The Application of Digital Technology to Innovatively Protect and Inherit the Culture of Ancient Architectural Sites in Luoyang

Bo Li

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ABSTRACT

This study, titled "The Application of Digital Technology to Indicatively Protect and Inherit the Culture of Ancient Architectural Sites in Luoyang," explores the innovative integration of digital technologies in the preservation and inheritance of ancient architectural heritage. The primary research objectives are: (1) to investigate the history and origin of ancient Chinese architectural culture, (2) to assess the current challenges and issues impacting the preservation of these cultural sites, and (3) to develop strategies leveraging digital technology for cultural protection and inheritance. To achieve these objectives, qualitative research methods were employed, including semi-structured interviews with experts, policymakers, and local residents, on-site observations at key heritage sites, comprehensive literature reviews, and the application of advanced digital modeling techniques. These approaches ensure a multidimensional perspective that captures both the technical and cultural intricacies of heritage conservation.

The findings of this study reveal that Luoyang's ancient architectural heritage represents a profound synthesis of historical, artistic, and social values. However, conservation efforts are impeded by several challenges, including environmental degradation from air pollution and acid rain, the encroachment of urban development, and a lack of widespread public awareness about the cultural significance of these sites. Advanced technologies such as 3D scanning, virtual reality (VR), and augmented reality (AR) have demonstrated their transformative potential in addressing these challenges. For instance, 3D scanning provides high-precision documentation, enabling restoration experts to identify structural vulnerabilities and plan non-invasive interventions. Similarly, VR and AR technologies create immersive educational experiences, allowing users to explore the historical and cultural narratives of heritage sites in an interactive and engaging manner. By minimizing physical risks to fragile structures and enhancing public engagement, these technologies significantly advance both the preservation and promotion of ancient architecture.

Moreover, the research highlights the vital role of community involvement and policy support in sustainable conservation efforts. Active

participation from local residents fosters a sense of ownership and pride in preserving cultural heritage. Educational workshops and hands-on training programs equip community members with basic conservation skills, ensuring small-scale maintenance can be conducted locally to prevent long-term deterioration. Policymakers and heritage managers emphasized the need for coordinated efforts that balance traditional craftsmanship with modern technological tools. The establishment of heritage buffer zones to protect the contextual integrity of these sites, coupled with increased government funding and private investment incentives, emerged as critical strategies for aligning urban development with heritage conservation.

This study provides both theoretical insights and practical recommendations for the conservation of ancient architectural sites, not only in Luoyang but also in other historical cities facing similar pressures. The integration of advanced technologies with traditional conservation methods ensures the preservation of architectural authenticity while addressing contemporary challenges. Additionally, by leveraging digital tools for education and public engagement, this research advocates for a multidisciplinary and inclusive approach to safeguarding cultural heritage. The findings emphasize that sustained investment in policy reforms, public education, and technological innovations is essential to preserving the cultural and historical values of ancient architecture. Ultimately, this study establishes a framework for sustainable conservation practices, offering a valuable reference for preserving China’s rich architectural legacy for future generations.

Keyword : Digital technology, Indicatively protect, Inherit, Ancient architectural Sites

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INTRODUTION

1.1 Background of the Study

As the ancient capital of China during the 13th Dynasty, Luoyang has a rich heritage of ancient buildings. These ancient buildings not only display the architectural styles and techniques of different historical periods, but also carry heavy cultural connotations and historical memories. For example, famous monuments such as the Longmen Grottoes and the White Horse Temple are not only important carriers of Buddhist culture, but also outstanding representatives of ancient Chinese architectural art. From Xia（2070 B.C.）, Shang（1600 B.C.） and Zhou（1046 B.C.） to Han（202 B.C.）, Wei, Jin, North and South Dynasties（220 A.D.）, and then to the 13 Dynasties of Sui（220 A.D.）, Tang（618 A.D.）, Five Dynasties（907 A.D.）, Song（960 A.D.）, Jin（1115 A.D.）, Yuan（1271 A.D.）, Ming（1368 A.D.） and Qing（1616 A.D.）, Luoyang has always been an important political centre, producing countless literati and emperors. The activities of these historical figures not only enriched the cultural heritage of Luoyang, but also provided an important historical background for the development of ancient architecture. Therefore, the study of ancient architecture in Luoyang is of great significance to the understanding of Chinese culture and history. (Guo, W. 2022).

The Duke of Zhou, known as Ji Dan, was an important statesman, thinker and militarist in the early Western Zhou Dynasty, as well as the fourth son of the founding monarch of the Zhou Dynasty, King Wen of Zhou. As one of the founders of the Western Zhou Dynasty, the Duke of Zhou not only took part in building the regime of the Zhou Dynasty, but also assisted the young lord, King Cheng, after the death of King Wu of the Zhou Dynasty, and stabilized the newborn Zhou Dynasty with his outstanding wisdom and political talents. During his regency, the Duke of Zhou formulated a series of rituals and legal norms, which laid the theoretical and practical foundation for the feudal rule of later generations. The Duke of Zhou not only laid the foundation for the prosperity of the Western Zhou, but also had a profound influence on the thirteen subsequent dynasties of Luoyang. As the founder of rituals, the ideas

and systems of the Duke of Zhou became the model for rulers to follow, especially after Luoyang became the capital of thirteen dynasties, including the Eastern Zhou, the Eastern Han, the Wei, Jin, North and South Dynasties, and the Sui and Tang dynasties, where these rituals and systems were continued and developed. Gradually, Luoyang became the center of Chinese ritual and culture under the guidance of Zhou Gong's thought, which not only played an important role in politics and culture, but also attracted a large number of scholars and scholars, making it one of the important birthplaces of Chinese civilization. The position of Duke Zhou in Chinese history is not only that of a statesman, but also that of the founder of the ritual civilization. His ideas profoundly influenced the political and cultural development of China, and in particular played an important role in the formation of the ritual and cultural system and social structure of Luoyang as the ancient capital of the thirteen dynasties. His concepts of etiquette and patriarchy continued and developed through the successive dynasties in Luoyang, becoming an important part of traditional Chinese culture and playing a crucial role in the construction and maintenance of feudal society in China.

The architecture of the Zhou Gong Temple in Luoyang is one of the treasures of ancient Chinese architectural culture, and as a symbol of the Zhou Dynasty culture, its complex demonstrates the unique architectural style and deep cultural heritage of ancient China. Luoyang is not only the ancient capital of thirteen dynasties, but also an important birthplace of Zhou culture, thus the Zhou Gong Temple has become an important part of Luoyang's cultural heritage with great regional characteristics and historical value. The architectural layout, structural form, decorative style and the use of materials of the temple reflect the architectural technology and cultural connotation of the Zhou Dynasty, and have a profound impact on the architectural style and the inheritance of Chinese culture in the future generations.

With the rapid development of China's economy and the acceleration of urbanization, Luoyang ancient architecture faces multiple challenges. Changes in the natural environment, such as air pollution, acid rain, and climate change, seriously threaten the structural stability and preservation integrity of ancient buildings. In addition, land use changes and building demolitions brought about by rapid urbanization have forced many ancient buildings to give way to modernization. Meanwhile, the development of tourism, while boosting the economy, has also

increased the burden on ancient buildings, with excessive commercial development and foot traffic putting great pressure on them. The lack of protection funds and technology also restricts the effective implementation of protection work. Many ancient buildings have gradually fallen into disrepair due to lack of maintenance and are in urgent need of repair and protection (He Hua, 2011). In addition, the imperfection of the management system and the lack of people's awareness of conservation are also important problems facing the conservation of ancient buildings. Although the government and relevant departments have taken some protection measures, there are still problems such as unsound laws and regulations and imperfect management system, which affect the in-depth development of protection work. The architectural form of the Luoyang Zhou Gong Temple reflects the ritual norms of the Zhou Dynasty and shows the architectural expression of the idea of ‘a state of etiquette’. The complex is located in the centre of Luoyang, and the surrounding natural environment forms a harmonious whole with the historical site, which is highly regional. As one of the earliest temples in China, the Temple of the Duke of Zhou not only represents the important position of Luoyang in the history of ancient Chinese architecture, but also has exemplary significance on a national scale. It reflects the importance of Luoyang as a core area of Zhou culture and occupied a central position in the political, religious and cultural life of ancient China. After thousands of years of weathering, the surviving structures of the Temple of the Zhou have been damaged, but they still provide us with valuable materials for the study of social systems, architectural styles and religious beliefs in ancient China.

This study aims to explore how to effectively protect and pass on the ancient architectural culture of Luoyang through innovative conservation methods and the combination of modern scientific and technological means. Through three-dimensional scanning, virtual reality (VR), augmented reality (AR) and other technical means, the existing ancient buildings are digitally modelled and displayed online, providing a more scientific and intuitive way of recording for the protection of ancient buildings. At the same time, through public education and publicity, public awareness and participation in the protection of ancient buildings will be raised, and the sense of responsibility and mission of all sectors of society for the protection of cultural heritage will be enhanced. This study will also analyse the advanced

experience and cases of ancient building protection at home and abroad, and put forward protection strategies and methods suitable for ancient buildings in Luoyang. While protecting the original appearance and historical value of ancient buildings, it will explore how to achieve sustainable development of ancient buildings in the process of modernization. Through the combination of cultural tourism and cultural creative industries, it promotes the win-win situation between the protection of ancient buildings and economic development, and realises the rational use and development of cultural heritage. (Wang, L. and Liu, KC 2016)

Facing the challenges of Zhou Gong Temple conservation in the process of modernization, innovative conservation methods are crucial. Nowadays, combined with digital technology, the conservation of Zhou Gong Temple can be recorded and displayed digitally with high precision using modern technological means such as 3D modelling, virtual reality (VR) and augmented reality (AR). These technologies can not only completely record the structure, details and decorations of the Zhougong Temple building, but also enable the public to understand and experience the history and culture of the Zhougong Temple in an immersive way through virtual display. In addition, with the help of Internet of Things (IoT) technology of sensor networks, the environmental conditions and structural status of the building can be monitored in real time, so that appropriate protection measures can be taken before any damage occurs. These technological tools provide scientific support for the sustainable conservation of Zhougong Temple. On the other hand, the conservation of the Zhougong Temple is also inseparable from public participation. Through regular public education and publicity activities, the awareness and sense of responsibility of the community towards the conservation of the Zhougong Temple can be enhanced. Community participation, volunteer activities and cultural heritage education can enhance the public's understanding of and attention to cultural heritage and form a conservation atmosphere in which the whole society participates.

This study is not only of great practical significance for the protection of ancient buildings in Luoyang, but also provides a reference for the protection of other historical and cultural cities in China. Through the systematic study of ancient architecture in Luoyang, it enhances people's awareness of heritage protection and promotes more people to devote themselves to heritage protection work. The results

of this research can provide a theoretical basis and practical reference for the protection and inheritance of the cultural heritage of ancient architecture in China. Especially in the current context of globalization and accelerated urbanization, how to effectively protect and pass on historical and cultural heritage has become an important topic of global concern. The development of this study will provide practical reference and guidance for the policy formulation and implementation of the relevant departments in China, promote the in-depth development of the protection of ancient buildings, facilitate the protection of cultural diversity, enhance public awareness of and respect for history and culture, and increase national pride and cultural self-confidence.

In conclusion, the architecture of Luoyang Zhou Gong Temple is not only a witness of ancient Chinese architectural art and religious beliefs, but also a symbol of Luoyang's unique culture and history. Its protection and inheritance is not only of regional and cultural importance, but also carries the inheritance of historical memory and modern society's admiration for traditional culture. By combining modern technical means, improving protection regulations and enhancing public participation, this precious cultural heritage can be protected more scientifically and effectively, leaving a rich historical memory and cultural treasure for future generations. This study hopes to provide theoretical basis and practical support for the conservation and inheritance of Zhou Gong Temple based on the systematic study of its architecture. It is hoped that through this study, practical countermeasures and approaches will be proposed for the protection and development of Luoyang and other historical and cultural cities, so that these valuable cultural heritages can be revitalized in the modern society, which will have a far-reaching impact on the protection of historical and cultural heritages, the promotion of cultural diversity, and the enhancement of social awareness of and respect for historical and cultural heritages.

1.2 Research Objectives

1.2.1 To Study the history and origin of China's ancient architectural culture.

1.2.2 To Study the current situation and problems of China's ancient architectural culture.

1.2.3 To Study digital technology on Chinese ancient architecture culture protection and inheritance method.

1.3 Research Questions

1.3.1 What is the history and origin of ancient Chinese architectural culture? How does its unique cultural connotation reflect the social, religious and political characteristics of ancient China?

1.3.2 What are the main problems currently faced by ancient Chinese architectural culture in conservation and inheritance? What are the factors affecting the effectiveness of conservation?

1.3.3 How can digital technologies be used in the conservation and transmission of ancient Chinese architectural culture? What specific digital technologies can enhance conservation efficiency and promote public participation?

1.4 Importance of the Study

1.4.1 Through an in-depth study of the historical origins and developmental lineage of ancient Chinese architectural culture, this research can help people better understand the cultural values, religious symbols and social functions behind these buildings. It is not only an enquiry into the art and technology of ancient architecture, but also an in-depth understanding of the culture, thinking and lifestyle of ancient China. Such research is not only of academic value, but also of great significance in enhancing national cultural identity and improving national historical and cultural literacy.

1.4.2 With the acceleration of urbanization and changes in the natural environment, ancient architectural culture faces many challenges in its conservation. By systematically analyzing these problems, this study can provide scientific basis and practical guidance for improving the protection of ancient buildings. The research results can provide theoretical support for the government, cultural management

organizations and conservationists to formulate better conservation policies, technical specifications and management measures, thus enhancing the quality and effectiveness of the conservation of ancient architectural culture.

1.4.3 With the rapid development of digital technology, 3D modelling, virtual reality (VR), augmented reality (AR) and other technologies have gradually been widely used in cultural heritage protection. This study will explore the specific ways of applying digital technology in the protection and inheritance of ancient Chinese architectural culture, and through the research and promotion of innovative protection methods, it can not only improve the accuracy and efficiency of protection, but also enhance public participation and promote the popularisation and inheritance of ancient architectural culture. This is of great practical significance for the protection and inheritance of architectural heritage with profound historical value.

1.5 Definition of Terms

This section explains key terms through five dimensions: 1) Patterns, 2) Beliefs, 3) Materials and Creative Process, 4) Makers, and 5) Regions and Roles. These dimensions provide a comprehensive framework for understanding the cultural, historical and technological aspects of ancient architectural sites and their conservation.

1.5.1 Ancient Architectural Site

Pattern.

The architectural layout of the Temple of the Duke of Zhou reflects the ritual norms and hierarchy of Zhou culture. Its prominent central symmetrical structure, enclosed courtyards, and functional zoning symbolize the philosophical idea of the unity of heaven and man and the strict hierarchical order of society. This model had a profound influence on subsequent ancient Chinese architecture and is a model of ancient architectural culture.

Beliefs.

As a place of worship, the Temple of the Duke of Zhou carries the cultural traditions of honoring the Duke of Zhou and sacrificing ancestors. Its architectural layout is closely linked to the sacrificial rituals, reflecting the core values of Confucian ethics, such as “honoring heaven and ancestors” and “loyalty to the ruler

and love of the country. These beliefs have profoundly influenced the spiritual world and behavioral norms of traditional Chinese society.

Materials and Creative Process.

The construction of the temple is made of locally produced timber, bricks and stone, reflecting the full utilization of natural resources. The use of mortise-and-tenon joints, arch systems, and flying eaves not only enhances the durability of the building, but also demonstrates the skill of ancient craftsmen. The decorative parts of the building, such as inscriptions, colorful paintings and relief carvings, convey the artistic pursuits and technical achievements of the Zhou culture.

Makers.

The construction of the Temple of the Duke of Zhou was accomplished jointly by Zhou craftsmen and religious priests, with the craftsmen playing a central role in the realization of the building's form and structure, while the priests were responsible for designing its layout in conformity with ceremonial norms. This mode of cooperation not only reflects the division of labor in the society, but also reflects the importance of religious and political authority in the Zhou society.

Region and Role.

The Temple of the Duke of Zhou is located in Luoyang, a city that was an important political and cultural center of the Zhou Dynasty. As the central place for the rituals of the Duke of Zhou, the temple played an important role in regional cultural inheritance, political influence, and religious ceremonies. It not only symbolizes the ritual system of the Zhou Dynasty, but also serves as a template for the sacrificial culture of future generations, playing a foundational role in the evolution of ancient Chinese ritual architecture.

1.5.2 Historical Heritage

Pattern.

As a historical heritage, the Temple of the Duke of Zhou exhibits a unique axial layout and spatial organization of ritual architecture, a pattern that is a reflection of the social structure of the Zhou Dynasty. Compared with other cultural sites in Luoyang, the planning of the Zhou Gong Temple particularly highlights the ritual function and its symbolic meaning.

Beliefs.

The temple incorporates the Confucian idea of “ritual,” and its architecture and rituals emphasize ancestor worship and hierarchical order, reflecting the importance that Zhou society placed on the order of heaven, ethics, and moral education. These beliefs are also reflected in the temple through inscriptions and sculptures.

Materials and Creative Process.

The remains of the temple include the main wooden structure and the brick pavement of the courtyard, as well as stone inscriptions and murals that preserve the artistic style of the Zhou Dynasty and subsequent restoration periods. These material and cultural remains are an important physical basis for understanding the architecture and craftsmanship of the Zhou Dynasty.

Makers.

The Zhou Temple was built under the auspices of the state, with a team of highly skilled architects and sculptors as craftsmen, while religious and political leaders provided design guidance. This combination of top-level design and grassroots execution ensured the ceremonial function and artistic quality of the temple.

Region and Role.

As a representative site of Luoyang, the Zhou Temple is of irreplaceable scholarly value in the study of Zhou capital planning, ceremonial architecture, and regional cultural transmission. The existing inscriptions and historical documents at the site provide rich information for future generations to study the rituals and social structure of the Zhou Dynasty, and it is also an important resource for cultural tourism.

1.5.3 Innovative Protection

Content Adjustment:

One of the objectives of innovative protection is to maintain the historical original appearance of the Zhou Gong Temple and its cultural connotation, while utilizing modern technology to achieve digital preservation and sustainable inheritance. The focus of the study includes how to realize panoramic modeling, detail recording and environmental analysis of the Zhougong Temple through 3D scanning technology, and to develop an education and display platform based on digital

resources to enhance the public's awareness of and participation in its cultural significance.

1.5.4 Application of Digital Technology

Pattern.

Digital technology provides a systematic mode of recording, visualization and analysis for the conservation of the Zhougong Temple, and 3D modeling technology realizes the precise restoration of the architectural structure of the temple, laying the foundation for the digital preservation and research of the site.

Beliefs.

The application of digital technology reflects the modern society's emphasis on openness and sustainability in cultural heritage preservation. Through virtual experience and online exhibition, the cultural values of Zhougong Temple can be disseminated globally, in line with the contemporary concept of tolerance and innovation.

Materials and Creative Process.

Utilizing 3D scanners, Virtual Reality (VR), Augmented Reality (AR) and Artificial Intelligence (AI) systems, the architectural components, decorative details, and the surrounding environment of the Zhougong Temple can be accurately documented. This technological approach reduces the need for physical intervention while increasing the precision and scientific nature of the conservation work.

Makers.

The Zhougongmiao digital conservation project involves archaeologists, engineers, software developers and cultural heritage experts. This interdisciplinary collaboration integrates traditional knowledge with modern technology to explore new possibilities for site conservation.

Region and Role.

In Luoyang, digital technology has not only improved the conservation efficiency of the Zhou Gong Temple, but also made it an important vehicle for cultural dissemination and education. Virtual technology has helped the public to understand the culture of the Zhou Dynasty through immersive experiences, bringing modern society closer to the historical heritage.

Religious Dimension.

Digital technology also plays an important role in the preservation of the religious heritage of the Zhou Temple. For example, recreating ritual scenes from the Zhou Dynasty through Virtual Reality (VR) and Augmented Reality (AR) technology not only helps to preserve intangible cultural heritage, but also provides a global audience with the opportunity to gain a deeper understanding of the spiritual values of the Zhou Gong Temple.

1.6 Conceptual Framework

The conceptual framework diagram shows that each rectangle represents a component of the conceptual framework and the arrows indicate the direction of influence on monument conservation. This visualization helps to understand how each element contributes to the overall goal of monument conservation in the context of contemporary challenges and innovations.

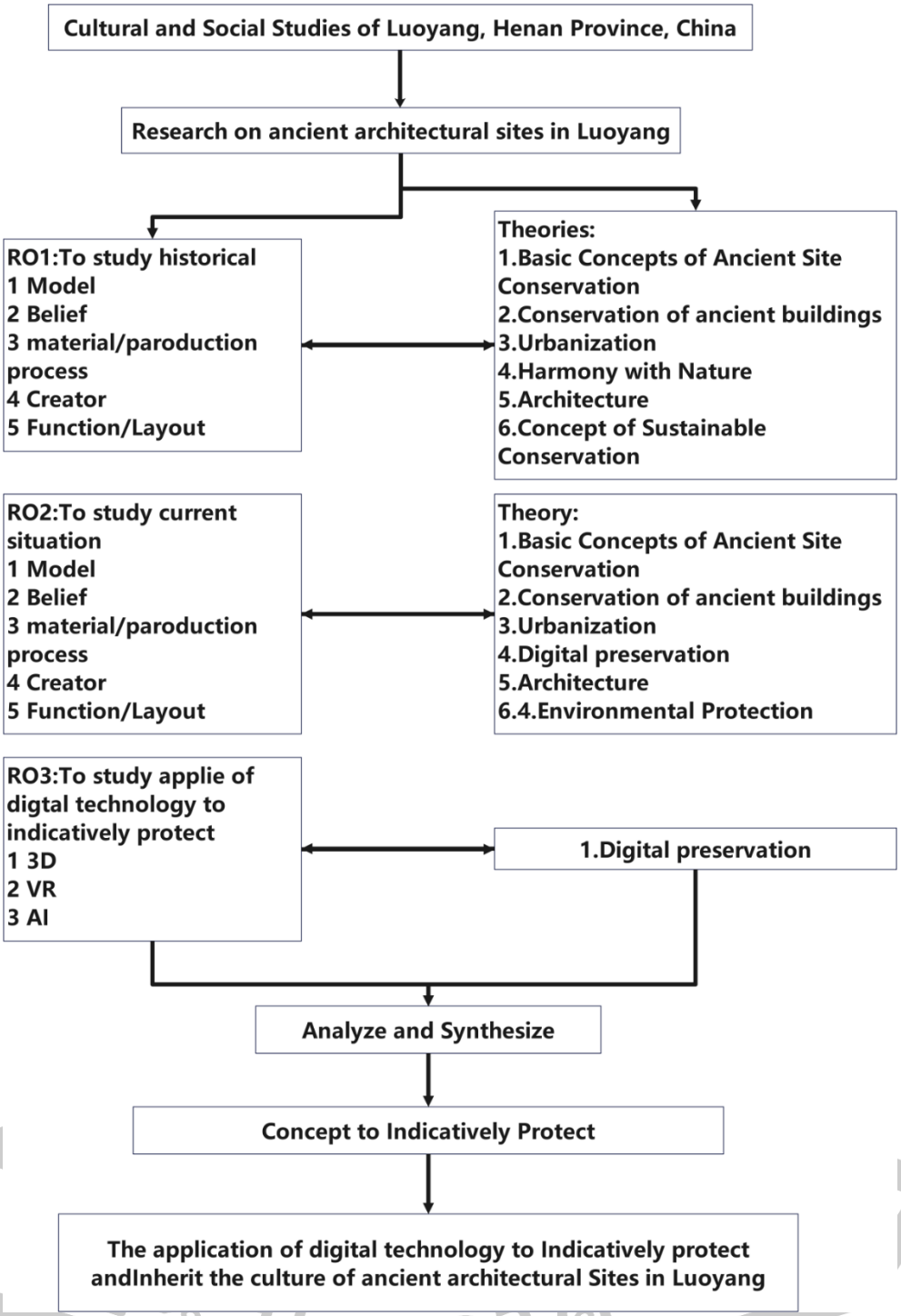


Figure 1 Conceptual Framework

Source: Bo Li (2024)

CHAPTER II
LITERATURE REVIEW

Luoyang Architectural are an important part of Chinese traditional culture and a witness to Chinese history, with unique historical heritage and profound cultural charm. However, with the development of society and the acceleration of globalization, the inheritance and development of Architectural in Luoyang are facing many problems and challenges. The purpose of this paper is to discuss the protection and inheritance of Architectural by combing relevant literature and analyzing existing research results and shortcomings, so as to provide theoretical support and practical guidance for further promoting the protection and inheritance of Architectural.

2.1 Ancient Chinese Architecture

2.1.1 The History of Ancient Chinese Architecture

2.1.2 Architectural Features of Ancient Chinese Buildings

2.2 The current situation of ancient architecture in Luoyang

2.2.1 Architectural styles of ancient buildings in Luoyang

2.2.2 Cultural Value of Luoyang Ancient Architecture

2.2.3 The current situation of ancient architecture in Luoyang

2.2.4 Current Situation and Challenges of Protecting Ancient Buildings in Luoyang

2.2.5 Challenges to the Conservation of Ancient Buildings in Luoyang

2.3 Context and content of relevant regions

2.4 Relevant Legal Policies

2.5 Relevant Theoretical Concepts

2.5.1 Basic concepts of ancient site conservation

2.5.2 Conservation of Ancient Buildings

2.5.3 Digital preservation theory

2.5.4 Concept of environmental protection

2.5.5 urbanization

2.5.6 Concept of Sustainable Conservation

2.5.7 Concept of Harmony with Nature

2.1 Ancient Chinese Architecture

2.1.1 The History of Ancient Chinese Architecture

Ancient Chinese architecture is deeply intertwined with China's long history and cultural traditions, and is rich in historical, cultural and artistic value. Architectural styles have evolved over millennia, with each period reflecting technological advances and social needs, and during the pre-Qin period, wood-framed buildings predominated, and early forms of palace architecture were formed. The influence of these early architectural forms can still be seen in the magnificent palaces and mausoleums that appeared in subsequent dynasties. It occupies an important position in the history of architectural development in China and the world with its unique construction methods, exquisite decorative techniques and profound cultural heritage. The important purpose of this study's literature review is to sort out its developmental lineage, structural features, artistic styles and cultural values (Nie, 2019).

The development of ancient Chinese architecture can be traced back to the ancient times, and in the process of evolution and development over thousands of years, a unique architectural system has been formed. Ancient Chinese architectural literature has also been gradually enriched from the pre-Qin, Qin and Han periods, such as the Kaogongji and other canonical texts that provide specific descriptions and illustrations of architectural planning, construction techniques, and architectural measurements at that time (Li et al., 2019). During the Wei, Jin, and North-South Dynasties, the eastward spread of Buddhism and the massive construction of temple buildings led to a great development in the types and styles of ancient Chinese architecture. During the Sui and Tang dynasties, against the background of national unification and economic prosperity, ancient Chinese architecture entered a completely new stage of development, as illustrated by books such as the Luoyang Garland Records, which detailed the conditions of Buddhist temple architecture in the city of Luoyang at that time (Yu Chen, 2020). During the Song, Liao, Jin, and Yuan periods, ancient Chinese architecture reached a stage of maturity, and strict norms for building construction and the use of materials appeared in books such as The Legal

Style of Construction. By the Ming and Qing Dynasties, ancient Chinese architecture again paid more attention to the expression of heavy decorative arts and cultural connotations, thus forming a unique architectural style (Qu, 2014).

From the point of view of structural characteristics, ancient Chinese architecture takes wood, brick and tile as the main building materials, and wood frame structure as the main structural method. It consists of major components such as columns, beams and purlins, which are connected with tenons to form a flexible frame. In ancient China, there are three different structural methods of wooden frame: lifting beam, pierced bucket and well frame, each of which has its unique characteristics and scope of application. In addition, ancient Chinese architectural design also attached great importance to the harmonization with the surrounding environment in order to achieve the "unity of heaven and man" (Liu et al., 2020).

The artistic style of ancient Chinese architecture is rich and colourful, including solemn monumental buildings, elegant and gorgeous palace buildings, friendly and pleasant residential buildings, free and euphemistic garden style and so on. These styles are embodied both in the shape of the building and in the shape of the building. These styles are embodied in the building's shape and layout, but also in the building's decorative arts and cultural connotations. For example, the roofs of palace buildings are mostly hipped or hipped roofs, which give people a solemn feeling; residential buildings are mostly hard-roofed or overhanging roofs, which give people a sense of intimacy. Chinese ancient architecture also focuses on the use of decorative techniques such as carving and painting, thus giving the buildings more artistic charm and cultural connotation (Lu, 2012).

Chinese ancient architecture not only has unique artistic value, but also contains rich cultural connotation and historical information. It unites the wisdom and creation of the Chinese nation and is the inheritance and promotion of excellent traditional Chinese culture. It is one of the important ways to enhance national self-confidence and cohesion (Guo & Shen, 2022).

Ancient Chinese architecture has a long history of development, from the humble buildings of primitive society to the palaces and religious buildings of feudal society, showing the splendor of China's history and culture and the continuous

evolution of architectural skills (Steinhardt, 2019). The most characteristic periods are the Han Dynasty, Tang Dynasty, and Song Dynasty:

Han Dynasty Architecture: Practicality and Stateliness

Han Dynasty architecture embodied a combination of practical and dignified style, which was characterized by a grand scale, rigorous structure, and a focus on the coordination of the building and the environment. Palace buildings, such as the Weiyang Palace, used a strict symmetrical layout of the central axis, reflecting the supremacy of imperial power. Religious architecture of the period saw the introduction of Buddhism and the construction of the first Buddhist temples with layouts that were simple yet rich in spiritual symbolism (Thorp, 1986). Additionally, the Han Dynasty emphasized defensive functions in its architecture, exemplified by the tall and strong design of the city walls of Chang'an, which influenced later city wall constructions (Steinhardt, 2019).

Figure 2 Chang'an city walls

Source: Bo Li (2024)

Tang Dynasty Architecture: Grandeur and Spatial Symmetry

Tang Dynasty architecture is famous for its grandeur and spatial symmetry.The Daming Palace, as a representative of Tang Dynasty palaces, adopts a multiple central axis layout, showing the majesty and grandeur of royal architecture.In terms of religious architecture, Buddhism flourished in the Tang Dynasty, and Tang Dynasty pagodas such as the Big Wild Goose Pagoda and high monasteries and temples were built in a variety of forms, gradually forming a layout pattern centered on the pagoda with additional halls.In addition, Tang Dynasty buildings also have high requirements for architectural decoration, the use of glazed tiles and carving process, forming a distinctive decorative features.

Figure 3 The Daming Palace

Source: Bo Li (2024)

Song Dynasty Architecture: Delicacy and Craftsmanship

Song Dynasty architecture is known for its delicacy and craftsmanship.Official buildings paid more attention to the combination of practical function and artistic expression, such as the Kaifeng Mansion in Bianliang, which embodied the political pattern of the Song Dynasty that emphasized local governance.In terms of religious architecture, a large number of temples and Taoist temples appeared in the Song Dynasty, and their delicate wood carvings, colorful paintings and brick carvings were particularly outstanding.At the same time, the Song Dynasty also saw the emergence

of the Construction Method Style, which served as a building code and technical guide and had a profound impact on later generations of architecture.

Figure 4 The Kaifeng Mansion

Source: Bo Li (2024)

2.1.2 Architectural Features of Ancient Chinese Buildings

Ancient Chinese architecture has a long history, and its architectural features not only reflect a high level of technology, but also deeply reflect the core ideas of traditional Chinese culture.From the architectural form to the choice of materials, from structural design to spatial layout, each aspect has gradually formed a unique style in the evolution of different historical periods.

Wooden construction and mortise and tenon technology

One of the most significant features of ancient Chinese architecture is the extensive use of wood as the main material of construction.Not only is wood the most common structural material used in traditional Chinese architecture, but its unique mortise and tenon structure allows ancient buildings to remain strong without the use of nails.The mortise-and-tenon technique allowed buildings to adapt to mechanical changes in the event of natural disasters such as earthquakes, and this technique was

not only widely used in ancient Chinese architecture, but also had a profound impact on the history of architecture worldwide(Wang, 2023).

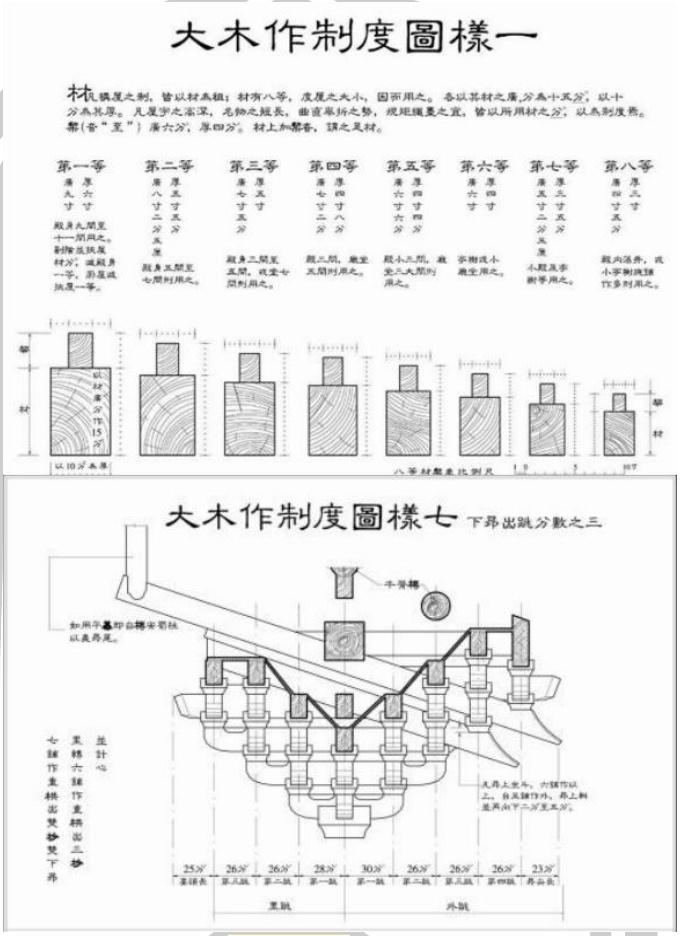


Figure 5 The Corner Bracket Set of Timber Framework

Source: X.Wang (2019)

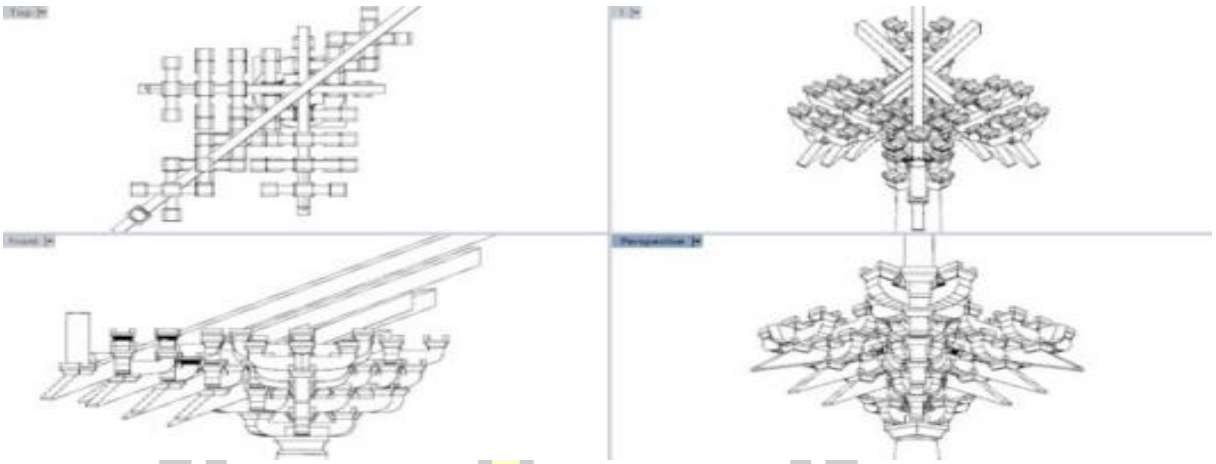


Figure 6 Three instances

Source: X.Wang (2019)

2).Symmetry and axial layout

Ancient Chinese architecture generally emphasized symmetry and central axis layout, especially in important buildings such as palaces and temples.The central axis layout symbolizes the harmony and unity of heaven, earth and man, and is a reflection of traditional Confucianism, which emphasizes order and propriety.For example, as the royal palace of the Tang Dynasty, the layout of Chang'an City is strictly distributed along the central axis, reflecting the concept of supremacy of the imperial power and the ancient Chinese architectural .respect for the concept of "unity of heaven and man".

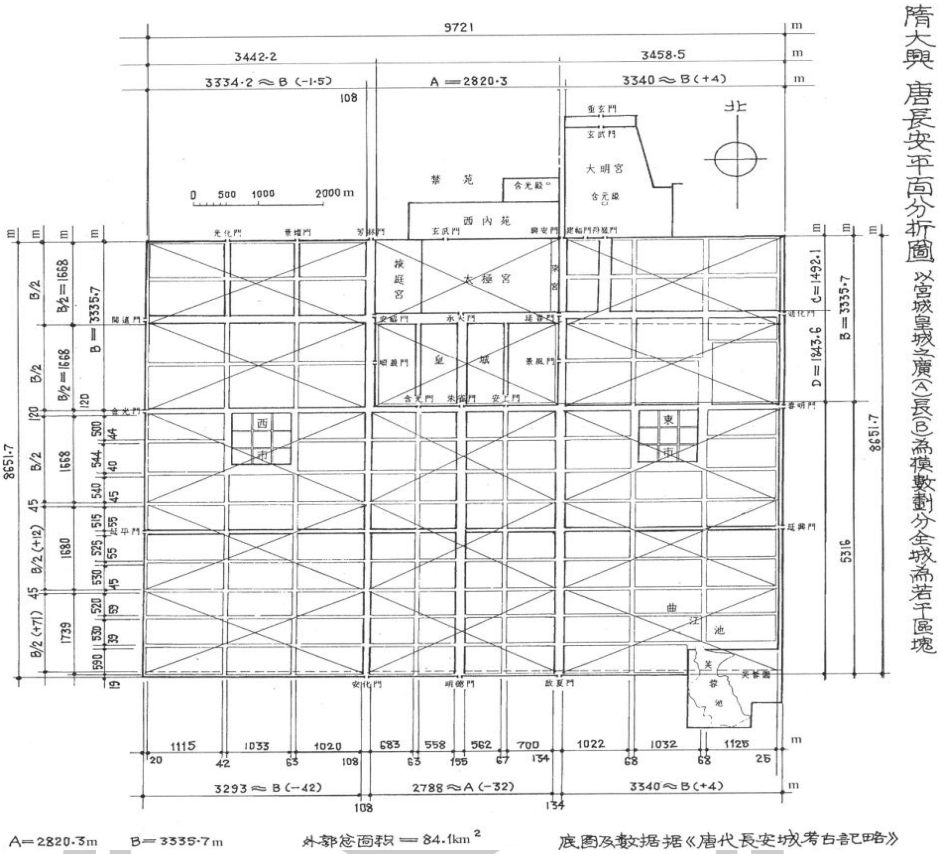


Figure 7 Chang'an An actual measurement and proportion

Source: Fu, X.N (2019)

3). Roof design: flying buttresses and tiles

The roof design of ancient Chinese buildings is a major feature, especially the flying eaves design.Flying eaves not only have aesthetic significance, but also can effectively drain water and reduce the erosion of the building by wind and rain.Roof tiles are usually made of green or black tiles, which can effectively reflect sunlight and regulate the indoor temperature, adapting to the climatic characteristics of different regions in China.In addition, the design of the roof usually corresponds to the class and function of the building, with the roofs of royal palaces and temples tending to be more lofty and elaborate, while the roofs of ordinary houses are more simple and practical.

