Classification and Evaluation Methods of Modern Urban Industrial Heritage Landscape: A case study of Shaanxi Province, China

PhD Thesis

by

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Declaration

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

Signed: Weiyu Lian

Date: 29/04/2024

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Contents

Abstract

The current high speed of urbanisation in China has promoted renewal and industrial restructuring in cities. In this context, a large number of industrial heritage sites that have witnessed industrial development are either being demolished or having their spaces renewed and converted to other uses. The study will identify whether industrial buildings have heritage value, whether the original evaluation criteria are still applicable, what appropriate new uses could be considered, and how to objectively assess the value of industrial heritage landscapes as this is crucial for the conservation and reuse of industrial heritage landscapes. The research aim is to find the most effective ways to classify and evaluate the industrial heritage landscape, and to provide new, comprehensive guidelines for the classification, evaluation and presentation of the industrial heritage landscape.

The research consists of five main parts, including (1) a theoretical and methodological study, (2) a study of evaluation methods, (3) a study of the current state of the industrial development history and heritage landscape in China and Shaanxi Province, (4) a development of a new method for evaluating industrial heritage, (5) and a study of the practical application of the proposed method. There are four main research methods used in this thesis, which are (1) literature review, (2) integrated interdisciplinary and inter-theoretical research method, (3) field/online surveys, data collection, analysis and systematisation that will underpin the development of a new method, and (4) validation of the new method through interviews by using questionnaires.

After a systematic analysis, this thesis selects the factors for quantitative evaluation and objectively analyses and explores the method of quantitative industrial heritage delineation, which is a useful technical complement to the study of industrial heritage management. It contributes to the study of industrial history, the conservation and use of industrial cultural heritage as well as to the classification and management system of industrial heritage. It can promote the deduction and improvement of the structure of the industrial heritage value evaluation system, and provide a practical reference for Chinese industrial heritage conservation legislation and the formulation of laws and regulations at all levels of government. This study also provides support for the subsequent development of industrial heritage conservation work.

Secondly, this study scientifically determines the principles for the selection of evaluation factors at each level, and also applies them to the evaluation of three cases of representative industrial heritage landscapes in Shaanxi Province, according to local conditions. On this basis, the results of the evaluation are used to develop different reuse criteria for each type of area, which has a strong practical relevance. This will help in the renewal and planning process. It provides a basis for the research and practice of industrial heritage conservation and management planning, and provides relevant methodologies and data support for the subsequent study of industrial heritage in Shaanxi, China.

Furthermore, this study combines Analytic Hierarchy Process (AHP) with Geographic Information System (GIS) visualisation technology to provide a clear and comprehensive quantitative evaluation of industrial heritage at all levels in a scientific manner. By analysing the technical advantages of GIS in the evaluation, the study reasonably proposes different conservation methods for industrial heritage landscapes of different values. The study provides an outlook for subsequent applications in industrial heritage conservation and management, and offers worthwhile suggestions for the future conservation of industrial heritage landscapes. The study analyses the ability of the GIS platform to store and visualise the current state of heritage resources in cities, integrate statistical research data, and assist in value assessment and conservation decision making. This provides an objective basis for identifying industrial heritage and proposing conservation measures, and has positive implications for the improvement of industrial heritage conservation methods.

Glossary

Dahua: The name of the Yarn factory in Xi'an City, Shaanxi Province, China

Daye: Chinese, the name of the iron ore opencast quarry in Huangshi City, Hebei Province, China

Hanye Ping: Chinese, the name of the coal and ironworks mine in Huangshi City, Hebei Province, China

Huaxin: Chinese, the name of the cement plant in Huangshi City, Hebei Province, China

Loft: A residence transformed from a high open space in an old factory or warehouse. It is smaller in size but has higher floor heights

M50: Creative industry park in Shanghai, China

No.8 Bridge: the name of Art Zone in Shanghai

Sihang: Chinese, the name of a warehouse in Shanghai, China

The third five-year plan: National Economic Development Plan developed by the Chinese Government

Third Line Construction: Large-scale infrastructure construction by the Chinese government in the western regions of China in 1964

Tianzifang: Chinese, the name of the Art Zone in Shanghai, China

Tonglvshan: Chinese, the name of the ancient copper mine in Huangshi City, Hebei Province, China

The Westernization Movement: It was a self-help campaign by the Chinese Qing Dynasty government from 1861 to 1894 to introduce Western military equipment, machine production and science and technology to save Qing rule

156 Key Projects: Introduced projects from the Soviet Union and Eastern European countries during China's first five-year plan.

The First Five-Year Plan: The plan drawn up by the Chinese government to develop the national economy between 1953 and 1957

The Cultural Revolution: A political campaign launched by the Chinese leadership between 1966 and 1976

China's Xinhai Revolution: The Chinese bourgeois democratic revolution led by Dr. Sun Yat-sen which overthrew the Qing Dynasty in 1911

Abbreviations

AHP: Analytic Hierarchy Process

GIS: Geographic Information System

HLC: Historical Landscape Characterisation

ICCROM: The International Centre for the Study of the Preservation and Restoration of Cultural Heritage

ICOM: The International Council of Museums

ICOMOS: The International Council on Monuments and Sites

IUCN: The International Union for the Conservation of Nature

LCA: Landscape Character Assessment

TICCIH: The International Committee for the Conservation of Industrial Heritage

UNESCO: The United Nations Educational, Scientific and Cultural Organization.

WHC: The World Heritage Committee

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Chapter 1. Introduction

1.1 Background

Since the Industrial Revolution, with the rapid development of industrial civilisation, there has been an acceleration in the transformation of original industrial land, leading to the abandonment of a large number of industrial facilities (Jorgensen, Dobson and Heatherington, 2017; Heatherington, Jorgensen and Walker, 2019). The buildings, facilities and equipment in the traditional industrial areas of the city centre are relatively outdated, and the backwardness and pollution of the industrial zones are a growing concern. Research by Loures, Panagopoulos and Burley (2016) shows that it is important to actively use the history, civilization, and culture of the industrial heritage while giving it a new function. For example, the "North Duisburg Landscape Park" is a renovation of a closed steel factory in Germany. It preserves the original structures and vegetation while presenting the original industrial character and landscape, creates a time travel experience and has many functions, such as catering, sports, museums, and entertainment (Gao and Liang, 2013). At the same time, Wilkinson and Harvey (2017) have argued that industrial heritage provides evidence of the economic development of a certain period and reflects the social characteristics of that time. This means that if not properly preserved and promoted, the memory of the city may be lost.

So far, there are few studies on the evaluation of industrial heritage landscape, and most of them focus on the planning and designing of industrial heritage landscape rather than the assessment of industrial heritage value (Cenci, 2018). Therefore, in order to plan land use, the management of urban landscape and the study of urban aesthetics and historical completeness, it is necessary to classify and evaluate different types of heritage forms and to address the lack of theoretical research on the classification and evaluation of industrial heritage landscape (Harvey and Waterton, 2015).

1.2 Research Problem

There is a conflict between heritage conservation and urban transformation and development; in the context of rapid urban expansion, a large number of industries located in city centres face relocation and become industrial heritage. These industrial heritage sites have become the object of competition between the government and real estate developers because of their location, their large area and their easy access to transport. However, as it is impossible and unrealistic to preserve all these industrial relics, there is a need to properly assess their value and to preserve those that have significant value as industrial heritage. The complexity of assessing the value of industrial heritage due to the different types of industrial heritage has become one of the most pressing issues in the establishment of a method for defining the value of industrial heritage.

1.3 Research Aim

The research aims to find the most effective ways to classify and evaluate the industrial heritage landscape, and will develop a new, comprehensive method for the classification, evaluation and presentation of industrial heritage landscape.

1.4 Research Hypothesis

(1) A classification method suitable for the industrial heritage landscape could be further developed.

(2) The evaluation method combining the Analytic Hierarchy Process (AHP) and Historical Landscape Characterisation (HLC) may lead to a more refined data analysis relevant for the evaluation of the industrial heritage landscape.

Saaty (1990) developed the Analytic Hierarchy Process (AHP) as an analytic method combining qualitative and quantitative analysis. AHP has been widely used in the comprehensive evaluation of garden landscapes such as parks and urban roads and in the analysis of complex problems with multiple criteria and objectives.

As one of the forms of landscape archaeology, the historical landscape characterisation (HLC) is used to understand and express the landscape (Aldred and Fairclough, 2003). The HLC is using the identified historic landscape character map as the basis to classify the sensitivity and value of each type by assessing the quality value. It is also used to guide planning practices such as land use planning and infrastructure site selection.

1.5 Research Questions

(1) What are the multifaceted values of the industrial heritage landscape?

(2) What classification, evaluation and presentation methods are used for the industrial heritage landscape?

(3) What is the most effective way to do that in the selected research area by using existing methods and developing new ones as appropriate?

(4) How the proposed method could be validated?

1.6 Research Objectives

(1) To find out the multifaceted value of the industrial heritage landscape.

(2) To identify classification, evaluation and presentation methods used for the industrial heritage landscape.

(3) To investigate the ways in which the above methods can be combined and used in the selected research area.

(4) To validate the new method.

1.7 Theoretical Framework

The aim of the theoretical framework is to identify different approach theories, to give a theoretical underpinning to my thesis, including the concept and connotation of industrial heritage, the evaluation methods now available and the strategies for its renovation and renewal, and to identify their benefits, efficiency and critically analyse them. The initial theoretical framework is shown in Figure 1.

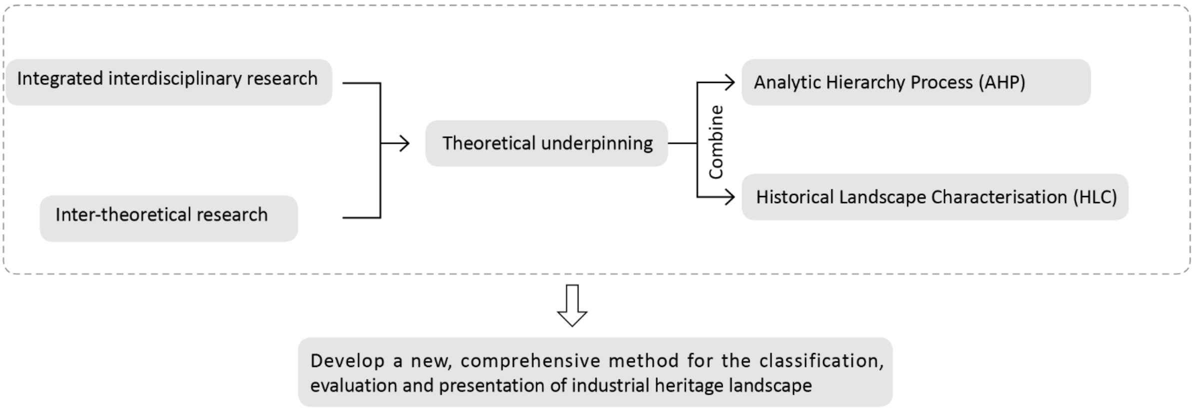


Figure 1. Initial Theoretical Framework

1.8 Thesis Structure

Following the above definition of research aim, questions and objectives (see Chapter 1), the research will entail the following phases:

(1) Investigation: Obtain knowledge by reading the literature on current methods of evaluation and classification of industrial heritage landscapes. Field research and collecting data on the selected industrial heritage site(s).

(2) Innovation: Combine Analytic Hierarchy Process (AHP) and Historical Landscape Characterisation (HLC) methods for evaluation of industrial heritage landscapes, and expand as needed based on the analysis and synthesis of data on the selected industrial heritage site(s).

(3) Practical application: Use the new combined and expanded Analytic Hierarchy Process (AHP) and Historical Landscape Characterisation (HLC) methods in selected locations.

(4) Validation: Undertake a survey by designing questionnaires and sending them to the public; analytical presentation of survey results. Possible improvements of the evaluation framework based on the survey results.

(5) Discussion on the research findings and Conclusions: Examine to what extent the research objectives have been met and identify potential future research.

The study of the classification and evaluation method of industrial heritage landscape in Shaanxi, China, contains six key parts: (1) problem identification and hypothesis; (2) problem analysis; (3) solution development; (4) solution testing; (5) solution refinement; (6) discussion and conclusions. The thesis structure is shown in Figure 2.

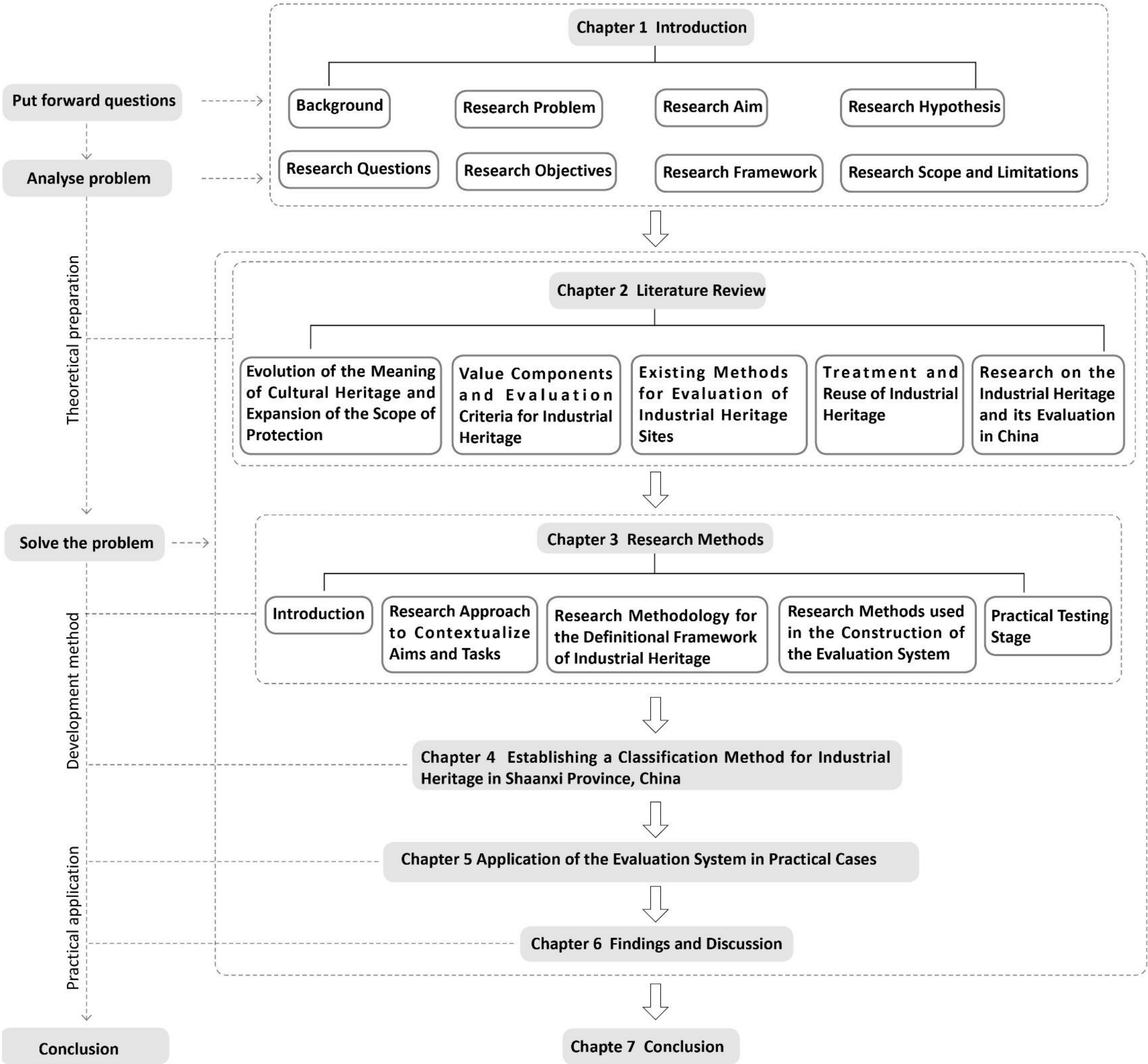


Figure 2. Flow Chart of Thesis Structure

1.9 Research Scope and Limitations

This research is about the modern industrial heritage landscape in Shaanxi Province. Before presenting the content of the study, the concept of the research object, the scope of the study and important keywords need to be clearly defined and explained to ensure the logic and rigour of the study.

1.9.1 Research Conceptual Scope

1.9.1.1 Concepts Related to Cultural Heritage

(1) Heritage

According to the International Charter on Cultural Tourism of the International Council on Monuments and Sites (ICOMOS, 1999), heritage is a broad concept that encompasses natural and cultural environments, as well as landscapes, historic places, sites and built environments, and biodiversity, collections, past as well as ongoing cultural practices, knowledge and life experiences. It records and expresses the long process of historical development, forms elements of different national, religious, indigenous and regional identities, and is an indispensable part of what constitutes modern life (ICOMOS, 1999).

In 1982, the ICOMOS Canada French-Speaking Committee adopted the Charter for the preservation of Quebec's Heritage, also known as the Deschambault Declaration, which states that Heritage is defined as (ICOMOS, 1982): "*the combined creations and products of nature and man, in their entirety, that make up the environment in which we live in space and time. Heritage is a reality, a possession of the community, and a rich inheritance that may be passed on, which invites our recognition and our participation*." (Quebec Association for the Interpretation of the National Heritage, Committee on Terminology, July 1980).

(2) Cultural heritage

According to the 1972 UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage, the following shall be considered as "cultural heritage" for the purposes of this Convention (UNESCO, 1972, p.147): *"monuments: architectural* *works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science;*

groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science;

sites: works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view."

(3) Architectural heritage

Based on the Amsterdam Declaration of the European Congress on Architectural Heritage (ICOMOS, 1975, p.5): *"The architectural heritage includes not only individual buildings of exceptional quality and their surroundings, but also all areas of towns or villages of historic or cultural interest."*

1.9.1.2 Concepts Related to Industrial Heritage Landscapes

(1) Industrial Heritage:

According to the Nizhny Tagil Charter on Industrial Heritage of the International Committee for the Conservation of Industrial Heritage (TICCIH), (TICCIH, 2003, p.2): *"Industrial heritage consists of the remains of industrial culture which are of historical, technological, social, architectural or scientific value. These remains consist of buildings and machinery, workshops, mills and factories, mines and sites for processing and refining, warehouses and stores, places where energy is generated, transmitted and used, transport and all its infrastructure, as well as places used for social activities related to industry such as housing, religious worship or education."*

1.9.1.3 The Concept of Industrial Heritage Landscape

At present, there are several industrial heritage landscapes in various countries around the world, such as the Windmills of Kinderdijk in the Netherlands, the Derwent Valley

Industrial Estate and the Cornwall and West Devon Mines in the United Kingdom, and the Canal du Midi in France, which are industrial remains of special value left behind by human beings after carrying out industrial activities, and integrate with the surrounding natural landscape environment to form a self-contained landscape, constituting a unique industrial heritage landscape (Falser, 2001).

Although some scholars currently point out that industrial heritage landscapes are industrial sites, and that ruins and heritage constitute industrial landscapes (Läuferts and Mavunganidze, 2009; Sutestad and Mosler, 2016), no scholars in the academia have yet made a consistent definition of industrial heritage landscapes. According to the concept of industrial heritage and the concept of post-industrial landscape, and studying the way existing industrial heritage landscapes exist and their inherent humanistic connotations, industrial heritage landscapes can be considered in a broader sense as post-industrial landscapes with industrial heritage values.

This study considers that industrial heritage landscapes in the broad sense are industrial heritage landscape complexes consisting of industrial remains of universal value, industrial sites, industrial heritage and their surroundings. An industrial heritage landscape in the narrow sense is the remains of an industrial civilisation with historical, social, technological, aesthetic, architectural or scientific value. It has real or potential heritage value, including both the natural landscape environment and human landscape with new functions and meanings formed after planning, transforming and reorganising the natural and artificial elements of these remains, and also the landscape environment left behind by the industrial production activities without human modification with the above values.

In terms of the scope of sites included in the concept, the industrial heritage landscape in the broad sense includes all sites of universal value related to industrial production, including both abandoned sites and industrial sites in use; the industrial heritage landscape in the narrow sense mainly refers to sites left behind after industrial production. In terms of the scope of value, industrial heritage landscapes in the narrower sense have only universal value; industrial heritage landscapes in the broader sense have special human and emotional value based on universal value.

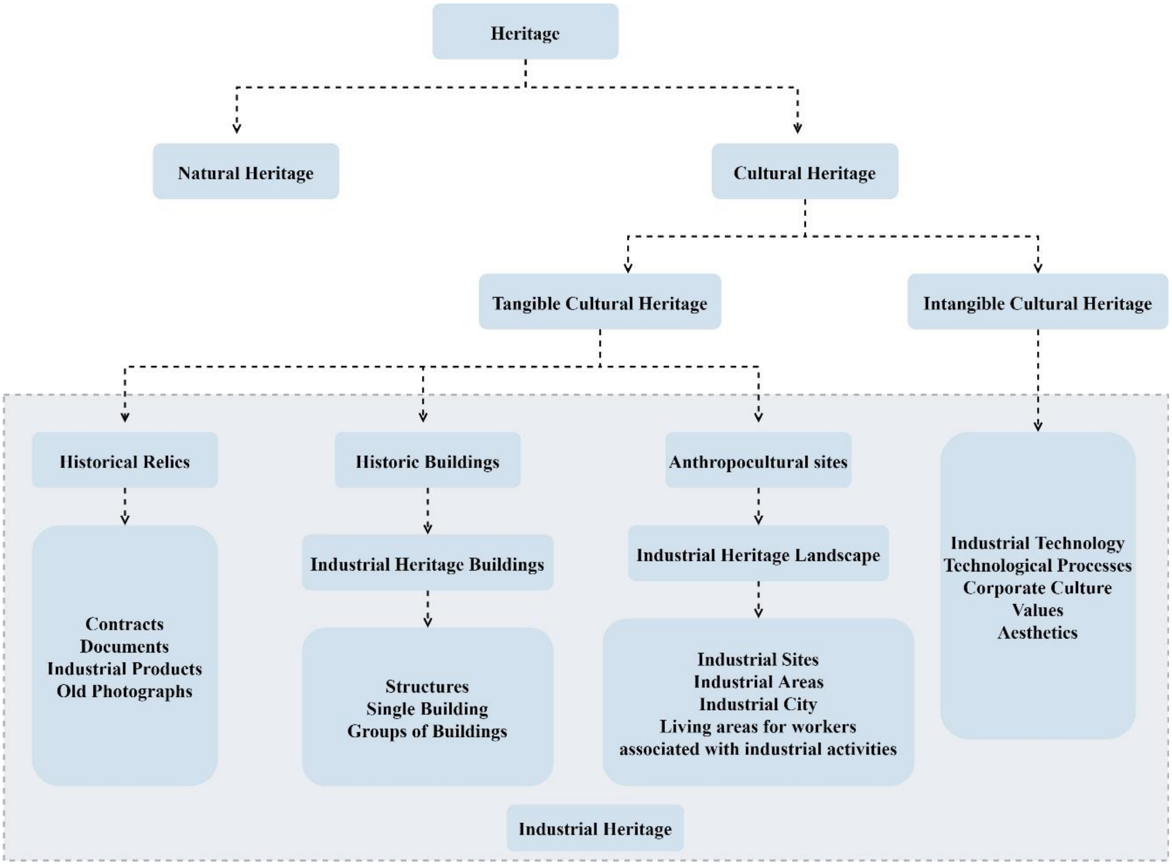


Figure 3. The Relationship Between Heritage and Industrial Heritage Landscapes

As can be seen from the Figure 3, industrial heritage landscape belongs to the category of industrial heritage, and industrial heritage includes part of heritage buildings and heritage landscape. In the research content of industrial heritage landscape, the buildings in the site are not studied in depth in the direction of architecture, but as landscape elements in the site, and the relationship between their shape and colour and the surrounding natural environment is studied.

1.9.1.4 Composition of Industrial Heritage Landscapes

As a landscape complex, the industrial heritage landscape includes tangible and intangible landscape resources in its resource composition (Zhang, Cenci and Becue, 2021). Tangible industrial heritage landscape resources include industrial cities, industrial areas or lots in cities, industrial sites, industrial buildings, machines, and workers' living areas related to industrial production. Intangible industrial heritage landscape resources are the historical information and corporate culture, values and aesthetics of the times, and other ideologies that are attached to the tangible resources.

1.9.2 Research Regional Scope

The research regional scope is Shaanxi Province, China. Shaanxi Province has a long industrial history and a rich industrial heritage, including industrial heritage buildings and landscapes. The food industry, the automobile industry, textiles, wine-making and mineral industry remain in the province. Researching on a provincial basis will make the research results more focused and representative.

1.9.3 Research Time Scope

The research on industrial heritage in this study is limited to the industrial heritage that has survived since the Opium Wars. This includes the industrial heritage between 1840 and 1949 and the modern industrial heritage from 1949 to the present.

1.9.4 Research Limitations

Some factories may be closed due to the impact of the COVID-19 pandemic, which may lead to delays in data collection for the field study.

Chapter 2. Literature Review

2.1 Introduction

At present, there has been significant progress in research on industrial heritage, which has important relevance to the evaluation of the industrial heritage landscape. Some researchers have also applied their research results in various fields such as tourism (Liu, 2012), law (Xie, 2006), and landscape design (Li et al., 2017). The research on industrial heritage is divided into three main directions: research on the value of industrial heritage, research on the existing evaluation methods of industrial heritage, and research on the progress of the treatment and reuse of industrial heritage. Each direction of research relates to the evaluation of industrial heritage methods, and has implications for the study of industrial heritage landscape evaluation. In this chapter, the literature is reviewed from the aspects of evolution of the meaning of cultural heritage and expansion of the scope of protection, value components and evaluation criteria for industrial heritage , existing methods for evaluation of industrial heritage sites, treatment and reuse of industrial heritage, research on the industrial heritage and its evaluation in China with a view to laying a solid theoretical foundation for the study.

2.2 Evolution of the Meaning of Cultural Heritage and Expansion of the Scope of Protection

The understanding of the concept of heritage has evolved over time. The different definitions of the concept of heritage in a large number of international charters are a good illustration of the many evolutions of the concept of heritage, for example, from individual heritage monuments to the totality of the historic environment, from land to underwater, and from the tangible to the intangible (Dawson, 2004). These evolutions have witnessed the attention and reflection given to the meaning of heritage and the scope of its protection at different times.

2.2.1 Evolving Concepts of Cultural Heritage Conservation

2.2.1.1 Extension of the Tangible Heritage Conservation Entity: from Individual Heritage Monuments to the Historic Environment as a Whole

The first International Congress of Architects and Technicians of Monuments was held in Athens in 1931 (ICOMOS, 1931). The Congress adopted the "Athens Charter for the Restoration of Historic Monuments". This Congress, in addition to referring to the restoration of monuments, included the area around historical monuments in the scope of protection, and was the prototype and basis for the Venice Charter that was later enacted (Cristina, 1997). It was also the first official document accepted by an international government to protect cultural heritage, signalling the beginning of an international consensus on cultural heritage protection (Cristina, 1997). However, as the understanding of specific protection measures and methods for monuments was not uniform among countries at that time, a vague approach was adopted.

The concept of heritage was defined in the Venice Charter for the Conservation and Restoration of Monuments and Sites, known as the Venice Charter, adopted in Venice in 1964 by the Second International Congress of Architects and Technicians of Monuments (ICOMOS, 1964). According to the Charter, not only single architectural works, but also historic urban or rural environments that bear witness to the existence of a civilisation or embody a meaningful historical event can be included in the concept of the historic monument. Historic monument can be used not only to refer to great works of art, but also to the more modest works of historical and cultural significance.

The Charter expanded the scope of monuments from buildings to cities and villages, and further expanded the concept of "monument" to provide for the protection of historical information attached to the monumental entity, which means that emphasis was placed on the protection of environments with historical and cultural characteristics. This laid the foundation for the protection of historic gardens, historic sites and historic towns (ICOMOS, 1964).

Alao, the Charter no longer dwells on the national and state attributes of cultural heritage, raises the awareness of the common heritage of mankind, comprehensively and systematically expresses the understanding, concepts, guiding ideology and technical methods of cultural heritage protection, and lays a scientific foundation for cultural heritage protection (ICOMOS, 1964). However, the Charter does not describe what historic properties and sites include, nor does it specifically discuss the character of the urban and rural environments (ICOMOS, 1964).

Congress International Architecture Modern (CIAM) met in Athens in 1933. The conference adopted the Athens Charter. This was the first internationally recognised programme document for urban planning. The proposal of Legacy of History was made, but it was not taken seriously in theory and practice (Gold, 1998).

In the mid-twentieth century, in the context of the devastating destruction of cultural heritage by the Second World War, which attracted widespread international attention, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) adopted the Hague Convention in The Hague, the Netherlands, in 1954, which shifted the centre of gravity to the protection of cultural property in the course of armed conflict (UNESCO, 1954).

2.2.2 Integration of the Concept of Cultural Heritage Protection

In 1972, the seventeenth session of UNESCO in Paris adopted the Convention Concerning the Protection of the World Cultural and Natural Heritage, which consolidated all the previous objects of protection and introduced the concepts of Cultural Heritage and Natural Heritage. It suggests that cultural heritage should include Monuments, Groups of buildings and Sites; natural heritage should include natural landscapes, ecological zones of animals and plants, and natural areas, and proposes measures for protection, which provide an institutional guarantee for heritage protection (UNESCO, 1972).

2.2.3 Expansion and Diversification of Cultural Heritage Protection

The diversity of the world's cultural heritage has been enhanced by expanding the scope of heritage conservation objects.

In 1976, the 19th session of UNESCO adopted the Recommendation concerning the Safeguarding and Contemporary Role of Historic Areas, also known as the Nairobi Recommendation. The general principles of the Recommendation emphasise that

"Historic areas and their surroundings should be actively protected, against damage of all kinds." (UNESCO, 1976, p.137).

The Australia ICOMOS (1979) adopted the Barra Charter, which is an academic and operational charter with a high degree of international renown, and which guides the protection and management of culturally significant sites and cultural heritage sites (Waterton, Smith and Campbell, 2006).

The Charter of Machu Picchu (1979) recommendation with regard to the preservation and protection of cultural values and historical heritage is to protect and preserve not only the city's historical monuments and sites, but also its cultural heritage. It is essential that efforts to conserve, restore and recycle existing historic areas and architectural monuments be integrated with the process of urban development in order to ensure their proper financial support and continued viability.

The Florence Charter, adopted by the Eighth General Assembly of the International Council on Monuments and Sites (ICOMOS) in Florence in 1981, defines the concept of "historic gardens" and the principles of their maintenance, conservation, restoration and reconstruction (ICOMOS, 1982). Historic gardens are included in the category of "historic monuments" and must be preserved in accordance with the provisions of the Venice Charter. The Florence Charter, based on the Venice Charter, explains the concept of "historic gardens" and sets out specific provisions for their maintenance, conservation and restoration, laying down the principles of conservation of historic gardens in the contemporary sense.

The Charter for the Conservation of Historic Towns and Urban Areas, also known as the Washington Charter, was adopted by the Eighth Plenary Session of the ICOMOS in 1987, which broadened the concept and content of the conservation of historic monuments and introduced the concepts of historic districts and historic urban areas (ICOMOS, 1987). The Charter refers to historic urban areas, which include "cities, towns and historic centres or settlements, as well as their natural and man-made environments", and protects the environment through the creation of buffer zones, with an emphasis on the preservation and continuation of people's lives in historic areas (ICOMOS, 1987). Since the concept of "intangible cultural heritage" was first introduced in the Law for the

Protection of Cultural Property enacted in Japan in 1950, the space for the protection of cultural heritage has been greatly expanded (UNESCO, 1950).

UNESCO set up the Committee of Experts on the Safeguarding of Folklore in 1982, and in the same year established “Section for the Non-Physical Heritage” This was the first international standard on the protection of intangible cultural heritage and a major turning point in the history of intangible cultural heritage protection (Bedjaoui, 2004). However, the lack of binding force of the Recommendation and the absence of provisions for its implementation meant that its role was not fully utilised in practice.

The NARA document on authenticity was drafted by UNESCO, the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), and the Ministry of Cultural Affairs of the Government of Japan in 1994 at the Nara Authenticity Conference related to the World Heritage Convention. The document follows the spirit of the Venice Charter, which elaborates on the concept and application of "authenticity" of cultural heritage, and rigorously verifies its "authenticity" (ICOMOS, 1994).

Dissemination of information on cultural heritage has been carried out successively after the relative perfection of heritage protection. The 1998 China-Europe Conference of Mayors of Historic Cities adopted the Suzhou Declaration on International Co-operation for Safeguarding & Development of Historic Cities, calling on countries to recognise the need to disseminate information (UNESCO, 1998). At the same time, the protection of historic cities should be strengthened according to the needs of social and economic development, and the principle of sustainable development should be followed in order to seek ways to protect the world's cultural heritage for the future (UNESCO, 1998).

In 1999, the ICOMOS issued the Charter of the Built Vernacular Heritage, which extends the concept of conservation to vernacular architecture, stating that vernacular architecture is "a fundamental expression of the culture of a society, of the relationship between the society and the region in which it is situated, and of the cultural diversity of the world" (ICOMOS, 1999).

Another achievement of World Heritage conservation in 1999 was the adoption ICOMOS of the International Cultural Tourism Charter - Managing Tourism at Places of Heritage Significance (ICOMOS, 1999). For the first time, the needs of tourists were taken into account and the expectations of tourists and the aspirations of local communities were realised (Zhao et al., 2023). The Charter encourages the involvement of local communities and tourists in heritage conservation and management, as well as the formulation of detailed and pragmatic development strategies and plans for the presentation of heritage sites and related cultural activities on the basis of conservation (ICOMOS, 1999).

In order to protect underwater cultural heritage from commercial exploitation, UNESCO promulgated the Convention on the Protection of the Underwater Cultural Heritage in 2001, recommending that States Parties carry out scientific exploration, protection and research on underwater cultural heritage (UNESCO, 2001). In the same year, the characteristics of cultural diversity also attracted much attention. UNESCO issued the Universal Declaration on Cultural Diversity in the hope that countries would respect and acknowledge cultural diversity and develop a broader solidarity and mutual exchange based on the recognition of cultural globalisation. The Declaration created new conditions for the intermingling of cultures (UNESCO, 2001).

The Seventh General Assembly of the International Council of Museums (ICOM) Asia-Pacific Region and the International Symposium on the Intangible Cultural Heritage of Museums adopted the Shanghai Charter in Shanghai in 2002, proposing the presentation of intangible cultural heritage by means of museums, which has had a great impact on the promotion of heritage conservation and utilisation, on local development as well as on the evolution of the concept and function of museums (ICOM, 2002). The concept of an "eco-museum", another type of museum, was proposed by the French in 1971 and introduced into China in 1990, and has had a better development in China since then (Liu, 2014).

In 2002, the Budapest Declaration on World Heritage issued by UNESCO once again called on States Parties to co-operate with each other in the protection of cultural heritage, and to share the responsibility for the protection and promotion of cultural heritage, so as to achieve the sustainable development of cultural heritage (UNESCO, 2002).

With the increasing awareness of human civilisation, the scope of protection of cultural heritage continues to expand. The ICOMOS issued the Principles for the Preservation and Conservation/Restoration of Wall Paintings in 2003, which emphasises that intervention in wall paintings should be carried out in the "smallest possible way" and "encourages the use of traditional materials", and stipulates the protection and restoration of wall paintings (ICOMOS, 2003).

In 2003, the 32nd UNESCO General Conference adopted the Convention for the Safeguarding of the Intangible Cultural Heritage, which defines ICH. It requires countries to make an inventory of existing intangible cultural heritage and to list heritage items that need to be rescued and that are of significance, providing a sense of identity for the communities and groups that pass on the intangible cultural heritage (UNESCO, 2003).

The International Committee for the Conservation of the Industrial Heritage (TICCIH) adopted in 2003 the Nizhny Tagil Charter on the Industrial Heritage, which elaborates on the content of the industrial heritage and provides a forward-looking perspective on most of the issues related to its conservation (TICCIH, 2003). This is the first international consensus document on the protection of industrial heritage, and the promulgation of this Charter is regarded as a landmark event in international industrial heritage protection. Industrial heritage has since been recognised as an integral part of cultural heritage (Lu, Liu and Wang, 2020).

The Xi'an declaration on the conservation of the setting of heritage structures, sites and areas, issued by ICOMOS in 2005, referred to as the Xi'an Declaration, raised the importance of the environment for heritage and monuments to a new level. The declaration extends the protection of cultural heritage to social or spiritual practices, customs, and traditional knowledge (ICOMOS, 2005).

The World Heritage Committee drafted the Vienna Memorandum on "World Heritage and Contemporary Architecture - Managing the Historic Urban Landscape" in 2005, which put forward the concept of historic urban landscape, emphasised the importance of historic urban landscape conservation and gave relevant recommendations (UNESCO, 2005). In the same year, UNESCO issued the Declaration on the Conservation of Historic Urban Landscapes. It builds on the Vienna Memorandum and addresses the key dilemma of contemporary architecture in historic urban landscapes (UNESCO, 2005). It also states that "The central challenge of contemporary architecture in the historic urban landscape is to respond to development dynamics in order to facilitate socio-economic changes and growth on the one hand, while simultaneously respecting the inherited townscape and its landscape setting on the other", and "in this process, the historic city's authenticity and integrity, which are determined by various factors, must not be compromised" (UNESCO, 2005).

The 17th General Assembly of ICOMOS in 2011 adopted the Principles for the Conservation of Industrial Heritage Sites, Structures, Areas and Landscapes, also known as the Dublin Principles (ICOMOS, 2011). The Principles take the issue of "integrity" of industrial heritage conservation to a new level by placing special emphasis on "Areas and Landscapes" on the basis of industrial heritage conservation (ICOMOS, 2011). The environment and intangible cultural heritage, which have been neglected in industrial heritage conservation, are emphasised in the Dublin Principles.

The Taipei Declaration, adopted by the 15th meeting of the International Committee for the Conservation of the Industrial Heritage in 2012, focused more on the conservation of industrial heritage in Asia (TICCIH, 2012). Subsequently, the 15th Ministerial Meeting of the Asia Co-operation Dialogue (ACD) adopted the Abu Dhabi Declaration at Abu Dhabi, UAE, in 2016, with the aim of preserving the endangered cultural heritage of peoples and cultural heritage endangered in the context of armed conflict (ICOMOS, 2016).

Under the leadership of international organisations, the legal system for the protection of the world's cultural heritage is constantly being improved, involving a wide variety of cultures and placing greater emphasis on the international consensus on the protection of cultural heritage. It is thus evident that the protection of cultural heritage is receiving increasing attention from the international community.

2.2.4 Value Perception and Protection Strategy of Cultural Heritage

The protection of cultural heritage is a complex social system project, and due to the ever-changing perception of the value of cultural heritage, the elements of protection and the time limit for the conservation of cultural heritage have been under dynamic development (Lin et al. 2023). Recognising and judging the value of cultural heritage is not only the basis for determining cultural heritage, but also the basis for protecting it. Therefore, the heritage community shares the view that the question of value is the main issue in modern heritage conservation (Taher Tolou Del, Saleh Sedghpour and Kamali Tabrizi, 2020).

Since the establishment of the Athens Charter in 1931, the international cultural heritage protection community's perception of the meaning of cultural heritage has deepened with practice (Liang, Ahmad and Mohidin, 2023). In this process, the value of cultural heritage has always been at the centre of the concept of heritage (Lin et al., 2023), and thus the perception of the value of cultural heritage can be reflected in the various concepts of heritage in the international representative documents of different periods.

2.2.4.1 Ancient Favouring Memorial Value, Light Entity Protection

In ancient times, there was no concept of cultural relics protection, and the value cognition favoured the commemorative value of "monument", and the material entity was not an important object of protection. At this stage, the importance of the monument is always related to the spirit and symbols given when it was originally built, and the essence of the "protection" behaviour is to maintain the "commemorative" significance of the monument (Chai and Li, 2019).

2.2.4.2 From Emphasis on Artistic Value to Historical Value, From Stylisation to Maintenance of Restoration and Conservation (1790-1920)

In terms of international organisations' perception of the value of cultural heritage, the 1897 and 1904 congresses held by the International Congress of Architects dealt with the restoration of historic buildings (Yazdani Mehr, 2019).

At the 1904 Congress in Madrid, the Preservation and Restoration of Ancient Monuments recommendation was adopted, which mentioned that restoration should be carried out in the original style of the monument (Tamura, 2013). Meanwhile, the concepts of the anti-restoration movement that emerged in England in 1850, represented by the writer and art critic John Ruskin (1819-1900) and the poet, fine arts and crafts designer Williams Morris (1834-1896), were very close to the modern principles of conservation, such as authenticity, minimal intervention and legibility (Yount, 2005).

2.2.5 Expansion of the Diversity of Cultural Heritage Values, from the Single Unit to the Whole Space Protection Method Associated with It (1930-1980)

2.2.5.1 Perception of Cultural Heritage Values

Between 1930 and 1980, the United Nations Educational, Scientific and Cultural Organization (UNESCO) (1945), the International Council of Museums (ICOM) (1946), the International Union for the Conservation of Nature (IUCN) (1948), the International Centre for the Study of the Preservation and Restoration of Cultural Heritage (ICCROM) (1956), the International Council on Monuments and Sites (ICOMOS (1965), the World Heritage Committee (WHC) (1972) and the International Committee for the Conservation of Industrial Heritage (TICCIH) (1978) promoted the extension of the material value of heritage.

2.2.5.2 Concepts and Methods of Cultural Heritage Protection

The methodology of cultural heritage protection has evolved from the absence of uniform protection principles to the establishment of monument protection principles, the formation of the concept of historical environmental protection and the establishment of a comprehensive approach to the protection of the historical environment (Petzet, 2004).

The Athens Charter on the Restoration of Historical Monuments of 1931 and the Athens Charter of 1933 laid down the foundational principles of monument protection: abandonment of restoration in style, avoidance of reconstruction, favouring of the authentic state of historical monuments, and preservation of the authentic information contained in historical monuments and works of art (Iamandi, 1997).

The Venice Charter of 1964 established the theoretical basis for the protection of cultural heritage, clarifying that the basis for protection is the historical information of the material entity of the monument (Petzet, 2004). It also expands the concept of "monument", emphasises the protection of the environment in which the monument is located, and specifies the principles of environmental protection related to "monuments" with historical and cultural characteristics (ICOMOS, 1964).

The 1975 European Charter for the Architectural Heritage stresses the synergetic conservation and restoration of monumental buildings and their surroundings, and that the organisation of historic centres and districts is conducive to the maintenance of a harmonious social balance. Article 7 of the Charter states that the implementation of a holistic approach to conservation requires support from legal, managerial, financial, technical and information exchange and international cooperation (ICOMOS, 1975).

The Nairobi Recommendations of 1976, from the standpoint of administrative legislation, technology and economic and social development, propose ways and means of preserving historic areas at both the general and local levels and of solving social and economic problems by subsidising the restoration of old buildings, drawing up regulations for new buildings, and disseminating information on cultural heritage preservation among the population (UNESCO, 1976).

The Convention for the Protection of the Architectural Heritage of Europe of 1985 explicitly identifies the protection of the architectural heritage as a key objective of town and country planning, ensures that this requirement is taken into account throughout all stages of the preparation of development plans and approvals, and establishes a comprehensive European conservation policy in Europe as a whole (Pickard, 2002; Granada, 1985).

The Washington Charter of 1987 emphasises that the conservation of cultural heritage is not only one of the main objectives of town planning, but that it should be made an integral part of the social development policies and plans of towns and cities (ICOMOS, 1987).

2.2.5.3 From Tangible and Intangible Values to Cultural Heritage Values, with Emphasis on the Originality and Integrity of Protection (1990 to present)

(1) Perception of cultural heritage values

The 1990s were the period in which the largest number of charters for the protection of cultural heritage were adopted by international organisations and countries around the world (Pickard, 2002). Following the Recommendation on the Safeguarding of Traditional Culture and Folklore issued by UNESCO in 1989, the heritage conservation community also turned its attention to intangible cultural heritage, which in turn led to a gradual expansion of the perception of the value of cultural heritage from the tangible value of heritage, centred on historical value, to the intangible value, which is a shift that continues to this day (Lazaro Ortiz and Jimenez de Madariaga, 2022; Lin et al., 2023).

At the same time, various intangible values of tangible cultural heritage have been recognised, such as continuity and identity; traditional land use, the role of public space in group interaction; and the integration of other socio-economic and environmental factors (Nic Craith, 2015; Munjeri, 2004).

In addition, as a result of the awakening of national cultural awareness and identity brought about by the dramatic changes in the world political landscape after the end of the Cold War and the crisis of cultural diversity in the field of culture as a result of globalisation, there has been a shift in the perception of the value of heritage from a focus on universal global values to unique cultural values (Harvey, 2001). This can be seen from the fact that a number of countries have developed national guidelines for cultural heritage protection under the guidance of international heritage protection documents, in response to specific problems faced by their own protection practices, such as A Preservation Charter for the Historic Towns and Areas of the U.S. (1992), the New Zealand Charter for the Conservation of Places of Cultural Heritage Value (revised in 2010), and the Principles for the Conservation of Heritage Sites in China (issued in 2000 and revised in 2015).

In the Burra Charter, as amended by Australia in 1979, the cultural significance means "aesthetic, historic, scientific or social value for past, present or future generations" (ICOMOS, 1979). The UNESCO adopted the Convention for the Safeguarding of the Intangible Cultural Heritage in 2003 (UNESCO, 2003) and the Convention on Diversity of Cultural Expressions in 2005 (UNESCO, 2003). In 2005, the ICOMOS adopted the Xi'an Declaration, which put forward the concept of "setting". As a result, it has become a common understanding that both tangible and intangible cultural heritage are important vehicles for the transmission of culture and the promotion of spirituality (ICOMOS, 2005). The protection of cultural heritage has also become one of the most important global and local issues (Tarrafa Pereira da Silva and Pereira Roders, 2021).

