsed cave edges, such as planting shrubs with well-developed roots, to prevent the expansion of geological disasters and preserve the ruins as landscape texture. The core intervention measure is to transform the seepage well system that has lost its drainage function into a Rain Garden, planting locally grown plants that are resistant to moisture and have purification functions at the bottom of the pit, and using the natural catchment terrain of the pit courtyard to collect surrounding surface runoff.

During the rainstorm, these abandoned courtyards distributed throughout the settlement can be used as temporary reservoirs to effectively absorb the surrounding surface runoff and reduce the overall drainage pressure of the village. During the dry season, the local microclimate environment is regulated through the transpiration of local plants that are tolerant to moisture and drought. This strategy transforms abandoned courtyards that originally had safety hazards into green sponge nodes that serve the overall ecological security of the village, achieving a functional transformation from architecture to landscape infrastructure.

For the landscape level, a lightweight steel structure walkway is designed to be elevated above the ruins, supported only by a few anchoring points, in order to avoid disturbing the fragile soil structure. This intervention establishes a physical isolation between visitors and the site, allowing people to cross from the top of the pit safely. From this perspective, tourists can overlook the natural vegetation growing at the bottom of the pit and the remaining cave ruins, experiencing the most natural evolution of Dikengyuan.

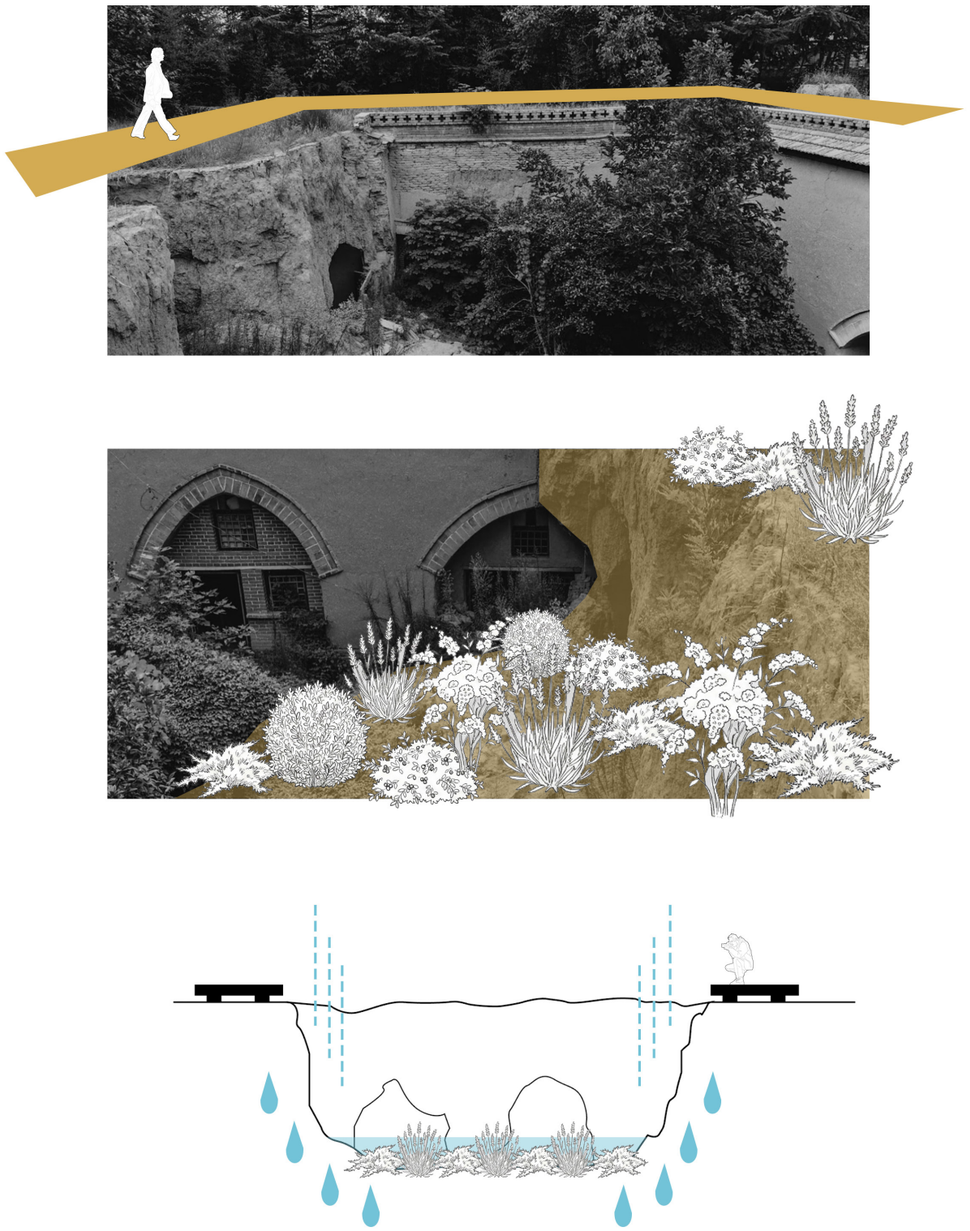


Fig. 130 *Intervention Strategies for the Abandoned Pit Courtyard.* Drawn by the author.

6.5 The Comparison Analysis