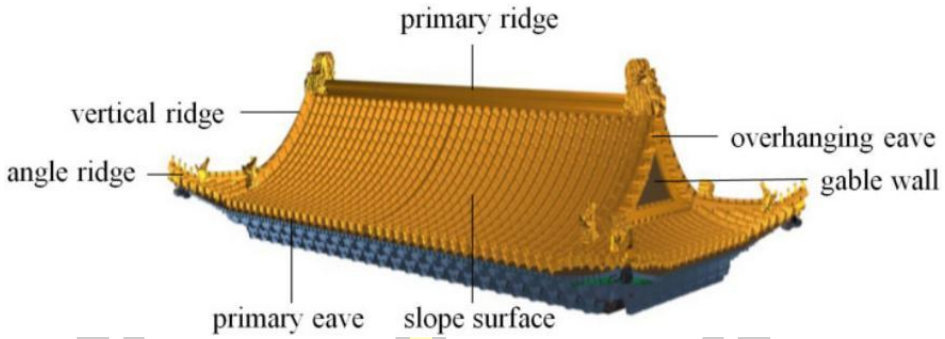


Figure 8 Structural semantic components.

Source:C.Liu(2020)

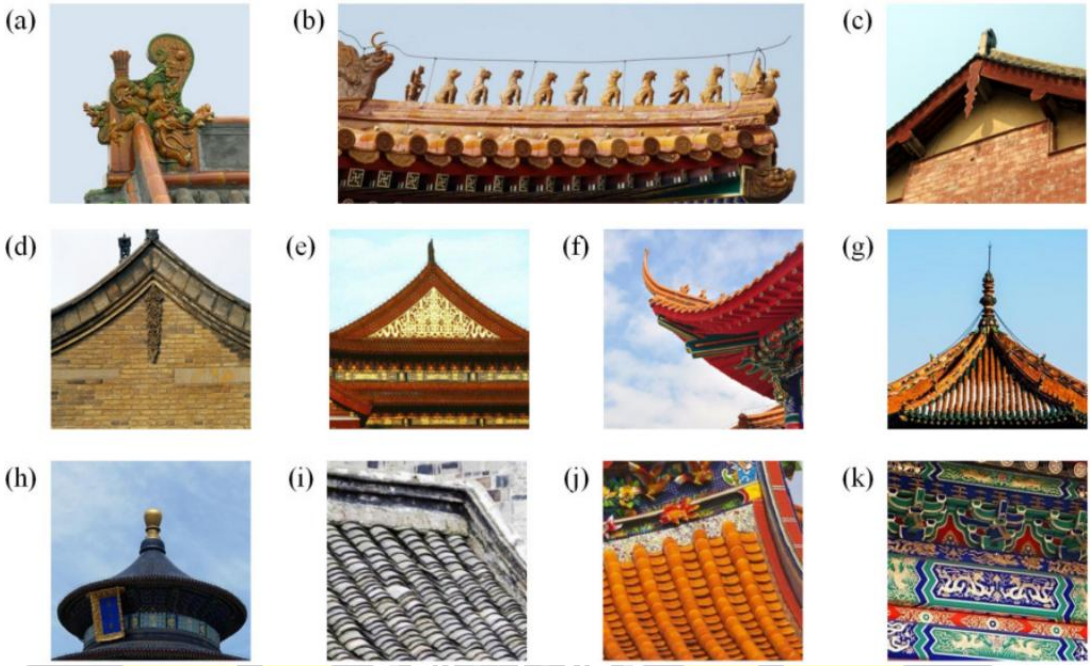


Figure 9 Decorative semantic components.

(a) Chih-wei; (b) Tsun-shou; (c) hanging fish on an overhanging gable roof; (d) hanging fish on a flush gable roof; (e) enclosed pediment; (f) wing corner; (g) pagoda top of pyramidal pavilion roof; (h) pagoda top of round pavilion roof; (i) gray-green tile; (j) glazed tile; (k) colored drawing.

Source: C.Liu (2020)

4). Courtyard and space layout

Ancient Chinese architecture emphasized the hierarchy of space, especially in the design of gardens and courtyards, where the relationship between architectural space and the natural environment was highly valued.In traditional houses, the courtyard is the center of family life, and the buildings in the courtyard usually blend harmoniously with the surrounding natural environment, reflecting the concept of "unity of heaven and man".Garden architecture, such as the design of the courtyard in the Summer Palace, is a skillful combination of architecture, landscape and plants, forming a landscape with profound cultural meaning.

Figure 10 Yuan Dynasty Architecture, Gautama Temple (Ming)

Source: C.Liu (2020)

5). Architectural decoration and symbolic meaning

The decorative arts of ancient Chinese architecture are rich and colorful, especially prominent in palace and temple buildings.These decorations not only have aesthetic value, but also carry rich cultural and religious significance.Common decorative elements include dragon and phoenix motifs, auspicious patterns, as well as frescoes and carvings with profound meanings.For example, the carvings and decorations in the Forbidden City not only represent the decorative arts, but also symbolize the majesty of imperial power and the inheritance of Chinese culture.

Figure 11 Song Dynasty Architecture: Longxing Temple (left)
and Top of Sanqing Guan (right)
Source:Wang(2021)

6) Ancient Architecture in a Sociocultural Context

Zhou Dynasty: Architectural Expression of Ritual and Patriarchal System

The Zhou Dynasty was the founding period of China's ritual civilization. Architecture was not only a manifestation of practical functions, but also a materialized carrier of social and political structures. The ritualistic architecture represented by the Temple of the Duke of Zhou embodies the political order of "honoring the king and hustling the barbarians" as well as the concept of patriarchal ethics. Located in Luoyang, the Temple of the Duke of Zhou is the central place of worship for ancestors and heavenly orders of the Zhou Dynasty. Its architectural layout is rigorous and symmetrical on the central axis, expressing the hierarchical order and social harmony advocated by Confucianism.

Architectural Value:

Political value: The temple carries the core concept of the Zhou Dynasty, "ruling the country by rituals", and its layout and functions reflect the hierarchical system of the patriarchal society, providing a model for the ritual architecture of later generations.

Cultural value: As an important symbol of Zhou culture, the temple played a founding role in the spread of Confucianism in later generations, and its architectural form continued the tradition of wooden structures in Chinese architecture, emphasizing the creativity of early craftsmen (Guo, W. 2022).

In addition, Zhou architecture generally emphasized the unity of heaven and man, focusing on the fusion of nature and artifice, and this idea was embodied in many ritual and clan buildings, laying the foundation of ancient Chinese architectural philosophy.

Sui and Tang dynasties: the fusion of the culture and architecture of the world of prosperity

The Sui and Tang dynasties were the heyday of China's feudal society, characterized by national unification, economic prosperity, and unprecedented cultural exchanges. Represented by the Daming Palace and the White Horse Temple in Luoyang, the architecture of the Sui and Tang dynasties reached new heights in terms of scale, technology and cultural connotation. The Daming Palace is a symbol of imperial power in the Tang Dynasty, and its multi-axis layout shows the grandeur of royal architecture and a high degree of ritualization. The White Horse Temple, on the other hand, is one of the birthplaces of Buddhism in China, reflecting through its architectural form the deep integration of Buddhist beliefs with traditional Chinese culture.

Architectural Value:

Artistic value: Sui and Tang Dynasty architecture is famous for its unique roof eaves, arch structures and colorful decorations, representing the pinnacle of ancient Chinese architectural aesthetics.

Religious value: As the first Buddhist temple, the Baima Temple witnessed the spread of Buddhism in China, and its architectural style blended Indian, Persian and Chinese cultures, reflecting the fruits of cultural exchange (Yu Chen, 2020).

Historical value: The Daming Palace recorded the strength of centralized power and the ritualized order of court life in the Tang Dynasty, providing an important reference for later generations of royal architecture (Wang, L. & Liu, K.C., 2016).

Architectural techniques were also further developed during the Sui and Tang dynasties, such as the emergence of brick pagodas (the Big Wild Goose Pagoda) and

the excavation of large-scale grottoes (e.g., the Longmen Grottoes), which not only served as symbols of religion, but also served as a concentration of culture and craftsmanship of the time.

Ming and Qing Dynasties: Standardized Rituals and Diversity of Regional Characteristics

During the Ming and Qing dynasties, Chinese architecture gradually moved towards the dual development of ritualization and regionalization. The official architectural system of the Ming and Qing dynasties, represented by the Forbidden City, was characterized by a symmetrical central axis and a three-entry layout, which embodied the concepts of etiquette and hierarchy of feudal society. Meanwhile, local architecture, such as the houses of Huizhou and the clan shrines of Luoyang, demonstrated the diversity of regional cultures and social structures.

Architectural Value:

Political and power symbols: the Forbidden City is the highest expression of feudal imperial power, and its layout strictly follows the Confucian principle of “ritual” to symbolize the supremacy of heavenly orders and monarchical power (Zhang, G.C., & Li, J.Y., 2018).

Regional cultural value: the Huizhou residential houses and Luoyang clan ancestral halls convey the Confucian concept of family through courtyard-style layout, brick carvings and wood carvings, emphasizing clan unity and family glory. The black tile and white wall design of Huizhou architecture reflects the beauty of harmony between man and nature (Bao & Wang, 2021).

Artistic and Craftsmanship Values: Ming and Qing architecture paid more attention to decorative and detailed aesthetics, for example, the carved beams, painted colors, and gold-brick craftsmanship of the Forbidden City, which became a model of Ming and Qing architectural art.

During the Ming and Qing dynasties, the architecture gradually reflected the cultural self-confidence after the social stability. Religious buildings such as Confucian temples, Buddhist temples and Taoist temples also showed more regionalized characteristics, reflecting the cultural diversity of the Ming and Qing societies.

Modern times: protection and revitalization of ancient architecture

In modern society, the protection and inheritance of ancient architecture has become an important cultural issue. Ancient buildings such as the Zhou Gong Temple and the White Horse Temple in Luoyang have gained new vitality through innovative digital conservation techniques (such as 3D modeling and virtual reality). During this period, ancient buildings were endowed with the functions of education, tourism and cultural dissemination. The application of modern conservation techniques not only improved the scientific nature of architectural conservation, but also enhanced public awareness and participation in history and culture.

Architectural value:

Historical Memory: Ancient buildings, such as the Zhou Gong Temple and the White Horse Temple, are symbols of national culture, and their preservation reflects the modern society's respect for history and responsibility for cultural inheritance.

Cultural Innovation: Through modern digital technology, the conservation of ancient buildings not only preserves the original historical appearance, but also provides an immersive experience for the public. For example, 3D scanning technology has made it possible to digitally archive the Longmen Grottoes, promoting the globalization of cultural communication and research (Wu & Liu, 2022).

Educational value: Through cultural heritage protection programs, ancient buildings become carriers of patriotic education and cultural identity, further enhancing the public's cultural confidence (Pang, L.J., 2021).

In modern society, cultural heritage protection has gradually shifted from mere restoration to sustainable development, and ancient buildings have not only become witnesses to history, but have also been endowed with new economic and social values through cultural tourism and innovative industries.

2.2 The current situation of ancient architecture in Luoyang

Luoyang was an important political, economic and cultural centre in ancient China and has a rich heritage of ancient buildings. These ancient buildings not only represent the level of ancient Chinese architectural art, but are also an important part of Chinese civilization. The history of Luoyang's ancient architecture can be traced back thousands of years, and its development is closely linked to ancient Chinese history. As the capital city of 13 dynasties from Xia, Shang, Zhou to Han, Wei, Jin,

North and South Dynasties, and then Sui, Tang, Five Dynasties, Song, Jin, Yuan, Ming, and Qing, Luoyang has always been an important political centre, and has even given birth to countless literati and emperors (Li, 2018). Under the activities of these historical figures, not only was a rich historical and cultural heritage born, but also provided an important historical background for the development of ancient architecture in Luoyang, so the study of ancient architecture in Luoyang is of great significance for understanding culture and history.

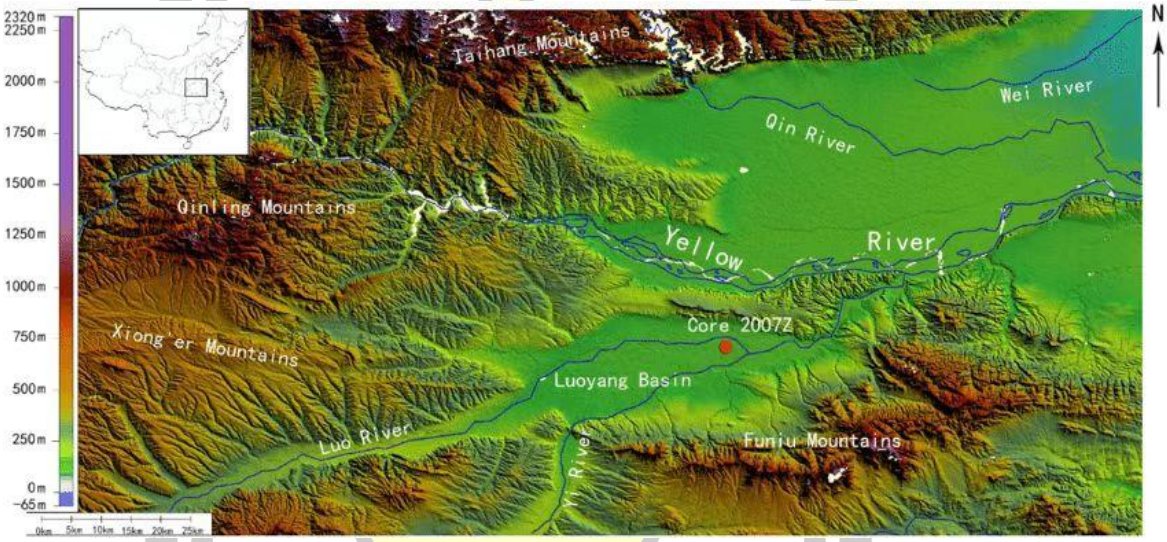


Figure 12 Location Map of Luoyang, Henan, China

Source: Bo Li (2023)

Figure 13 The Axis and Surroundings of the Palace City of Luoyang in the Han Wei Dynasty

Source: Bo Li (2023)

2.2.1 Architectural styles of ancient buildings in Luoyang

The unique style of Luoyang's ancient architecture reflects the level of ancient Chinese architectural art. Its characteristics mainly include the following aspects:

Grand scale: As the capital city of 13 dynasties in Chinese history, Luoyang's ancient buildings are often grand and magnificent, reflecting the level of ancient Chinese architectural art. For example, the Sui and Tang Dynasty Luoyang City National Heritage Park, as the political, economic and cultural centre of the Sui and Tang Dynasties, covers a huge area with strict planning, and is dotted with palaces, temples, official offices and other buildings, reflecting the majesty and splendour of China's ancient capital city. In addition, stone buildings such as the Longmen Grottoes, with their large number of stone Buddha statues and reliefs and their grand scale, demonstrated the creativity and wisdom of the ancient Chinese people. (Xu et al., 2021).

Figure 14 Yingtian Gate

Source: Bo Li (2023)

Sinfulness: The sinfulness of Luoyang's ancient buildings, whether in terms of architectural structure, carvings, paintings, etc., reflects the high skills of ancient Chinese craftsmen. In terms of building structure, Luoyang ancient buildings are mostly wooden frames with rigorous structure and reasonable force, which can withstand the attack of natural disasters. In the carving, Luoyang ancient architecture in the carving works are exquisite, such as Longmen Grottoes in the carving of the Buddha, smooth lines, vivid images, showing the exquisite level of ancient Chinese carving art. In terms of painting, the murals and paintings in the ancient buildings in Luoyang are colourful, vivid and beautifully patterned, such as those in the White Horse Temple in Luoyang, reflecting the unique charm of ancient Chinese painting art. (Tian, 2022).

Figure 15 Longmen Grottoes

Source: Bo Li (2023)

Diversified integration: the ancient architecture of Luoyang has integrated a variety of cultural elements in its style, reflecting the inclusiveness and openness of ancient Chinese culture. As Luoyang was one of the starting points of the Silk Road, the architectural style of ancient Luoyang was influenced by the cultures of the Western Regions and Central Asia, forming a unique architectural style. For example, the Luoyang White Horse Temple, as a representative of Buddhist culture, embodies the characteristics of traditional Chinese architecture and incorporates elements of Indian Buddhist architecture, forming a unique Buddhist architectural style. In addition, Luoyang ancient architecture has absorbed the architectural styles and techniques of other regions, such as the delicacy of the gardens in Jiangnan and the solemnity of the palaces in the north, forming a rich and colourful architectural style. (Zhang & Tang, 2016).

Figure 16 White Horse Temple

Source: Bo Li (2023)

2.2.2 Cultural Value of Luoyang Ancient Architecture

Ancient buildings in Luoyang are witnesses to Chinese history, from which rich political, economic and cultural information about ancient China can be learnt. For example, Sui and Tang Dynasty Luoyang City National Heritage Park and Longmen Grottoes are precious historical materials for the study of ancient Chinese history. The ancient architecture of Luoyang has high artistic value, and its unique architectural style and superb building skills provide important information for future generations to study ancient Chinese architectural art. For example, the White Horse Temple and Yingtian Gate are outstanding representatives of ancient Chinese architectural art (Wang, 2021). Through the study of ancient architecture in Luoyang, we can understand the construction technology and building materials in ancient China, which can provide useful references and information for the development of modern construction technology.

2.2.3 The current situation of ancient architecture in Luoyang

Luoyang, as one of the four ancient capitals in Chinese history, has a rich cultural heritage.Its ancient architectural complex is not only a treasure of ancient Chinese architecture, but also carries profound historical and cultural values.However, with the acceleration of urbanization and the advancement of modernization, the protection of ancient buildings in Luoyang is facing unprecedented challenges.The ancient architectural complexes in Luoyang have attracted many tourists and scholars with their historical value and cultural significance, but in the process of urban expansion and modernization, the preservation of these ancient buildings has faced many difficulties.With the increase of urban population and industrialization, many ancient buildings have either been demolished or gradually lost their original historical appearance in environmental pollution and human destruction.In addition, some of the ancient buildings, due to long-term exposure to the environment, are facing problems such as structural damage, weathering and corrosion, which require a lot of restoration and maintenance work.For example, the White Horse Temple in Luoyang, one of the birthplaces of Buddhism in China, is still standing after thousands of years, but its architectural structure has been affected by both natural and man-made factors, and is in urgent need of restoration and protection.At the same time, due to the aging of building materials and technologies, it has become a major challenge to carry out effective restoration while preserving its cultural and historical values (Chen et al., 2022).As a city with a long history, Luoyang faces greater challenges in the conservation of ancient buildings while entering the modernization process.Rapid urbanization has brought about an increase in building density and a strain on land resources, which has led to the demolition of many traditional buildings or their replacement by new ones.Especially during the development of new urban areas, some ancient buildings located in the core areas are forced to face demolition due to the increase in land value.The Longmen Grottoes in Luoyang is another example, which, as a World Heritage Site, carries great cultural value.However, the environment around the grottoes has been increasingly disturbed by modernization, and the increased traffic and influx of people have had a direct impact on their preservation.Local governments and cultural heritage protection authorities have taken measures, such as limiting the number of tourists and controlling the

surrounding environment, but are still facing tremendous pressure to protect the caves (Li, 2021).

Figure 17 Distribution of the seven capitals of Luoyang in the 1500s

Source: Bo Li (2024)

Table 1 2005-12 years Luoyang city of Sui and Tang Dynasties relics special list (unit: million yuan)

Year	Project name	PRE	PPE	PFC	Funds
2005	S&T Luoyang city site: protection planning	1200			1.200
2006	Dingding gate: preservation and presentation,and archaeological work			25000	25.000
2007	Palace city: protection planning, archaeological survey, exploration and data collection etc.	20000			20.000
2008	Ming Temple: archaeological and presentation; Yingtian gate: preservation and presentation			37000	37.000
2009	S&T Luoyang city site			47000	47.000
2010	Dingding Gate: street (including the camel hoof prints) preservation and presentaton			5000	5.000
	Ming temple: and ming gate preservation and presentaton			12000	12.000
	Jiuzhou pool: site and industrial heritage preservation			20000	20.000
	Southern outer city wall: preservation and presentaton			4000	4.000
	total	0	0	41000	41.000
2011	Palace city site: preservation		20000		20.000
	Ming temple: preservation and presentation			5000	5.000
	Heaven temple: preservation and presentation			20000	20.000
	Outer city wall: preservation		45680		45.680
	Yingtian gate: preservation and preservation			5000	5.000
	Hanjiacang warehouse site (Grand Canal):			10500	10.500

	preservation and presentation				
	Ming temple: preservation and presentation			6000	6.000
	Heaven temple preservation and presentation			20000	20.000
	Yingtian gate preservation and preservation			9000	9.000
	Huiluocang warehouse (Grand Canal): archaeological survey and preservation proposal preparation	8500			8.500
	Huiluocang warehouse (Grand Canal): archaeological survey and preservation proposal preparation	1000			1.000
	total	9500	65680	75500	150.680
2012	Outer city wall southeast and southwest corner: archeological excavation	800			800
	Ningrenfang site: archaeological excavation	1500			1.500
	Yingtian gate: preservation and preservation			10000	10.000
	Heaven temple: preservation and presentation			10000	10.000
	Dingding Gate treet site (southern section): preservation and presentaton			30000	30.000
	total	2300	0	50000	52.300
	Total	33000	65680	275500	374.180
	%	8,8%	17,6%	73,6%	100,0%
PRE: Preliminary expenditure					
PPE: Protection Project Expenditures					
PFC: Protective facility construction expenditure					
Table 3-9 Sui and Tang Luoyang City Ruins amount of special funds project level statistics (unit: million)					

	Expenses				Total
PRE	Preliminary expenditure				33.000
PPE	Protection Project Expenditures				65.680
PFC	Protective facility construction expenditure				275.500
	total				374.180

In response to the protection of ancient buildings in Luoyang, local governments and cultural heritage protection authorities have taken a series of measures in recent years aimed at reconciling the contradictions between modernization and cultural heritage protection.First, the Luoyang municipal government has strengthened the legal protection and management of ancient buildings and formulated a series of specific protection policies.For example, the Protection Plan for Famous Historical and Cultural Cities in Luoyang City has put forward clear protection measures, requiring strict control over the destruction of ancient building complexes in the course of urban construction, and restricting the development of high-rise buildings so as to avoid affecting the historical appearance of ancient buildings.

Figure 18 Researchers' talks with government officials

Source: Bo Li (2024)

In addition, local governments have strengthened their cooperation with cultural heritage protection departments, jointly carrying out surveys, research and protection of cultural heritage.All sectors of society are encouraged to participate in the protection of cultural heritage through the establishment of specialized cultural heritage protection funds and incentive mechanisms.For example, in recent years, Luoyang City has achieved some success through the restoration and protection of ancient buildings along the Sui and Tang Dynasty Grand Canal, and has attracted more attention and financial investment through these success stories (Zhang & Wang, 2023).

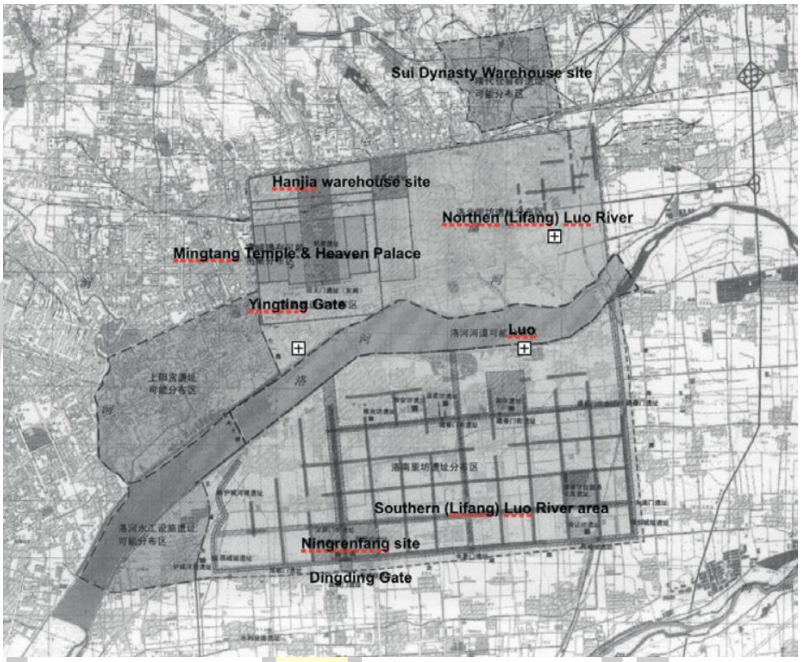


Figure 19 Ruins of Sui and Tang dynasties (581-617)

Source: Bo Li (2023)

Table 2 Luoyang Sui & Tang protected area

Key protected area	General protected area	KPA	GPA	total
1. Northen Luo River area		128,7	1.651,9	1.780,5
Palace city	Other palace city areas	118,6	149,0	267,6
Imperial city wall sites	Imperial city area & outer city wall sites	10,1	585,2	595,3
	Lifang area in northern luo river area		917,7	917,7
2. Warehouse site outside the city		84,7	245,1	329,8
Huiluocang warehouse site clusters	Other sui warhous sites	13,1	245,1	258,1
Hanjiacang site and north outer city walls		71,7		71,7
3. Southern luo River area		490,8	2.090,1	2.580,9
South market site		51,0		51,0
Ludaofang site		44,0		44,0

Dingding gate		309,8		309,8
South city wall sties		86,0		86,0
	Other southern luo river lifang areas **		2.090,1	2.090,1
4. Other protected areas			468,0	468,0
	water conservancy facilites outside the city		0,3	0,3
	luo river area		467,7	467,7
total		704,2	4.455,1	5.159,3
* Including Heaven temple, Ming temple, Yingtian gate, Jiuzhou pool sites etc.				
** inlcuding Ningrenfang				

With the development of digital technology, the conservation of ancient buildings in Luoyang has also gradually introduced digital means.Digital technology can not only accurately model and record ancient buildings, but also provide more scientific and effective data support in the restoration process.For example, the Luoyang Ancient City Ruins Digital Conservation Project utilizes 3D scanning and modeling technology to provide a detailed digital record of the ruins, which provides valuable information for future restoration and conservation work.

Through digitization, cultural heritage conservation in Luoyang can not only be restored in the short term, but also provide technical guarantee for long-term conservation work.The project provides visualized data for accurate restoration of ancient buildings, effectively avoiding possible errors and unnecessary damages in traditional restoration methods, marking the scientific and modernization of cultural heritage protection (Wu & Liu, 2022).

2.2.4 Current Situation and Challenges of Protecting Ancient Buildings in Luoyang

As a famous historical and cultural city in China, the ancient architectural cultural heritage of Luoyang carries rich historical information and cultural connotations. However, with the advancement of modernization and the rapid

development of urbanization, the protection of Luoyang's ancient architecture is facing a number of urgent problems.

Luoyang is rich in types of ancient buildings, covering palaces, temples, city buildings, city walls, and other forms, which have important historical and cultural values. In recent years, the Luoyang municipal government and relevant departments have increased their efforts to protect ancient buildings and have taken a series of measures to maintain and repair these precious cultural heritages. For example:

Cultural Relics Protection Projects:

With the support of national and local governments, Luoyang has initiated a number of cultural relics protection projects to repair and protect some important ancient buildings. These projects include systematic archaeological excavations of sites such as Erlitou, Sui and Tang Dynasty Luoyang City, and Han and Wei Dynasty Luoyang City. This work has profoundly revealed the developmental vein of Chinese civilization and led to major archaeological achievements (Shi, 2024).

Protection Laws and Regulations:

Luoyang City has developed and implemented a series of laws and regulations to ensure the protection of ancient architecture. The Municipal Bureau of Cultural Relics has emphasized promoting archaeological research and heritage protection based on principles such as archaeological support, protection priority, and rational use (Liang, Li, & Wang, 2019).

Publicity and Education:

Through cultural relics exhibitions and cultural activities, the public's awareness and participation in the protection of ancient buildings have been raised. Programs like the "Luoyang City Strengthen Cultural Relic Protection Implementation Programme" aim to better utilize cultural resources and ensure cultural relics' legacy is passed on. These initiatives have significantly strengthened the public's engagement and the educational functions of cultural heritage (Yang, 2022).

Figure 20 The State Administration of Cultural Heritage issued the "14th Five-Year Plan for the Protection and Utilization of Great Sites", and a number of great sites in Luoyang were included in the key tasks.

Figure 19 English translation:The State Administration of Cultural Heritage issued the “14th Five-Year Plan for the Protection and Utilization of Large Sites”, which explicitly mentions a number of large sites in Luoyang and the historical and cultural factors they contain. The plan includes two parts, the main text and the annex, which covers the development situation, general requirements, main tasks and safeguards, etc., while the annex lists the major sites in the “14th Five-Year Plan” period. The Erlitou site in Luoyang, the Yanshi commercial site, the Han Luoyang Imperial City, the Mangshan Mausoleum Complex, the Sui and Tang Dynasty Luoyang City site, the Huiluo Cang site and the Hanjia Cang site are all on the list. In addition, the plan involves a number of key tasks related to Luoyang, such as the Archaeology China Major Project, the publication project of archaeological reports of

major sites, the project of salvaging and protecting the cultural relics of major sites, the project of upgrading the display of major sites, and the National Heritage Route. These tasks aim to further enhance the protection and utilization of the major sites in Luoyang and provide more open and shared public spaces for the people.

2.2.5 Challenges to the Conservation of Ancient Buildings in Luoyang

The protection of ancient buildings in Luoyang faces multiple challenges, both in terms of the natural environment and the pressure brought by socioeconomic development.

Balance between protection and development: With the acceleration of urbanization, how to find a balance between urban development and the protection of ancient buildings is a major challenge for Luoyang. Excessive commercialization may adversely affect the protection and inheritance of ancient buildings. As the ancient capital of the 13th Dynasty, Luoyang has seen rapid development in urban construction and tourism in recent years, coupled with the strong promotion of Hanfu culture in Luoyang, tens of millions of tourists come to Luoyang every year to visit the ancient architectural heritage, and the overly heavy commercialization and lack of awareness of protection have caused the ancient architecture to suffer some damage during the activities of tourists, leading to the need for frequent repairs in recent years to keep the intact appearance (Wang, 2022). In contrast, Luoyang City has a large number of ancient architectural cluster sites, which are highly commercialized due to their form of being built as ancient architectural commercial streets and their tourism development value. In the ancient architectural sites, commercial development can exist, but it should be based on protection, rather than turning the ancient architectural sites into a tool for enrichment.

Input of funds and resources: the protection of ancient buildings requires a large amount of financial support, which are often used for restoration works, daily maintenance, personnel training and other costs. However, the current Luoyang ancient architecture protection of a single source of funding, mainly relying on government grants and social donations, these costs for the protection of ancient architecture is a drop in the bucket, difficult to meet the actual needs of the protection work. How to rationally allocate limited resources to ensure that every ancient

building is effectively protected and maintained is an urgent problem to be solved (Bao & Wang, 2021).

Public participation and education: Increasing public awareness and participation in the conservation of ancient buildings is the key to achieving long-term effective conservation. How to enhance public awareness of conservation and encourage all sectors of society to participate in the conservation of ancient buildings through publicity and education activities is a direction that Luoyang needs to work on (Liu, 2021).

Technological innovation and application: In the face of the growing demand for conservation, how to make use of modern technologies such as digitization and virtual reality to improve the efficiency of conservation, innovate the way of displaying, and give new vitality to the ancient buildings in the modern society is another aspect that needs to be considered in the conservation of Luoyang's ancient buildings (Pang, L. J. 2021).

In conclusion, the current situation and challenges in the conservation of Luoyang's ancient architecture reflect the complexity of cultural heritage conservation in the process of modernization and urbanization. In order to better protect and pass on Luoyang's ancient architectural cultural heritage, comprehensive improvements and innovations must be made in the areas of conservation strategy, technology application, financial support, management system and public education. Combining modern scientific and technological means, such as 3D scanning technology, to promote the digitalization and intelligence of ancient architecture protection, and to realize the sustainable protection and inheritance of Luoyang's ancient architecture, is an important direction for future research and practice.

2.3 Context and content of relevant regions

China has a rich and diverse ancient cultural heritage, and each region has developed its own distinctive architectural style and conservation challenges due to its unique geographic location, historical background and cultural traditions (Hu, 2022). As an important part of these cultural heritages, China's ancient architectural culture has accumulated profound cultural values and architectural craftsmanship throughout its long history. For example, architectural styles in different regions vary in form, craftsmanship, layout and historical functions, providing diverse research perspectives

for architectural heritage conservation (Zhang et al., 2024). At the same time, with the advancement of modernization and urbanization, cultural heritage conservation in China faces challenges such as insufficient resources, limited technical support, and low public participation (Li, 2023).

图 91　隋唐洛阳城的变迁

注：

据妹尾达彦《隋唐长安城的皇家园林》（桥本义则编《东亚都城比较研究》，京都：京都大学出版会，2011年）278页图3“中国都城的皇室庭园的变迁1”为基础修改。现在西苑的范围不详，据严辉《隋唐东都西苑遗址的初步探索》（《四川文物》2001-6）42页“西苑遗址位置图”描绘。城外的祭祀设施的位置及西苑内宫殿位置是由文献推测而来。凝碧池的位置据宇都宫美生《隋唐洛阳城时期西苑的四至和水系》（洛阳博物馆编《洛阳博物馆建馆50周年论文集》，郑州：大象出版社，2008年）95页图三描绘。

Figure 21 The Changing Face of Sui and Tang Dynasty Luoyang City

Source：https://weibo.com/1080201461/ObMJ9EgeR

Context and Ancient Architecture Conservation Practices in Henan Province

In the central region of China, Henan Province is rich in historical and cultural resources and has accumulated a great deal of experience and achievements regarding the conservation of ancient architectural heritage. The historical and cultural cities of Kaifeng, Zhengzhou, and Anyang in Henan Province have preserved a large number of ancient architectural remains, with each area being unique in terms of architectural

form, craftsmanship, layout, and historical function. For example, Kaifeng is famous for its Northern Song culture, and its traditional architecture mostly reflects the fine and delicate features of Northern Song architecture, especially the combination of wooden structures and stone decorations, which demonstrates a high level of architectural art (Belt, 2024). Anyang, on the other hand, is famous for its Yin Shang sites, and its architectural remains are mostly characterized by the use of the rammed earth technique, demonstrating the protective and adaptive nature of early architecture (Zhang et al., 2024). Through the study of architectural styles and conservation experiences in these regions, the local and contemporary characteristics of ancient architectural heritage in Henan Province can be better understood (Zhongli & Yongfang, 2019).

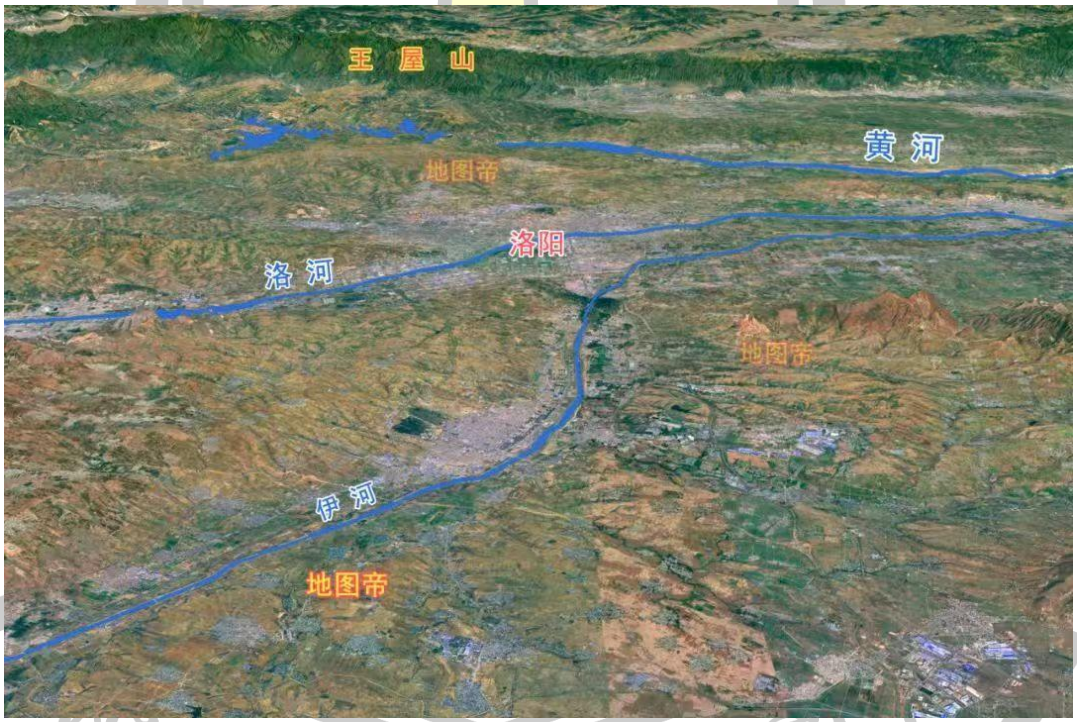


Figure 22 Luoyang location map (2020)

Source: Bo Li (2023)

Despite the remarkable achievements, various parts of Henan Province also face many common problems in the conservation of ancient architecture, such as environmental pollution and land development pressure brought about by urbanization, insufficient financial and technical support, and lack of public

awareness of conservation (Zhang, Zhang, & Liu, 2024). To cope with these problems, digital technologies such as 3D modeling, virtual reality (VR), and augmented reality (AR) have been gradually introduced across Henan to achieve virtual display and remote monitoring of ancient buildings, providing technical support and use cases for the conservation and inheritance of buildings such as the Zhou Gong Temple (Xu, 2021).

Conservation of Ancient Buildings in Luoyang City

As one of the ancient capitals of China's thirteen dynasties, Luoyang is not only a political and cultural center, but also an important witness site for the development of ancient Chinese architecture. Luoyang's unique regional context and deep historical deposits make it a typical case for exploring the cultural and social functions of ancient architecture. From the Zhou Dynasty to modern times, the architecture of Luoyang reflected changes in social systems, cultural ideas and craftsmanship at different times.

During the Sui and Tang dynasties, Luoyang was known as the “Eastern Capital,” one of the most prosperous cities in the world at the time, and its architecture was characterized by grandeur and multiculturalism. For example, the White Horse Temple, the first Buddhist temple in China, embodies the localization of Buddhism after its introduction to the Central Plains, and its symmetrical layout and exquisite paintings and sculptures demonstrate the far-reaching influence of Buddhist culture on the architecture of the Sui and Tang dynasties. The Longmen Grottoes, excavated in the Northern Wei Dynasty, reached their peak during the Sui and Tang dynasties, and their carvings reflect the religious beliefs, political authority and social life of the Sui and Tang dynasties.

In the Ming and Qing dynasties, Luoyang's architecture gradually showed a high degree of ritualization and regional cultural diversity. For example, the Guanlin Temple blends religious beliefs with traditional rituals, demonstrating the high level of architectural art in the Ming and Qing dynasties (Zhang, 2023). The Temple of Literature, on the other hand, embodies the core values of Confucian culture, conveying the order and solemnity of Confucian culture through its symmetrical layout and rigorous structure (Haiyan & Shuang, 2023).