(2) Protection concepts and methods

From the 1990s to the present, the main documents adopted by international organisations for the protection of cultural heritage include:

Table 1. List of Main Documents

	Name of documents	Name of issuing organisation	Year
1	Recommendation concerning the Safeguarding and Contemporary Role of Historic Areas	UNESCO	1976
2	The NARA document on authenticity	ICOMOS	1994
3	International Cultural Tourism Charter Managing Tourism	ICOMOS	1999
4	Charter of the Built Vernacular Heritage	ICOMOS	1999
5	Convention on the Protection of the Underwater Cultural Heritage	UNESCO	2001
6	Text of the Convention for the Safeguarding of the Intangible Cultural Heritage	UNESCO	2003
7	ICOMOS charter Principles for the analysis, conservation and Structural Restoration of Architectural Heritage	ICOMOS	2003
8	Nizhny Tagil Charter on Industrial Heritage	TICCIH	2003
9	World Heritage and Contemporary Architecture - Managing the Historic Urban Landscape	UNESCO	2005
10	Xi'an declaration on the conservation of the setting of heritage structures, sites and areas	ICOMOS	2005
11	Convention on the Protection and Promotion of the Diversity of Cultural Expressions	UNESCO	2005
12	The ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites	ICOMOS	2008
13	The ICOMOS Charter on Cultural Routes	ICOMOS	2008
14	QUÉBEC DECLARATION on The Preservation of the Spirit of Place	UNESCO	2008
15	Hoi An Protocols for best conservation practice in Asia	UNESCO	2009
16	The Valletta Principles for the Safeguarding and Management of Historic Cities, Towns and Urban Areas	ICOMOS	2011
17	Recommendation on the Historic Urban Landscape, including a glossary of definitions	UNESCO	2011
18	Dublin Principles	ICOMOS	2011
19	The Florence Declaration on Heritage and Landscape as Human Values	ICOMOS	2014

These documents show that the international field of heritage conservation has undertaken sustained and in-depth research in response to specific types of heritage or specific conservation issues in relation to the work of conservation.

For example, the Valletta Principles for the Safeguarding and Management of Historic Cities, Towns and Urban Areas (the Valletta Principles), was issued by the ICOMOS (2011) to replace the Washington Charter of 24 years ago. The document explains the characteristics of historic towns as living heritage, focuses on the dynamic evolution and development of historic towns, and redefines the objectives, principles and intervention tools for their safeguarding and management (ICOMOS, 2011).

The Recommendation on the Historic Urban Landscape (2011) unifies the urban environment as a whole as urban heritage and proposes means and methods of integrating the conservation of urban heritage into the broader framework of urban development (UNESCO, 2011). The purpose of historic urban landscapes is not only conservation, which is only one part of the process, but also the preservation and enhancement of the overall living environment of human beings (UNESCO, 2011).

The Florence Declaration on Heritage and Landscapes as Human Values (2014) emphasises community-led interpretation and sustainable development of cultural heritage and landscapes, expanding the concept of "landscape", suggesting that landscapes are at the level of biodiversity and go beyond a single natural and cultural context (ICOMOS, 2014). As can be seen from the elements involved in the protection documents and the concept of protection, among the issues studied in depth in cultural heritage protection, the authenticity and integrity of cultural heritage is the core issue of heritage protection, and thus it is the foundation and core thought of cultural heritage protection, as well as the main guiding principle of cultural heritage protection practice.

Correspondingly, the attitude of protecting cultural heritage has changed from passively protecting the heritage ontology to actively controlling the changes for the purpose of transmission (Mekonnen, Bires and Berhanu, 2022).

As the sociability of heritage protection has become more and more prominent, the approach to cultural heritage protection has evolved from favouring the protection of the physical environment to a comprehensive approach to protection that not only protects the physical environment but also controls changes in economic and social development, which in turn leads to an integralist approach to protection.

2.3 Value Components and Evaluation Criteria for Industrial Heritage

The value composition of industrial heritage is a systematic generalisation and summary of the value of industrial heritage that exists objectively, and it is the basic definition of the value of industrial heritage. Research on the value composition of industrial heritage is the first step in establishing the evaluation method of industrial heritage.

This section studies the value composition of industrial heritage, points out the basic value of industrial heritage, analyses the criteria for the evaluation of industrial heritage value, identifies the relationship between the value of industrial heritage, the value of industrial architectural heritage and the value of cultural heritage, and lays a theoretical foundation for the establishment of the value evaluation system of modern industrial heritage in Shaanxi Province in terms of the value composition.

2.3.1 Study of the Value Composition of Heritage

Industrial heritage contains architectural heritage, and industrial heritage is contained in cultural heritage. Therefore, in order to analyse the value connotation and value composition of industrial heritage, it is necessary to study the value composition and characteristics of cultural heritage and architectural heritage.

2.3.1.1 Composition of Cultural Heritage Values

The meaning and scope of heritage has changed considerably since the 20th century. The meaning of heritage has developed into "the common cultural wealth left by our ancestors to all mankind", and the scope of heritage has expanded from general material wealth to encompass almost the entire content of human civilisation (Harvey, 2001).

According to the Convention Concerning the Protection of the World Cultural and Natural Heritage, an authoritative document in the field of world heritage protection, heritage can be classified into natural heritage and cultural heritage, depending on its cause, i.e. whether it is a legacy of the evolution of the Earth or a legacy of human behaviour (UNESCO, 1972).

It can be seen from the basis of the classification that the value requirements and selection conditions of cultural heritage are more relevant for the value analysis of industrial heritage than those of natural heritage.

Cultural heritage refers to the valuable legacy that can witness the creative activities carried out by human beings in the course of civilisation, and it includes both tangible and intangible cultural heritage (Munjeri, 2004). Tangible cultural heritage comprises artefacts, ensembles and sites. Intangible cultural heritage encompasses the ‘living cultural heritage’ of skills, experience and spirituality centred on human beings. Both tangible and intangible cultural heritage have historical, artistic, scientific and technological values, while the latter contains more cultural and social values than the former (UNESCO, 1972).

There are six conditions for the nomination of cultural heritage, which combine the value characteristics of both tangible and intangible cultural heritage. Each of these conditions characterises one or more aspects of cultural heritage values in particular and reflects the focus of the evaluation of the values of the heritage. Only if at least one or more of them are present at the nominated site, it will be recognised as a World Cultural Heritage (Table 2).

Table 2. UNESCO’s World Heritage Conditions and Corresponding Values

	Condition	**Value**	**Focus**
1	Represent a unique artistic achievement, a creative masterpiece	Artistic Value	Representativeness
2	Have had a disproportionate impact on architecture, monumental art, urban planning or landscape design over a period of time or in a cultural region of the world	Cultural Value Scientific and technological value	Representativeness
3	Provide a unique, or at least exceptional, testimony to an extinct civilisation or cultural tradition	Historical Value	Scarcity
4	Be an outstanding example of a building or group of buildings or a landscape illustrating an important phase or phases in the history of mankind	Historical Value Scientific and technological value	Representativeness

5	May be an outstanding example of a traditional human habitation or use, representing one or more cultures, particularly if it has become vulnerable to the effects of irreversible change	Cultural Value	Vulnerability
6	Have a direct or substantial connection with events， existing traditions， ideas， beliefs， works of literature or art of special universal significance	Cultural Value Social Value	Universality

2.3.1.2 Composition of Building Heritage Value

As a type of cultural heritage, built heritage is a tangible cultural heritage created by human beings, which is expressed in buildings (or structures). To be a built heritage, two conditions must be met: firstly, it must have a certain history, and secondly, it must have a certain value. Regarding the value of built heritage, a great deal of research and studies have been carried out by academics, with fruitful results (Riegl, 1982; Feilden, 1994).

For example, internationally: Alois Riegl, an Austrian art theorist, in his article "The Modern Cult of Cultural Objects: Its Disadvantages and Origins", summarised the value of cultural objects into two main categories: monumental and contemporary values, the former of which is subdivided into chronological, historical and intentional commemorative values; and the latter is divided into the value of use, artistic value and the creation of new values (Riegl, 1982).

Bernard M. Feilden established a system for evaluating the value of historic buildings in his book ‘Conservation of Historic Buildings’. In this evaluation system, he prioritises the value of historic buildings by dividing it into cultural value, emotional value, and use value (contemporary socio-economic value) (Feilden, 1994). The Russian scholar O. H. Prutsyn divided the value of architectural heritage into historical value, artistic-emotional value, scientific-restorative value, architectural aesthetic value, urban planning value and functional value, and explained each of these values (Prutsyn, 1990). These categorisations and interpretations of values reflect the different foci and emphases of researchers, and in different systems. Concepts with the same name have their own meanings in terms of connotations and extensions. For example, Prutsyn (1990) argues that historical values should focus on historical events and historical significance, while Feilden (1994) emphasises more on its scarcity.

In China, The Law of the People's Republic of China on the Protection of Cultural Relics (hereinafter referred to as the "Cultural Relics Law") divides cultural relics into movable and immovable cultural relics, of which the vast majority of the latter are architectural heritage (Huo, 2016).

Therefore, when evaluating the value of architectural heritage, the value criteria based on which the law classifies cultural heritage - historical value, artistic value and scientific value are often adopted or referred to. These three values summarise the core value of cultural heritage, but in fact, the value of cultural heritage is very rich in connotation (Ahmad, 2006; Li, 2020). It is worth mentioning that among these three major values, historical value is placed in the first position, reflecting the importance of the physical evidence of historical value of cultural heritage.

In addition to directly applying the value classification of cultural relics to classify the value of architectural heritage, the academia has also explored the difference between architectural heritage and cultural relics as well as the value characteristics of architectural heritage itself. For example, Song et al. (2014) divided the value of modern architectural heritage into basic value and subsidiary value, the basic value is the "three major values" in the Law on Cultural Relics, and the subsidiary value includes cultural and emotional value, environmental value and property value.

Wang (2012) believes that the value of architectural heritage should include five aspects, which are historical value, artistic value, scientific value, use value and landscape value. The first three of these five values are the basic values of architectural heritage, which are also derived from the Law on Cultural Heritage.

Qin (2013) summarised the value elements of architectural heritage as historical, artistic, scientific, cultural and educational and economic values, of which the first four are the cultural value of the heritage, and the latter is the derived value of the cultural value. In other words, economic value is not a non-dependent value inherent in architectural heritage itself, and economic value can only be derived when architectural heritage has cultural value.

It is now recognised in the academic community that built heritage has firstly the "three values" of cultural heritage and then its own special values. These special values generally focus on emphasising the cultural attributes of built heritage. Moreover, among these special values, the economic value is in a marginal state and is not a necessary item in the value composition of the built heritage.

2.3.2 International Research on the Value Composition of Industrial Heritage

The birth of industrial archaeology in the 1950s opened the prelude to the study of industrial heritage, and after more than 60 years of development, the international community and academia have gradually deepened and clarified their understanding of the value of industrial heritage, and the results of their research have continued to accumulate and innovate (Palmer, 2005). These achievements have been reflected in the landmark international charters on industrial heritage research on the one hand, and in the national evaluation standards of industrial heritage value on the other.

2.3.2.1 Composition of industrial (architectural) heritage values based on international charters and documents

Although the study of industrial heritage began in the 1950s, it was not until the First International Congress on Industrial Monuments (FICCIM) in 1973 that the international community's interest in industrial heritage increased significantly (Mihić and Makarun, 2017).

The internationalisation of industrial heritage research was marked by the establishment of the International Committee for the Conservation of Industrial Heritage (TICCIH) in 1978. It was the first international organisation in the world dedicated to industrial heritage research and conservation, and was later adopted by the International Council on Monuments and Sites (ICOMOS) as its own consultative body, specialising in providing advice on industrial heritage research.

As a result, industrial heritage research has become an integral part of global cultural heritage protection, and the international community's focus on industrial heritage has increased year by year. On this basis, the International Committee for the Protection of Industrial Heritage (ICPI) and the International Council on Monuments and Sites (ICOMOS) have started to develop international charters dedicated to the protection of industrial heritage.

From 2003 to the present, three international charters dedicated to the study of industrial heritage - the Nizhny Tagil Charter, the Dublin Principles and the Taipei Declaration - have been developed (TICCIH, 2003; TICCIH, 2011 and TICCIH, 2012).

(1) The Nizhny Tagil Charter (TICCIH, 2003)

As the world's first international charter dedicated to the study and protection of industrial heritage, the Nizhny Tagil Charter gives for the first time a clear definition of industrial heritage, points out the importance of recording, studying and identifying the value of industrial heritage, and establishes principles and norms as well as proposes methodologies and guidelines for the legislative protection of industrial heritage.

The Charter provides a preliminary definition of the content of industrial heritage values. It addresses the value of industrial heritage in four articles. The first article begins with a discussion of the historical value of industrial heritage. The Charter points out that human industrial activities have an important impact on the development of human society as a whole and that, as a direct testimony to these activities, the value of industrial heritage lies first and foremost in its historical value as a witness. It is also emphasised that the historical value of industrial heritage does not lie in the specificity of a particular case, but rather in its universal significance for all peoples.

The second article states that industrial heritage has a social value as part of the life of ordinary people; a technical and scientific value due to production, engineering and architectural needs; and an aesthetic value due to architectural and planning reasons. Furthermore, the third article points out that industrial heritage has intangible elements and that these intangible elements also have their own value. In its fourth article, it states that special types of industrial heritage have an added value due to their scarcity. The significance of the Charter lies in the fact that, for the first time, it recognises historical, social, scientific and technical and aesthetic values as the four fundamental values of industrial heritage.

Although the Charter does not explore the connotation of each value, it serves as a starting point for the study of the value of industrial heritage and establishes a basic framework for subsequent research.

(2) The Dublin Principles (TICCIH, 2011)

The Dublin Principles comprise a total of 14 articles in their entirety, with the exception of the opening two articles, which define industrial heritage and emphasise the characteristic attributes of industrial heritage, respectively, the remaining 12 articles are divided into four main parts.

The first part contains three articles dealing with the recording and understanding of the structural, locational, regional and landscape values of industrial heritage. The Dublin Principles build on the Nizhny Tagil Charter by further emphasising the value of the intangible components of industrial heritage, which are dispersed among the artistic, technological and cultural values of industrial heritage. In particular, in traditional industries, the technical and operational knowledge of the workers is a very important resource that must be included in the process of assessing the value of the heritage.

The Principles also emphasise that industrial heritage should be valued in its specific context and that the landscape of industrial heritage is also examined as a separate item in the valuation. It can be seen that the Principles analyse the value of industrial heritage in a more detailed and inclusive manner than the Charter, deepening and complementing the Charter.

(3) The Taipei Declaration (TICCIH, 2012)

The Taipei Declaration further emphasises the cultural value of industrial heritage. The technology, the mechanical operations, the knowledge and even the staff involved in industrial production are all part of the industrial heritage and are valued accordingly. The Declaration also points out that Asian industrial heritage is different from other regions in that it has its own characteristics in terms of the value it places on it.

Firstly, Asian industrial heritage is embedded in the relationship between people and land, which is extremely deep and strong, and this special cultural value of Asian industrial heritage should be taken into account in its valorisation and preservation. Secondly, much of Asia's industrial heritage is associated with colonial power and cultural imports, and this cultural heritage has value and should be preserved.

2.3.2.2 Typical Criteria for Recognising the Value of Industrial Heritage

In the field of industrial heritage research, western countries have always been in the leading position, especially represented by the UK. The study of industrial heritage recognition criteria in the UK is of great significance to the research on the value of industrial heritage in China. There are three tiers of heritage value assessment in the UK: the first level is English Heritage's categorisation of the value of cultural heritage. At the second level, there are a number of typologies and systems, of which the two most significant at the national level are the Scheduled Monuments and Listed Buildings, which are the general criteria for determining the value of the objects of study in their respective systems. The third level consists of guidelines for assessing the value of Scheduled Monuments and Listed Buildings in relation to specific types of heritage. English Heritage classifies the value of cultural heritage into four categories: evidential value, historic value, aesthetic value and communal value, which constitute the basic framework for the identification of cultural heritage value (Fredheim and Khalaf, 2016).

Scheduled Monuments classify archaeological sites, natural landscapes or landscapes that are both natural and man-made into 18 categories (Historic England, 2024). Scheduled Monuments have detailed identification criteria, including general identification criteria and identification guidelines for each type of heritage. The Scheduled Monuments define the general criteria as age, rarity, documentation, group value, survival, vulnerability, diversity and potential.

Also, the Scheduled Monuments divides industrial heritage into two parts: the Historical Overview and the Overarching Criteria. In addition, the Historical Overview describes the UK's industrial heritage in six periods, and the Overarching Criteria consists of eight items (Historic England, 2024). “Listed Buildings" focuses on historic buildings and structures. It divides historic buildings and structures into 20 categories. Like "Scheduled Monuments", "Listed Buildings" also have comprehensive general selection criteria and detailed selection guidelines for various types of buildings. The Principles of Selection for Listing Buildings divide the general criteria into statutory criteria and general principles (Historic England, 2011).

The statutory criteria are divided into two categories: architectural value and historic value; and the latter includes five categories: age and rarity, aesthetic value, selectivity, national value, and state of repair. In addition to the general criteria, the "Listed Buildings" are also subdivided into specific types of buildings, for which corresponding guidelines have been formulated. Guideline for the evaluation of industrial structures consists of a historical overview and general criteria. The historical overview describes industrial buildings in four periods. The general criteria are also divided into eight items. In addition, " Listed Buildings " classifies industrial structures and sets out more detailed guidelines on the characteristics of each type. The criteria for recognising industrial heritage in Scheduled Monuments and Listed Buildings are shown in Table 3, which is based on the Principles of selection for listed buildings (2010) and Industrial Buildings Listing Selection Guide (2011).

Table 3. The Historic England Criteria for the Identification of Industrial Heritage as "Scheduled Monuments" and "Listed Buildings"

	Scheduled Monuments		**Listed Buildings**	
General identification standard	Period Rarity Documentation/Finds Group value Survival/condition Fragility/vulnerability Diversity Potential		Statutory criteria	Architectural Interest; Historic Interest
			General Principles	Age and rarity; Aesthetic merits; Selectivity; National interest; State of repair
Industrial Buildings Listing Selection Guide	Historical Summary	Prehistoric and Roman Periods Anglo-Saxon and Viking Medieval 1550-1700 1700-1815 1815-1914	Up to 1700 1700-1850 1815-1914 1914-now	
	General Principles	Period Rarity, Representativity, Selectivity Documentation Historical Importance Group Value Survival/Condition Potential	Integrated sites Architectural display Regional factors Machinery Historic interest, including innovation Extent of listing	

2.3.3 Research on the Value Composition of Industrial Heritage in China

The research on industrial heritage in China has achieved fruitful results in its development during the past decade. As the basis for the protection and reuse of industrial heritage, the research on the value of industrial heritage in China has been gradually carried out and deepened, which is not only reflected in the laws, regulations and documents concerning industrial heritage, but also in the research of the academic community on the value composition of industrial heritage and the assessment of the value of industrial heritage in specific cities and regions.

2.3.3.1 Value Composition of Industrial Heritage under the Vision of Regulations and Documents

At present, the regulations and documents for the recognition of heritage value related to built heritage in China can be divided into two categories: cultural heritage value recognition system and industrial heritage value recognition system. Among them, the former has a larger scope and is the basic framework of the latter, while the latter is more targeted and more specific.

(1) Cultural Heritage Value Recognition System

At present, the prevailing cultural heritage value recognition system in China is the Cultural Relics Law of the People's Republic of China (2013) (hereinafter referred to as the Cultural Relics Law) and the Guidelines for the Protection of Cultural Relics and Monuments in China (2015) (hereinafter referred to as the Guidelines). The Cultural Relics Law is the basic law for the protection of China's cultural heritage, and Article 2, states that cultural relics have historical, artistic and scientific values. These three values are the basic values for determining the value of cultural heritage in China (Chai and Li, 2019).

The emphasis placed by the Cultural Relics Law on the historical value of cultural objects is consistent with the inherent nature of cultural objects. Cultural relics are the products of a specific historical era and have a specific epochal character (Li, 2015). The epochal nature of cultural relics lies on the one hand in the position of cultural relics in the era in which they were created, and on the other hand in the fact that cultural relics can reflect the multi-dimensional and multi-faceted situation of human societies in a certain period of history (Li, 2015), i.e. the epochal characteristics of human societies, that is to say, the historicity. This historicity is the most important characteristic of cultural relics (Erikse, 2014).

It enables people to know history concretely and figuratively as well as to restore the original appearance of history. In contrast to the emphasis on the historical value of cultural objects in the Cultural Relics Law, the Guidelines emphasise the social outreach of cultural heritage - social and cultural values (Chai and Li, 2019).

The shift in emphasis in the Guidelines on the valuation of cultural heritage is in line with the cultural shift in the valuation of world cultural heritage in recent years, which has seen a growing emphasis on the significant impact of heritage on local cultures and the societies in which they live. Both historical, social and cultural values are intrinsic to cultural heritage. Although the Cultural Relics Law and the Guidelines differ in their focus on heritage values, the basic values they propose are inherent to cultural heritage and are not predicated on other values.

(2) System for recognising the value of industrial heritage

The Wuxi Recommendations for the Protection of 20th Century Heritage were adopted by the Forum on the Protection of China's Industrial Heritage held on 18 April 2006 in Wuxi, Jiangsu Province, China (Mo, Wang and Rao, 2022). As the first document on industrial heritage in China, the Wuxi Recommendation defines industrial heritage for the first time and affirms the value of industrial heritage, pointing out that industrial heritage has historical, social, architectural, scientific and technological, and aesthetic values (Zhang, 2018). This was the earliest time that China defined the concept and classified the value of industrial heritage, which laid the foundation for the subsequent research on the value of industrial heritage in China.

In 2014, the Guidelines for the Protection and Utilisation of Industrial Heritage (Trial Draft) (hereinafter referred to as the Guidelines), which were jointly prepared by the China Cultural Heritage Administration and the China Academy of Cultural Heritage, were issued. The Guidelines are divided into five parts, namely general provisions, investigation, identification, protection, utilisation and management, with a total of 24 clauses, one of which is the assessment, identification and classification of the value of industrial heritage (Chu, 2016).

The Guidelines take the four basic values of historical, scientific and technological, artistic and social values as the criteria, and assess the value of industrial heritage comprehensively on the basis of five factors: authenticity, integrity, accessibility, scarcity and endangerment (Mo, Wang and Rao, 2022).

Based on the Wuxi Recommendation, the Guidelines make the value composition of industrial heritage more systematic and comprehensive, and establish an operational system for the assessment of industrial heritage value.

However, the Guidelines, as a nationally applicable universal standard, with a framework assessment of value and a broader assessment content and methodology, are applicable to the initial screening of industrial heritage in most regions of the country. Cities and regions should also determine the value characteristics of industrial heritage in their regions according to the actual situation of each place, and formulate detailed industrial heritage value assessment standards and evaluation index systems.

2.3.3.3 Research on Industrial Heritage Value Assessment

Since the Wuxi Recommendations, governments at all levels in China have begun to initiate the investigation and identification of urban industrial heritage, and some cities have introduced criteria for the identification of industrial heritage. At the same time, academics have also conducted value assessment studies of different forms and depths of industrial heritage in many cities or regions. The following is an analysis of the current research on the recognition of the value of urban industrial heritage in China, taking several key cities as examples.

(1) Beijing

In 2009, Beijing issued the Guidelines for the Protection and Re-use of Beijing's Industrial Heritage, stating that the criteria for assessing industrial heritage are historical value, socio-cultural value, scientific and technological value, artistic and aesthetic value and economic utilisation value.

The Guidelines refer to the way cultural heritage is recognised in the Convention for the Protection of the World Cultural and Natural Heritage and set five basic conditions, one of which can be recognised as industrial heritage. These five basic conditions pay attention to the characteristics of each value of industrial heritage in terms of scarcity, uniqueness, representativeness, advancement and integrity (Liu and Li, 2008).

In the academic research, Liu and Li (2008) divided the value of Beijing's industrial heritage into the "value given to industrial heritage by history" and the "value of current status, protection and reuse". The former includes historical value, scientific and technological value, social and cultural value, artistic and aesthetic value and economic utilisation value.

Historical value is divided into time and relationship with historical events and figures; scientific and technological value is divided into industry pioneering, advanced technology and engineering technology; social and cultural value is divided into social emotion and enterprise culture; artistic and aesthetic value is divided into architectural and engineering aesthetics and industrial landscape characteristics; and economic utilisation value is divided into structural utilisation and spatial utilisation.

There are five categories and ten sub-categories of "value of industrial heritage endowed by history", and the researchers have explained the connotation of each category and class with examples of Beijing's industrial heritage and conducted quantitative research on them. The "value of industrial heritage given by history" scores 100 points, and each subcategory scores 10 points, which are divided into four time periods according to the historical stages of Beijing's industrial development, and each time period corresponds to a score ranging from 3 to 10 points. From this, the "value of Beijing's industrial heritage given by history" can be calculated. A similar categorisation and scoring method is used for the "value of status, conservation and reuse".

As the earliest city-specific value evaluation method and system in China, the Beijing Industrial Heritage Evaluation Approach is highly targeted at categorising and scoring the value of industrial heritage in a specific city, and explores ways to assess the unique value of the city's industrial heritage. Currently, at the administrative and legal level, Beijing's industrial heritage is recognised in accordance with the Guidelines, while the academic community uses the evaluation system of Liu and Li (2008) as the standard.

(2) Shanghai

Although Shanghai has not yet issued regulations specifically for the protection of industrial heritage, it has set selection conditions for industrial buildings selected as outstanding historic buildings. This is the first time that the protection of industrial buildings has been mentioned in the local regulations for the protection of historic buildings in mainland cities in China. In addition, in the Third National Cultural Heritage Census in 2007, Shanghai identified 215 new industrial heritage sites based on the three main values of cultural relics.

In the academia, Huang (2007) of Tongji University established a combined qualitative and quantitative evaluation standard for the value of modern industrial buildings in Shanghai in his doctoral thesis. The standard divides the value of modern industrial buildings in Shanghai into six items: historical value, artistic value, scientific value, environmental value, economic value, and social and emotional value, and each of the remaining five items is divided into three sub-items, except for social and emotional value. Historical value is divided into city level, community enterprise level and building body level; artistic value is divided into regional characteristics of architectural shape, artistry of spatial form and level of detail decoration and renovation; scientific value is divided into structural technology, characteristics of materials and construction art and craft; environmental value is divided into landmark, continuity and regional style; economic value is divided into locational advantages, adaptability to functional changes and economy of functional changes (Huang, 2007).

(3) Tianjin

In 2011, Tianjin, China conducted a city-wide industrial heritage census, and Tianjin University participated in the development of the "Standards for the Recognition of Tianjin's Industrial Heritage (Draft)", and based on the Standards, a list of Tianjin's industrial heritage recommended for preservation was developed (Chu, 2016; Ji, Xu and Aoki, 2011).

The Standard divides the value of Tianjin's industrial heritage into six categories: historical value, technical value, architectural value, landscape value, social value and utilisation value. The total score of historical value is 20 points, divided into "long history" and "connection with major historical events or great historical figures", each with 10 points. The technical value of 10 points, no sub-items, refers to the production process in the industry's pioneering, uniqueness and endangerment (Ji, 2011).

The architectural value is divided into two items: "typical or unique architectural style and aesthetic value" and "uniqueness and advancement of architectural structure", with 10 points each. Landscape value is 10 points in total, with no sub-items, referring to the unique industrial landscape characteristics of the buildings and structures. Social Value: 20 points, 10 points each for "profound social influence and special social emotion" and "unique corporate culture". The utilisation value is 20 points, with 10 points each for " utilisation of building structure" and " utilisation of building space" (Ji, 2011).

In recent years, the China Industrial Heritage Study Group of Tianjin University has amended and enriched the Standard, merging and adjusting the six basic values in the original value composition into four values: historical value, scientific and technological value, aesthetic value and social and cultural value. The subdivision of each basic value and the evaluation criteria are still being enriched and perfected (Ji, 2011; Zhang et al., 2022).

(4) Chongqing

Li, Zheng and Zhang (2012) divided the value of Chongqing's industrial heritage into seven categories: historical value, scientific and technological value, social value, artistic value, economic value, uniqueness value and scarcity value.

Historical value is related to the age and historical events and figures; scientific and technological value is related to the pioneering of the industry and the level of engineering technology; social value is related to social emotion and enterprise culture; artistic value is related to the aesthetics of architectural engineering and the characteristics of the industrial landscape; and economic value is related to the use of structure and the use of space.

Xu (2012) also divided the value of Chongqing's industrial heritage into five items, namely: historical value, technical value, social value, aesthetic value and economic value, and added authenticity and integrity as criteria after these five items.

Historical value is divided into the age of creation and related to major historical periods and figures; technical value is divided into the symbol of an industry's pioneering and leading and the products represent the leading level at that time; social value is divided into the promotion of local economic and social development and urbanisation and corporate culture, employee identity; aesthetic value is divided into the landscape of the industrial facilities with outstanding individuality and architectural design and decoration; economic value is divided into the industrial construction of a huge investment and has the potential value of the development of culture, tourism and other modern service industry potential value.

Comparison of the two value compositions shows that they are basically the same in the basic value composition, similar in each subsection, and complement each other. In addition, Li (2012) focuses on the uniqueness and scarcity of Chongqing's industrial heritage and lists it as an independent value, while Xu (2012) focuses more on the authenticity and integrity of the heritage as a complementary criterion to the basic value.

(5) Nanjing

In 2011, Nanjing conducted a city-wide census of industrial and mining enterprises built before 1978, and set conditions and recognition criteria for enterprises to be included in the industrial heritage list and those under key protection (Deng et al., 2011). The criteria include the age of the enterprise (built between 1840 and 1978), a more complete layout of the plant, as well as better preserved characteristics of the plant's landscape and higher quality buildings. A total of more than 50 sites were identified as meeting the criteria, and 14 sites with high value were selected as the first batch of industrial heritage under key protection in Nanjing.

There are four criteria for its recognition, which are further improved on the basis of the conditions. The recognition criteria require that the key protected industrial heritage must firstly be rare, unique and iconic within the corresponding historical period; secondly, the enterprise must be representative, advanced and pioneering within the same industry in the country; thirdly, the factory must have industrial landscape characteristics, complete architectural pattern and advanced construction technology; fourthly, the enterprise can represent and reflect the industrial development and history of Nanjing within a certain period of time (Deng et al., 2011).

Deng et al. (2011) assessed the value of Nanjing's industrial heritage, which is divided into six items: historical value, scientific and technological value, social and cultural value, artistic and aesthetic value, economic utilisation value and preservation status.

The historical value is divided into "long history" and "relationship between historical figures and events"; the scientific and technological value is divided into "pioneering industry" and "advanced engineering technology"; the social and cultural value is divided into "advanced industry" and "advanced engineering technology"; the social and cultural value is divided into "advanced industry" and "advanced engineering technology"; the social and cultural value is divided into "pioneering industry" and "advanced engineering technology";

Artistic and aesthetic value is divided into "architectural and engineering aesthetics" and "landscape features"; economic utilisation value is divided into "structural utilisation" and "spatial utilisation". The preservation status refers to the degree of intactness and is not divided into items. Compared with the official criteria, the value composition has increased the consideration of economic factors.

(6) Wuhan

The Plan for the Protection and Utilisation of Industrial Heritage in Wuhan was issued in 2011, organised by the Wuhan Land and Planning Bureau, and was the first special plan for industrial heritage in Wuhan. The Plan selects 371 factories as research objects, 95 of which are listed in the "Wuhan Industrial Heritage List", and according to the selection criteria, 27 of which are recommended as Wuhan industrial heritage.

The document shows that there are four criteria for assessing industrial heritage. Firstly, it is rare and unique in the corresponding period, and an industrial enterprise with high influence in the whole country or Wuhan. This examines the scarcity and uniqueness of industrial heritage. Secondly, it is representative or advanced in the same industry in the whole country, the industrial enterprises which are the earliest, the most productive, the highest quality, the most influential brand, the most advanced technology, and the nationally famous trademarks and trade names in the same period of time. This examines the representativeness and advancement of the industrial heritage. Thirdly, it is the characteristic industrial enterprises with complete architectural pattern or advanced construction technology, and with the characteristics of the times and industrial style. This examines the period characteristics and industrial features of the industrial heritage. Fourthly, other industrial heritage of high value (The Plan for the Protection and Utilisation of Industrial Heritage in Wuhan, 2011).

Tian (2013), Qi and Ding (2008) have studied the value of Wuhan's industrial heritage. Tian (2013) divided the value of Wuhan industrial heritage into five aspects: historical value, social value, economic value, aesthetic value and scarcity value, and explained its connotation. Qi and Ding (2008) established a qualitative and quantitative evaluation system for Wuhan industrial heritage. They divided the value of Wuhan industrial heritage into five items: historical value, social value, scientific and technological value, artistic and aesthetic value, and additional value, except for the scientific and technological value, the other four items are divided into two small items each.

In summary, China's research on the value of industrial heritage in various cities is still relatively macroscopic, and there is not yet enough detail for more specific breakdown indicators, pending further research in each region according to specific conditions.

2.3.4 Process of Exploring the Cognition and Assessment of Industrial Heritage Values

The value of industrial heritage is characterised by different values depending on the evaluation perspective. For cities, the historical heritage of an industrial site could add to the city's cultural connotation and enhance its historical significance; for architects, industrial buildings and their spatial system are evidence of the speed and simplicity of the industrial era's production methods, and their spatial layout and functional layout are studied; for artists, the changes and vicissitudes of industrial sites bring back memories of the past and stimulate creativity. The value of industrial heritage is interpreted differently by different people and from different perspectives.

An important point in evaluating the value of industrial heritage is how to recognize and understand industrial heritage from a comprehensive and complete perspective. The following is an analysis of the exploration of industrial heritage value cognition and assessment through three points. The aim is to understand the development history and the changes of evaluation elements in industrial heritage in order to provide a guide and reference for industrial heritage evaluation and conservation.

2.3.4.1 Changes in the Cognition of Heritage Values

The study of industrial heritage originated in the United Kingdom. Michael Rix, a historian at the University of Birmingham, first introduced the concept of industrial archaeology in 1955 with his paper titled Industrial Archaeology. Rix (1955) holds the view that Britain was the first country to complete the Industrial Revolution, which left abundant remains recording the era and its events. He argued that the country should establish institutions and statutes to protect the industrial heritage that changed the face of the globe. Following the initiative of experts and scholars, the Council for British Archaeology set up the Research Committee on Industrial Archaeology in 1959 to make urgent recommendations to the British government on the development of an industrial heritage list and conservation policy, and to urge the government to initiate the Industrial Monuments Survey (Palmer, 2010). The research and conservation of industrial heritage began in the UK and has spread in various countries. Regarding the perception of value, the earliest elements of heritage value assessment were proposed by art historians, mainly for antiquities and monuments, and were classified in terms of historical commemorative values, artistic values, and present-day values (Riegl, 1903). Alois Reigl, an Austrian art historian, first proposed a system of monument values from an art-historical perspective in 1902, dividing monuments into two categories: commemorative values and present-day values. Monumental value contains age value, historical value, and intentional commemorative value; present-day value contains use value and artistic value (Riegl, 1903).

After the 1980s, the exploration of heritage values began to emerge in the fields of archaeology and architectural history. From the perspective of cultural historiography, a distinction emerged between intrinsic and extrinsic heritage values. The intrinsic value is focused on the historical, commemorative and cultural value of the heritage itself, while the extrinsic value includes economic, social, and educational values (Lipe, 1984; Feilden, and Jokilehto, 1993; Frey, 1997). William D. Lipe, an American archaeologist, classified heritage in terms of economics into economic, aesthetic, associative symbolic, and informational values in 1984. Jukka Jokilehto, a Finnish historian of architectural and cultural heritage conservation, and Bernard Feilden, a British architect, classified heritage into cultural and socio-economic values (Feilden and Jokilehto, 1993). Feilden and Jokilehto (1993) suggested that the cultural value contains aesthetic, technical and scarcity values; the socio-economic value contains functional, economic, educational, social and political values. Furthermore, the Swiss economist Bruno. S. Frey (1997) argued that heritage contains financial, selection, existence, bequest, prestige, and educational values. Prutsin (1997), president of the Russian Academy of Restoration Sciences, proposed the intrinsic and extrinsic value of heritage, arguing that the commemorative, historical, aesthetic and artistic emotional values of heritage itself constitute its intrinsic value, while urban planning, scientific restoration and functional values constitute its extrinsic value.

In the late 20th century, scholars in the field of economics began to consider the value of heritage from the perspective of capital (Throsby, 2001). At the beginning of the 21st century, in the process of globalisation and urbanisation, with the growing interdisciplinary recognition of heritage, the economic and use-value of heritage has also gradually gained attention. David Throsby (2001), an Australian economist, proposed to measure heritage values in terms of cultural capital. He classified cultural heritage into aesthetic, spiritual, social, historical, symbolic, authentic, and economic values. Research by Randall Mason (2002), an American scholar of historic building preservation engineering, classified cultural heritage into socio-cultural and economic values. The Italian scholars Sergio Barile and Marialuisa Saviano (2015, p. 84) divided heritage into intrinsic and use values.

In conclusion, for over a century, the perception of heritage value has been explored through a variety of disciplines, from art history, archaeology, architectural history and economics, from a focus on the historical commemorative value of heritage to a consideration of both the intrinsic and extrinsic value of heritage combined with its measurement in terms of cultural capital. The development and changes in the perception of heritage values have also contributed to the formation of relevant policies and institutions, which have moved from theoretical discussions to practical guidelines that can be implemented.

2.3.4.2 Institutional Policy Changes Regarding the Value of Industrial Heritage

In terms of institutional policies, the Australian National Committee of the International Council on Monuments and Sites (ICOMOS) adopted the Burra Charter, which defines cultural significance as including aesthetic, historical, scientific, social and spiritual values in 1979 (Avrami et al., 2019). The publication of the Burra Charter marked the beginning of an operational international standard for the recognition of heritage values. Then, the Guidelines to the Burra Charter - Cultural Significance divided heritage values into aesthetic, historical, scientific and social (Avrami et al., 2019). In the 21st century, the assessment and conservation of cultural heritage has become increasingly developed, and under the impact and challenges of globalisation and urban regeneration, there is an urgent need to develop a systematic understanding of heritage and a complete system of value assessment. Moreover, the International Federation for the Conservation of Industrial Heritage adopted the Nizhny Tagil Charter on Industrial Heritage in 1979, which gives industrial heritage, as a specific type of heritage, a more focused consideration in terms of recognition, classification and value assessment (TICCIH, 2003).

Furthermore, the English Heritage in 2008 classified heritage values as evidential, historical, aesthetic and communal (Historic England, 2008). In 2011, ICOMOS adopted the Dublin Principles which emphasise the intangible value of industrial heritage, stating that the value of industrial heritage resides in the production structure or site itself, including the material components such as machinery and equipment, the industrial landscape, documentation, and the intangible records present in memory, art, and custom (Hughes, 2018). The Burra Charter (Australia ICOMOS 2013) states that assessed values should encompass a wider range of heritage values (extending to the social and intangible values) (Avrami et al., 2019).

Table 4. The Different Standards of Documents of International Organizations on the Industrial Heritage

Name	**Relevant content**
The Venice Charter (1964)	Proposes that the conservation and restoration of heritage buildings should follow the principles of authenticity and integrity
Protection of the World Cultural and Natural Heritage (1972)	(1) Proposes that cultural values are viewed from social, artistic, scientific, aesthetic and anthropological perspectives (2) Outstanding universal value describes the qualitative criteria of cultural heritage
The Nara Document on Authenticity (1994)	(1) Proposes respect for cultural diversity and heritage diversity (2) Emphasis on values related to authenticity
Charter of Nizhny Tagil (2003)	(1) Defines industrial heritage and points out that it has historical, technological, social, architectural, scientific and aesthetic values (2) Suggests that special production processes, scarcity, early years and inventiveness make the industrial heritage of special value
Operational Guidelines for the Implementation of the World Heritage Convention (2005)	(1) Development of the outstanding universal value assessment criteria (2) Detailed explanation of the meaning and conditions of authenticity and integrity
Dublin principle (2011)	Enriches and deepens the definition of industrial heritage, emphasising the diversity of types of industrial heritage, paying more attention to the intangible heritage and the whole process of production, in addition to the tangible
Taipei Declaration on Asian Industrial Heritage (2012)	(1) It is noted that the definition of industrial heritage in Asia covers the pre-Industrial Revolution period as well as the post-Industrial Revolution period in time (2) The formation of industrial heritage in Asia is largely associated with Western colonisation and has a colonial character (3) Aesthetic and technological values of the history of local architecture, construction or equipment (4) Emphasis on the cultural value of the industrial heritage, such as the intangible cultural heritage of operating technology, corporate culture and the life of the inhabitants

	(5) Emphasis on the holistic nature of the objects to be protected, including the tangible cultural heritage such as the housing of labourers, the origin of raw materials and transport, and the intangible cultural heritage such as operational techniques and knowledge

Table 5. The Different National Standards on the Value of Industrial Heritage

<table>
<tr><th>Name</th><th>Relevant content</th><th>Country</th><th>Time</th></tr>
<tr><td>Management Policy 2006: Guidelines for the management of the National Park System</td><td rowspan="3">Historical value, artistic value, scientific value;
Age, representativeness, uniqueness, integrity, authenticity, group value, public value, potential</td><td rowspan="3">The United States</td><td rowspan="3">2006</td></tr>
<tr><td>U.S. National Historic Landmark Standard</td></tr>
<tr><td>National Registration Standards for Historic Sites in the United States</td></tr>
<tr><td>UK Conservation guidelines: Policies and guidelines for the sustainable management of the historic environment</td><td>Classifies the value of cultural heritage into four basic values: physical evidence, historical value, aesthetic value and communal value;
The criteria of age, selectivity, representativeness, integrity, authenticity, group value, vulnerability and diversity are proposed</td><td>The United Kingdom</td><td>2008</td></tr>
<tr><td>Guidelines for the management of archaeological resources</td><td rowspan="2">The aesthetic, historical, scientific cultural social or spiritual significance;
The heritage value of a cultural resource is reflected in the characteristic elements that define it;
Age, representativeness, scarcity, uniqueness, integrity, group value, monumentality</td><td rowspan="2">Canada</td><td rowspan="2">2015</td></tr>
<tr><td>Cultural Resources Management Policy</td></tr>
</table>

Most of the current research on industrial heritage is oriented towards the reuse of industrial heritage and industrial tourism, with less research on the grading of industrial heritage. Florentina-Cristina et al. (2014) chose a series of case studies to examine the diversity and richness of Romania's industrial building fabric in terms of architecture, industrial profile and period. They suggest reusing the cultural values embedded in industrial heritage in order to emphasise its status as a cultural resource and its symbolic value. Cho and Shin (2014) analysed how a cultural policy project in Incheon, South Korea, dealt with industrial heritage issues. They suggested that industrial heritage conservation involves not only adaptive reuse, but also the creation of cultural values in obsolete spaces.

Claver, Sebastián and Sanz-Lobera (2015) proposed a global approach to the study of Spain's industrial heritage. The method focuses on the identification, selection and classification of elements, considering that each heritage type has specific properties. It was noted that in a multi-criteria approach, it is reasonable to use the AHP method to deal with different criteria of different levels of importance (Claver, Sebastián and Sanz-Lobera, 2015). Sutestad and Mosler (2016) explored the possibility of reactivating the abandoned site of the Coryton refinery in Thurrock, UK, as a cultural heritage site by analysing its relationship with the landscape, people and their interrelated processes. Moreover, Claver et al., (2019) built on the initial inventory established by relevant scholars to create a multi-criteria asset inventory for the study, management and cultural enhancement of assets related to industrial heritage in Spain by increasing the number of assets and establishing new classification criteria.

In summary, (1) the international community has continued to expand the definition and types of industrial heritage, with its time span and intangible dimensions expanding. The composition of industrial heritage values has become more diversified, forming five basic values: historical, social, scientific and technological, aesthetic and cultural, and emphasising sub-categories of values that are easily overlooked; (2) The Operational Guidelines for the Implementation of the World Heritage Convention establish ten criteria for cultural heritage, complemented by the assessment of authenticity and integrity. Other international documents point out that specificity, early date, inventiveness, scarcity, integrity and coloniality play a role in influencing the value of industrial heritage; (3) Although the UK, US and Canada have different understandings of the individual values of cultural heritage, they share a similar understanding of the overall scope of heritage values. The value assessment indicators have their own focus, and 14 common indicators have been extracted, namely relevance, symbolism, publicness, development contribution, aesthetic significance, scientific significance, age, selectivity and representativeness, rarity and uniqueness, integrity and group value, authenticity, documentation, vulnerability and potential. It is a meaningful reference and implications for the perception of value and conservation development of industrial heritage in China.

Through the reading of relevant documents, it is found that the value criteria of industrial heritage have been included in them, both in China and internationally, but in general, they are scattered and disorganised, each with its own focus, and no unified system has been formed (Table 6).

Therefore, by studying the relevant important documents in depth, the statistics in this paper show that authenticity, integrity, representativeness and scarcity appear more frequently, while advancement, endangerment and uniqueness are less frequent.

Table 6. Statistical Table of Evaluation Criteria in Institutional Policies

Relevant documents or standards	**Authenticity**	**Integrity**	**Representativeness**	**Advancement**	**Scarcity**	**Endangerment**	**Uniqueness**	**Diversity**	**Earliness**
Venice Charter	×	×							
The Nara Document on Authenticity	×							×	
TICCIH’s Charter of Nizhny Tagil					×				×
Operational Guidelines for the Implementation of the World Heritage Convention	×	×							
Dublin Principles		×						×	
Taipei Declaration		×							
UK Conservation principles: policies and guidance for the sustainable management of the historic environment		×	×		×			×	
United States Standard	×	×	×						
United Kingdom Standards	×	×	×					×	

Canadian Standard		×	×		×				
Guidelines for the protection and use of industrial heritage, Canada	×	×			×	×			
Wuxi City, China Industrial Heritage Census and Recognition Measures					×		×		×
Guidelines for the Protection and Reuse of Industrial Heritage in Beijing			×	×	×		×		×
Total	6	9	5	1	6	1	2	4	3

2.3.4.3 Characterising the Value of Industrial Heritage

In recent years, research on the value of industrial heritage has been growing. Cultural charters (e.g. International Charter for the Conservation and Restoration of Monuments and Sites) suggest that a historical building with innovative, historical, social, cultural, artistic, economic, technological, and spiritual value can be regarded as heritage (Marsden, 2015). Compared with cultural charters, the Nizhny Tagil Charter for the Industrial Heritage emphasizes scientific value (TICCIH, 2003). It defines the values of industrial heritage as historical, technological, artistic, aesthetic, social, economic, cultural, educational, industrial, spiritual, peculiarity and scarcity. The value proposition assists in deciding the potential new functions of heritage such as an industrial museum, a post-industrial landscape, a creative industrial zone or a synthesized garden.

Palus (2006) believes that the main reason for the conservation of industrial heritage is that it is a special surviving part of the urbanisation process and a carrier and witness of the development of human industrial civilisation. As a nostalgic landscape, industrial heritage has multiple values, including historical research value, scientific and technological value, humanistic and social value, architectural and artistic value and economic value. Davies (2008) pointed out that industrial heritage, as an important material carrier of industrial civilisation surviving to this day, is a witness of the industrial civilisation era, and its value is mainly historical, social and technological. The connotation of industrial cultural value contains historical, aesthetic and social meanings, reflecting the unique way of work and life of the industrial era, and has become the theoretical basis for strengthening conservation. Industrial heritage is an important part of cultural heritage, and the evaluation of its value should take into account various considerations such as technical, cultural and economic.