Through horizontal comparison, it can be found that although the three cases are located in the same village, the graphic contours of radar chart after value assessment show significant morphological differences. By visualizing the five value dimensions, the essential differences in the resource attributes of different types of pit courtyards were intuitively revealed, proving that the framework constructed in this study is not only a data recording tool, but also a sensitive diagnostic tool with the ability to deal with different types of Dikengyuan. From qualitative analysis to quantitative analysis, the complex state of buildings was quantified, and the decision-making process provided a solid logical foundation for subsequent differentiated interventions, effectively avoiding the extreme tendency of large-scale demolition and construction in traditional rural planning.

As an application part of the research, this chapter demonstrates that the constructed *value assessment - differentiated intervention* framework has clear operational logic and significant practical value, and can provide replicable methodological support for the renovation of pit courtyard settlements in the Loess Plateau region.

	case I Qu Village Old Yard	case II Starlight B&B	case III Abandoned Courtyard
A. Historical Value	4.3	2.7	1
B. Social Value	5	5	0
C. Technical Value	3.7	4.3	1
D. Landscape Value	2.7	3.7	2
E. Economic Value	3	5	3

Table 22 *Detailed Value Comparison.* Based on the author's fieldwork.

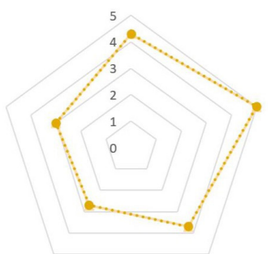
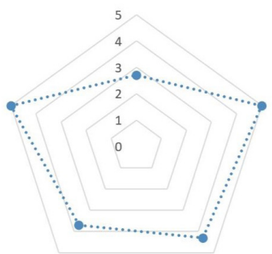
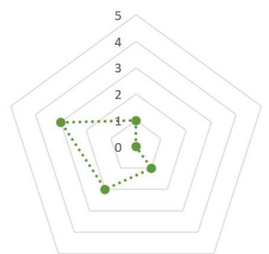
case I Qu Village Old Yard	case II Starlight B&B	case III Abandoned Pit Courtyard
		

Table 23 *Value Radar Chart Comparison.* Drawn by the author.

07

CONCLUSION

7.1 Summary of Main Research Findings

This thesis began with a focus on the crisis of the gradual decline of pit courtyards, aiming to explore a new path that can balance vernacular heritage conservation and modern development. By conducting a comparison analysis based on a cross-cultural perspective between China and Italy, and combining it with empirical research in Qu Village, Sanmenxia, Henan, this thesis confirms the necessity and significance of a value assessment and differentiated intervention framework for the pit courtyard in heritage practice.