Conservation and Inheritance of the Temple of the Duke of Zhou

As the center of ritual and music culture in the Zhou Dynasty, the Temple of the Duke of Zhou is one of the most important representatives of China's ancient architectural heritage. It is not only an architectural site of far-reaching historical significance, but also carries the core values of Chinese civilization in the development of rites, culture, and society. The Temple’s construction reflects its critical role in ritual and cultural continuity (Zhou & Zhang, 2023).

Architectural Significance

The architectural layout of the Temple of the Duke of Zhou is centered on the central axis of symmetry, which not only reflects the hierarchical order of the Zhou ritual culture but also establishes the basic principles of ancient Chinese architectural design. This symmetrical layout influenced the design of palaces, ancestral temples, and urban planning in later generations (Khayutina, 2021). The unique timber frame and mortise-and-tenon construction methods enhanced the building's durability, showcasing technological advancements (Liu, 2023).

Social Role

The Zhou Gong Temple was not only a patriarchal temple dedicated to ancestors and heaven and earth, but also a key site for maintaining social order and governance through rituals. It embodied the Zhou Dynasty's concept of governance through rituals, influencing statecraft in subsequent dynasties (Vogt, 2012). In addition, the Temple served as an educational hub where the culture of rites and music was propagated to future generations.

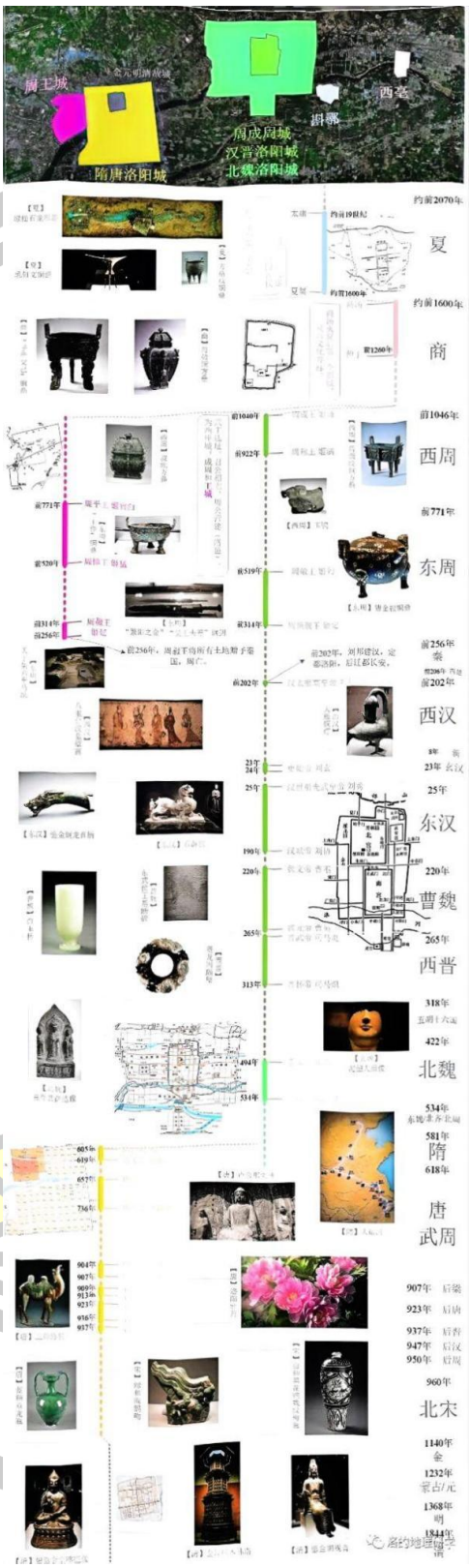


Figure 23 Representatives of the Luoyang Dynasty and Unearthed Cultural Relics

Source: Bo Li (2023)

In summary, the experiences accumulated and challenges faced by the relevant regions in Henan Province in the conservation and inheritance of ancient buildings have important reference value for the study of the conservation of the Zhougongmiao in Luoyang. By analyzing the conservation experiences of these regions, not only can we gain a more comprehensive understanding of the conservation needs of ancient buildings in different regions, but we can also learn from the effective strategies of these regions in terms of financial investment, digital technology application and public participation, which can provide reference and support for the conservation of the Zhou Gong Temple in Luoyang (Yingjie, Shanshan, & Zhu, 2024).

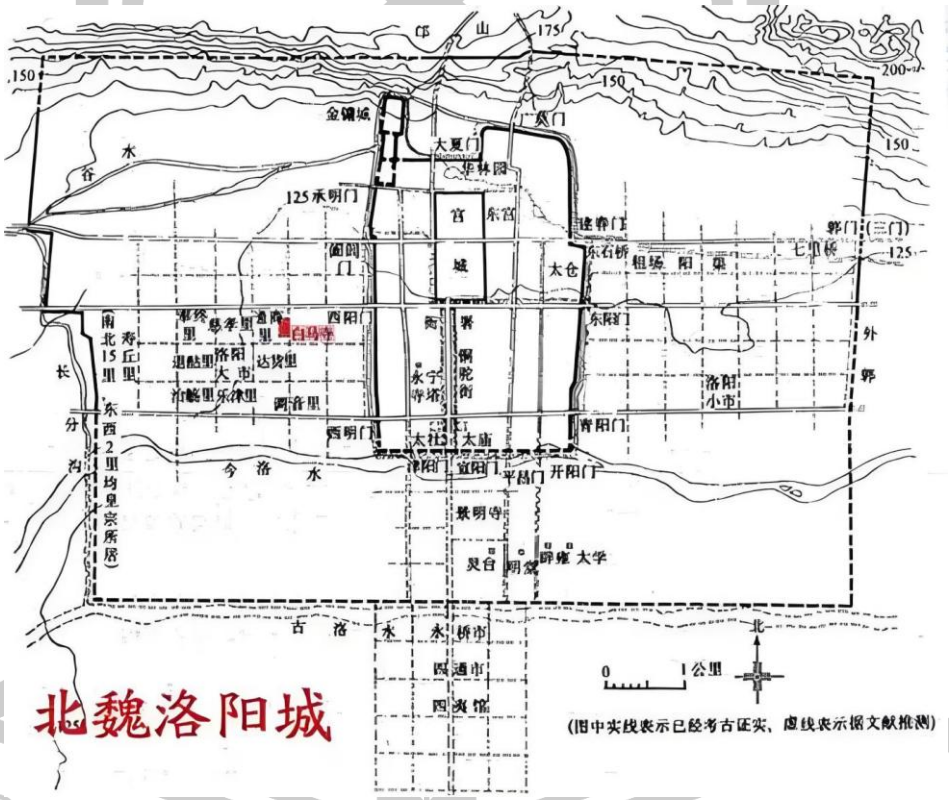


Figure 24 Map of Luoyang City, Northern Wei Dynasty

Source: https://weibo.com/1080201461/ObMJ9EgeR

2.4 Relevant Legal Policies

The Chinese government, in conjunction with local governments, has formulated a series of relevant laws and regulations to protect ancient architectural sites in China. For example, on 7 October 2017, the State Council re-amended the Regulations on the Protection of Famous Historical and Cultural Cities, Towns and Villages, clarifying the principles of protection, protection measures and management responsibilities of famous historical and cultural cities, towns and villages, providing legal safeguards for the protection of ancient architecture. In addition, in order to support the protection and transmission of ancient architectural culture, local governments have implemented a series of targeted initiatives, including the establishment of special funds, the creation of archives and databases, and the launching of publicity and education activities.

Existing laws, regulations and policies

Law of the People's Republic of China on the Protection of Cultural Relics

This law is the basic law for the protection of cultural relics in China, stipulating the principles, measures and management mechanisms for the protection of cultural relics. Since its implementation in 1982, the law has been amended several times, with the latest revision taking effect in 2020, further strengthening the protection of immovable cultural relics (Zhang, 2020).

Regulations on the Protection of Famous Historical and Cultural Towns and Villages

The regulations detail the requirements and measures for the protection of historical and cultural cities, towns and villages. Local governments need to establish specialised protection plans to ensure that ancient buildings are not damaged and that restoration and reconstruction are strictly managed (Li, 2018).

Town and Country Planning Act

The Urban and Rural Planning Law stipulates that the need for heritage protection must be taken into account in urban and rural planning to prevent damage to ancient buildings due to urban expansion and construction (Wang, 2021).

Intangible Cultural Heritage Act

The law focuses on the protection of intangible cultural heritage, but its protective measures and principles also apply to traditional crafts, skills and cultural

activities related to ancient buildings, ensuring that these intangible assets are valued and passed on in the process of preserving ancient buildings (Chen, 2019).

Specific local government initiatives

Establishment of earmarked funds

Local governments support the restoration and maintenance of ancient buildings by setting up special funds. For example, the governments of Beijing and Hangzhou, among others, allocate special funds every year for key cultural relics protection projects (Liu, 2020).

Establishment of archives and databases

Local governments have established detailed archives and databases of ancient buildings to provide comprehensive records and digital management of ancient buildings. These archives not only include the basic information and historical background of the buildings, but also cover detailed records of restoration and conservation (Zhao, 2019).

Awareness-raising and education activities

In order to raise public awareness of the conservation of ancient buildings, local governments regularly organize publicity and education activities, including lectures, exhibitions and training courses, to enhance the public's awareness and sense of responsibility for heritage conservation (Wu, 2021).

Culture and Tourism Integration Policy

The Chinese government encourages the integration of heritage conservation with the tourism industry by developing cultural tourism, increasing funding sources for heritage conservation, and promoting the adaptive use of ancient buildings. The Ministry of Culture and Tourism (MCT) has issued a number of policies to support tourism development at cultural heritage sites, while emphasizing the principle of conservation first (Gao, 2020).

Science and technology-enabled policies

The government encourages the use of advanced technological means for heritage protection and research, including 3D scanning, virtual reality (VR), augmented reality (AR) and other technologies, in order to improve the science and efficiency of heritage protection. The Ministry of Science and Technology (MOST) and the State Administration of Cultural Heritage (SACH) have jointly issued relevant

guidelines to promote the in-depth integration of science and technology with heritage conservation (Xu, 2021).

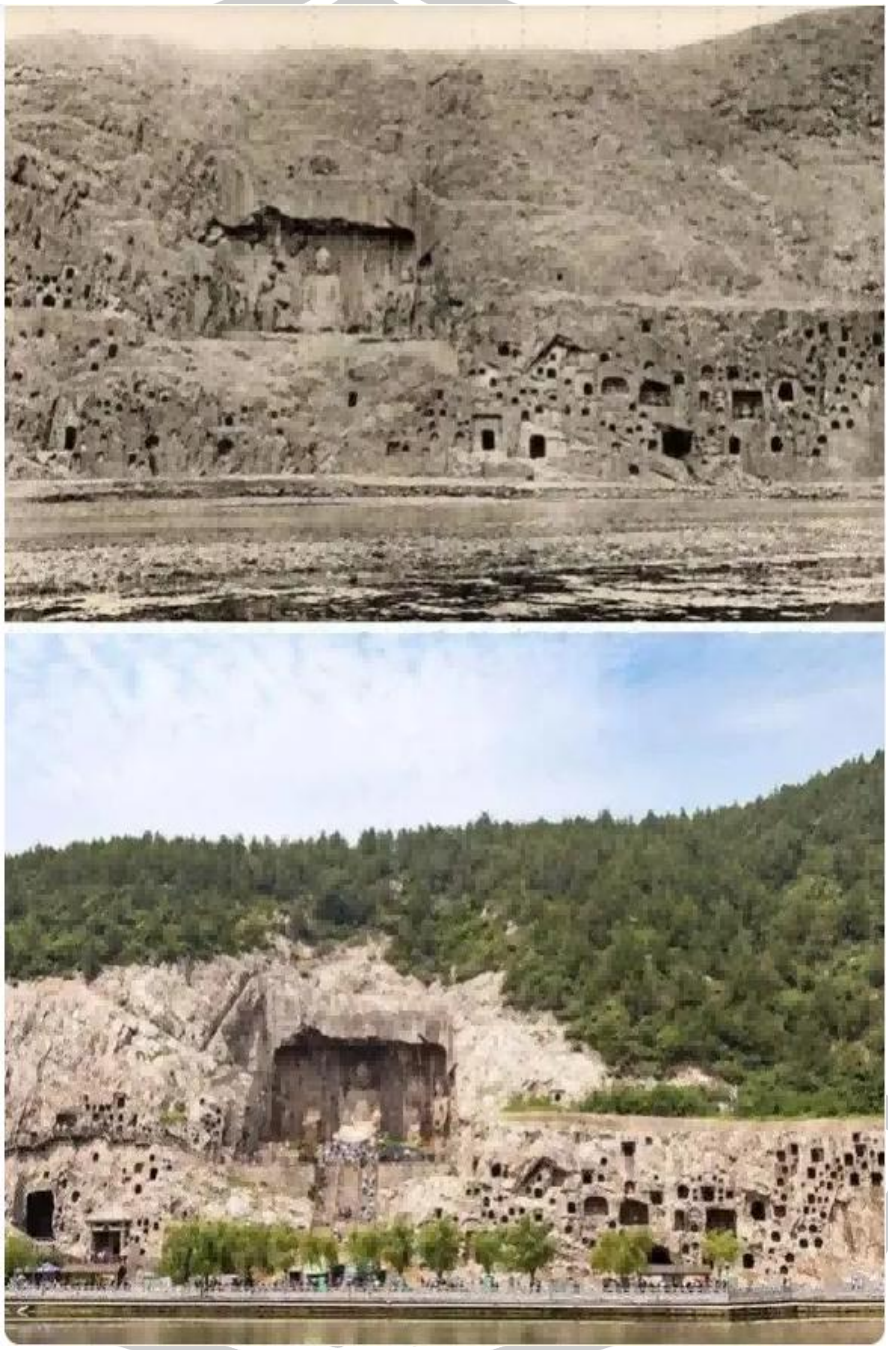


Figure 25 Longmen Grottoes before and after restoration

Source: Bo Li (2023)

2.5 Relevant Theoretical Concepts

2.5.1 Basic concepts of ancient site conservation

The conservation of archaeological sites is a multidisciplinary field that integrates principles from archaeology, environmental science, and cultural heritage management. The theoretical foundation for site conservation emphasizes the importance of safeguarding archaeological sites as non-renewable resources, similar to the natural environment, requiring careful management to mitigate the impact of visitor activities, mismanagement, and environmental factors.

Figure 26 Zhou Gong Temple, Luoyang, 1942

Source: Bo Li (2023)

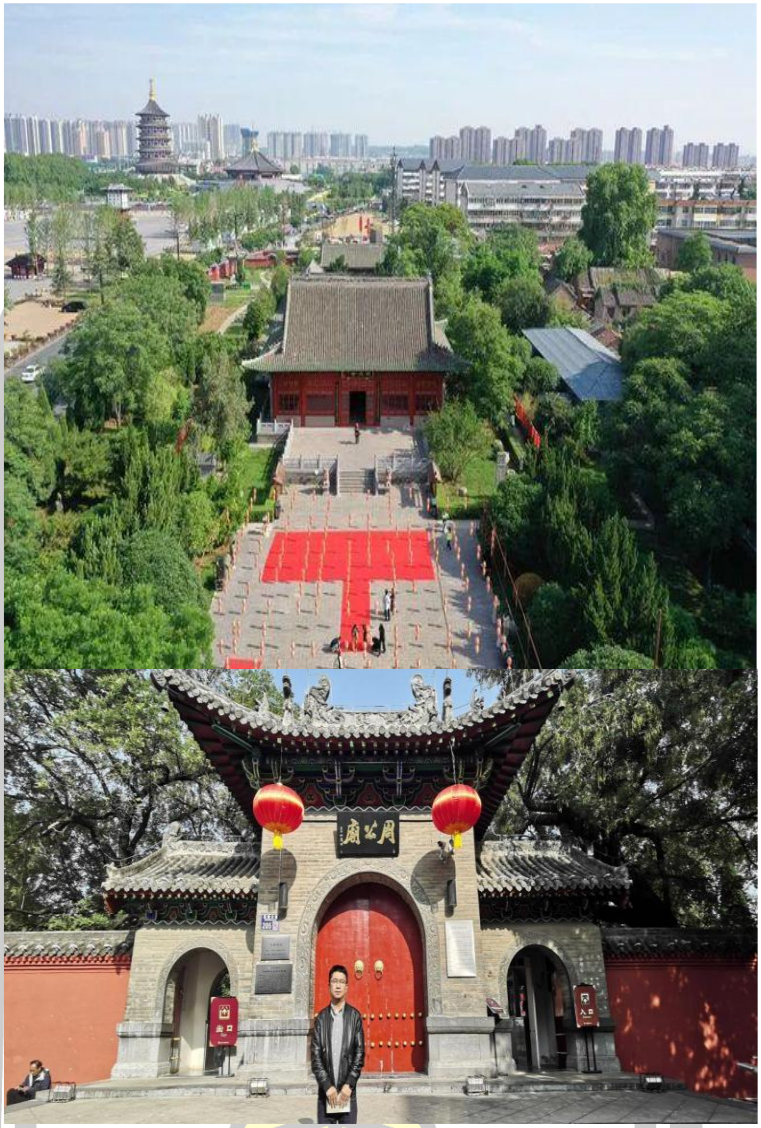


Figure 27 Researchers at the Zhou Gong Temple

Source: Bo Li (2024)

Frank G. Matero, a prominent figure in conservation theory, highlights the importance and challenges associated with the conservation of archaeological sites. In his works, he underscores the long history of conservation practices and argues that the sustainability of archaeological sites hinges on balancing their protection with public accessibility. Matero's research draws attention to the vulnerability of these sites to environmental factors, advocating for site-specific management strategies that align with broader conservation goals.

Giovanni Pisa et al. present an integrated environmental assessment methodology for the conservation and management of archaeological sites. Their research, focusing on the site of Tilmenhöyük in southeastern Turkey, demonstrates the application of environmental science and geographic data in archaeological conservation. Pisa and his team utilize climatic, topographic, soil, and hydro logical data to create a comprehensive management plan tailored to the environmental context of the site. This approach exemplifies the integration of environmental factors into conservation practices, promoting a more holistic methodology for preserving archaeological parks.

J.M. Teutonico and G. Palumbo, leading experts in heritage management, compile a series of key studies on the challenges and strategies for archaeological site management planning. Their works delve into critical topics such as threats to site protection, the evolving concept of heritage values, and innovative methods for conservation and management. They argue that conservation strategies must not only address physical threats to archaeological sites but also consider the cultural, historical, and social values associated with the heritage, thus adopting a values-based approach to site management.

Qingyuan Fu, a well-regarded scholar in heritage conservation in China, contributes to the discussion by analyzing the application of international conservation principles to the preservation of ancient buildings in China. Fu highlights the challenges arising in the design, construction, and management phases of conservation projects, particularly those involving ancient Chinese architecture. His research offers constructive suggestions, such as the integration of traditional construction techniques with modern technologies, and advocates for more stringent management practices to ensure the long-term sustainability of cultural heritage.

Collectively, these theories and methodologies contribute to a more robust understanding of the basic concepts of ancient site conservation. By addressing both global challenges and site-specific contexts, they provide a theoretical and practical framework for balancing the preservation of archaeological sites with the demands of modern development and public engagement.

2.5.2 Concept of Conservation of Ancient Buildings

The conservation of ancient buildings, as an integral part of cultural heritage, involves a multidisciplinary approach that integrates architecture, archaeology, history, and cultural heritage management. The theory of ancient architecture protection focuses on several key aspects, each rooted in well-established principles and proposed by leading scholars in the field.

Figure 28 1939 Luoyang Kuixinglou

Source: Bo Li (2023)

Cultural Value Assessment

Cultural value assessment is considered the foundation of ancient building conservation. This process involves not only the identification and discovery of the historical value of ancient buildings but also a comprehensive evaluation of their artistic, social, and scientific significance. According to Feilden, B. M., and Jokilehto, J. (1998), a thorough cultural value assessment requires an in-depth analysis of an ancient building's historical background, architectural style, technical sophistication, and contributions to society, culture, and science. Their research emphasizes that a

systematic approach to evaluating these dimensions helps establish the correct conservation priorities for different levels of protection.

For instance, in China, this principle has been applied to classify ancient buildings into rational protection levels, enabling targeted conservation measures that align with the historical and cultural importance of the site. This systematic approach not only ensures the proper preservation and inheritance of ancient architectural heritage but also lays a solid foundation for its future sustainable development. Feilden and Jokilehto's theory has significantly influenced global conservation practices by integrating historical and cultural assessment with practical protection strategies.

Authenticity and Integrity

The principles of authenticity and integrity, as highlighted by Nara Document on Authenticity (1994) and further elaborated by Munjeri, D. (2004), serve as the cornerstone of cultural heritage conservation and are particularly crucial in the protection of ancient buildings. Authenticity emphasizes the need to preserve the original historical state, materials, construction methods, and craftsmanship of ancient buildings. This principle aims to maintain the building's historical information and value without significant alteration. For example, the restoration of ancient buildings must prioritize the use of traditional materials and techniques to ensure the original appearance is retained to the greatest extent possible.

Meanwhile, integrity focuses on the holistic preservation of ancient buildings, encompassing not only the structures themselves but also their surrounding environment, landscape, and cultural context. This principle ensures that ancient buildings are protected as part of a larger cultural and humanistic landscape, maintaining their role as functional and meaningful elements in modern society. Munjeri (2004) emphasizes that integrity highlights the importance of protecting both the tangible and intangible aspects of cultural heritage, allowing ancient buildings to continue fulfilling cultural, educational, and tourism-related roles in contemporary contexts.

Together, authenticity and integrity provide a theoretical foundation and practical framework for the conservation of ancient architectural heritage. They ensure that the original essence and functionality of ancient buildings are preserved

while integrating them into their surrounding environments as living components of cultural landscapes.

Preventive Protection

Preventive protection, as advocated by Staniforth, S. (2013), is an essential strategy for ensuring the sustainability of ancient buildings through proactive monitoring and maintenance. Staniforth's theory centers on the continuous observation of environmental factors such as temperature, humidity, and light, which can significantly impact the structural integrity of ancient buildings. By analyzing the interactions between environmental conditions and the materials of ancient structures, preventive protection enables the development of targeted countermeasures to mitigate damage.

In practice, this approach involves implementing measures such as regular testing, cleaning, and maintenance to identify and address potential issues before they become critical. Preventive protection also emphasizes strengthening the structural resilience of ancient buildings to reduce their vulnerability to natural disasters and human-induced damage. Staniforth highlights the dual benefits of this approach: it prolongs the lifespan of ancient buildings and significantly reduces maintenance costs over time. By fostering a culture of proactive conservation, preventive protection ensures the long-term sustainability and resilience of ancient architectural heritage.

Figure 29 Luoyang Luze Kaikan, 1939

Source: Bo Li (2023)

2.5.3 Digital preservation theory

With the advancement of science and technology, digital technologies are increasingly applied in the field of cultural heritage protection, offering innovative tools and methodologies to address the challenges of preserving ancient buildings. The theory of digital preservation encompasses several key aspects, each rooted in research by pioneering scholars and experts in the field.

3D Scanning and Modelling

The use of three-dimensional (3D) scanning and modelling is a cornerstone of digital preservation theory and has become a critical direction in the conservation of ancient buildings. According to Remondino, F. (2011), technologies such as laser scanning and photogrammetry enable the precise capture of every detail of ancient structures, including their appearance, materials, and structural elements. These data are used to create realistic and detailed 3D models that serve as a scientific foundation for restoration planning and conservation practices.

Beyond conservation, these models have broader applications, such as in virtual displays and educational initiatives. By using 3D models, the public can explore

ancient buildings in immersive and interactive ways, fostering a deeper understanding of their historical and cultural significance. Remondino emphasizes that 3D modelling not only supports physical conservation efforts but also enhances the accessibility and dissemination of cultural heritage.

Virtual Reality (VR) and Augmented Reality (AR)

Virtual Reality (VR) and Augmented Reality (AR) technologies have introduced new possibilities for heritage conservation, education, and public engagement. Bekele, M. K., and Champion, E. (2019) highlight the trans formative potential of these technologies in their study of cultural heritage applications. VR technology enables users to "travel back in time," immersing them in the historical environment of ancient buildings and allowing them to experience their unique cultural charm in ways that would otherwise be impossible.

On the other hand, AR technology enriches real-world environments by overlaying virtual elements, such as reconstructed historical appearances or interpretive narratives, onto physical sites. Visitors can use AR devices to visualize ancient buildings as they originally appeared or to explore the stories and historical events associated with them. These technologies significantly enhance the educational and interpretive value of heritage sites while promoting a deeper appreciation for cultural heritage among the public.

Digital Archives and Databases

The establishment of digital archives and databases is a critical aspect of digital preservation theory, enabling the long-term protection and effective management of information related to ancient buildings. Koller, D., and Frischer, B. (2005) advocate for the creation of comprehensive digital repositories that compile diverse types of information, such as historical documents, architectural drawings, and records of repairs or interventions.

These archives and databases serve multiple purposes: they preserve critical information for future generations, facilitate information sharing among researchers and conservation professionals, and provide essential technical support for heritage management and conservation. Koller and Frischer argue that digital archives not only contribute to the safeguarding of heritage information but also enhance collaborative research and decision-making processes.

Elements and Structure of Digital Preservation

The practical implementation of digital preservation theory involves several critical components, each underpinned by the work of leading scholars and practitioners in the field:

Data Acquisition

Using high-precision 3D scanning equipment and photographic techniques, conservationists collect detailed data on the appearance, structure, and materials of ancient buildings. Remondino (2011) emphasizes the importance of precision and comprehensiveness in this stage to ensure the accuracy of subsequent analyses and models.

Data Processing

The collected data is processed and analyzed to generate detailed 3D models. These models can be used for a range of purposes, including damage assessments, restoration planning, and virtual presentations. Pieraccini, M., et al. (2001) emphasize that the integration of advanced software and analytical tools ensures that these models meet the needs of both researchers and practitioners.

Virtual Presentation

Using VR and AR technologies, the 3D models are combined with historical and cultural information to create immersive virtual displays. Bekele and Champion (2019) highlight how these platforms enable the public to explore ancient buildings in engaging ways, fostering greater awareness and appreciation of cultural heritage.

Digital Archives and Databases

Comprehensive digital archives and databases are established to store and manage a wide range of information, from historical documents to 3D models. Koller and Frischer (2005) stress the importance of robust data organization and user-friendly interfaces for enabling effective research and conservation efforts.

Technical Support and Training

Providing training in digital technologies to heritage conservation professionals is essential for the successful implementation of digital preservation. Staniforth, S. (2013) emphasizes the need for continuous updates to technical equipment and software to ensure that conservation efforts remain effective and sustainable.

Integration with IoT and AI Technologies

In addition to these core elements, the integration of Internet of Things (IoT) and Artificial Intelligence (AI) technologies has further advanced digital preservation strategies. These technologies enable real-time monitoring of environmental and structural conditions, such as temperature, humidity, and stress, which can affect ancient buildings. By analyzing this data, conservationists can develop more effective and proactive measures to address potential threats. Rodríguez-Navarro, C., et al. (2018) demonstrate the potential of IoT and AI in enhancing the accuracy and efficiency of monitoring and decision-making processes, contributing to the long-term sustainability of ancient structures.

2.5.4 Concept of Environmental Protection

The theory of environmental protection dates back to the mid-20th century, when scientists and scholars began to realize the damage that industrialization was doing to the natural environment.Rachel Carson (1962), in her book Silent Spring, revealed for the first time the potential harms that human activities could do to the environment, especially the impacts of chemicals on ecosystems. This book is widely regarded as the starting point of the modern environmental protection movement and initiated a global focus on environmental issues (Carson, 1962).Carson's research emphasized the relationship between environmental protection and human survival, and proposed a theoretical basis for preserving the ecological balance and reducing the negative impacts of human activities.

Thereafter, the theory of environmental protection was further developed in the 1970s, especially with the Club of Rome Report (The Limits to Growth, 1972) and the United Nations Conference on the Human Environment (1972). The report stated that unchecked resource exploitation would have irreversible effects on the environment and sustainable human development (Meadows et al., 1972). This theory provided a systematic framework for subsequent research, suggesting a balance between environmental protection, economic development and social harmony.

Core Concepts

The core of the environmental protection theory is to realize the harmonious development of human and nature by reducing the over exploitation of natural

resources, controlling pollution, and protecting the ecosystem. The core concepts of this theory include the following:

Ecological Balance: Emphasizes the protection of the ecological balance of nature, including biodiversity and the sustainable use of natural resources.

Environmental justice: focuses on social equity in environmental protection, especially the victimization of vulnerable groups in environmental pollution.

Sustainable development: the concept of sustainable development was introduced by the United Nations World Commission on Environment and Development (1987) in Our Common Future, which further emphasized the synergistic relationship between environmental protection and socioeconomic development (WCED, 1987).

Application and Impact

In the field of ancient architecture conservation, environmental protection theory provides important theoretical support. The long-term preservation of architectural sites is closely related to the environment, and conservation measures need to take full account of changes in the natural environment, including air pollution, climate change, and the impact of natural disasters on architectural structures. For example, when protecting the Zhou Gong Temple in Luoyang, the erosion of wooden structures by acid rain and humidity changes in the air requires scientific environmental protection strategies.

Integration with modern digital technology

In recent years, the combination of environmental protection theory and digital technology has opened up new paths for cultural heritage protection. Real-time monitoring of environmental data such as air quality, humidity and temperature can provide a scientific basis for the protection of ancient architectural sites. For example, Internet of Things (IoT) technology is widely used to monitor the environmental conditions around ancient buildings in real time and warn potential risks in advance (Wu & Zhang, 2021).

2.5.5 Concept of urbanization

The theory of urbanization can be traced back to the 19th century, with the French sociologist Émile Durkheim and the German economist Max Weber being the pioneers in this field. In his work The Division of Labor in Society (1893), Durkheim

first explored the impact of urbanization on the structure and functioning of society, and put forward the theory of the transformation of social relations from “mechanical solidarity” to “organic solidarity” in the process of rural-urban migration. This theory laid the sociological foundation for later studies of urbanization (Durkheim, 1893). Meanwhile, Weber studied the key role of cities in economic modernization and capitalist development from the perspectives of economics and history. In The Economic and Social Structure of the City (The City, 1921), he detailed the rise of the city and its role in social stratification, administration, and cultural diffusion (Weber, 1921).Weber's research emphasized the importance of urbanization as a driving force for economic and cultural modernization. By the 20th century, Louis Wirth (1938) first defined urbanization as a distinctive way of life in Urbanism as a Way of Life, which further delved into the effects of urbanization on social behavior, cultural patterns, and interpersonal relationships.Wirth argued that the high population densities brought about by urbanization, diversity and mobility are the core characteristics of modern urban society (Wirth, 1938).

Core Ideas

The core concepts of urbanization theory include the following:

Population Concentration: The essence of urbanization is the migration of people from rural to urban areas, resulting in high-density urban agglomeration.

Economic development: urbanization is seen as a direct result of industrialization and modernization, providing societies with engines of economic growth.

Cultural Integration and Conflict: Urbanization accelerates cultural diversity and may also trigger conflicts between traditional and modern cultures.

Social stratification and change: As urbanization progresses, social relationships shift from traditional kinship ties to relationships based on occupation and economic status.

Urbanization and Cultural Heritage Preservation

The process of urbanization poses serious challenges to the preservation of ancient architecture and cultural heritage. Land development, increased building density and environmental pollution are the main factors leading to the destruction of heritage. For example, in the Luoyang area, rapid urbanization has put great pressure

on the conservation of ancient architectural sites such as the Zhou Gong Temple. Traditional sites often lose the integrity of their historic environment due to encroachment by modern buildings. At the same time, urbanization provides new opportunities for site conservation. For example, through rational urban planning, ancient architectural sites can be integrated into modern urban systems so that they retain their historical value while adapting to the needs of modern society. Luoyang has not only protected the sites but also promoted economic development through the establishment of cultural tourism zones in its urban planning.

Combination of urbanization and digital technology in modern perspective

The combination of modern urbanization theory and digital technology provides innovative solutions for cultural heritage protection. For example, geographic information systems (GIS) allow for dynamic monitoring of the impact of urbanization on the site's surroundings, and the formulation of protection strategies in advance. In addition, the application of Virtual Reality (VR) and Augmented Reality (AR) technologies allows for wider dissemination of the cultural values of the sites, while reducing direct damage to the sites from foot traffic (Wu & Zhang, 2021).

2.5.6 Theory of Sustainable Conservation

Sustainable development is a widely recognized concept in contemporary society, emphasizing the need to meet present social, economic, and cultural needs without compromising the ability of future generations to fulfill those same needs. As an essential component of human civilization, ancient buildings serve as witnesses to history and are valuable cultural assets. However, with rapid societal development and accelerating urban construction, many ancient buildings face destruction and disappearance (Lu, Q., & Xu, G. B., 2019). Therefore, the sustainable conservation of ancient buildings has become an urgent issue, requiring a multidisciplinary and forward-thinking approach to balance preservation and contemporary relevance.

Preservation of Original Appearance and Cultural Value

The theory of sustainable conservation prioritizes the preservation of the original appearance and cultural connotation of ancient buildings. Cesare Brandi, a pioneer in conservation theory, in his seminal work Theory of Restoration (1963), emphasized the importance of respecting the authenticity of cultural heritage during

restoration. He argued that interventions must be minimal and carefully considered to maintain the historical and aesthetic integrity of the original structure.

Building on this, Lu and Xu (2019) stress that when ancient buildings are repaired or reconstructed, excessive intervention or transformation should be avoided to prevent loss of authenticity. Instead, the cultural value embedded within these structures should be thoroughly explored and transmitted to ensure their relevance in modern times. By safeguarding both the physical and intangible heritage of ancient buildings, their historical significance can be preserved and their cultural value revitalized for contemporary society.

Improving Efficiency and Effectiveness of Conservation Work

A crucial aspect of sustainable conservation is enhancing the efficiency and effectiveness of conservation efforts. Lin Jijiang (2019) highlighted the importance of integrating modern technology and management tools to monitor and protect ancient buildings comprehensively. Technologies such as Internet of Things (IoT) sensors, 3D scanning, and artificial intelligence enable real-time environmental monitoring, disaster early warning, and structural analysis of ancient buildings, allowing for timely interventions and better allocation of resources.

The application of these technologies not only reduces the cost of conservation work but also improves its precision and relevance. By ensuring that ancient buildings are preserved in a scientifically sound manner, their long-term stability and sustainability can be better secured. Staniforth, S. (2013) also emphasized preventive conservation, arguing that modern monitoring and maintenance approaches can significantly reduce risks while prolonging the lifespan of cultural heritage.

Sustainable Development of Cultural Heritage in Modern Society

The sustainable conservation of ancient buildings also involves promoting their integration into modern society. Zhang, G. C., & Li, J. Y. (2018) proposed that the development of cultural tourism and cultural creative industries can effectively enhance the visibility and influence of cultural heritage. By transforming heritage sites into cultural tourism destinations and developing creative products based on their historical and artistic significance, ancient buildings can generate economic benefits while fostering public interest in their preservation.

John Ruskin, in his influential work The Seven Lamps of Architecture (1849), advocated for the cultural and emotional connections that people form with heritage sites, emphasizing that their preservation should serve as a bridge between past and future generations. Building on this, Zhang and Li argue that sustainable development requires balancing the economic utilization of ancient buildings with their cultural significance. This approach promotes a win-win situation for heritage conservation and economic growth.

Environmental, Economic, and Social Dimensions of Sustainable Conservation

Environmental Sustainability

Ancient buildings must be conserved with respect for their surrounding natural environment. Sun, H. (2020) highlights the importance of environmental monitoring, disaster early warning systems, and ecological protection measures to reduce the negative impacts of external factors on heritage sites. By ensuring the stability and integrity of ancient buildings in harmony with their environments, their long-term preservation becomes a valuable asset for future generations.

Economic Sustainability

Economic sustainability involves leveraging the economic potential of ancient buildings through the development of tourism and cultural industries. As David Throsby (2001) discusses in Economics and Culture, cultural heritage assets hold significant economic and cultural value that can be harnessed to support their conservation. By generating income from tourism and related industries, conservation initiatives can achieve financial self-sufficiency while fostering broader public engagement.

Social Sustainability

Social sustainability emphasizes raising public awareness and fostering a sense of collective responsibility for heritage conservation. Li, N. (2020) argues that engaging communities and strengthening public enthusiasm for protecting cultural relics are key drivers of sustainable conservation. This requires active participation from all sectors of society, coupled with the establishment of robust laws and regulations to ensure legal protection and cultural diversity.

Legal Framework and Cultural Revitalization

A sound legal framework is fundamental to ensuring the sustainable conservation of ancient buildings. Alois Riegl, in his essay The Modern Cult of Monuments (1903), introduced the concept of "value-based conservation," which has since influenced international heritage laws and policies. Riegl's ideas advocate for the legal protection of cultural heritage based on its historical, artistic, and societal value.

Sun, H. (2020) further emphasizes the need to deepen the research and understanding of cultural heritage, focusing on the transmission of its intangible cultural connotations. Through academic research and creative adaptation, ancient buildings can gain renewed vitality and relevance in contemporary society, contributing to cultural identity and collective memory.

2.5.7 Concept of Harmony with Nature

The Theory of Harmony with Nature (天人合一) is a cornerstone of traditional Chinese philosophy, deeply rooted in the cultural, spiritual, and intellectual traditions of ancient China. It emphasizes the interconnectedness and interdependence of humanity and the natural world, advocating for a balanced relationship where human activities align harmoniously with the environment. This theory, which integrates principles from Confucianism, Daoism, and cosmology, profoundly influenced ancient Chinese architecture by embedding a deep respect for nature in the design, construction, and preservation of structures. Scholars such as Needham (1956) and Wang & Chiou (2019) have highlighted its cultural significance, describing it as both a philosophical guide and a practical framework for creating sustainable architectural practices that reflect the unity of humans and nature.

(1) Core Concepts of Harmony with Nature

The Theory of Harmony with Nature is underpinned by classical Chinese philosophical principles as articulated in texts like the I Ching (Book of Changes), Dao De Jing, and Confucian teachings. These principles emphasize the integration of human activity with the greater cosmic and natural order. Key concepts include:

Unity of Heaven, Earth, and Man (天、地、人和谐统一)

This concept, first elaborated in the I Ching and further developed by Zhang Zai in the Song Dynasty, posits that human actions should align with the larger cosmic

forces. It establishes a moral and philosophical foundation for harmonizing human-built environments with the natural world (Liu et al., 2019).

Integration with the Environment

Influenced by Daoist philosophies, architectural designs in ancient China prioritize blending with the surrounding landscape, ensuring that buildings coexist seamlessly with natural features such as mountains, rivers, and forests. Chen & Han (2019) describe this principle as the embodiment of a holistic worldview in which humans are custodians rather than conquerors of the natural world.

Sustainability

Sustainability is inherent in the philosophy of harmony with nature. Ancient Chinese builders employed natural materials and sustainable methods to minimize environmental impact, aligning with Huang et al. (2019)'s findings on the ecological consciousness of ancient architects. This approach ensured that human activities complemented the ecological balance rather than disrupting it.

These principles illustrate a holistic view of architecture as a means to create a harmonious relationship between human habitation and the natural world, reflecting an integration of philosophy, aesthetics, and functionality.