In recent years, there has been a growing number of studies by Chinese scholars on industrial heritage. From an international perspective, China's industrial heritage shows the uniqueness and scarcity value of a semi-colonial and semi-feudal society. Industrial heritage has cultural, social and economic values in addition to the historical, scientific and artistic values, depending on its characteristics (Liu and Li, 2008).

Liu (2012) pointed out that the value of industrial heritage is not limited to the industrial buildings themselves, and is not only a witness to the industrial development of the city, but its value is more in witnessing the former urban life. Heritage conservation cannot be equated with the total preservation of the past, and the process of its conservation should include evaluation and selection, otherwise, there will be no real and effective conservation, and conservation entails valuing the value.

Liu (2018) argues that industrial heritage is closely linked to politics, economy and culture, and is a faithful record of social development; industrial buildings are the crystallisation of human civilisation and have a high conservation value. Wang and Wang (2018) indicated that industrial heritage reflects cultural heritage and humanistic care. The reuse of industrial buildings allows them to play a greater role in urban development and people's lives. Liu, Zhao and Yang (2018) suggested that the value of industrial heritage may be represented through the following spectrum of values: historical, scientific, artistic, spiritual and use. They proposed that the motive of protecting industrial heritage is to protect its general value, rather than special protection of a single site, and that scientific and reasonable identification of the value of industrial heritage is the basis for its protection, utilization and management.

Ji (2019) believes that not enough attention has been paid to the scientific and technological value in the study of the value of industrial heritage. He argues that using the architectural heritage instead of its technological value or conflating the two is a misunderstanding in evaluating the value of overall industrial heritage as industrial architectural heritage is part of industrial heritage. Ji (2019) divides the technological value of industrial heritage into four types depending on the attribution of the value: (1) Industrial heritage does not have production processes, the technological value is attributed to the equipment. The technological progress of equipment directly contributes to the development of industries, such as the machine processing industry; (2) The industrial heritage has processes, which merely reflect the steps of production; (3) The scientific and technological value of the industrial heritage is attributed to the processes; (4) The processes of the industrial heritage and the equipment in each step of the process are in constant interaction, and advances in equipment can bring about changes in the processing. Industrial heritage requires a systematic study of the evolution of process development, and the relationship between process and equipment. This means that when industrial heritage conflicts with urban regeneration, it is important to grasp the core values of production process so that it can be determined whether all or part of the production lines of industrial heritage should be preserved. Industrial buildings could be preserved, renovated or demolished.

The above-mentioned experts and scholars have expressed their views on the value of industrial heritage, and although there are differences in details, there is a general consistency in their views (Table 7). The main points include: firstly, industrial heritage has value in historical research. Industrial heritage bears witness to the production and lifestyle of the industrial era, and carries the historical memories of different regions and nationalities during the Industrial Revolution. China’s industrial heritage is a record of the hard struggle of the Chinese people, from which we can clearly see the development of recent and modern Chinese industry, and is also the best illustration of the recent urbanization process. The second is the value of science and technology. Industrial production is a concrete expression of scientific and technological practice. Industrial heritage, as an expression of technology in the era of the Industrial Revolution, is the best illustration of the course of human technological development.

Thirdly, it is the value of humanities and society. Industrial heritage is the product of people’s production activities in a specific historical period, and contains the memories of production and life of the people concerned, which not only becomes the common historical memory of the people in the region, but also generates a strong sense of cultural identity and belonging. The other is the value of architectural art. Industrial heritage relies on certain construction techniques and is an iconic building of a particular era. The design of the industrial buildings and the layout of the internal space presents a unique aesthetic perspective and design concept. The next step is economic value, which is a renewable value. Through the conservation and reuse of industrial buildings and structures, it is possible to make full use of them by replacing their original functions to provide a space that might be used for new functions and reduce the need to build new buildings. The aim is to reduce the cost of demolition and construction and to save on construction resources. Facilities that have lost their original productive function can also be transformed and reused in a variety of ways, using highly artistic expressions as an effective way of gaining economic profit.

Table 7. An Overview of Values of Industrial Heritage

Source	**Innovative**	**Historical**	**Social**	**Cultural**	**Artistic/ Aesthetic**	**Economic**	**Technical/ scientific**	**Industrial**	**Spiritual**	**Educational**	**Scarcity/ peculiarity**
Palus, 2006		×	×		×	×	×				
Davies, 2008		×	×				×				
Liu and Li, 2008		×	×	×	×	×	×	×			
Liu, 2012		×									
Marsden, 2015	×	×	×	×	×	×	×		×		
Liu, Zhao and Yang, 2018		×			×		×		×		
Wang and Wang, 2018			×	×							
Ji, 2019							×				

2.3.5 Limitations of the Current Landscape Value of Industrial Heritage

Value includes the objective existence of things, but also what role and significance they have for different subjects in different contexts of the time. As for the value of cultural heritage, its value composition is usually based on historical, artistic, scientific and social values, and these values are often the main factors in evaluating the degree of value of cultural heritage (Ireland, Brown and Schofield, 2020).

The industrial heritage landscape belongs to the category of industrial heritage, which is subordinate to cultural heritage. In terms of value composition, although Liu and Li (2008) emphasized the industrial value of industrial heritage which expands the scope of value composition factors of industrial heritage under the value system of cultural heritage according to the characteristics and assessment principles of industrial heritage, it is still difficult to highlight its value characteristics that are different from the universal values of other types of cultural heritage. The classification of the value composition system is not clear enough, and the division of value factors is too general. The classification of industrial heritage is basically based on the value composition of the cultural heritage and without highlighting the industrial characteristics of the industrial heritage.

Current studies on the value of industrial heritage landscapes have concluded that the values of industrial heritage landscapes include the following values: historical, cultural, aesthetic or artistic, social, touristic, technical or scientific (which is also referred to as industrial value), and economic. Among these values, the historical, scientific and social aspects are those of a universal nature as defined for industrial heritage in the Nizhny Tagil Charter on Industrial Heritage (Li et al., 2017; Hughes, 2018). The content covered by social and economic values may be too general in the value composition, limiting the depth and refinement of the understanding of values. As that will have an impact on the future value evaluation of industrial heritage landscapes, it is necessary to establish a more accurate classification and a clearer structure of the value composition of industrial heritage landscapes.

Tourism value is based on the historical value, artistic value, technological value and emotional value of the industrial heritage landscape, and the value generated by transforming the above values into tourism resources, and is influenced by the location and environment in which the heritage is located. Therefore, this study considers that tourism value is one of the utilization methods derived from the reuse process of the industrial heritage landscape, depending on the value of the industrial heritage landscape, which should not be included in the framework of the value composition of the industrial heritage landscape.

2.4 Existing Methods for Evaluation of Industrial Heritage Sites

In the research of industrial heritage evaluation, there are different methods and technical tools used by scholars, and the common evaluation methods are analysed as follows.

2.4.1 Methods for Landscape Character Assessment (LCA) and Historic Landscape Characterisation (HLC)

In recent years, the practice of landscape evaluation has developed in the direction of detail and digitization. Fairclough and Herring (2016) used two methods for analysing industrial heritage landscape which are the Landscape Character Assessment (LCA) and Historical Landscape Characterisation (HLC). They suggest that the landscape should no longer be evaluated as an indistinct whole but should be subdivided into different landscape characteristics. This could be done by using technical tools such as Geographic Information System (GIS), a tool for spatial data processing and analysis, and aerial photography to produce landscape maps, using data to describe the landscape and form an overall landscape resource map of an area.

Fairclough and Herring (2016) state that the LCA provides classification, description and illustration of different landscape types. Bao and Zhou (2015) practiced LCA in Hong Kong by developing a landscape characterisation map and database for Hong Kong, and providing a system reference framework for decision making. The LCA approach generally includes four steps: defining the scope of the study, case study, field investigation, and category description. The evaluation process begins with the analysis and categorization of the landscape, resulting in a landscape character area map and database, followed by an evaluation of the landscape character of the site. Similarly, it has been found that the LCA method is useful as a basis for establishing the landscape planning system and sustainability assessment at the regional level (Fairclough and Herring, 2016).

Another method for evaluating the industrial heritage landscape uses the Historical Landscape Characterisation (HLC). Wilkinson and Harvey (2017) indicate that the HLC aims to identify, describe and illustrate the major historical factors and their ingredients which influenced landscape formation. Fairclough and Herring (2016) presented a case study of the Cornwall HLC that mainly used the historic and current maps, and aerial photographs to identify the time-dimensions of the historic landscape such as the 19th mid-century or 20th century. The preliminary identification of historic landscape character types is based on different temporal dimensions, combined with geological, soil and hydrological maps. Field research was used to revise and add character elements, resulting in the identification of character types such as working industrial sites and abandoned industrial sites, which are expressed on the map in different colour blocks to form the Cornwall Historic Landscape Character Types Map.

The HLC method distinguishes between sensitivity and value classes of historic landscapes by judging the sensitivity, completeness and rareness of feature types (Wilkinson and Harvey, 2017). HLC is also used to guide planning practices such as land use planning and infrastructure site selection. Additionally, Wilkinson and Harvey (2017) found that in practice the different feature types are not neatly divided as HLC presents the color blocks, they are blended into each other. This relatively rigid division of boundaries fragments may reduce the integrity of the landscape.

2.4.2 Geographic Information System (GIS) as a Visualization Tool

As Geographic Information System (GIS) technology is used in both the HLC and LCA methods mentioned above, the current status of GIS application is analysed below. This is intended to provide a new perspective on the classification and evaluation of industrial heritage. GIS is an interdisciplinary discipline between earth science and information science that has developed rapidly in recent years (Ciski, Rzasa and Ogryzek, 2019). It is a combination of geography, cartography, mapping and computer science, and is a technical system for managing and studying geospatial data. It is now fully applied to urban planning (Turner, 2006). It has become an important tool for planning management, planning analysis and decision making, and carrying out public participation. GIS originated from the digital management and analysis of geographic information (Ciski, Rzasa and Ogryzek, 2019). The concept of GIS was first introduced by Roger F. Tomlinson in 1963, defining GIS as a digital system for the analysis and manipulation of geographic data. This means that GIS is a system composed of computers and different methods to collect, manage, analyse and display spatial data.

One of the core capabilities of GIS technology for urban planning is the spatial analysis function (Ciski, Rzasa and Ogryzek, 2019). The analysis of geographic location information and geomorphological feature data is a common function of GIS. Commonly used types of spatial analysis are as follows (Bao and Zhou, 2015): (1) query analysis; (2) location analysis; (3) trend analysis; (4) simulation analysis.

At the same time, the multi-layered, multi-factor overlay analysis method of GIS in the HLC and LCA methods, which forms a colour block representation on the map, makes it possible to visualise the results of a comprehensive evaluation of the value of industrial heritage (Fairclough and Herring, 2016).

In summary, current approaches to the classification and evaluation of cultural heritage are increasingly being combined with computer technology. As a unique cultural heritage, the classification and evaluation of heritage information can be well combined with the spatial analysis capability of GIS, which can collect and input the information data of industrial heritage better. Therefore, the application of GIS technology in the classification and evaluation of industrial heritage, combining evaluation methods with rational scientific methods, is of great significance for the conservation and reuse of industrial heritage.

2.4.3 Method for Analytic Hierarchy Process (AHP)

The AHP method is characterised by a combination of qualitative and quantitative analysis to produce intuitive data (Qi, 2018). Liu (2018) argues that any demolition of industrial heritage facilities to meet modernization needs or the indiscriminate disposal of certain ancillary facilities may affect the overall style and quality of the industrial heritage landscape. He suggests that the use of the AHP could help in selecting and individually assessing each element of industrial heritage and choosing the appropriate ways of improvement. Qi (2018) found that AHP provides an important opportunity to enhance the overall style and quality of the industrial heritage landscape. In other words, the AHP may provide new perspectives on the values of the industrial heritage landscape.

Liu and Li (2008) have developed a preliminary evaluation system for Beijing's industrial heritage. They use a quantitative approach to evaluate the value of the industrial heritage in all its aspects and use the results of the quantitative evaluation as the basis for the final assessment of its heritage value. The evaluation system is divided into two parts: the first part is the value given to the industrial heritage by history, and the second part is the value related to the current state of the industrial heritage and its conservation and reuse, which is mainly evaluated by means of a scoring method.

Firstly, the heritage value is judged according to the evaluation of the first part, which results in the value of the industrial heritage itself (Liu and Li, 2008). On the basis of the industrial heritage identified in the first part of the evaluation, additional evaluations should be carried out according to the second part of the evaluation approach when discussing industrial heritage conservation and reuse proposals or when developing industrial heritage conservation plans (Liu and Li, 2008). The results of the additional evaluation do not affect the judgement on the value of the industrial heritage made in the first part of the evaluation, and are only used as a reference for the selection and decision-making of conservation and reuse options.

Liu and Chu (2011) made a preliminary value assessment system for the industrial architectural heritage of Chongqing, China from the 1960s and 1970s. The main objects of study are conventional factories such as military, chemical machinery, ships, and nuclear power stations (Liu and Chu, 2011). In the research of Liu and Chu (2011), the value of industrial architectural heritage is divided into intrinsic value and usable value, based on the description of heritage value categories in the World Heritage Convention. The evaluation system is made using the same quantitative approach, whereby the assessment scale (Table 8) is generally graded on “Four Levels” of 100-80, 80-60, 60 and less than 60 (Liu and Chu, 2011).

Table 8. Liu and Chu’s Assessment Scale of Industrial Heritage (Liu and Chu, 2011)

	100-80 score	**80-60 score**	**60 score**	**Below 60 score**
Historic authenticity value	Pre-1949, or having significant historical value	1949-1964, or having greater historical value	1969-1984 or having some historical value	After 1984
Scientific and technical value	Significantly innovative, excellent quality of preservation	Some representative, good quality of preservation	Some technical features, fair quality of preservation	No technical representation
Aesthetic-artistic value	Typical of the period	Typical of the region	Typical of local representation	None

Both of these evaluation methods explore the industrial heritage from different perspectives, categorising and stratifying a range of influencing factors. They both adopt a scoring approach to evaluate, which does not pursue advanced mathematical theories, is relatively simple and easy to implement. These methods require a few quantitative data information, both of which could be used as research methods for the initial evaluation of industrial heritage. However, none of them treats the research object as a complete system, and establishes indicator factors while reducing the influence of each factor on the results, and the scoring system of the indicator system is heavily influenced by subjective factors as it is mainly based on expert scores and the results can be subjective if the number of experts is small and also because evaluation factors are mainly evaluated individually and not comprehensively.

In conclusion, there are qualitative and quantitative methods of evaluating industrial heritage. Both qualitative and quantitative methods are necessary for comprehensive evaluation. Qualitative evaluation is generally based on the evaluator's impression of the value of the industrial heritage (Liu and Chu, 2011). This method of evaluation was the first to be applied to the evaluation of industrial heritage values, and is currently the main method used to determine the value of industrial heritage. Among the value evaluation indicators of industrial heritage projects, many are qualitative, and these qualitative indicators mainly describe the nature of the evaluation object. For example, in the social emotion, corporate culture and location advantages of the industrial heritage factory are semantic descriptions, mainly through research, interviews, questionnaires and other means.

The qualitative evaluation method is simple to operate, but the evaluation process is too subjective and not rigorous enough, and the scientific nature of the evaluation results is insufficient. In order to overcome the drawbacks of qualitative evaluation and improve the scientificity of the evaluation results, quantitative evaluation methods can be used to evaluate the value of industrial heritage. The quantitative evaluation method is a rational analysis method with a certain scientific character (Liu, Zhao and Yang, 2018). It is a mathematical and rational analysis of the evaluation object and the construction of an evaluation model.

It can be said that qualitative and quantitative analyses are complementary in the process of industrial heritage value evaluation. Qualitative analysis is the basis for quantitative analysis, and quantitative analysis is the concretization of qualitative analysis. Based on this characteristic of industrial heritage value evaluation, this study is based on the idea of combining qualitative and quantitative approaches to construct an evaluation method for modern industrial heritage in Shaanxi Province, China.

2.5 Treatment and Reuse of Industrial Heritage

The transformation of industrial heritage not only sustains the local culture and historical identity of the city and increases the pride and self-confidence of the population, but should also be consistent with the goal of sustainable development, and considered as far as possible to practice a renovation route beneficial to ecological and energy conservation by reducing waste of resources, reducing energy consumption and minimising environmental impact (Fibiger, 2015). Many areas of Manchester, such as Castlefield and Ancoast, have extensive greenery, clean waterways, renovated industrial buildings, and safe public spaces that are walkable, setting an example for other cities in converting derelict industrial sites into vibrant urban spaces (Mengusoglu and Boyacioglu, 2013).

The original industrial production areas and industrial buildings were often planned and built for the needs of large-scale mechanised production activities. The layout and spaciousness of the factory are often not sufficiently considered in terms of energy saving and emission reduction, thermal comfort and microclimate of the physical environment. In the current ecological and environmental protection development needs, some industrial heritage will not be able to meet the requirements of sustainable transformation such as reduced energy consumption, carbon emissions and environmental pollution while meeting the needs of human comfort. The sustainable reuse of industrial heritage is becoming increasingly important.

Liu (2018) claims that some research on the reuse of industrial heritage has focused on the development and management of industrial heritage sites for tourism purposes. The scope of research on the reuse of industrial heritage sites also extends to related types of sites such as industrial wastelands (Liu, 2018). Among the projects that have been carried out, most of the reuse models for industrial heritage are the conversion of industrial heritage buildings into museums, memorial halls, artists' studios and creative industrial parks (Oevermann et al., 2016). Furthermore, industrial heritage sites have been transformed into parks or landscape areas with tourism as the main function, and abandoned industrial sites with low industrial heritage value have been transformed into residential areas (Palmentieri, 2020). With the restructuring and renewal of the general urban layout, the development model of industrial heritage sites and how to give them new functions and contents have become issues of concern to relevant researchers and government departments in recent years.

Examples of the reuse of industrial heritage identified in the literature show that, according to the function of the transformed buildings, they could be divided into several categories of new functions: cultural and creative industries, heritage tourism, exhibition venues, landscape parks and integrated development.

2.5.1 Reuse of Industrial Heritage for Cultural Activities and Creative Industries

Industrial heritage buildings reflect the historical traces of the industrial era and often provide a source of inspiration for artists' creations. The renovation cost of industrial buildings is generally not high, and the relatively cheap rents are suitable for the economic situation and needs of cultural creators. At the same time, as industrial heritage buildings are often located in old urban areas with convenient transportation and facilities, they provide ideal conditions for the development of cultural and creative industries. This also becomes another important opportunity for the conservation and reuse of industrial heritage. This reuse method of the industrial heritage is suitable for industrial heritage buildings and areas with open sites.

2.5.1.1 The Link Between the Cultural and Creative Industries and Industrial Heritage

With the rise of cultural and creative industries, their important role in tourism development, urban renewal and the establishment of a city's impression and sense of place are becoming more and more significant (Wang and Wang, 2018). Currently, industrial heritage is increasingly transformed into cultural and creative industries gathering places, which also indicates the connection between cultural and creative industries and industrial heritage (Liang and Wang, 2020). Wang and Wang (2018) suggest the relevance of culture and heritage from the perspective of value creation, and pointed out that heritage is a key category for understanding cultural values. It might be a disposable and useless thing or a material that people have been trying to recycle and reuse. Through the cultural industries, it is possible to mitigate the negative impacts of abandoned materials, transforming them into economic value and creating value (Wang and Wang, 2018). However, the problems posed by industrial heritage are not simply economic or environmental; the complex ways in which value is created and destroyed require diverse research methods involving cultural, political, ethical and philosophical aspects.

2.5.1.2 The Relevance of Cultural and Creative Industry Development to Industrial Heritage Conservation

Industrial heritage with profound values reflects culture and history (Liu, 2018). Liu (2018) explores the transformation model of cultural and creative industrial heritage from an aesthetic perspective. Former factories have been transformed into artist Lofts, such as South of Houston Street (SOHO) in New York, USA, because such industrial ruins provide an aesthetic experience that enables avoiding the overly constrained and monotonous urban design. The memory of industrial history is often reproduced and continued in artistic activities. It can be said that the relics of the industrial period are recycled in new artistic and cultural forms (Lu, Liu and Wang, 2020).

2.5.1.3 Examples of the Reuse of Industrial Heritage for Cultural Activities and Creative Industries

The conservation and utilization of industrial heritage by cultural and creative industries in China started with the establishment of a studio by Taiwanese architect Deng in Shanghai’s Sihang Warehouse at the end of the 20th century (Yan and Xu, 2009). It then triggered the trend of integrating industrial heritage with cultural and creative industries. The 798 Art Zone in Beijing City, Tianzifang Art Zone in Shanghai City, M50 creative industry park in Shanghai, No.8 Bridge Art Zone in Shanghai and other typical creative industrial parks have all made use of the organic integration of industrial heritage resources and cultural and creative industries, transforming into multi-faceted and composite cultural and creative industrial gathering areas (Dai, Huang and Zhu, 2015).

The studies of Dai, Huang and Zhu (2015) and Liu (2012) in China have explored the symbiotic blend effect of industrial heritage and cultural and creative industries, pointing out that the establishment of cultural and creative industrial parks within industrial heritage needs to focus on further exploring cultural characteristics, fully displaying the value of industrial heritage features, integrating creative elements and creative technology means, and promoting the efficient integration of industrial heritage resources, so as to enhance vitality and quality of industrial heritage.

The analysis of the industrial heritage of Hongkou District in Shanghai captured the architectural characteristics and preservation status of industrial heritage, and used the renovation project of 1933 Old Square as an example to explain the characteristics of creative industry-oriented transformation (González Martìnez, 2017). González Martìnez (2017) proposed to establish a historic building protection system, focusing on the connection between industrial heritage and creative environment, and promoting regional cultural revival through industrial heritage protection.

2.5.2 Industrial Heritage Tourism

Tourism development of industrial heritage is also one of the ways to preserve and reuse industrial heritage. The recreation of industrial production processes, process technologies and scenes of workers' lives gives visitors an experience that is both nostalgic and fresh (Szromek, Herman and Naramski, 2021). The development of industrial heritage as a tourist attraction not only triggers the tracing of cultural origins, stimulates interest in history and culture and offers the possibility to satisfy the public's need to experience the originality of the heritage, but is also more convincing for the preservation of the historical, cultural, religious and industrialised past of the region (Szromek, Herman and Naramski, 2021). This is appropriate for industrial heritage areas that meet the requirements of the development of landscape displays and scenic experience projects (Xie, 2006). In the context of increasing globalisation, emphasising the value of the local industrial past helps to enhance the regional identity of residents and encourages the development of local culture. While there are currently many ways to develop a regional economy, industrial heritage tourism could be an emerging method to improve the identity of a region and realise economic benefits.

2.5.2.1 Heritage Tourism Models

There are many studies on heritage tourism models. Chris (2009) explored the establishment of a green tourism model for malt whisky distilleries in Scotland. Liu (2012) explored the continuation of history and culture, using the birthplace of the Industrial Revolution as an example - the Ironbridge Gorge and its museum in England. Industrial tourism is becoming an important socio-economic phenomenon and enhancing the tourism image of cities and regions. However, it has also been pointed out that the development of economies dependent on industrial heritage appears to be limited due to the coexistence of benefits and losses in practice. This is because, from an employment perspective, the jobs created by industrial tourism do not fully compensate for the loss of employment caused by the closure of previous factories (Forgan, 1992).

The types of industrial heritage tourism development models in China include cultural heritage, integrated landscape, modern company, artwork display, industrial park or museum (Liu, 2012). The development of tourism models needs to focus on unified planning and management, scientific organisation of routes and rational allocation of resources to highlight the characteristics of industrial tourism (Liu, 2012). Qi (2021) has also proposed a low-carbon tourism transformation model for industrial heritage, which is an exploration of heritage tourism in the context of sustainable development. It requires the integration of beneficial conditions within the region, the strengthening of joint collaboration with neighbouring tourism resources, and the establishment of a spatial organisation system structured by a low-carbon tourism industry chain through low-carbon transport planning, green landscape systems and low-carbon energy-efficient buildings (Fouseki and Nicolau, 2018). Guzman (2020) has also proposed a planning and development model for industrial heritage tourism complexes to realise the conservation and utilisation of the comprehensive value of industrial heritage.

2.5.2.2 Evaluation Criteria for Reuse of Industrial Heritage in Tourism

According to Liu (2012), the development of heritage tourism is a double-edged sword. Tourism is developed as a means of conservation through the adaptive reuse of historic buildings. In the process, the value of the intangible cultural heritage might be reduced. On the one hand, it actively assists in the conservation of industrial legacies; on the other hand, this act of conservation by tourism development can lead to the destruction of the more valuable intangible cultural heritage. Liu (2012) argues that the benefits of industrial heritage tourism development outweigh negative aspects through the creation of a characteristic tourist attraction that fully exploits the potential for adaptive redevelopment of industrial heritage. There is a view that industrial heritage tourism will not only provide visitors with an authentic experience of heritage tourism and evoke lost industrial memories, but will also contribute to the shaping of the city's image and identity (Gao and Liang, 2013).

The transformation model of industrial heritage relying on tourism development may bring the preservation and enhancement of the value of intangible cultural heritage. The factors influencing the development of industrial heritage tourism can be categorised into five areas: exploitable potential, adaptive reuse, economic benefits, the authenticity of the place, and public perceptions. These factors can be considered as providing important measures and criteria for testing and evaluating industrial heritage tourism (Xie, 2006).

2.5.2.3 Examples of Industrial Heritage Tourism

The industrial heritage conservation movement in Europe has preserved a large amount of industrial heritage, creating 'industrial sites' and 'industrial heritage corridors' that are now important places for industrial cultural tourism, such as the Ironbridge Gorge and the Derwent Valley in the UK (Crisman, 2007).

The Zollverein Coal Mine Industrial Complex in Essen, Germany, has been transformed from an old and polluted industrial area into a tourist attraction, where visitors can experience the underground mines through the preserved industrial facilities, experience the former coal mining environment, or take a tour on the former coal trains and participate in various activities (Crisman, 2007). The economic benefits are achieved while regenerating the vitality of industrial heritage. As awareness of the value of industrial heritage increases, industrial heritage tourism in China is gradually gaining attention. Industrial heritage tourism in Huangshi City, Hubei Province, China is a typical example. The Huangshi industrial heritage tourism area, covering sites such as the Hanye Ping coal and ironworks mine, the Tonglvshan ancient copper mine, the Huaxin cement plant and the Daye iron ore opencast quarry, systematically shows the development of China's modern industrialisation (Liu, 2012).

2.5.3 Industrial Heritage as an Architectural Exhibit

The conservation of industrial heritage buildings in their original state and their display in the form of an exhibition building is the initial and priority option for the conservation and use of industrial heritage buildings. Through the display of industrial heritage architecture and production technology processes, the preservation and continuation of historical and cultural values are achieved. The renovation process should focus on the protection of the originality of industrial resources and the presentation of history and culture, in order to evoke the public's historical memory and social identity, thus promoting the conservation of industrial heritage and the transmission of culture. This applies to industrial heritage buildings with important historical, scientific and cultural values (Liu, Zhao and Yang, 2018).

2.5.3.1 Presenting Authenticity

As a product of cultural and economic development, industrial heritage is in the process of being commercialised. This process often results in the neglect of the immaterial attributes of heritage, leading to the loss of the originality and historical and cultural significance of industrial heritage resources (Jokilehto, 1999). Graham, Ashworth and Tunbridge (2000) point out that heritage is a part of the past, and by selecting only the needed and useful parts from the past in order to meet current needs, we are actually distorting history. Liu and Li (2008) suggest that museological conservation of industrial architectural heritage is a way to maximise the presentation of the originality of heritage. The advantages of museological conservation of industrial heritage are analysed theoretically and technically, and the principles of holistic and effective museological conservation methods and criteria for building museums are explored (Liu and Li, 2008). In other words, on the basis of defining the complete core area of the museum, the key areas should be ecologically restored and landscaped, while the relevant functional areas such as commercial leisure areas should be reasonably laid out.

2.5.3.2 Reuse of Industrial Heritage as Cultural Venues

Crisman (2007) compared four museums that have been transformed from an industrial heritage: Tate Modern in London, which was transformed from a power station; Dia: Beacon in New York, which was transformed from a cardboard printing factory; Design Zentrum Nordrhe in Westfalen, which was converted from Zeche Zollverein Schacht XII, Essen, and the Massachusetts Museum of Contemporary Art, which was transformed from a printing factory.

As symbols of culture, each of the four museums has undergone a journey from an ordinary industrial facility to a public cultural venue, all re-presenting the relics of past industrial production. The difference is in the attitude towards the accumulated industrial dirt and leftover materials that they show in their renovation strategies. According to Crisman (2007), the Massachusetts Museum of Contemporary Art and the North Wales Design Centre preserve the decaying state of matter and materials as a way of presenting the past and imagining the future. Not only the interior spaces, but also the supporting structures, equipment and facilities have been developed as exhibition spaces, reflecting the simple and clear structural logic characteristic of modern architecture, and moreover full respect for the industrial past.

In contrast, the clean skins of the Dia: Beacon and Tate Modern art galleries show more concern for globalisation and rustic simplicity of the present. The study offers a range of effective methods for the reuse of future industrial heritage projects through comparative analysis, and suggests that the inclusion of material decay and industrial dirt in the renovation and reconstruction of industrial monuments and buildings is an effective means of preserving the memory of the past. The preservation and continuation of industrial history cannot be limited to the preservation of materials and the original skin, but should also be combined with the creation of functional space and the reproduction of the spirit of place. The Tate Modern Gallery could be said to have retained almost all of its original appearance compared to the power station of the time, not only in terms of functionality and aesthetics to meet the needs of contemporary museum architecture, but also in terms of the spirit of the place to evoke the public's memory of its industrial past.

2.5.3.3 Examples of the Reuse of Industrial Heritage as Cultural Venues

In addition to the above examples, there are also museums in the Albert Dock Industrial Estate in Liverpool, UK, and the Museum of Science and Industry (MOSI) in Manchester that was transformed from an old railway station (Tian, 2015). Germany is represented by the Ruhr industrial area, which concentrates on the achievements of early industry, including the Rhineland Industrial Museum in Oberhausen and the German Mining Museum in Bochum (Crisman, 2007). With the conservation of modern industrial heritage buildings, a wave of renovation and construction with museums as a transformative function has gradually emerged in China. For example, the China National Industry and Commerce Museum in Wuxi, the Dahua Industry Museum in Xi'an and the Shougang Industry Museum are all examples of the development of China's recent national industry and the level of production technology, reflecting respect for the historical heritage of industry and the continuation of the spirit of place (Liu, 2012).

2.5.4 Industrial Heritage Landscape Parks

This type is based on preserving the characteristics of industrial buildings and sites, exploring the potential for creative use of abandoned materials and sites, integrating existing landscape elements and combining them with new design techniques to form open urban public landscape spaces, providing an important way to cater for the public's recreational needs. This category applies to industrial heritage brownfield sites with wide areas and abandoned architectures and structures (Franz and Rahman, 2006).

2.5.4.1 Post-industrial Landscape Concept and Model

The industrial landscape design concept is mainly based on ecological ideas. In the transformation of industrial abandoned sites, it adopts the idea of minimal intervention on the site, respects the landscape characteristics and ecological development of the site and promotes the recycling of materials and energy on the site as much as possible, giving fully developed value to the abandoned industrial materials. It not only reflects the echoing of the historical atmosphere of the site, but also the practice of sustainable use of materials. Forman (1995) proposes that the sustainability of industrial heritage is the search for an optimal spatial configuration of ecosystems and land use to support ecological integrality and maximise environmental sustainability. Earth art is another trend of thought that has had a strong influence on post-industrial landscape design (Forman, 1995).

Liesch (2014) argues for the art of landscape that helps to restore the natural order that has been destroyed by humans. He suggested in the early 1970s that the best places for earth art were those that had been destroyed and abandoned by industry and mindless urbanisation. That is to say, earth art is used to enhance the landscape quality of the site and improve the visual value of the environment, becoming one of the effective ways to renew, restore and reuse industrial abandoned sites. Liu (2012) believes that industrial relics on abandoned land are like earth art, the artwork left behind by industrial production on the earth.

Lee (2019) analyses and discusses the ideas and models of post-industrial landscape design, proposing that in the design process, attention should be paid to the treatment of abandoned industrial buildings and facilities, the treatment of surface traces of industrial sites, the reuse of waste materials and pollution treatment, and the configuration of plant landscapes. The ecological and artistic concepts are integrated to create a post-industrial landscape that adapts to contemporary needs (De Sousa, 2014). Ming (2014) proposes the concept of "Loft" organic landscape, which organically combines creative cultural industries with industrial heritage. It explores ways to regenerate heritage landscapes based on new cultural concepts and forms.

2.5.4.2 Examples of Industrial Heritage Landscape Parks

The North Duisburg Landscape Park, a post-industrial landscape park in Germany, is a good example of landscape park type industrial heritage conservation (Tian, 2015). Its landscape architect Peter Latz used the term earth art to describe the industrial plants and facilities on this industrial wasteland. He argues that the approach to the closed industrial and mining site is to accept the character of the site, including its degraded natural ecology and damaged landform, and to adopt a respectful and protective attitude towards all landscape elements including landform and wild plants on the former industrial site. At the same time, these elements leave physical relics of the original production site due to the industrial imprint and environmental pollution.

In order to exploit their creative potential, these relics should be taken into consideration for renovation, rather than being seen as waste that needs to be erased or covered up. Throughout the park, it is possible to find creative uses of not only the old buildings, for example, the used gas storage tanks have been transformed into a training pool for the diving club, and parts of the factory and warehouses have been changed into a disco and concert hall. It is also possible to subtly turn the former processing area into a walled garden, to transform the bunker of the raw material store into a climbing wall, to purify the storage tank into a water garden, and the concrete yard where iron ore was formerly stockpiled designed as a youth activity area. Even elegant orchestral music is performed against the backdrop of the giant steel smelting furnace. None of this is new, and nothing seems to have changed fundamentally since the last transformation in 1985 (Liu, 2012). It could be argued that this is all based on full respect and careful handling of the original venue and its special atmosphere.

Seattle Gas Works, USA, an urban park converted from an old industrial site, fully respects the history of the site and the heavily contaminated soil has been purified by biochemical methods (Liang and Gao, 2013). The original refining furnace has been preserved as a reminder of the industrial era, including the machines and equipment in the compressor plant which has been transformed into a children's playground and painted in different colours to attract children's activities. The park not only makes great use of the historical and aesthetic values of the original factory, but also provides a public space for recreation and relaxation for the surrounding residents. China's Zhongshan Qijiang Park preserves the original industrial buildings and equipment facilities on a large scale on the original site of the Yuezhong Shipyard (Li et al., 2017). Combining a variety of artistic expressions and cultural functions, it transforms the abandoned and unused factory into a diverse open space and cultural landscape, pioneering practice in post-industrial landscape design in China (Li et al., 2017).

2.5.5 Integrated Redevelopment of Industrial Heritage

Influenced by the concept of 'mixed use', some industrial heritage sites have been developed as mixed-use facilities with shops, cafes, restaurants, offices, residences, shopping and cultural facilities (Lee and Hwang, 2018). This is suitable for the adaptive reuse of abandoned industrial areas with a large footprint and impact.

2.5.5.1 Functional Integration

With the coming of the information society, urban living places and workspaces are gradually merging with each other. It is different from the past when people lived, worked, studied and relaxed in different functional types of buildings (Roman, 2014). Research shows that in the post-industrial era renovated old factory buildings with their high space and extensive areas provide ideal places for the new lifestyles that are emerging (Roman, 2014). As most industrial heritage is located in urban and waterfront areas, buildings and facilities that are large and publicly owned are monumental and symbolic and play an important role in the construction of collective memory. At the same time, they present the public with social and historical information related to past architectural constructions and industrial production techniques, and are essentially educational in nature. These characteristics of industrial heritage play an active role in enhancing the attractiveness of social spaces to the population. The integration of complex functions such as residential, office, leisure and entertainment will lead to new public lifestyles, and museums, theatres, parks and squares situated in former sites of industrial heritage will become new social spaces for the public (He and Gebhardt, 2014).

2.5.5.2 Examples of Sustainable Reuse of Industrial Heritage

Typical practices such as the Ruhr district regeneration project in Germany, the district regeneration in the UK, such as the Ironbridge Gorge and the Derwent Valley (Crisman, 2007), and the transformation of the “gas tank new town” complex in Vienna are mostly based on the regeneration of old urban areas, with the aim of revitalising them and restoring their value (Roman, 2014; Sharma, 2013). In China, the transformation of the regional level of industrial heritage into integrated development is at a developmental stage (Liang and Gao, 2013). The function-oriented transformation categories of each type of industrial heritage present different emphases in terms of applicable scope, conservation significance, technical approaches, practical experience and research perspectives, respectively (Table 9). They reflect an active exploration of the inheritance and continuation of the spirit and cultural connotations of industrial sites, as well as a search for a way for the renewable use of existing resources and the sustainable development of the urban environment.

Table 9. Comparison of Functional Categories of Industrial Heritage after Transformation

Types	**Suitable industrial heritage**	**Approach**	**Typical cases**
Cultural and creative industries	Heritage buildings and areas with open spaces	To promote the integration of existing resources with diverse cultural and creative industries	Soho, New York 798 Art District, Beijing
Heritage tourism	Heritage areas suitable for the development of heritage display and scenic experience projects	Preserving the production site, recreating the production process and developing experiential activities	Zollverein Coal Mine Industrial Complex in Essen, Germany
Exhibition architecture	Heritage buildings of significant value	Preserve historical memories and implant contemporary functional spaces	German Mining Museum Dahua Industry Museum, China
Landscape Park	Heritage sites with open spaces and abandoned structures	Respect the character of the site, give it a public function and make full use of abandoned resources	The North Duisburg Landscape Park
Integrated-type of development	Heritage areas with large areas of land and impact	Integrating complex functions and spaces for public life	Ruhr district regeneration project in Germany

2.6 Research on the Industrial Heritage and its Evaluation in China

Research on the conservation and reuse of industrial heritage in China started relatively late (Liu, 2018). In the 1990s, some experts and scholars in the field of architecture and urban planning started to introduce cases of industrial heritage conservation in the West (Wang and Wang, 2018). These presentations were generally carried out from the perspective of architecture and urban planning (Li et al., 2017). Then, in the late 1990s, the industrial heritage conservation movement, which took the transformation of urban harbour terminals and urban waterfronts as an opportunity, was gradually introduced to China, and the concept of industrial heritage gradually became known (Lu, Liu and Wang, 2020).

During this period, the dissemination and study of it attracted more attention from local scholars, and the presentation of these cases was also an attempt to promote them from the perspective of professional knowledge (Liu, 2018). Entering the 21st century, research on the modes of protection and reuse of industrial heritage has gradually increased in various fields in China, mainly from several perspectives such as urban development and planning, protection and use of industrial architectural heritage, a transformation of urban industrial landscapes, development of industrial tourism, and combination of creative industries and transformation of industrial building groups (Liu and Li, 2008).

2.6.1 Historical Outline of Industrial Development in Shaanxi Province, China

The history of recent and modern Chinese industry is generally considered to start from the Opium War in 1840 until now, but a more detailed delineation is inconclusive (Li, 2021). This is because analysing modern Chinese industry from different perspectives, such as economic history, industrial history and heritage conservation, would lead to different results (Lu, Liu and Wang, 2020).

In terms of industrial history, Zhu and Li (2007) divide the period of development of modern Chinese industry into five periods: the nascent period (1840-1894), the period of initial development (1895-1913), the period of rapid development (1914-1937), the period of difficult development and brief post-war recovery (1938-1949), the period of speed development (1949-now). Liu and Li (2011) divide China's modern industry into five periods: the budding period (1840-1894), the period of initial development (1895-1913), the period of great development (1914-1922), the period of slow development (1923-1936) and the period of decay and destruction (1937-1949). Dai and Yan (2000) divide China's modern industry into four phases from the perspective of the geographical distribution of industry: 1840-1894, 1895-1913, 1914-1936 and 1937-1949. Combining the above studies, this study divides recent and modern Shaanxi's industry into six periods.

(1) 1840-1934, The beginning of the modern industry in Shaanxi Province, China

This period was characterised by the appearance of modern military and civilian industries. The overall industry, apart from a small number of military industries, is mainly based on old manual industries (Jue, 2008). The number of industries is small and small-scale, and transportation is inconvenient. The types of industry were mainly in the daily life of the citizens, including umbrella making and shoe making. In this period, almost nothing industrial heritage remains (Ji and Wang, 2015).

(2) 1935-1945, The period of initial development

In December 1934, the Longhai Railway was connected to Shaanxi, and a large, high scale modern machine industry system appeared (Zhu and Li, 2007). The mechanisation of production led to the reform of building structures and the appearance of steel-framed, multi-storey buildings. An example is the Dahua Yarn Factory.

(3) 1945-1949, Period of decline

By the time of the Anti-Japanese War, Xi'an City, Shaanxi Province, China became the target of air raids by Japanese aircraft (Ji and Wang, 2015). The companies established in Xi'an moved away. In addition to the interference of the civil war, Shaanxi's modern industry came to a standstill and industrial development was difficult (Liu and Li, 2011). By 1948, only 69 Xi'an industries remained, with no new industrial buildings (Liu, 2012).

(4) 1949-1962, Initial development

After the founding of New China, the national economy recovered and began to invest in mainland industries (Jue, 2008). Of the 156 key construction projects supported by the former Soviet Union and Eastern European socialist countries, 17 were located in Xi'an. Local industries in Shaanxi Province also began to develop on a large scale (Liu, 2012). The factory area was planned with a complete road network and clear functional divisions. The office areas are mostly brick and concrete multi-storey structures with wooden roof frames (Ji and Wang, 2015).

(5) 1963-1978, Unstable development

China's government policy which is the third five-year plan gradually changed the layout of the industry, adjusting the uneven spatial distribution of China's industries through the "Third Line Construction", which means focus on construction in Northwest China (Liu and Li, 2011). With the exception of a few new factories, most of them were reconstructed and expanded using existing buildings or old factory sites (Jue, 2008). For example, the Shaanxi Steel Factory.

(6) 1978-now, Stable development stage

After 1978, the Shaanxi industry entered a period of sustained and stable development. The process of industrialisation gradually accelerated and some industrial enterprises of the modern era gradually decayed (Liu, 2012). During the expansion of the city and the transformation of the old city, a large number of old factory buildings were regarded as obstacles to the development of the city and were demolished or moved away from the city centre (Liu and Li, 2011).

2.6.2 Main Development Stages and Characteristics of Industrial Buildings in Shaanxi Province, China

2.6.2.1 Stage 1: The Beginning of Recent Industrial Architecture in Shaanxi Province (1840-1934)

Most of the early industries in recent times in Shaanxi Province, China were founded by the private sector, while government-run and government-business joint ventures emerged after the Westernization Movement in 1861 (Pan, 2004). In terms of industrial building form, the industrial buildings of this period basically followed the traditional old-style buildings using mostly regional materials such as wood and stone and construction techniques without machinery but the function changed to an industrial production nature (Fu, Wu and Yang, 2008). The Westernization movement from 1861-1865 was the first to introduce Western forms of industrial architecture, such as Western-style brick and timber buildings (Xu et al., 2017). The Fuzhou Bureau of Shipping, founded by Zongtang Zuo in 1866, was the first to adopt cast-iron columns for some of its buildings, in addition to the traditional brick and timber structures (Deng, 2009). The Xi'an Machine Bureau, founded by Zongtang Zuo in 1869, was the first modern industrial enterprise to be established in the Xi'an area. It was designed by specialised technicians in charge of the design of the workshops and used relatively advanced engineering design and technology of the time. In terms of factory planning, after 1911 the Shaanxi Provincial Machine Bureau had a total of over 150 workers, with workshops for turning, clamping, sand turning and carpentry, as well as offices for general affairs, accounting and storage. Special areas were set up for skilled craftsmen to design, work and live in (Nobuo, Zhang and Xu, 2016). It can be seen that there are separate workshops according to the division of production and special premises for skilled craftsmen.

The industrial buildings of this period have the following characteristics:

(1) The architectural form is traditional, basically following the traditional architecture, and there is no obvious difference between the architectural appearance and that of ordinary buildings (Deng, 2009).

(2) The functional partitioning of handicraft buildings is integrated. The handicraft workshops were mostly in the form of a shop in front and a house in the back, with shops, workshops, warehouses and housing usually combined into the same unit (Ren, 2005).

(3) For factories of a certain scale, the initial planning of the functional layout was carried out (Nobuo, Zhang and Xu, 2016).

2.6.2.2 Stage 2: The Development of Recent Industrial Architecture in Shaanxi Province (1935-1949)

Into the 1930s, new structures, materials and forms were gradually applied to industrial buildings. The textile workshop of the Dahua Yarn Factory was the first industrial building to use large-scale steel structures, with a steel roof frame, steel columns for load-bearing and structural nodes using screw anchors (Wei and Zhang, 2015). The roof is made of saw-tooth windows. The external walls are brick with concrete plaster. The roof frame is covered with roof panels and asbestos tiles, as well as is fitted with temperature and humidity control equipment imported from Japan.

The mill building of Huafeng and Chengfeng Flour Company is a 4 or 5 storey multi-storey brick and wood mixed structure building. The facade of the building has a unified vertical composition. The top of the whole roof is in the form of a semi-circular arch vault and the windows are of uniform form of rectangular (Fu, Wu and Yang, 2008).

The industrial buildings of this period have the following characteristics.

(1) In terms of the building structure, brick and wood, steel and reinforced concrete factory buildings have all appeared. They were mainly concentrated in a few strong

national capital and government enterprises, and were not widely spread (Wei and Zhang, 2015).

(2) In terms of architectural forms, they began to break away from the constraints of traditional architecture, with the unified treatment of facades in multi-storey buildings and the emergence of new architectural features, the new mass-produced materials such as steel and glass are being used in construction (Pan, 2004).

(3) Advanced production equipment was purchased to meet production needs. This reflects the refinement of craftsmanship (Deng, 2009).

(4) With the expansion of the scale of the enterprise, the functions of the factory area have become more abundant, prompting the rational planning of the functional layout of the factory area and the production flow. The closeness of production areas and living areas is a common layout method (Deng, 2009).

2.6.2.3 Stage 3: the Beginnings of Modern Industrial Architecture in Shaanxi Province (1949-1962)

During this period the state began to pay attention to investing in the construction of industry in land. During the First Five-Year Plan (the plan drawn up by the Chinese government to develop the national economy), Shaanxi Province received 24 projects. Most of these factories were designed and built with the aid of the former Soviet Union and the former German Democratic Republic, providing complete sets of industrial and technical equipment for production (Ren, Liu and Xiao, 2014).

These aid industrial projects had a complete and mature system from the planning of the plant to the design of the pre-plant area, the layout of the workshop processes, the design coordination and co-ordination of the various types of work, and the preparation of technical documents for each design stage (Zou, 2003). At the same time, the national government arranged for construction projects above the quota, represented by Textile Cities; the main works were designed and constructed in China, with the participation of Soviet experts to guide them.