Through comparative analysis, this thesis confirms that Matera's transformation from an abandoned slum to a UNESCO World Heritage Site offers highly relevant insights for the conservation of pit courtyards in China. Although the two are in different cultural and environmental contexts, they present a high degree of consistency in terms of cave dwelling characteristics in architectural typology, poverty stigmatization encountered in history, and depopulation in the modernization process. This commonality demonstrates that the conservation of pit courtyards could be situated within the global underground architectural heritage regeneration. By introducing Matera's practice experience, this thesis confirms that the pit courtyard has the potential to transform from a backward symbol to a valuable form of contemporary living heritage.

In response to the vague criteria in traditional vernacular architecture conservation, this thesis constructs and verifies a value-based assessment system consisting of five dimensions: historical, social, technical, landscape, and economic. The empirical results in Qu village show that this assessment tool can accurately identify different resource attributes among individual pit courtyards, and can be visualised through the radar chart. This finding changes the previous decision-making model that was driven mainly by experience or benefits, and provides a clear theoretical method for differentiated management of existing pit courtyards.

A critical contribution of this research is the establishment of a differentiated intervention framework derived directly from the assessment results. Overcoming the limitations of traditional uniform conservation approaches, this system defines precise practical methods for distinct samples. For high historical value pit courtyards, the research confirms the necessity of adopting recognizable technologies and materials to preserve the authenticity of historical information. For pit courtyards with high reuse potential, the introduction of prefabricated structures demonstrates the feasibility of improving indoor environmental conditions while retaining the original cave pattern. For already abandoned pit courtyards, the study proposes a strategy related to landscape to integrate them with the environment as ecological nodes. This differentiated system challenges the conventional view that every ruin must be fully restored to be considered saved. It provides various solutions for conservation in different contexts.

7.2 Research Limitations

Although this thesis establishes a relatively complete framework for assessment and intervention, several limitations remain due to objective constraints.

In terms of sample scope, the empirical research focuses on Qu Village in Sanmenxia, Henan. While the village is representative, the Loess Plateau covers a vast area, and different villages show significant differences in geological conditions, economic levels, and spatial patterns. The information and scoring process of the framework are currently based on data from Qu Village and have not yet been tested and calibrated on a larger scale. Therefore, when applying the framework to other villages, adaptive adjustments may be required.

In terms of technical verification, the adaptive renewal strategies proposed in this study are mainly presented through assumed analysis and design guidelines. Due to the lack of long-term on field monitoring, there is still a lack of measured evidence regarding specific improvements in the indoor physical environment. In addition, the real construction costs and technical difficulties of these strategies under local construction conditions require further verification through future practice.

7.3 Future Prospects

The pit courtyard is the result of long-term interaction between land and people, its conservation and development constitute a dynamic process. Based on the current research, future work can be further expanded in the following aspects.

By promoting the digital transformation of heritage management, applying digital twin technology and building information modeling, the static assessment model developed in this thesis can be transformed into a dynamic digital management platform. Through the establishment of a digital database for pit courtyards, it would be possible to enable a shift from reactive preservation to preventive conservation.

In addition, moving beyond an expert-dominated perspective and establishing a community involved system, placing greater emphasis on the participation of local residents during conservation practice, ensuring that conservation planning genuinely reflects community needs and supports the sustainable development.

This research could be extended and validated to the entire Loess Plateau region, providing a methodological reference for the conservation of other types of earthen architecture in Northwest China.

The pit courtyard, as a record of the ancient living wisdom on the Loess Plateau, should not be regarded as a symbol of poverty, but as a heritage with considerable ecological and cultural potential. Through continuous research and practical exploration, these ancient cave dwellings can regain their value again in the contemporary context and continue to support both the land and people's everyday life.

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