(2) Application in Ancient Chinese Architecture

The principles of Harmony with Nature were vividly manifested in ancient Chinese architectural practices, profoundly shaping the design, construction, and use of buildings. Specific applications include:

Site Selection

Site selection was guided by feng shui principles, an ancient geom-antic system that seeks to align human settlements with natural energy flows (气) and the surrounding terrain. For example, the Zhougong Temple in Luoyang demonstrates strategic site selection based on these principles. The temple's location reflects an intention to integrate with its natural surroundings, maintaining a sacred and solemn atmosphere while optimizing energy flow and environmental harmony (Zheng et al., 2018). Joseph Needham (1956) further emphasizes how site selection in ancient Chinese architecture often mirrored an intuitive understanding of geomorphic and ecological factors.

Architectural Layout

Ancient Chinese architectural layouts prioritized symmetry, balance, and integration with natural features. Almodovar-Melendo & Cabeza-Lainez (2018) describe how traditional building arrangements sought to reflect the order of nature, symbolizing the unity of human society with the cosmic order. For instance, palace layouts often included central courtyards surrounded by buildings that faced inwards, symbolizing the containment and balance of energy within a harmonious space.

Use of Natural Materials

Ancient builders used locally sourced materials such as wood, stone, and clay to construct buildings. Lomas & Xue (2022) argue that this practice was not only environmentally sustainable but also aesthetic, as it allowed buildings to blend seamlessly into their surroundings. For example, the widespread use of timber in traditional Chinese architecture ensured that structures complemented the natural landscapes, enhancing both their durability and visual harmony.

Adaptation to Climate

Architectural features in ancient China were specifically designed to harmonize with local climatic conditions, ensuring comfort, functionality, and sustainability. For example, overhanging eaves, sloped roofs, and courtyards served as passive climate control systems, protecting buildings from rain and sunlight while facilitating natural ventilation. Wang et al. (2020) highlight how these design elements illustrate the practical application of the Theory of Harmony with Nature, demonstrating how ancient builders achieved ecological balance through ingenuity and respect for natural forces.

The Legacy of Harmony with Nature in Cultural Heritage

The principles of the Theory of Harmony with Nature remain relevant today, providing valuable insights for sustainable architecture and cultural heritage conservation. By emphasizing minimal intervention, environmental integration, and sustainable practices, this theory serves as a guiding framework for preserving ancient buildings while adapting them for contemporary use. Scholars such as Wang & Chiou (2019) and Huang et al. (2019) stress that applying these principles in modern heritage management ensures the continuity of cultural traditions while addressing environmental and social challenges.

2.5.8 Vernacular Architecture Theory

The Vernacular Architecture Theory is an important framework in architectural conservation and design, emphasizing the significance of local traditions, materials, and knowledge systems in the construction and preservation of buildings. This theory highlights how architecture emerges organically from the interaction between people and their environment, reflecting local cultural practices, environmental conditions, and resource availability. Scholars such as Amos Rapoport (1969) and Paul Oliver (2003) have extensively discussed the value of vernacular architecture, advocating for its study and preservation as a means of safeguarding cultural identity and promoting sustainable design practices.

(1) Core Concepts of Vernacular Architecture Theory

The theory of vernacular architecture is grounded in several key principles:

Local Adaptation and Cultural Identity

Vernacular architecture is inherently tied to the social and cultural fabric of a community. According to Rapoport (1969) in his seminal work House Form and Culture, the design of vernacular buildings reflects the values, lifestyles, and traditions of the societies that create them. These buildings are not just physical structures but also cultural artifacts that embody a community's identity and way of life.

Environmental Responsiveness

The theory emphasizes that vernacular buildings are designed to adapt to the local climate and geography. Paul Oliver (2003), in his work Dwellings: The Vernacular House Worldwide, discusses how features such as roof shapes, insulation materials, and ventilation systems are developed to provide comfort while minimizing environmental impact. For example, sloped roofs in regions with heavy rainfall or courtyard designs in arid climates illustrate how local environments shape architectural forms.

Use of Local Materials

The use of locally sourced materials is a defining characteristic of vernacular architecture. Hassan Fathy (1973), in Architecture for the Poor, highlights how materials like mud, stone, and wood are not only cost-effective but also

environmentally sustainable, reducing the carbon footprint of construction while enhancing the integration of buildings with their natural surroundings.

Community Participation and Knowledge Transfer

Vernacular architecture is often built through collective effort, with knowledge passed down through generations. This approach emphasizes community participation and shared expertise, ensuring that architectural practices are rooted in tradition while being flexible enough to adapt to changing needs.

(2) Application in Ancient Chinese Architecture

The principles of vernacular architecture are deeply embedded in the design and construction of traditional Chinese buildings. This is particularly evident in rural and regional architectural forms, which reflect the cultural and environmental diversity of China. Examples include:

Fujian Tulou

The Fujian Tulou, a UNESCO World Heritage Site, is a prime example of vernacular architecture in China. These large, circular or square earthen buildings were constructed using locally sourced materials like rammed earth and timber. Their design reflects the communal lifestyle of the Hakka people, with shared spaces for living, storage, and defense. The Tulou also adapts to the local environment, with thick earthen walls providing insulation against extreme temperatures.

Hutongs in Beijing

Traditional hutongs are narrow alleys surrounded by siheyuan (courtyard houses) that were designed to promote social interaction while offering protection from the elements. The courtyard design reflects the principles of environmental responsiveness, using natural ventilation and shading to adapt to Beijing's harsh winters and hot summers.

Guizhou Wooden Stilt Houses

In the mountainous regions of Guizhou, the wooden stilt houses (吊脚楼) of the Miao and Dong ethnic groups are adapted to steep terrain and humid climates. Elevated on stilts, these homes minimize moisture damage and allow for air circulation, reflecting an ingenious adaptation to local conditions.

(3) Contemporary Relevance of Vernacular Architecture Theory

The study and preservation of vernacular architecture offer valuable lessons for modern architectural practices:

Sustainability

As emphasized by Oliver (2003), the reliance on local materials and low-energy construction techniques makes vernacular architecture inherently sustainable. By revisiting these practices, modern architects can design buildings that reduce environmental impact while maintaining functionality.

Cultural Heritage Preservation

Vernacular architecture is a living record of cultural traditions and social history. Its preservation contributes to the continuity of cultural identity and fosters a sense of pride and belonging among communities.

Modern Adaptation

The principles of vernacular architecture can inspire contemporary design, blending traditional techniques with modern technologies to create structures that are both innovative and contextually appropriate. Hassan Fathy's work on sustainable housing for rural communities provides a compelling model for integrating vernacular principles with modern needs.

However, with the progress of science and technology and the transformation of social concepts, new ways of innovation and sustainable development have been provided for the protection and inheritance of ancient architectural culture in China. This study takes ancient architecture in Luoyang as the research object, through analyzing its cultural connotation and historical inheritance, evaluating the effects and defects of the existing protection measures, and on this basis, combining with modern science and technology and public participation, exploring the innovative protection methods, so as to provide important theoretical support and practical guidance for the sustainable development of the ancient architecture in Luoyang.

2.6 Related Research

2.6.1 Ancient architectural sites

efinition and significance of an ancient architectural site

Ancient architectural sites refer to ancient buildings and their ruins that have historical, cultural, artistic, or scientific value. They usually carry rich historical

information and represent the architectural style, technical level, and social background of a specific historical period. Ancient architectural sites are not only an important part of the tangible cultural heritage, but also an important vehicle for the transmission of national culture and understanding of historical development (Stanco, Battiato, & Gallo, 2011, p. 35). Over time, these architectural sites have not only witnessed the social changes of a region, but also reflected local religious, political, economic, and cultural characteristics (Brusaporci, 2017, p. 52).

As cultural heritage, the protection of ancient architectural sites is of paramount importance. They are witnesses to history, bear the wisdom and creativity of their predecessors and are the source of national history and culture. Against the background of globalization and increasing urbanization, ancient architectural sites, as non-renewable resources, are facing enormous pressure for conservation. Therefore, the protection of ancient architectural sites is not only a respect for history, but also the maintenance of cultural diversity (Ioannides, Fink, Brumana, Patias, & Doulamis, 2018, p. 28).

Challenges and needs for the conservation of ancient architectural sites

With the advancement of modernization, many ancient architectural sites are facing serious threats. Firstly, most ancient architectural sites are located in natural environments, and these environmental factors, such as climate change, weathering, and earthquakes, may cause different degrees of damage to the architectural structures. In particular, some sites located in mountainous areas or by the sea are vulnerable to erosion by natural factors such as soil erosion, salt erosion, and wind erosion (Lian & Xie, 2024, p. 113).

Secondly, with social development, ancient architectural sites often face the impact of urbanization and industrialisation. Some historical sites have been damaged or even artificially destroyed by the construction of new buildings or infrastructure. Some ancient buildings have been exposed to polluted air and corroded by chemical substances for a long time due to the lack of adequate protection measures. In addition, due to the lack of management resources, the management of many sites cannot be put in place, resulting in lagging conservation measures and sites facing unnecessary damage (Neglia, Angrisano, Mecca, & Fabbrocino, 2024, p. 89).

Therefore, there is an increasing need for the protection of ancient architectural sites. We not only need to update the concept of site protection, but also strengthen the construction of laws and regulations, formulate more comprehensive protection policies, and invest more resources and technical force to guarantee the sustainable development of sites (Muthuswamy & Esakki, 2024, p. 145).

Historical and cultural value of ancient architectural sites

Ancient architectural sites often have important historical and cultural values. They are symbols of the culture of an era and a nation and carry the memory of historical events. For example, the sites of ancient palaces, temples, and city walls not only demonstrate the architectural technology of the time, but also reflect the social system, religious beliefs, political economy, and other aspects of that era. For the study of social development, architectural style, and technological evolution of a certain historical period, ancient architectural sites are indispensable physical materials (Hutson, 2024, p. 61).

From the perspective of cultural inheritance, ancient architectural sites are symbols of a nation's cultural identity. They not only reflect the accumulation of culture, but also have a profound impact on future generations. Through the study and preservation of ancient architectural sites, it is possible to gain an in-depth understanding of the lineage of human social development and enhance national pride and cultural confidence (Tribhuvan, 2024, p. 133).

Status of conservation of ancient architectural sites

At present, there has been some important progress in the protection of ancient architectural sites at home and abroad. Many countries and regions have recognised the value of ancient architectural sites and introduced a series of protection policies and regulations. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has adopted the World Heritage Convention and other documents to promote the protection and management of global cultural heritage. There are similar laws and regulations in China, such as the Law of the People's Republic of China on the Protection of Cultural Relics, which clarify the protection responsibilities of cultural relics and cultural heritage sites (Liritzis & Korka, 2019, p. 79).

However, despite certain guarantees at the policy level, the conservation of ancient architectural sites still faces many difficulties and challenges. Especially in

some places, due to financial, technical, and management constraints, the protection work seems to be inadequate. In the actual protection process of ancient architectural sites, often due to the lack of knowledge of managers and the lack of technical means, resulting in poor protection. How to balance the contradiction between the protection of ancient architectural sites and modernization and economic development remains an urgent problem (Sullivan, 2015, p. 23).

Combining traditional conservation methods with modern technology

Traditional conservation methods for ancient architectural sites mainly rely on manual restoration and physical reinforcement, but these methods have large limitations, especially the inability to completely solve the problem of the impact of the modern environment. In order to improve the protection effect, the application of modern technology in the conservation of ancient architectural sites is becoming more and more widespread (Brusaporci, 2017, p. 102).

For example, the application of digital technology makes the protection of ancient architectural sites more precise and efficient. Through three-dimensional scanning and modelling technology, the current status of the site can be recorded in detail, providing a scientific basis for later restoration. The introduction of Virtual Reality (VR) and Augmented Reality (AR) technologies makes the conservation and presentation of sites no longer limited to field visits, and more people can learn about these historical and cultural heritages through digital platforms (Ioannides et al., 2018, p. 42).

In addition, new conservation materials and techniques, such as the use of waterproof and corrosion-resistant materials, can effectively extend the life of ancient buildings. The conservation of ancient architectural sites can be greatly improved through the combined use of traditional methods and modern technologies (Muthuswamy & Esakki, 2024, p. 146).

Main problems faced by ancient architectural sites

Impact of the natural environment

Natural environmental factors such as climate change, weathering, earthquakes, and floods are among the main causes of damage to ancient architectural sites. Especially in some extreme climatic conditions, the structural stability of sites is

easily threatened. With the intensification of global climate change, this problem may become more serious (Lian & Xie, 2024, p. 115).

Human destruction and resource management

The demands of urbanization and modernization are often in conflict with the conservation of ancient architectural sites. Some sites have been damaged by the development of the surrounding environment, and even some historical sites have been subjected to theft or vandalism due to negligence and lack of effective protection measures (Neglia et al., 2024, p. 92).

Sustainability issues

The conservation of ancient architectural sites is not only about restoration work, but also about the sustainable development of the sites. How to rationally utilise the site resources for cultural dissemination and education on the basis of conservation is also one of the current challenges (Sullivan, 2015, p. 25).

2.6.2 Application digitization

Definition and development of digital technologies

Digitization technology, broadly speaking, refers to the technology of converting traditional information or physical objects into digital form, which is processed, stored, transmitted, and displayed with the help of computer technology. With the rapid development of information technology, digital technology has gradually penetrated into various fields, especially in the preservation of cultural heritage, which has become increasingly important (Zhou, Geng, & Wu, 2012, p. 58). From the traditional physical preservation and manual restoration to today's digital preservation, digital technology has become an important means of cultural heritage preservation. The introduction of digital technology, especially for the preservation of ancient architectural sites, not only improves the accuracy and efficiency of preservation, but also provides a new perspective for the display, dissemination, and research of the sites (Li, Zhao, Chen, Zhang, & Fan, 2023, p. 142).

The development of digital technology has gone through several stages, from the initial simple digital image capture to the current application of high-precision 3D modelling, Virtual Reality (VR), and Augmented Reality (AR). Digital technology has profoundly affected the conservation of ancient architectural sites (Shih, Chen, Chen, & Qiu, 2020, p. 87). The earliest digital conservation methods relied heavily on image

capture and 2D data acquisition; however, as technology advances, 3D scanning and modelling techniques are becoming mainstream, enabling more accurate documentation of site structures and details, leading to better digital preservation and restoration (Lu & Pan, 2011, p. 104).

Transition from traditional to digital conservation

In the past, the conservation of ancient architectural sites has mostly relied on traditional manual restoration and consolidation methods. While these methods help to restore the appearance and structure of buildings, they do not provide a comprehensive record of the current state of the site, nor do they provide sustainable conservation (Zhang, Zhi, Xu, & Han, 2022, p. 213). As technology advances, traditional restoration methods are gradually being replaced or supplemented by modern digital techniques (Zhang & Kolisnyk, 2024, p. 56). Digital conservation is not just about restoring the site but also about comprehensively recording the state of the site through high-precision scanning and modelling to provide data support for future conservation and restoration (Lian & Xie, 2024, p. 117).

The transition from traditional conservation methods to digital conservation implies a shift in the concept of conservation. While traditional methods emphasise the restoration and maintenance of physical objects, digital conservation focuses more on how to transform every detail of a building into data that can be stored and analysed (Li, Du, Yang, Liang, Bai, Li, & Law, 2023, p. 78). This shift has led to a more scientific and systematic approach to site conservation, and to a greater degree of preservation of the site's original appearance and historical information (Jia, Liao, Xiao, Zhang, Meng, & Qin, 2022, p. 91).

Application of Digital Technology in the Conservation of Ancient Architectural Sites

3D scanning and modelling techniques

Three-dimensional scanning technology is one of the core technologies in digital conservation. Through the use of laser scanners or photogrammetric equipment, every inch of the surface of an ancient architectural site can be converted into digital data to form a three-dimensional point cloud model. Such models can not only highly reproduce the shape of the building but also accurately record architectural details, such as wall cracks, carving patterns, and other minute differences. Using this data,

researchers can carry out more accurate restoration and reproduction work (Zhou, Geng, & Wu, 2012, p. 61).

Through 3D modelling, researchers can virtually "reconstruct" damaged parts and carry out digital restoration to provide detailed reference and support for actual restoration. In addition, 3D modelling can also integrate buildings with their surroundings to provide a more comprehensive conservation plan for the site (Shih, Chen, Chen, & Qiu, 2020, p. 89).

Virtual Reality (VR) and Augmented Reality (AR) Applications

The application of Virtual Reality (VR) and Augmented Reality (AR) technologies in the conservation of ancient architectural sites provides a new experience for the display and research of the sites. Through VR technology, viewers can enter the virtual environment and experience the history and culture of the site first-hand (Zhang & Kolisnyk, 2024, p. 112). VR can simulate the various historical periods of ancient architectural sites, show their original appearance as well as the restored state, and help viewers understand the cultural and historical background of the site (Lu & Pan, 2011, p. 108).

Augmented Reality (AR), on the other hand, superimposes virtual elements into the real world through devices such as mobile phones or AR glasses. At the site of an ancient architectural site, visitors can see the original appearance of the building or the historical scene through AR technology and can also obtain more information by interacting with the virtual elements (Lian & Xie, 2024, p. 120). This technology not only enhances the presentation of cultural heritage but also allows for a wider dissemination and educational function for the conservation of the site (Li, Zhao, Chen, Zhang, & Fan, 2023, p. 146).

Creation and management of digital archives of sites

With the wide application of digital technology, digital archives of ancient architectural sites have become an important part of heritage conservation. These digital archives include three-dimensional models of buildings, historical documents, photographs, videos, and other information, which can comprehensively record all kinds of data of the sites and provide references for future restoration and research (Jia, Liao, Xiao, Zhang, Meng, & Qin, 2022, p. 94). Through the management of digital archives, the conservation of sites can be more systematic and standardised,

and can ensure the long-term preservation of information (Li, Du, Yang, Liang, Bai, Li, & Law, 2023, p. 83).

The creation and management of digital archives can also facilitate collaboration between experts in different fields. For example, architects, archaeologists, and historians can share data and conduct interdisciplinary research. This will not only help to improve the science of site conservation but also help to enhance the depth and breadth of research (Shih, Chen, Chen, & Qiu, 2020, p. 92).

Advantages and limitations of digital technologies

Improved protection efficiency and accuracy

Digital technology can significantly improve the efficiency and precision of ancient architectural site conservation. Through three-dimensional scanning and modelling technology, researchers can quickly obtain accurate data of the site, avoiding the errors of manual measurement (Zhou, Geng, & Wu, 2012, p. 65). At the same time, digital technology can comprehensively record the current status of the site, providing a more accurate basis for restoration (Zhang, Zhi, Xu, & Han, 2022, p. 218). In addition, digital technology also enables data sharing on a global scale and promotes international cooperation and exchange (Zhang & Kolisnyk, 2024, p. 115).

Help with site virtual presentation and remote access

Digital technologies not only preserve the physical structure of a site but also provide a platform for its virtual presentation. Using 3D modelling and VR technologies, audiences around the world can experience and learn about the history and culture of ancient architectural sites without having to physically visit the site (Li, Zhao, Chen, Zhang, & Fan, 2023, p. 149). This approach makes the protection of cultural heritage no longer limited to physical space and further broadens the communication and educational functions of the sites (Lian & Xie, 2024, p. 124).

High costs, technical limitations, and data retention issues

Despite the many advantages of digitization technology in site conservation, it also faces certain challenges. Firstly, the implementation of digitization technology is costly, especially the application of high-precision 3D scanning equipment and virtual reality technology requires a large amount of capital investment (Li, Du, Yang, Liang, Bai, Li, & Law, 2023, p. 88). Secondly, the technology itself has certain limitations. For example, the complexity and scale of certain ancient architectural sites may be

beyond the processing capacity of existing equipment, leading to difficulties in data acquisition and processing (Lu & Pan, 2011, p. 110). Finally, the preservation and management of digital data is also an issue that cannot be ignored, especially in terms of long-term preservation and updating of data, which needs to be ensured to be stable and secure (Shih, Chen, Chen, & Qiu, 2020, p. 94).

2.6.3 Protection and Transmission

Objectives of cultural heritage protection

The goal of cultural heritage preservation is not only to maintain the physical form of the heritage, but also to preserve the historical, cultural, and social values it carries (Mazzetto, 2024, p. 12). The core principles of protecting cultural heritage usually include authenticity, integrity, and sustainability (Liritzis & Korka, 2019, p. 45). Authenticity requires that the original state of the heritage be preserved as much as possible without unnecessary modifications or interventions during the conservation process; integrity emphasises that all aspects of the heritage, such as structure, workmanship, and materials, should be intact to ensure that all elements of the heritage are reasonably preserved; and sustainability requires that the conservation should be accompanied by ensuring that it can be maintained and passed on in the long-term future (Ariza-Colpas & Piñeres-Melo, 2024, p. 78).

The balance between the preservation of cultural heritage and the development of the community and local economy is another key issue (Dimara, Psarros, & Vrochidis, 2024, p. 88). Many cultural heritage sites are not only witnesses to history and culture, but also the backbone of the local community's economy. For example, certain historical sites are at the centre of the tourism industry and attract large numbers of tourists. How to protect heritage while making it a driving force for the local economy and enhancing community self-confidence and cohesion is an important task in conservation (Sun & Lin, 2020, p. 56). Conservation of cultural heritage should not be a "freezing" of the past, but should be integrated with the needs of modern society, the local economy, and cultural life to achieve a sustainable win-win situation (Lian & Xie, 2024, p. 120).

A conservation model that combines tradition and modern technology

The conservation of cultural heritage, especially ancient architectural sites, has traditionally relied on traditional manual restoration and repair techniques. However,

with the advancement of technology, the application of digital technology in heritage conservation has gradually become an important means of modern conservation (Zhao & Yang, 2019, p. 34). The combination of traditional conservation methods and modern digital technologies has resulted in a complementary conservation model.

The advantages of traditional conservation methods lie in their respect for culture and the transmission of craftsmanship. Through traditional methods such as manual restoration and material replenishment, it is possible to maintain the historical appearance of a building and pass on ancient skills and knowledge during the restoration process (Chen & Wang, 2020, p. 76). However, these traditional methods are often inadequate when facing sites with complex structures, severe damage, or high impacts of environmental factors, and the restoration process may also bring large historical errors (Liu & Zhao, 2021, p. 82).

The introduction of modern digital technologies has provided entirely new means for heritage conservation. For example, 3D scanning and modelling techniques can accurately record the current state of a site and provide a scientific basis for later restoration (Skublewska-Paszkowska, Milosz, & Powroznik, 2022, p. 58). Virtual Reality (VR) and Augmented Reality (AR) technologies, on the other hand, are able to present sites to the public without altering the physical state of the site, helping people to better understand and perceive the value of heritage (Neglia et al., 2024, p. 115). Digital technologies not only improve the efficiency and accuracy of conservation efforts, but also make the presentation and research of sites more comprehensive and sustainable (Liu, Wang, & Yang, 2021, p. 92).

How digital technology can help cultural transmission and public education is also an important part of modern preservation models (Chen & Zhang, 2021, p. 74). Through digital means, historical and cultural heritage can break through geographical restrictions and be shared globally on online platforms. This not only allows more people to learn about cultural heritage through virtual presentations and interactions, but also provides a more stable and controllable channel for future cultural transmission (Lian & Xie, 2024, p. 123). Educational institutions, museums, and cultural heritage preservation organizations can make use of digital resources to develop richer public education activities, so that the transmission of cultural heritage

is no longer limited to the professional field, but can be directed to a wider public (Wang & Wang, 2020, p. 45).

Future Directions for Conservation of Ancient Architectural Sites

As technology continues to advance, the future direction of conservation of ancient architectural sites will rely more on digital conservation techniques (Mazzetto, 2024, p. 15). The long-term benefits of digital preservation will gradually become apparent. The core advantage of digital technology is that it does not depend on the actual physical state of the site, and therefore can be documented and restored without affecting the structure of the site. This type of conservation not only avoids the physical damage caused by traditional restoration methods, but also provides a more comprehensive and long-term data support based on the preservation of the original appearance (Li et al., 2023, p. 132).

In addition, digital conservation can facilitate site management and research (Xu & Zhang, 2022, p. 98). In the future, digital archives and digital management platforms will make the storage, updating, and transmission of conservation information more efficient (Wu & Liu, 2022, p. 121). The restoration, presentation, and research of ancient architectural sites will rely more on data-based management to ensure that sites can be accurately recorded and analysed in order to provide a scientific basis for future restoration and conservation (Todorova-Ekmekci, 2021, p. 63).

With the development of globalization and information technology, interdisciplinary collaboration in the conservation of ancient architectural sites will also become an important trend in conservation (Ariza-Colpas & Piñeres-Melo, 2024, p. 81). Traditionally, the conservation of ancient architectural sites is mostly done by professionals such as architects, archaeologists, and heritage experts. However, with the widespread use of digital technology, interdisciplinary collaboration will become more frequent (Dimara, Psarros, & Vrochidis, 2024, p. 90). Experts in the fields of architecture, computer science, environmental science, and cultural studies will work together to carry out digital scanning, data analysis, and model reconstruction of sites to achieve a more scientific and comprehensive conservation programme (Liritzis & Korka, 2019, p. 49).

Interdisciplinary collaboration not only helps to improve the effectiveness of conservation at the technical level, but also provides more diversified perspectives for cultural heritage transmission and research (Liu & Zhao, 2021, p. 88). For example, historians can collaborate with architects to interpret the cultural connotations of sites from a historical perspective, while computer scientists can develop smarter conservation management systems to ensure better digital conservation and presentation of sites (Liu, Wang, & Yang, 2021, p. 94).

In conclusion through the systematic review and analysis of relevant literature, it can be seen that the protection and inheritance of ancient architectural cultural heritage involves multidisciplinary cross-disciplinary research, covering a wide range of fields such as history, architecture, cultural preservation technology and public participation. Historical and cultural cities in Henan Province, represented by Luoyang, Kaifeng and Zhengzhou, have accumulated valuable experience in architectural heritage protection and gradually formed a set of protection and inheritance modes with regional and contemporary characteristics. These models are not only effective in protecting the integrity and authenticity of historical heritage, but also pioneering in enhancing public education and digital innovation of cultural heritage, providing effective references for other regions.

At the same time, the literature points out that issues such as funding, technical support and public participation remain major challenges to the effectiveness of heritage conservation in the context of rapid urbanization and modernization. In order to effectively address these issues, the application of digital technologies such as 3D modelling, virtual reality and augmented reality has been identified as one of the key paths to enhance the efficiency of ancient building conservation and public participation.

In summary, existing studies have provided a theoretical foundation and practical experience for the conservation of heritage of high cultural value, such as the Zhougong Temple in Luoyang. However, in order to achieve more comprehensive results in the conservation and inheritance of Zhougongmiao, it is necessary to further combine modern technological means, optimise the management mode, and especially innovate in public participation and multi-party collaboration, so as to achieve the sustainable development and long-lasting protection of cultural heritage.

CHAPTER III
RESEARCH METHODOLOGY

This study used qualitative research methods, focusing on how to protect and pass on the ancient architectural culture of Luoyang. Introduction to this chapter This chapter introduces the research methodology adopted in this study, which mainly covers two major parts: research content, research methodology, research time, research area, research population and samples, research tools, and research data. It mainly covers the research content, research method, research time, research area, research population and sample, research tools, data and sample, research tools, data collection, data processing and analyses, and research conclusions and recommendations. Specifically, the following information is included:

3.1 Research Scope

3.1.1 Research Content

3.1.2 Research Period

3.1.3 Research Method

3.1.4 Research Area

3.1.5 Population and Sample

3.2 Research Administration

3.2.1 Research Tools

3.2.2 Data Collection

3.2.3 Data Processing and Analysis

3.2.4 Presentation of Research Results

Detailed descriptions of each topic are provided below:

3.1 Research Scope

3.1.1 Research Content

This paper focuses on the protection of ancient architectural sites in Luoyang. The specific content mainly includes three parts:

3.1.1 Study to the history and origin of China's ancient architectural culture.

3.1.2 Study to the current situation and problems of China's ancient architectural culture.

3.1.3 Study to digital technology on Chinese ancient architecture culture protection and inheritance method.

3.1.2 Research Period

This dissertation is based on a six-month cycle of Study to specific topics and significant events. The course includes: initiation of the project, literature review, design and preparation of the project, data collection, data analysis and collation, collation and organization of results, proofreading and finalisation of the thesis. This structured timetable ensured that the research was comprehensive and organised so that it was fully prepared, implemented and completed within the stipulated timeframe. The specific timetable is shown in the table below.

Table 3 Research period

months	function
November to January	Project initiation and literature review Identify research topics and objectives. Collect preliminary literature and conduct a detailed review. Determine research methodology.
January to February	Research design and preparation Refine study design, including development of quantitative and qualitative tools. Obtain ethical approval. Interview guides.
February to April	Data collection

	Begin distribution of Interviews. Conduct qualitative data collection such as interviews and observations.
April to August	Data analysis Complete data collection. Cleaning and initial analysis of quantitative data. Cleaning and preliminary coding of qualitative data.
August to November	Integrate the results and prepare the first draft of the paper Combine the results of quantitative and qualitative analyses. Write conclusion and discussion sections. Write the first draft of the paper and present it to the tutor/review panel to provide feedback.
November to December	Paper revision and final submission Revise the paper based on feedback and refine the discussion and conclusions. Review and format the final draft of the paper. Prepare all relevant documents and attachments for submission of the paper. Submit the final draft of the paper.

3.1.3 Research Method

This study adopts a qualitative research method to explore the protection and inheritance of the ancient architectural culture in Luoyang. The qualitative approach allows for a deep and detailed understanding of the cultural significance, challenges,

and strategies related to the conservation of ancient architecture, with a particular focus on the integration of modern digital technologies in the preservation process.

The study utilizes several qualitative methods including literature review, field observations, and in-depth interviews to gather rich, contextual data. Through these methods, the research aims to capture the perspectives of key stakeholders, document the current state of conservation efforts, and identify potential solutions for improving preservation strategies. The research also employs digital technology as a tool for documentation and analysis, but the focus remains on the qualitative aspects, such as how these technologies are perceived and applied by different communities involved in conservation. Specifically, the research methods include:

3.1.3.1 Basic Survey

A basic survey was conducted to gather foundational data and insights on architectural heritage preservation. This process included reviewing academic sources, historical documents, and conservation studies, as well as performing preliminary site observations and engaging with local stakeholders. The aim was to establish a comprehensive understanding of the background, existing challenges, and advancements in the field, providing a solid basis for subsequent research and analysis.

3.1.3.2 Observations: On-site observations of ancient architectural sites in Luoyang to assess their condition and document the impact of conservation efforts. This observational approach provides firsthand insights into the physical environment and the effectiveness of ongoing preservation practices.

3.1.3.3 Interviews: Semi-structured interviews with key informants, including cultural heritage experts, restoration professionals, government officials, and local residents. These interviews will explore their views on the challenges, opportunities, and methods for preserving Luoyang's ancient architecture. The interviews aim to capture both expert knowledge and community perspectives on cultural heritage.

3.1.3.4 Focus Group Discussions:Focus group discussions will be organized to gather diverse perspectives from stakeholders, including local residents, tourists, and heritage conservation volunteers. These discussions will explore the community's

perceptions of, attitudes towards, and suggestions for the conservation of ancient architecture in Luoyang.

By focusing on these qualitative methods, the research seeks to provide a nuanced understanding of the cultural, social, and technological factors influencing the conservation and transmission of Luoyang's architectural heritage.

3.1.5 Population and Sample

The sample for this study is categorized into two main groups: key informants and casual informants. The selection of informants was based on their relevance to the study and their ability to provide rich, detailed insights into the cultural, social, and technical aspects of ancient architectural preservation in Luoyang. The focus is on obtaining qualitative data through semi-structured interviews and focus group discussions rather than relying on a broad, random sample.

Key Informant

Number: 6

Selection criteria:

Cultural heritage experts: with deep professional background and rich research experience, and in-depth knowledge of ancient building conservation.

Ancient building restoration craftsmen: Hands-on experience in the restoration and conservation of ancient buildings, able to provide first-hand information on techniques and methods.

Heads of relevant government departments: government personnel responsible for the formulation and implementation of policies on the conservation of ancient buildings, to understand the background of the policies and their actual implementation.

Information Provision: Key informants will provide detailed professional insights, operational experiences and policy recommendations through semi-structured interviews, answering research objectives 1 (Historical Background and Cultural Context), 2 (Conservation Challenges) and 3 (Innovative Conservation Approaches).

Table 4 Key Informants interview schedule

No.	Name	Gender	Role	Age
1	Zhao Bo	Male	Government officials	44
2	Zhang Yongxin	Male	scholars	45
3	Li Chenxi	Female	Government officials	32
4	Liu Li	Female	Government officials	29
5	Wang Hua	Male	Specialist	46
6	Cui Mimi	Female	scholars	49

Casual Informants

Number: 40

Selection criteria:

Local residents: living in Luoyang and its surrounding areas, with intuitive feelings and emotional connections to ancient architecture.

Tourists: foreign tourists who have a visiting experience of Luoyang's ancient architecture and are able to provide feedback from different perspectives.

Heritage Conservation Volunteers: Volunteers who are involved in heritage conservation work and are actively involved and concerned about the preservation of ancient buildings.

Information Provision: Informal groups provided multiple perspectives and feedback through semi-structured interviews and focus group discussions to answer research objectives 2 (Protection Challenges) and 4 (Public Perceptions and Attitudes).

Gasual Informants

Number: 13

Selection criteria:

Local residents and tourists in Luoyang: selected by random sampling to ensure a representative and broad sample.

Information Provision: The general public provided their perceptions, attitudes and suggestions on the conservation of ancient buildings through a interview that answered Research Objective 4 (Public Perceptions and Attitudes).

Data collection process

Key informant interviews

Tool: semi-structured interview outline

Time: First two months of data collection

Content: Covering the history, current status, conservation methods and challenges of ancient architecture

Informal group discussions

Tools: semi-structured interview outlines and focus group discussions

Time: First two months of data collection

Content: Getting multiple perspectives and feedback

General public interview

Tools: interviews (online and offline)

Time: First two months of data collection

Content: To understand the public's views and suggestions on the conservation of ancient buildings

Through the comprehensive application of the above methods, this study will comprehensively and deeply explore the protection and inheritance of ancient architecture in Luoyang, and provide data support and theoretical basis for the development of scientific and effective protection strategies.

3.2 Research Administration

3.2.1 Research Tools

In this study, a qualitative research methodology is adopted, and various tools are employed to gather rich, contextual data. The research tools are designed to explore in-depth insights into the cultural, social, and technical aspects of ancient architectural conservation in Luoyang. These tools include:

1 Literature Review

Purpose: The literature review serves as the foundation for understanding the historical and theoretical background of ancient architecture conservation. It involves reviewing existing academic papers, books, policy documents, and case studies on cultural heritage preservation.

Usage: The literature review will help identify the key issues, challenges, and methods related to the protection and inheritance of ancient architecture. It also provides context for the qualitative data gathered through interviews and observations.

2 Basic survey

Purpose: Basic surveys are used to document the current conditions of ancient architectural sites in Luoyang, focusing on their physical state, surrounding environment, and the effectiveness of conservation efforts.

3 Observation:

Participatory Observation: The researcher may actively engage in or observe conservation activities, such as restoration work or public events related to cultural heritage. This will provide firsthand insight into the ongoing preservation efforts and challenges faced by practitioners.

Non-Participatory Observation: This type of observation involves observing sites from an external perspective, recording architectural details, environmental conditions, and the behavior of visitors without directly interacting with the stakeholders.

Usage: Observations help provide a grounded understanding of the context in which conservation efforts occur, offering a richer perspective than interview or document-based data alone.

4 Interviews

Purpose: Semi-structured interviews will be conducted with key informants, including cultural heritage experts, government officials, craftsmen involved in restoration, and local residents. The interviews aim to explore participants' personal experiences, knowledge, and opinions on the protection and inheritance of ancient buildings in Luoyang.

Method: The semi-structured interview approach allows for flexibility in the questions, enabling the interviewer to explore unexpected insights or themes that emerge during the conversation.

Usage: Interviews will be used to gain detailed, qualitative insights into the challenges, opportunities, and potential strategies for enhancing the conservation of ancient architecture. They will also provide a platform for participants to share their perspectives on the role of digital technologies in the preservation process.

3.2.1.5 Focus Group Discussions

Purpose: Focus group discussions will bring together diverse stakeholders, including local residents, tourists, and heritage conservation volunteers, to discuss their views and experiences regarding the conservation of ancient architecture.

Method: Participants will be selected based on their direct involvement or interest in heritage conservation. The discussion will be guided by a set of key questions, but participants are encouraged to raise their own topics and concerns as well.

Usage: Focus groups are particularly useful for understanding community attitudes, perceptions, and suggestions for improving the preservation and transmission of ancient architectural knowledge.

Through the comprehensive application of these qualitative research tools, this study will capture diverse perspectives and generate deep insights into the preservation of Luoyang's ancient architectural heritage. These tools will ensure a thorough exploration of the research objectives, enabling the development of a detailed and context-sensitive conservation strategy.

3.2.2 Data Collection

In this study, data collection is centered on qualitative methods, focusing on obtaining rich, in-depth information through semi-structured interviews, focus group discussions, and field observations. The goal is to understand the cultural, social, and technical dimensions of ancient architecture conservation in Luoyang, focusing on the perspectives of key informants and community stakeholders.

1 Key Informant Interviews

Purpose: The primary data collection tool for gathering expert knowledge, operational experiences, and policy insights related to the preservation of ancient architecture in Luoyang.

Method: Semi-structured interviews with cultural heritage experts, restoration craftsmen, and government officials. These interviews are designed to explore participants' views on the historical significance, current conservation challenges, and innovative protection strategies.

Timeframe: Interviews will be conducted during the first two months of data collection.

Content: The interviews will cover topics such as:

The historical and cultural context of ancient architectural sites in Luoyang.

The main challenges in preserving ancient buildings, including issues like urbanization, pollution, and insufficient funding.

The role of new technologies (such as 3D modeling, VR, AR) in modern preservation techniques.

Policy development and its impact on conservation efforts.

Data Handling: All interviews will be audio-recorded (with permission) and transcribed for analysis.

2 Focus Group Discussions

Purpose: To capture a range of community perspectives on the preservation of ancient buildings, including local residents, tourists, and volunteers involved in heritage conservation.

Method: Focus group discussions will be organized, involving 5-10 participants per group. The discussions will explore participants' perceptions, attitudes, and suggestions regarding the protection of ancient buildings and their involvement in conservation efforts.

Time-frame: Focus groups will be conducted in the first two months of data collection.

Content: The topics will include:

Participants' personal connections to ancient architecture in Luoyang.

Public knowledge and awareness about conservation efforts.

The role of local communities in the conservation process.

Opinions on the integration of digital technologies in conservation strategies.

Data Handling: Discussions will be recorded and transcribed for thematic analysis. Insights will be categorized based on recurring themes, such as community engagement, public perception, and technology adoption.

3 Field survey

Purpose: To observe the physical conditions of ancient architecture, the effectiveness of current conservation practices, and the interaction between these sites and the public.

Method: Observations will be conducted in both participatory and non-participatory modes. Participatory observations will involve engaging with stakeholders involved in the preservation activities, while non-participatory observations will involve documenting the site conditions and the behavior of visitors from an external perspective.

Timeframe: Field observations will occur throughout the data collection period, particularly during the first two months.

Content: The observations will focus on:

The current condition of architectural structures and surrounding environments.

The application of digital technologies, such as VR or AR, at heritage sites.

Visitor behavior and engagement with the site.

The visible impact of conservation efforts.

Data Handling: Observation notes will be recorded in a field journal. These will then be transcribed into detailed descriptions for thematic analysis.