The industrial buildings of this period had the following characteristics.

(1) The 156 key industrial construction projects (introduced projects from the Soviet Union and Eastern European countries during China's first five-year plan) were planned in a unified manner, with a complete road network system and functional zoning consisting of two parts: the office area and the production area (Ren, Liu and Xiao, 2014).

The administrative building in the office area with remarkable style features, generally consists of two to four storeys of brick and concrete structure with wooden structure and wooden frame. The factory workshop is divided into two parts, the living area and the production area, and the main production building is basically a reinforced concrete row frame structure with a single-storey multi-span system in order to form a large-span production space (Ren, 2005).

(2) For projects where the government has arranged for excess construction, the factory area is usually divided into the pre-factory area, the production area and the warehouse area. At the same time, consideration is given to the needs of workers' families for additional living facilities such as nursing rooms and childcare centres. The production area and the living area are unified in layout, with living area buildings close to the factory to facilitate commuting and reflect humanistic care (Wei and Zhang, 2015). The office buildings in the factory compound are of two to three storey brick and concrete structures, mostly combined with the living area of the factory. The main plant is a single-storey sawtooth steel frame structure with prefabricated roof frames and concrete roof panels. The roof is covered with waterproof insulation and the light is let in through double glazed windows.

(3) The construction is of excellent quality and the planning is forward-looking, with the functions of the industrial building becoming more refined according to the specific production process. Gradually conforming to modern process standards, it is a modern industrial building system (Zou, 2003).

2.6.2.4 Stage 4: the Unstable Development of Modern Industrial Development in Shaanxi Province (1963-1978)

The construction of the "Third Line" was a large-scale infrastructure project in the central and western regions of China, guided by the idea of war preparedness (Ren, 2005). It was mainly located in the area around Xi'an, with the Guanzhong region being the focus of construction (Liu, 2012). In addition, the construction of industrial buildings was influenced by the Cultural Revolution (a political campaign launched by the Chinese leadership between 1966 and 1976), and some local industries such as the Xi'an Road Construction Machinery Factory and the Coal Mining Machinery Factory were renovated and expanded in the 1960s (Wei and Zhang, 2015).

The industrial buildings of this period are characterised by the following.

(1) For the industries of the "Third Line Construction", the factories were built on the principle of being close to the mountains, scattered and hidden, and the industrial buildings were located in relatively remote and scattered locations (Wei and Zhang, 2015).

(2) Xi'an factory construction is based on partial reconstruction and expansion. According to the national requirements, the design, infrastructure construction and scientific research are carried out simultaneously. The construction period for infrastructure construction is very short. A small number of new plants was built and the quality of the buildings is average (Liu, 2012).

2.6.3 The Current State of Industrial Building Heritage in Shaanxi Province

As this stage is a literature review to study the current situation of industrial heritage in Shaanxi, the data may not be complete, and the data at this stage will be supplemented by field research at a later stage. The distribution characteristics of the industrial heritage in Shaanxi are shown in

Figure 4, Figure 5, Figure 6 and Table 10, through the collection of the relevant data from the internet search (Wei and Zhang, 2015). In terms of industry distribution, Shaanxi's industrial remains are mainly concentrated in the mechanical, light and textile industries; in terms of regional distribution, they are mainly located in Xi'an, Baoji and Xianyang; in terms of temporal distribution, Stage 1 accounts for a very small proportion: 1%, and Stage 2, 3 and 4 (here the stages are analysed in Section 2.6.2) account for a 30%, 30%, 39% proportion respectively.

2.6.3.1 Distribution Characteristics of Industrial Heritage

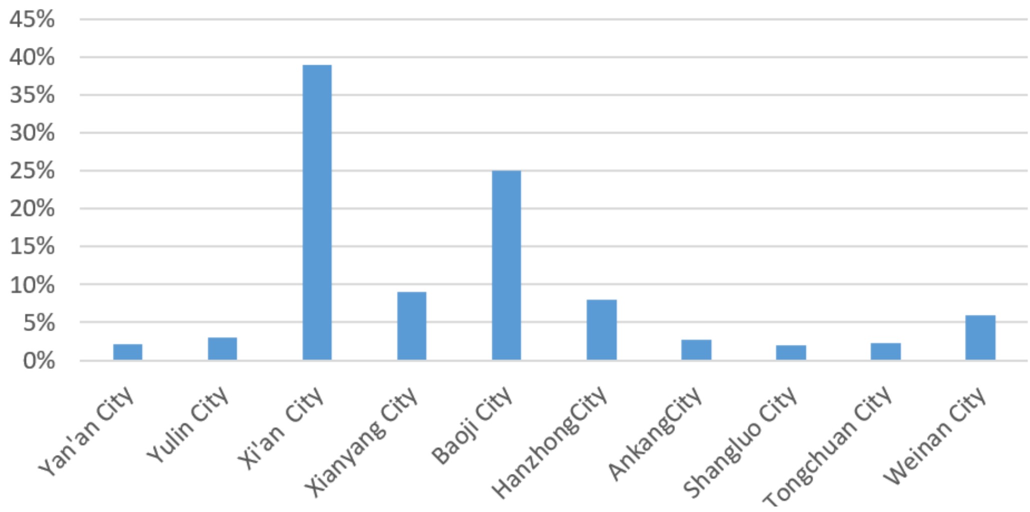


Figure 4. The Proportion of Industrial Heritage in Shaanxi Province (adapted from Wei and Zhang, 2015)

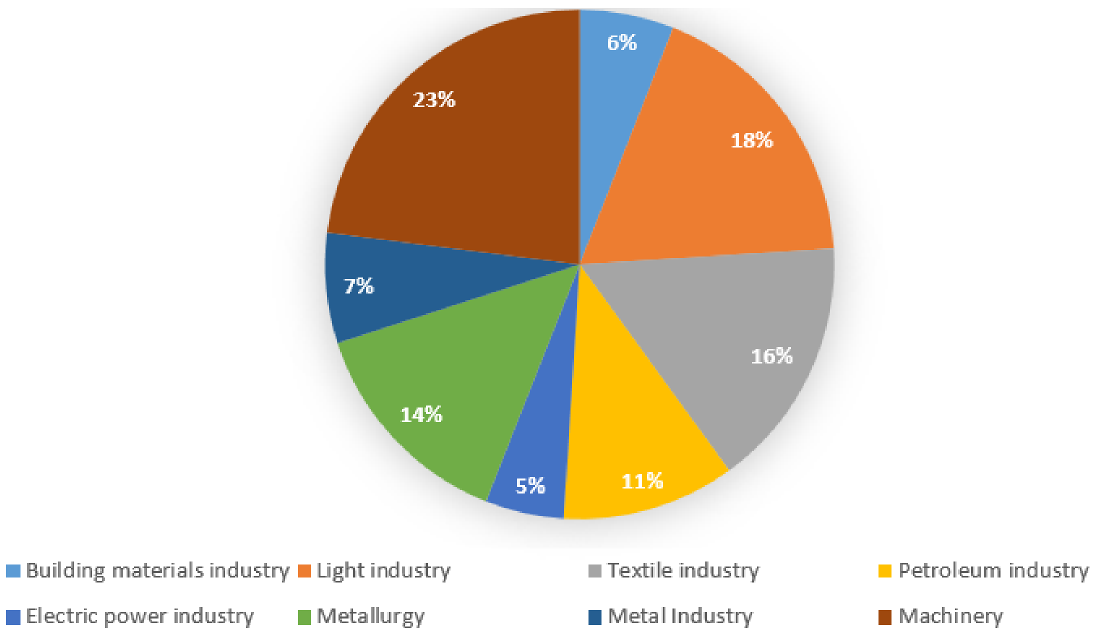


Figure 5. The Distribution Ratio of Industrial Heritage Industry Types in Shaanxi Province (adapted from Liu and Li, 2011)

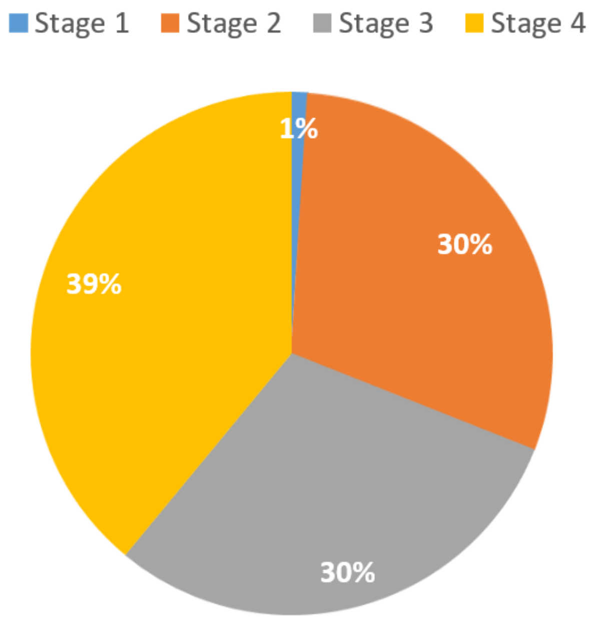


Figure 6. Time Distribution of Shaanxi's Industrial Heritage in Proportion (adapted from Liu, 2012)

Table 10. Major Industries and Typical Companies of Shaanxi's Industrial Heritage (adapted from Liu and Li, 2011)

Classification	**Case**
Textile Industry (12)	Dahua Yarn Factory, State Northwest Second Cotton Spinning Factory, State Northwest Third Cotton Spinning Factory, State Northwest Fourth Cotton Spinning Factory, State Northwest Fifth Cotton Spinning Factory, State Northwest Sixth Cotton Spinning Factory, State Cotton Third Factory, State Cotton Fourth Factory, State Cotton Fifth Factory, State Cotton Sixth Factory, Shaanxi Eighth Cotton Spinning Factory, Shaanxi Twelfth Cotton Spinning Factory
Petrochemical Industry (4)	Yanchang Petroleum, Xi'an Integrated Three Acid Factory, Northwest People's Pharmaceutical Factory, Baoji Petroleum Steel Pipe Factory
Power Industry (2)	Xijing Power Factory, Baqiao Thermal Power Factory
Metallurgical Industry (2)	Shaanxi Iron and Steel Factory, Loyang Iron and Steel Factory
Non-ferrous metal industry	Huashan Non-ferrous Metallurgical Machinery Factory in Shaanxi
Machinery Industry	Northwest Machinery Bureau
Building Materials Industry (2)	Hongqi Cement Products Factory, Yaoxian Cement Factory
Other Light Industries (3)	Yan'an Cigarette Factory, Baoji Cigarette Factory, Hanzhong Cigarette Factory No.2

2.6.3.2 Structural Features of the Building

The structural system of industrial buildings is broadly divided into three categories: steel frame system, space structure and bent structure (Zhou, 2003). The steel frame system is a rigid connection between the load-bearing columns of the plant and the roof, and there are few examples of this in industrial buildings in Xi'an. The space structure only appears in the plant of the Xi'an People's Enamel Factory in 1951, which has now been demolished. Most of the industrial buildings in Shaanxi belong to the bent structure (Liu, 2012). Bent structures are broadly classified according to building materials as timber structures, steel framed structures and reinforced concrete structures. The following is an analysis of the state of use of bent structures in industrial buildings in Shaanxi Province.

(1) Brick and timber structures

The wooden structure is a traditional structural form in China and was widely used in ancient and early modern architecture. In the Republican period from 1912 to 1949 mixed brick and timber structures were widely used in various types of buildings, such as the main building of the Zhang Xueliang Mansion built in 1932 in Xi'an and other public buildings and official residence buildings. Most of the early industrial buildings in recent times used old cottages, and the first industrial buildings in the Republic of China period used and developed brick and timber mixed structure plants, with the lower brick columns bearing the weight and the upper wooden roof frame (Zhou, 2003). For example, the production workshops of the Shenxin Yarn Factory in Baoji City in 1938 and the warehouses of the Dahua Yarn Factory East in Xi'an City in 1935.

(2) Steel bent frame structure

With the introduction of Western construction technology, steel structures began to appear in Chinese industrial buildings in the 1860s, and large-scale steel industrial buildings appeared in Shaanxi in the 1930s. The textile workshop of the Xi'an Dahua Yarn Factory in 1935 was the first building to use steel construction, and the building was one of the largest single structures of its time, with a total roof frame width of 48 metres and a total length of 112 metres (Liu and Li, 2011).

The factory is supported by a steel triangular roof frame and steel columns, with screw anchorage at the structural joints (Wei and Zhang, 2015). Although the strength of the steel structure was higher than that of the masonry structure, it was easy to rust, which was detrimental to the production of the plant, so it was soon replaced by reinforced concrete structures.

(3) Reinforced concrete structures

After the founding of the People's Republic of China, industrial buildings in Shaanxi were upgraded in terms of structure, materials, scale, design and construction techniques, and reinforced concrete row structures began to be commonly adopted. Typical techniques for industrial buildings such as "cow corner columns" with outcrop structure to accommodate crane beam appeared and were widely used.

By the 1950s, Project 156 had led to more advanced industrial construction techniques and, depending on production requirements, a variety of reinforced concrete columns, such as double component concrete column, I-beams and rectangular columns, were introduced (Wei and Zhang, 2015).

2.6.3.3 Architectural style characteristics

(1) Recent Western style

Since Shaanxi entered the modern era, architectural culture has been influenced by the West, and the art of Western classical and church-style brick and wood mixed structures was gradually introduced and copied, creating a precedent for modern architecture in Shaanxi, such as the Xijing Guest House and the Gao Guizi Mansion in Xi'an. In the field of industrial architecture, the office building of the Shaanxi Cotton Nine Factory in Baoji and the mill building of the Xi'an Huafeng Flour Company, built in 1936, were both influenced by Western architectural styles (Zhu and Li, 2007). As most of the architectural design and construction was carried out by domestic craftsmen, the modern Western-style architecture in Shaanxi is characterised by a combination of Chinese and Western influences.

(2) Traditional Chinese style

Industrial buildings in the traditional Chinese architectural style use traditional materials such as red tiles, green bricks and timber, and the form is often characterised by sloping roofs and brick wall without plastering (Zhang, 2007). In recent industrial buildings, some factory office buildings still retain traditional symbols on the roof and ridge. For example, the South Court office building in the Dahua yarn factory has a gable and hip roof.

The traditional style was widely used in factory buildings in 1949. The gable and hip roof and local decoration are retained, and the whole building is simple and dignified, such as the Huashan Machinery Factory office building, built in 1958. Four storeys in the middle and symmetrical single storeys on both sides, with brick wall without plastering inside. It is constructed in the traditional three-part composition of roof, body and plinth (Wei and Zhang, 2015).

(3) Imitation of Soviet style

The Soviet Union played an important role in the preparation and implementation of our first five-year plan (Ren, 2014). It also brought with it experience in industrial architecture. The planning and design of industrial buildings were influenced by the industrial architecture of the Soviet Union, including architectural colonnades and spires, important features of Soviet architecture (Fu, Wu and Yang, 2008). The gold leaf decorated spires, surrounded by elaborate decoration, form a strong central symmetry. For example, the high-voltage switchyard office building of the Western Electric Company in Xi’an has a horizontal three-part façade with arched window openings and window columns and a wooden structure with a pointed square tower. The bay windows are decorated with white relief line feet underneath, with Soviet-style arched window casings. In addition, the high-voltage electric porcelain factory office building in Xi’an also imitates the Soviet style (Deng, 2009).

(4) General style

Most industrial buildings use modern building materials and design methods for structural forms, focusing on functionality and practicality. Particularly after the antiwaste campaign in China in 1958, the design and construction were fast, monotonous in form and no longer influenced by architectural styles (Deng, 2009).

2.6.4 Local Characteristics of Industrial Heritage in Shaanxi Province

This study selected a few key industrial heritage landscapes in Shaanxi Province for an overview, by selecting some representative industrial heritage landscapes among the many industrial heritage sites in Shaanxi Province, and by analysing them, summarised the characteristics of the industrial heritage landscapes in Shaanxi Province.

In selecting key industrial heritage landscapes, the following selection criteria were used in this study.

(1) Being rated as industrial heritage by the relevant authorities and having the basic elements of landscape composition to form an industrial heritage landscape.

(2) Industrial landscapes that were constructed from 1840, are ground breaking or iconic in the history of industrial development, and are associated with significant historical events.

(3) Representing the advanced productivity and production techniques of the time in terms of industrial technology, representing technological innovation or innovation in the level of management.

(4) Representing the aesthetic orientation of the time in terms of industrial art form.

(5) Industrial heritage needs to have a positive effect and significance on the social development of the time and can have a profound impact on the future development of the city in political, social and economic terms. Ultimately, a comprehensive evaluation should also take into account the specific circumstances of Shaanxi Province’s industrial heritage and the uniqueness of the landscape site itself.

2.6.4.1 Industrial Heritage Reuse for Local Arts

Currently, influenced by the national industrial structure adjustment, the development of information industry is encouraged, as well as the development of industries with high technological content, good economic efficiency, low resource consumption and less environmental pollution (Liu, 2012). Some traditional industries have closed down and ceased production. As the central city of Shaanxi, Xi'an, relying on its good economic and cultural environment, a number of industrial heritages have been reused. For example, the Northwest No. 1 Printing and Dyeing Factory was transformed in 2007 into the Textile City Art Zone with several art disciplines exhibition venues such as oil painting, sculpture, pottery and photography; the Old Steel Factory in Shaanxi in 2002 was developed into the Old Steel Factory Design and Creative Industrial Park; and the Dahua Yarn Factory in 2014 was turned into a cultural and commercial centre with functions such as an industrial museum, cultural exhibitions and theatre performances. The industrial heritage has become a space for cultural and creative industries that accommodate local art activities (Lu, Liu and Wang, 2020).

2.6.4.2 Industrial Heritage as Part of the Local Landscape

(1) Baoji City

The industrial development of the Baoji City in Shaanxi Province began with the construction of the Longhai Railway in China. After the liberation of China in 1949, the city became an important industrial base in northwest China through national investment during the "First Five-Year Plan" and "Third Line" construction periods (Fu, Wu and Yang, 2008). The Longhai Railway was opened from Gansu Province, Lanzhou City to Baoji City on December 7, 1936. In 1937, with the outbreak of the War of Resistance against Japan, a large number of coastal industries moved to Shaanxi along the Longhai Line (Ren, 2014). In 1938, two Rong enterprises moved north of the Baoji Railway Station, followed by more than 200 enterprises such as the Hongshun Machine Factory in Hanyang, which moved to Shilipu in Baoji.

In 1941 the Shilipu Industrial Zone was formed with the Shenxin Company as the centre, leading to the comprehensive development of machinery, ceramics, schools, banks, post offices, hospitals and so on. Today, the industrial heritage of the Longhai Line to the south and the Changle Plateau to the north forms the local landscape of Shilipu in Baoji City (Liu and Li, 2011).

(2) Hanzhong City

For war preparation reasons, the Third Line construction adopted the principle of selecting factories close to the mountains, scattered and hidden, and a large number of coastal enterprises were relocated deep into the mountains. In Shaanxi, there were hundreds of Third Line factories in total, mainly in Hanzhong, Baoji, Tongchuan and Weinan (Deng, 2009).

The Nanfeng Machinery Factory, located in the town of Xiaonanhai in Nanzheng County, Hanzhong, Shaanxi Province, was put into operation in 1966, covering an area of 860,000 square metres (Zhu, 2003). Moved out before 1995, the factory site now has more than 90 buildings, including large workshops, office buildings, family buildings, schools, clubs and stadiums, forming a complex of buildings surrounded by mountains and a beautiful environment with a distinctive local style. Most of the former site of the factory has now been taken over by the Nanzheng County Tourism Bureau and has been designated as a tourist scenic area, while a small portion of the assets has been allocated to the local government of Xiaonanhai Town for use and management.

2.6.4.3 Industrial Heritage Reflects Local Industrial Characteristics

(1) Tongchuan City

Tongchuan has a long history of coal mining, which began in the Tang Dynasty, flourished in the Song Dynasty and became famous in the Province during the Republican period. After 1949, Tongchuan’s coal industry developed rapidly (Liu, 2012). The city’s coal fields cover an area of 522 square kilometres and have formed a coal industry base in Shaanxi Province, including the two major mining areas of Tongchuan and Jopping. Tongchuan is an industrial city that sprang up with coal production and is the coal base of Shaanxi. Coal production and the lives of miners are an important part of the city’s economic and social development (Zhou, 2003).

Located in the eastern suburbs of Tongchuan, the Wang Shi Wa coal mine was one of the 156 key projects built with the aid of the former Soviet Union during the First Five-Year Plan period (Ren, 2014). It was also the first, largest and most mechanised mine in northwest China at the time, and the only coal project in the western region. The Wang

Shi Wa coal mine was officially closed in 2015. It was selected as the second batch of national industrial heritage in 2018 and is now transformed into a heritage park.

(2) Yan'an City

Yan'an's speciality is the oil industry. Oil extraction in Yan'an first originated in the Qing Dynasty in 1907, when an oil well was drilled outside the old west gate of Yan'an County, producing 1.5 tons of crude oil per day, which was named the "Yan'an Well" and was known as the first oil well on land in China (Deng, 2009). After years of rapid development, the oil industry has become a pillar industry in Yan'an. In 2018 the old site of the Yanchang oil plant was selected as the second batch of national industrial heritage (Ren, 2005).

(3) Ankang City

In the late Ming and early Qing dynasties in China, from 1600 to 1644, immigrants from abroad brought in good seeds and new techniques to promote the development of the silk industry in Ankang City. Ankang folk have been reeling silk from silkworms since ancient times. During the Republican period from 1912 to 1949, due to the War of Resistance against Japan and the warlords, the silk industry has risen and fallen (Pan, 2004).

After 1949, with the active support of the Chinese People's Government, the silk industry developed rapidly from the start of indigenous production to the establishment of professional chemical plants. The Ankang First Reeling Factory and the Second Reeling Factory were put into operation in 1960 and 1970 respectively. The white factory silk produced by these factories under the brand of Plum Blossom is of high quality and has become an export product. In 1988, Ankang First Reeling Factory and Second Reeling Factory were awarded the title of Provincial Advanced Enterprise in Shaanxi (Fu, Wu and Yang, 2008).

2.7 Conclusions

2.7.1 Knowledge Gap

The knowledge gap identified through the literature review is as follows:

(1) Lack of research on the intangible aspects of industrial heritage

As shown above, at present, the perspective of industrial heritage protection generally focuses on the protection of physical objects such as industrial sites, structures or equipment, but often neglects the protection and utilisation of the related remains of industrial heritage, such as documentary records of the development of industrial buildings, production techniques and memories. These precious materials are being rapidly lost. It is also an essential part of the industrial heritage that carries the memory of the city's development. However, there is currently a relative lack of research and analysis of the intangible content of industrial heritage.

(2) Lack of the application of research results in evaluation systems

Through the above research, it can be seen that there is currently a lack of a formal set of laws and regulations for the classification and evaluation of industrial heritage landscapes in China. Although the transformation of industrial heritage buildings is being promoted, and theories, practices and support policies for their recycling are increasing, and the conservation of industrial heritage buildings and their cultures are receiving attention, however, there is still a lack of evaluation systems for the value of industrial heritage in the existing research. The existing research findings show that the evaluation method is static, without a definition of time, and lacks consideration of important features such as historical development and urban regeneration.

(3) Theoretical research still needs to be improved

China's industrial heritage related theoretical research and practice are still at a preliminary stage. Although some valuable experience has been accumulated in the transformation and reuse of industrial buildings and foreign experience and practices have been borrowed, many practices have not yet been raised to a theoretical level. From the analysis of existing research results, it can be seen that currently there is a lack of a systematic approach to screening, research, identification, reuse and subsequent management of the various types of industrial heritage.

How to consider these landscape resources with the aesthetic value of industrial art and transform them to create landscape features with regional characteristics; how to make the economic value of industrial heritage landscape fully reflected while protecting; how to deal with the relationship between abandoned industries and the areas where they are located, and to develop and utilise them in a reasonable way while protecting them? These are the issues that deserve our in-depth consideration and research, and they are also the focus of many experts and scholars in recent years.

However, there has been to some extent a lack of a theoretical system for evaluating the value of industrial cultural heritage in China, and the evaluation always relies on personal perceptions and lacks a theoretical basis. Therefore, in the research and practical application of industrial heritage landscape conservation, it is necessary to explore effective value evaluation methods to avoid the embarrassing situation of having no rules to follow in the practical industrial heritage landscape conservation.

(4) Lack of systematic, integrated and multi-disciplinary cross-level conservation research

With regard to the evaluation and classification of industrial heritage in Shaanxi Province, China, some theoretical research results have emerged in recent years, but the research on industrial heritage remains at the level of functional transformation, spatial utilization and environmental improvement, and there is still a lack of systematic, integrated and multi-disciplinary cross-level conservation research. Research on the value evaluation of Shaanxi’s industrial heritage is mainly based on qualitative evaluation, and a systematic and complete value evaluation method has not been established, and the value evaluation is usually not well targeted. These studies have not yet systematically evaluated the value of the existing buildings within the industrial heritage factory.

2.7.2 Conceptual Framework

Based on the research questions and the research gaps identified through the literature review, the conceptual framework for this thesis is shown in Figure 7.

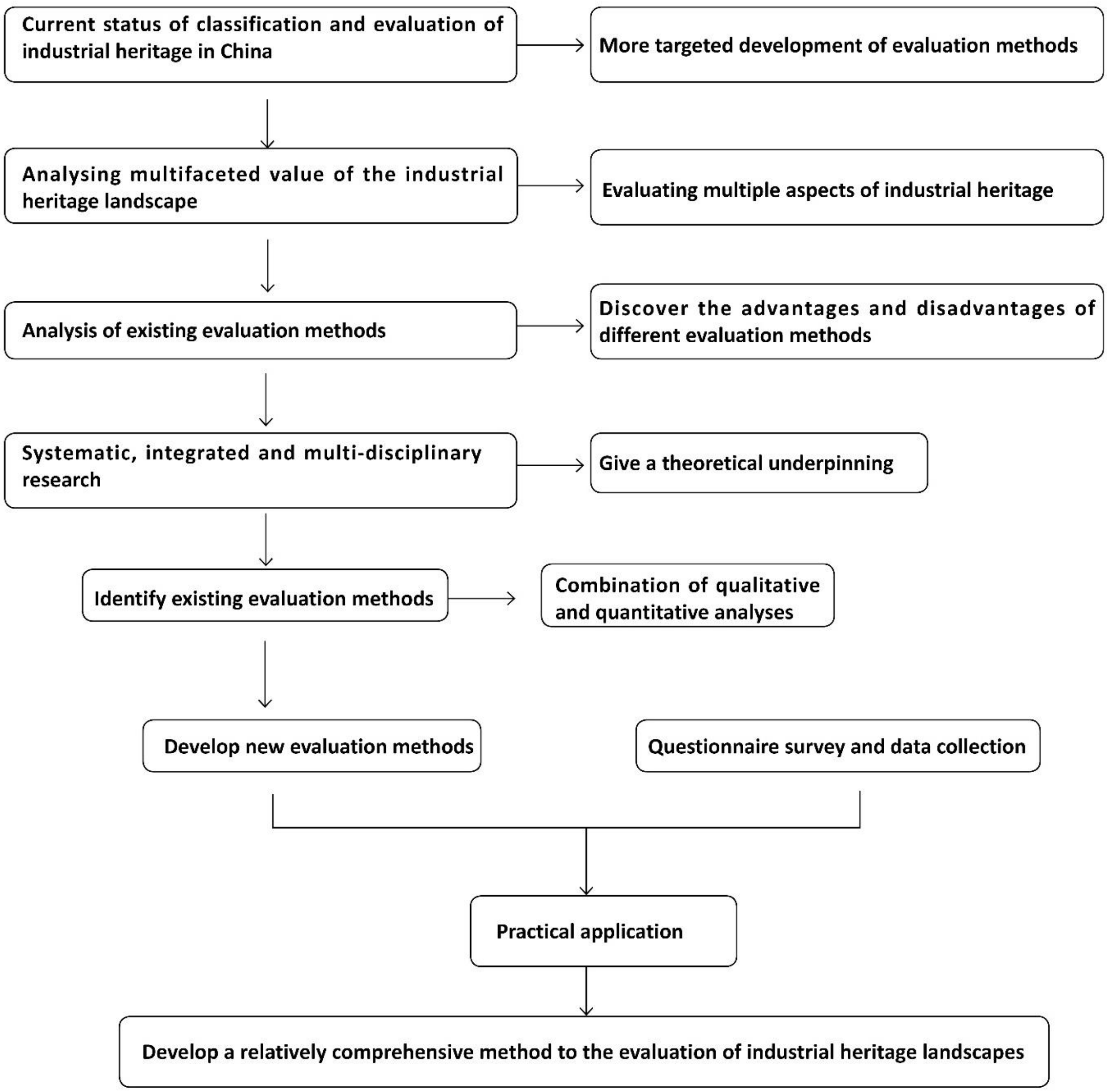


Figure 7. Diagram of Conceptual Framework

Chapter 3. Research Methods

3.1 Introduction: Methodology for Integrating Sociology of Valuation and Evaluation (SVE) of the Heritage Values

Scientific evaluation, or evaluative activity in the scientific field, is an important element in the Sociology of Valuation and Evaluation (SVE), beginning in the 1950s with Merton's (1957) research on reward systems in the scientific community. Pierre Bourdieu's analyses of the academic field in the 1980s introduced a cultural sociological perspective to the observation of academic evaluation and provided an important theoretical basis for the study of the sociology of valuation and evaluation (Bourdieu, 1977; Wolniak, and Houston, 2023).

More importantly, research on research evaluation from a sociological perspective reveals the socially constructed attributes of research evaluation and analyses the complex social technologies behind various types of research evaluation tools, methods and approaches, that is, categorisation and legitimisation (Timmermans and Epstein, 2010; Schudson, 1989). Evaluation is the judgement of how much value, monetary, symbolic, and so on, is contained or embodied in human things. In Lamont's (2012) account, the sociology of assessment is systematically constructed.

The study is an attempt to understand assessment and evaluation in terms of categorisation and legitimisation, heterarchy, and the practice of assessment or evaluation (Lamont, 2012). The authors argue that in a minimal sense, evaluation or assessment requires categorisation (or typification), which means considering and determining the set within which the entity belongs (e.g., the set of objects or people) (Lamont, 2012). Once the broad features or characteristics of an entity have been examined and considered, it can be positioned in one or more categories and considered whether and how these categories fit into one or more hierarchies (Lamont, 2012). Also central to the sociology of assessment is the multidimensionality or plurality of actual or potential hierarchical structures, valuation (evaluation) criteria/grammars (Lamont, 2012).

This insight builds on Weber's (1978) writings on types of rationality and related research on distributive criteria (Walzer, 1983). Thus, much of the sociology of valuation and evaluation research consists of the revelation of evaluative criteria and attempts to uncover the strategies, mechanisms, or structures of cultural societies that support or enable those criteria (Lamont & Thévenot, 2000).

Lamont points out that categorisation is an inclusionary and exclusionary process that determines whether the subject of evaluation is eligible for inclusion in the evaluation (Lamont, 2012). In other words, before placing the object of evaluation in a hierarchical consideration, it is necessary to confirm that the object of evaluation does have a certain value. Legitimisation refers to the recognition of value by oneself and others (Lamont, 2012). On this issue, Lamont borrows Bourdieu and Johnson's (1993) concept of field, pointing out the role of various gatekeepers in the establishment of evaluation criteria and their relationship with other fields. In addition to the criteria of evaluation, evaluation behaviour is also influenced by evaluation techniques, the rules agreed upon in the field, the self-positioning of gatekeepers, and human and non-human elements of evaluation (Lamont, 2012).

The sociology of valuation and evaluation is a "booming field" (Meer and Lamont, 2016) that provides a thematic framework for a large number of different empirical phenomena. In addition to the study of valuation and evaluation processes, conceptualised as value orders (Boltanski and Thévenot, 2006; Lamont and Thévenot, 2000) or institutional logics (Friedland, 2017; Friedland and Alford, 1991; Thornton, Ocasio and Lounsbury, 2012) of normative value orders has been a problem to be analysed, raising questions of heterogeneity, conflict and compromise between different value orders that need to be dealt with in everyday practice (Boltanski and Thévenot, 1999; Lamont, 2009; Stark, 2009).

Krueger and Reinhart (2017) also explore the issue of theory development. Many studies of various phenomena have been subsumed under the sociology of valuation and evaluation, whereas the actual object of study is not always clearly defined analytically or theoretically, but is treated as a single empirical phenomenon. This poses problems for a comprehensive discussion of this new field of research and the connotations of its basic concepts. It is therefore necessary to begin by delineating the different perspectives and objects of study in the valuation and evaluation literature and to identify four key concepts: value, values, value categorisation and value evaluation.

An important contribution of the sociology of valuation and evaluation is to point out the socially constructed attributes of evaluation activities and to analyse in depth the complex interactions of social actors in the process of categorisation and legitimisation of evaluation activities (Krueger and Reinhart, 2016). It also directs attention to how evaluation activities are carried out within and between evaluators and evaluated through social interactions such as communication, negotiation, conflict and compromise, providing new theoretical perspectives and analytical tools to open up evaluation activities, which in turn help people's various types of evaluation criteria and evaluation practices to remain reflective enough to provide possibilities for finding more agreeable categorisations and evaluations (Cefai, 2015; Krueger and Reinhart, 2016).

This study argues that the introduction of a sociology of valuation and evaluation perspective into the current methodology of industrial heritage evaluation in China will help to provide an overview of the overall picture of heritage evaluation and provide a choice of methods that can be applied when actually visiting and investigating heritage sites. It will also help to clarify the systematic framework of heritage evaluation and to grasp the overall evaluation framework.

Based on the theoretical perspective and conceptual tools of the sociology of valuation and evaluation (SVE) (Lamont, 2012), which has emerged in the West in recent years, this chapter argues that the essence of research evaluation is to simplify the complexity of scientific research reality by establishing a set of systems of representation based on a specific classification. From this perspective, this chapter outlines the methodology and procedures adopted to conduct the research for this thesis. It is divided into five main sections: Section 3.1 presented the background research. It also entails a strategy for simplifying objectives and outlining tasks' expected results. The overall objective of this research is to establish a comprehensive and rational methodology for categorising and evaluating industrial heritage. In Section 3.2, the research methodology adopted to fulfil the first task of proposing a definitional framework for industrial heritage (screening of value indicators) is discussed. In Section 3.3, the theoretical research methodology for a simple and operational understanding of industrial heritage valuation is discussed. Section 3.4 describes the development of an operational framework for the establishment of industrial heritage evaluation. Section 3.5 outlines the validation of the research findings.

In summary, the limitations of this study also highlight the potential for further improvement and development of the research findings. For the reader, it is hoped that this research methodology will support the robust nature of the thesis, suggest ways to take this research further and inspire other novel and pragmatic work aimed at improving our cities.

3.2 Research Approach to Contextualize Aims and Tasks: Literature Review

At the outset of the research, a pragmatic perspective (Creswell, 2009) was adopted to approach the main area of concern of classification and evaluation methods for industrial heritage. This entailed conducting research based on a broad understanding of heritage, the current realities, problems or challenges of industrial heritage, and with the aim of being able to contribute practically to the management of industrial heritage in a way that is relevant to the above aspects. Having gained knowledge and experience on the urgency of research on industrial heritage and the inadequacy of existing evaluation studies on industrial heritage (see Sections 2.4), an extensive literature review was conducted to understand: (1) the evolution of cultural heritage connotations and the expansion of the scope of protection; (2) the exploratory process of evaluating industrial heritage; (3) the existing evaluation methodologies on industrial heritage; (4) the methods of preservation and reuse of industrial heritage; (5) the development of Shaanxi's industrial development and the development of the industrial heritage in Shaanxi Province; (5) Historical overview of industrial development in Shaanxi and the current situation and local characteristics of Shaanxi's industrial heritage; (6) Research gaps currently facing industrial heritage research.

The literature review was extended to general information on industrial heritage evaluation. The author collected a large number of writings, and journal articles, including the concept of World Heritage inscription, World Heritage conservation and management, tourism, identity, community, and many other topics; checked the official websites of UNESCO, ICOMOS, the World Heritage Centre, the State Administration of Cultural Heritage, and the China Academy of Cultural Heritage, and interpreted the official documents including conventions, declarations, proclamations, regulations, guidelines, which were formed by the World Heritage General Assemblies; paid attention to important news reports, especially documentary articles and reports around heritage, and tried to interpret these texts. The researcher focused on the important news reports, especially the documentary articles and reports on heritage, and tried to analyse and interpret the texts concerned with the doctoral theses on heritage and industrial heritage in recent years, and analysed the structure of doctoral theses of different research directions, and the combination of theory and practice. The search engines for research sources included the Google Search, Google Scholar, Scopus, the University of Strathclyde's Suprimo library repository. These search engines were employed throughout the study. Through this review, it is understood that China is now in the stage of rapid urbanisation and industrial heritage, as a new type of heritage, has yet to be improved in terms of social recognition and protection awareness (Chen et al., 2022).

The classification and evaluation of industrial heritage is an important prerequisite for its subsequent protection and reuse, but previous studies have shown that there are fewer studies on the classification and evaluation of industrial heritage in China, and systematic research needs to be filled urgently (Chu, 2016). In addition, the scope of heritage is constantly changing, and industrial heritage is part of cultural heritage (Chu, 2016; Deng et al., 2011). At present, the general situation of China's industrial heritage is that the number of industrial buildings in the existing industrial heritage plant area is huge, with varying quality, and to identify industrial heritage, it is necessary to investigate and screen these industrial buildings and landscapes, and the basis of screening is the value of heritage.

In the case of industrial heritage, it is necessary to analyse its characteristics on the basis of the process of its historical formation in order to judge its value and thus identify the industrial heritage (Gao and Liang, 2013). Based on this point of view, this research considers that the establishment of an accurate and practical evaluation system for the heritage value of industrial buildings is an effective way to judge the heritage value of industrial heritage. The value evaluation system should be highly relevant and operable. It should be established based on sufficiently solid research and systematic and rigorous theoretical demonstration, and should carry out an operational value assessment of a specific type of historical industrial building, period or geographical area, so that only the heritage that meets a certain standard can be regarded as industrial heritage.

Specifically, the industrial heritage in Shaanxi, China, has both common values of industrial heritage and unique value connotations due to its regional characteristics. It is necessary to establish a targeted evaluation system for the value of modern industrial heritage in Shaanxi according to the special characteristics of the value of recent industrial heritage in Shaanxi.

This study aims to develop a comprehensive and systematic method for the classification and evaluation of industrial heritage, which, according to the literature review, can be achieved through the following three tasks: (1) proposing a comprehensive and operational framework for describing and defining industrial heritage; (2) establishing a systematic and comprehensive operational framework for the determination of industrial heritage; (3) applying the framework for the evaluation of industrial heritage to Shaanxi. Sections 3.3 to 3.5 below describe how the research tasks were carried out.

3.3 Research Methodology for the Definitional Framework of Industrial Heritage: Historical Literature Review, Theoretical and Qualitative Content Analysis and Comparative Studies

In order to fulfil the first research task, to develop a strategy for describing and comprehensively defining the industrial heritage, so as to subsequently find a suitable and justified methodology for a comprehensive evaluation of the industrial heritage, a three-step research methodology has been adopted.

3.3.1 Historical Literature Review

The first step was to review the history of industrial heritage, from the emergence of its concept in Western countries to its current global interest. Special emphasis is placed here on the researcher's view of cultural heritage, industrial heritage, and the efforts made to properly understand industrial heritage. The focus of the literature review centred on the conservation of the built heritage itself and the development of heritage concepts, rather than focusing on issues such as the design of heritage environments and displays. Although much of the literature provides an overview of cultural heritage, there is not much discussion specifically on how to understand and define industrial heritage (Davies, 2008; Liu, Zhao and Yang, 2018). Specifically, the literature review focuses on selections and themes, the context of which includes not only current research on the origins and history of industrial heritage, but also the collection, collation and analysis of research results and practice examples of industrial heritage from various countries.

At this stage, access to published book reviews to aid specific searches was essential. Literature sources included books, published journals, dissertations, government reports, typical national and international documents, and regulatory and normative documents. The study also examined current efforts to evaluate industrial heritage, a common but unfulfilled goal. The study also examined current proposals to fill the gaps in order to develop a comprehensive framework for evaluating industrial heritage and to provide a practical definition of industrial heritage. There are few such proposals, including publications by Kohli et al. (2012) and Gulyani and Bassett (2010) respectively. These reviews show that heritage and value are closely linked and that the diverse values of industrial heritage are very complex both in the past and presently. However, the question of how to view the significance and value of fragmented historical remnants is a difficult one, and value evaluation is a central issue for industrial heritage (Fredhei and Khalaf, 2016). The literature review is also helpful in understanding the importance of industrial heritage, the urgency of preserving it, and in identifying the implications of a evaluation framework.

In addition, the literature also helped the researcher to define the object and scope of this study, as well as the most important aspect of the evaluation methodology is the determination of the classification of values (Lamont, 2012), and enabled the researcher to identify and summarise the gaps in the current research on the classification of industrial heritage, for example, there is no systematic and procedural paradigm for the evaluation of the classification of China's industrial heritage and the classification of the value of the industrial heritage has yet to be improved. The evaluation framework of industrial heritage should be based on science, rationality and feasibility (Chu, 2016).

The process of heritage conservation planning and management proposed by Mason (2002), a Senior Programme Specialist in Getty Conservation Institute, USA, can be divided into three parts: identification and description, assessment and analysis, and response to assessment results. The identification and description part is to establish the evaluation object and stakeholders, and to start collecting and analysing the relevant information of the heritage (Mason, 2002; Mason, 2003).

The architectural heritage evaluation system proposed by the British scholar Feilden (2007) emphasises the link between value assessment and conservation. According to Feilden (2007), the conservation planning team should be interdisciplinary, identify the value of the heritage only after establishing the conservation objectives, and rank the value, prioritise the value as the deciding factor for intervention, and preserve the key information of the object heritage. In terms of theoretical foundations, Feilden cited the American Getty Conservation Institute's framework for heritage conservation planning (Feilden, 2007; Mason, 2002).

Based on this theoretical foundation, this research used a combination of value theory and cognitive theory to develop a definitional framework that is scientific, rational and feasible. After an initial reading, the literature search focused on " the composition of value", "the criteria of value", "the type or form of the object's attributes", and "the nature of the object". The literature sources for this theoretical analysis included journals, books, online books and websites. The results of the analysis indicate that interactive and multidimensional cognitive features play a role in describing industrial heritage values; these can be collated and logically organised in order to provide a comprehensive description and definition.

3.3.2. Theoretical and Qualitative Content Analysis

Therefore, in order to develop a comprehensive methodology for describing and defining industrial heritage, the second approach consisted of a qualitative analysis of the content, and documentation.

This includes journals, books, online books, reports, websites and conference publications, and dissertations. Content analysis is a method of subjective but systematic interpretation of textual content by identifying and coding themes and patterns in the text that are not otherwise the focus (Hsieh and Shannon, 2005). Coding consisted of segmenting the data into meaningful groups and then labelling these groups in terms that the researcher deemed appropriate (Creswell, 2009). The content analysis method was applicable to this study as the overall context of the research aims lent itself to extensive analysis. In this study, the content analysis approach focuses on identifying, analysing and organising and critically cataloguing multi-value features commonly found in industrial heritage. In addition, this phase of the study required extensive analyses of a wide range of concepts, which required a significant investment of time.

3.3.3. Comparative Studies

It is worth mentioning that there is considerable emphasis on "comparative studies" in the assessment and recording of heritage values as a means of locating heritage in its historical context and confirming its value and level of value, such as in the Principles of Recording, which include cross-checking with records of related buildings, documents, archaeological and environmental reports as part of their record identification (ICOMOS, 1996).

The comparative research applied in this research is divided into several levels: (1) Theoretical and practical: Observation of possible variations in the application of value systems and valuation theories to practical work within institutional frameworks; (2) Comparison of Concepts: Comparing the concepts of cultural heritage, value and culture in different discourses, and comparing the concepts and principles of heritage valuation at home and abroad; (3) Comparison of domestic and international systems: Comparison of domestic and international systems of value assessment and implementation cases, and comparison of domestic and international practices and policies on industrial heritage assessment.

3.4 Research Methods used in the Construction of the Evaluation System

The evaluation of the value of modern industrial heritage is a complex process, and the selection of evaluation indices should fully consider the comprehensiveness and representativeness, so that the evaluation results can reflect the real situation of industrial heritage to the greatest extent (Claver, García-Domínguez, and Sebastián, 2020). The determination of the evaluation indices of industrial heritage value should first determine the method of constructing the index system (Zhang, Liu and Feng, 2022). Through the literature review, the evaluation indicators are initially classified, and then the establishment of the indicator system is realised through a scientific screening step.

Evaluation system refers to the analysis system and method of synthesising many evaluation indicators of different natures and attributes, which cannot be added together directly, through certain theories and methods to reach a final conclusion (Patton, 2014). Usually, the purpose is to reveal the characteristics and essence of a certain aspect of the evaluation object, and the data obtained from investigation and research are analysed and calculated as a means (Patton, 2014).

After determining the purpose of the evaluation, the comprehensive evaluation system is generally composed of evaluation subjects, evaluation objects, evaluation indicators and evaluation models (Lamont, 2012; Patton, 2014). The purpose of this evaluation system is to determine the high or low value of industrial heritage.

The evaluation subject refers to the individual or group that carries out the evaluation system, and the authority and diversity of the evaluation subject will also affect the scientificity and credibility of the evaluation results (Lamont, 2012). In the case of the industrial heritage under study, the evaluation subjects are the stakeholders related to the industrial heritage in this research: those who also study industrial heritage; those who develop policies and rules related to industrial heritage; professionals involved in preservation and reuse of industrial heritage (designers); people who have a cross-relationship with industrial heritage, in different fields, but who have an intersection with industrial heritage; people who are interested in the industrial heritage; industrial heritage owners, local residents and employees.

The evaluation object is the target of evaluation, and in the case of this study the evaluation object is the modern industrial heritage in Shaanxi Province. Evaluation indicator refers to a collection of multiple indicators reflecting a specific characteristic of the evaluation object, and this indicator system composed of multiple indicators is used to measure the value of a selected heritage object'. Each evaluation index has different degree of importance in the evaluation system, which in turn requires the weights of the indicators to be configured. The evaluation index of this research is a collection of the main factors affecting the evaluation of modern industrial heritage in Shaanxi Province (See Section 4.1). The evaluation model refers to the integration of the scoring results of the evaluation indicators into a comprehensive evaluation result through a certain mathematical algorithm or model.

Based on the summary of the research on the theoretical methods and practices of evaluation and the sociology of valuation and evaluation, the process of evaluation can generally be divided into three major steps: the preparation stage, the conduct stage and the end stage (Mertens and Wilson, 2018; Stufflebeam, and Coryn, 2014).