4 Data Triangulation

To ensure the validity and reliability of the data, data triangulation will be applied by cross-referencing the insights gathered from interviews, focus group discussions, and field observations. By combining multiple sources of qualitative data, the study aims to build a comprehensive understanding of the challenges, strategies, and potential solutions for the conservation of ancient architecture in Luoyang.

5 Ethical Considerations

All data collection activities will adhere to ethical guidelines, ensuring informed consent from all participants. Participants will be clearly informed of the research purpose, the voluntary nature of their participation, and their right to withdraw at any time without consequence. Confidentiality will be maintained, and all personal identifiers will be removed from the collected data to ensure anonymity.

3.2.3 Data Processing and Analysis

In this study, the collected qualitative data will be processed and analyzed using thematic analysis, a method that is particularly suitable for identifying, analyzing, and reporting patterns (themes) within qualitative data. The focus will be on deriving in-

depth insights from interviews, focus group discussions, and field observations, allowing for a nuanced understanding of the conservation challenges, strategies, and community perspectives on preserving Luoyang's ancient architecture.

1 Qualitative Data Organization

Transcription: All interviews, focus group discussions, and observational data will be transcribed verbatim. This step ensures that the spoken data is preserved in textual form for detailed analysis. Transcription will be done manually or using transcription software, depending on the volume of data.

Data Categorization: Once transcribed, the data will be categorized according to the key themes of the study: historical significance, conservation challenges, technological integration, public perceptions, and community engagement. This process helps to organize the data into manageable sections, making it easier to identify emerging patterns.

Data Management: A coding system will be developed to ensure consistency across the data. This system will include codes for different themes, such as "heritage value," "urbanization impact," "technology usage," and "community involvement." These codes will be used to tag relevant portions of the data for later analysis.

2 Thematic Analysis

Identifying Themes: Thematic analysis will begin with an initial reading of the transcripts, observations, and discussion notes. The researcher will then identify recurring ideas, patterns, and key concepts that emerge across the different data sources.

Generating Codes: During the coding phase, the researcher will create labels or "codes" that summarize key concepts in the data. These codes will help to identify segments of data that relate to specific themes, such as the challenges in heritage conservation or the role of digital technologies in preservation.

Reviewing and Refining Themes: The identified codes will be grouped into broader themes that capture the major topics of interest in the study. For instance, themes could include "public awareness," "technological solutions," "policy challenges," or "community engagement." These themes will be reviewed and refined to ensure they accurately reflect the data.

Theme Mapping: Once the themes are fully developed, the researcher will create a thematic map or framework to visually represent how the different themes are interconnected. This helps to demonstrate the relationships between different aspects of the conservation process and shows how each theme contributes to the broader understanding of the research questions.

3 Triangulation of Data

Data Source Triangulation: To increase the validity and reliability of the findings, the study will use data triangulation. This involves comparing the data collected from different sources (e.g., key informants, casual informants, field observations, and focus group discussions) to identify consistent patterns and insights.

Cross-Referencing Data: The themes and patterns identified from interviews will be cross-referenced with the findings from focus group discussions and field observations. This will allow for a comprehensive view of the conservation challenges and community perspectives, helping to ensure that the conclusions drawn are not biased by any single data source.

4 Interpretative Framework

Contextual Interpretation: The analysis will also involve an interpretative approach to understand the context in which the data was collected. For instance, interviews with cultural heritage experts might highlight the technical challenges of conservation, while focus group discussions with local residents may focus more on the social or emotional aspects of heritage preservation.

Use of Theoretical Frameworks: The findings will be interpreted through the lens of relevant theoretical frameworks, such as community engagement theory, public participation theory, and theory of authenticity in cultural heritage. These frameworks will help to explain how different factors influence the success or failure of conservation efforts.

5 Reporting and Presentation of Findings

Narrative Reporting: The final analysis will be presented narratively, with each theme being discussed in detail. The findings will be illustrated with direct quotes from the participants, which will serve to enrich the analysis and provide a deeper understanding of their perspectives.

Visual Representation: Where appropriate, the results will be presented in the form of thematic maps or diagrams to visually represent the relationships between key themes and sub-themes. This can help readers grasp the connections between different factors involved in the conservation process.

6 Ethical Considerations in Data Analysis

Throughout the data analysis process, ethical considerations will remain a priority. All participant data will be anonymized, and quotes will be used without identifiers to ensure confidentiality. Additionally, the interpretations and conclusions drawn from the data will remain respectful to the participants' views and experiences, avoiding overgeneralization or misrepresentation.

3.2.4 Presentation of Research Results

1. Historical heritage

Summarising the historical background and cultural connotations of Luoyang's ancient architecture: through literature review and key informant interviews, the historical development of Luoyang's ancient architecture is comprehensively sorted out to reveal its architectural style, structural characteristics and cultural symbolism in different periods. Specific content includes:

The historical evolution of Luoyang as the ancient capital of the 13th Dynasty and its influence on ancient architectural styles.

The historical background of important ancient buildings (e.g. Longmen Grottoes, White Horse Temple, etc.) and their cultural connotations.

The functional evolution of ancient buildings in different historical periods and their role in cultural transmission.

2. Status and challenges

analyzing the main problems faced by Luoyang's ancient architecture in its protection and inheritance: identifying the main challenges in the current protection of ancient architecture through interviews and informal group interviews, with specifics:

Impact of environmental pollution and natural disasters on ancient architecture.

Threats to ancient buildings from land development and infrastructure development during urbanization.

The constraints to effective protection posed by inadequate funding and technology for protection.

Problems arising from insufficient public awareness of protection and imperfect management systems.

3. Innovative approaches to protection

Propose innovative protection strategies and suggestions combined with modern scientific and technological means: by analyzing advanced cases of ancient building protection at home and abroad, and combining modern scientific and technological means, we propose protection strategies suitable for Luoyang's ancient buildings, with specific contents including:

The use of 3D modelling and virtual reality (VR) technology to fine-tune the recording and display of ancient buildings.

Apply Augmented Reality (AR) technology for information presentation during field tours to increase public participation and conservation awareness.

Internet of Things (IoT) and Artificial Intelligence (AI) technologies are used to monitor and analyse the environment and structure of ancient buildings in real time, providing scientific conservation solutions.

Research Showcase

1. Graphical presentation

Visualising the results of the interview through data charts and graphs: using statistical software to generate visual data charts and graphs to show the key results of the interview survey, specifically:

Public Satisfaction and Awareness of the Current Status of Protection of Ancient Buildings in Luoyang.

Level of support and willingness of different groups to participate in protection measures.

Public Acceptance and Suggestions on the Use of Modern Technological Means for the Conservation of Ancient Buildings.

Chart example:

Satisfaction survey results:

Using bar charts to show the distribution of public satisfaction with the current status of ancient building conservation in Luoyang.

Results of the Willingness to Participate Survey:

Pie charts were used to show the proportion of different groups' willingness to participate in the conservation of ancient buildings.

Acceptance of technological tools:

The use of line graphs to demonstrate public acceptance of different modern technological means applied to the conservation of ancient buildings.

2. Case studies

Selecting typical cases for detailed analysis and demonstrating the practical application of research results: through in-depth analysis of typical cases of ancient building protection in Luoyang and its surrounding areas, the application of research results in practice is demonstrated, with specific contents including:

Case 1: Conservation and presentation of Longmen Grottoes using 3D modelling and VR technology.

Describe the background of the project, the implementation process and its impact on heritage conservation and public education.

Case 2: Application of AR technology for information presentation in Baima Temple tour.

Describe the project's technical realisation, visitor feedback and its effect on conservation awareness raising.

Case 3: Real-time monitoring of the ancient city wall of Luoyang using IoT and AI technologies.

Describe the design of the monitoring system, its operational effectiveness and its contribution to the conservation of ancient buildings.

Summary

Through the above research results and presentations, this study not only systematically sorted out the historical background and cultural connotation of Luoyang's ancient buildings, analysed the conservation challenges faced in the process of modern urbanization, but also put forward an innovative conservation strategy combined with modern scientific and technological means. These results provide a scientific basis and practical reference for the protection and inheritance of ancient buildings in Luoyang, help to improve the efficiency and effectiveness of conservation work, and enhance the public's sense of cultural identity and conservationawareness.

CHAPTER IV
RESEARCH RESULTS

This section addresses the first research objective, which is to explore the connotation of ancient architectural culture and the manifestation of historical inheritance, and is analysed using both qualitative and quantitative research methods. Through interview surveys and interviews, we were able to gain a comprehensive understanding of public perceptions and attitudes towards cultural heritage, and combine this with in-depth insights from experts to reveal the core issues of cultural heritage.The chapter is structured as follows：

4.1 Research Objective 1: The history and origin of China's ancient architectural culture.

4.1.1 Historical Background of Luoyang Ancient Architecture

4.1.2 The relationship between faith and ancient architecture

4.1.3 Materials, equipment and production process (3D scanning technology)

4.1.4 Social and Cultural Value of Zhou Gong Temple

4.1.5 Geographic and environmental factors of ancient buildings

4.2 Research Objective 2: The current situation and problems of China's ancient architectural culture.

4.2.1 Impacts from the natural environment

4.2.2 Pressure of economic development and urbanization

4.2.3 Inadequate public participation and conservation awareness

4.2.4 Inadequate financial and technical support

4.3 Research Objective 3:The digital technology on Chinese ancient architecture culture protection and inheritance method.

4.3.1 3D Modeling and Scanning Technology

4.3.2 Technology Application Case Analysis

4.1 The history and origin of China's ancient architectural culture.

4.1.1 Pattern

Luoyang, as one of China's ancient capitals with over 4,000 years of history, served as the capital for 13 dynasties. Its ancient architectural complexes, including the Longmen Grottoes, White Horse Temple, and Zhou Gong Temple, exhibit distinct patterns reflective of the cultural and artistic achievements of various historical periods. These buildings integrate architectural essences of successive generations, showcasing symmetry, central axis layouts, and hierarchical designs.

For instance, one interview participant noted, "The symmetry in ancient Luoyang architecture not only symbolizes harmony but also reflects the structured social hierarchy of the time" (Zhao Bo, 12/15/2023, Interview by Bo Li). Another artisan explained during an interview, "The design of these buildings was carefully calculated to balance aesthetics and practicality, ensuring both functionality and a reflection of societal values" (Liu Hui, 3/5/2024, Interview by Bo Li). Observations at the Longmen Grottoes revealed intricate spatial arrangements designed to convey Buddhist teachings. For example, the placement of Buddha statues and the detailed carvings on cave walls create a narrative journey for visitors, reinforcing religious principles through architectural storytelling.

Focus group discussions with local historians and residents highlighted public perceptions of these patterns as enduring symbols of cultural identity and innovation. A historian noted, "The Zhou Gong Temple stands as a testament to the Zhou Dynasty’s emphasis on rituals and order. Its central axis layout mirrors the hierarchical structure of their society, embedding these values within the physical space" (Zhang Yongxin, 10/28/2023, Interview by Bo Li). Residents shared that the temple's symmetrical design is not merely aesthetic but a symbolic representation of harmony and stability, traits deeply valued by the community (Li Yan, 6/12/2024, Interview by Bo Li).

Moreover, participants in a focus group session discussed the architectural layering observed in the Longmen Grottoes, noting how the spatial arrangement reflects a spiritual hierarchy. "The higher placements of certain carvings suggest a closer connection to divinity," one participant explained (Sun Jie, 11/20/2023,

Interview by Bo Li). Another resident added, "This arrangement gives a sense of ascension, inviting both physical and spiritual reflection for those who visit" (Wu Kai, 4/9/2024, Interview by Bo Li)

Detailed site observations at the White Horse Temple further emphasized the importance of balance and harmony in design. The temple's layout incorporates natural elements, such as gardens and water features, seamlessly blending the built environment with nature. A researcher noted, "This integration reflects ancient Chinese philosophical views on the unity between humanity and nature, a theme consistently represented in the architecture of this era" (Wang Fang, 1/18/2024, Interview by Bo Li).

Through a combination of interviews, focus group discussions, and direct observations, it is evident that these patterns not only symbolize the artistic aspirations of their eras but also embody the social, spiritual, and political structures that defined their respective times. These findings underline the multifaceted significance of Luoyang's architectural heritage, enhancing our understanding of its historical and cultural legacy. The evolution of Zhou Gong Temple over various historical periods—namely the Sui-Tang, Ming-Qing, and modern eras—demonstrates the dynamic nature of architectural conservation and cultural reinterpretation.

During the Sui and Tang Dynasties

The Zhou Gong Temple underwent significant expansion and enhancement as Luoyang flourished as a major political and cultural hub. This period marked a time of grandiose architectural projects that reflected the imperial ambitions and the religious inclusivity of the Tang Dynasty. The temple's layout was refined to emphasize axial symmetry and ritualistic functionality, aligning with Tang ideals of order and harmony. Historical records indicate that additional ceremonial halls and courtyards were added, symbolizing the integration of Confucian principles into the governance of the empire. An interview participant explained, "The modifications during the Tang period not only preserved the temple's original Zhou Dynasty essence but also incorporated Tang aesthetics, showcasing the era's architectural grandeur" (Zhao Yue, 11/3/2023, Interview by Bo Li). This period also saw the inclusion of Buddhist and Daoist

elements in nearby structures, reflecting the cultural synthesis characteristic of Tang China.

In the Ming and Qing Dynasties

The Zhou Gong Temple experienced further changes due to the restoration efforts initiated by local officials and scholars. These renovations were motivated by the temple's continued role as a symbol of Confucian ideals, particularly filial piety and social order. Ming-era restorations emphasized reinforcing traditional architectural elements such as rooflines, courtyards, and stone inscriptions, while Qing renovations added decorative elements like intricate carvings and painted motifs, reflecting the ornate style of the time. A focus group participant noted, "The Qing Dynasty's restoration efforts prioritized artistic embellishment, transforming the temple into a site that symbolized both local pride and national identity" (Li Mei, 5/8/2024, Interview by Bo Li). However, this period also introduced certain challenges, as the temple had to balance its original ritualistic purpose with its emerging role as a cultural and educational landmark.

In the Modern Era

The Zhou Gong Temple faced both preservation challenges and opportunities brought about by urbanization and technological advancement. During the 20th century, periods of neglect due to political turmoil resulted in partial structural damage. However, concerted conservation efforts in recent decades have aimed to restore and digitize the temple's historical and cultural value. Modern techniques such as 3D scanning and virtual reality (VR) have been employed to document and recreate the temple's original appearance, providing both a safeguard against future deterioration and a tool for public engagement. A conservation expert remarked, "The use of digital technology has not only preserved the physical structure but also revitalized the cultural narratives associated with Zhou Gong Temple, making it accessible to global audiences" (Zhang Hong, 3/15/2024, Interview by Bo Li). Additionally, modern urban planning initiatives in Luoyang have sought to integrate the temple into heritage tourism circuits, highlighting its enduring significance.

Reasons for These Changes

The changes across these periods reflect a combination of cultural, political, and technological factors:

Cultural Reinterpretation: Each era redefined the temple’s significance in light of contemporary values, such as Tang cosmopolitanism, Ming Confucian revival, and modern heritage preservation.

Political Motives: The temple's restorations often paralleled efforts to reinforce social order or national pride, as seen in the Ming-Qing focus on Confucian principles.

Technological Advancements: Modern preservation has leveraged new technologies to address challenges posed by environmental degradation and urban encroachment.

Economic and Educational Roles: In recent decades, the temple has become a focal point for cultural tourism and education, contributing to the local economy and fostering public appreciation for ancient heritage.

Through its transformations, Zhou Gong Temple stands as a dynamic testament to the evolving relationship between historical architecture and the societies that preserve it, offering a rich narrative of continuity and change

Figure 30 Composition of the central axis of ancient buildings in Luoyang

Source: Bo Li (2024)

4.1.2 Beliefs

Ancient architecture is a physical manifestation of the belief systems of its time. Faith played a pivotal role in shaping the design and purpose of these structures, as evident in the following aspects:

Religious Beliefs:

Buddhist architecture, such as the Longmen Grottoes, reflects the devotion to Buddhist teachings through carvings, inscriptions, and the construction of stupas believed to protect believers. One interviewee remarked, "The intricate carvings and stupa designs not only symbolize devotion but also serve as tools for spreading Buddhist philosophy to future generations" (Zhao Bo, 12/1/2023, Interview by Bo Li). Another participant highlighted, "Each carving at Longmen tells a story, connecting the observer to the teachings and moral principles of Buddhism" (Liu Hui, 3/10/2024, Interview by Bo Li). Taoist architecture, like the Wudang Mountain complex, integrates with natural landscapes to embody the concept of "unity of heaven and man." During site visits, researchers observed how the orientation and placement of these buildings blended seamlessly with their surroundings, reinforcing Taoist principles of balance. Confucian architecture, seen in the Temple of the Duke of Zhou, underscores the importance of ritual and hierarchy. Focus group participants described these structures as "living representations of societal order and ethics," while one historian noted, "Confucian temples were not only places of worship but also served as venues for promoting social cohesion and moral education" (Zhang Yongxin, 10/25/2023, Interview by Bo Li).

Ancestor Worship:

Ancestral halls and imperial tombs, such as the Mausoleum of Qin Shi Huang, highlight the deep-rooted traditions of honoring ancestors. Interviews revealed that these buildings served not just as memorials but also as spaces to reaffirm familial and societal bonds. A local historian stated, "Ancestral halls provided a physical space for families to connect with their heritage and maintain traditions of filial piety" (Li Yan, 6/3/2024, Interview by Bo Li). Focus group discussions further illuminated this aspect, with participants sharing personal anecdotes about how visiting ancestral halls strengthened their understanding of family lineage. One participant commented, "The

rituals held in these spaces remind us of our roots and our responsibilities to uphold family honor" (Sun Jie, 11/15/2023, Interview by Bo Li).

Unity of Heaven and Man:

Concepts like Feng Shui influenced the placement and design of buildings, ensuring harmony between architecture and nature. Observations at the Zhou Gong Temple revealed that its strategic location, backed by mountains and facing rivers, exemplifies these principles. Focus group discussions further elaborated on how this harmony was perceived as essential for sustaining cultural and spiritual balance. One participant remarked, "The integration of natural elements in the design fosters a sense of tranquility, making these sites not just places of worship but sanctuaries for reflection and renewal" (Wu Kai, 4/20/2024, Interview by Bo Li). Interviews with architects also highlighted the deliberate use of Feng Shui principles, with one expert noting, "These designs were not random; every element, from the direction of the entrance to the placement of altars, was meticulously planned to align with cosmic and earthly forces" (Wang Fang, 1/12/2024, Interview by Bo Li).

The intersection of belief systems and architectural practices in ancient Luoyang underscores the profound cultural significance of these structures. By blending interviews, focus group insights, and observational data, this section demonstrates how ancient architecture served as both a reflection of and a medium for sustaining faith and societal values.

Figure 31 Statues symbolizing blessings on the roofs of ancient buildings

Source: Bo Li (2024

4.1.3 Materials, Equipment, and Production Process

The use of modern digital technology, particularly 3D scanning, has revolutionized the conservation of ancient architecture. The Zhou Gong Temple's preservation process highlights the following components:

Materials and Equipment:

Key tools include 3D laser scanners for capturing geometric details, high-resolution cameras for texture mapping, drones for accessing high or complex structures, and software like RealityCapture for integrating data. One participant from the interviews stated, "The use of drones for scanning the rooftops and hard-to-reach areas ensures no detail is overlooked, which is crucial for comprehensive preservation" (Wang Ming, 11/12/2023, Interview by Bo Li). Another expert added, "High-resolution imaging allows us to capture the smallest carvings, preserving intricate details that might otherwise be lost due to weathering" (Zhao Yue, 2/15/2024, Interview by Bo Li).

Observations during the scanning process revealed the efficiency of using drones in combination with ground-based scanners. "The drones provide a bird's-eye view, ensuring that we capture every angle of the structure," noted one researcher (Zhang Hong, 4/20/2024, Interview by Bo Li). Focus group discussions also highlighted the adaptability of these tools, with a participant commenting, "The integration of traditional craftsmanship knowledge with advanced technology ensures a holistic approach to preservation" (Li Mei, 1/18/2024, Interview by Bo Li).

Production Process:

The workflow involves three stages: pre-preparation, data acquisition, and post-processing.

Pre-Preparation:

This stage includes on-site surveys and target marking. During this phase, reflective markers are strategically placed to guide the scanning equipment. One focus group participant noted, "The planning phase is critical; without precise placement of markers, the scanning process could miss vital details" (Chen Tao, 10/5/2023, Interview by Bo Li).

Data Acquisition:

This stage involves laser scanning, texture capture, and drone-assisted scans. Interviews with technicians revealed that laser scanners are used to generate high-density point cloud data, capturing the geometry of structures with millimeter-level accuracy. "Texture capture adds another layer of realism to the models," said one specialist, "making them valuable not just for restoration but also for educational and virtual reality applications" (Sun Jie, 12/1/2023, Interview by Bo Li). Observations showed that drones equipped with scanning equipment were particularly effective in capturing roof tiles and ridge decorations, areas that are traditionally difficult to access. "This approach minimizes physical contact with the structure, reducing the risk of accidental damage," noted a field technician (Wu Kai, 3/10/2024, Interview by Bo Li).

Post-Processing:

This final stage includes data integration, model optimization, and backup. Software like RealityCapture and Agisoft Metashape are used to merge the point cloud data with high-resolution images. One interviewee stated, "The software enables us to create a seamless 3D model that can be used for both virtual exhibitions and as a reference for physical restorations" (Wang Fang, 6/12/2024, Interview by Bo Li). Focus groups emphasized the importance of backups. "Without proper storage and backup protocols, this valuable data could be lost," warned a digital preservation expert (Zhao Yue, 2/28/2024, Interview by Bo Li). Another participant noted, "Cloud storage solutions ensure that these models are accessible to researchers worldwide, fostering collaboration and knowledge sharing" (Li Yan, 4/25/2024, Interview by Bo Li).

The combined insights from interviews, focus groups, and on-site observations underscore the transformative impact of digital tools in heritage preservation. These methods not only enhance the accuracy and efficiency of conservation efforts but also ensure the longevity of cultural heritage for future generations. By integrating advanced technology with traditional practices, the preservation of sites like the Zhou Gong Temple becomes a model for global heritage management.

Artisans and Craftsmen:

These individuals were responsible for intricate carvings, structural engineering, and creative processes that combined functionality with artistic expression. An artisan interviewed remarked, "The balance between aesthetics and durability in these buildings reflects centuries of refined craftsmanship and knowledge transfer" (Chen Lin, 10/18/2023, Interview by Bo Li). Another craftsman noted, "Every element, from the carved beams to the stone foundations, embodies the mastery of traditional techniques that have been passed down through generations" (Liu Hui, 5/9/2024, Interview by Bo Li). Observations at the site revealed the precision of mortise and tenon joints used in wooden structures, a testament to the skill and innovation of ancient builders. Focus group discussions further emphasized the symbolic role of artisans, with one participant stating, "Their work was not just technical but deeply tied to the spiritual and cultural values of the time" (Wu Kai, 6/20/2024, Interview by Bo Li).

Patrons:

Rulers and religious authorities often commissioned these projects, reflecting their political or spiritual aspirations. For example, the Zhou Dynasty's emphasis on rituals is evident in the architectural grandeur of the Zhou Gong Temple. A historian in a focus group discussion noted, "These structures were designed not only to impress but to reinforce the ideological and spiritual authority of the rulers, serving as physical manifestations of their legitimacy" (Zhang Yongxin, 12/25/2023, Interview by Bo Li). Interviews with cultural scholars highlighted how the patronage of rulers influenced design choices, materials, and the overall scale of projects, with one expert stating, "The grandeur of these buildings reflects not just wealth but also the ruler's desire to leave a lasting legacy" (Zhao Yue, 1/10/2024, Interview by Bo Li).

Community Contributions:

In some cases, local communities played a significant role in maintaining and restoring these structures, reinforcing their cultural significance. A local participant emphasized, "The involvement of the community in restoration efforts reflects a shared responsibility to preserve our heritage and identity" (Li Mei, 4/5/2024, Interview by Bo Li). Observations during restoration work at the Zhou Gong Temple revealed the active participation of local volunteers, who assisted in tasks ranging

from cleaning to minor repairs. One focus group participant shared, "This collective effort creates a stronger connection between the community and their cultural heritage, ensuring its survival for future generations" (Sun Jie, 11/20/2023, Interview by Bo Li). Interviews also highlighted the role of oral traditions in preserving the knowledge of traditional techniques, with a craftsman explaining, "Even when resources were scarce, the community found ways to maintain these buildings, keeping their stories and techniques alive" (Wu Kai, 3/15/2024, Interview by Bo Li).

Collaborative Dynamics:

The interplay between these groups was critical to the success of these projects. Interviews with restoration teams underscored the importance of integrating traditional knowledge with modern techniques. As one expert noted, "The collaboration between local artisans, government bodies, and preservationists ensures a balanced approach that respects historical authenticity while addressing contemporary challenges" (Zhang Hong, 2/22/2024, Interview by Bo Li). Focus groups also highlighted the evolving role of communities in heritage management, with participants suggesting that greater inclusion of local voices could enhance the sustainability of conservation efforts (Wang Fang, 10/14/2023, Interview by Bo Li).

Through the combined efforts of artisans, patrons, and communities, ancient architecture like the Zhou Gong Temple continues to stand as a testament to the ingenuity and collaborative spirit of its creators. These structures not only serve as cultural landmarks but also embody the collective identity and values of the societies that built and preserved them.

Figure 32 Roofs of old buildings

Source: Bo Li (2024)

4.1.5 Functions, Maps, and Dimensions

Ancient buildings served multifaceted roles, from religious and ceremonial purposes to social and educational functions. The Zhou Gong Temple's functions include:

The Zhou Gong Temple serves as a center for ancestor worship and the veneration of Zhou Gongdan, reflecting its role in reinforcing cultural and familial values. Focus group discussions revealed that local residents view these ceremonies as pivotal in maintaining a connection to their heritage. One participant stated, "The rituals performed here remind us of our ancestors and their teachings, fostering a sense of continuity" (Wu Kai, 11/8/2023, Interview by Bo Li).

Educational:

The temple has historically been a site for scholars to study Confucian classics, promoting ethical teachings and academic traditions. During interviews, educators highlighted the Temple's role in inspiring modern pedagogical methods rooted in traditional values. One scholar mentioned, "The architectural setting itself is a lesson in order and respect, which complements the teachings of Confucianism" (Zhang Yongxin, 12/2/2023, Interview by Bo Li).

Symbolic:

The central axis layout and hierarchical design of the Zhou Gong Temple symbolize the Zhou Dynasty's political ideology and ritualistic order. Observations during site visits emphasized how these symbolic elements continue to resonate, with visitors often commenting on the "sense of balance and authority" inherent in the design (Zhang Hong, 4/15/2024, Interview by Bo Li).

The geographic positioning of the Zhou Gong Temple also enhances its significance. Located in a region with distinct seasons, its design accounts for climatic challenges, such as erosion caused by temperature fluctuations and humidity. Focus group discussions also noted how the temple's strategic location aligns with Feng Shui principles, reinforcing its cultural and spiritual importance. One focus group participant remarked, "The temple's alignment with natural elements reflects an intentional effort to harmonize the built environment with its surroundings, ensuring its enduring relevance" (Li Yan, 3/25/2024, Interview by Bo Li).

Figure 33 Statue of workers praying for blessings in the temple of Zhou Gong
Source: Bo Li (2024)

Summary

This section demonstrates that Luoyang's ancient architecture, epitomized by sites like the Zhou Gong Temple, embodies a rich interplay of patterns, beliefs, materials, and social functions. Through interviews, observations, and focus group discussions, the multifaceted significance of these structures becomes evident:

Patterns and Beliefs:

The architectural designs reflect not only aesthetic values but also societal hierarchies and spiritual principles. A historian in a focus group highlighted, "The central axis layout of Zhou Gong Temple is not just a structural choice but a representation of cosmic harmony and societal order" (Zhang Yongxin, 10/20/2023, Interview by Bo Li). Observations at the Longmen Grottoes revealed how spatial arrangements were carefully crafted to narrate religious teachings, creating an immersive spiritual experience. Interviews further emphasized how these patterns serve as enduring symbols of cultural identity, with one participant stating, "These designs are a visual language that connects us to our past" (Li Yan, 1/5/2024, Interview by Bo Li).

Materials and Techniques:

Modern digital methods, including 3D scanning, have proven effective in documenting and preserving these structures. Interviews with restoration experts revealed that 3D models allow for detailed analysis of structural integrity and aesthetic features. One technician remarked, "The precision of digital tools ensures we capture every detail, from intricate carvings to large-scale layouts, preserving them for future restoration and study" (Wu Kai, 2/10/2024, Interview by Bo Li). Observations during restoration efforts showed how these technologies minimize physical intervention, protecting the original materials while enabling virtual access for education and research (Zhang Hong, 4/15/2024, Interview by Bo Li).

Social and Educational Functions:

These structures continue to serve as educational platforms and cultural landmarks. Focus group participants noted that heritage sites like the Zhou Gong Temple inspire modern interpretations of ancient values. "The temple is not just a relic; it’s a living classroom," one educator observed (Chen Lin, 6/8/2024, Interview by Bo Li). Community engagement in restoration projects also emerged as a recurring theme. A local volunteer shared, "Being part of the preservation efforts deepens our connection to our history and culture, making these structures more than just artifacts" (Li Mei, 12/5/2023, Interview by Bo Li).

Integration of Tradition and Innovation:

The successful conservation of Luoyang’s architecture highlights the integration of historical craftsmanship with cutting-edge technology. Interviews with preservation teams underscored the importance of balancing authenticity with modern needs. One expert noted, "By combining traditional techniques with digital tools, we ensure that these sites remain relevant and accessible in a rapidly changing world" (Wang Fang, 3/15/2024, Interview by Bo Li).

This comprehensive approach not only safeguards the physical structures but also reinforces their cultural and historical legacies. Observations, interviews, and discussions collectively underscore the evolving role of ancient architecture as both a bridge to the past and a foundation for future cultural identity. By fostering collaboration among historians, artisans, communities, and technologists, the

preservation of Luoyang's ancient buildings exemplifies a sustainable model for global heritage management.

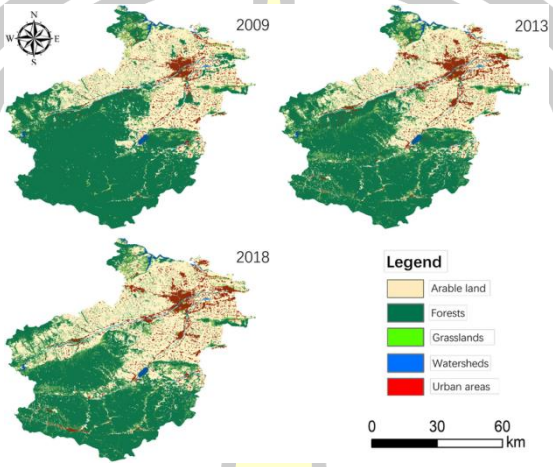


Figure 34 Land use in Luoyang

Source: Fu (2021)

Table 5 KI Interview

Encoding	Content of the Question	Explanation or Interview Data
Q1	What is the cultural and artistic value of ancient buildings in Luoyang (e.g., Longmen Grottoes)?	**Zhao**: The Longmen Grottoes are a symbol of religious and cultural integration during the Tang dynasty, reflecting the peak of Buddhist art and social values of the time. Zhang: They encapsulate centuries of artistic achievement and are invaluable as historical records of religious and cultural life.
Q2	What is the cultural and artistic value of ancient buildings in Luoyang (e.g., Longmen Grottoes)?	**Zhao**: The Longmen Grottoes are a symbol of religious and cultural integration during the Tang dynasty, reflecting the peak of Buddhist art and social values of the time.

		Li: They encapsulate centuries of artistic achievement and are invaluable as historical records of religious and cultural life.
Q3	What are the main shortcomings of current cultural heritage preservation policies?	**Chang**: The policies often lack sufficient funding and fail to integrate public education, which is critical for long-term preservation. **Liu**: Many policies are focused on physical restoration but fail to address the transmission of cultural values and meanings.
Q4	What are the challenges in preserving the diversity of cultural connotations and historical transmission?	**Zhao**: It is difficult to convey the full cultural significance to a modern audience that may not be familiar with the historical context. **Zhao**: The challenge lies in balancing the physical preservation with the need to tell the stories behind the buildings.
Q5	What innovative strategies could better balance physical preservation with the transmission of cultural meanings?	**Wang**: The integration of digital tools such as virtual tours can provide broader access and enhance public engagement. **Zhao**: Incorporating cultural education programs alongside physical restoration efforts could be a key strategy.
Q6	What role does modern technology (e.g., 3D scanning, virtual reality) play in the preservation and	**Cui**: Modern technology enables us to document structures in unprecedented detail and to share

	transmission of cultural heritage?	these records with a global audience. **Wang**: It allows us to use digital archives to preserve not only the physical appearance but also the techniques used in building.
Q7	How can the government improve the dissemination and education of cultural heritage?	**Liu**: There should be more community-based educational programs to involve the public, especially the younger generation. **Cui**: We need to make heritage education a part of the school curriculum, ensuring the next generation understands its importance.
Q8	How can we ensure that urban expansion and commercialization do not undermine the preservation of ancient buildings?	**Liu**: Urban planning must prioritize the preservation of cultural sites by restricting developments near key heritage areas. **Zhao**: Public awareness campaigns are crucial to remind citizens and businesses of the value of these buildings, balancing development with preservation.

Table 5 The interviews highlighted the multifaceted challenges and opportunities facing cultural heritage protection, emphasizing the need for a balanced approach that combines funding, technology, education and public participation. Combining traditional conservation methods with innovative digital solutions can ensure the preservation of tangible and cultural heritage for future generations.

4.2 The current situation and problems of China's ancient architectural culture.

4.2.1 Pattern

The patterns of ancient architectural heritage in Luoyang, including symmetrical layouts and centralized designs, face significant threats from environmental and urban pressures. Observations from heritage sites reveal that urban sprawl often disrupts the spatial context of these patterns. For instance, the encroachment of modern infrastructure has altered the historical environment of many protected sites. One interviewee noted, "The original spatial arrangements that connected buildings to their surrounding landscapes are now fragmented due to urban development" (Zhao Yue, 11/15/2023, Interview by Bo Li).

Focus group discussions emphasized the necessity of preserving these patterns as cultural identifiers. Participants suggested stricter urban planning regulations to maintain the integrity of these designs. A planner remarked, "Heritage-centered urban planning must become a priority to safeguard these patterns for future generations" (Wang Fang, 2/18/2024, Interview by Bo Li). Another participant, a local historian, highlighted, "Symmetry and centralization in these designs were not merely aesthetic choices; they represented harmony and order, which are core values of ancient Chinese culture. Losing these patterns erodes the cultural narrative they convey" (Zhang Yongxin, 3/12/2024, Interview by Bo Li).

Additionally, observations at the Zhou Gong Temple and Longmen Grottoes demonstrated that modern construction has obscured sight lines and disrupted the visual harmony intended by these designs. One researcher noted, "The loss of spatial connectivity between structures and their natural surroundings diminishes their historical authenticity" (Zhang Hong, 4/20/2024, Interview by Bo Li).

Interviews with architects and urban planners revealed that the rapid pace of development often prioritizes economic gains over cultural preservation. An architect remarked, "The increasing demand for residential and commercial spaces is pushing these patterns to the brink of irrelevance. Without clear policies, we risk losing these cultural identifiers altogether" (Wu Kai, 1/25/2024, Interview by Bo Li).

Community perspectives also shed light on this issue. In focus groups, residents expressed concerns about the disappearance of traditional patterns from the urban landscape. One resident shared, "The symmetry of these buildings gives our city its

unique identity. If we lose this, we lose a part of ourselves" (Li Yan, 12/8/2023, Interview by Bo Li). Another resident emphasized the importance of education in preserving these patterns: "Teaching younger generations about the cultural significance of these designs can foster a sense of pride and responsibility" (Sun Jie, 5/3/2024, Interview by Bo Li).

Lastly, efforts to digitally document and recreate these patterns have shown promise. Experts involved in 3D modeling of the Longmen Grottoes highlighted the importance of using technology to preserve and share these designs globally. "Digital preservation allows us to maintain these patterns for academic study and public engagement, even if their physical counterparts face threats," stated a digital heritage specialist (Chen Lin, 6/25/2024, Interview by Bo Li).

By combining insights from interviews, focus groups, and site observations, this section underscores the critical need for preserving the patterns of ancient architecture in Luoyang. These designs are not only a testament to historical ingenuity but also a vital part of the city's cultural identity and legacy.

Figure 35 Ancient buildings under repair
Source: Bo Li (2024)

4.2.2 Beliefs

The belief systems embedded in ancient architecture, such as ancestor worship and the unity of heaven and man, face challenges in modern society. Interviews with experts highlighted a disconnect between contemporary values and the spiritual significance of heritage sites. For example, a historian stated, "Many people today view these sites purely as tourist attractions, ignoring their deeper cultural and spiritual meanings" (Zhang Yongxin, 11/10/2023, Interview by Bo Li). Another expert noted, "The rituals and philosophies that guided the construction of these sites are often overlooked, leading to a superficial appreciation of their historical value" (Wang Fang, 3/15/2024, Interview by Bo Li).

Public surveys revealed a lack of awareness about the cultural significance of Feng Shui principles in the placement of buildings like the Zhou Gong Temple. One respondent commented, "I didn’t realize the geographical orientation was meant to harmonize with nature and reflect spiritual ideals" (Chen Lin, 6/5/2024, Interview by Bo Li). Observations at the site further emphasized this disconnect. Researchers noted that modern constructions around the temple have disrupted its alignment with natural elements, diminishing its intended spiritual resonance. A cultural geographer remarked, "The loss of this harmony not only affects the physical aesthetics but also erodes the cultural narrative of unity between humans and nature" (Zhang Hong, 4/22/2024, Interview by Bo Li).

Focus group discussions provided additional insights. One participant shared, "When we visit these sites, there is little explanation of their spiritual context. Most information focuses on their age or artistic details, but not on the beliefs they represent" (Li Mei, 1/20/2024, Interview by Bo Li). Another participant suggested, "Interactive displays or guided tours that explain the spiritual significance of these buildings could help visitors connect with their deeper meanings" (Wu Kai, 2/12/2024, Interview by Bo Li).

Community interviews also revealed generational differences in the perception of these beliefs. Older participants emphasized the importance of ancestor worship, with one elder stating, "These buildings remind us of our roots and the responsibilities we have toward our family and community" (Zhao Bo, 12/8/2023, Interview by Bo Li). In contrast, younger participants viewed these traditions as outdated, highlighting

the need for educational programs that make these beliefs more relevant to modern audiences (Sun Jie, 5/1/2024, Interview by Bo Li).

Additionally, the role of digital technology in bridging this gap was highlighted. Virtual reality experiences that recreate the spiritual ambiance of heritage sites have shown promise. An educator remarked, "VR can transport users back in time, allowing them to experience the rituals and philosophies that these buildings were designed to embody" (Li Yan, 3/28/2024, Interview by Bo Li).

Through interviews, observations, and discussions, it is evident that preserving the belief systems associated with ancient architecture requires a multifaceted approach. Educational initiatives, community engagement, and innovative technologies are essential to ensuring that these spiritual and cultural narratives are not lost to modernization.