Evaluation preparation stage entails determining the evaluation object, the evaluation method and the evaluator, and data collection and analysis. Evaluation conduct stage includes determining the rating indicators and the weight of the indicators, a single evaluation, and a comprehensive evaluation. Evaluation end stage comprises the analysis of evaluation results, evaluation report writing, and promoting of the evaluation application (Mertens and Wilson, 2018; Stufflebeam, and Coryn, 2014). Based on the general process of comprehensive evaluation, summarised in the literature study (Mertens and Wilson, 2018; Stufflebeam, and Coryn, 2014; Lamont, 2012, the process of constructing the evaluation index system in this study consists of three steps: the preliminary construction stage of the evaluation indices, the quantitative weighting stage and the practice test stage.

The index construction stage mainly uses the comprehensive analysis of literature according to the evaluation objectives of the preliminary identification and refinement of the construction of evaluation indicators. The quantitative weighting stage is mainly the questionnaire method and statistical method. The importance of different factors in the evaluation of industrial heritage was determined by distributing questionnaires to stakeholders such as local people, people interested in industrial heritage. The statistical method of Analytic Hierarchy Process was used to weight the collected data in order to obtain the importance of each evaluation indices constructed in the previous step and to calculate their weights. The aim of weighting is to establish a hierarchy of significance of evaluation indices.

The study collected data through questionnaires and weighted the collected data with the statistical method of hierarchical analysis. The practical test stage entails selecting typical cases to demonstrate the detailed process of value evaluation and analysing the evaluation results to test the validity and dynamics of the constructed evaluation index system.

3.4.1 The Preliminary Construction Stage of the Evaluation indices

This stage is to construct, as far as possible, a comprehensive and complete collection of evaluation indicators that match the characteristics of the object of evaluation. Comprehensiveness is its main requirement in order to screen them at a later stage. Generally, the most commonly used methods at this stage are the comprehensive analysis method and the expert consultation method (Rihoux, and Ragin, 2008). However, these traditional methods mainly rely on human experience and intuition, are highly arbitrary, and lack rigorous logic and scientificity (Feng, Wang, and Yang, 2012). The preliminary construction of evaluation indicators in this research adopts the findings of systematic literature review.

Firstly, after systematically collating the relevant literature on industrial heritage evaluation using the systematic literature review method, the relevant information collected was summarised to produce a set of evaluation indicators. The above process built on wider research on indicators used in evaluating industrial heritage to ensure that appropriate indicators are included in the evaluation of Shaanxi industrial heritage now (see Section 4.1), and to increase the comprehensiveness of the indicators in this stage.

Then, the retrieved research data and data from the questionnaires developed for the evaluation factors will be sorted out. The survey of above-mentioned stakeholders included a questionnaire on the importance of evaluation factors to determine the importance of value evaluation factors(see Appendix A).

3.4.1.1 Literature Review of Classification and Evaluation methods

The systematic literature review method is used to study the literature related to the classification and evaluation methods of modern industrial heritage, which is searched in the literature databases of SUPrimo and Google Scholar with the keywords of value evaluation, historical building evaluation, heritage evaluation, modern industrial heritage evaluation, industrial heritage evaluation and industrial heritage value evaluation respectively.

Through the reading of the literature, it is summarised that the studies related to the evaluation of industrial heritage mainly focus on the evaluation of one of its aspects, and the studies on the evaluation of the value of historical industrial heritage account for a major part of them. The existing value evaluation studies in China are basically developed by adding some other contents on the basis of the three major values of history, art and science put forward in the Protection Law of Cultural Relics and Buildings in China, and there is a lack of the refinement of the value indicators of industrial heritage and the delineation of the evaluation standards (Chu, 2016; Song et al., 2014), which is exactly the focus of the research in this study. By analysing the literature as systematically as possible, the identified evaluation indicators are collated in Section 4.1, and the value subdivision is shown in Table 21 and Section 5.1.9.

In addition, the study by Qi (2018) showed that the Analytic Hierarchy Process (AHP) can be used to decompose the evaluation objectives layer by layer, and categorise and hierarchically arrange them according to the attributes of the evaluation factors, so as to form the final hierarchical structure of the objectives. This is in line with the diversity and complexity of values.

The AHP method is an analytic method combining qualitative and quantitative analysis, proposed by Professor Saaty in the 1970s (Qi, 2018). The method, also known as the chromatography analysis, has been widely used in the comprehensive evaluation of the plant landscape such as parks and urban roads, and is also used for the analysis of complex problems with multiple criteria and objectives (Wei and Zhang, 2017). The analysis of the basic data of industrial heritage landscape in the urban area results in the evaluation of the value of different landscapes in the later use and planning design.

Since both the landscape and the heritage are constantly changing (Harvey, 2015) in the urban industrial heritage landscape, AHP can only analyse the landscape factors of the studied plot, and there are still limitations regarding the overall landscape structure, the patch space structure, the landscape continuity and the cultural implications of the city (Turnpenny, 2004; Whitehand, 2009). To be more scientific in the evaluation of the industrial heritage landscape, comprehensive data will be obtained from the perspective of the Historical Landscape Characterisation (HLC), and the spatial information system will be established by using Geographic Information System (GIS) for a comprehensive evaluation by using AHP.

Based on the hierarchical analysis method, the study determined the index layer, criterion layer, and factor layer of the evaluation index system of industrial heritage in Shaanxi Province. The final comprehensive evaluation index system of modern industrial heritage in Shaanxi Province was obtained, as shown in Table 21.

According to Darko et al. (2019), the aim of AHP method is to include weights of each indicator after determining the indicator system. Because different indicators have different impacts and play different roles in the whole evaluation system, the size of the weights is used to reflect and measure the importance of the indicators. It should be noted that the quantitative score of the value evaluation can only be accurately assigned through a large number of surveys and researches, and be constantly revised through practice, so as to practically improve the reliability and validity of the measurement, and to be more in line with the value standards of industrial heritage in different cities. Therefore, after the Shaanxi industrial heritage evaluation system is established, each indicator should be given a corresponding weight following the related surveys of stakeholders.

3.4.2 Determination of Weights Stage - Subjective Weighting Method

The literature review showed that subjective assessment can be used to determine weights and judge the relative importance of each indicator, based on uncertain subjective information (Creswell, 2009). The main means of obtaining subjective information is to give the relevant evaluators a questionnaire for judging the weights of the indicators. The evaluators compare and consider the weights of the evaluation indicators in accordance with their own previous experience, knowledge and preferences, and give verbal or numerical judgments.

Analytic hierarchy process (AHP) method is a commonly used in subjective weighting method, which relies on constructing a judgement matrix and then solving it to obtain the weights. The main steps are to compare the same group of indicators at each level in turn, according to their relative importance of the corresponding ratio, and then, following the corresponding computational model, use these values to construct the judgement matrix and obtain the eigenvectors of the matrix to determine the indicator weight (see Table 25).

The first step was to design the questionnaire and the importance option values for each factor individually according to the content of the study and the form of the questionnaire that facilitates the calculation and analysis of the hierarchical analysis method. The draft questionnaire was first sent to colleagues and teachers in the Department of Architecture at the University of Strathclyde, with secondary revisions made to address the relative lack of clarity to form the final questionnaire (See Appendix A). The questionnaire was distributed online and through field research.

Around 300 stakeholders of different age groups and professional backgrounds were selected to investigate their attitudes towards industrial heritage and the evaluations generated from the fieldwork. The aim is to understand the audience's tendency to understand and accept industrial heritage landscapes, so as to rationalise the evaluation of different types and scales of industrial heritage, and to develop aesthetic strategies to find more appropriate industrial heritage. A 2x2 matrix is constructed using AHP method to examine the consistency of obtained evaluation results, and the final summative score of each index is calculated. The final score of the questionnaire is used for value assessment.

3.4.3 Data Visualisation - Geographic Information System (GIS)

Geographic Information System (GIS) technology combines geography and cartography as well as remote sensing and computer science, and is a computer-based tool that can analyse and process spatial information (Ciski, Rzasa, and Ogryzek, 2019). It has powerful spatial and attribute data management, visual display, and analysis and application capabilities, and it is not only applied in urban planning and management work, but also started to be applied in cultural heritage protection planning. GIS has been effectively applied in many fields due to its powerful data storage, management capability and efficient and intuitive spatial analysis. GIS technology has been widely used in archaeological exploration, historical heritage protection.

Rajangam and Rajan (2017) have applied GIS technology in archaeological excavation work and protection measures for cultural and architectural heritage, and the Yorkshire Dales National Park has summarised and collated information related to its architectural heritage through a geographic information system (GIS) and released it to the web for public access (Summerby-Murray, 2001). In Europe, 3S technology has been applied as early as at the end of the twentieth century in the protection and management of major World Heritage sites (Zhou, Geng and Wu, 2012). Ogryzek and Rząsa (2016) believe that GIS brings new conceptual ideas and technical means to the study of historical and cultural heritage protection methods.

The evaluation of the value of industrial heritage includes environment, geography and other elements, that the related data need to be stored and managed efficiently and quickly. The biggest feature of GIS technology is the establishment of a spatial database, which can be used to obtain data resources more conveniently, store and manage various types of data more efficiently, and use the database to draw a variety of current situation analysis maps required for the protection of industrial heritage.

In addition, GIS also has a strong analytical ability to analyse and process all kinds of complex data, and the results are accurate, clear and intuitively visible (Spiridon, Ursu, and Sandu, 2016). Due to the variety and complexity of data contained in the evaluation method of industrial heritage, a method is needed to make people understand the information about industrial heritage in various aspects and feel the evaluation results more intuitively. Therefore, this research believes that the application of GIS technology in this study can bring together and store the information obtained from field research, and can graphically and intuitively reflect the evaluation results of the hierarchical analysis method. The specific evaluation and visualisation process of industrial heritage using the GIS method is shown in Section 4.9.2.

3.5 Practical Testing Stage: Sampling Method, Field Research, and Historical Documentary Research.

In the previous section, the evaluation system of industrial heritage classification was established and the weight factors of indicators were determined. Meanwhile, in order to explain the specific process of evaluation more clearly, and also to illustrate the scientificity and practicability of the value evaluation system and evaluation method, the focus of the next section is on a trial evaluation of the main typical industrial heritage sites in Shaanxi Province based on the data and information obtained from the research on the current situation of the modern industrial heritage in Shaanxi Province, and compared with the indicator system constructed in the previous step.

In this study, three industrial heritage sites in Shaanxi Province were selected to demonstrate the detailed process of value evaluation, and the evaluation results were analysed. The main research methods used in this section are: sampling method, field research, and historical documentary research.

The study of heritage conservation should not be based solely on technical expertise or on the conservation of individual cultural heritage, but rather on the perspective of the population and the needs of social development, and in the context of new trends of the times (De la Torre, 2013). Social research has developed a rich variety of contemporary social research methods, including sampling, field research, and survey research, which are most widely used, by applying its own traditional research methods while borrowing and integrating research methods from other disciplines (Crano, Brewer and Lac, 2014). Sampling and field research, the basic research methods of social sciences, can be introduced into the study to make the study of industrial heritage more comprehensive and effective.

3.5.1 Sampling Methods

Since the 20th century, empirical survey methods have become progressively more systematic and precise (Blackwood, 2010). This is mainly due to the development and introduction of modern scientific and technological means. The main progress of social survey techniques is that statistical survey methods are more perfect, and various methods of statistics are applied to social research in large numbers.

For example, the sampling theory of Fisher (1925), the founder of British classical statistical analysis, and the correlation coefficient method of K. Pearson, the founder of British modern statistics (Victor, 1981), have contributed to the widespread application of sample statistical surveys, questionnaires and opinion polls. The sampling methods of social research can be divided into non-probability samples and probability samples (Haque, 2010).

Since the majority of cities and regions in China have not yet completed the census of industrial heritage (Zhang et al., 2023), the comprehensive study of industrial heritage in a city or region actually adopts the sampling research method, the characterisation of the industrial heritage of the whole city based on case studies. Convenience sample and purposive sample methods of non-probability sampling are generally used in heritage research (Makwana et al., 2023). In the former case, the researcher selects the sample using the most convenient method for the researcher; in the latter case, the researcher draws the sample according to the judgement of the research purpose.

Based on this, according to the purposive sample method, in order to test the practicability of the factors in the evaluation method in the actual evaluation, this study chooses three different industrial heritage sites in the same regional cultural context, each of which has a different scale and state of conservation, so as to make the test results more representative. The three cases are Shaanxi Old Steel Factory (1965) in Xi'an, Wang Shi Wa Coal Mine (1957) in Tongchuan and Shenxin Yarn Factory (1939) in Baoji.

3.5.2 Methodology of Historical Documentation

The Venice Charter states that restoration shall be based on respect for original materials and solid documentation, and archaeological and historical research must be carried out on monuments before and during restoration (ICOMOS, 1964). Therefore, the preliminary study is the basis of all conservation work as it can provide the value of the heritage of the "first-hand" information.

China in the protection of traditional cultural relics and buildings is more focused on the collection of historical materials, documentation, Western countries are more emphasis on empirical investigation methods, based on more photographs, pictures, on-site archaeological and mapping of ancient buildings in the field data, which is more objective (Lai, 2016).

Based on this, firstly, the literature research of this study is not only reviewing the relevant theoretical literature on industrial (architectural) heritage research, but also collating and reviewing the Shaanxi historical records, archives, newspapers, periodicals, and local literature such as the history of factories of the modern industrial heritage, so as to sort out the general lineage of the development of the modern industry in Shaanxi, and to summarise the characteristics of the various stages of development, with the information mainly originating from the local historical archives, libraries, cultural and heritage departments.

In addition, the method of directly asking the public, especially the old residents, about the historical situation in the form of questionnaires and interviews is an equally effective source of information. By analysing all of the above basic information, it is possible to gain an understanding of the environment of the heritage area as well as the historical development of the building itself and its historical background.

3.5.3 Field Research

Field research first originated from anthropology by using the participant observation method and interview method (Burgess, 2003). It is a research method that collects data by observation and interview, and achieves the understanding and interpretation of the research object through the analysis of these data.

For industrial heritage, structured observation method can be adopted. It entails developing a unified and standardised observation form, and adopting uniform regulations on the procedure, content, recording methods and methods of observation, which can be used as the basic basis of observation for data collection. In order to better understand the current situation of the industrial heritage, assess its value, and find a basis for subsequent planning and renewal, this study conducted a detailed investigation of the architectural elements within the industrial site by means of field research, questionnaires and interviews. Firstly, a questionnaire (Table 26 and Table 27) was used for each building to obtain its basic architectural information.

A survey of the overall environmental conditions of the current state of the industrial heritage was also carried out, including a survey of the state of the natural landscape of the area, as well as the geographic location and elements of the natural environment and landscape. In addition to this, data collection in the field was also carried out. For example, on-site survey, filling out forms, taking photos of building facades and details, a series of information including the current state of preservation of the building, damage, usability, number of floors, infrastructure conditions, cultural value, use value, relationship with neighbouring lots, and constraints on the special requirements of the neighbouring units were obtained.

3.6 Conclusion: Limitations of the Current Research Methodology

This chapter attempts to provide the reader with a brief overview of the methods adopted in initiating and carrying out the research task and how these methods and results are summarised. The research methods and procedures discussed in this chapter are those that were logical and effective in accomplishing the research tasks. Admittedly, as with most studies, there are some limitations to the research methodology adopted.

In the research process of industrial heritage evaluation, the author has also experienced the vastness of this field. Even if the author has searched a large amount of literature within the topic, due the research conditions and time constraints, it is difficult to exhaust all the literature by one's strength and effort, and it is impossible to involve all the relevant literature. In the study, based on the researcher's personal practical experience and the research achievements of related experts and scholars, combined with some thoughts and inspirations in the study, the study tries to explore the evaluation of the value of industrial heritage, and strives to analyse and summarize on the basis of the existing evaluation theories and methods, and seeks for progress. However, due to the different fields of expertise, the understanding of some of the literature may also be deficient, to be further strengthened.

As data for some of the cases in the study were not available due to confidentiality of information within the Government, such as old photographs and CAD drawings, the author can only make full use of the existing literature and the information available, but inevitably, there is still insufficient knowledge.

The evaluation of industrial heritage value is a multidisciplinary and complex subject, and although the evaluation method proposed by the author cannot completely solve all the problems encountered in the practice of industrial heritage evaluation, it can be seen as a useful exploration of and endeavour in the application of AHP and GIS in researching and presenting research findings related to the preservation of industrial heritage in China.

Chapter 4. Establishing a Classification Method for Industrial Heritage in Shaanxi Province, China

With the rapid development of China's cities, the pressure on urban space and other resources has led society to pay more attention to the protection, transformation and reuse of industrial heritage. Due to the lack of attention to industrial heritage in the past, its number is decreasing or even about to be destroyed. As a result, cities such as Beijing and Nanjing City have started to survey and identify industrial heritage, and have included valuable industrial heritage in the scope of protection, renovation and reuse (Liu, 2012). However, there is still less unified standard on how to determine the value of industrial heritage in a scientific and reasonable manner. Therefore, this chapter will focus on the assessment of industrial heritage value and provide new ideas for such issues.

The Interim Measures for the Management of National Industrial Heritage in China indicate that national industrial heritage refers to industrial relics that have been formed during the long-term development of Chinese industry, have high historical, technological, social and artistic values, and are recognised by the Ministry of Industry and Information Technology (Interim Measures for the Management of Chinese National Industrial Heritage, 2018). The chapter on recognition procedures stipulates that applications for national industrial heritage must be distinctively industrial and have five conditions.

(1) Iconic significance in China's history or the history of the industry, witnessing the beginnings of the industry in the world or in China, having a significant impact on Chinese history or world history, and being closely related to social changes or important historical events and figures in China.

(2) Representative of major changes in industrial production technology, reflecting technological innovation and breakthroughs in a certain industry, region or a certain

historical period, and having an important impact on subsequent technological development.

(3) It has a rich industrial cultural connotation, has a strong influence on the socio-economic and cultural development of the time, reflects the social landscape of the same period, and has wide recognition among the public.

(4) Its planning, design and engineering represent the landscape features of a specific historical period or region and have an important impact on industrial aesthetics.

(5) It has a good basis for conservation and use work.

The first four of these articles describe the heritage value, while the fifth article stipulates that the nominated object must have a good basis for conservation and use work. As industrial architectural heritage is a tangible heritage, this paper considers that a good foundation for conservation and utilization is mainly reflected in the good preservation of the heritage body and environment (Interim Measures for the Management of Chinese National Industrial Heritage, 2018). In addition, drawing on the first batch of national industrial heritage recognition, Shaanxi's industrial architectural heritage is graded from two dimensions: heritage value and preservation condition.

4.1 Selection of Classification and Evaluation Indicators for Industrial Heritage in Shaanxi Province, China

The value of industrial heritage is the aspects of industrial heritage resources that have value and significance to people. So, before studying the value composition of industrial heritage landscapes, it is necessary to define the scope of industrial heritage landscape resources in a comprehensive manner (Hughes, 2018). According to the definition of industrial heritage in the Nizhny Tagil Charter on Industrial Heritage, industrial heritage resources should include both tangible and intangible heritage resources (TICCIH, 2003).

Tangible industrial heritage resources include buildings, machinery, workshops, factories, and mines for ore processing and smelting, stratigraphic and engineering structures, warehouses, sites for the production, transmission and use of energy, transport and infrastructure, as well as sites for social activities and habitats associated with industry, such as religious and educational facilities, workers' living quarters, industrial towns, natural landscapes, for historical documents and records created for or by industrial production, such as deeds and contracts, trade names and trademarks, product samples, manuscripts and handwritten notes, signage, ticket books, photographic topographies, library materials and audiovisual productions (Patiwael, Groote and Vanclay, 2019).

The intangible industrial heritage includes processes, production skills, corporate cultures and their expressions, values and aesthetics influenced by the industrial society. The value of the buildings, workshops and factories within the site will be considered purely from a historical and aesthetic perspective (Xie, 2006).

Based on the research on the industrial heritage landscape in Shaanxi Province and the collection and study of relevant data, and combined with the research results of related disciplines on the value composition of industrial heritage and industrial heritage landscape, this study divides the value of industrial heritage landscape in Shaanxi Province into intrinsic value and derived value. Among them, the objective value of industrial heritage is called the intrinsic value, including its historical value, scientific and technological value, cultural value and artistic value (Liu, 2012).

The values of industrial heritage that are influenced by time, space and evaluators are called derived values, including location value, environmental value, group value, social value and emotional value.

4.1.1 Intrinsic Value

Intrinsic value refers to the value of industrial heritage itself, including historical value, technological value, cultural value and artistic value (Liu, 2012). It results from an evaluation of the character and usefulness of industrial heritage, which exists without being limited by the subjective feelings of the evaluator, is not affected by changes in time and space, and is part of the established properties of the industrial heritage itself. The summary chart is shown in Figure 8.

4.1.1.1 Historical Value

The development of industry in Shaanxi Province in modern times is closely related to the national situation, from the Westernization Movement in 1861 to the war against

Japan in 1937. After the liberation of China in 1949, Shaanxi was supported by national policies and industries were developed (Liu, 2018). As a historical carrier, the industrial heritage has witnessed the history of industrial and social development. The historical value is subdivided into industrial historical value and social historical value, with social history referring to the association with important historical events, figures and organisations in Chinese history (Ji, 2019). The industrial buildings under evaluation, as part of the factory, not only have their own architectural history, but also bear witness to the history of industrial development.

Historical value includes the following aspects (Ji, 2019; Liu, 2018): witnesses to the material and immaterial dimensions of human life and social development at a certain point in time or period in history; witness to the level of social development; the witnessing of important historical events or activities with temporal and spatial coordinates; the corroboration, addition and completion of historical documents; scarcity or uniqueness adds to the historical value of heritage; the completeness of the heritage determines the significance of its value on a historical level.

For example, the Duisburg Landscape Park in Germany, which is now being transformed to focus on industrial tourism, is located in the Ruhr district of Germany, which has an industrial history of nearly 200 years, and was converted by the designers from the original site of the steelworks (Tian, 2015). The site itself has seen the region's coal and steel industries go from glory to decline, as well as the closure of factories and the loss of workers. It is still possible to understand and recall that history from the site. As a witness to the development of the times, the industrial heritage is of great historical value. In brief the historical value can be summarised in six items (Liu, 2018) (Table 11):

(1) The date of construction of the heritage

The date of construction of heritage is generally the basic information about cultural heritage as a documentary feature (Xie, 2006). In the broad sense of cultural heritage, the longer the period, the higher its value. Although the historical period of industrial heritage landscapes is much shorter than that of other types of cultural heritage, they can be divided based on the relative concentration of periods in which the heritage is distributed (Tian, 2015). For example, a) before 1911 (before China's Xinhai Revolution which is the Chinese bourgeois democratic revolution led by Dr. Sun Yat-sen which overthrew the Qing Dynasty in 1911); b) 1911-1948 (after China’s Xinhai Revolution in 1911 to before the establishment of New China in 1949; c) 1949-1977 (after the establishment of New China in 1949 to before China’s reform and opening up in 1978); d) 1978-now (after China’s reform and opening up in 1978) (Liu, 2018; Tian, 2015).

(2) Witness to the level of social development

Witnessing the level of social development is one of the key features of the industrial heritage landscape (Liu, 2018). Generally speaking, the areas or regions where a large amount of industrial heritage is formed are often key gathering places from a period of great industrial development. They bear witness to a long era of industrial civilisation, or to the rise of a city’s characteristic industries and the beginnings of advanced production techniques of the time. The content of these witnessing will change in value depending on the regional recognition and the length of time witnessed (Xie, 2006). Based on the analysis of the literature, this study will detail the witness to the level of social development from the following points: a) witnessing the beginning and transformation of the industrial age of an entire country; b) witnessed the industrial development of a particular province or region; c) witnessed the innovative application of industrial technology in a particular field; d) witnessed only its own existence and decline (Liu, 2018; Xie, 2006).

(3) Witness to important events

The witnessing of important events refers to events that have taken place in the industrial heritage area with a degree of influence (Szromek, Herman and Naramski, 2021). These events are often associated with major production projects or important historical figures. The witnessing of important events in this study can initially be divided into (Szromek, Herman and Naramski, 2021; Liu, 2012): a) the event or historical person witnessed has a worldwide impact; b) the event or historical person witnessed has a national impact; c) the event or historical person witnessed has a provincial impact; d) the event or historical person witnessed has a regional impact.

(4) The addition and completion of historical documents

The addition and completion of historical documents refer to the instrumental value of industrial heritage in confirming, complementing and improving existing sources (Loes, 2015). This type of value will generally be well represented in historic cultural heritage (Liu, 2012). The addition and completion of historical documents can be initially subdivided in this study as follows (Liu, 2012; Loes, 2015): a) the current documentation on this industrial heritage is poor, but the industrial heritage is well preserved with detailed information that would complement the existing documentary material; b) this industrial heritage preservation information and the existing documentation are complimentary in the relationship; c) the existing documentation and the materials preserved in this industrial heritage are evidence of each other; d) the industrial heritage is relatively poorly preserved in terms of information and is less than that of existing documentation; e) there are few existing records of this industrial heritage and very little information has been preserved about it.

(5) Uniqueness

Uniqueness is a favourable criterion for evaluating the value of various types of heritage. If the type of industrial heritage landscape is preserved in large numbers, or if similar heritage exists in many regions or cities, then the object being evaluated will have a low factor rating value in terms of uniqueness and scarcity. Conversely, if there is only one industrial heritage landscape of a certain type within a larger area, or if there were many, but none remain, then the evaluated object will have a high uniqueness and scarcity value (Liu, 2012). The uniqueness value can be categorised as (Xie, 2006): a) only one heritage of the same type in the province or wider area; b) no more than three similar types industrial heritage within the province; c) more than three similar types within a provincial area but of special value or significance in this area; d) there are many similar types and they are widespread within a certain area.

(6) Completeness

Completeness refers to the degree of completeness of the industrial heritage remaining at the point in time when the industrial heritage value is evaluated compared to when the industrial heritage once performed an industrial role or function (Wilkinson and Harvey, 2017). It is generally not possible to be absolutely complete, but the surviving industrial heritage can be considered to be intact as long as it remains as a complete physical system or area of the site that allows the largely intact industrial scene and industrial technology of the time to be recognised (Ji, 2019).

Based on the analysis of the research on Ji (2019), Wilkinson and Harvey, 2017, this study initially subdivides completeness: a) The existing state of the industrial heritage is consistent with the style and character of the industrial period when it was not abandoned. 80%-100% complete; b) A small part has been transformed, but largely able to provide complete information about the industrial period. 50%-80% complete; c) The majority of the industrial heritage has been transformed but can provide a complete information of a perspective of the industrial period. 20%-50% complete; d) Has been completely transformed and cannot provide a view of the previous industrial period. 0-20% complete.

Table 11. Subdivided Chart of Historical Values

Intrinsic value		
1) Historical value	(1) The date of construction of the heritage	a) Before 1911
		b) 1911-1948
		c) 1949-1977
		d) 1978-now
	(2) Witness to the level of social development	a) The beginning and transformation of the industrial age of an entire country
		b) The industrial development of a particular province or region
		c) The innovative application of industrial technology in a particular field
		d) It's own existence and decline
	(3) Witness to important events	a) The event or historical person witnessed has a worldwide impact
		b) The event or historical person witnessed has a national impact
		c) The event or historical person witnessed has a provincial impact
		d) The event or historical person witnessed has a regional impact

	(4) The addition and completion of historical documents	a) Independent confirmation of the authenticity of a documentary record
		b) Non-independent confirmation of the authenticity of a documentary record;
		c) Complementary to the documentary record;
		d) Related in some way to the documentary record
	(5) Uniqueness	a) One type in the province or wider area
		b) Less three similar types within the province
		c) More than three similar types within a provincial area
		d) There are many similar types
	(6) Completeness	a) 0-20% complete
		b) 21-50% complete
		c) 51-80% complete
		d) 81-100% complete

4.1.1.2 Scientific and Technological Value

The scientific and technological value of industrial heritage is expressed in two main areas. The first is industrial technology, which is divided into production equipment, operating techniques and processes. The second is construction technology, which is divided into building materials, architectural design and construction techniques (Liu, 2012). As non-productive construction technology did not have an industrial production function, its scientific and technological value was mainly reflected in the latter. Modern industries in Shaanxi after 1840, such as the Dahua Yarn Factory, have a high technological value, with its textile workshops being the first large-scale industrial buildings in the northwest to adopt steel structures. The large red slate tiles used in the factory are machine-fired and remain intact after 80 years. At the beginning of its construction, the factory made great efforts to purchase advanced textile equipment from the UK, Japan, the US and Germany, such as the X52 vertical milling machine produced by General Motors, the Swiss Rieter spinning machine, the Japanese Toyota spinning machine and the Sakamoto automatic cloth machine (Lee, 2019). The archives, objects or memories left behind are an important part of the value of science and technology. The scientific and technological value is dependent on the building and equipment entity, which is a physical and individual value, and therefore the scientific and technological value is mainly reflected in the building being evaluated itself (De Sousa, 2014).

The development of industrial civilisation is a process of continuous innovation in science and technology (González Martìnez, 2017). The machinery, transport, plants and structures used in industrial production that have been left behind in the industrial heritage landscape are a record of the level of scientific and technological development of the time, and the machinery left behind reflects the construction techniques of the time. The industrial structures reflect the use of building materials and the form of the structures from an architectural point of view. These are the scientific and technological values reflected in the industrial heritage landscape.

The scientific and technological value of the industrial heritage landscape reflects the level of scientific and technological development and the state of knowledge of a particular industry at the corresponding period, which includes the following elements (Liu, 2012; Martinović and Ifko, 2018): the science and technology-related aspects recorded in itself, such as buildings, machinery and equipment; the functional significance of the period in which the industrial heritage is intact, such as the processes and procedures; whether the industrial technology is representative in industrial heritage.

The above three points can be summarised as follows (Table 12):

(1) Industrial buildings and equipment

Industrial buildings and equipment are the basis of industrial heritage. Industrial heritage needs material evidence (De Sousa, 2014). These factories, structures and industrial houses record the large spaces, large scales and even the peculiar shapes of the structures that were formed during the industrial period as a result of the technical needs of their industrial production (Lee, 2019). These industrial buildings and equipment represent the presence of technological values in a direct way. Based on the research of De Sousa (2014) and Lee (2019), this study will initially analyse the scientific and technical value of industrial buildings and equipment from the following points of view: a) Industrial buildings and equipment can express production technology from a variety of perspectives; b) Industrial buildings and equipment can express the main production technologies of the time; c) Industrial buildings and equipment can express basic functions; d) The industrial buildings and equipment are incomplete and represent only a few basic functions.

(2) Production processes

The production process is also an important aspect of the technological value that can be represented by industrial heritage (Szromek, Herman and Naramski, 2021). There is a difference between production processes and industrial buildings and equipment (Ji, 2019). While industrial buildings and equipment can generally be represented by their own functions, an industrial site cannot produce a product with a single piece of equipment or building, but rather through a series of processes, such as material preparation, production, forming and a series of other processes.

It is also an important reflection of the value of industrial heritage in terms of science and technology whether the processes can still be reappeared. Based on the research of (Szromek, Herman and Naramski, 2021), the technological value of the process is initially subdivided into the following points: a) The processes of the industrial period can be fully reflected in the industrial equipment; b) The processes are relatively complete, with a few missing elements; c) The processes are less complete, but the core technological aspects can be reflected; d) Only a small part of the processes of the period can be reflected.

(3) Technological representativeness

The representativeness of the industrial technologies carried by industrial heritage is also an aspect that determines the scientific and technological value of industrial heritage (Liu, 2012). Some industrial heritage represents production technologies that were commonly used during the industrial period, but not much tangible evidence has survived. Some industrial heritage represents production techniques that were rarely used but have been preserved. Some industrial heritage represents industrial technologies that were advanced at the time but have not been widely disseminated since (Liu, Zhao and Yang, 2018). Each of these situations is reflected in a different factor of technological value. Based on the research of Liu, Zhao and Yang (2018) and Liu (2012), the technological representativeness can be initially subdivided into the following ways (Liu, Zhao and Yang, 2018): a) shows the most advanced industrial technology at the provincial or national level at the time and which has since been widely used; b) shows a technology that was commonly used at the provincial level; c) shows a technology that has been infrequently used but has been preserved in kind; d) very little or no industrial technology has been preserved.

Table 12. Subdivided Chart of Scientific and Technological Value

Intrinsic value		
2) Scientific and technological value	(1) Industrial buildings and equipment	a) Can express production technology from a variety of perspectives
		b) Can express the main production technologies of the time
		c) Can express basic functions
		d) Incomplete and represent only a few basic functions
	(2) Production processes	a) Can be fully reflected in the industrial equipment
		b) Relatively complete, with a few missing elements
		c) Less complete, but the core technical aspects can be reflected
		d) Only a small part of the processes of the period can be reflected
	(3) Technological representativeness	a) Shows the most advanced industrial technology at the provincial or national level at the time and which has since been widely used
		b) Shows a technology that was commonly used at the provincial level
		c) Shows a technology that has been infrequently used but has been preserved in kind
		d) Very little or no industrial technology has been preserved

4.1.1.3 Cultural Value

Industrial enterprises form a close link with workers and people in the process of development. A large number of aspiring people in Shaanxi in recent times, including many expatriate enterprises and individuals, vigorously developed industry, producing many moving stories of hard work and struggle. In the early 1949 years, China's government arranged key construction projects in Shaanxi, complete with large-scale industrial factories integrating production, living, medical care, education and entertainment functions, such as the Textile City Society and the Xiguang community in

Xi’an (Wei and Zhang, 2015). Some industrial architectural heritage has therefore become an important element of regional belonging, identity and urban memory, and has a social and cultural value, subdivided into two levels: social development and industrial culture. Industrial culture entails aspects such as national spirit, corporate culture, development philosophy, and innovation spirit. Considering that culture is an abstract concept that is anchored in all aspects of social life, it is listed with social values (Liu, 2012). The social and cultural value belongs to the information value, which is less connected to the specific building entity and belongs to the public value of the factory building.

The cultural value has a strong intangible character. The industrial heritage landscape records the historical development as well as the cultural lineage of the site (Ning, 2013). The cultural value of the industrial heritage landscape is reflected in the culture of the company, its business philosophy and the spirit of striving in a special period. This spirit and philosophy can be found in the literature, visual materials and slogans of the same historical period, as well as in the style of the buildings, the structural layout of the site planning and the lifestyle of the workers, which are characteristic of the regional culture and the times. Therefore, the industrial heritage landscape has cultural value.

The cultural value of industrial heritage includes the following (Ning, 2013; Liu, 2012): the cultural value of positive energy for the existence of the social community at the value evaluation stage; the cultural value of the existence of negative energy for the social community at the value evaluation stage (this negative energy has the potential to be transformed into positive energy); cultural values that have little significance for the social community at the value evaluation stage.

The above three points can be summarised as positive energy value, negative energy value and neutral energy value (Table 13).

(1) Positive energy value

Positive energy value means that industrial heritage, in the process of embodying cultural values, cannot only embody the mode of production represented by industrial culture, but also transmit energy that inspires patriotic enthusiasm, the spirit of struggle to work hard, the spirit of sacrifice to dedicate oneself, the spirit of solidarity to devote oneself to cooperation, and other energies with positive aspects of significance (Liu and Li, 2011). Therefore, the positive energy value can be analysed in the following ways: a) it reflects the great energy of the country and the nation; b) it reflects the collective spirit of the regional culture; c) it reflects the pioneering role of the representatives on the industry; d) it reflects the spirit of struggle based solely on the function of industrial production (Liu and Li, 2011; Ning, 2013).

(2) Negative energy value

Negative energy values refer to industrial heritage in the process of embodying cultural values, as well as being able to embody the mode of production represented by industrial culture; it also embodies the humiliation of the country and the nation, the oppression of the period when it was a colony, the compromise with the invasive imperialist construction, and the injury to national dignity (Ning, 2013). These are the negative meanings given to the evaluator in an intuitive understanding of the negative energy. But this negative energy also brings an uplifting feeling of not forgetting the national shame, and is the driving force that inspires people to be patriotic and motivates them to work hard. It is only that this motivation is indirect and not as direct as positive energy. In other words, this negative energy can be transformed like positive energy transmission in general. The negative value can be analysed from the following aspects: a) negative energy involving national humiliation and insult to national dignity; b) negative energy involving regional transformation by oppression; c) the fact of being oppressed by technological backwardness; d) the fact of an inequality involving former technical cooperation (Ning, 2013).

(3) Neutral energy value

Neutral energy value means that the energy transmitted by the industrial heritage has different relevance for different groups, but is of little value to the social community as a whole. For example, the construction and technological application of certain factories had a great impact on the development of the entire technological field, but are only known to the industry (Deng, 2009). There are industrial technologies that reflect the huge investment of research and development staff at the time, but are not widely used due to technological innovation. Its impact on the social community was modest, but its significance to this part of the research and development workforce was extraordinary

(Han and Kim, 2018). In other words, the neutral energy value can be analysed in the following ways: a) its value has a widespread impact on the industry; b) its value has a profound impact on a professional system; c) its value has a significant impact on a group of people; d) its value affects some of the people involved (Deng, 2009; Han and Kim, 2018).

Table 13. Subdivided Chart of Cultural Value

Intrinsic value		
3) Cultural value	(1) Positive energy value	a) It reflects the great energy of the country and the nation
		b) It reflects the collective spirit of the regional culture
		c) It reflects the pioneering role of the representatives in the industry
		d) It reflects the spirit of struggle based solely on the function of industrial production
	(2) Negative energy value	a) Negative energy involving national humiliation and insult to national dignity
		b) Negative energy involving regional transformation by oppression
		c) The fact of being oppressed by technological backwardness
		d) The fact of an inequality involving former technical cooperation
	(3) Neutral energy value	a) Its value has a widespread impact on the industry
		b) Its value has a profound impact on a professional system
		c) Its value has a significant impact on a group of people
		d) Its value affects some of the people involved

4.1.1.4 Artistic value

Artistic value refers to the aesthetic interest and artistic expression of industrial architectural heritage entities. It is subdivided into architectural style, formal aesthetics and industrial style, of which the industrial style is mainly reflected in the production buildings. In terms of how closely the value is related to the material entity, the artistic value is dependent on the building and equipment entity, and belongs to the entity value, individual value, so the artistic value is mainly reflected in the building being evaluated itself (Davies, 2008).

If the artistic value of the industrial heritage is evaluated, it is judged by its individuality and artistic style (Ji, 2019). As a landscape complex composed of several elements, the artistic value of the industrial heritage landscape is reflected both in the various landscape elements of the site and in the overall landscape complex. The buildings on the site reflect the architectural styles of different historical contexts. The architecture is frozen music, a combination of art and technology (Liu, 2018). Architecture expresses its artistic value through the combination of various spaces, the aesthetically pleasing structural shapes, the harmonious proportions and scales, and the colours and textures of the materials. Industrial machinery and equipment embody the aesthetic value of industry (Ji, 2019).

The buildings, structures, machinery and equipment, interior decoration and ancillary facilities of industrial heritage were designed and built according to the technological level and construction style of the time. It is a reflection of the aesthetic sensibilities, architectural genres, styles, features and the spirit of the times of a particular historical period (Davies, 2008). The artistic value of the industrial heritage landscape includes the following elements (Ji, 2019; Davies, 2008): the artistic qualities of the industrial heritage itself, the sense of beauty or form that is part of it; the artwork attached to the industrial heritage landscape; the artistic style expressed in the industrial heritage landscape and the artistic standards achieved.

The above three points can be summarised as the aesthetic landscape value, the dependent artwork value and the level of artistic style expression (Table 14).

(1) Aesthetic landscape value

Aesthetic landscape value is the core artistic value of industrial heritage landscape, which is a series of landscape values evaluated from an aesthetic perspective, such as the appearance of buildings, the appearance of structures, mechanical equipment and interior decoration of industrial heritage (Ji, 2019). Including the industrial heritage as a whole or an individual embodied sense of rhythm, form, contrast and change, the force and beauty expressed by the sense of space and volume, and other elements can be judged from an artistic perspective (Liu, 2018). Through the analysis of the research by Liu (2018) and Ji (2019), this study initially detailed the aesthetic landscape value as the following aspects: a) industrial heritage as a whole has outstanding aesthetic value; b) some elements of industrial heritage have outstanding aesthetic value; c) a few parts of industrial heritage have aesthetic value.

(2) The value of the artwork

The value of artwork is generally more evident in cultural heritage, while in industrial heritage the buildings or structures are mostly focused on functional requirements, with fewer artworks on the exterior and interior (Davies, 2008). Through the analysis of the research by Davies (2008), this study initially detailed the value of artworks value as the following ways: a) more than ten artworks; b) more than five and less than ten artworks; c) more than one and less than five dependent artworks; d) one artwork.

(3) The level of artistic style expression

The level of artistic expression is based on the overall industrial heritage (Davies, 2008). This includes situations such as whether the artistic style is well expressed in terms of fine material and detail, or whether it is somehow schematically represented or some reaction of stylistic elements that can hardly yet be called an independent style (Stibral and Faktorová, 2021). The results of these situations are different in the evaluation of the value factor. In this study, based on analysis of the research by Stibral and Faktorová (2021), the level of artistic expression will be initially analysed in the following ways: a) the artistic style is obvious and well expressed in detail; b) the artistic style is clear and slightly simplified, highlighting the main elements; c) it partially reflects a certain artistic style, highlighting some of the key points; d) it is an elemental embodiment of a certain artistic style.

Table 14. Subdivided Chart of Artistic Value

Intrinsic values		
4) Artistic value	(1) Aesthetic landscape value	a) Industrial heritage as a whole has outstanding aesthetic value
		b) Some elements of industrial heritage have outstanding aesthetic value
		c) A few parts of industrial heritage have aesthetic value
		a) More than ten artworks
		b) More than five and less than ten artworks

	(2) The value of artwork	c) More than one and less than five dependent artworks
		d) One artwork
	(3) The level of artistic style expression	a) The artistic style is obvious and well expressed in detail
		b) The artistic style is clear and slightly simplified, highlighting the main elements
		c) It partially reflects a certain artistic style, highlighting some of the key points
		d) It is an elemental embodiment of a certain artistic style

4.1.2 Derived Values

Derived values differ from intrinsic values in that they are subject to changes in people's perceptions of industrial heritage and the elements associated with it (Liu, 2012). These include locational, environmental, group, social and emotional values. It can therefore be argued that the evaluation of the derived values must be determined in terms of the period of evaluation. During the process of renovation and renewal of the heritage, the derived values may change considerably.

4.1.2.1 Location Value

Location value is the advantageous factors possessed by an area that are beneficial to the social and economic development of the area, such as geographical location, accessibility and regional resources (Lee, 2019). Therefore, industrial heritage landscapes in different parts of the city have locational value, and the level of locational value is determined by the number of factors that are favourable to the social and economic development of the area. The location of many industrial heritage sites has been transformed from suburban or peri-urban areas into urban areas during the expansion of the city, and the distance from the central area is conducive to the concentration of popularity and the embodiment of cultural values in the reuse process, allowing for small investments with high returns. In an analysis of industrial heritage landscape projects in Shaanxi Province, it was found that when a heritage landscape reuse project is located in the economic and cultural core of the city, its various other values can be better utilised, and can provide a more comprehensive value experience for all different users (Ning, 2013).

The evaluation of location value includes (Lee, 2019; Ning, 2013) (Table 15):

(1) Distance from the city centre

The distance from the central city determines the actual attractiveness of the industrial heritage to the population of the central city. If the distance to the central city is too far, the urban population will tend not to choose industrial heritage as a destination because of the long journey (De Gregorio et al., 2020). The distance can be a relatively large barrier, especially when China is still in the process of exploring its industrial heritage and heritage areas are hardly attractive (Liu, Hu and Zhang, 2017). When industrial heritage is located within the fringe of a central city, this distance is considered to be negative, in which case the locational value is relatively high when people are likely to be close to home when learning about and using the industrial heritage site (Guzman, 2020).

Through analysing the research of Guzman (2020) and Liu, Hu and Zhang (2017), this study initially subdivided the distance of the central city in the following ways: a) the distance of the central city is negative (meaning within the built-up area of the city); b) the distance to the central city is within 10 km; c) the distance to the central city is between 10 km and 50 km; d) the distance the central city is above 50 km.

(2) Transport situation to the city centre

The accessibility of an industrial heritage area is also determined by its transport links to the city centre (Wei and Zhang, 2017). If it is far from the edge of the city but has good accessibility, then its location value is still high. Some industrial heritage is within the built-up area of the central city, but is surrounded by post-built buildings, and the industrial heritage is surrounded by winding and endless roads, then its locational value is also affected (Lee, 2019). Through analysis of the research by Wei and Zhang (2017), Lee (2019), the accessibility of an industrial heritage area in this study will be initially analysed in terms of: a) easy transport links, accessible by three or more modes of transport, with rail links; b) relatively easy transport links in the vicinity, accessible by two modes of transport; c) smooth and easily accessible roads in the vicinity; d) accessible but not convenient, with road links in the vicinity in need of renovation.

(3) The number of central cities or tourist areas in the wider regional context

On a wider regional scale, the number of central cities (cities with an urban population of 1 million or more) or tourist areas are also an important factor in measuring location value (Liu, 2012). Where the distance from the edge of the built-up area of a central city is relatively large, if it is located between two central cities, it is likely to be closer to another secondary central city, which can similarly attract the population of the secondary city (Guzman, 2020; Graham, Ashworth and Tunbridge, 2000). Alternatively, when located closer to a tourist area, the industrial heritage area could be used as part of a system of expanded attractions or tourist routes in the tourist area. In this case, the industrial heritage area would have the same locational value of attracting population (Zhang, 2007). Based on the research of Zhang (2007), Guzman (2020), Graham, Ashworth and Tunbridge (2000), this study initially subdivides the number of central cities into: a) four or more central cities or tourist attractions within 100 km radius of the industrial heritage; b) three central cities or tourist attractions within a 100 km radius of the industrial heritage; c) two central cities or tourist attractions within a 100 km radius of the industrial heritage; d) one central city or tourist attraction within a 200 km radius of the industrial heritage.

Table 15. Subdivided Chart of Location Value

Derived values		
1) Location value	(1) Distance from the city centre	a) The distance of the central city is negative
		b) The distance to the central city is within 10 km
		c) The distance to central city is between 10 km and 50 km
		d) The distance the central city is above 50 km
	(2) Transport situation to the city centre	a) Easy transport links, accessible by three or more modes of transport, with rail links
		b) Relatively easy transport links in the vicinity, accessible by two modes of transport
		c) Smooth and easily accessible roads in the vicinity
		d) Accessible but not convenient, with road links in the vicinity in need of renovation
	(3) The number of central cities or	a) Four or more central cities or tourist attractions within a 100 km radius of the industrial heritage

	tourist areas in the wider regional context	b) Three central cities or tourist attractions within a 100 km radius of the industrial heritage
		c) Two central cities or tourist attractions within a 100 km radius of the industrial heritage
		d) One central city or tourist attraction within a 200 km radius of the industrial heritage

4.1.2.2 Environmental Value

The environmental value of the industrial heritage landscape mainly refers to the positive role and significance of the area where the industrial heritage landscape is located for people's survival and development, and the positive influence and transformable potential of the surrounding environment due to the existence of industrial heritage (Wei and Zhang, 2015). Some industrial heritage landscapes have low environmental value before transformation, some even have less environmental value or have a destructive effect on the environment, but after scientific and reasonable planning and design, their environmental value is enhanced, and will play a role in promoting other values (Xie, 2006). To evaluate the environmental value of industrial heritage, two points need to be measured (Xie, 2006; Wei and Zhang, 2015): The impact of the original production function of industrial heritage on the environment; the environmental scope of the industrial heritage. This is an analysis of the environmental value of industrial heritage from two perspectives (Table 16).

(1) The impact of the original production function of industrial heritage on the environment

Industrial heritage sites were built during the industrial period with industrial production as their core function, and many industrial sectors were involved in polluting production projects such as Class II or Class III industries (González Martìnez, 2017). After decades of production, the sites on which the industrial heritage is located have been physically or chemically contaminated. Many of these contaminants still have a degree of impact on the environment within and around the site after the formation of the industrial heritage (Roman, 2014). The renewal of the industrial heritage then requires, first of all, decontamination of the site environment, which requires significant technical and economic investment. In some cases, a long period of restoration of the contaminated environment is required, so that the value of the industrial heritage site in this case should be reduced (González Martìnez, 2017). The impact of the original production function of industrial heritage on the environment can be analysed in the following ways (Roman, 2014; González Martìnez, 2017): a) the industrial heritage was not polluted during the industrial period; b) the industrial heritage was polluted during the industrial period, but the pollution was no longer present during the value assessment period; c) the industrial heritage was heavily polluted during the industrial period, but the pollution was largely non-existent during the value assessment period; d) the industrial heritage was still polluted during the value assessment period and required investment in remediation.

(2) The environmental scope of the industrial heritage

The location of the industrial heritage was established during the industrial period (Liu and Chu, 2011). With the development and change of the city, the industrial function gradually declined and the buildings and structures in their original locations lost their functional significance and gradually became abandoned (Wei and Zhang, 2017). As many of the original elements have been preserved to the present day, they have the value of industrial heritage conservation and renovation. However, industrial heritage is not as valued in China as historical relics. Especially when located in urban centres, industrial heritage sites are often surrounded by tall buildings, or by multi-storey residential areas and shanty towns. Even access to the site is difficult, not to mention accessibility. In this case, the environmental value of the industrial heritage is reduced (Roman, 2014). When the site is surrounded by new high-rise or large public buildings, there is little scope for adaptation. There is potential for renovation when the surrounding area is an older neighbourhood, but it will take time to renovate. This can be analysed in the following ways (Liu and Chu, 2011; Roman, 2014): a) there are few site constraints in the surrounding or industrial heritage area and the potential for improvement is high; b) one or several areas in the surrounding or industrial heritage area are not appropriate for improvement or have some restrictions; c) the surrounding area is an old multi-storey residential area or shantytown (generally over twenty years); d) the surrounding site is a new high-rise multi-storey area or a large public building area, resulting in congestion on the industrial heritage site.

Table 16. Subdivided Chart of Environmental Value

Derived values		
2) Environmental value	(1) The impact of the original production function of industrial heritage on the environment	a) Not polluted during the industrial period
		b) Slightly polluted during the industrial period, but the pollution was no longer present during the value assessment period
		c) Heavily polluted during the industrial period, but the pollution was largely non-existent during the value assessment period
		d) Still suffer pollution during the value evaluation period and required investment in remediation
	(2) The environmental scope of the industrial heritage	a) Few site constraints and the potential for improvement is high
		b) One or several areas are not appropriate for improvement or have some restrictions
		c) The surrounding area is an old multi-storey residential area or shantytown (generally over twenty years)
		d) The surrounding site is a new high-rise multi-storey area or a large public building area, resulting in congestion on the industrial heritage site

4.1.2.3 Group Value

Many industrial heritage sites will contain multiple buildings and structures of heritage value. These structures, buildings and machinery vary in terms of construction date, production date and functional characteristics. A single plant does not reflect the full value of its period and function (Patiwael, Groote and Vanclay, 2019). Groups are broad in scope and can refer to one or more adjacent industrial heritage landscapes of factory scale, or to industrial administrative districts in cities with a higher concentration of industrial enterprises. Some industrial heritage landscapes are evenly spread over a larger regional scale, such as some industrial cities, which embody the industrial character and social context of an era. Only when they are grouped together can they reflect a certain production process or the functional significance of completeness. The combined value of such groups of buildings or structures is much greater than the value of the individual ones (Liu, 2012). The value of groups of industrial heritage landscapes is influenced by the following factors (Liu, 2012; Patiwael, Groote and Vanclay, 2019) (Table 17):

(1) The scale of the group

A group is a concentration of similar industrial heritage in a certain area, which are of different scales and with different emphases, and which can focus on the overall industrial character of a city or region (Lu, Liu and Wang, 2020). These industrial heritage sites will be transformed in the future to form industrial heritage groups, which in turn will form a system of tourist itineraries to reinforce the overall industrial heritage character (Ji, 2019). Taken as a whole this situation will increase the mutual value of the industrial heritage of the individual sites. The greater the number of similar individual heritage sites included in such groups, the greater the total value, which will be much greater than the sum of the individual values, which then means that their mutual value will also be greater, and the number included is what is called a scale level. This can be analysed in the following ways (Lu, Liu and Wang, 2020): a) a scale level of five or more; b) a scale level of four; c) a scale level of three; d) a scale level of two.

(2) Relationship of the group

The relevance of the individual sites in the group refers to the interrelationship between the individual sites of industrial heritage that can form the group (Liu and Li, 2008). The stronger the interrelationship, the more fully it will be reflected in the value of the group in its future transformation (Mengusoglu and Boyacioglu, 2013). The interrelationship can be measured from several perspectives (Liu and Li, 2008): a) belong to a large industrial category; b) whether they have formed industrial chains; c) whether they were once part of the same enterprise or factory under a large enterprise or institution.

(3) The potential for wide-scale groups of industrial heritage

Previously it was mentioned that the scale level of the study covers the distribution of industrial heritage within 10 km. This is appropriate where the site is within a built up urban area. Many of the large industrial sites of the industrial period were often located in areas close to resources and not within built up urban areas (Wang and Wang, 2018). The sites are also located at great distances from each other. In this case, the 10 km radius of the selected group is very unlikely, so this distance is extended to 30 km, which is a convenient distance by car and public transport, and is then selected for the non-urban built-up area (Liu, Hu and Zhang, 2017). This can be analysed in the following ways (Liu, Hu and Zhang, 2017; Wang and Wang, 2018): a) there are three or more industrial heritage sites with easy access to each other, a strong possibility; b) there are three or more industrial heritage sites with access to each other requiring capital investment, a high possibility; c) there are two industrial heritage sites with industrial links to each other, a certain possibility; d) there are two industrial heritage sites with weak industrial links and transport links to each other, a low possibility.

Table 17. Subdivided Chart of Group Value

Derived values		
3) Group value	(1) The scale of the group	a) A scale level of five or more
		b) A scale level of four
		c) A scale level of three;
		d) A scale level of two
	(2) Relationship of the group	a) Belong to a large industrial category
		b) Whether they have formed industrial chains
		c) Whether they were once part of the same enterprise or factory under a large enterprise or institution
	(3) The potential for wide-scale groups of industrial heritage	a) Three or more industrial heritage sites; easy access to each other; strong possibility
		b) Three or more industrial heritage sites with access to each other requiring capital investment; a high possibility
		c) There are two industrial heritage sites with industrial links to each other, a certain possibility;
		d) Industrial heritage sites with weak industrial links and transport links to each other, a low possibility

4.1.2.4 Social Value

The industrial heritage landscape was once the bearer of industrial activities in a certain historical period. Industrial activities created rich material wealth for society, provided people with positive spiritual pursuits, safeguarded people’s living needs, and assumed the social responsibility that factories and enterprises should assume (Liu, 2018). After these industrial sites and all the industrial elements they contain have become today’s industrial heritage landscape, people can still find in its legacy the positive, enterprising, hard-working and progressive industrial spirit of the past. The industrial heritage landscape provides an opportunity to look back at the history of industrial development, the development of the city and to understand the way people produced and lived in the context of the times (Ning, 2013). The industrial heritage landscape, which has been transformed and reorganised, has been given functions and roles that meet the needs of the times in the new era and continues to contribute to society. Therefore, the industrial heritage landscape has a social value.

The social value of the industrial heritage landscape is mainly reflected in the following aspects: In the industrial heritage landscape in the industrialisation stage and after becoming industrial heritage landscape have provided a certain number of employment opportunities for society, to some extent, to maintain the harmonious and stable development of society (Liu, 2018); Industrial heritage landscapes carry the function of a science education base, providing an educational venue for the next generation to understand urban development and the development of industrial civilization (Wilkinson and Harvey, 2017); Some industrial heritage landscapes, after being transformed into urban public green areas, provide places for recreation and entertainment for the public, providing them with space for exercise and interaction (Liu, 2018); The industrial heritage landscape of a well-protected and reasonably reused city represents the rich historical and humanistic connotations of a city. It plays an important role in enhancing the image of the city and driving regional development. The social value includes evaluating the role of the object in its glory period for social politics, culture and economy, as well as after it has become an industrial heritage landscape (Gao and Liang, 2013).

The above four points can be summarised as follows (Table 18):

(1) The ability to solve re-employment

In terms of solving the problem of re-employability, industrial heritage, after renovation, requires the services of people with the appropriate technical skills in terms of management and operation, technical maintenance, display and promotion, and interpretation (Wilkinson and Harvey, 2017). These personnel can be recruited from the community (Mengusoglu and Boyacioglu, 2013). The ideal way to provide interpretation and display services involving the reproduction of the original industrial scenario is to hire or invite the original staff to carry out the work, through social recruitment (Gao and Liang, 2013). This is tantamount to providing employment and re-employment opportunities for the community, and the fact that service industries involving industrial heritage require appropriate technical training is improving the overall quality of the people employed, a social contribution of value on two levels. Based on the research of Gao and Liang (2013), Mengusoglu and Boyacioglu (2013), Wilkinson and Harvey (2017), this study provides an initial subdivision of solving the problem of re-employability into the following ways: a) over a hundred people to be employed; b) fifty to a hundred people to be employed; c) twenty to fifty people to be employed; d) less than twenty people to be employed.

(2) Educational function

In terms of educational functions, industrial heritage is an ideal place for the education of industrial science and knowledge (He and Gebhardt, 2014). At the same time, industrial heritage sites can arrange for the recreation of industrial production processes and the participation of visitors in experiential activities, depending on the industrial technology of the site itself (Mengusoglu and Boyacioglu, 2013). These are the two main types of objects for the realisation of the educational function. At the level of popularisation of scientific knowledge and dissemination of industrial culture, its social value is incalculable. Based on the research of He and Gebhardt (2014), and Mengusoglu and Boyacioglu (2013), this study provides an initially subdivided of s educational functions into the following ways: a) Industrial heritage is rich in scientific knowledge and display methods, with more than five experiential projects available; b) Industrial heritage is rich in scientific knowledge and display methods, with three to four experiential projects available; c) Industrial heritage is rich in scientific and popular knowledge and presentation, with one or two experiential programmes; d) Industrial heritage is limited in scientific and popular knowledge and presentation, with no experiential programmes.

(3) The potential to provide a place of leisure for the public

The majority of industrial heritage sites have the potential to provide recreational opportunities for people. Some relatively monolithic industrial heritage sites have been expanded, where funding and policy permit, to achieve better views and fuller protection of the surrounding environment (Wei and Zhang, 2015). These expanded environments are generally offered to people who visit, experience and use them on a daily basis, as public spaces that are well landscaped, functional and have a good interaction with the industrial heritage. At the same time, in cases where there are more factory buildings, which form an industrial heritage area, often many of the abandoned sites within the industrial heritage site can themselves be transformed into environmentally sound public spaces (Jorgensen, Dobson and Heatherington, 2017). Based on the research of Jorgensen, Dobson, and Heatherington (2017), as well as Wei and Zhang (2015), this study provides an initial subdivision of its potential to provide a place of leisure for the public into the following ways: a) the public space available has the conditions of a heritage park (more than 5,000 square metres); b) the public space available is similar to a street park regulation; c) the public space available can meet the basic requirements of viewing and visitor rest around the industrial heritage landscape; d) the places available are limited, but better than before the transformation.

(4) Enhancing the image or symbolism of the city

The rational transformation and reuse of industrial heritage landscapes can transform some of the negatively valued abandoned sites in cities into positive urban public spaces (Mengusoglu and Boyacioglu, 2013). These public spaces will be different due to the special nature of industrial heritage, and will carry the rise and fall of a city's industrial civilisation (Ji, 2019). With well-planned reuse, it can even become a prominent calling card in the cultural sense, a memory card of a city that has flourished through the industrial period, a testament to the former glory and reality of a city's heritage, and a powerful exponent of its image. Based on the research of Ji (2019), Mengusoglu and Boyacioglu (2013), this study has initially subdivided the efforts to enhance the city's image into the following aspects: a) the industrial heritage landscape after reuse has a prominent image and far-reaching meaning, and is the first business card of the city; b) the industrial heritage landscape after reuse has a prominent symbolic meaning and is one of the image cards of the city; c) the industrial heritage landscape after reuse has a beautiful image and can effectively improve the cultural appearance of the city and the streetscape; d) the industrial heritage landscape after reuse has a significantly improved image compared to the image.

Table 18. Subdivided Chart of Social Value

Derived values		
4) Social value	(1) The ability to solve re-employment	a) Over a hundred people to be employed
		b) Fifty to a hundred people to be employed
		c) Twenty to fifty people to be employed
		d) Less than twenty people to be employed
	(2) Educational function	a) Rich in scientific knowledge and display methods, with more than five experiential projects available
		b) Rich in scientific knowledge and display methods, with three to four experiential projects available
		c) Rich in scientific and popular knowledge and presentation, with one or two experiential programmes
		d) Limited in scientific and popular knowledge and presentation, with no experiential programmes
	(3) The potential to provide a place of leisure for the public	a) The public space available has the conditions of a heritage park
		b) The public space available is similar to a street park regulation
		c) The public space available can meet the basic requirements of viewing and visitor rest around the industrial heritage landscape
		d) The places available are limited, but better than before the reuse
	(4) Enhancing the image or symbolism of the city	a) The industrial heritage landscape after reuse has a prominent image and far-reaching meaning, and is the first business card of the city
		b) The industrial heritage landscape after reuse has a prominent symbolic meaning and is one of the image cards of the city
		c) The industrial heritage landscape after reuse has a beautiful image and can effectively improve the cultural appearance of the city and the streetscape
		d) The industrial heritage landscape after reuse has a significantly improved image compared to the image

4.1.2.5 Emotional Value

Emotion is the psychological reaction of people after being stimulated by the outside world, and is an internal feeling of people. The emotional value of the industrial heritage landscape is that the industrial heritage landscape itself can stimulate people's feelings and make them feel satisfied, happy, even sad, and angry (Liu and Li, 2011). Therefore, the industrial heritage landscape has an emotional value for people. Many industrial heritage sites are the result of years of hard work and dedication by industrial workers, managers and constructors, and the existence of heritage has irreplaceable value and meaning for these people. The emotional value comes mainly from the workers and their families who used to work and live in the industrial heritage landscape, from their fond memories of their past work, life and recreation (Han and Kim, 2018). Of course, through integration, transformation and the extrapolation of time, the number of subjects generating emotional value is constantly increasing.

The emotional value of industrial heritage is influenced and conditioned by the following factors (Han and Kim, 2018; Liu and Li, 2011) (Table 19):

(1) Number of people who have an emotional connection to industrial heritage

The people who experience emotional connection are those who can find emotional resonance through the presence of industrial heritage (Han and Kim, 2018). They can be the workers who have worked there, the leaders of the management, the customers who have traded. They can even be the tourists who come to visit, the residents who relax, the students who study after the transformation and renewal of the industrial heritage landscape (Ning, 2013). Anyone who has interacted with the industrial heritage at any point in time can have an emotional resonance through the industrial heritage, and is therefore referred to in this study as people who have an emotional connection to industrial heritage. The larger the size of the subject, the wider the age range and the wider the range of occupations, the higher the emotional value (Han and Kim, 2018). Through the research of Ning (2013), Han and Kim (2018) the people who have an emotional connection to industrial heritage in this research will be initially subdivided into: a) the number of people who have an emotional connection to industrial heritage is over 10,000; b) the number of people is between two thousand and ten thousand; c) the number of people is between two hundred and one thousand; d) the number of people is under two hundred.

(2) The age range of the people who have an emotional connection to industrial heritage

The age range of the people who have emotional connection to industrial heritage is also a parameter that reflects the influence of the value of the industrial heritage landscape (Liu, 2012). If the age range of people with affective value in industrial heritage landscapes covers multiple age groups such as old, middle-aged, youth, teenagers and children, then the factor score of affective value is higher in the age structure, and vice versa. In this study, the old age means over 60 years old, middle age means 45 to 59 years old, youth means 18 to 44 years old, teenager means 12 to 18 years old and child means under 12 years old. In this study, the age range of the people who have an emotional connection to industrial heritage will initially be subdivided into the following ways: a) the age range includes the five categories above; b) the age range includes the three to four categories above; c) the age range includes the two categories above; d) the age range includes the one category above.

(3) Structural characteristics of the careers of people with emotional value

Structural characteristics of the careers of people with emotional value is also a parameter that reflects the influence of the value of the industrial heritage landscape (Han and Kim, 2018). Generally speaking, industrial heritage has an inseparable emotional value for the workers in the factory during the industrial period, and is relatively single in terms of the career structure of the people involved (Ning, 2013). However, if the renovation and renewal work is done well during the industrial heritage period, it will affect not only the workers, but also the elderly and children who remain there, who will be emotionally connected to the industrial heritage landscape because of the improved quality of life brought to them by the industrial heritage sites. The structural characteristics of the careers of people with emotional value can be analysed in the following ways (Ning, 2013): a) people from nearly all careers; b) people from the majority of careers around the industrial heritage; c) people's job related to the industrial heritage.

Table 19. Subdivided Chart of Emotional Value

Derived values		
5) Emotional value	(1) Number of people who have an emotional connection to industrial heritage	a) The number is over 10,000
		b) The number of people is between two thousand and ten thousand
		c) The number of people is between two hundred and one thousand
		d) The number of people is under two hundred
	(2) The age range of the people who have an emotional connection to industrial heritage	a) The age range includes the five categories above
		b) The age range includes the three to four categories above
		c) The age range includes the two categories above
		d) The age range includes the one category above
	(3) Structural characteristics of the careers of people with emotional value	a) People from nearly all careers
		b) People from the majority of careers around the industrial heritage
		c) People's jobs related to the industrial heritage

4.2 Characteristics of Industrial Heritage Landscape Values in Shaanxi Province

In terms of its affiliation, the industrial heritage landscape is part of the tangible cultural heritage, with both architectural complexes and cultural heritage sites including elements of the industrial heritage landscape (Deng, 2009). However, due to the unique technical attributes and functional significance of the industrial heritage landscape, it also has significant differences from other cultural heritage.

4.2.1 Historical Value

In terms of historical value, the industrial heritage landscape has a smaller temporal breadth. The evaluation of historical value needs to consider the positive and progressive impact that things have had on the development of human society, thus helping people to understand history. Although the industrial heritage landscape belongs to cultural heritage, its historical value is limited in terms of time breadth compared with heritage or some intangible cultural heritage, and its time breadth is smaller. The industrial heritage that currently exists in China is dominated by the industrial heritage left over from the first five-year plan period from 1953 to 1957 (Ren, 2005). The small amount of industrial heritage of high historical value is concentrated in the period of the westernization movement in the early recent period of 1861-1895, which is only about 150 years old, a relatively short period. This chronological feature is mainly due to the late start of China's industry (Pan, 2004).

The development of industry was hampered by historical events such as the "Great Leap Forward" (a nationwide mass movement to achieve high targets for industrial and agricultural production) between 1858 and 1860, and the "Cultural Revolution" (civil unrest that was wrongly launched by the Chinese leaders and exploited by counter-revolutionary groups, causing serious disasters to the Party, the country and the people of all ethnic groups) between 1966 and 1976 (Fu, Wu and Tang, 2008).

Moreover, China's perception of the value of industrial heritage was also later than that of some European countries, and some of the earlier industrial heritage with longer histories were neglected and demolished or destroyed, leading to the current small temporal breadth of the industrial heritage landscape (Deng, 2009).

4.2.2 The Value of Science and Technology

The technological dependence of the industrial heritage landscape is strong. This is mainly due to the fact that the technological value of the industrial heritage landscape is mainly reflected through the technological content of the machinery and equipment, the level of the production process, the level of production, the production process and the materials and structure of the industrial buildings (Liu, 2012). These elements can only be reflected through the presence of industrial buildings and machinery, and cannot exist in isolation. In the same industrial heritage landscape, there are sometimes buildings built in different eras, and machinery is often not manufactured at the same time. These differences reflect the development and progress of science and technology in different historical periods, and record the historical lineage of technological renewal. Science and technology exist as a non-material form and must be embodied in a material vehicle (Lee, 2019). The material entities in the industrial heritage landscape are the bearers of industrial science and technology, and if they are separated from each other, they both lose part of their value and meaning, and therefore have a strong dependency in terms of scientific and technological value.

4.2.3 Cultural Value

In terms of cultural value, the industrial heritage landscape conveys more positive energy. Cultural value is a value created by people, which meets people’s cultural needs and reflects the cultural form in a certain historical period (Ning, 2013). Different people have different needs for culture, and the attributes of the cultural values formed are also diverse. The cultural values of the industrial heritage landscape mostly reflect the respect for science, the pursuit of detail, the insistence on standards, the industrial spirit of excellence, tenacity and pragmatism, which transmits positive energy to modern people.

4.2.4 Artistic Value

In terms of artistic value, industrial heritage landscapes are mostly of indirect value. The artistic value is mainly reflected from some special media, such as painting, sculpture, dance, music and theatre, which are more direct and intuitive in their embodiment. As a landscape complex, it is difficult to directly reflect the artistic value of the industrial heritage landscape as a whole (Davies, 2008). The artistic value of the landscape is indirectly reflected through the buildings and structures, and is mostly reflected in the art of architecture and the art of mechanical industrial modelling, and therefore has an indirect character in terms of artistic value.

4.2.5 Locational Value

In terms of locational value, industrial heritage landscapes are more influenced by urban expansion. The urban expansion will cause areas that were originally on the edge of the city to be expanded into the main area of the city, resulting in an increase in locational value. The locational value of industrial heritage landscapes is influenced by the surrounding traffic conditions, regional resources and regional popularity, and urban expansion has a direct impact on these factors, so urban expansion has a greater impact on the locational value of industrial heritage landscapes (Liu and Li, 2011).

4.2.6 Emotional Value

In terms of emotional value, the subject of the occurrence of industrial heritage landscapes is often a part of the group. Not all people are spontaneously interested and emotionally involved in industrial heritage landscapes. It is often the part of the population that has an association with the industrial heritage landscape that has spontaneous emotions towards it. This group includes workers who have previously worked in the industrial heritage site, their friends and relatives, and people who have lived in the vicinity of the heritage site (Liu, 2012). They are the main group of people in this segment. There is also a group of people who have become interested in the industrial heritage landscape through publicity or referrals from friends. However, some people do not become interested even if they are stimulated by the outside world (Ning, 2013). Therefore, in terms of emotional value, the industrial heritage landscape does not resonate with all people, and it is only a part of the population that is emotionally involved.

4.2.7 Group Value

In terms of group value, industrial heritage landscape groups are large in scale. Unlike industrial heritage buildings, industrial heritage landscapes are landscape complexes that bring together a variety of landscape elements, usually on a large scale and rich in intrinsic landscape elements (Liu, 2018). An industrial heritage landscape will often contain plants, warehouses, structures for industrial transport, machinery and equipment from different eras, and large-scale industrial heritage landscapes may even include workers' villages and related supporting facilities and services. As a result, industrial heritage landscapes are often larger in scale than other types of the landscape such as the centre green space. In terms of value, they have a group value that many types of landscapes do not have, and the level of group value is closely related to the scale of the industrial heritage landscape.

4.2.8 Environmental Value

In terms of environmental value, industrial heritage landscapes often have a negative effect before the transformation. Most of the sites of industrial heritage landscapes were industrial wastelands before the transformation, and their landscape value was not prominent enough, and they even had a negative effect on the improvement of the surrounding environment (Ning, 2013). The soil and water bodies on the site are often contaminated with chemicals needed and produced by industrial production, which contain some toxic and harmful substances for humans and other organisms. Plant communities are also destroyed by the demands of industrial production. Such sites are difficult to use again without human modification. Therefore, compared to other types of landscape sites, industrial heritage landscape sites may have low environmental value or have negative environmental effects before the transformation.

4.3 Factors Influencing the Evaluation of Industrial Heritage in Shaanxi Province

The evaluation of industrial landscapes is influenced by a number of factors. The choice of evaluation factors, the derivation of evaluation formulas and the diversity of evaluators all have different degrees of influence on it. The following five points will be analysed in order to make the evaluation method more scientific and comprehensive.

4.3.1 The Scientificity of the Selection of Evaluation Factors

The selection of evaluation factors is one of the core elements in the evaluation of industrial heritage landscapes in Shaanxi Province. Whether the selection can follow the principle of scientificity will affect the scientificity and rationality of the evaluation method. Through the collection, collation and analysis of relevant data of the research object, and the use of research methods such as site survey and questionnaire, a scientific method of value evaluation will be formed (Liu and Li, 2011).

4.3.2 Reasonableness of the Weights Given to the Evaluation Factors

The final result of the evaluation of the value of the industrial heritage landscape in Shaanxi Province is obtained by adding up the scores of each value evaluation factor. The weight values of the evaluation factors will directly affect the final value evaluation results, and thus the way and effect of reusing the industrial heritage landscape (Loes, 2015). The weighting of the factors will be derived from comprehensive research and analysis by means of interviews and questionnaires. As far as possible, the weights of the evaluation factors will be reasonable and have an impact on the evaluation results of the value of the industrial heritage landscape.

4.3.3 Correctness of the Derivation of the Evaluation Formula

This study will use a comprehensive analysis to obtain weighting values for the evaluation factors, which in turn directly affect the evaluation results. Li (2012) used a formula to derive the weights of the evaluation factors. For this study, it was prepared to adjust the formula based on the existing formula and research experience, and to combine it with the questionnaire to derive the evaluation factor weights to ensure the correctness of the final derivation.

4.3.4 Completeness of Information of Evaluation Objects

As the object of value evaluation, the age of construction of the heritage landscape, the type of industry, its position and role in history, the condition of internal facilities, the completeness of preservation and many other information are factors that need to be referred to when evaluating the value of the industrial heritage landscape in Shaanxi Province (Liu and Chu, 2011). Some of this information is also taken into account when selecting the value factors. The completeness of the information on the object of evaluation, therefore, determines the final score of the value evaluation. Therefore, the collection of information on the subject of evaluation is a very important element in the early stage of the evaluation of the value of the industrial heritage landscape. This study will collect information and literature from relevant government and enterprise departments and field surveys to collect more detailed and complete information on the industrial heritage landscape in Shaanxi Province.

4.3.5 Comprehensiveness of the Evaluator’s Background

While the influencing factors mentioned above are all objective, the evaluator, as one of the influencing factors, has subjective aspects to the evaluation results. People of different ages, genders, occupations, educational backgrounds and life backgrounds have different feelings and needs for industrial heritage landscapes (Fouseki and Nicolau, 2018). Their judging criteria are also different. As a weighted questionnaire will be included in the evaluation step, a complete information profile of the evaluators will help to categorise them at a later stage and the conclusions drawn will stand up better to argument. Therefore, the comprehensiveness of the background of the evaluator has an important influence on the evaluation of the landscape value of the industrial heritage.

4.4 Principles for the Construction of Indicators

In the process of constructing the evaluation method, the following principles should be implemented in order that the evaluation indicators will be precise and scientific.

4.4.1 Integrality and Representativeness Principle

Integrality is reflected in the fact that the indicators of the value evaluation form a whole with each other, and the indicators of any aspect will establish a close internal link with the indicators of other aspects (Craig, 2008). Representativeness is reflected in the fact that the indicators of value evaluation should remain independent of each other, preventing repetition and inclusion of each other (Loes, 2015).

4.4.2 Principle of Feasibility and Operability

The principle of feasibility means that the meaning of the indicators should be clear and should be able to practically reflect the various aspects of the cultural value of the regeneration and use of industrial heritage buildings (Guzman, 2020). Operability means that the evaluation indicators should be determined on the basis of statistical analysis and can be calculated and analysed based on data, and can achieve the purpose of evaluation.

4.4.3 Scientific and Systematic Principles

The value evaluation method must evaluate all aspects of industrial heritage, provide people with complete information about industrial heritage buildings, and through the results of the evaluation method, be able to understand the intrinsic characteristics of the evaluation object; the evaluation information needs to exist in connection with each other and cannot exist in isolation; the evaluation criteria should match the evaluation object and be able to reflect the value of the industrial heritage from multiple levels and angles, and the definition of the index should be precise and clear to form a complete system (Loes, 2015).

4.4.4 The Principle of Comprehensiveness and Adaptability

Comprehensiveness means that the construction of evaluation indicators requires consideration of factors whose coverage is complete and informative, and can reflect the comprehensiveness of industrial heritage values; adaptability means that adjustments can be made on the basis of this evaluation method, adapting to the value evaluation of industrial heritage in different regions (Fouseki and Nicolau, 2018).

4.4.5 Combination of Qualitative and Quantitative Principles

In the evaluation of value, there is uncertainty in the indicators, so a combination of quantitative and qualitative methods should be used. This will avoid the existence of too many subjective factors and improve the scientific and objective nature of the evaluation (Liu, Zhao and Yang, 2018).

4.4.6 The Principle of Regional Uniqueness

The main object of evaluation in this research is industrial heritage in Shaanxi Province, China. Because the industrial heritage buildings in each region have their own characteristics, the evaluation indicators should have regional specificity.

4.5 Basic Process and Approach to Establishing Evaluation Methods

This part is the core of the study. The analysis in this section will be used to determine the process and formulae for the evaluation method of Shaanxi Province's industrial heritage. The formula needs to be established through four steps: determining the factor hierarchy, expanding the factor options, questionnaire survey, and adjusting the weight value coefficients.

4.5.1 Determining the Evaluation Method - AHP

The AHP method breaks down the objectives to be evaluated in layers by creating a multi-level decision matrix (Turner, 2006). The influence weights of each layer of influencing factors on the decision are calculated to ultimately assist the decision. The process of applying AHP is actually the process of ranking the influence factors. In the heritage evaluation method, using AHP to determine the weight of each indicator factor can reduce the influence of subjective factors on the evaluation results and increase the scientific nature of the evaluation method (Liu, Zhao and Yang, 2018). In this study, AHP will be used to determine the factor weights of industrial heritage value indicators.

4.5.1.1 The Scientificity of the Evaluation Method

This study will use the AHP method to divide the value composition of the industrial heritage landscape into four layers, which are the objective layer, the feature layer, the factor layer and the detail layer. The AHP method is a kind of multi-indicator comprehensive evaluation method (Saaty, 1990). A comprehensive multi-indicator evaluation method uses mathematical statistics to evaluate multiple indicators and factors of the evaluation object to obtain a high or low value. In the multi-indicator evaluation method, the weighting coefficients will have a fundamental impact on the evaluation results (Qi, 2018). In this study, the weights of each factor will be calculated by means of weighted summation. In a weighting system, the judgement made by a single user on the importance of a factor is not representative. Therefore, this study will collect the factors from users of different genders, ages and occupations. The aim is to get closer to the general users' perceptions of the value of the industrial heritage landscape.

4.5.1.2 Establishing Evaluation Factors and Hierarchies

The weights of the evaluation factors determine the importance of the different intensities of that factor in the value evaluation (Liu, 2012). The weights of the evaluation factors will be calculated from the results of scoring investigators of different occupational and age structures. Before this process, it should first be clarified what the multi-tiered evaluation factors are. The objective layer is the value of what is being evaluated and is the highest layer. The feature layer is a broad category of features classified according to the factor characteristics of the evaluation object, which can generally be divided into only two or three. The factor layer is the nature perspective category that has a valuable outcome impact on the object of evaluation and is the middle category of the stratified characteristics. The detail layer is the detailed factors that have an impact on the valued outcome of the object of evaluation and is the sub-category of the stratified characteristics. The four factor layers together form a hierarchy of industrial heritage value evaluation factors (Figure 8). According to the value analysis of industrial heritage in the previous article section, the objective layer in this case is the overall value of industrial heritage. The feature layer can be divided into intrinsic value and derived value. The intrinsic value in the factor layer can be broken down into historical value, technological value, cultural value and artistic value; the derived value in the factor layer can be broken down into location value, environmental value, group value, social value and emotional value.

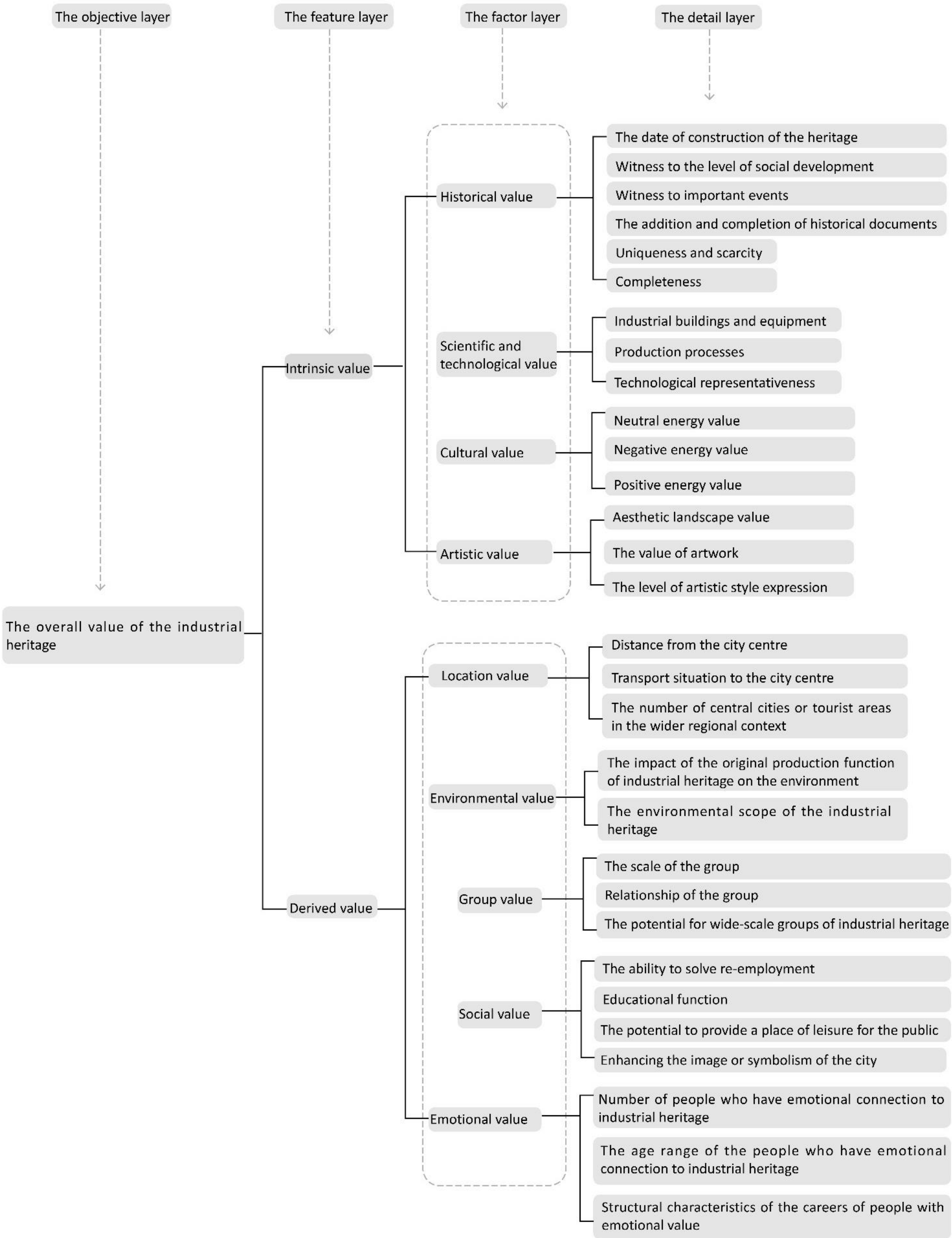


Figure 8. Diagram of Industrial Heritage Landscape Value Factors

4.5.1.3 The Mathematical Theoretical Basis of the Weighting Formula

In the calculation of the valuation value of industrial heritage, the concept of a weighted average will be mainly applied. A weighted average is a set of data which, in the practical application of a mathematical formula, requires a weighted average when there is a set of data that requires an average, each of which has a different degree of importance (Saaty, 1990).

Let $X1, X2,..., Xn$ be n numbers, their arithmetic mean is: $(X1 + X2 +... + Xn) / n$.

Let $A1, A2,..., An$ is n positive numbers, and $A1 + A2 +... + An = 1$, then $X1 \times A1 + A2 \times A2+...+Xn\times An$, is called the weighted average of X1, $X2,..., Xn$, where $A1, A2,..., An$ are called weights or weighting factors.

The weighted average when the weights are all equal is the arithmetic average. When the weights are different, the result of the calculation is the weighted average (Liu, Zhao and Yang, 2018).

4.5.2 Determining the Evaluation Method: GIS (Obtaining and Analysing Data + Visualisation of Weights)

The evaluation of industrial heritage values includes elements such as environment and geography, which need to be stored and managed efficiently and quickly. The most important feature of GIS technology is the creation of a spatial database (Fairclough and Herring, 2016). This allows for easier access to data resources and more efficient storage and management of multiple types of data (Table 20). The database can also be used to create a variety of analysis maps of the current situation required for industrial heritage conservation. In addition, GIS has powerful analytical capabilities to analyse and process all types of complex data, with accurate, clear and intuitive results. The industrial heritage is often evaluated through field surveys and the information obtained covers a wide range of different disciplines (Ciski, Rzasa and Ogryzek, 2019). The ability of GIS technology to edit, analyse, evaluate and make decisions can improve the scientific and systematic nature of industrial heritage classification and evaluation. In summary, the core functions played by GIS in industrial heritage classification and evaluation contain data acquisition, storage, editing, analysis, and spatial decision support.

Table 20. Table of Industrial Heritage Related Data Available from GIS

Type	**Content**	**Form**	**Source**
Environmental data	Spatial data or attribute data on the spatial pattern of industrial sites Distribution of roads, relationship of industrial heritage to the environment	Mapping, aerial imagery, field research	Obtained by relevant authorities, field research
Historical resource data	Data on the attributes or spatial patterns of a factory at a certain historical period	Maps, literature data	Historical maps, literature, research by historical scholars
Border data	Description of the borders of the industrial heritage factory area	Geometric spatial data and graphs of statistical borders	Field research data, maps, literature

The application of the AHP method can directly evaluate the value of industrial heritage by numerically calculating the weights (Wei and Zhang, 2011). However, the spatial information such as shape, area, geographical coordinates and mutual location of industrial heritage cannot be reflected visually and intuitively. Geographic Information Systems (GIS) can visualise and spatially integrate multiple data for evaluation and analysis, providing a basis for the classification and evaluation of industrial heritage (Fairclough and Herring, 2016). In other words, through the comprehensive evaluation method of industrial heritage value by AHP, the spatial analysis function of GIS technology can be used to realize its visual, procedural and spatial evaluation and analyse results. The industrial heritage value evaluation by GIS technology is a means to visualise the conclusions of the comprehensive industrial heritage value evaluation method. The main process is through a detailed research of the industrial heritage factory area and the surrounding environment. The attribute data of buildings, structures, roads, landscape and other elements are entered into the GIS platform. The value evaluation method index factors are selected and the above GIS spatial analysis method is applied to generate a comprehensive value evaluation grading map in GIS.

4.6 Designing the Questionnaire

The role of the questionnaire in this study is to provide a descriptive criterion as a score when determining the value of industrial heritage landscapes in industrial heritage conservation work. This study will obtain weighting values for each of the industrial heritage landscape value evaluation factors by scoring the importance of the industrial heritage landscape value factors by around three hundred respondents.

4.6.1 Forming a Survey Questionnaire of the Weighting Factor

In order to enable the interviewees to understand the content of the research, the questions were asked in a way that the public could understand, and the interviewees rated the importance of each factor according to their understanding. The study will select three hundred respondents of all genders, age groups and occupations for the questionnaire. Each weighting factor is scored from 0 to 9, with a score of 7-9 or more shows that the factor is extremely important in the evaluation of industrial heritage values, 5-7 showing that the factor is important in the evaluation of industrial heritage values, and so on. Higher scores show greater importance, lower scores show less importance.

4.6.1.1 Sample of Questionnaire 1: A Survey on the Value Weighting of Industrial Heritage Landscapes

This survey is about the importance of the landscape value of industrial heritage. The industrial heritage referred to in the survey means abandoned industrial sites, old industrial buildings and plants, disused machinery and equipment in cities, and industrial-type areas in cities where there was once a large concentration of factory enterprises.

The online survey is available in Appendix A.

4.6.2 Forming the Value Evaluation Questionnaire

Based on the collation and analysis of previous research data on industrial heritage landscapes, this study further decomposes the value of industrial heritage landscapes into value factors. The evaluation options were developed according to the value factors, and the evaluation questionnaire was thus formed. The weights of the evaluation factors in the evaluation questionnaire will be derived from the data collated from the previous research questionnaire (see Appendix A) combined with mathematical formulas. The purpose of the evaluation questionnaire is to make the study more scientific and objective. Based on the data collection, analysis and research, the value evaluation factors of the industrial heritage landscape will be established and scored according to the importance of the evaluation factors. The questionnaire consists of five parts, namely the objective layer, the feature layer, the factors layer, the detail layer and the weights.

Table 21. Overview of the Industrial Heritage Value Evaluation Indicators

The objective layer	**The feature layer**	**The factors layer**	**The detail layer**	**Weights**
The overall value of industrial heritage landscape	**A** Intrinsic value	**A1** Historical value	**A11** The date of construction of the heritage	
			A12 Witness to the level of social development	
			A13 Witness to important events	
			A14 The addition and completion of historical documents	
			A15 Uniqueness and scarcity	
			A16 Completeness	
		A2 Scientific and technological value	**A21** Industrial buildings and equipment	
			A22 Production processes	
			A23 Technological representativeness	
		A3 Cultural value	**A31** Positive energy value	
			A32 Negative energy value	
			A33 Neutral energy value	
		A4 Artistic value	**A41** Aesthetic landscape value	
			A42 The value of the artwork	
			A43 The level of artistic style expression	
	B Derived value	**B1** Location value	**B11** Distance from the city centre	
			B12 Transport situation to the city centre	
			B13 The number of central cities or tourist areas in the wider regional context	

		B2 Environmental value	**B21** The impact of the original production function of industrial heritage on the environment	
			B22 The environmental scope of the industrial heritage	
		B3 Group value	**B31** The scale of the group	
			B32 Relationship of the group	
			B33 The potential for wide-scale groups of industrial heritage	
		B4 Social value	**B41** The ability to solve re-employment	
			B42 Educational function	
			B43 The potential to provide a place of leisure for the public	
			B44 Enhancing the image or symbolism of the city	
		B5 Emotional value	**B51** Number of people who have an emotional connection to industrial heritage	
			B52 The age range of the people who have an emotional connection to industrial heritage	
			B53 Characteristics of the careers of people with emotional value	

4.7 Fundamentals of the Analytic Hierarchy Process

This research has used the Analytic Hierarchy Process (AHP) to evaluate the comprehensive value of industrial heritage. The AHP consists of the following aspects: firstly, the establishment of a multi-level evaluation indicator system, which generally requires the division of the indicators to be evaluated into more detailed layers. Secondly, comparing the importance of the evaluation indicators in pairs, the relative weights of the indicators are derived through a judgement matrix according to the scaling method given by Saaty (1990). Then, the numerical value of each evaluation is determined.

The evaluation of the value of industrial heritage involves many indicators, and individual indicators can only reflect one-sided information or one aspect of the industrial heritage. In order to make a comprehensive and reasonable evaluation, it is necessary to process various indicators in an integrated manner. The specific steps are as follows.

4.7.1 Build the Structure of Hierarchy

This research divides the hierarchy of value evaluation methods into four levels, which are the objective layer, the feature layer, the factors layer and the detail layer. The objective layer identifies the overall goal of this evaluation method, which is to evaluate the overall value of the industrial heritage landscape. The second layer, called the feature layer, contains the intrinsic value and the derived value, which contribute to the implementation of the objective layer. The decomposition and refinement of the feature layer result in the factors layer and the detail layer, which show the characteristics of the different indicators when they are judged.

4.7.2 Building the Judgment Matrix

Once the hierarchy has been established, the affiliation of the elements of the evaluation system is then determined. Assume that A is an above-level factor and that the next-level factors that it dominates are B_1, B_2, B_3,..., B_n, which we need to weigh according to their relative importance to target A. In this step, the AHP is used to derive the weights for B_1, B_2, B_3,..., B_n by means of a pair-wise comparison. The pair-wise comparison process is carried out by several experts. In this process, the experts are asked to answer the question: which element is more important for the target A, B_x or B_y. The importance scale uses the 1-9 scale proposed by Saaty, which uses the numbers 1-9 and their reciprocals to indicate how important one element is over another. The specific meaning of the 1-9 scale is shown in Table 22.

Table 22. The 1-9 Fundamental Scale of AHP (Saaty, 1990)

Intensity of importance	Definition
1	B_x and B_y are equally important
3	B_x is slightly more important than B_y
5	B_x is strongly more important than B_y
7	B_x is very strongly more important than B_y
9	B_x is extremely more important than B_y
2,4,6,8	Means the middle value of the above adjacent judgement
Reciprocal	If the ratio of the importance of the B_x factor to the B_y factor is B_{xy}, then the ratio of the importance of the B_y factor to the B_x factor is $1/B_{xy}$

From a psychological point of view, too much hierarchy will make it more difficult to make judgements. Saaty's study compared the correctness of people's judgements on a variety of scales and the results showed that a scale of 1-9 was most appropriate.

Thus, still, the elements of the above layer A and the elements of the next layer B_1, B_2, B_3,..., B_n as an example, a pair-wise comparison of all elements of layer B leads to the following comparison matrix presented in Table 23. The result of the comparison of the i-th factor with respect to the j-th factor is denoted by b_{ij}. The matrix uses b_{ij} to show the results of the comparison of the i-th factor with the j-th factor (Saaty, 1990).