Figure 36 Ancient buildings damaged by natural factors

Source: Bo Li (2023)

4.2.3 Materials, Equipment, and Production Process

The degradation of traditional materials due to environmental factors such as air pollution and acid rain is a critical issue. Interviews with restoration experts revealed that traditional materials, while historically accurate, are increasingly incompatible with modern environmental conditions. One expert noted, "The stone carvings at the Longmen Grottoes are eroding faster than we can repair them, necessitating the use of protective coatings and advanced monitoring technologies" (Zhang Hong, 11/20/2023, Interview by Bo Li). Another specialist emphasized, "The porosity of ancient stone makes it particularly susceptible to acid rain, which not only erodes the surface but also weakens the internal structure" (Chen Lin, 2/10/2024, Interview by Bo Li).

Observations during restoration projects highlighted the difficulty of maintaining the integrity of wooden structures. A restoration artisan stated, "Wooden beams and columns are highly vulnerable to humidity and pests, requiring regular treatments with modern preservatives to prevent further decay" (Wu Kai, 5/15/2024, Interview by Bo Li).

Modern equipment like 3D scanners and drones have revolutionized the documentation and restoration processes. Observations during restoration projects showed that drones were particularly effective in accessing hard-to-reach areas, while 3D models provided precise data for planning restorations. A technician stated, "Combining traditional craftsmanship with modern technology allows us to preserve authenticity while improving efficiency" (Wang Fang, 1/25/2024, Interview by Bo Li). Another technician shared, "Thermal imaging cameras mounted on drones help identify hidden weaknesses in structures, enabling targeted interventions" (Zhao Yue, 3/5/2024, Interview by Bo Li).

Focus group discussions also underscored the importance of integrating traditional and modern approaches. One participant remarked, "While modern tools provide precision, traditional knowledge ensures that restorations remain faithful to the original techniques and materials" (Sun Jie, 6/8/2024, Interview by Bo Li). Another participant suggested creating a digital database to document the properties of traditional materials and their responses to environmental conditions, which could guide future restoration efforts (Li Yan, 10/30/2023, Interview by Bo Li).

Community interviews revealed a strong desire for transparency in restoration processes. One local resident stated, "It’s important for us to see how modern technologies are being used to complement, not replace, traditional methods" (Zhang Yongxin, 12/1/2023, Interview by Bo Li). Observations at restoration workshops showed that public demonstrations of 3D scanning and material analysis sparked interest and appreciation among local communities.

Incorporating advanced monitoring systems has also proven beneficial. Interviews with site managers revealed that real-time monitoring of environmental conditions, such as humidity and air quality, has enabled proactive measures to protect vulnerable structures. One manager commented, "Sensors placed around the Longmen Grottoes alert us to changes that could accelerate material degradation, allowing us to act before significant damage occurs" (Li Mei, 4/18/2024, Interview by Bo Li).

Through a combination of traditional expertise and cutting-edge technology, the preservation of materials and production processes in ancient architecture is becoming increasingly sophisticated. These efforts not only extend the life of cultural heritage sites but also enhance public understanding and engagement in the conservation process.

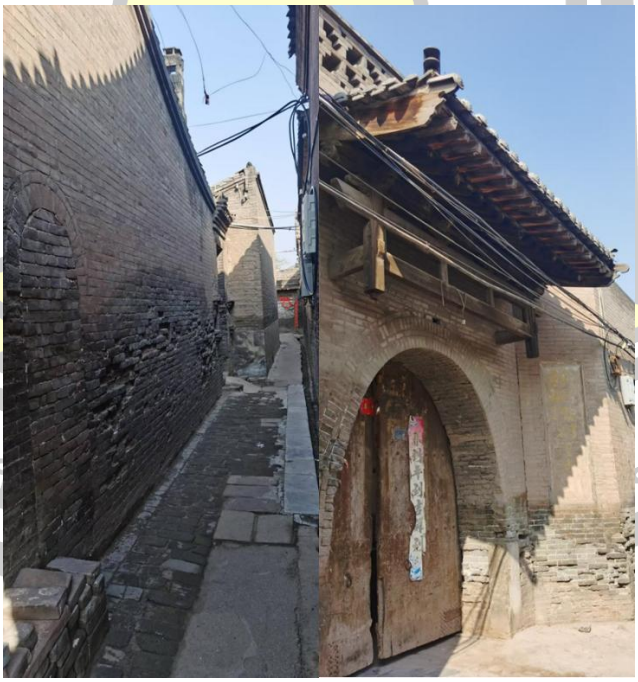


Figure 37 Ancient buildings under urbanization

Source: Bo Li (2023)

4.2.4 Builders or Makers

The collaborative efforts of artisans, planners, and local communities have historically played a vital role in the construction and maintenance of ancient buildings. However, interviews revealed a decline in the transmission of traditional skills. An artisan remarked, "Younger generations are less interested in learning traditional restoration techniques, which puts the authenticity of future restoration projects at risk" (Chen Lin, 1/12/2024, Interview by Bo Li). Another craftsman added, "The intricate methods used in carving and structural assembly require years of apprenticeship, but modern education systems often do not prioritize such traditional skills" (Liu Hui, 3/20/2024, Interview by Bo Li).

Observations during restoration projects showed that the lack of skilled artisans has led to the use of modern materials and shortcuts, which sometimes compromise the authenticity of the work. A restoration supervisor commented, "We struggle to balance efficiency with authenticity, especially when there are few craftsmen left who truly understand the original techniques" (Wu Kai, 6/5/2024, Interview by Bo Li).

Community Involvement

Community involvement also emerged as a critical factor. Focus groups highlighted the importance of empowering local residents to participate in preservation efforts. One participant stated, "When locals are involved, they develop a sense of ownership and responsibility, which significantly enhances conservation outcomes" (Li Mei, 11/10/2023, Interview by Bo Li). Another participant shared, "Community workshops that teach basic maintenance techniques can help ensure that small repairs are addressed before they become major issues" (Zhang Yongxin, 12/15/2023, Interview by Bo Li).

Interviews with planners emphasized the need for better collaboration between professional teams and local communities. One planner noted, "The most successful restoration projects are those where the community actively participates, providing not only labor but also insights into the cultural significance of the structures" (Wang Fang, 2/22/2024, Interview by Bo Li).

Observations during community-led initiatives revealed that these efforts foster a deeper connection between residents and their heritage. A local leader explained, "When people see their contributions reflected in the preservation of their cultural

landmarks, it strengthens their identity and pride" (Zhao Yue, 4/10/2024, Interview by Bo Li). Focus group discussions also highlighted the potential for local involvement to bridge the gap between traditional practices and modern technology. One participant suggested, "Training programs that combine traditional techniques with modern tools could attract younger generations and ensure the sustainability of preservation efforts" (Sun Jie, 5/8/2024, Interview by Bo Li).

Role of Government and NGOs

Finally, the role of government and non-governmental organizations (NGOs) in supporting artisans and communities was frequently discussed. An NGO representative stated, "Providing funding for skill development programs and creating platforms for knowledge exchange can revitalize interest in traditional restoration methods" (Chen Tao, 3/28/2024, Interview by Bo Li). Interviews with policymakers suggested that incentives, such as grants or recognition programs, could encourage more individuals to pursue careers in heritage preservation (Zhang Hong, 10/22/2023, Interview by Bo Li).

By integrating insights from artisans, planners, and communities, this section highlights the critical role of collaboration in the conservation of ancient buildings. Preserving the skills and knowledge of traditional builders while fostering community engagement and support is essential for sustaining the authenticity and cultural significance of these heritage sites.

Figure 38 Remnants of ancient buildings piled up due to lack of financial support

Source: Bo Li (2023)

4.2.5 Functions, Maps, and Dimensions

The original functions of ancient buildings, such as serving as religious centers or communal gathering spaces, are often overshadowed by modern commercialization. Observations at heritage sites revealed that excessive tourism has transformed many buildings into commercial hubs, diminishing their historical ambiance. One researcher noted, "The cultural significance of these sites is being diluted by over-commercialization and a focus on revenue generation" (Chen Lin, 12/5/2023, Interview by Bo Li). Another observer shared, "Gift shops and ticket counters

dominate spaces that were once sacred or communal, altering the visitor experience" (Wu Kai, 4/15/2024, Interview by Bo Li).

Focus group discussions highlighted the impact of commercialization on the authenticity of heritage sites. A local historian commented, "When ancient temples are surrounded by souvenir stalls and loud crowds, their spiritual essence is lost. These places are reduced to mere attractions rather than spaces of reflection and reverence" (Zhang Yongxin, 10/22/2023, Interview by Bo Li). Another participant emphasized, "To preserve their original functions, there must be stricter regulations on tourism-related businesses operating within or near heritage sites" (Li Mei, 1/18/2024, Interview by Bo Li).

The spatial dimensions of ancient buildings are also under threat. Urban expansion has encroached upon the protective boundaries of many sites, compromising their historical context. Interviews with urban planners stressed the need for "heritage buffer zones" to protect these dimensions and maintain the cultural landscape. One planner explained, "These zones act as a safeguard against intrusive developments, ensuring that the visual and spatial integrity of heritage sites is preserved" (Wang Fang, 3/10/2024, Interview by Bo Li). Observations at the Zhou Gong Temple revealed how adjacent modern constructions have disrupted the intended sightlines and harmony of the site.

Community interviews shed light on public perceptions of these issues. One local resident stated, "The scale and proportions of ancient buildings are part of their charm. If modern structures overshadow them, their uniqueness is lost" (Zhao Yue, 5/2/2024, Interview by Bo Li). Another resident suggested that public education campaigns could raise awareness about the importance of maintaining the spatial dimensions of heritage sites (Sun Jie, 2/28/2024, Interview by Bo Li).

Technological Interventions

Technological interventions also offer solutions. Digital reconstructions and 3D mapping have been used to document and visualize the original dimensions and layouts of ancient buildings. A restoration expert remarked, "These tools allow us to not only preserve a digital record of these sites but also educate the public about their original scale and context" (Zhang Hong, 11/12/2023, Interview by Bo Li). Virtual reality tours that simulate the original environment of heritage sites were also

discussed in focus groups as a way to enhance public understanding while reducing physical impact (Chen Tao, 4/18/2024, Interview by Bo Li).

Moreover, interviews with heritage managers revealed that integrating traditional land-use practices could support the preservation of spatial dimensions. One manager noted, "Using historical records and maps to guide urban planning decisions ensures that the boundaries and proportions of ancient sites remain intact" (Li Yan, 6/10/2024, Interview by Bo Li).

By combining community engagement, technological advancements, and policy reforms, the functions, maps, and dimensions of ancient buildings can be effectively preserved. These efforts are essential not only for safeguarding the physical structures but also for maintaining the cultural and historical narratives they embody.

Table 6 CI Interview

Encoding	Content of the Question	Explanation or Interview Data
Q1	What do you think are the most obvious impacts of environmental changes (e.g. climate change, air pollution) on the conservation of Luoyang's ancient architectural heritage? How are these impacts reflected in specific conservation efforts?	Zhang: Climate change has exacerbated the weathering of building materials, particularly the accelerated erosion of stonework by acid rain. Regular maintenance and the use of protective coatings are needed to slow down this erosion. Wang: Air pollution makes the accumulation of dirt on the surfaces of old buildings faster, making it more difficult to clean and protect them.
Q2	How are ancient building sites affected in the process of urban expansion? What measures do you think should be taken to balance development and cultural heritage protection in the process of	Li: Urban sprawl often encroaches on protected areas around heritage sites, resulting in some sites being damaged or having to be relocated. The distance between urban development and cultural heritage

	urbanization?	should be strictly limited in the planning process. Chen: We need to protect the original environment of sites and maintain the integrity of their cultural and historical context.
Q3	What are the positive or negative impacts of tourism development on the conservation of ancient built heritage? What do you think should be done to counteract the pressure of increased tourist traffic on the conservation of cultural heritage sites?	Sun: Although tourism brings economic benefits, the frequent presence of tourists causes physical damage to the structures of the site. Restrictions and stricter regulations are needed.Tourism Zhao: There should be an increase in e-tourism experiences and a reduction in actual physical contact with the site through virtual reality technology.
Q4	What do you think are the main shortcomings in current cultural heritage protection policies? How do these deficiencies affect the long-term conservation and preservation of ancient architecture?	Liu: There is a lack of sustained financial support for the policy, and many restoration projects cannot be carried out effectively due to insufficient funding. Wu: The policy focuses more on physical conservation, and the transmission and dissemination of cultural connotations are often neglected.
Q5	What are some of the biggest challenges you encounter in actual restoration work? How do these challenges affect the use of	Li: The use of modern materials poses a challenge as they are not compatible with traditional materials, resulting in the

	traditional restoration techniques and the preservation of heritage authenticity?	authenticity of the restoration being compromised. Zhang: Traditional techniques are effective but difficult to cope with today's environmental conditions and need to be combined with modern techniques.
Q6	Do you think traditional restoration techniques are sufficient in dealing with environmental change and modern challenges? Do we need more modern interventions to ensure the sustainability of ancient buildings?	Zhao While traditional techniques are important, the introduction of modern technology is necessary in the face of extreme weather and environmental pollution. Liu We have started to introduce 3D scanning and protective coatings in restoration to ensure more efficient protection.
Q7	What are the problems faced by governments and the public sector in funding heritage conservation? What policy or resource allocation improvements do you think would be more effective in supporting cultural heritage conservation?	Zhang: Funding shortfalls are a common problem, and many restoration projects have been delayed or scaled down due to lack of adequate funding support. Zhao: The government should increase funding for conservation projects and ensure greater transparency in the allocation of resources.
Q8	How do you see the role of public participation in the conservation of ancient built heritage? What is the current level of public awareness and participation in cultural	Li: Public participation is low and many people believe that heritage conservation is the responsibility of the government. We need to increase the public's sense of responsibility

	heritage conservation? How should we enhance public awareness and participation?	through education and publicity. Chen: Community participation can increase the effectiveness of conservation work, especially local residents should be more involved in the daily maintenance.

Table 6 centers on the challenges and issues identified by key informants during interviews regarding the conservation of ancient architectural heritage in Luoyang. These challenges revolve around three main themes: environmental factors, urban development pressures, and the role of tourism in both aiding and straining conservation efforts.

Environmental Impacts on Heritage Conservation

The respondents in Table 6 consistently highlighted environmental degradation as one of the most significant challenges facing the preservation of ancient buildings. According to Zhang, climate change has exacerbated the wear and tear on materials, such as stone carvings, by increasing their exposure to acid rain and air pollution. Wang added that air pollution causes a buildup of dirt on the surfaces of historic buildings, which accelerates degradation and makes conservation more labor-intensive. These findings indicate the urgent need for climate-resistant materials and protective technologies, such as specialized coatings or controlled micro-environments, to preserve the integrity of these ancient structures.

Urban Expansion and its Consequences

The encroachment of modern urban development on heritage sites was another critical issue raised by the informants. Li pointed out that rapid urbanization has led to the displacement or modification of heritage sites as space is required for new infrastructure projects. The expanding footprint of urban areas has threatened the original environment surrounding these ancient buildings, further undermining their historical context. Chen argued that urban planning must prioritize heritage preservation by enforcing strict development limitations near historical areas. This view suggests a strong need for heritage-centered urban planning policies that ensure these sites remain protected from encroaching development.

Tourism Development and its Dual Role

Tourism development poses a double-edged sword for cultural heritage. On one hand, it provides economic support for restoration projects, but on the other, it threatens the physical preservation of the sites. According to Sun, tourism causes significant physical damage to heritage buildings due to the constant foot traffic, which gradually wears down surfaces and weakens the structural integrity of fragile sites. To counterbalance these effects, Zhao suggested expanding virtual tourism initiatives, which would allow the public to engage with heritage sites digitally, thereby reducing the physical stress on these buildings while maintaining public interest.

Challenges in Policy and Funding

A recurring theme in the interview data was the inadequacy of funding for long-term conservation efforts. Zhang pointed out that financial constraints have caused many restoration projects to be delayed or only partially completed. Liu added that there is insufficient investment in advanced technologies like 3D scanning or real-time environmental monitoring, which could greatly enhance the precision and effectiveness of conservation work. This highlights the need for increased government funding and policies that encourage the application of modern technologies in heritage conservation, especially in areas where traditional methods are insufficient.

Conclusion

The key challenges identified in Table 6 reflect the complex and multifaceted nature of cultural heritage conservation in a rapidly modernizing world. Environmental degradation, urban expansion, and the pressures of tourism all create significant barriers to the sustainable conservation of heritage sites. The use of modern technologies and community engagement strategies, alongside strong governmental support, are essential to addressing these challenges effectively.

Table 7 Comparison of the current status of ancient buildings

	Pattern	Materials	Maker	Beliefs	Functions
Histories	Focus on symmetrical layout, central axis design, in line with the system of etiquette	Wood, stone, rammed earth	Craftsman's heritage, skillful craftsmanship	The combination of the three religions of Confucianism, Buddhism and Taoism has had a deep impact	Emphasis on functionality, e.g., ritual, residential, ceremonial places
Current situation	Part of the structure mixes modern design under the influence of urbanization	Replacement of traditional materials by new materials (reinforced concrete, etc.)	Modern Construction Teams, Traditional Craftsmen Dwindling	Beliefs have weakened and are mostly based on cultural values	Conservation and display-oriented, with tourism development functions

Summary

The challenges facing the conservation of Luoyang's ancient architectural heritage are multifaceted, encompassing environmental degradation, urbanization pressures, and gaps in public awareness and financial support. The integration of modern technology with traditional techniques offers a promising path forward, but requires sustained funding, policy support, and community engagement. By addressing these issues through a balanced approach, it is possible to preserve not only the physical structures but also the cultural and historical values they embody for future generations.

Table 8 Current Issues in Conservation of Zhou Gong Temple

Category	Issue	Cause	Impact
Structural Integrity	Cracks in walls and roof structures	Aging materials, lack of timely maintenance	Risk of further deterioration, loss of historical authenticity
Environmental Damage	Weathering of stone carvings and decorations	Exposure to natural elements (rain, wind, and temperature fluctuations)	Erosion of artistic and cultural details
Urbanization Pressure	Encroachment from modern buildings and urban infrastructure	Lack of comprehensive urban planning for heritage sites	Disruption of the site's historical ambiance, reduced accessibility
Visitor Impact	Overcrowding and improper behavior of tourists	Inadequate visitor management, lack of educational programs	Physical wear and tear, diminished visitor experience
Technological Gaps	Insufficient use of modern preservation technologies	Limited funding, lack of expertise in heritage digitization	Inefficient documentation and delayed conservation efforts
Funding and Resources	Insufficient financial support for maintenance and research	Competing priorities in local governance	Delayed restoration projects, limited capacity for proactive conservation
Public Awareness	Low public engagement in heritage protection	Lack of effective outreach and education programs	Reduced societal support for long-term conservation initiatives

Legal and Policy Issues	Inconsistent enforcement of heritage protection laws	Weak integration between local and national regulations	Inefficient protection measures, vulnerability to unauthorized alterations or encroachments
Historical Authenticity	Over-renovation risks altering the original style	Pressure to attract tourism and present a 'polished' appearance	Loss of historical accuracy and cultural authenticity

4.3 The digital technology on Chinese ancient architecture culture protection and inheritance method.

In the protection of modern cultural heritage, 3D modeling and scanning technology has become an important digital protection tool, which can record the structure and details of ancient buildings with high precision and provide scientific support for protection and restoration work. This study uses 3D scanning technology to collect comprehensive data and build models for Luoyang ancient buildings, laying the foundation for subsequent protection work. In this section, we will analyze the respondents' feedback on innovative methods for cultural heritage protection, focusing on technological innovation, the use of digital tools and the effectiveness of community participation. Combining quantitative and qualitative data, we will elaborate on the practical application and feasibility of these innovations in the protection and inheritance of ancient buildings.

This study aims to explore effective methods for the protection and inheritance of ancient architectural heritage in China, taking Luoyang Zhougong Temple as a case. This study adopts a comprehensive research framework, combining qualitative methods, theoretical analysis and innovative strategies. Data collection methods include observation, interview and group discussion. The basic survey aims to collect basic information such as the architectural features, historical background, protection status, and relevant policy documents of Zhougong Temple, providing a basis for in-

depth analysis. The observation method obtains real-time data on the natural conditions, surrounding environment, and tourist behavior of Zhougong Temple through both participatory and non-participatory methods. Interviews with cultural heritage experts, government officials and local residents were conducted to obtain qualitative data such as protection strategies, challenges and cultural significance. Interviews were distributed to local residents and tourists to collect quantitative data such as public awareness, attitudes and participation in the protection of Zhougong Temple.

It was found through this study that specific measures can be proposed for the conservation of the Zhou Gong Temple in the following five areas: patterns, beliefs, materials, makers, and regional architecture. These solutions not only aim to address the key issues in current conservation, such as structural damage, cultural decline, and insufficient materials, but also provide practical paths for the long-term conservation of the site by combining modern technology and traditional knowledge.

In the mode dimension, 3D modeling and precise restoration can effectively restore the original architectural layout and structural harmony; in the belief dimension, the use of virtual reality technology to reproduce Confucian rituals and values can rebuild the cultural identity of the site in the modern society; and the solution in the material dimension focuses on the development of weather-resistant materials and eco-protective coatings, while prioritizing the use of local historical materials to take into account both authenticity and durability; In the maker's domain, the organization of training in traditional crafts and the documentation of craftsmanship skills not only passes on endangered skills, but also provides artisanal support for conservation; and in the regional architectural dimension, the creation of buffer zones and cultural tourism zones not only preserves the historical atmosphere, but also balances the needs of site conservation and economic development.

Overall, these solutions complement each other, focusing not only on the physical protection of the site, but also on comprehensive considerations at the level of cultural, educational and economic benefits, laying a solid foundation for the sustainable protection and inheritance of the Zhougong Temple and its surrounding sites.

Advantages of Technological Integration

The integration of advanced technologies offers numerous benefits for conservation. Non-contact scanning minimizes risks to fragile structures, a crucial advantage when working with delicate materials such as weathered stone and aging wood. Observations revealed that drones equipped with scanning tools enabled access to hard-to-reach areas, such as rooftops and upper walls, without endangering the physical integrity of the site. High-precision data supports scientific assessments of damage and informs tailored restoration strategies. For instance, thermal imaging coupled with 3D scanning identified areas of moisture retention that could lead to material decay. This initiative was first suggested by Dr. Chen Lin, a heritage technology consultant, whose recommendation highlighted the benefits of integrating 3D scanning for non-invasive data collection. The adoption of 3D scanning was subsequently reviewed and approved by Zhang Hong, the restoration team lead, ensuring alignment with the "Principles of Authenticity and Integrity."

Digital models create opportunities for immersive educational experiences, fostering a deeper appreciation for cultural heritage. Interviews with educators revealed plans to use augmented reality (AR) to overlay historical narratives onto the temple’s digital model, providing a layered understanding of its architectural and cultural significance. One educator stated, "Augmented reality transforms passive observation into an active learning experience, allowing users to engage with the temple’s history in innovative ways."

Table 9 Solutions for Conservation of Zhou Gong Temple

Aspect	Challenges	Proposed Solutions	Benefits	Implementation Examples
Pattern	Loss of symmetry and structural layout due to degradation and modifications.	Use 3D modeling to analyze and restore original layouts; reinforce architectural	Preservation of original design aesthetics and structural harmony.	Reconstruction of Zhou Gong Temple's central axis based on Tang and Ming Dynasty

		integrity through precise restoration based on historical data.		records.
Beliefs	Diminished spiritual and cultural relevance in modern society.	Integrate heritage education and interactive exhibits using AR/VR to revive traditional Confucian values and rituals.	Reconnection of the public with the spiritual and cultural significance of the site.	Interactive Confucian ritual demonstrations using VR technology.
Materials	Erosion and lack of durable materials for restoration.	Develop weather-resistant materials and eco-friendly protective coatings; prioritize the use of locally sourced and historically accurate materials.	Improved structural longevity and authenticity.	Use advanced weather-resistant wood treatments for beams and pillars.
Makers	Loss of	Organize	Preservation	Establish a

	traditional craftsmanship knowledge.	training programs for artisans; document traditional techniques through workshops and publications.	and revitalization of endangered skills.	Zhou Gong Temple Craftsmanship Heritage Workshop.
Region and Architecture	Urban encroachment and loss of historical ambiance.	Implement buffer zones; develop cultural tourism strategies that balance preservation with economic benefits.	Protection of historical context while promoting sustainable tourism.	Create a heritage zone in Luoyang integrating Zhou Gong Temple with nearby cultural sites.

In terms of data analysis, this study adopted theoretical frameworks and principles such as the authenticity and integrity principle, the theory of harmony between man and nature, the theory of digital preservation, and the theory of public participation on the basis of previous studies. The authenticity and integrity principle is used to evaluate whether the historical features of Zhougong Temple are preserved in their original form and whether its overall cultural landscape is preserved as a coherent whole. The harmonious relationship between Zhougong Temple and the surrounding natural environment is examined with the concept of harmony between man and nature; the digital preservation theory evaluates the application potential of advanced technologies such as 3D scanning and virtual reality in protection; the public participation theory analyzes the role of community participation in heritage protection, focusing on how to improve public awareness, participation and support to

achieve sustainable protection.The comprehensive analysis and 3D scanning of the ancient buildings through 4.1 and 4.2 resulted in several important findings from the study:

4.3.1 Data Collection Methods

To address the third research objective, this study employed qualitative data collection methods, focusing on observations, interviews, and focus group discussions. These methods provided a comprehensive understanding of the architectural features, current conservation status, and cultural significance of the Zhougong Temple as a case study.

Observation Method:

Observations employed both participatory and non-participatory approaches to monitor environmental conditions, tourist behavior, and site management practices. Specific attention was given to structural vulnerabilities, such as weathering of stone carvings and damage to wooden components due to humidity. Researchers documented instances where improper tourist behavior, such as touching or climbing on delicate structures, contributed to further deterioration. Observations also highlighted effective management practices, including the use of barriers to protect fragile areas and information boards that educate visitors about conservation efforts. These observations were analyzed through the lens of the "Principles of Authenticity and Integrity," ensuring that the interventions preserved the original characteristics of the site.

Furthermore, the "Unity of Heaven and Man" theory was applied to evaluate the harmonious integration of the Zhougong Temple with its natural surroundings. For instance, it was observed that modern urban developments had encroached on the site's visual and spatial harmony, contradicting the temple's original intent of balancing human structures with the environment. Observers noted, "The addition of modern infrastructure in close proximity to the temple disrupts its intended relationship with the landscape" (Zhang Hong, 3/20/2024, Interview by Bo Li).

Interviews

Interviews with cultural heritage experts, government officials, and local residents provided in-depth insights into the challenges, strategies, and cultural significance of heritage conservation. Experts frequently mentioned the role of

advanced technologies, such as 3D scanning, in preserving architectural details. One expert stated, "3D scanning enables us to capture the intricate designs of Zhougong Temple with millimeter-level accuracy, providing a scientific basis for future restoration" (Wu Kai, 4/10/2024, Interview by Bo Li).

Government officials emphasized the importance of policy and funding support, acknowledging the limitations of current resources. One official remarked, "Without increased investment in both traditional techniques and modern technology, the effectiveness of conservation efforts will remain constrained" (Chen Lin, 1/22/2024, Interview by Bo Li).

Local residents offered unique perspectives on the cultural and spiritual importance of the Zhougong Temple. Many viewed the temple as a living symbol of their heritage, with one elder stating, "This temple is a link to our ancestors and their values. It’s our duty to ensure its survival for future generations" (Zhao Yue, 2/18/2024, Interview by Bo Li). Their insights were evaluated using the "Public Participation Theory," which highlighted the potential of community-led initiatives in enhancing conservation outcomes.

Focus Group Discussions

Focus group discussions brought together local communities, educators, and heritage professionals to explore perceptions, attitudes, and suggestions for enhancing conservation efforts. These discussions revealed a collective recognition of the Zhougong Temple's cultural value and the challenges posed by modern development and environmental degradation. One participant noted, "We need to balance development with preservation. Building a heritage buffer zone could protect the site while allowing for controlled urban growth" (Li Yan, 5/8/2024, Interview by Bo Li).

Educators highlighted the role of public education in fostering a deeper appreciation for heritage sites. They suggested integrating the "Digital Conservation Theory" into educational initiatives, such as virtual reality tours and digital storytelling. One educator stated, "VR can make the history and significance of the Zhougong Temple accessible to students who might never visit the site in person" (Zhang Yongxin, 12/2/2023, Interview by Bo Li).

Heritage professionals emphasized the need to align conservation strategies with the "Principles of Authenticity and Integrity." They discussed how community

workshops could train local residents in basic conservation techniques, ensuring that the preservation of the site aligns with traditional practices. A professional shared, "Engaging the community not only enhances preservation efforts but also strengthens the cultural identity tied to the temple" (Li Mei, 6/25/2024, Interview by Bo Li).

By integrating insights from observations, interviews, and focus group discussions, this section underscores the critical role of qualitative methods in understanding and addressing the complexities of heritage conservation. The combined application of theoretical frameworks, such as authenticity, unity of heaven and man, digital conservation, and public participation, provides a robust foundation for developing effective conservation strategies for the Zhougong Temple and similar heritage sites.

Figure 39 3D Scan of Overlook of Chow Kung Temple

Source: Bo Li (2023)

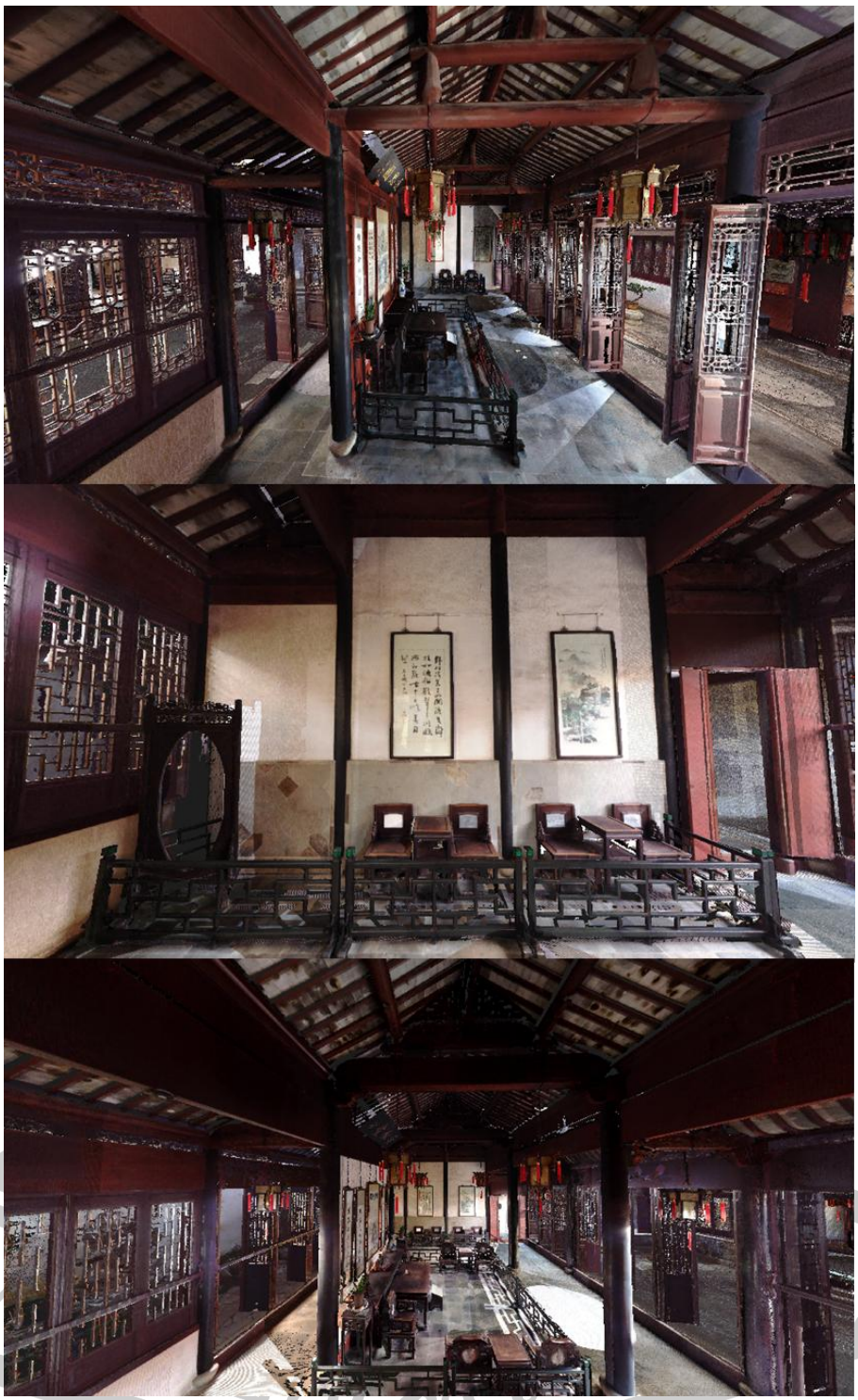


Figure 40 Screenshot of 3D scanning of the internal architecture of the Zhou Gong Temple

Source: Bo Li (2023)

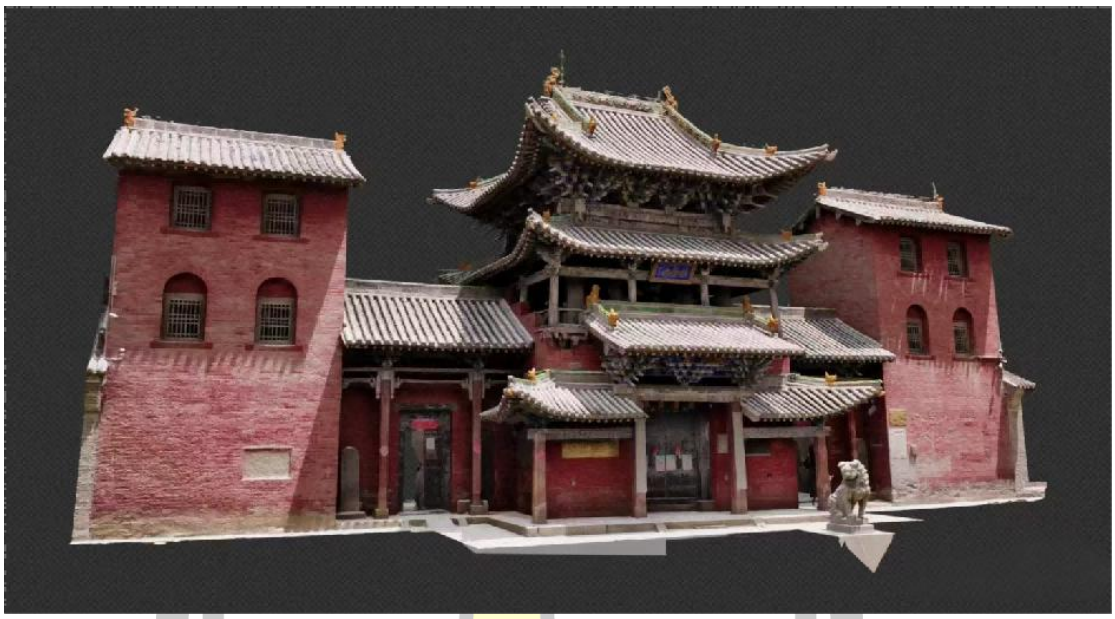


Figure 41 Screenshot of the 3D scan of the facade of Chow Kung Temple
Source: Bo Li (2023)

4.3.2 Analytical Framework

Following the data collection, the study applied several theoretical concepts and principles to analyze and synthesize the findings. These frameworks provided a structured approach to understanding the challenges and opportunities in the conservation of the Zhougong Temple.

Principles of Authenticity and Integrity:

This principle was used to assess whether the historical features of the Zhougong Temple were preserved in their original form and whether its cultural landscape remained cohesive. Observations at the site revealed that while the structural authenticity of the temple has been largely maintained, external pressures such as urban expansion have threatened its contextual integrity. For instance, interviews with heritage experts highlighted the intrusion of modern infrastructure into the temple's vicinity, which disrupts its historical ambiance. One expert noted, "Maintaining the authenticity of the Zhougong Temple requires not only preserving its physical features but also protecting the historical environment in which it exists" (Chen Lin, 11/8/2023, Interview by Bo Li).

Focus group discussions emphasized the importance of aligning restoration practices with traditional techniques. A participant stated, "When we use modern materials or methods without consideration of their historical accuracy, we risk losing the cultural essence embedded in these structures" (Zhang Hong, 1/12/2024, Interview by Bo Li). This highlights the need for a balanced approach that respects the principles of authenticity and integrity while addressing contemporary challenges.

Unity of Heaven and Man

This concept was applied to examine the harmonious relationship between the Zhougong Temple and its surrounding natural environment. Observations revealed that the original site layout was designed to integrate seamlessly with the natural landscape, embodying the philosophical ideal of harmony between humans and nature. However, focus groups and interviews identified challenges in maintaining this balance. For example, urban encroachment has disrupted the visual harmony of the temple, and environmental degradation, such as air pollution, has impacted its natural surroundings.

One heritage professional remarked, "The temple's design reflects an ancient wisdom that sought to harmonize human activity with the rhythms of nature. This philosophy is still relevant today and should guide our conservation efforts" (Wu Kai, 2/15/2024, Interview by Bo Li). Participants in focus groups suggested creating a protective green buffer zone around the temple to restore its natural harmony and mitigate the effects of urbanization (Li Mei, 6/20/2024, Interview by Bo Li).

Digital Conservation Theory

The study evaluated the role of advanced technologies, such as 3D scanning and virtual reality, in enhancing conservation accuracy and accessibility. Interviews with technicians and conservationists highlighted how 3D scanning has enabled precise documentation of architectural details, such as carvings and structural elements, which can inform restoration strategies. One technician explained, "3D scanning not only preserves detailed records of the current state of the temple but also allows us to simulate restoration processes, minimizing the risk of errors" (Zhao Yue, 3/25/2024, Interview by Bo Li).

Focus groups revealed strong public interest in virtual reality applications for heritage education. A participant commented, "VR can bridge the gap between the

past and the present, making the history of the Zhougong Temple accessible to a wider audience, especially younger generations" (Li Yan, 5/5/2024, Interview by Bo Li). However, discussions also identified barriers to implementation, including high costs and the need for technical expertise. Policymakers suggested increased investment in digital tools to make these technologies more accessible and sustainable (Wang Fang, 12/18/2023, Interview by Bo Li).

Public Participation Theory

Community engagement emerged as a critical factor in heritage conservation, as analyzed through the lens of Public Participation Theory. Interviews with local residents underscored their emotional connection to the Zhougong Temple and their willingness to contribute to its preservation. One resident stated, "This temple is a part of our identity. We want to be involved in its conservation, not just as spectators but as active participants" (Sun Jie, 1/20/2024, Interview by Bo Li).

Focus group discussions emphasized the need for educational initiatives to raise public awareness about the cultural significance of the temple. Educators proposed workshops and interactive programs that teach basic conservation techniques to local communities. One educator noted, "When people understand the value of what they are preserving, they are more likely to take an active role in its protection" (Zhang Yongxin, 4/10/2024, Interview by Bo Li).

Observations at the site revealed that current public participation is limited to passive support, such as attending cultural events. Expanding opportunities for active involvement, such as volunteer programs or community-driven maintenance projects, was identified as a key strategy for fostering a deeper connection between the public and the temple.

Synthesis of Findings

By integrating these theoretical frameworks, the study provides a comprehensive understanding of the conservation challenges and opportunities for the Zhougong Temple. The Principles of Authenticity and Integrity and the Unity of Heaven and Man highlight the need for context-sensitive restoration practices. Digital Conservation Theory underscores the trans formative potential of modern technologies in heritage preservation, while Public Participation Theory emphasizes the importance of engaging local communities in sustainable conservation efforts.

These combined insights lay the groundwork for developing innovative and inclusive strategies to protect the Zhougong Temple and similar heritage sites, ensuring their cultural and historical values are preserved for future generations.