Table 23. Table of AHP Method Matrix

$$B = (b_{ij})_{n\times n} \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{bmatrix}$$

4.7.3 Calculation of the Weights of the Judgment Matrix

4.7.3.1 The Process of Calculating the Weights of the Judgment Matrix

The process of calculating the weights of the judgment matrix is as follows (Saaty, 1990):

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_t = \prod_{j=1} b_{ij}, i = 1, 2 \cdots n$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i}$$

Further, normalise the vectors $W^* = \left(w_1^*, w_2^*, \cdots, w_n^*\right)^T$,

$$w_i = \frac{w_i^*}{\sum_{i=1}^{n} w_i^*}$$

The weights calculated are the weight vectors of the required solutions. w_1, w_2...... w_n is the weight value corresponding to each factor.

4.7.3.2 Consistency Test

Consistency refers to the logical consistency of judgemental thinking. For example, when A is strongly more important than C, and B is slightly more important than C, A must be more important than B. This is the logical consistency of judgemental thinking, otherwise, judgements would be contradictory.

The steps of the consistency test for the judgment matrix are as follows (Saaty, 1990).

The consistency index (*CI)* is calculated from the maximum eigenvalue λmax of the judgment matrix:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

The formula for the maximum characteristic root $\lambda_{\max}$ of which is:

$$\lambda_{\max} = \frac{1}{\mathrm{n}} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i}$$

Then, find the corresponding average random consistency index (*RI)*. For n = 1,..., 9, Saaty (1990) gives the scores of *RI* as shown in Table 24.

Table 24. Table of AHP Method RI Scores (Saaty, 1990)

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

Next, calculate the consistency ratio (*CR)*

$$CR = \frac{CI}{RI}$$

When $CR < 0.10$, the consistency of the judgement matrix is considered acceptable; otherwise, the judgement matrix should be suitably amended.

4.8 Calculation of Weights for Industrial Heritage Value Evaluation Indicators

As shown in Table 21, there are 2 feature layers, 9 factor layers and 30 detail layers in the comprehensive evaluation method of this study, and they are of different levels of importance in the comprehensive evaluation. Indicators that are important should be given a more significant weight; conversely, they should be given a lesser weight (Saaty, 1990). The main process is to compare the importance of the indicators by questionnaire, to determine the weights by using the Analytic Hierarchy Process (AHP) and finally to verify the consistency.

Firstly, a judgement matrix should be constructed. For the objective layer, the relative importance of the elements in the comprehensive evaluation layer is compared between two and two, and the judgment matrix of two comparisons is obtained.

A total of 212 questionnaires were collected from respondents of different genders, ages and occupations. Through the analysis and collation of the collected data and its results, on the one hand, it can prove the scientific foundation of the research method, on the other hand, it can prove the stability and reliability of the results of this survey, and test and further improve the evaluation method of industrial heritage landscape value. The process of analysing the data collected by the questionnaire and calculating the specific weights is described in Appendix B. The weighting summary is calculated as Table 25.

Table 25. Summary Weightings

The feature layer	Relative weight	The factors layer	Relative weight	The detail layer	Relative weight	Absolute Weight	Order
A Intrinsic value	0.75	**A1** Historical value	0.3933	**A11** The date of construction of the heritage	0.2803	0.0827	3
				A12 Witness to the level of social development	0.1573	0.0464	8
				A13 Witness to important events	0.0991	0.0292	15
				A14 The addition and completion of historical documents	0.1982	0.0585	4
				A15 Uniqueness and scarcity	0.1402	0.0413	9
				A16 Completeness	0.1249	0.0368	11
		A2 Scientific and technological value	0.1390	**A21** Industrial buildings and equipment	0.4934	0.0515	7
				A22 Production processes	0.1958	0.0204	19
				A23 Technological representativeness	0.3108	0.0324	14

		A3 Cultural value	0.2338	**A31** Positive energy value	0.4934	0.0865	2
				A32 Negative energy value	0.1958	0.0343	13
				A33 Neutral energy value	0.3108	0.0545	6
		A4 Artistic value	0.2338	**A41** Aesthetic landscape value	0.4934	0.0865	1
				A42 The value of the artwork	0.1958	0.0343	12
				A43 The level of artistic style expression	0.3108	0.0545	5
B Derived value	0.25	**B1** Location value	0.3291	**B11** Distance from the city centre	0.4934	0.0406	10
				B12 Transport situation to the city centre	0.1958	0.0161	23
				B13 The number of central cities or tourist areas in the wider regional context	0.3108	0.0256	17
		B2 Environmental value	0.1247	**B21** The impact of the original production function of industrial heritage on the environment	0.6667	0.0208	18
				B22 The environmental scope of the industrial heritage	0.3333	0.0104	26
		B3 Group value	0.1645	**B31** The scale of the group	0.4934	0.0203	20
				B32 Relationship of the group	0.1958	0.0081	29
				B33 The potential for wide-scale groups of industrial heritage	0.3108	0.0128	24
		B4 Social value	0.1645	**B41** The ability to solve re-employment	0.3976	0.0164	22
				B42 Educational function	0.2364	0.0097	27
				B43 The potential to provide a place of leisure for the public	0.1672	0.0069	30

				B44 Enhancing the image or symbolism of the city	0.1988	0.0082	28
		B5 Emotional value	0.2171	**B51** Number of people who have an emotional connection to industrial heritage	0.4934	0.0268	16
				B52 The age range of the people who have an emotional connection to industrial heritage	0.3108	0.0169	21
				B53 Characteristics of the careers of people with emotional value	0.1958	0.0106	25

** Absolute weights correspond to the importance of the indicator for the overall objective. The relative weight is the importance of the indicator for this layer.*

This section establishes a multi-level evaluation method for the value of modern industrial heritage in Shaanxi Province, China, based on the study of the development process of modern industry and the study of the types and characteristics of modern industrial heritage in Shaanxi.

This evaluation method sets up separate evaluation index terms for the different values in modern industrial heritage. The feature layer of the value evaluation includes Intrinsic value and Derived value, while the factors layer and detail layer have different indicators. The evaluation method is validated by filtering the indicators to form a logical hierarchy.

This evaluation method evaluates the value of the modern industrial architectural heritage in Shaanxi, and in the calculation process, the weights of each indicator are derived from the analytic hierarchy process This method achieves at a theoretical level a quantitative approach to the evaluation of the value of the industrial architectural heritage within the modern industrial heritage factory in Shaanxi.

The ordering in the last column of the table is a ranking of the absolute value of the detail layers and the serial number shows the importance of the detail layers to the overall objective. Several characteristics of industrial heritage can be seen in the table. Firstly, the Aesthetic landscape value of industrial heritage has a high weighting, reflecting the unique value of the industrial landscape reflecting industrial facilities and buildings, and the importance of the industrial iconic landscape in shaping the landscape characteristics of industrial cities. The second is the high weight of Positive energy value, reflecting the importance of the positive aspects of the energy conveyed behind the industrial culture. Thirdly, the date of construction of the heritage is given a high weighting. This reflects the importance of the date of construction of the heritage.

4.9 The Process of Visualizing and Evaluating the Value of Industrial Heritage Based on GIS Technology

In Section 4.5, it was determined that a Geographic Information System (GIS) would be used as a tool for visualising the value of industrial heritage. It is possible to integrate spatial location data and properties information of industrial heritage through GIS, as well as representing historical information on 2D electronic topographic maps or in satellite images. In addition, the GIS is not only available to link the current photos and basic information of the heritage, but also enables the overlay analysis of the different factors' weights calculated by the AHP method for each building, thus visually presenting the comprehensive value of the buildings in the industrial area. The next section will analyse the relevant spatial analysis functions and visualisation processes of GIS in this study.

The first step was the collection of GIS data, followed by the creation of a database. The collection of data was undertaken by field research, literature review, questionnaires and interviews with project managers. The aim is to collect information on the age, name and change of use function of industrial buildings and to enter it into the GIS platform. The data collection, input, storage, management, spatial analysis, query, output, and display functions of GIS are used to correlate spatial and property data and create a database. The next step is to determine the weights of each factor using the analytic hierarchy process (AHP) on the basis of building data and to establish a calculation model. After scoring the individual indicators of each building, the model is used to calculate the overall score and present it on the map in different colour blocks. Based on the results of the composite score, the buildings are then graded and classified, and different conservation and planning measures are proposed for the different levels of industrial buildings. The specific steps are as follows.

4.9.1 Data Collection

In order to better understand the current state of the industrial heritage and to evaluate its value, as well as to seek a basis for subsequent planning and renewals, field research, questionnaires and interviews were used to investigate in detail the elements of the buildings within the industrial site. Firstly, a survey form (Table 26 and Table 27) was applied to each building to obtain its basic building information.

Table 26 records information about the basic attributes of individual buildings, and Table 27 records information about buildings and factories based on evaluation criteria (see Section 4.1). Secondly, other information needed for the evaluation factors is obtained based on interviews, as well as review of local literature.

Table 26. Survey Sheet on Industrial Heritage

Name	Current name		
	Original name		
Address			
Establishment date		Factory area (square meters)	
Distance from the city centre (km)			
Completeness	□81-100% complete □51-80% complete □21-50% complete □0-20% complete		
Type of industry	□Electronics □Petrochemicals □Vehicle and shipbuilding □Machinery □Building materials □Light industry □Instrumentation □Power □Pharmaceuticals □Extractive metallurgy □Other _______		
Type of enterprise	□Chinese state-owned enterprises □Collective enterprises □ Joint-stock cooperative enterprises □Joint-stock enterprises □Foreign and Hong Kong □Macao and Taiwan enterprises □Other economic enterprises_______		
Enterprise operating status	□Normal operation □Discontinued and idle □Partially leased □Proposed transfers □Other _______		

Condition of equipment	Presence of the production lines from the beginning of the factory	□YES □NO
	Presence of the production equipment from the beginning of the factory	□YES □NO
Integrity and authenticity	□Original buildings intact □Partial demolition of old buildings □Partial conversion of old buildings □Partial demolition followed by new construction □Total demolition followed by reconstruction	
Evidence of a technical invention or patent with independent intellectual property rights	□YES (□1 item □ 2 items □3 items □more than 3 items)	
	□NO	
Availability of factory history files	□YES □NO	
Availability of old building construction drawings	□YES □NO	
Availability of older trees	□YES （□<30 years □ 30 - 50 years □ >50 years)	
	□NO	
Technological value Note: 1. This item investigates both a) Architectural design and construction technology; b) Industrial equipment and technology. If the factory has other more prominent values, they can be added. 2. This item is multiple choice	a) Architectural design and construction techniques □ Was the largest plant of its time □ First to use a particular construction system or building process □ First to use a particular building material b) Industrial equipment and technology □ The most advanced equipment and largest production enterprise in China/the province when the factory was built □ Pioneered the use of the most advanced equipment in the industry □ Used a certain type of important production process, technology or plant system □ Largest production scale and highest quality in its industry	

	(3) Other______________________
Industry status	□ Unique in China □ Unique in the region of China □ Unique in the province □ Unique in the city □Leading in China □Leading in the western region of China □Leading in the province □Leading in the city
Important people/events in the history of the company	The following people and events are reference options, please add if there are other relevant people or times. □ Business founder □ Architectural designer □ Product developer/designer □ Important national leaders visiting □ Other prominent members of the community □ Effective events in the establishment/development of the enterprise □ Other _______
Enterprise Honours	The following honours are reference options, please add if there are other honours. □ China Enterprise Management Excellence Award □ Famous Brand Product of Shaanxi Province □ Xi'an Famous Brand Product □ Xi'an Famous Trademark □ Shaanxi Province Famous Trademark □Other _______
Positive energy value	□ It reflects the great energy of the country and the nation □ It reflects the collective spirit of the regional culture □ It reflects the pioneering role of the representatives in the industry □ It reflects the spirit of struggle based solely on the function of industrial production □Other _______
Negative energy value	□ Negative energy involving national humiliation and insult to national dignity □ Negative energy involving regional transformation by oppression □ The fact of being oppressed by technological backwardness □ The fact of an inequality involving former technical cooperation □Other _______
Neutral energy value	□ Its value has a widespread impact on the industry □ Its value has a profound impact on a professional system □ Its value has a significant impact on a group of people □ Its value affects some of the people involved □Other _______

Aesthetic landscape value	□ Industrial heritage as a whole has outstanding aesthetic value □ Some elements of industrial heritage have outstanding aesthetic value □ A few parts of industrial heritage have aesthetic value □ low aesthetic value □ Other _______
Quantity of artwork	_____________________
The level of artistic style expression	□ The artistic style is obvious and well expressed in detail □ The artistic style is clear and slightly simplified, highlighting the main elements □ It partially reflects a certain artistic style, highlighting some of the key points □ It is an elemental embodiment of a certain artistic style □Other _______
Transport situation to the city centre	□ Easy transport links, accessible by three or more modes of transport, with rail links □ Relatively easy transport links in the vicinity, accessible by two modes of transport □ Smooth and easily accessible roads in the vicinity □ Accessible but not convenient, with road links in the vicinity in need of renovation □ Other _______
How many central cities or tourist attractions are there within 100 km of the industrial heritage?	
The impact of the original production function of industrial heritage on the environment	□ Not polluted during the industrial period □ Slightly polluted during the industrial period, but the pollution was no longer present during the value assessment period □ Heavily polluted during the industrial period, but the pollution was largely non-existent during the value assessment period □ Still suffered pollution during the value evaluation period and required investment in remediation □ Other _______
The environmental scope of the industrial heritage	□ Few site constraints and the potential for improvement is high □ One or several areas are not appropriate for improvement or have some restrictions □ The surrounding area is an old multi-storey residential area or shantytown (generally over twenty years)

	□ The surrounding site is a new high-rise multi-storey area or a large public building area, resulting in congestion around the industrial heritage site □ Other ________
The scale of the group	□ A scale level of five or more □ A scale level of four □ A scale level of three □ A scale level of two □ Other ________
Relationship of the group	□ They have formed industrial production chains □ They were once part of the same enterprise or factory under a large enterprise or institution □ Belong to a large industrial category □ Low relationship □ Other ________
The potential for wide-scale groups of industrial heritage	□ Three or more industrial heritage sites; easy access to each other; strong possibility □ Three or more industrial heritage sites with access to each other requiring capital investment; a high possibility □ There are two industrial heritage sites with industrial links to each other, a certain possibility □ Industrial heritage sites with weak industrial links and transport links to each other, a low possibility □ Other ________
How many job opportunities can be provided	
How many types of scientific displays are there?	
The potential to provide a place of leisure for the public	□ The public space available has the conditions of a heritage park □ The public space available is similar to a street park regulation □ The public space available can meet the basic requirements of viewing and visitor rest around the industrial heritage landscape □ The places available are limited, but better than before the reuse □ Other ________
Enhancing the image or symbolism of the city	□ The industrial heritage landscape after reuse has a prominent image and far-reaching meaning, and is the first business card of the city

	□ The industrial heritage landscape after reuse has a prominent symbolic meaning and is one of the image cards of the city □ The industrial heritage landscape after reuse has a beautiful image and can effectively improve the cultural appearance of the city and the streetscape □ The industrial heritage landscape after reuse has a significantly improved image compared before □ Other _______
Number of people who have an emotional connection to industrial heritage	□ The number is over 10,000 □ The number of people is between two thousand and ten thousand □ The number of people is between two hundred and one thousand □ The number of people is under two hundred □ Other _______
The age range of the people who have an emotional connection to industrial heritage Age range: a) 60 years old b) 45 to 59 years old c) 18 to 44 years old d) 12 to 18 years old e) under 12 years old	□ The age range includes the five categories above □ The age range includes the three to four categories above □ The age range includes the two categories above □ The age range includes the one category above □ Other _______
Structural characteristics of the careers of people with emotional value	□ People from nearly all careers □ People from the majority of careers around the industrial heritage □ People's jobs related to the industrial heritage □ Only the factory staff □ Other _______

Table 27. Building Survey Form

Name of building	Current name		Physical condition
	Former name		
Area of the building (m^2)			
Build Date			
Date of reuse			
Current use			

Original use			
Location			
Current photo			
Building type	□ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form		
Structure Facade	Column	□Timber □ Brick □ Brick and concrete □ Reinforced concrete □Steel □Other	□ No observed damage □ Minor damages □ Significant damage □_______________
	Colour	□ Wooden column □ Brick column □ Steel column □ Reinforced concrete column □ Other	
Facade Main entrance/exit	Material	Stone Gray	□ No observed damage □ Minor damages □ Significant damage □_______________
	Door materials	□Ganged brick □Ceramic tile □Cement □Plastering □Other	
Main entrance/exit Main facade window	Shape	□Copper □Steel □Wood □Mixed □Other	□ No observed damage □ Minor damages □ Significant damage □_______________
	Window frame material	□Rectangular □Round □Arched □Other	
Main facade window Roof	Shape	□Steel □Wood □Other	□No observed damage □ Minor damages □ Significant damage □_______________
	Form	□Rectangular □Round □Arched □Other	
Roof	Roof frame	□Gable Roof □Mansard Roof □Flat Roof □Other	□ No observed damage □ Minor damages □ Significant damage □_______________
	Tile/roofing sheets	□Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other	
	Tile/roofing sheets Lantern roof	Colour	
		Form	
		Material	
	Chimneys	□Yes □No	

4.9.2 GIS Visualization

The application of GIS needs to rely on GIS software, currently, the more commonly used GIS software in the planning industry is the ArcGIS series of software developed by ESRI, including ArcMap, which handles the configuration of 2D maps, and ArcSenen, ArcGIS pro, which is used to carry out 3D display and analysis. This section analyses the spatial analysis functions in ArcGIS Tool that are relevant to this research.

4.9.2.1 Data Type

The data types of ArcGIS covered in this study are divided into two types: spatial data, which represents spatial locations, and property data, which represents characteristics. Among them, spatial data is divided into two types: vector data and raster data.

The raster data refers to the image type data, including field collection photos, satellite remote sensing images, location maps and historical maps. This includes data with the file extensions .img, .jpg, .grid, and .tiff.

Vector data mostly refers to graphical data. Specifically points, lines and polygon elements that are edited in ArcGIS, as well as data imported into ArcGIS from CAD. It is a visual representation of the spatial relationships of industrial buildings, facilities. Includes .shp, .dbf, and .shx format files. This study uses lines to represent roads, polygons to represent buildings and points to represent artworks and equipment.

Property data, which is based on the characteristics of buildings, structures, roads, landscapes and other elements obtained from field surveys, needs to be entered, edited and modified in the ArcGIS platform.

4.9.2.2 Visualisation Process

The application of GIS technology allows for the visual and spatial evaluation of heritage values. The main process is through field research, drawing a base map in ArcMap and entering the required property data for each building into the ArcGIS platform, applying ArcGIS spatial analysis methods to display the scores of different indicators of the buildings on the map and generating a comprehensive value evaluation grading map. The application steps of ArcGIS in this process are as follows:

Firstly, a detailed survey of the industrial heritage factory and the surrounding environment is carried out based on the building survey form, taking photographs of each building and reviewing relevant information. Through field research to obtain textual, graphic and image information and generate building documentation forms, data collection and collation are completed to obtain information on the basic properties of the industrial heritage. Then, the base map is drawn in ArcMap, and the required property data is entered into the GIS platform, so that graphical data and image data and property data are linked to each other. This means that if you click on the plan of the current building in the ArcMap, you can quickly find out the property data for the survey.

The next is a single-factor evaluation. By converting the property data into raster data in ArcGIS, the indicators A1 Historical value, A2 Scientific and technological value, A3 Cultural value, A4 Artistic value, B1 Location value, B2 Environmental value, B3 Group value, B4 Social value, and B5 Emotional value were assigned a single factor layer and graded into four score bands of 4 3 2 1 (based on Section 4.1).

These evaluation indicators are divided into two categories, one for quantitative analysis and one for qualitative analysis. The quantitative values are assigned directly by consulting the relevant historical archives or according to the size of the indicator. For example, according to the evaluation criteria (see Section 4.1), buildings before 1911 are assigned a score of 4 and buildings after 1978 have a score of 1. The qualitative values are assigned based on questionnaires and interviews. This was followed by entering the scores in ArcGIS, which was done using the ArcGIS tool raster calculator, to obtain a one-factor raster evaluation map of the indicator layer.

The third is a multi-factor weighted overlay evaluation. As the value of different buildings under the same indicator, and the value of the same building under different indicators varies considerably, an overlay analysis of all single-factor evaluations for each building is required. For example, data on the attributes of a factory have a different impact on the value of industrial heritage, which can be divided into historical, technological, cultural and other properties. There is a ranking of the importance of the value of industrial heritage under these indicator factors. The spatial overlay function of GIS can be used to calculate the overlay based on the weight values of each index factor calculated by the analytic hierarchy process (AHP), and finally obtain a comprehensive value distribution map of industrial heritage buildings. The multi-factor weighted overlay evaluation of industrial building heritage values can be achieved by using the spatial analysis function of GIS technology. On the basis of the above single-factor evaluation, a weighted overlay is carried out by raster data to generate an evaluation model and obtain a comprehensive evaluation score and GIS overlay analysis map.

Chapter 5. Application of the Evaluation System in Practical Cases

Shaanxi Province is one of the modern concentrations of national industries (products produced by machines) in China. From the end of the 19th century to the beginning of the 20th century, Shaanxi Province developed industries such as cotton textiles, flour, machinery and ceramics along the Weihe River basin (in Baoji, Xi'an and Weinan) and in the Guanzhong region (in Baoji, Xi'an, Xianyang, Tongchuan and Weinan) and built some important water infrastructure such as the Guanzhong Baihui Aqueduct. From the 1950s to the 1970s, with the implementation of large-scale national economic development and five-year plans, Shaanxi established a more complete range of textile, machinery, electricity, electronics, aerospace, aviation and national defence industries. Especially during the Third Line Development period (1964-1980), the Chinese government built a large number of strategically important factories and military bases in Shaanxi.

Over time, these buildings, factory workshops, machinery and equipment, and special facilities have gradually become industrial heritage with specific values which is facing destruction. The Figure 9 shows the number of industrial heritage sites (the total number is 596) in Shaanxi Province which has been collated from relevant information from the Third National Cultural Heritage Census in Shaanxi (Wang, 2011).

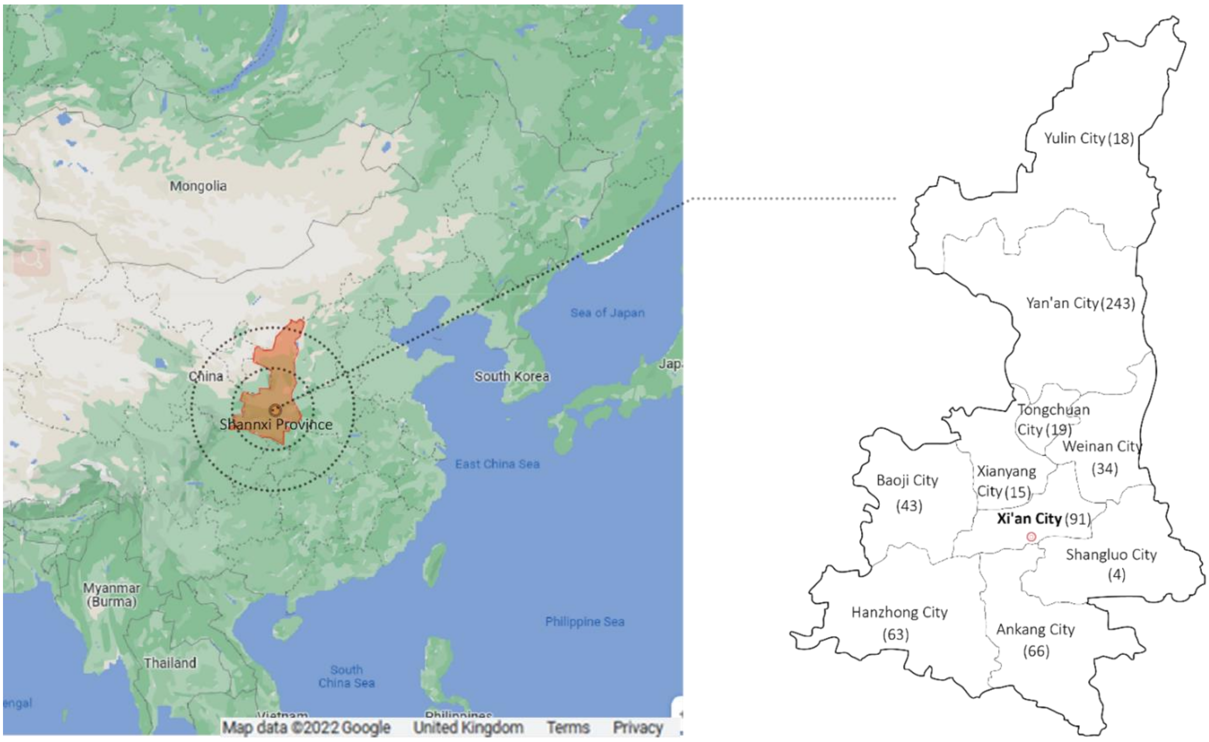


Figure 9. Overview of Industrial Heritage in Shaanxi Province. Source: Image adapted by the author from Google Maps.

The list of China's National Industrial Heritage is a list of industrial heritage identified by China's Ministry of Industry and Information Technology after declaration, evaluation and on-site verification. China's National Industrial Heritage refers to industrial relics that have been formed during the long-term development process of Chinese industry, have high value and are recognised by the Ministry of Industry and Information Technology (Liu, Xiao and Liang, 2021).

In Shaanxi Province, the first list of national industrial heritage sites in China includes the Shenxin Yarn Factory in Baoji City (MIIT, 2017). The second list of national industrial heritage sites in China includes the following industries in Shaanxi: the Baocheng Railway from Shaanxi to Sichuan, the Yanchang Petroleum Plant in Yan'an City and the Wang Shi Wa Coal Mine in Tongchuan City (MIIT, 2018). The third list of National Industrial Heritage of China includes the following industries in Shaanxi, the former site of the Sixth Institute of Aerospace in Feng County, Baoji City, the Dingbian Salt Farm in Dingbian County, Yulin City and the Pucheng Long and Short Wave Timing Station of the National Timing Centre of the Chinese Academy of Sciences in Pucheng County, Weinan City (MIIT, 2019). The fourth list has the industrial heritage group of ceramics in Yaozhou, Tongchuan (MIIT, 2020). The fifth list has the Xi'an Film Studio West Film Factory and the Baoji Xifeng Liquor Factory (MIIT, 2021).

By initially identifying Xi'an's industrial heritage and removing those enterprises that are no longer in existence (Sun, 2015; Wang, 2011), the final industrial heritage is shown in Table 28.

Table 28. List of Xi'an's Industrial Heritage

	Present name	**Year of establishment**	**Address**
1	Shaanxi Huanghe Group Company Limited	1953	No. 21, Xingfu North Road, Xincheng District, Xi'an
2	Xi'an Qinchuan Machinery Factory	1954	No. 37, Xingfu Zhong Road, Xincheng District, Xi'an
3	Xi'an Dongfang Machinery Factory	1953	No. 1, Xingfu South Road, Xincheng District, Xi'an
4	Xi'an Kunlun Industry Ltd.	1955	No. 67, Xingfu North Road, Xincheng District, Xi'an
5	Qinan Group Company Limited	1955	No. 628, Daqing Road, Lianhu District, Xi'an
6	Huashan Machinery Factory	1953	No. 37, Xingfuzhong Road, Xincheng District, Xi'an
7	Xi'an Yuandong Machinery Manufacturing Company	1953	No. 296, Hancheng South Road, Lianhu District, Xi'an
8	Xi'an Dongfeng Instrument Factory	1959	Dongyi Road, Yanta District, Xi'an
9	Qing Hua Electrical Appliances Manufacturing Factory	1956	No. 1 Tian Hong Zheng Street, Baqiao District
10	Xi'an Northwest Photoelectric Instrument Factory	1953	No. 35 Changle Middle Road, Xi'an
11	Baqiao Thermal Power Factory	1953	Baqiao District, Eastern Suburb of Xi'an
12	Xi'an Power Capacitor Factory	1953	No. 10, North Exit of Taoyuan Road, Lianhu District, Xi'an
13	Xi'an High Voltage Switch Factory	1955	Daqing Road, Lianhu District, Xi'an
14	Xi'an Electric Power Rectifier Factory	1955	No. 31, Daqing Road, Xi'an
15	Xi'an High Voltage Electric Porcelain Factory	1953	No. 579 Daqing Road, Lianhu District, Xi'an

16	Xi’an Insulation Materials Factory	1956	Taoyuan Road, Lianhu District, Xi’an
17	Hui’an Chemical Factory	1957	Yuxia Town, Hu County
18	Hu County Thermal Power Plant	1956	Yuxia Town, Hu County
19	Xi’an Instrument Factory	1954	Daqing Road, Lianhu District, Xi’an
20	Northwest Metal Structure Factory	1954	No. 15, West District, Hongqing Industrial Park, Xi’an
21	Northwest National Cotton Five Factory - Wuhuan Group	1954	No. 158, Textile City West Street, Baqiao District
22	Northwest First Printing and Dyeing Factory	1956	West Street, Textile City, Baqiao District, Xi’an
23	Xi’an Pharmaceutical Factory	1953	East Hancheng Road, Lianhu District, Xi’an
24	Qinghua Institute of Electrical and Mechanical Research	1956	No. 10, East Zhangba Road, Xi’an
25	Xi’an Guohua Pharmaceutical Factory	1956	51 Xi’an Xiying Road
26	Dengjiacun Sewage Treatment Plant	1956	Northwest Suburb of Xi’an
27	Xi’an Electric Machinery Factory	1956	No. 115, Hanpo Road, Baqiao District, Xi’an
28	Xi’an Standard Elevator Factory	1956	No. 1 Hongqi East Road, Xujiawan, Weiyang District
29	Xi’an Bingfeng Beverage Co.	1953	189 Jiuxie Road, Weiyang District, Xi’an
30	Xi’an Mining Machinery Factory	1951	Mine Road, North Section of East Second Ring Road, Xi’an
31	Xi’an No.1 Silk Factory	1955	No. 253, Hanyuan Road, Xincheng District
32	Xi’an No.1 Printing Factory	1951	No.1 Jiandong Street, Beilin District, Xi’an
33	China Motor Group Xi’an Lishan Automobile Manufacturing	1929	No. 90 Zaoyuan West Road, Xi’an
34	Jianhua Sanwu Yi Yi Spinning Co.	1949	No.2 Kunming Road
35	Dahua Yarn Factory	1934	No.251 Taihua South Road, Xi’an
36	Xi’an Steel Factory	1950	No. 58 Hongguang Road, Lianhu District, Xi’an
37	Xi’an brewery	1953	No.1 Beer Road, Taihua North Road, Xi’an

38	Xi'an Putian Microwave Equipment Factory	1958	42 Xianning Middle Road, Beilin District, Xi'an
39	Xi'an metallurgical machinery factory	1958	Xilan Road, Xi'an West Suburb
40	Xi'an Silicate Products Factory	1960	No.1 Xinsi Road, Baqiao District, Xi'an
41	Xi'an Chemical Factory	1958	356 Kunming Road, Xi'an West Suburb
42	Xi'an Nanfeng Daily Chemical Factory	1958	No. 7, Zhanba North Road, Xi'an
43	Xi'an Butterfly Watch Factory	1969	No.1 A-Zi, Buren Village, Chang'an District, Xi'an
44	Xi'an West Grain Company Martengkong Reserve	1972	South Xingfu Road, Xi'an
45	Xi'an Railway Signal Co.	1958	No. 3 Jinhua South Road, Xi'an
46	Xi'an Navigation Technology Research Institute	1961	No. 1 Baisha Road, Xi'an, Shaanxi Province
47	Xi'an Fine Arts Ceramics Factory	1958	No. 5 East Power Plant Road, Xi'an
48	Xi'an Sun Food Group Co.	1986	No. 466 Xi Ying Road, Xi'an
49	Shaanxi Steel Factory	1958	No. 109, South Happiness Road, Xi'an
50	Xi'an Standard Parts Factory	1958	22 Hongguang Road, Lianhu District, Xi'an
51	Xi'an Trademark Printing Factory	1958	24 Xingzhong Road, Lianhu District, Xi'an
52	Xi'an University of Architecture and Technology Seismic and Structural Laboratory	1958	Xi'an University of Architecture and Technology

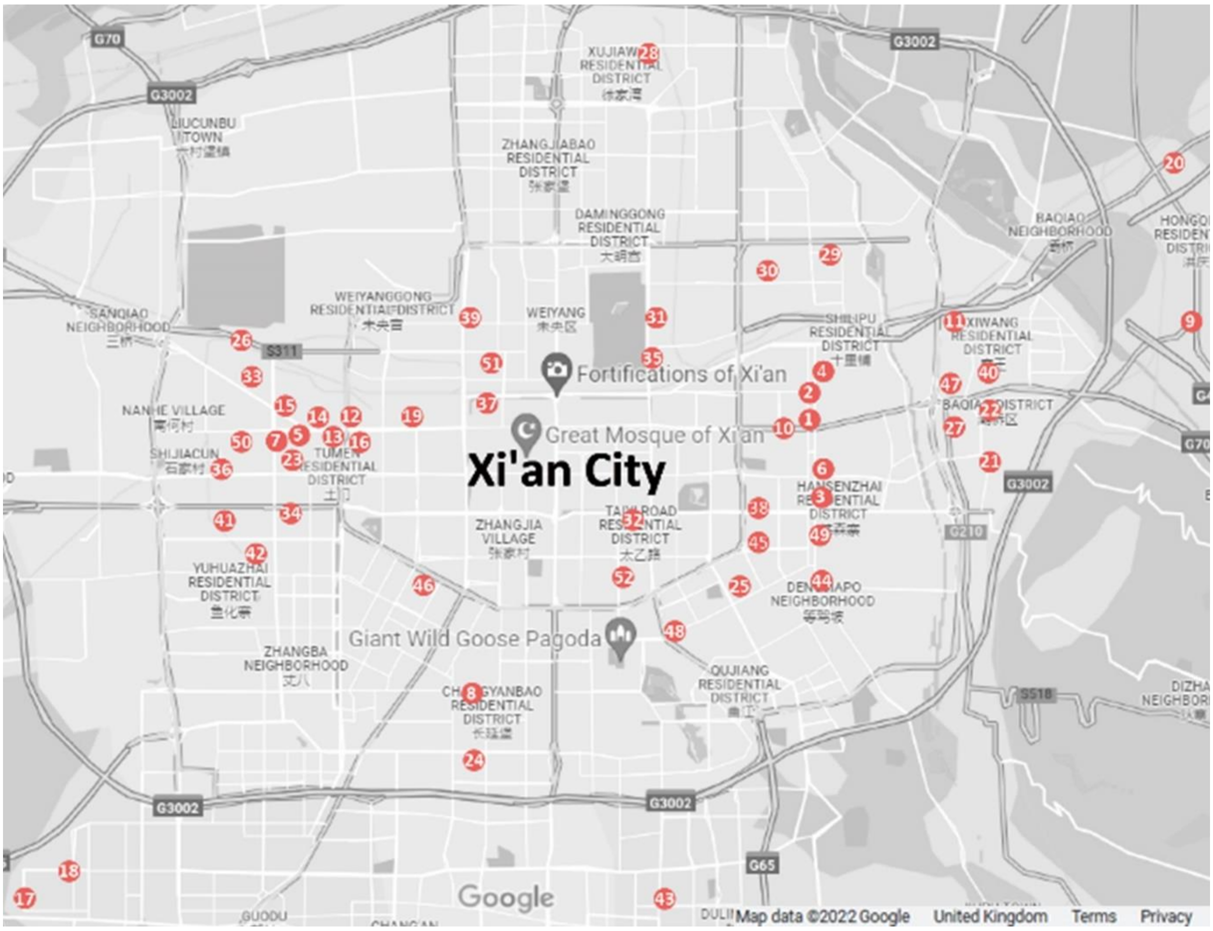


Figure 10. Distribution Map of Xi'an's Industrial Heritage. Source: Image adapted by the author from Google Maps.

In Shaanxi, according to the latest list of cities in China's old industrial bases (GOV.CN, 2013), Baoji, Xianyang, Tongchuan and Hanzhong, as well as Baqiao District in Xi'an, are included in the planning scope of the National Plan for the Adjustment and Renovation of Old Industrial Bases (2013-2022) (GOV.CN, 2013). These old industrial bases were formed during the First Five-Year Plan (1953-1957), Second Five-Year Plan (1958-1962) and Third Line development periods (1964-1980), with the heavy industry as the basis. The oil industry in Baoji, the textile industry in Xianyang, the coal mining industry in Tongchuan and the aviation manufacturing industry in Hanzhong were all formed in the context of national support for the development of the economy and heavy industry (Liu and Li, 2011).

In order to be able to test the realistic operability of the factors in the evaluation method in actual evaluation, the study will choose three industrial heritage landscapes with in

Shaanxi Province as the case study, and will apply the industrial heritage landscape value evaluation method in the cases. The three cases are Shaanxi Old Steel Factory (1965) in Xi'an, Wang Shi Wa Coal Mine (1957) in Tongchuan and Shenxin Yarn Factory (1939) in Baoji. They represent three different industrial heritage sites in one regional cultural context, each with different size and conservation situation, making the test results more representative.

5.1 Industrial Heritage of the Shaanxi Old Steel Factory, Xi'an City, China

One of the objects selected for study in this paper is the old Shaanxi Steel Factory, an important industrial heritage formed during the development of Xi'an City. Officially established in 1965, the Shaanxi Steel Factory was developed over the decades, and during its active production period, it had an important role in raising the GDP indicators of Xi'an City (Wu, Chen and Zhang, 2018).

In the 1980s Shaanxi Steel Factory was able to reach an annual production of 600,000 tonnes of steel. The development of the Shaanxi Iron and Steel Works has since been seriously affected by economic and policy reasons (Yang, 2017). As the plant's annual expenditure on workers' wages, and equipment maintenance and renewal amounted to tens of millions of yuan (around 120 million Pounds), it gradually became unable to make ends meet.

By 2002, the situation of insolvency became more and more serious and the Shaanxi Provincial Government approved the official bankruptcy of the steel factory (Jin et al., 2016). With the decline of the Shaanxi steel factory, a large number of industrial heritage sites were vacated, and abandoned production and processing equipment was unmanaged, which led to the issue of conservation and reusing of the Shaanxi steel factory's industrial heritage. In 2002, Xi'an University of Architecture and Technology's Science and Education Industries Company Limited acquired the former site of Shaanxi Steel Factory and started the reuse project (He, 2016).

In terms of the construction of industrial heritage at the national level, the Shaanxi Steel Factory was built in the early days of China's industrial development. It was once ranked among the top ten steel mills in China (Yang, 2017). Within Northwest China, it was the first and largest steel factory with the most advanced equipment at that time.

Within Shaanxi Province, Steel Factory was the first modern medium-sized steel factory and represented the highest level of the steel industry.

The steel produced by Shaanxi Steel Factory's No. 1 oxygen converter also ended the history of Shaanxi Province's lack of an iron and steel industry. Shaanxi steel smelting was realised from scratch and enabled the steel industry in Shaanxi Province to begin to develop. Whether on a national, regional or local level, the historical importance of Shaanxi Steel Factory is very significant. The Shaanxi steel factory, as the largest modern steel enterprise in Xi'an, has witnessed the development of modern industry in the city (Yang, 2017). This study will identify the scope of the research on the Shaanxi steel factory by considering its location, its development history and the preservation of its buildings. It will evaluate its value to verify the feasibility of the evaluation method.

5.1.1 Location Conditions

Shaanxi steel factory is located in the southeast of Xi'an urban area. It is bordered by Xianning East Road to the north and Xingfu South Road to the west. Together with the surrounding factories for producing building material components and the Oriental Machinery Factory, it forms a traditional industrial area in Xi'an (Jin et al., 2016). In addition to the building materials factory, the Qinchuan factory and the Oriental Machinery Factory, located to the north and south of the Shaanxi Steel Factory, there are also technology-based industrial parks such as the High-Tech Development Zone and the New Town Technology Industrial Park to the south-west of this traditional industrial area. (Liu et al., 2021).

Figure 11. Location Map of Shaanxi Old Steel Factory. Source: Image adapted by the author from Google Maps.

In 2002, Xi'an University of Architecture and Technology Science and Education Industry Limited Liability Company acquired the Shaanxi Steel factory and renovated it. The construction of its Science and Education Industrial Park started. The Shaanxi Steel factory, which is the Huaqing campus of the Xi'an University of Architecture and Technology, has abundant educational resources in the surrounding area. To the west of the Shaanxi Steel Factory are a secondary school and a primary school, which are Xi'an Dongfang Secondary School built in 1957 and Xi'an Xincheng District Dongfang Primary School built in 1956. On its east side is the Qinchuan Secondary School, built in 1962 (Yang, 2017; Liu et al., 2021).

Due to the rich educational resources and the denser concentration of businesses in the surrounding area, the Huaching Xuefucheng community was built in 2014 as a complement to the south of the old steel factory, and the Shaanxi steel factory was transformed from the original traditional industrial area into a scientific and educational industrial zone in the eastern part of Xi'an.

5.1.2 Development History of Shaanxi Steel Factory

The construction of China Shaanxi Steel Factory began in 1965. It is one of the key special steel producers in China's metallurgical industry and is also a large state-owned enterprise in Shaanxi Province. In its operation as a steel producer, it made a significant contribution to the economy of Shaanxi Province. The Shaanxi steel plant covers an area of 81.7 hectares, of which the plant area is divided into a production area and housing. The production area was developed over 62 hectares (including 2.7 hectares for the mechanical maintenance branch) and the housing for workers over 19.7 hectares (including 0.64 hectares for housing of the mechanical maintenance workers). Shaanxi steel factory was a special steel factory whose main products were loadbearing steel, carbon steel, gear steel, stainless steel, high-speed tool steel, alloy structural steel, alloy tool steel and spring steel. Since the conversion of the Xi'an steel factory into Shaanxi steel factory in 1964, Shaanxi steel has produced a total of 2.43 million tonnes of steel. In 1996, due to changes in the steel market and its own operational problems, the Shaanxi steel factory started to operate in debt (Jin et al., 2016). At the beginning of the 21st century, as a result of China's national economic austerity policies and controls on the scale of credit, the entire steel market experienced an economic downturn (Wei and Zhang, 2015). Ultimately, the Shaanxi steel factory went into bankruptcy on 30 October 2002 (Yang, 2017).

5.1.3 Historical Stages of Shaanxi Steel Factory

There are four historical periods of the Shaanxi Steel Factory development. These four historical periods are: (1) the period of the Xi'an Steel factory; (2) the period of the Ministry of Metallurgy Wu-er Factory, Shaanxi Steel factory; (3) the period of the Shaanxi Special Steel Company Limited; (4) the period of the Xi'an University of Architecture and Technology Science and Education Industry Limited Liability Company. The following are the details of the development of the Shaanxi steel factory within the four historical periods.

5.1.3.1 The Xi'an Steel Factory Period (1958-1964)

The period between 1958 and 1964 was the period of the birth of the Shaanxi steel factory, that is to say, it was the period of the Xi'an steel factory (Ren, Liu and Xiao, 2014). During this period, the steel industry in Shaanxi Province began to develop well because of the establishment of the Xi'an steel factory. At the same time, steel production was rising every year with workers' enthusiasm for production and the quality pass rate of steel production was rising. The development of the Xi'an steel factory came to a halt in April 1962 when China restructured and reorganised the country's steel industry (Yang, 2017).

5.1.3.2 The period of the Metallurgy's Wu-er Factory and Shaanxi Steel Factory (1964-1999)

In September 1964, the Metallurgical Industry proposed the relocation of the precision alloy and wire workshop in Dalian, Liaoning Province, China, to the Xi'an steel factory (Li and Xu, 1990). This move brought with it some of the industrial technology from the Dalian precision alloy factory and the workers who had previously worked there. In October of the same year, the Metallurgy named the Xi'an Steel Works as the Metallurgy's Wu-er factory. At the same time, the history of the Wu-er factory (Xi'an steel factory) as a manufacturer of military construction materials began to develop and the first wire rod workshops were put into operation in October of the same year. A year later, the cold drawing shop was also put into production. By 1969, the Wu-er factory had become a military steel plant with an annual output of over 100 million tonnes (Li and Xu, 1990).

In 1978, China started the reform and opening-up policy (Wei and Zhang, 2015). The gross industrial output of the Shaanxi steel factory increased from the 1980s to the 1990s and the products produced were put to use in various industries. In 1987, the total industrial output value of the Shaanxi steel factory exceeded the 100 million yuan mark for the first time and the products produced began to be sold overseas. After 1990, Shaanxi Steel's production declined, economic and management pressures increased and the market weakened, culminating in the announcement in May 1997 that Shaanxi Steel had ceased production (Jin et al., 2016).

5.1.3.3 The Period of Shaanxi Special Steel Company Limited (July 1997 - May 2002)

During the period from 1997 to 2002, Shaanxi Special Steel Company Limited took over the operations and the main industry during this period was still the secondary industry, i.e. special steel manufacturing.

The Board of Directors and leadership of Shaanxi Special Steel Company in 1997 were elected at the first general meeting of shareholders held by Shaanxi Special Steel Company. In 1999, due to production and management problems as well as the continuous changes in the steel market, after five years of miserable operation, the

Shaanxi Special Steel Company's income and expenditure on steel production had become unsustainable and announced a complete shutdown of production. In May 2002, Shaanxi Special Steel Company Limited was officially declared policy bankrupt (Fu, Wu and Yang, 2008). The factory buildings were dilapidated during this period and were used as warehouses by some nearby factories (Jin et al., 2016).

5.1.3.4 The Period of Xi'an University of Architecture and Technology's Science and Education Industry Limited Liability Company (May 2002 - present)

In 2002, Xi'an University of Architecture and Technology's Science and Education Industry Company Limited acquired the Shaanxi Steel Factory and renovated it, changing its name to the Old Steel Factory Creative Industrial Park. The function was changed from a forging plant for special steel to a scientific and educational area with cultural and creative functions (Jin et al., 2016). The former factory buildings have been transformed into creative industrial parks, colleges, museums and creative studios. The population living in the area has also changed from workers and their families in the mills to students and residents in the vicinity. With the change of industrial function and the transformation of the buildings, the once dormant Shaanxi Steel Factory has been given a new lease of life (Jin et al., 2016).

The above four historical periods in the history of the Shaanxi steel factory correspond to different periods of the development history of the Shaanxi steel factory. They correspond to the four periods of the birth, development, bankruptcy, and reuse of Shaanxi steel factory, respectively. The Table 29 provides and overview of the major events of the Shaanxi steel factory at different times.