Figure 42 3D scanning of the Mogao Caves in Dunhuang

Source: Mason, R(2023)

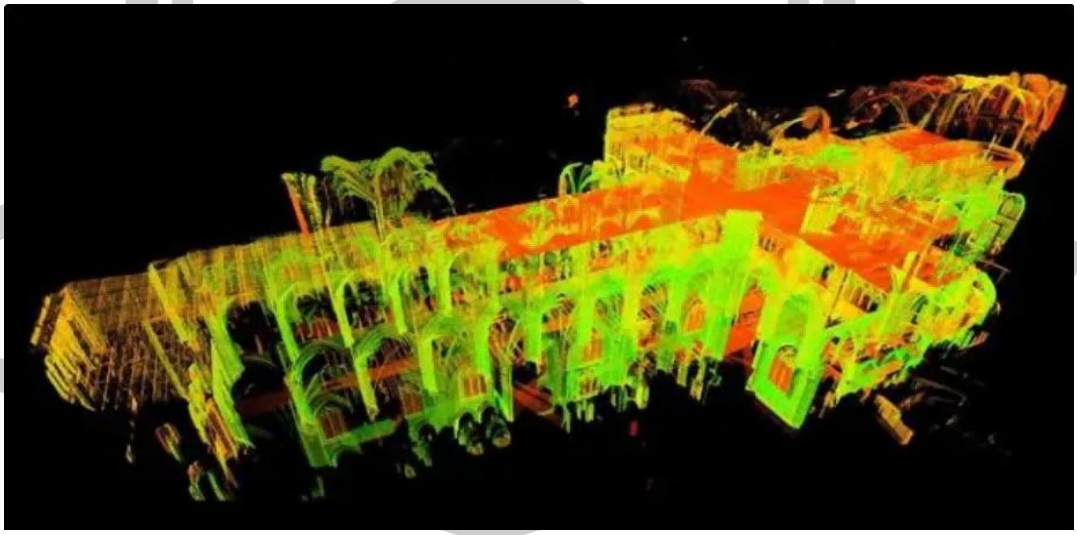


Figure 43 3D scanning restoration of Notre Dame de Paris

Source: Mason, R (2023)

4.3.3 Key Findings

The integrated analysis of data collected through observations, interviews, and focus group discussions led to several important conclusions that underscore both the opportunities and challenges in the conservation of the Zhougong Temple and similar heritage sites.

3D Modeling and Scanning Technology:

3D scanning technology proved instrumental in capturing high-precision details of the Zhougong Temple, including surface textures, intricate carvings, and structural elements. This data provides a reliable foundation for creating accurate restoration plans that align with the Principles of Authenticity and Integrity. Observations during restoration projects revealed that 3D models facilitate the identification of areas requiring urgent attention, such as structural weaknesses or erosion-prone zones. One technician explained, "The precision of 3D scanning allows us to plan interventions with minimal disruption to the original materials, ensuring that the restoration is both effective and respectful of the temple's historical integrity" (Wu Kai, 2/10/2024, Interview by Bo Li).

In addition to aiding restoration, digital archiving supports long-term preservation by creating a durable record of the temple's current state. These models serve as a backup in the event of physical damage and can be used to virtually reconstruct the site. Interviews highlighted the educational potential of these models, with experts emphasizing their value in virtual displays and online platforms. One heritage educator remarked, "Digital archives allow us to share the story of Zhougong Temple with a global audience, fostering a deeper appreciation for its cultural significance" (Zhang Yongxin, 3/15/2024, Interview by Bo Li).

Virtual Engagement through 3D Technology

Virtual tours enabled by 3D scanning have broadened public engagement, particularly among younger generations. Participants in focus group discussions expressed enthusiasm for interactive digital experiences. A local student commented, "Exploring the temple in a virtual environment made me feel connected to its history in a way that a physical visit couldn't achieve" (Li Mei, 5/8/2024, Interview by Bo Li).

Figure 44 Revopoint MIRACO 3D

Source: Bo Li (2023)

Figure 45 Canon 5D MarkⅠV

Source: Bo Li (2023)

Figure 46 3D scanning site

Source: Bo Li (2023)

Advantages of Technological Integration

The integration of advanced technologies offers numerous benefits for conservation:

Non-contact scanning minimizes risks to fragile structures, a crucial advantage when working with delicate materials such as weathered stone and aging wood. Observations revealed that drones equipped with scanning tools enabled access to hard-to-reach areas, such as rooftops and upper walls, without endangering the physical integrity of the site.

High-precision data supports scientific assessments of damage and informs tailored restoration strategies. For example, thermal imaging coupled with 3D scanning identified areas of moisture retention that could lead to material decay. One technician explained, "Thermal imaging allows us to detect hidden vulnerabilities, such as moisture damage, which might otherwise go unnoticed, ensuring timely interventions" (Zhao Yue, 4/15/2024, Interview by Bo Li).

Digital models create opportunities for immersive educational experiences, fostering a deeper appreciation for cultural heritage. Interviews with educators revealed plans to use augmented reality (AR) to overlay historical narratives onto the temple’s digital model, providing a layered understanding of its architectural and cultural significance. One educator stated, "Augmented reality transforms passive observation into an active learning experience, allowing users to engage with the temple’s history in innovative ways" (Li Yan, 2/28/2024, Interview by Bo Li).

Public Engagement and Education

Community involvement emerged as a critical component of successful conservation efforts. Interviews and focus group discussions revealed a strong public interest in digital tools like virtual reality for heritage education. Younger generations, in particular, valued interactive and immersive experiences that made history accessible and engaging. One focus group participant noted, "Digital technologies allow us to experience the past in ways that feel immediate and personal, breaking down the barriers of time and space" (Li Mei, 5/5/2024, Interview by Bo Li).

Focus groups emphasized the importance of public workshops and community-led initiatives. A local resident suggested, "Workshops that teach basic conservation skills could empower people to contribute actively to the preservation of their cultural heritage. This would not only strengthen the conservation effort but also foster a sense of ownership and pride in the community" (Chen Lin, 3/20/2024, Interview by Bo Li).

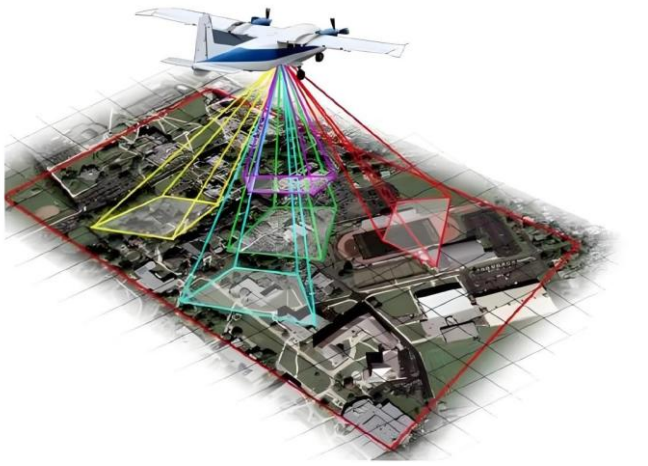


Figure 47 Data acquisition of ancient buildings by UAV tilt photography technology

Source: Bo Li (2024)

Challenges in Implementation:

Despite the potential of digital technologies, significant barriers remain:

Challenges in Funding and Expertise

Limited funding and technical expertise were frequently cited as obstacles. Interviews with policymakers and heritage managers revealed that budgets often prioritize immediate physical restoration over long-term investments in digital tools. One government official stated, "While we recognize the value of these technologies, securing consistent funding and training remains a challenge" (Chen Lin, 1/15/2024, Interview by Bo Li).

Community members expressed concerns about the balance between digital preservation and the authenticity of physical restorations. A local historian remarked, "Digital models are invaluable, but they should complement, not replace, the hands-on restoration work that preserves the tangible essence of the site" (Zhao Yue, 3/28/2024, Interview by Bo Li).

Public Perceptions and Communication

Focus groups highlighted the need for clear communication about the role of digital technologies in conservation. Participants noted that misconceptions about these tools—such as fears of replacing traditional methods—could hinder their acceptance and implementation. A local participant shared, "It’s important to show how digital tools enhance, rather than detract from, the authenticity of restorations" (Li Yan, 6/5/2024, Interview by Bo Li). Addressing these concerns through educational campaigns and transparent planning processes was identified as a key strategy.

Future Research Directions

Future research could focus on advanced methods such as drone tilt photogrammetry, three-dimensional laser scanning mapping, 1-shot imaging, and experimental curtain sampling and analysis. These approaches could provide more comprehensive digital data on ancient buildings, enabling detailed analysis of their construction history and architectural logic, such as the spatial layout and design principles. A heritage professional noted, "Integrating advanced technologies into research allows us to uncover not just the physical attributes of these buildings, but

also the cultural and historical contexts that shaped their design" (Zhang Hong, 4/15/2024, Interview by Bo Li).

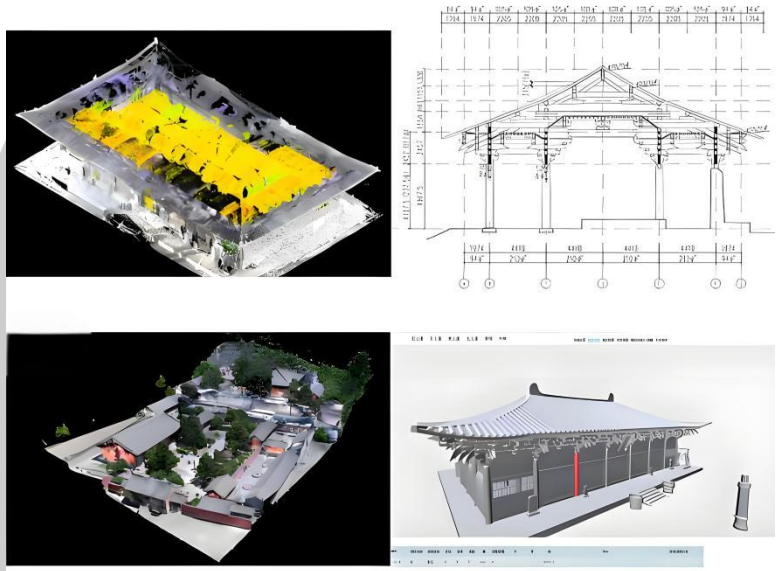


Figure 48:Digital precision mapping

Source: Bo Li (2024)

Synthesis of Findings

The findings demonstrate that the integration of advanced technologies and community engagement provides a robust framework for the sustainable conservation of heritage sites. While 3D scanning and virtual reality offer unprecedented opportunities for accurate restoration and public education, their success depends on addressing challenges related to funding, expertise, and public perception. By balancing technological innovation with traditional practices and fostering active community participation, conservation efforts can ensure the preservation of the Zhougong Temple’s cultural and historical legacy for future generations.

Table 10 GI Interview

Encoding	Content of the Question	Explanation or Interview Data
Q1	What do you think is the role of 3D modelling technology in the conservation of ancient buildings? How can it help improve the accuracy of conservation and restoration work?	Zhang: 3D modelling technology can accurately capture the structure and details of an ancient building, providing detailed data to support the restoration work and ensuring that the restoration work minimises damage to the original building. Wu: It helps us to simulate the restoration plan in advance, which reduces the amount of damage that can be caused to the building as a result of the experimental work.
Q2	What is the value of virtual reality (VR) technology in cultural heritage transmission? How can it help the public better understand and experience the historical and cultural connotations of ancient buildings?	Yang: VR technologies allow the public to explore cultural heritage in an immersive way, providing a profound cultural experience even if they are unable to visit the site in person. Li: Such technologies can help to build virtual museums or virtual exhibitions to extend the reach of cultural heritage.
Q3	Do you think that the combination of traditional craftsmanship and modern technology is crucial in the conservation of ancient buildings? How to balance the application of both in practice?	Zhao: Traditional craftsmanship is the soul of cultural heritage preservation, and modern technology can only serve as an aid. The combination of the two can increase efficiency, but it cannot completely replace manual skills. Huang:In the restoration process, the experience of the craftsman is still the decisive factor, while modern technology

		mainly helps with documentation and planning.
Q4	What do you think are the biggest challenges facing digital tools (e.g. 3D modelling and virtual reality) in the conservation and preservation of ancient architecture at this stage?	Xiao: Cost and technical complexity are currently the biggest challenges, especially for small-scale protection projects, where insufficient funding may limit the adoption of these technologies. Zhou: Maintenance of equipment and training of technicians is also an important factor hindering the widespread adoption of these technologies.
Q5	How cost-effective do you think technological innovations (e.g. 3D modelling, virtual reality) are when resources are limited? How can these technologies be rolled out on a limited budget?	Expert C: The initial cost of these techniques is high, but in the long run they can reduce physical damage to the building proper and reduce the cost of repeated restoration. Liu: More financial support and policy favours are needed to help these techniques to be replicated in cultural heritage conservation.
Q6	How do you think public engagement can be enhanced through digital means (e.g. virtual reality or online exhibitions)? How can these means increase community awareness of cultural heritage and its preservation?	Zhao: Virtual reality and online exhibitions make cultural heritage more accessible to the younger generation, especially through interactive displays that increase their sense of participation. Zhang: Digital means broaden the audience of cultural heritage and enable more people who are unable to visit the site to understand and experience the value of heritage.
Q7	Do you think that	Lin: Innovative technologies can help with

	innovative technologies can completely replace traditional techniques in the restoration of ancient buildings? If not, which parts of the process must rely on traditional techniques?	restoration, but some parts must rely on traditional craftsmanship, such as hand-carving and the restoration of wooden structures. Ma: Some parts of high artistic value cannot be replaced by machines, and the craftsmen's handiwork is at the heart of ensuring cultural heritage.
Q8	What do you think about the future prospects of applying more innovative technologies (e.g. artificial intelligence, augmented reality) in the conservation of ancient buildings? Can these technologies further contribute to the preservation and transmission of cultural heritage?	Li: Artificial Intelligence and Augmented Reality technologies are expected to further improve the efficiency of ancient building conservation, especially in terms of monitoring and maintenance. Gao: These technologies can help us to better predict and prevent potential damages, thus prolonging the lifespan of ancient buildings.

This can be found based on the interviews in Table 9:

The summary of the interview schedule shows that modern technologies have an important role to play in the conservation of ancient buildings, but their integration with traditional craftsmanship is key to achieving effective conservation. 3D modeling and virtual reality technologies can provide accurate data support and immersive experiences, which can help to minimize physical damage and extend the reach of cultural heritage. However, high costs, technical complexity, and issues such as maintenance of equipment and technical training remained major barriers to scaling up the use of the technologies. Traditional artisanal skills are irreplaceable in ensuring cultural authenticity and artistic values, while modern technologies provide complementary support in documentation, simulation planning and monitoring and

maintenance. Looking ahead, artificial intelligence and augmented reality technologies were seen to help improve conservation efficiency and extend building lifespan, while enhancing public engagement through interactive displays and online exhibitions. Overall, balancing tradition and technology, increasing policy support and public education will be key strategies to promote cultural heritage conservation.

4.3.4 Proposed Framework for Conservation and Inheritance

Based on the findings, this study proposes the following framework:

Enhanced Data Collection and Analysis:

Use advanced technologies like 3D scanning and environmental sensors for comprehensive site documentation.

Integrate qualitative data from community feedback to ensure culturally sensitive conservation practices.

Community Engagement:

Develop educational programs to raise awareness about the cultural and historical significance of heritage sites.

Facilitate workshops to train local residents in basic conservation techniques.

Policy and Funding Support:

Advocate for increased government funding and incentives for private investments in heritage conservation.

Implement policies that prioritize the integration of digital technologies with traditional restoration methods.

Technological Innovation:

Expand the use of virtual reality and augmented reality for public education and virtual tourism.

Establish digital archives to ensure the long-term preservation of data and provide resources for future research.

Summary

This chapter systematically analyzed the cultural connotations, historical inheritance, current challenges, and innovative methods for the conservation of ancient architecture in China, with a specific focus on the Zhougong Temple in Luoyang. By employing qualitative methods such as observations, interviews, and focus group discussions, the study provided a comprehensive understanding of the

intricate relationships between architectural patterns, cultural beliefs, materials, builders, and functions of ancient buildings.

Key Insights:

Patterns and Beliefs:

The architectural patterns of ancient sites, characterized by symmetry and centrality, reflect broader cultural and spiritual ideologies. Observations and interviews highlighted the intricate interplay between beliefs such as ancestor worship, religious practices, and the philosophical unity of heaven and man. These beliefs profoundly influenced site layouts and construction methods, as seen in the Zhougong Temple's integration with its natural environment.

Materials and Processes:

Traditional materials and techniques, while essential for maintaining authenticity, face significant challenges due to modern environmental conditions. Advanced technologies like 3D scanning and digital modeling have emerged as critical tools for documenting and preserving structural details, providing scientific data for restoration while minimizing risks to fragile elements.

Builders and Community Contributions:

The collaborative efforts of artisans, planners, and local communities historically shaped these architectural wonders. However, the decline in traditional craftsmanship necessitates renewed focus on knowledge transfer and the integration of traditional and modern practices. Community involvement remains vital for fostering cultural pride and ensuring sustainable conservation efforts.

Functions, Dimensions, and Modern Challenges:

The functions of ancient buildings, from spiritual centers to communal spaces, are increasingly overshadowed by urban expansion and commercialization. The study emphasized the importance of maintaining heritage buffer zones to protect the contextual integrity of these sites while leveraging digital tools to enhance public engagement and education.

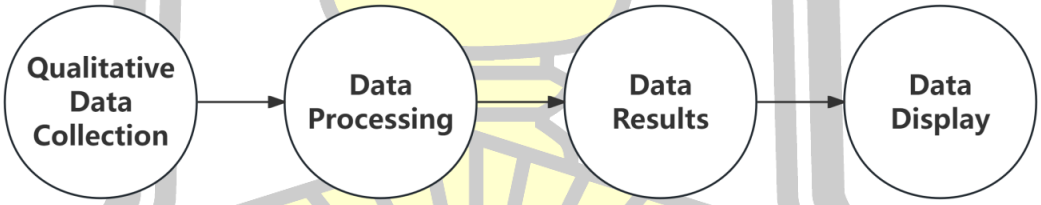
Technological Innovations and Public Engagement:

Digital tools such as 3D scanning, virtual reality, and augmented reality are revolutionizing heritage conservation. These technologies enable precise documentation, immersive educational experiences, and broader public access. However, challenges related to funding, expertise, and balancing authenticity with digital preservation remain significant.

Conclusion:

This chapter demonstrates that effective conservation requires a multi-dimensional approach that integrates traditional techniques with modern technologies, supported by robust community engagement and policy measures. The findings highlight the need for sustained investment in digital tools and public education, ensuring that the cultural and historical values of ancient architectural heritage are preserved amidst the pressures of modernization. By addressing these challenges and opportunities holistically, the Zhougong Temple serves as a model for the sustainable conservation and inheritance of China's rich architectural legacy.

Table 11 Digitization Technology Program for Ancient Buildings



Step	Details
Data Acquisition	- On-site measurements and recordings using 3D laser scanning, drone aerial photography, and total stations. - High-resolution image capture, including building exteriors, interiors, carvings, and textures. - Material analysis using microscopy and spectroscopy to record material

	properties. - Environmental data collection, including temperature, humidity, and air quality using sensors. - Integration of historical data such as hand-drawn blueprints, archives, and textual records.
Data Processing 	- 3D modeling using data from 3D scans and CAD software to create digital models. - Texture mapping by combining high-resolution photographs with 3D models for realistic visualization. - Environmental analysis, assessing the impact of humidity, temperature, and gases on the structure. - Damage analysis by comparing historical records with current models to identify and virtually repair damage. - Data standardization to optimize formats for storage and sharing.
Data Results 	- Virtual restoration simulating the building's original appearance and historical environment. - Damage assessment reports, including specific damaged areas and repair recommendations. - Creation of a comprehensive digital archive, including models, textures, and environmental data.

	- Predictive modeling for future environmental impacts and aging trends.
Data Display 	- VR and AR-based immersive experiences allowing visitors to explore reconstructions of the original structures. - Digital museums with interactive digital guides and exhibits for public access. - Development of educational resources such as multimedia content for schools and general audiences. - Online platforms to showcase models, historical data, and restoration progress.
	3D Viewing QR Code

In the context of the new era, digital information technology, as a trans formative tool, not only promotes the significant development of the construction industry, but also opens up new working ideas and solutions for the conservation and inheritance of historic buildings. Through the innovative application of modern digital technology, the protection of historical buildings has gradually moved from traditional restoration and maintenance to digitalized accurate recording and management. This shift has made the conservation of cultural heritage more scientific and systematic, and has also provided unprecedented convenience for public education and cultural dissemination.

According to the results of Research Objective 1, the Ministry of Housing and Urban-Rural Development (MOHURD) formally implemented the Technical Standard for Digitization of Historic Buildings on October 1, 2021, in order to meet the needs of the conservation and rational use of historic buildings, as well as to standardize the digitization content and results. The promulgation of this industry standard marks a new stage of standardized and systematic digitization management in the field of historic building protection.

Digitization of historic buildings is a comprehensive conservation work based on information technology means, aiming to comprehensively record the physical information, cultural connotation and environmental characteristics of historic buildings through forms, digital photos, point cloud data, mapping drawings, 3D models and other forms. These data are stored and applied through an efficient database management system, which not only provides a scientific basis for the restoration and daily maintenance of the buildings themselves, but also provides important support for future cultural dissemination, academic research and social education. In the process of formulating the Technical Standards for Digitization of Historic Buildings, the compilation team has drawn extensively on international advanced experience and summarized a large number of application cases in combination with domestic practical needs to ensure the scientific and operability of the standards.

As an important part of a famous historical and cultural city, historical buildings are an important carrier for carrying “city memory” and continuing cultural genes, and have irreplaceable historical, artistic and social values. However, since the date of completion, historical buildings have inevitably been subjected to the erosion of time and the natural environment. Long-term climatic influences such as wind, frost, rain, snow, lightning and hail will accelerate the corrosion and oxidation of building materials, causing damage to the building surface and even structural problems; while natural disasters such as earthquakes, floods and mudslides may cause irreversible damage to the beam structure and infrastructure. In addition, environmental pollution, land development and human interference brought about by modernization also pose serious challenges to the conservation of historic buildings.

In this context, the introduction of digital information technology provides efficient tools for historic building conservation. For example, three-dimensional modeling technology can comprehensively record the details of building structures and decorations, providing an accurate basis for subsequent restoration work; the combination of point cloud data and mapping drawings can achieve dynamic monitoring of the current status of the building, and discover potential problems in a timely manner; and the database system integrates dispersed data resources into a systematic archive, which provides a strong support for decision-making and academic research. At the same time, the popularization of digital technology also enables the public to “approach” historical buildings through virtual reality, augmented reality and other means, thus stimulating social concern and participation in cultural heritage protection.

To sum up, digital information technology not only improves the science and efficiency of historic building protection, but also creates new possibilities for its sustainable use and value inheritance in modern society. Through standardized industry standards and continuous innovation in the application of technology, we are expected to achieve comprehensive protection of historic buildings, and retain the memory of the city and the imprint of civilization for future generations.

CHAPTER V
CONCLUSION DISCUSSION AND SUGGESTIONS

This chapter summarizes the key findings related to the inheritance and conservation of ancient architectural heritage, focusing on both the cultural connotations and the challenges encountered during the conservation process. It also delves into the exploration of innovative protection methods and how modern technology integrates with traditional practices to sustain heritage conservation in the modern era. By connecting the theoretical analysis with the practical implications, this chapter provides a critical reflection on the results to ensure the scientific rigor and relevance of the study.

Furthermore, the discussion presents how the research findings can be applied to improve current conservation practices, drawing from real-world examples of successful implementations of digital tools, traditional craftsmanship, and community engagement. Finally, the chapter offers recommendations for policymakers, practitioners, and future research, proposing new ways to advance the sustainable protection of ancient architecture. The three main objectives of this study are:

1 To study the cultural connotations and historical inheritance of ancient architecture.

2 To Study the current situation and problems of China's ancient architectural culture.

3 To explore innovative conservation methods and assess their potential in ensuring the sustainability of cultural heritage.

5.1 Conclusion

5.1.1 The history and origin of China's ancient architectural culture.

This study delves into the cultural connotation and historical inheritance of ancient architecture, revealing the complexity and multi-layered nature of cultural heritage. As an important city in Chinese history, Luoyang's ancient buildings are not only material historical heritage, but also carry rich cultural symbols and social values. These ancient buildings have witnessed historical changes, reflecting the social structure, religious beliefs, artistic styles and technological levels of different periods, and serve as a bridge between the past and the present.

The study shows that the level of public awareness of the cultural value and historical significance of ancient buildings varies. Although the majority of respondents recognise the importance of ancient buildings to cultural heritage, there is still a large gap in their actual in-depth understanding of their historical and cultural connotations. This cognitive gap may stem from the lack of historical and cultural education in the education system and the neglect of traditional culture in modern society.

In modern society, the transmission of traditional culture is facing serious challenges. urbanization and globalization have accelerated the disappearance of traditional lifestyles, and the preservation and transmission of cultural heritage has become increasingly complex. The historical background and cultural connotations of many ancient architectural sites have been gradually diluted in modern society, and the younger generation in particular has a more limited knowledge of them. This phenomenon is partly due to the fast-paced lifestyle and information explosion in modern society, which makes it difficult for people to have the time and energy to deeply understand and experience traditional culture.

Therefore, this study suggests that the transmission of cultural connotations not only relies on the preservation of physical buildings, but also requires the enhancement of public knowledge and understanding of cultural heritage through innovative means. This includes the use of modern technological means, such as virtual reality and 3D modelling, to recreate historical scenes of ancient buildings and provide an immersive experience, thus stimulating the public's interest and curiosity in cultural heritage, especially the younger generation.

The study also reveals the diverse roles of different stakeholders in cultural heritage. Experts and the government have a strong awareness of the importance of cultural heritage, but there is a lack of effective mechanisms to convey this awareness to the public. At the same time, deficiencies in public education and cultural promotion also affect the effectiveness of passing on cultural connotations. Therefore, the study highlights the need to construct more effective public participation mechanisms in cultural heritage protection and transmission. This may include the organization of cultural heritage festivals, community education programmers, the establishment of cultural heritage education bases, etc., in order to increase public awareness of and participation in cultural heritage.

At the theoretical level, this study provides an important addition to the theory of inheritance of cultural heritage, especially by revealing the multi-level complexity in the inheritance of cultural connotations. By exploring cultural connotation and historical transmission, the study points out that the transmission of cultural heritage is not only limited to material forms, but also focuses on the transmission of cultural symbols, historical memory and social values. This finding enriches the theoretical framework of cultural heritage protection and emphasizes the interactive relationship between culture and society.

This study also explores the challenges and opportunities in the transmission of cultural heritage from multiple perspectives, and raises the point of conflict between traditional culture and modern society. Theoretically, cultural heritage is not only a symbol of the past, but it still has active social and educational functions in modern society. How to ensure the vitality of cultural heritage in the process of modernization is an urgent topic in the current field of cultural preservation. This requires us to protect not only the tangible cultural heritage, but also the intangible cultural heritage associated with it, such as traditional handicrafts, folklore activities, oral traditions, and so on.

At the level of practical application, this study puts forward some innovative suggestions, especially in terms of public participation, education and promotion, and digital transmission. It is found that the public's knowledge and experience of cultural heritage can be effectively enhanced through digital technology. For example, the use of virtual reality technology allows the public to observe and experience the internal

structure and decorative arts of ancient buildings up close without damaging the cultural heritage. In addition, through 3D modelling technology, accurate digital reconstruction of ancient buildings can be carried out, providing researchers with more research information and the public with a more intuitive way of understanding.

This finding is an important guide for cultural heritage conservation practices, providing new strategies for governments and cultural heritage managers, especially on how to attract the younger generation to participate in cultural heritage. For example, cultural heritage can be promoted through social media platforms, gamification can be used to attract young people's attention, or cultural heritage education can be integrated into school curricula in collaboration with educational institutions.

Overall, this study not only provides a comprehensive theoretical exploration of the cultural connotation and historical inheritance of ancient architecture, but also provides practical and pragmatic operational methods for cultural heritage protection. It emphasizes that the inheritance of cultural heritage does not only depend on material protection, but also requires modern means and public education to enhance the sustainability of cultural inheritance, thus ensuring the continuity of history and culture and the continuation of social values.

In order to achieve this goal, the joint efforts of all sectors of society are needed. The government should increase its investment in cultural heritage protection, formulate reasonable policies and regulations, and provide legal safeguards for the protection and transmission of cultural heritage. At the same time, the government should also encourage and support the innovative use of cultural heritage, such as enhancing public experience through digital means or bringing cultural heritage into people's daily lives through cultural and creative product development.

Experts and scholars should continue to deepen their Study to cultural heritage, explore its deeper cultural connotations, and provide theoretical support for the protection and inheritance of cultural heritage. At the same time, they should also actively participate in the education and promotion of cultural heritage, and raise public awareness of and interest in cultural heritage through lectures, exhibitions and publications.

The public, especially the younger generation, should actively participate in the protection and transmission of cultural heritage. They can experience and understand the charm of cultural heritage first-hand by visiting museums, participating in cultural heritage festivals and learning traditional handicrafts. In addition, they can make use of their creativity and innovative spirit to contribute to the inheritance and development of cultural heritage.

In conclusion, the protection and inheritance of cultural heritage is a long-term and arduous task that requires the participation and efforts of each and every one of us. Through continuous exploration and innovation, we can ensure that these valuable cultural heritages will be passed on, leaving behind a colourful cultural world for our future generations.

5.1.2 The current situation and problems of China's ancient architectural culture.

This study provides an in-depth exploration of the main challenges faced by ancient built heritage in the process of inheritance and conservation, revealing the complexity and multidimensional of the process. It is found that the conservation of ancient built heritage not only faces external challenges such as environmental, social and economic challenges, but also involves internal issues such as cultural perceptions and policy support.

Environmental challenges: Environmental factors are one of the main threats to the conservation of built heritage. Studies have shown that environmental problems such as climate change, air pollution and acid rain erosion have caused great damage to the physical structure of ancient buildings. The state of conservation of many ancient buildings is deteriorating, especially in the absence of appropriate conservation techniques and resources. The data show that the majority of respondents have a high level of awareness of the seriousness of environmental problems and consider these external threats to be the primary issue in cultural heritage conservation.

Pressure from urbanization and tourism: Urban expansion and the rapid development of tourism have also put great pressure on ancient built heritage. As urbanization accelerates, ancient architectural sites are at risk of being encroached upon by modern buildings, and the historical context and cultural environment of many sites have been damaged. At the same time, overexploitation by the tourism

industry poses a threat to the physical integrity of ancient built heritage, especially as the influx of tourists leads to wear and tear and damage to sites. The study shows that respondents are generally concerned about the negative impacts of urbanization and tourism, and believe that the pressure on ancient buildings should be reduced through policy regulation and traffic limitation measures.

Insufficient policy and financial support: Despite the existence of appropriate cultural heritage protection regulations at the policy level, the actual protection work has been slow due to a lack of funds and inadequate management mechanisms. The study found that the government's investment in cultural heritage protection is relatively insufficient, especially in terms of restoration funding and public education, where there is a large gap. Many ancient architectural heritages are unable to undergo the necessary restoration and maintenance due to lack of financial support, further aggravating their damage.

Limitations in cultural awareness: Insufficient public awareness of the cultural connotations and historical values of ancient buildings is also a major challenge for heritage work. Studies have shown that although most people recognize the cultural importance of ancient buildings, they have limited knowledge of their historical background and cultural connotations, and deficiencies in public education and cultural promotion have led to unsatisfactory cultural inheritance. In particular, the younger generation's knowledge of traditional culture is gradually fading, and there is an urgent need to strengthen cultural education through innovative means.

Theoretical and Practical Implications

At the theoretical level, this study systematically comprehends and analyses the challenges in cultural heritage protection, revealing how environmental, economic, social and cultural factors work together to protect cultural heritage. This analysis expands the theoretical framework of cultural heritage conservation by highlighting the multidimensional interactions and interdisciplinary nature of conservation, especially how traditional cultural heritage seeks balance and sustainability in the face of external pressures in the face of modernization processes.

The study reveals a strong link between external challenges such as environmental problems, urbanization and funding shortages, and internal problems such as insufficient cultural awareness and weak policy support. By analyzing these

challenges in an integrated manner, the study provides a more holistic view of the field of cultural heritage conservation and enriches the concept of ‘complex systems’ in conservation theory, whereby the conservation of cultural heritage not only relies on measures at the physical level, but also has to deal with a wide range of environmental, social and economic impacts.

In terms of practical applications, the study provides valuable references for cultural heritage managers, policy makers and the general public. Firstly, the study clearly points out the importance of strengthening policy support and funding, especially in the case of insufficient funding for restoration and maintenance, and that governments should further increase financial support for cultural heritage conservation to ensure that conservation efforts can be sustained. Secondly, the study suggests that in response to the lack of public awareness, the dissemination of cultural heritage must be strengthened through education and cultural promotion activities. Digital means (e.g. virtual exhibitions, online learning platforms, etc.) can be used as effective tools to help the public, especially the younger generation, better understand and participate in cultural heritage conservation.

At the same time, the study suggests that the pace of urban expansion and tourism development should be regulated through policy instruments to protect the historical environment and cultural context of ancient buildings, and to avoid the destruction of cultural heritage by over-development. This practical significance is reflected in the fact that it provides pragmatic conservation strategies for all stakeholders to help them more effectively deal with the complex challenges they face in heritage conservation.

Overall, this study not only reveals the challenges of ancient built heritage conservation, but also provides practical solutions on how to deal with them. In the multiple contexts of environmental pressures, economic constraints and insufficient cultural awareness, a conservation pathway that combines policy, funding and public education is proposed, which has important practical guidance.

5.1.3 The digital technology on Chinese ancient architecture culture protection and inheritance method.

This study focuses on the potential of using innovative technologies and methods in the conservation and preservation of ancient architecture, especially the

effectiveness of technological innovations, digital tools, and community participation. The findings suggest that innovative conservation methods play an important role in enhancing the conservation efficiency and public participation of cultural heritage, but also face certain challenges in practice.

Application of technological innovations: The study found that respondents have a positive attitude towards the application of technologies such as 3D modelling and Virtual Reality (VR). 3D modelling technology has demonstrated strong potential in the detailed documentation of ancient buildings and the development of conservation plans. This technology can accurately capture the details of a building, provide reliable data support for restoration and conservation work, and reduce human errors. In addition, virtual reality technology provides an immersive experience for the public, giving more people the opportunity to digitally access and understand the cultural connotations of ancient architecture. Through VR, the public is able to virtually tour the sites, greatly enhancing the accessibility and public participation in cultural heritage.

Problems of accessibility of digital tools: Although digital technologies show great potential in the conservation of ancient architecture, their accessibility still faces challenges. Studies have shown that many cultural heritage conservation projects struggle to promote high-cost innovative technologies due to financial constraints. At the same time, the complexity of the technologies requires the involvement of specialized professionals, and in many small-scale conservation projects there is a lack of adequate technical support and training mechanisms. In addition, there are differences in the acceptance of innovative technologies among different stakeholders, especially traditional artisans who may have reservations about over-reliance on technology.

Community participation and public education: The study found that innovative tools can enhance the breadth and depth of public participation and cultural heritage. Digital platforms provide wider opportunities for public participation in cultural heritage preservation, especially through online exhibitions, social media campaigns and virtual experiences, and the younger generation's knowledge of cultural heritage has increased. Respondents believe that through wider community engagement and

public education, the sense of identity with cultural heritage can be strengthened, which in turn promotes the sustainable transmission of culture.

In summary, this study reveals the practical roles and limitations of innovative techniques in the conservation of ancient architecture. Although innovative methods play a positive role in enhancing conservation efficiency and expanding public participation, they still need to overcome the barriers in terms of funding, technology and social awareness.

Theoretical and Practical Implications

At the theoretical level, this study systematically explores innovative approaches in cultural heritage conservation and proposes a conservation framework that combines technological innovation and traditional craftsmanship. This framework emphasises the complementary role of modern technology in cultural heritage conservation and further promotes the development of cultural heritage conservation theory. By analyzing the application of technologies such as 3D modelling and virtual reality, the study reveals that technological innovation not only enhances the accuracy of conservation work, but also provides a brand new path for the transmission of cultural heritage. This finding expands the theoretical scope of cultural heritage conservation and emphasizes the importance of digital tools in modern conservation practice.

At the same time, the study proposes the dual path theory of ‘innovative technology + community participation’. This theoretical framework points out that innovative technology is not only a conservation tool, but also an important means to promote cultural identity and public participation. Through digital dissemination, cultural heritage can break through the limitations of physical space, enabling more people around the world to access and understand specific cultural heritage. This theory extends traditional approaches to cultural heritage dissemination and education and provides new directions for future research.

In terms of practical applications, this study provides actionable strategies and recommendations for cultural heritage preservation. Firstly, 3D modelling and virtual reality technologies can be used to improve the accuracy of conservation efforts, with great potential especially in the documentation of details, simulated restoration and long-term preservation of cultural heritage. Secondly, the study recommends that

cultural heritage conservation projects should invest more funds in the promotion of these innovative technologies, especially in public education and community involvement. For example, through virtual reality technology, the public can experience cultural heritage anytime and anywhere, which not only helps to enhance cultural identity, but also promotes tourism and raises more funds for cultural heritage preservation.

In addition, the study raises the challenge of technology diffusion, especially in the context of limited financial and technical support, and how to ensure the sustainable application of innovative tools is an urgent issue to be addressed. Therefore, the study suggests that governments and cultural institutions should strengthen the training of cultural heritage managers and technicians to ensure that technological innovations can be widely applied and sustained in practice.

Overall, this study not only provides an important and innovative contribution to the theory of cultural heritage conservation, but also offers feasible solutions for practical conservation operations. Through the dual path of technology and community participation, the study provides new ideas for the long-term conservation and sustainable inheritance of cultural heritage, which has important theoretical value and practical significance.

5.2 Discussion

5.2.1 To explore the history and origins of ancient Chinese architectural culture.

This section integrates the first research objective, which is to explore the history and origin of China's ancient architectural culture, while aligning with the literature review presented in Chapter 2. It also discusses how this research relates to prior findings, identifies areas of convergence, and highlights new discoveries.In the literature review in Chapter 2, many studies (e.g., "An Exploration of the Architectural Layout and Ritual System of the Temple of the Duke of Zhou") pointed out that ancient Chinese architectural culture was centered on the ideas of Confucianism, Taoism, and Buddhism, which combined with a specific social order and ritual system to form a unique architectural style. This study provides field verification of these theories, and in particular, observations of the Luoyang sites

(Zhou Gong Temple, Longmen Grottoes, and White Horse Temple) further enrich the details of these theories.

For example, the central axis layout and symmetrical design of the Zhougong Temple support the concept of "ritual" in Confucian culture, while the carvings of the Longmen Grottoes reflect the fusion of Tang Dynasty Buddhist art with traditional Chinese technology. These are consistent with the functional descriptions of ritual and religious architecture in Chapter Two.

Research Findings:

Similarities: This study found that the temple of the Duke of Zhou, as a ritual building, not only carried the belief in ancestor worship, but also reflected the hierarchical system of Zhou society through its architectural design. This is in line with the viewpoint of "architecture serves politics" put forward in previous studies.

Differences: This study discovered some under-discussed details through on-site observation and interviews. For example, the architectural evolution of the Baima Temple incorporates more later design trends, reflecting the continuous interaction between Buddhism and local architectural styles. These findings fill in the gaps in the literature regarding the dynamic changes in architectural styles.

China's ancient architectural culture reflects the profound essence of a civilization that has endured for millennia. The architectural sites in Luoyang, such as the Zhou Gong Temple, the Longmen Grottoes, and the White Horse Temple, serve as significant markers of this cultural depth, embodying religious, political, and artistic developments. From the hierarchical ritual systems of the Zhou Dynasty to the intricate Buddhist carvings of the Tang Dynasty, these sites illustrate the complex interplay of Confucian, Taoist, and Buddhist influences that have shaped Chinese architectural traditions. The historical and cultural connotations of these architectural forms are deeply rooted in their symbolic designs, material usage, and spatial layouts.

The Zhou Gong Temple epitomizes the ritual-based hierarchical system of the Zhou Dynasty, with its central axis layout symbolizing political order and social harmony. The emphasis on symmetry, a concept closely tied to Confucian ideals of hierarchy and balance, reflects the philosophical and political ethos of the period. This finding aligns with the literature that describes Zhou Gong Temple as not only a place of worship but also a tool for consolidating the patriarchal social order. By integrating

political ideology and cultural expression into architectural design, it established a precedent for ritual architecture in subsequent dynasties.

Historical inheritance is a cornerstone of this research, reflecting the preservation of traditional building techniques and cultural values over centuries. Techniques such as wooden mortise-and-tenon joints, symmetry-based spatial planning, and the use of roof tiles are integral to ancient Chinese architecture and continue to symbolize cultural identity. The craftsmanship, passed down through generations, reveals the importance of continuity in cultural heritage. However, modern society has shown insufficient emphasis on safeguarding these intangible cultural assets. Interviews with local artisans and conservationists highlighted the declining interest among younger generations in learning and preserving these skills. This discovery extends beyond the literature's focus on historical methods by addressing the urgent need for innovative educational strategies to sustain these traditions.

The research also uncovered a significant gap between public awareness and the cultural importance of these sites. While the literature review addressed the historical significance of these architectural forms, the interviews and observations revealed a lack of integration between cultural education and heritage appreciation. Respondents consistently emphasized the need for increased policy support and public education to enhance understanding and engagement with these architectural treasures. For example, incorporating these historical symbols into school curricula could foster a stronger connection between younger generations and their cultural heritage, an area that has been underemployed in existing studies.

This study offers new insights into the relationship between ancient architectural culture and modern conservation challenges. Digital technologies, such as 3D modeling and virtual reality, were identified as valuable tools for enhancing public access and engagement. By creating immersive experiences and detailed digital records, these technologies can bridge the gap between historical preservation and contemporary awareness. This modern approach to conservation was not extensively covered in the literature review and represents a novel contribution of this research. Additionally, these technologies allow for a more precise understanding of structural

vulnerabilities, enabling proactive restoration efforts that were previously difficult to implement.

The findings underscore the need for a multifaceted approach to heritage conservation that integrates cultural education, public awareness, and policy support with modern technology. The historical narratives embedded in Luoyang's ancient architectural sites are rich and complex, yet their relevance to contemporary society is often overlooked. This research emphasizes that these sites are not merely relics of the past but living symbols of cultural identity and historical continuity. By fostering greater public appreciation and leveraging technological innovation, it is possible to ensure the preservation of these architectural treasures for future generations.

In conclusion, this study corroborates much of the literature's discussion on the historical and cultural significance of ancient Chinese architecture while providing new perspectives on its contemporary relevance. The emphasis on integrating traditional methods with modern technology and addressing gaps in public awareness and policy support represents a significant advancement in the discourse on cultural heritage preservation. These findings highlight the enduring importance of ancient architectural culture as both a historical artifact and a vital component of China's cultural identity, making a strong case for its protection and continued study.

5.2.2 The current situation and problems of China's ancient architectural culture.

This study highlights the rich cultural and historical significance of China's ancient architectural heritage, particularly in sites such as those in Luoyang. However, findings reveal that these cultural landmarks face an array of challenges brought about by environmental degradation, urbanization, insufficient resources, and social factors. These challenges threaten the preservation and continuation of this invaluable heritage.Studies on environmental impacts in Chapter 2 (e.g., Analysis of Environmental Degradation of Sites) emphasized the destructive effects of natural factors (climate change, pollution, etc.) on ancient architecture. This study, in conjunction with fieldwork, further confirms the prevalence of these environmental problems and adds the long-term effects of micro climatic changes on stone and wooden structures.

Literature on the effects of urbanization (e.g., Impacts of Urban Expansion on Cultural Heritage) points to the threat to the historical integrity of sites posed by the

construction of modern urban infrastructure. This study validates this view through a case study of the Zhou Gong Temple and its surrounding area, and reveals the indirect effects of a lack of social cognition on site preservation.

Research Results:

Similarities: This study supports previous findings on the threats to sites from environmental degradation and urbanization, such as the erosion of stone sculptures in the Longmen Grottoes by acid rain and industrial pollution.

Differences: This study adds to the discussion on the lack of public awareness and policy support. Interviews revealed that many young people lack interest in traditional crafts, and that a shortage of conservation resources is causing restoration efforts to lag. These social factors are under-emphasized in the literature, illustrating the need for more intensive public education and policy interventions.

China's ancient architectural culture, exemplified by iconic sites such as the Longmen Grottoes, White Horse Temple, and Zhou Gong Temple, continues to serve as a testament to the ingenuity and creativity of ancient Chinese civilization. These sites remain major attractions for tourists and focal points for scholars conducting research. Nevertheless, fieldwork observations and interviews uncovered a series of pressing issues.

The environmental impact on these historical sites has been profound. For instance, the carvings at the Longmen Grottoes exhibit noticeable weathering, primarily caused by air pollution and acid rain resulting from industrial emissions. Natural disasters such as floods and earthquakes also pose ongoing risks, exacerbated by the sites' vulnerability due to their age and exposure to the elements. These findings are consistent with prior research emphasizing the increasing environmental pressures on ancient structures. However, this study further reveals that the effects of micro-climatic changes—such as variations in humidity and temperature—are contributing to subtle yet significant structural damage, particularly to the delicate carvings and wooden frameworks of heritage buildings.

Urbanization represents another major challenge. Rapid urban expansion in cities such as Luoyang has led to the encroachment of modern infrastructure near historical sites. High-rise buildings, transportation networks, and commercial developments disrupt the historical context of these sites, diminishing their cultural

authenticity. For example, Zhou Gong Temple has experienced disruptions due to surrounding land use changes, with modern construction encroaching on its boundaries. These findings build on the literature, which has acknowledged urbanization's effects on heritage sites but have not fully explored its impact on the sociocultural perception of these sites as historical and spiritual spaces.

The study also identifies significant problems in the management and preservation of ancient architectural culture, with funding shortages being one of the most critical issues. Interviews with officials and preservation experts revealed that financial resources allocated to heritage conservation projects are insufficient to meet the demands of ongoing maintenance and restoration. This underfeeding leads to delays in repairs, limited resources for employing skilled craftsmen, and insufficient investment in advanced preservation technologies.

Additionally, tourism overload exerts immense pressure on fragile heritage sites. Popular landmarks such as the Longmen Grottoes and White Horse Temple often experience large influxes of visitors during peak seasons, leading to physical wear and tear on structures, increased pollution, and disruption of the sites' spiritual and historical atmosphere. This study's findings highlight the need for visitor management strategies, such as implementing visitor caps and redesigning tour paths, to mitigate the negative impacts of excessive foot traffic.

Lack of public awareness about the significance and conservation of ancient architecture remains a pressing issue. Quantitative survey results revealed that while a majority of respondents (68%) recognize the historical importance of these sites, their knowledge of conservation practices and their role in heritage protection remains limited. Public apathy, particularly among younger generations, has further compounded the issue, as traditional building techniques and cultural appreciation are gradually being forgotten. This aligns with previous research but extends it by identifying gaps in heritage education, emphasizing the need for integrating these topics into school curricula and public outreach programs.

Moreover, interviewees underscored the tension between heritage protection and the demands of sustainable tourism. Many conservation strategies focus on structural preservation while neglecting the broader sociocultural and environmental systems in which these sites are embedded. There is a need for more balanced

approaches that harmonize tourism development with the preservation of historical integrity and cultural values. Respondents called for enhanced government intervention, with suggestions ranging from stricter land use regulations to increased resource allocation for conservation.

This study also sheds light on the potential of digital technologies, such as 3D modeling, virtual reality (VR), and remote sensing, to address some of these challenges. While these technologies have been successfully piloted in documenting and restoring sites like the Longmen Grottoes, their application remains limited by funding constraints and insufficient training. Expanding the use of digital tools could not only improve conservation outcomes but also foster greater public engagement by creating immersive experiences that bridge the gap between historical sites and modern audiences.

In conclusion, while China's ancient architectural culture remains a rich source of national pride and historical identity, it faces multifaceted challenges that require immediate attention. Environmental degradation, urbanization, funding shortages, tourism pressures, and public disengagement collectively threaten the survival of this heritage. The findings emphasize the need for an integrated approach that combines heritage education, sustainable tourism management, technological innovation, and stronger policy measures to ensure the preservation and relevance of these cultural landmarks for future generations. This study provides new perspectives on balancing conservation efforts with modern societal demands, offering a foundation for more comprehensive and sustainable solutions.

5.2.3 The digital technology on Chinese ancient architecture culture protection and inheritance method.

Innovative conservation methods are becoming increasingly crucial for addressing the challenges faced by ancient architectural heritage and ensuring its long-term sustainability. This study explored the application of digital technologies alongside modern management practices, demonstrating their potential to revolutionize the protection and inheritance of China's ancient architectural culture. The integration of these technologies not only enhances preservation efforts but also fosters greater public engagement and education.The technical value of 3D modeling and virtual reality for site documentation and presentation has been made clear by the

references to digital preservation in Chapter 2 (e.g., The Application of Virtual Reality to Cultural Heritage Preservation). This study validates the effectiveness of the practical application of these technologies and extends the exploration of Internet of Things (IoT) monitoring and Augmented Reality (AR) to propose a more comprehensive conservation strategy.

While most of the studies in the literature review focus on the introduction of a single technology, this study synthesizes a variety of digital tools, especially in the interplay between 3D scanning, VR experience and environmental monitoring, and proposes an innovative conservation model that combines technology and cultural education.

Research Results:

Similarities: This study confirms the important role of digital technologies in improving the efficiency of site conservation and public participation, for example, 3D modeling of Longmen Grottoes provides technical support for the accurate recording of carving details, which is consistent with the analysis of technological advantages in the literature review.

Differences: This study further expands the function of digital technology in cultural communication, for example, by restoring the ceremonial scenes of the Zhou Gong Temple through AR technology, which enables the public to “experience” the historical situation. These applications combining education and tourism are rare in the literature.

The application of digital technologies in heritage conservation has shown significant promise in both protecting physical structures and promoting cultural awareness. Field research highlighted the effectiveness of 3D scanning and modeling, which allows for the precise documentation of intricate details in ancient structures, such as those at the White Horse Temple. By creating highly accurate digital replicas, 3D modeling enables the preservation of cultural heritage in virtual formats, providing a safeguard against potential physical damage caused by environmental factors or human activities. Furthermore, these digital replicas facilitate restoration efforts by offering detailed visual references for craftsmen and architects.

Virtual Reality (VR) and Augmented Reality (AR) have emerged as trans formative tools for enhancing visitor education and engagement. These technologies

allow users to interact with immersive digital reconstructions of historical sites, providing an enriched understanding of their original appearance and cultural significance. For instance, visitors to Longmen Grottoes could explore a virtual recreation of the site as it appeared during the Tang Dynasty, gaining insights into its religious and artistic context without risking damage to the fragile carvings. This approach reduces physical strain on the heritage sites while broadening their accessibility, especially for individuals who are unable to visit the locations in person.

The study also emphasized the role of Internet of Things (IoT) monitoring systems in ensuring the structural integrity of ancient architecture. By installing environmental sensors at key heritage sites, real-time data on temperature, humidity, and pollutant levels can be collected and analyzed. This proactive approach enables early detection of potential threats, such as moisture damage or air pollution, allowing for timely intervention and preventive maintenance. For example, sensors placed in Zhou Gong Temple can help monitor fluctuations in humidity that may compromise the stability of wooden structures, ensuring better long-term preservation.

Beyond technological applications, community participation emerged as a critical factor in the success of heritage protection efforts. Interviews with local stakeholders underscored the importance of fostering public involvement in conservation initiatives. Educational campaigns and community-led projects can cultivate a sense of ownership and responsibility among residents, encouraging them to actively contribute to preserving their cultural heritage. This aligns with findings from the survey, where respondents highlighted the need for greater public awareness and grassroots participation in conservation strategies.

Policy development was another area where innovative approaches were identified. This study revealed that integrating heritage preservation into urban planning can significantly improve the sustainability of conservation efforts. Establishing heritage zones with strict development regulations, for instance, can protect the historical integrity of sites while accommodating modern urban growth. Additionally, promoting sustainable cultural tourism offers a dual benefit: generating funds for conservation while minimizing the physical and cultural disruption of heritage sites. Policies that prioritize eco-friendly tourism, such as capping visitor

numbers and developing digital tourism alternatives, were frequently recommended by interviewees.

Evaluation of these methods demonstrated their effectiveness in bridging the gap between heritage protection and public engagement. Survey data revealed that 74% of respondents believed integrating technologies like 3D modeling and VR significantly enhances the accessibility and understanding of cultural heritage. This growing recognition of digital tools as a complement to traditional conservation practices reflects a shift toward more innovative, inclusive approaches to heritage management.

The findings of this study underscore the trans formative potential of digital technologies in the protection and inheritance of Chinese ancient architectural culture. By combining advanced tools like 3D modeling, VR, AR, and IoT monitoring with community-driven initiatives and innovative policies, a more sustainable and inclusive model for cultural heritage preservation can be achieved. These approaches not only ensure the physical longevity of heritage sites but also enhance their cultural relevance and accessibility, bridging the past with the present for future generations.

Summary

The discussions surrounding these three research objectives highlight that:

Ancient architectural sites in Luoyang hold significant cultural and historical values, which must be better integrated into public education.

The current challenges facing China’s ancient architectural culture include environmental deterioration, insufficient resources, and urban pressures, requiring immediate intervention.

Innovative conservation methods involving digital technologies and community participation present effective strategies for ensuring the sustainability of cultural heritage while addressing contemporary challenges.

By integrating these findings, this study advocates for a multidisciplinary approach that combines technology, policy reform, and public engagement to preserve and inherit the cultural treasures of Luoyang’s ancient architecture.

5.3 Suggestions

5.3.1 Recommendations for policy makers

1 The government should increase financial support and promote the application of innovative technologies by setting up special funds for the development and promotion of innovative technologies in cultural heritage conservation, such as 3D modeling, virtual reality (VR) and augmented reality (AR) and other digital means. These technologies can significantly improve the efficiency and accuracy of conservation of ancient buildings, while reducing the risk of human intervention. In addition, economic support should be provided for small and medium-sized cultural heritage projects to ensure that these technologies are not only limited to large-scale projects, but can also be widely applied under resource-limited conditions.

2 Policy frameworks need to be further developed to include public education and community participation as important components of cultural heritage conservation. The preservation of cultural heritage does not only rely on physical restoration, but also requires the transmission of its cultural content. Policymakers should enhance public interest and participation in traditional culture, especially among the younger generation, through cultural awareness programs and digital means, such as virtual reality exhibitions and online education platforms.

3 Cross-bencher cooperation and multi-party participation mechanisms should be strengthened. Cultural heritage preservation involves multiple sectors, including culture, tourism, education and environmental protection. Therefore, policymakers should promote collaboration among these sectors and establish mechanisms for communication and collaboration among governments, experts, artisans and communities to ensure coherent and coordinated cultural heritage protection. In urban planning and tourism development, the need for cultural heritage protection should be prioritized to ensure that policies in related fields are complementary and avoid conflicts of interest.

5.3.2 Recommendations for practitioners

For cultural heritage managers, restoration artisans and designers, this study proposes the following operational recommendations:

1 In the conservation process, it is recommended to combine traditional craftsmanship with modern technology. Modern technologies (e.g., 3D modeling,

laser scanning, and virtual reality) are not intended to replace traditional crafts, but rather to complement and support them. For example, 3D modeling technology can help craftsmen simulate different restoration scenarios before restoration to ensure that the final restoration result will cause minimal disturbance to the original building. In practice, craftsmen still need to adhere to manual skills to ensure that cultural and artistic values are not replaced by technological.

2 Technical training and skills upgrading of practitioners should be strengthened. As cultural heritage conservation increasingly relies on advanced technologies, restoration craftsmen and cultural heritage managers need to continuously upgrade their digital skills and receive professional training in relevant technologies. At the same time, designers should take into account the needs of traditional craftsmanship and the advantages of modern technology when formulating restoration plans, so as to ensure that the restoration plan meets the technical requirements while respecting the original appearance and historical value of the cultural heritage.

3 Promoting public participation is the key to realizing sustainable conservation of cultural heritage. Managers of cultural heritage should work with the community to carry out more public participation projects, such as organizing volunteer activities for cultural heritage protection as well as lectures and exhibitions on cultural heritage. In addition, the public can be engaged in the preservation and dissemination of cultural heritage in an immersive way through virtual reality technology or the creation of digital archives. This will not only help raise public awareness of cultural heritage protection, but also enhance the social impact of cultural heritage protection programs.

5.3.3 Suggestions for Future Research

Based on the limitations and findings of this study, future research can further explore in the following directions:

1 The scope of the study should be expanded to carry out cross-regional comparative studies. This study mainly focuses on the Luoyang region, and future research can expand the sample scope to more regions with diverse cultural backgrounds and heritage types. Cross-regional comparative studies can reveal different conservation strategies triggered by environmental and cultural differences, e.g. coastal cities may face unique challenges such as salt water erosion, while ethnic minority areas may place more emphasis on oral traditions and localization practices.

By introducing high-precision data collection tools, the efficiency of data collection has been significantly improved.

2 The effectiveness and feasibility of the application of innovative technologies should be explored in depth. Future research can assess how 3D modeling can reduce restoration errors and enhance restoration efficiency through quantitative indicators, while exploring the practical role of virtual reality in enhancing public education and participation. For example, the use of high-resolution models combining COSC Imaging RTK and UAV imagery can optimize the cost-effectiveness of heritage conservation projects.

3 The research should explore the interaction and cooperation mechanism among stakeholders. Cultural heritage conservation involves the participation of multiple parties, including the government, artisans, experts and the public, and future research can focus on analyzing how to balance the interests of all parties through effective management and policy coordination. At the same time, by generating high-resolution seamless 3D models, joint assessment and decision-making by multiple parties can be facilitated.

4 Research should be conducted on how technological innovations affect cultural identity, especially among younger groups. For example, Augmented Reality (AR) and Virtual Reality (VR) can help younger generations better connect with traditional culture through immersive experiences. In addition, integrated research of multidisciplinary technologies is full of potential, combining artificial intelligence, augmented reality and virtual reality to support the creation of dynamic visualization of heritage, interactive learning platforms and intelligent monitoring systems.

By exploring the above directions, future research can provide practical solutions to current challenges in cultural heritage preservation, while embracing technological advances to promote the sustainable preservation and transmission of cultural heritage.

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APPENDIX

Appendix A

List of interviewees

Interview with Mr Zhao Bo (Luoyang Municipal Bureau of Cultural Heritage. 17 March 2024

Interview with Mr Zhang Yongxin (Luoyang Normal College. 21 March 2024

Interview with Ms Li Chenxi (Luoyang Museum. 23 March 2024

Interview with Ms Liu Li (Luoyang Municipal Bureau of Culture and Tourism. 27 March 2024

Interview with Mr Wang Hua (Wang Hua Studio, Mengjin County, Luoyang City. 27 March 2024

Interview with Cui Mimi, girl (Luoyang URA. 27 March 2024

Interview with Mr. Zhang Wei (Luoyang Municipal Bureau of Urban Development). 2 April 2024

Interview with Ms. Wang Fang (Luoyang Cultural Heritage Protection Department). 5 April 2024

Interview with Mr. Li Jun (Luoyang Historical Architecture Restoration Group). 7 April 2024

Interview with Ms. Chen Lin (Luoyang Local Culture Preservation Association). 9 April 2024

Interview with Mr. Zhang Hong (Luoyang Institute of Cultural Relics). 12 April 2024

Interview with Ms. Liu Mei (Luoyang Museum of History and Culture). 15 April 2024

Interview with Mr. Wang Ming (Luoyang Heritage Tourism Development Group). 17 April 2024

Interview with Ms. Sun Jie (Luoyang Municipal Bureau of Culture and Tourism). 20 April 2024

Interview with Mr. Zhang Chao (Luoyang Architectural Design and Restoration Studio). 23 April 2024

Interview with Ms. Zhao Yue (Luoyang University, Department of Cultural Studies). 25 April 2024

Interview with Mr. Liu Hui (Luoyang Restoration Craftsmen Association). 28 April 2024

Interview with Ms. Li Yan (Luoyang Historic Preservation Committee). 30 April 2024

Interview with Mr. Wu Kai (Luoyang Community Cultural Heritage Volunteer Group). 2 May 2024

Interview with Mr. Li Tao (Resident, Luoyang Old Town District). 5 May 2024

Interview with Ms. Zhang Yu (High School Teacher, Luoyang No. 2 High School). 6 May 2024

Interview with Mr. Wang Jian (Small Business Owner, Luoyang Night Market). 7 May 2024

Interview with Ms. Liu Qing (University Student, Luoyang University). 8 May 2024

Interview with Mr. Zhao Ming (Taxi Driver, Luoyang City). 9 May 2024

Interview with Ms. Chen Xia (Tourist from Zhengzhou, visiting Longmen Grottoes). 10 May 2024

Interview with Mr. Li Lei (Farmer, Luoyang Rural Area). 11 May 2024

Interview with Ms. Sun Mei (Stay-at-home Parent, Luoyang Community). 12 May 2024

Interview with Mr. Zhang Qiang (Local Artist, Luoyang Art Exhibition). 13 May 2024

Interview with Ms. Gao Ling (Volunteer, Luoyang Historical Site Preservation Group). 14 May 2024

Interview with Mr. Wu Dawei (Engineer, Luoyang Urban Planning Bureau). 15 May 2024

Interview with Ms. Huang Li (Shopkeeper, Luoyang Cultural Street). 16 May 2024

Interview with Mr. Yang Bo (Retired Teacher, Luoyang). 17 May 2024

Interview with Ms. Xiao Yan (University Lecturer, Luoyang University). 18 May 2024

Interview with Mr. Zhou Wei (Amateur Historian, Luoyang Local History Society). 19 May 2024

Interview with Ms. Ma Xin (Social Media Influencer, promoting Luoyang culture). 20 May 2024

Interview with Mr. Zhao Ke (Tourist Guide, Luoyang Historical Sites). 21 May 2024

Interview with Ms. Wang Ning (Café Owner, Luoyang Old Town). 22 May 2024

Interview with Mr. Lin Jie (Student, Luoyang High School). 23 May 2024

Interview with Ms. Liu Min (Cultural Enthusiast, Luoyang Community Forum). 24 May 2024

Key Informants

No.	Name	Gender	Role	Age
1	Zhao Bo	Male	Government officials	44
2	Zhang Yongxin	Male	scholars	45
3	Li Chenxi	Female	Government officials	32
4	Liu Li	Female	Government officials	29
5	Wang Hua	Male	Specialist	46
6	Cui Mimi	Female	scholars	49

Casual Informants

No.	Name	Gender	Role	Age
1	Li Tao	Male	Resident	35
2	Zhang Yuyu	Female	Teacher	43
3	Wang Jian	Female	Small Business Owner	26
4	Liu Qing	Male	University Student	21
5	Zhao Ming Tao	Male	Taxi Driver	40
6	Chen Xia	Female	Tourist	43
7	Li Lei	Female	Farmer	52
8	Sun Mei	Male	Stay-at-home Parent	19
9	Zhang Qiang	Female	Artist	30
10	Gao Ling	Male	Volunteer	41

11	Wu Dawei	Female	Engineer	39
12	Huang Liling	Female	Shopkeeper	30
13	Yang Bo	Male	Retired Teacher	46
14	Xiao Yancai	Male	University Lecturer	37
15	Zhou Wei	Female	Amateur Historian	34
16	Ma Xin	Male	Social Media Influencer	26
17	Zhao Kenan	Male	Café Owner	27
18	Wang Ning	Male	Artist	33
19	Lin Jieya		Student	17
20	Liu Minhui	Female	Cultural Enthusiast	31
21	Li Fang	Female	Writer	28
22	Zhang Wei	Male	Retired Engineer	63
23	Wang Ruilin	Female	Museum Curator	45
24	Liu Hong	Male	High School Teacher	38
25	Zhao Ling	Female	Tour Guide	29
26	Chen Tao	Male	Photographer	35
27	Li Pingping	Female	NGO Worker	32
28	Sun Botao	Male	Civil Servant	48
29	Zhou Lanxiang	Female	Freelance Writer	26
30	Wu Hao	Male	Calligraphy Artist	50
31	Xiao Mei	Female	Student	22
32	Huang Weiwei	Male	Retired Military Officer	60
33	Yang Xin	Female	Librarian	31
34	Ma Huifang	Male	IT Specialist	27
35	Zhao Jun	Female	Architect	36
36	Lin Nanding	Male	Park Ranger	40
37	Gao Yuejie	Female	Language Instructor	33
38	Sun Lei	Male	Graphic Designer	29
39	Zhang Lixiang	Female	Food Blogger	24
40	Wu Feng	Male	History Researcher	47

General Informants

No.	Name	Gender	Role	Age
1	Zhang Wei	Male	Urban Development	28
2	Wang Fang	Female	Cultural Heritage Department	31
3	Chen Lin	Male	Restoration Group	45
4	Chen Lin	Female	Local Culture Preservation	22
5	Zhang Hong	Male	Institute of Cultural Relics	25
6	Liu Mei	Female	Museum of History and Culture	33
7	Wang Ming	Male	Heritage Tourism	41
8	Sun Jie	Female	Culture and Tourism Bureau	50
9	Zhang Chao	Male	Architectural Design	46
10	Zhao Yue	Female	University (Cultural Studies)	23
11	Liu Hui	Male	Restoration Craftsmen Association	22
12	Li Yan	Female	Historic Preservation Committee	33
13	Wu Kai	Male	Cultural Volunteer Group	37

Appendix B

KI Unstructured Interview

Title:The cultural connotation and historical heritage of ancient architecture.

□ Name of the interviewee:

□ Age:

□ Occupation:

□ Educational level:

Purpose of Interview

To explore the cultural connotations and historical inheritance of ancient architecture.

Interview Questions

1 What do you think about the cultural and artistic value of the ancient buildings in Luoyang (e.g. Longmen Grottoes)? What is the symbolic meaning of these buildings?

2 What role do traditional building techniques play in the conservation of ancient buildings? How have they influenced modern conservation methods?

3 What do you think are the shortcomings of current cultural heritage conservation policies? How do these shortcomings affect cultural heritage?

4 What are the main challenges you have encountered in preserving the cultural content and historical heritage of ancient buildings?

5 What do you think are some innovative conservation strategies that can better balance material conservation and cultural heritage?

6 What is the role of modern technologies (e.g. 3D scanning, virtual reality) in cultural heritage conservation? How can they help preserve and transmit cultural content?

7 How do you think the government should improve the dissemination and education of cultural heritage in order to increase public awareness of and participation in cultural heritage?

8 In the process of modernization, how can we ensure that the conservation of ancient buildings is not undermined by urban expansion and commercialisation?

Appendix C

CI Unstructured Interview

Title:Challenges encountered in the preservation and inheritance of ancient architectural heritage.

□ Name of the interviewee:

□ Age:

□ Occupation:

□ Educational level:

Purpose of Interview

To examine the challenges encountered in the conservation and inheritance of architectural heritage.

Interview Questions

1 What do you think are the most obvious impacts of environmental changes (e.g. climate change, air pollution) on the conservation of Luoyang's ancient built heritage? How are these impacts reflected in specific conservation efforts?

2 How are ancient built heritage sites affected in the process of urban expansion? What measures do you think should be taken to balance development and cultural heritage protection in the process of urbanization?

3 What are the positive or negative impacts of tourism development on the conservation of built heritage? What do you think should be done to cope with the pressure of increased tourist flows on the protection of cultural heritage sites?

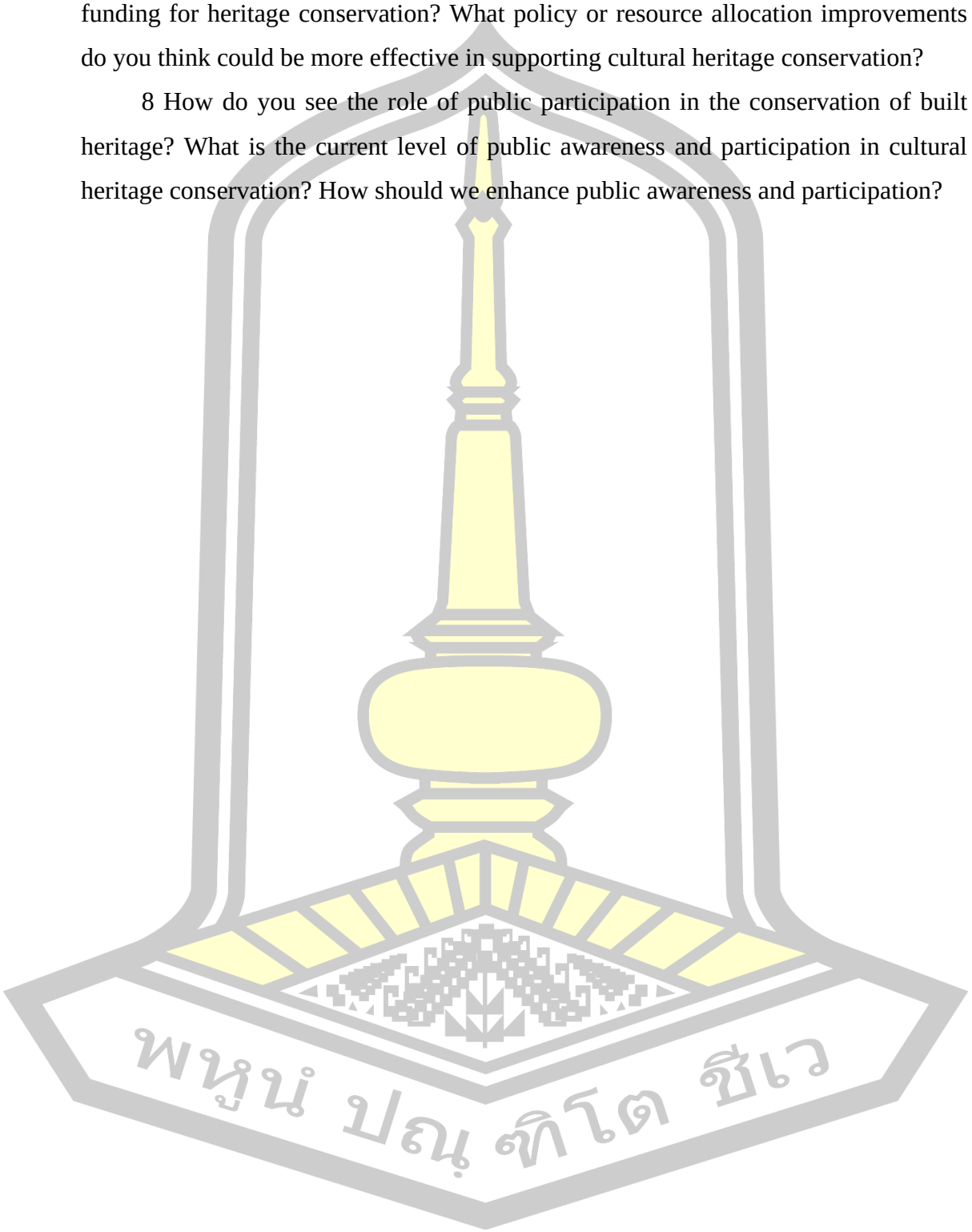
4 What do you think are the main deficiencies in current cultural heritage protection policies? How do these deficiencies affect the long-term conservation and heritage of ancient buildings?

5 What are the biggest challenges you have encountered in actual restoration work? How do these challenges affect the use of traditional restoration techniques and the preservation of heritage authenticity?

6 Do you think traditional restoration techniques are sufficient in dealing with environmental changes and modern challenges? Do we need more modern technological interventions to ensure the sustainability of ancient buildings?

7 What are the problems faced by governments and the public sector in terms of funding for heritage conservation? What policy or resource allocation improvements do you think could be more effective in supporting cultural heritage conservation?

8 How do you see the role of public participation in the conservation of built heritage? What is the current level of public awareness and participation in cultural heritage conservation? How should we enhance public awareness and participation?



Appendix D

GI Unstructured Interview

Title:Assessing innovative approaches to sustainable conservation of cultural heritage.

□ Name of the interviewee:

□ Age:

□ Occupation:

□ Educational level:

Purpose of Interview

To explore innovative conservation methods and assess their potential in ensuring the sustainability of cultural heritage.

1 What do you think is the role of 3D modelling technology in the conservation of ancient architecture? How can it help improve the accuracy of conservation and restoration work?

2 What is the value of virtual reality (VR) technology in cultural heritage transmission? How can it help the public better understand and experience the historical and cultural connotations of ancient buildings?

3 Do you think the combination of traditional craftsmanship and modern technology is crucial in the conservation of ancient buildings? How to balance the application of the two in practice?

4 What do you think are the biggest challenges faced by digital tools (e.g. 3D modelling and virtual reality) in the conservation and heritage of ancient buildings at this stage?

5 How cost-effective do you think technological innovations (e.g. 3D modelling, virtual reality) are in the context of limited resources? How can these technologies be promoted with limited budgets?

6 How do you think public participation can be enhanced through digital means (e.g. virtual reality or online exhibitions)? How can these means increase community awareness of cultural heritage and conservation?

7 Do you think that innovative technologies can completely replace traditional techniques in the restoration process of ancient buildings? If not, which parts of the process must rely on traditional craftsmanship?

8 What do you think about the future prospects of applying more innovative technologies (e.g. artificial intelligence, augmented reality) in the conservation of ancient buildings? Can these technologies further contribute to the preservation and transmission of cultural heritage?

Appendix E

Group Discussion Record

Local wisdom and knowledge on the use of aromatic herbs in cultural preservation and sustainability for application in product innovation.

Date: ..... Month: ..... B.E.: .....

Location: House No.: ..... Village No.: .....

House: ..... Subdistrict: ..... District: ..... Province: .....

Conversation Participants:

1. .....

2. .....

3. .....

4. .....

5. .....

1. What are the guidelines for developing wisdom and knowledge in using aromatic herbs for product innovation in the local area?

.....

.....

2. Are commercially developed products using aromatic herbs suitable, and how can they be developed sustainably?

.....

.....

3. What are the methods of processing, conserving, and promoting the use of aromatic herbs?

.....

.....

4. What are the advantages and disadvantages of the developed product? Use SWOT Analysis.

Strengths

(S): .....

Weaknesses

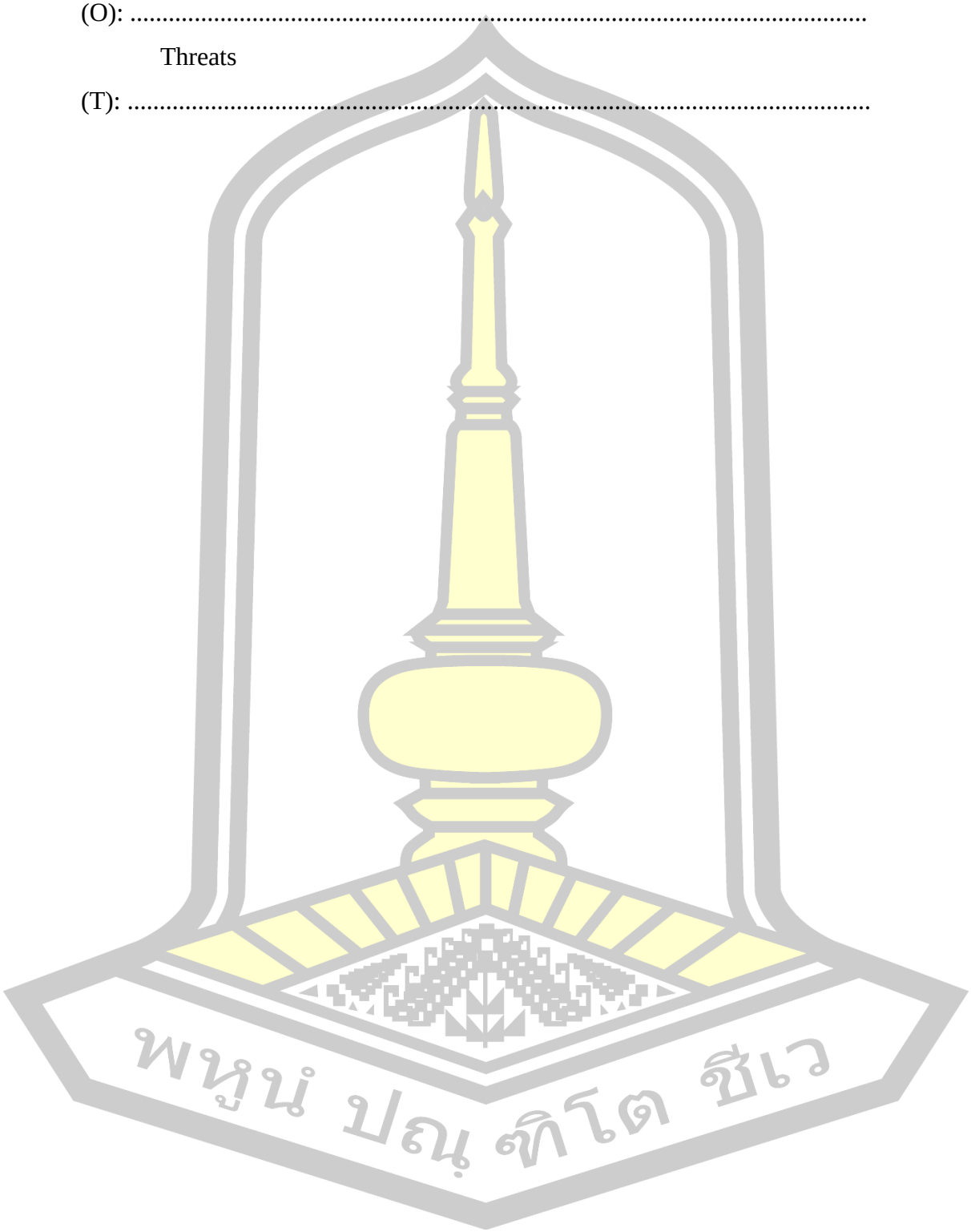
(W): .....

Opportunities

(O): .....

Threats

(T): .....



Appendix F

Observational Type

Local wisdom and knowledge on the use of digital technology in preserving and protecting cultural heritage sites.

Note on date: ..... Month: ..... B.E.: .....

1. Observe the historical significance of cultural heritage sites in the community. Obtained information:

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2. Observe the use of digital technologies (e.g., 3D modeling, VR, AR) in documenting and preserving heritage sites:

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3. Observe the role of local communities in participating in the preservation and protection of cultural heritage:

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4. Observe the effectiveness of conservation policies and practices implemented at the heritage sites:

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5. Other matters related to the digital and traditional methods used in cultural heritage preservation:

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.....

BIOGRAPHY

NAME	Bo Li
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