Table 29. Phases of Shaanxi Steel Factory

The birth period of the Shaanxi steel factory	**The development period of the Shaanxi steel factory**	**The bankruptcy period of the Shaanxi steel factory**	**The reuse period of the Shaanxi steel factory**
On 8 October 1958, the first steel was produced and Shaanxi Iron and Steel achieved a history from scratch.	In September 1964, Dalian Steel Factory was relocated internally and renamed as the Ministry of Metallurgy's Wu-er Factory.	In 1997, the steel factory experienced operational difficulties and production ceased from May 1997.	In 2002, the name changes to the Old Steel Factory Creative Industrial Park.

	In March 1975, the Wu-er Factory was renamed Shaanxi Steel Factory. Shaanxi Steel Factory became a military steel factory, contributing to the construction of the country.	The Shaanxi Special Steel Company Limited resumed operations in January 1998 and ceased production completely a year later.	On 19 May 2010, the company changed its corporate name to Xi'an Huaqing Science and Education Industry (Group) Co (Jin et al., 2016).
	In 1989, the steel factory was reformed economically. 1980 to 1991 was a glorious period in the history of the Shaanxi Steel Factory.		

5.1.4 Scope of the Survey of Shaanxi Steel Factory

The scope of this survey is mainly the current old steel factory creative park, which contains the former slender steel wire workshop, the former wire drawing, oil tempering furnace workshop, the former exquisite steel wire grinding workshop of the factory, the former wire drawing workshop, the former new equipment workshop, the former packaging workshop, the former finished goods warehouse, the former heat treatment workshop east section, the former heat treatment workshop west section, and the former pickling workshop (Figure 12).

Figure 12. Shaanxi Old Steel Factory Survey Scope. Source: Image adapted by the author from Google Maps.

5.1.5 Current Situation Around the Xi'an Old Steel Factory Creative Park

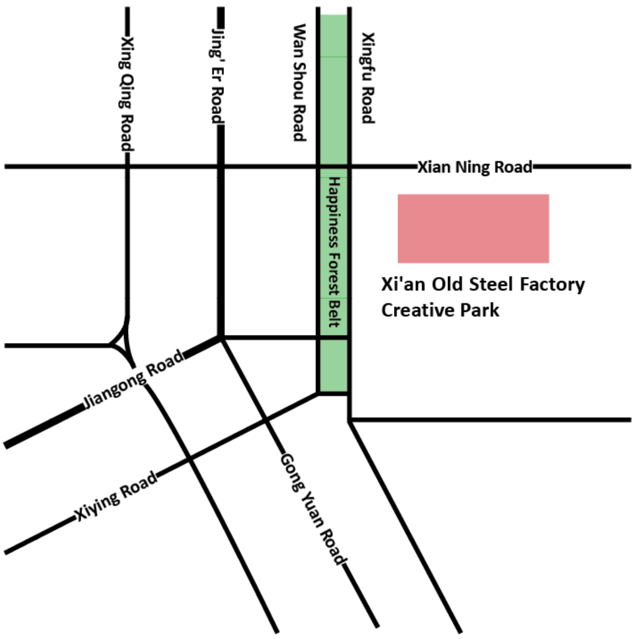


Figure 13. The Site and Road Analysis of Shaanxi Old Steel Factory. Source: Author.

Table 30. Table of the Current Situation Around the Shaanxi Old Steel Factory

Survey items	**Survey content**	**Description**	**Conclusion**
Site Analysis	The character of the site and the surrounding area	Industrial, Housing, Business	The main commercial services are concentrated on both sides of the main road on Xian Ning Road, Jing' Er Road and Xing Fu Road (Figure 12).
	Trends in land development	Housing, education and research	
	Surrounding public services	Mostly small and medium-sized shopping malls, convenience stores, small restaurants, and one commercial complex (Xi'an Happiness Forest Belt Global Harbor Shopping Centre) Medical care: large, good conditions and relatively well-equipped facilities Education: it is relatively well developed and has a good teaching staff with high quality teaching	
Road traffic	Name of surrounding roads	Jian Gong Road; Wan Shou Road; Xing Fu Road; Xian Ning Road; Gong Yuan Road (Figure 12)	The road network has a structure of "two horizontal and two vertical".
	Surrounding road grade	Jian Gong Road: main Road Xian Ning Road: secondary road Wan Shou Road: secondary arterial Xing Fu Road: secondary road Gong Yuan Road: secondary road	Jian Gong Road is a four-lane road and Xian Ning Road is a three-lane road. The Xing Fu road immediately adjacent to the site is a one-way road running from south to north. Only the eastern side has a non-motorised lane and the western sidewalk is adjacent to the motorised lane, so traffic and pedestrians can easily interfere with each other.
	Surrounding parking facilities	No large public car parks. Mainly on-street parking. Combined use of fast lanes in nearby neighbourhoods and hotels to provide parking.	On-street parking interferes with the flow of non-motorised traffic.
	Public transport stations	There are 5 bus stops within a 10 minute walking distance. The underground line 8 on Happiness Road is now under construction.	Commuting needs can be met and all major areas of Xi'an can be reached.

	On-site parking facilities	There are 2 centralised car parks (one underground and one above ground), followed by on-street parking	The site's parking requirements can be met.
Landscape	Important surrounding landscape zones	Xi'an Happiness Forest Belt	The project of the Happiness Forest Belt enhances the greening of the landscape and improves the quality of the environment.
	Greening of roads on the site	Both main and secondary roads have greening	The site is well landscaped but the surrounding roads are lacking in greenery.

5.1.5.1. Existing Issues Around the Site

The site of the Shaanxi Old Steel Factory is one of the traditional industrial areas of Xi'an. After China's reform and opening-up movement in 1978, economic policies were changed, such as the introduction of foreign investment, industrial restructuring and optimisation, which had a great impact on the development of traditional industrial enterprises in China. Many enterprises have experienced shrinkage and stagnation in production, while some have regained their development trajectory after a second start-up, and some of them have gone bankrupt. The industry and the overall influence of the area in the Eastern Suburbs Industrial Zone, to which Xi'an's old steelworks belonged, are losing their status in the city. The residential environment of the area has been greatly improved through recent development, but the urban function is relatively simple, only meeting the basic needs of life. The urban vitality of the area has not been fully developed, and there is still a sense of depression and decay. Some of the unused land and urban villages in the area have low utilisation of the land, resulting in waste. This is in contrast to the shortage of land resources for urban development.

It was found through the survey that in terms of land use, the former Shaanxi Steel Factory site and the surrounding areas are mostly industrial lands, which is one of the traditional industrial areas in Xi'an. The housing sites are mostly used for the families of the company's employees. There have also been a number of property projects developed and constructed in recent years, mainly concentrated around Jian Gong Road.

In terms of road traffic, the area is dominated by one main road and four secondary urban roads, forming a road network with appropriate density and good accessibility. Its traffic organization is generally orderly, but it cannot meet the parking needs of residents.

In the field of landscape greenery, the survey area is dominated by road greenery and internal greenery in residential areas and corporate offices. A Happiness Forest Belt project with an integrated park and commercial area has been built around the site. This project can enhance the greening of the landscape and improve the quality of the environment in the area.

With regard to education, the schools in the area are complete and of high quality, which can meet the demand for education of the residents in the area. Most the primary and junior high schools are affiliated with enterprises or universities, relying on the foundation of universities such as Xi’an Jiaotong University, Xi’an University of Technology and Xi’an Engineering University, which have the potential to develop the education industry.

In the field of medical facilities, there are three larger hospitals within two kilometres of the survey area, Xi’an Huashan Central Hospital, Shaanxi Metallurgical Hospital and the Fourth People’s Hospital of Shaanxi Province, and their distribution and scale are able to meet the demand for medical services.

In terms of commercial services, the existing larger commercial service facility in the surrounding area is the Xi’an Happiness Forest Belt Global Harbor Shopping Centre, which completed in July 2021. The rest of the commercial, dining and entertainment services are basically scattered along the street.

Regarding the urban image of the survey area, the traditional industrial area on the east side, bounded by Happiness Road and Wanshou Road, is characterised by overall decay and depression; the area to the west has formed a spatially complete and clear living area after recent years of construction, but the area still lacks spatial characteristics and place markers, and is relatively lacking in urban vitality.

The city’s infrastructure such as water supply and drainage, electricity and telecommunication facilities can meet the demand. However, facilities such as lighting, sanitary facilities and signage systems are old and not well supported. The existing facilities are mostly old and dilapidated and need further construction.

5.1.6 Current Status of Reuse within the Xi'an Old Steel Factory Creative Park

This subsection consolidates information about the building proper of the old steel factory. The buildings recorded are the Xi'an Old Steel Factory Creative Park (Buildings 1#-12#). The information includes the construction date of the buildings, information on the basic dimensional data, the condition of the existence, and the reuse of the buildings. The field survey information sheet of old steel factory can be found in Appendix C. From the survey, it can be concluded that most of the buildings in the factory area were constructed between 1964 and 1980 during the period of China's Third Line Development.

Buildings #1 to #8 and #12 in the current Creative Industries Park were built in 1965 and the main structure is well preserved. Building #9 has collapsed due to age and disrepair. Buildings #10 and #11 were also constructed in 1958. The architecture and structure are modernist in style with an emphasis on function, technology and economy.

The main body of the factory building was well preserved before the renovation and had the value of reuse as a spatial entity. However, the long-term industrial production use and abandonment after bankruptcy have caused problems such as ground damage, stained and dilapidated walls, rusted and peeling doors and windows and old waterproof thermal materials.

5.1.6.1 Reuse of Space in the Old Steel Factory

The old steelworks were heavy plants used for processing steel and were mostly double-height spaces. Due to the demands of the newly placed functions, the space utilisation of the double-height was relatively limited and the thermal insulation properties are poor. The vertical space was therefore divided during the renewal process by the addition of a steel mezzanine. The vertical division of space makes maximum use of the building space. The space is divided by partition walls as required. In the process of reuse, new functions are inserted for the different features of the different factory buildings. The specific reuse of the old steel factory is as follows.

Table 31. Analysis of Spatial Reuse of Old Steel Factory Buildings (Information updated on 18/06/2022)

Name	Function	Contents of the space transformation	Photos (Source: Author)
1#	Urban Memories Museum	Partial addition of partitioned space for exhibition and office.	
2#	Indoor basketball court	The interior space is partially divided into two levels as office space.	
3#	Speciality Businesses	Temporarily closed due to COVID-19	
4#	Architecture Studio	Addition of 1 storey at the top	

5#	Creative Theme Studio	The entrance is added as an extension of the interior. Divided into several rooms using partition walls.	
		Partial vertical subdivision into four floors with open entrance foyers and corridors.	
6#	Design of themed studios	Removal of the perimeter wall to create an open space.	
7#	The steel mill mark	Dividing the building into three floors and dividing the space according to functional needs.	

8#	Office space	Partial addition of 1 storey on the top floor to increase building utilisation	
9#	Creative Building (gym on the ground floor)	Dividing building space to accommodate incoming businesses requirements	
10#	Art Communication Centre	Ground floor lounge and communication area, 2nd floor internal office area	
11#	Left and Right Guest Theme Hotel	The space on either side is divided into 2 floors of guest room space.	
12#	Old Steel Factory Arts Centre	Partial addition of a floor to form office and storage space	

5.1.6.2 Façade Improvements

The façade is the most intuitive part of any building, influencing the overall visual effect of the building and providing good communication and connection with the outside environment. In the process of regenerating industrial buildings, the facade often does not match the style as the function and structure are renewed, which is why the reshaping of the facade is so important. By reshaping the facade of the building, the artistic level of the whole building could be obviously improved, and it could also be adapted to the new function of building regeneration and use. In the process of transforming the industrial heritage into a cultural and creative industrial park, the phenomenon of all being the same should be avoided in the process of surface update. Each industrial park should have a park image that fits its own character.

The Shaanxi Steel factory buildings are modernist in style, but as the buildings were not built at the same time, they all show different architectural detailing. Overall, the roof has a gable and a flat roof, and the façade is a full blend of red brick and white paint, with traces of history found everywhere on the façade.

The old buildings in the old steel factory originally had a large number of brick façades. In the process of redeveloping the buildings, most of them have preserved the original brick façade. It is only restored and partially highlights the original façade. This approach not only saves many renovation costs, but also preserves the industrial architectural style of the factory. The distinctive character of the old industrial buildings is reflected through the effective use of industrial elements, including walls, truss beams, columns and industrial equipment used for production and processing. The façade improvements of the Shaanxi Steel factory are as follows:

Table 32. Approach to Façade Improvement at the Shaanxi Old Steel Factory

Name of building	**Type of facade improvement**	**Photos (Source: Author)**
1#	The façade completely retains the form, window openings and materials of the old building, increasing the size and enhancing the form of the entrance.	
2#	The building maintains its original structure and retains the separation distance of the door sign. The window areas have been partially enlarged to improve interior light and natural ventilation.	
3#	The façade retains the original architectural form, with partial façade decoration to suit the functional requirements of the incoming businesses. On the east side, glass blocks have been added to contrast with the brick wall material.	
4#	The façade retains the original form of plain brick, with a red brick top floor addition. The form of the window openings has been added.	

5#	The façade retains the architectural form of the old building, with some artistic graffiti enhancing the expression.	
6#	Upgrading the entrance with new red bricks, making the original wall more prominent in terms of continuity of material and colour.	 
	The east side of the facade has been removed to create a two-storey elevated lounge space. A large glass curtain wall replaces the brick façade.	

7#	The façade retains the plain brick form of the old building, with the addition of a dark red marble plate at the entrance. This enhances the form of the building entrance while highlighting the culture of the old steel factory.	
8#	The original façade of the building has been retained and the exterior space has been added with dark grey steel panels.	
9#	A completely new and modern architectural language has been adopted for the renovation. Taking a creative window opening to give a fresh and novel façade effect	
10#	The south façade retains all the forms of the old building. Part of the entrance is decorated with concrete and steel plates	
	The north facade uses a new architectural form to artistically arrange the red bricks.	

11#	While retaining the form of the old façade, the entrance porch, door frames and window frames have been redecorated with deep red rusted thick steel plates, and the surrounding red brickwork walls to achieve a harmonious decorative effect overall.	
12#	The original façade of the building remains unchanged, with the side entrance removed and the brickwork recreated.	

5.1.6.3 Integration of Landscape and Industrial Elements

Unlike traditional landscape design, the landscape design of old industrial areas should not only provide green spaces for people to rest and move around, but also be combined with industrial history. A large number of parts produced by the steel mill are left in the factory. These parts are the main elements of the steel factory culture, a carrier of the history and culture, highly recognisable, and in combination with the landscape elements, it is easier to highlight the atmosphere of industrial culture.

Figure 14. Industrial Character Landscape Decoration. Source: Author.

The connected roof plaza and the sunken plaza together form the landscape core of the plaza space. The two plazas complement each other in terms of function. The sunken courtyard space is centripetal and serves as a gathering place for people and can be used for group activities in good weather. The spaces are divided into several different sizes to meet the different requirements of people. The roof plaza has some seating areas with deciduous broad-leaved plants to ensure shade in summer and adequate sunlight in winter. The removal of the external envelope of the factory building enhances the connection between the interior space and the neighbourhood space. This treatment increases the spatial level of the neighbourhood and enhances the experience of viewing the area.

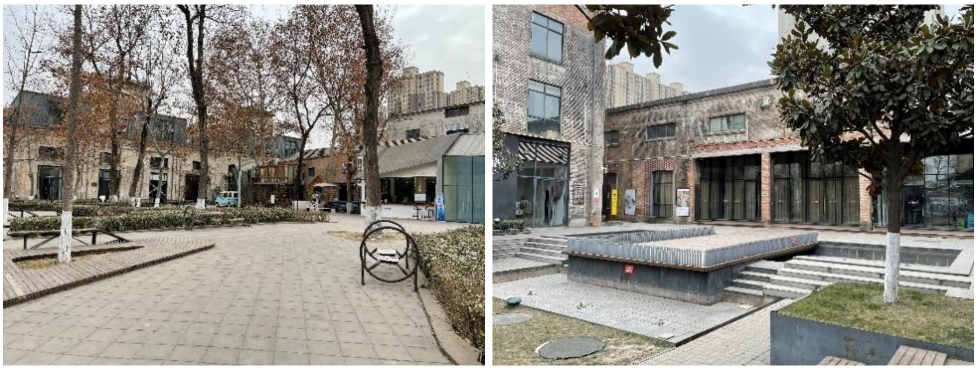


Figure 15. Roof Plaza and the Sunken Plaza. Source: Author.

5.1.7 Current Status Summary

The old industrial buildings of the Old Steel Factory Creative Industries Park are divided into 12 buildings based on the former production workshops. The surrounding buildings are high in height, while the centre is a lower level building. There are roof plazas and sunken plazas, and each building is relatively independent and forms a relatively closed courtyard. All the old buildings in the creative park are basically in a state of reuse.

5.1.7.1 Positive Aspects

Some of the catering shops serve multiple functions: some catering businesses operate as normal during the school day when students are in class and staff are at work, and turn into bistros in the evening after the end of the workday. This approach is an adaptive use of old building spaces, bringing them to complete their functions while adding new ones.

The enterprises and merchants in the park provide part-time and internship positions for students. Some companies can offer training to university students to develop their entrepreneurial skills. This greatly facilitates the exchange and cooperation between the park and the campus.

5.1.7.2 Negative Aspects

The roof plaza and the sunken plaza, which are public spaces throughout the campus, are underused. They are mainly used by businesses and commercial tenants, students on campus, and only a small number of residents and visitors from the neighbourhood. For businesses and traders, these spaces are only used for commuting, or events when the space is needed; for students on campus, they are mostly used in the afternoon and the evening; and for tourists, they only stop for a short time to visit and take photos.

5.1.7.3 Other Aspects

The change in the flow of people on the steel factory site is related to the availability of activities, weekends and campus holiday times. As a cultural and art exhibition space, the 12# Building Art Centre holds various art exhibitions, lectures, forums and other large-scale cultural exchange activities on a regular schedule, while some enterprises and commercial tenants also undertake small-scale cultural activities such as lectures and performances in their own spaces. During events, there is a sharp increase in the flow of people in the park, centred on Building 12, which radiates to the surrounding shops, when the use of the building and environment is at its highest. After the event, it returns to its usual level, which increases again on holidays. Whenever schools are closed for the summer and winter holidays, most shops close for the day, when the flow of people is at its lowest level.

5.1.8 Functional Composition of the Shaanxi Old Steel Factory

More than 100 enterprises are now located in the old steel factory creative park, including landscape, architecture and advertising design enterprises, publishing and planning-related cultural and creative enterprises, as well as commercial enterprises such as photography, experience shops, theme hotels and restaurants, and enterprises in the old steel factory art centre as an exhibition function. It offers the possibility for the old steel factory to radiate vitality again (Table 33).

Table 33. The Functional Composition of the Transformed Old Steel Factory Creative Park

Building name	Function before transformation	Date of construction	Function after transformation	Completion date of the transformation
1# building	Workshop for the production of slender steel wire	1965	Xi'an City Memory Museum	02/2015
2# building	Former small size wire drawing and oil tempering furnace workshop	1965	Customized office	03/2015
3# building	Original exquisite wire grinder workshop	1965	Business	02/2015
4# building	Former wire drawing workshop	1965	Xi'an Senco Architectural Engineering Design & Consulting Co.	08/2013
5# building	Former wire drawing workshop	1965	Creative Theme Studio	05/2014
6# building	Former new equipment workshop	1965	Design Theme Studio	10/2013
7# building	Former packaging workshop	1965	Cultural Studio	01/2015
8# building	Former finished goods store	1965	Office Courtyard	01/2015
9# building	New building	2013	Gym, Office	2016
10# building	East section of the former heat treatment workshop	1958	Old steel factory architecture and art	04/2015

			communication centre	
11# building	West section of the former heat treatment workshop	1958	Left and Right Guest Theme Hotel	04/2015
12# building	Former pickling workshop	1965	The old steel factory art centre	11/2014

5.1.8.1 Buildings 7# and 8#

(1) Architectural history of buildings 7# and 8#

Buildings 7# and 8#, located in the southeast corner of the Old Steel Factory Creative Park (Figure 16), are adjacent to the eastern boundary of the park. It is the original Shaanxi Steel Factory steel wire packing workshop and finished goods warehouse, which was built in 1965. The building before the transformation consisted of three parts. The northern side is connected by two rows of reinforced concrete row-frame structured with Gable roof workshops. The former packaging workshop was located to the west on the north side, and the former finished goods warehouse to the east on the north side. The third part, located on the south side, is a three-storey brick and concrete office building.

According to the introduction board of the old steel factory creative park on the function of the original building, it can be seen that the packaging section mainly packages all the steel wires, with a large sedimentation pool, oil dipping pool and two automated packaging production lines. The packaging material is kraft paper, plastic woven bags plus thick transparent plastic film. The packaged products are put into storage or transported directly to the use units by means of a travelling car and rail. The packaged products are put into storage by crane and track or transported directly to the user site. The finished goods store is connected to the packaging workshop and has two cranes, which are connected to the wire drawing and heat treatment packaging and are mainly used for storing the packaged finished goods. The finished goods store is the quietest part of the workshop, where the crane operators and storekeepers work. The transformation of buildings 7# and 8# began in 2014 and was completed in January 2015 (Li, 2020).

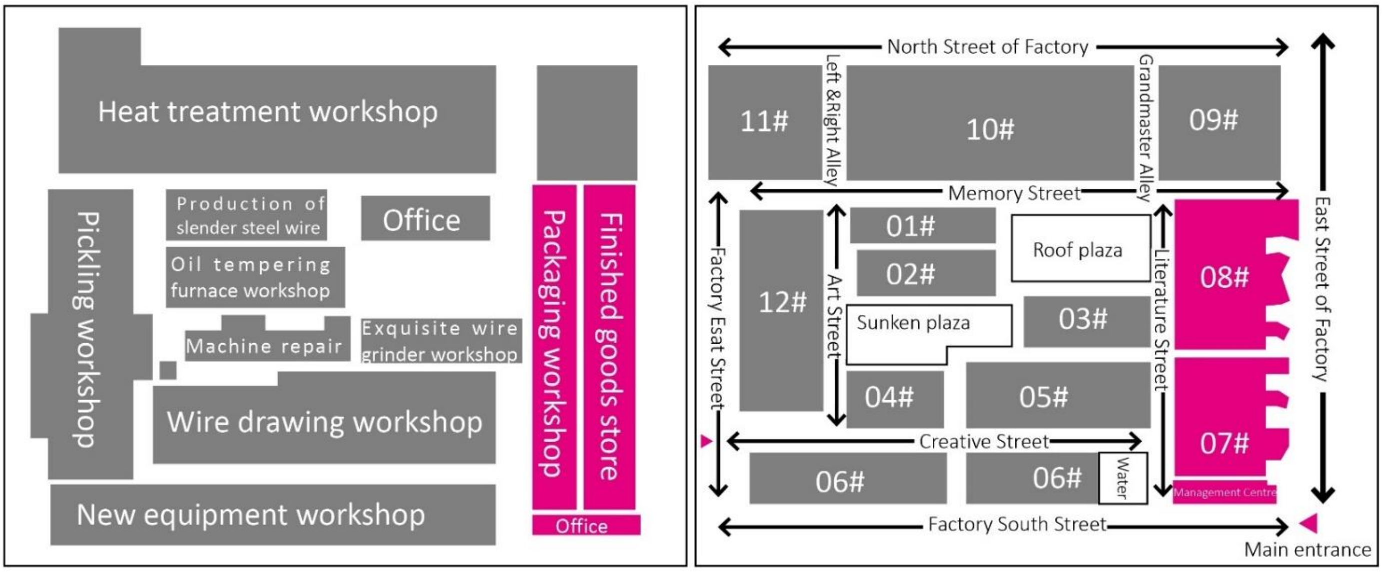


Figure 16. Building 7# and 8# Spatial Texture Changes (The left is before the transformation, the right is after). Source: Author.

(2) Description of the building space

The steel wire packing workshop is 94 metres long, with a span of 15 metres and a total height of 9.2 metres. The finished goods storage building has the same structural form and length as the west side of the building, but has a greater span of 18 metres and a higher height of 11.3 metres. The two buildings share a row of structural columns which are separated by brick walls and the spaces are not interconnected. The third part, located on the south side, is a three-storey brick and concrete service building, measuring 33, 6 and 10 metres in length, width and height respectively (Figure 17).

Figure 17. The Original Building Space of Building 7# and 8# (Source: Image adapted from a photograph taken by author in the 'Steelmark' Museum)

(3) Functional reorganisation of the building

Buildings 7#, 8# and the Park Service Centre, located at the southeast corner of the entire Old Steel Factory Creative Park, are adjacent to the road between the Xi'an University of Architecture and Technology and the third phase of Huaqing Xuefu residential district. The service building on the south side has been reorganised on the basis of the original Shaanxi steel factory steel wire finished goods warehouse offices: commercial on the ground floor, property management offices on the first floor and offices of the old steel factory creative industrial park on the second floor.

Buildings 7# and 8# are divided horizontally into two parts on the basis of the original steel wire finished goods warehouse, and the space volume is expanded in different directions along the street in the east.

The internal space is made up of a mezzanine floor with partial double-height, combined with a rooftop viewing platform to form a composite office space. The interior of the ground floor of building 7# has been transformed into a 'Steelmark' museum (Figure 18) in conjunction with the public space of double high. The ground floor exterior is converted into cultural studios along the perimeter road and the upper floor space. Building 8# is transformed into a courtyard office space (Table 34).

Figure 18. 'Steelmark' Museum Entrance. Source: Author.

Table 34. Functional Reorganisation of the Buildings 7# and 8#

Function before the transformation of building 7#	**Date of construction**	**Function after transformation of building 7#**	**Total floor area after transformation of building 7# and 8#**
Packing workshop	1965	Cultural studios, businesses, 'Steelmark' museum	8700 m^2
Settled merchants after the transformation			
Ground floor space function	7-101	Lewan Smart Music Centre	
	7-102	Wendu Education	
	7-103	Shaanxi Zhongta Engineering Technology Co.	
	7-104	Shaanxi Shengdeli Information Technology Co.	
	7-105	Yishile (movable type printing)	
	7-106	SWEET Restaurant	
	7-107	White Bear Restaurant	
	7-108	Yu Qing Restaurant	
	7-109	Xi'an Fangteng Cultural and Creative Planning Company	
	7-110	Xi'an Maiger Machinery Co.	
	7-111	Axia Fast Food	
First floor space function	7-201	Planning and Landscape Research Center of Mechanical Industry Survey and Design	
	7-202	Guizhou Moutai Wine Sales	
	7-203	Xi'an Tian Xiaoguo Food Co.	
	7-204	Zhongyang Culture	
	7-205	OA Studios	
Function before the transformation of building 8#	**Date of construction**	**Function after transformation of building 8#**	**Total floor area after transformation of building 7# and 8#**
Finished steel wire storage workshop	1965	Office courtyard, Business	8700 m^2
Settled merchants after the transformation			

Ground floor space function	8-101	Shaanxi Hailan Environmental Protection Technology Co.	
	8-102	Shenzhen City Xinren Technology Co.	
	8-103	Kui Shan Design	
	8-104	Xi'an Zhianbo Technology Co.	
	8-105	Boa Precision Engineering Xi'an	
	8-106	Xi'an Zhifan Architecture & Landscape Design Co.	
	8-107	Qunqing Photography Studio	
	8-108	No.8 Canteen	
	8-109	Shaanxi Jiangfei Technology Co.	
	8-110	Red Man Clothing	
First floor space function	8-205	Shaanxi Aike Coffee Culture Communication Co.	
	8-206	Xi'an Wufan Catering Co.	
Function before the transformation of Office building	**Date of construction**	**Function after transformation of Office building**	**Total floor area after transformation of building 7# and 8#**
Finished steel wire storage workshop office	1965	Park Service Centre	8700 m^2
Settled merchants after the transformation			
Ground floor space function	Z-101	Guanghe Baking	
	Z-102	Mr Wang's Tea	
	Z-103	Handmade Hot & Sour Noodles	
	Z-104	Potato Grill	
	Z-105	Shou Ye Ren Hair Studio	
	Z-106	Enjoyable Pie	
	Z-107	Ground Grains	
	Z-108	Floral Life	
First floor space function	Park Property Management		
Second floor space function	Shaanxi Steel Factory Creative Park Office		

(4) Reorganisation of the building space

The building is integrated with the park courtyard, the trees along the street and the secondary entrance space to the park (Figure 19), with extensions on the north-west roof of the building, on the east side of the street façade and the south side of the entrance space. The new addition contrasts with the main building in terms of form and material. In the transformation that creates difference, the emphasis is on conflict, and the identity of the old and the new elements is further enhanced and amplified by each other.

The new space is small in volume and the old building is large in volume, both merging into the historical scene in a completely opposite manner. The new addition is a reflection of the old building's status as the main body of the building, while the old and the new are intertwined to form an organic narrative whole, echoing the environment of the place.

The southeast corner of buildings 7# and 8# are the main entrances into the park. A new box space with weatherproof steel cladding is added to the ground floor of the service building to the south (Figure 20). The new material creates visual contrast with the retained old brick wall, which in turn accentuates the southeast corner entrance and also increases the commercial area on the ground floor. On the east side of the building, there is a row of tall, lush sycamore trees with a distance of approximately 8 metres between them and the east façade. Seven irregular boxes are built adjacent to the eastern facade of the building, each box turning in a direction that corresponds to the preserved sycamore trees on the site, forming an enframed scenery.

Figure 19. Southeast Side of Building 7. Source: Author.

Figure 20. Southwest Corner of Building 7. Source: Author.

Figure 21. Additional Space on Top of Building 8. Source: Author.

Figure 22. External Extension Space to Buildings 10# and 11#. Source: Author.

5.1.8.2 Architectural History of Buildings 10# and 11#

Buildings 10# and 11# were built in 1958 (He, Liu and Fan, 2021), originally as a whole a factory building, functioned as a heat treatment workshop, and later separated into two parts during the renovation (Figure 23). The heat treatment section is the first process of steel wire production, and the plant is distributed with continuous furnaces, bogie furnaces, pit-type furnaces and hood-type furnaces.

Buildings 10# and 11#, located in the northwest corner of the Old Steel Factory Creative Park, are adjacent to the dormitory area to the north. The open space between the two is set up for badminton and table tennis recreational activities, and is adjacent to Building 9# of the industrial park to the east.

In April 2015, the transformation of the overall building into two sections, east and west, was completed (Li, 2020). The western section of the building was transformed into the 11# Xi’an Old Steel Factory Left and Right Guest Theme Hotel, and the floor area of which is approximately 1600 m^2. The character and memory of the industrial factory are retained in the building transformation.

The eastern section of the building is transformed into the Building 10# Architecture and Art Exchange Centre, with additional space at the northern end of the building, directly exposing the frame structure skeleton and filling the interior with red brick walls.

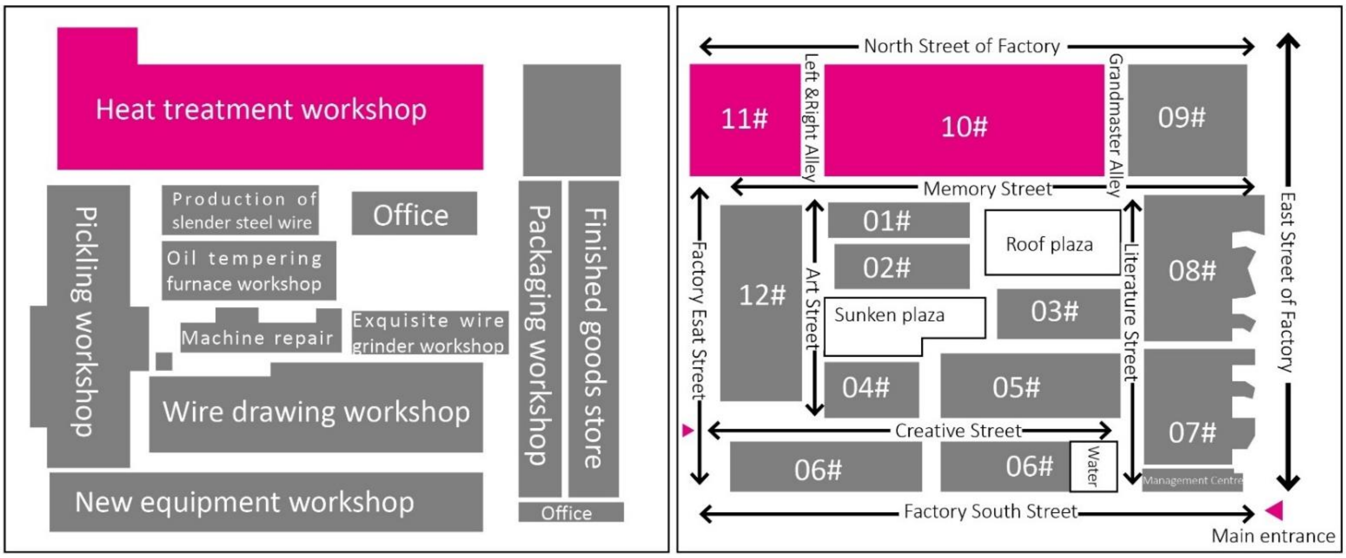


Figure 23. Building 11# Spatial Texture Changes. Source: Author.

(1) Description of the building space

The main body of buildings 10 and 11 consists of two parts, high and low. The upper part has flat rectangular windows with a horizontal length greater than the vertical length, while the lower rectangle is a rectangular window with a vertical length greater than the horizontal length, and the horizontal length of the upper and lower windows are equal (Figure 24).

The overall external space volume is characterised by a modern factory style and is made of ganged brick walls.

Figure 24. The Original Building Space of Building 11# (Image adapted from a photograph taken by author in the ‘SteelMark’ Museum)

Figure 25. South Facade of Buildings 10 and 11 after transformation. Source: Author.

Table 35. Functional Reorganisation of the Building

Function before the transformation of building 10#	**Date of construction**	**Function after transformation of building 10#**	**Completion date of the transformation of building 10#**
East Section of Heat Treatment Workshop	1958	Architecture and Art Communication Centre	04/2015
Settled merchants after the transformation			
10-S101	Block 10 comprehensive sports hall		
10-S107	Xi'an Huabei Decoration Design & Engineering Co.		
10-S109	Xi'an Mingcheng Institute of History and Culture Co.		
10-S110	Xi'an Mingyi Traditional Culture Communication Co.		
10-S111	Liu Kecheng Artists United Studio		
10-01	Shenzhen Leio Planning and Design Consulting Co.		
10-03	Xi'an Wu Yang Information Technology Co.		
10-04	Dianshang art space		
10-06	Xi'an Maiwo Culture Communication Co.		
10-11	Ziyi Dream Art Centre		
10-12	CCDI design		
10-13	Guangxi Province Mechanical and Electrical Equipment Bidding Center Co.		
10-14	Huihaijia Culture Communication Co.		
10-16	Chengdu Xiadao Enterprise Management Co.		
10-17	S-flower		
Function before the transformation of building 11#	**Date of construction**	**Function after transformation of building 11#**	**Completion date of the transformation of building 11#**
West section of the heat treatment workshop	1958	Left and Right Guest Theme Hotel	04/2015

5.1.8.3 Architectural History of Buildings 12#

Building 12# was built in 1965 (Li, 2020) and the original building functioned as a pickling workshop. Pickling is the process of cleaning the surface of steel wires after heat treatment or drawing to remove impurities and small traces on the surface. Some wires are coated with phosphorus and sulphurised, others are dipped in alkali and annealed at medium temperature (He, 2021) (Figure 26).

The main processes are a hot wash with phosphoric acid and sulphuric acid, caustic alkali washing followed by water washing and high-pressure water spraying (He, 2021). The plant is heavily acidic and all equipment is regularly serviced and replaced. In November 2014 the whole building was divided in two internally and transformed into the old steel factory art centre and 12# creative office space (Li, 2020).

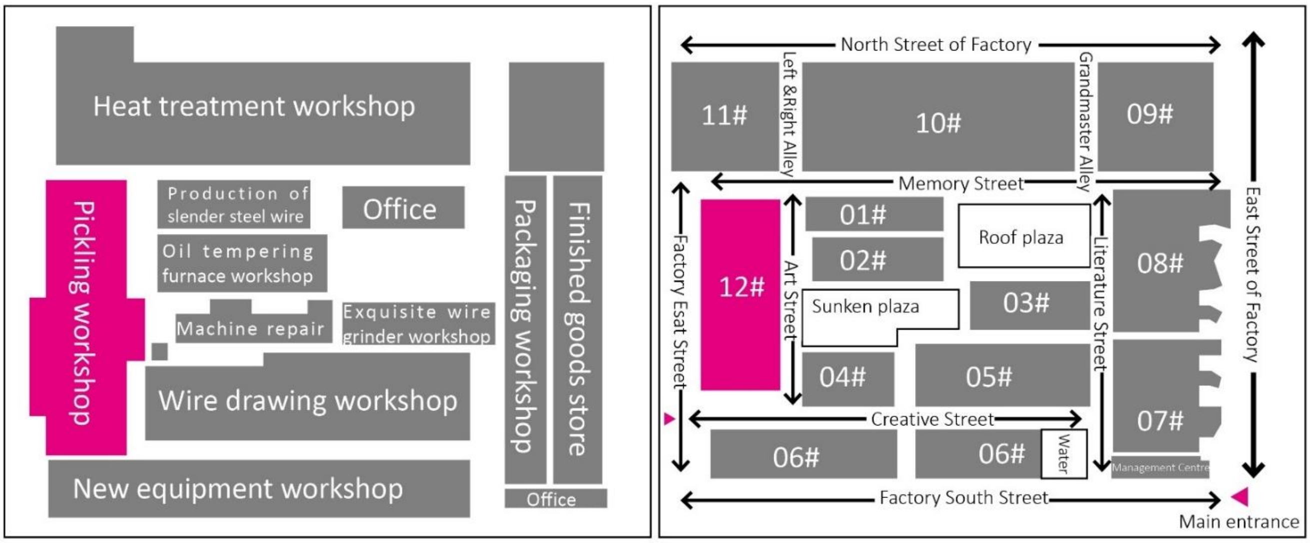


Figure 26. Building 12# Spatial Texture Changes. Source: Author.

(1) Description of the building space

The external space volume of Building 12# is characterised by a modern factory style, closed and heavy, with brick walls, and rectangular square windows neatly arranged on the upper and lower levels.

The upper level consists of a row of horizontal high side windows, while the lower level corresponds to a large area of glass windows to meet the light and ventilation requirements of normal industrial production (Figure 27 and Figure 29).

Figure 27. Entrance at the South-west Corner of Building 12. Source: Author.

Figure 28. West Facade of Building 12. Source: Author.

Figure 29. East Facade of Building 12. Source: Author.

(2) Functional reorganisation of the building space

Building 12# is located in the southwest corner of the whole old steel factory creative industrial park transformation project, the main entrance of the art centre on the southern interface of the building is diagonally opposite the Huaqing Square of Xi’an University of Architecture and Technology.

The southern space of the main building is transformed into the old steel factory art centre and the service office space that encloses the north and south sides of the art centre, while the northern space is transformed into the old steel factory 12# creative office space. The space to the south of Building 12 is used as the Old Steel Factory Art Centre (Figure 28). In addition to the large, wide open space and integrated space to meet the functional requirements, the most distinctive feature of the space is the bridge-like corridor set into the centre column of the original two-span interior structure.

The bridge space connects the north and south parts of the building, while at the same time incorporating the beam structure and the projecting window space into the experience, allowing people to easily perceive the building components (Figure 30). The interior of the North Creative Office Space accommodates and integrates different spaces such as art exhibition spaces, composite office spaces, and foyer spaces of different volumes.

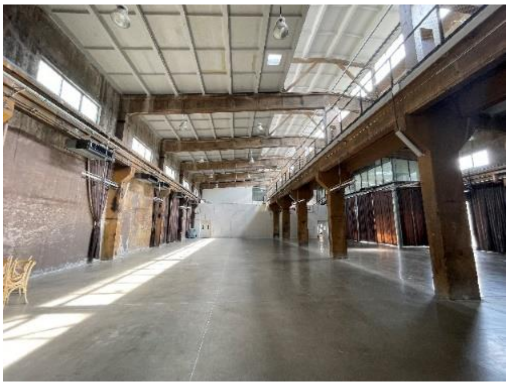


Figure 30. Internal Structure of Building 12. Source: Author.

5.1.9 Description of Evaluation Criteria Indicators

The following evaluation criteria are derived from the analysis of values in Section 4.1. A score for the value of each building within the industrial heritage can be obtained from the following criteria, with the overall value of the industrial heritage taking the average score of the buildings.

Table 36. Evaluation Criteria for Historical Value

Intrinsic value		**Evaluation criteria**	**Score**
1) Historical value	(1) The date of construction of the heritage	a) Before 1911	4
		b) 1911-1948	3
		c) 1949-1977	2
		d) 1978-now	1

	(2) Witness to the level of social development	a) The beginning and transformation of the industrial age of an entire country	4
		b) The industrial development of a particular province or region	3
		c) The innovative application of industrial technology in a particular field	2
		d) Its own existence and decline	1
	(3) Witness to important events	a) The event or historical person witnessed has a worldwide impact	4
		b) The event or historical person witnessed has a national impact	3
		c) The event or historical person witnessed has a provincial impact	2
		d) The event or historical person witnessed has a regional impact	1
	(4) The addition and completion of historical documents	a) Independent confirmation of the authenticity of a documentary record	4
		b) Non-independent confirmation of the authenticity of a documentary record	3
		c) Complementary to the documentary record	2
		d) Related in some way to the documentary record	1
	(5) Uniqueness	a) One type in the province or wider area	4
		b) Less than three similar types within the province	3
		c) More than three similar types within a provincial area	2
		d) There are many similar types	1
	(6) Completeness	a) 81-100% complete	4
		b) 51-80% complete	3
		c) 21-50% complete	2
		d) 0-20% complete	1

Table 37. Evaluation Criteria for Scientific and Technological Value

Intrinsic value		**Evaluation criteria**	**Score**
2) Scientific and technological value	(1) Industrial buildings and equipment	a) Can express production technology from a variety of perspectives	4
		b) Can express the main production technologies of the time	3
		c) Can express basic functions	2
		d) Incomplete and represent only a few basic functions	1
	(2) Production processes	a) Can be fully reflected in the industrial equipment	4
		b) Relatively complete, with a few missing elements	3
		c) Incomplete, but the core technical aspects can be reflected	2
		d) Only a small part of the processes of the period can be reflected	1
	(3) Technological representativeness	a) Shows the most advanced industrial technology at the provincial or national level at the time and which has since been widely used	4
		b) Shows a technology that was commonly used at the provincial level	3
		c) Shows a technology that has been infrequently used but has been preserved	2
		d) Very little or no industrial technology has been preserved	1

Table 38. Evaluation Criteria for Cultural Value

Intrinsic value		**Evaluation criteria**	**Score**
3) Cultural value	(1) Positive energy value	a) It reflects the great energy of the country and the nation	4 points if 4 criteria are met
		b) It reflects the collective spirit of the regional culture	
		c) It reflects the pioneering role of the representatives in the industry	
		d) It reflects the spirit of struggle based solely on the function of industrial production	

	(2) Negative energy value	a) Negative energy involving national humiliation and insult to national dignity	4 points if 4 criteria are met
		b) Negative energy involving regional transformation by oppression	
		c) The fact of being oppressed by technological backwardness	
		d) The fact of an inequality involving former technical cooperation	
	(3) Neutral energy value	a) Its value has a widespread impact on the industry	4
		b) Its value has a profound impact on a professional system	3
		c) Its value has a significant impact on a group of people	2
		d) Its value affects some of the people involved	1

Table 39. Evaluation Criteria for Artistic Value

Intrinsic values		**Evaluation criteria**	**Score**
4) Artistic value	(1) Aesthetic landscape value	a) Industrial heritage as a whole has outstanding aesthetic value	4
		b) Some elements of industrial heritage have outstanding aesthetic value	3
		c) A few parts of industrial heritage have aesthetic value	2
		d) Low aesthetic value	1
	(2) The value of the artwork	a) More than ten artworks	4
		b) More than five and less than ten artworks	3
		c) More than one and less than five dependent artworks	2
		d) One artwork	1
	(3) The level of artistic style expression	a) The artistic style is obvious and well expressed in detail	4
		b) The artistic style is clear and slightly simplified, highlighting the main elements	3
		c) It partially reflects a certain artistic style, highlighting some of the key points	2
		d) It is an elemental embodiment of a certain artistic style	1

Table 40. Evaluation Criteria for Location Value

Derived values		Evaluation criteria	Score
1) Location value	(1) Distance from the city centre	a) It is within the central city	4
		b) The distance to the central city is within 10 km	3
		c) The distance to the central city is between 10 km and 50 km	2
		d) The distance to the central city is above 50 km	1
	(2) Transport situation to the city centre	a) Easy transport links, accessible by three or more modes of transport, with rail links	4
		b) Relatively easy transport links in the vicinity, accessible by two modes of transport	3
		c) Smooth and easily accessible roads in the vicinity	2
		d) Accessible but not convenient, with road links in the vicinity in need of renovation	1
	(3) The number of central cities or tourist areas in the wider regional context	a) Four or more central cities or tourist attractions within a 100 km radius of the industrial heritage	4
		b) Three central cities or tourist attractions within a 100 km radius of the industrial heritage	3
		c) Two central cities or tourist attractions within a 100 km radius of the industrial heritage	2
		d) One central city or tourist attraction within a 200 km radius of the industrial heritage	1

Table 41. Evaluation Criteria for Environmental Value

Derived values		Evaluation criteria	Score
2) Environmental value	(1) The impact of the original production function of industrial heritage on the environment	a) Not polluted during the industrial period	4
		b) Slightly polluted during the industrial period, but the pollution was no longer present during the value assessment period	3

		c) Heavily polluted during the industrial period, but the pollution was largely non-existent during the value assessment period	2
		d) Still suffered pollution during the value evaluation period and required investment in remediation	1
	(2) The environmental scope of the industrial heritage	a) Few site constraints and the potential for improvement is high	4
		b) One or several areas are not appropriate for improvement or have some restrictions	3
		c) The surrounding area is an old multi-storey residential area or shantytown (generally over twenty years)	2
		d) The surrounding site is a new high-rise multi-storey area or a large public building area, resulting in congestion around the industrial heritage site	1

Table 42. Evaluation Criteria for Group Value

Derived values		**Evaluation criteria**	**Score**
3) Group value	(1) The scale of the group	a) A scale level of five or more	4
		b) A scale level of four	3
		c) A scale level of three	2
		d) A scale level of two	1
	(2) Relationship of the group	a) They have formed industrial production chains	4
		b) They were once part of the same enterprise or factory under a large enterprise or institution	3
		c) Belong to a large industrial category	2
		d) Low relationship	1
	(3) The potential for wide-scale groups of industrial heritage	a) Three or more industrial heritage sites; easy access to each other; strong possibility	4
		b) Three or more industrial heritage sites with access to each other	3

		requiring capital investment; a high possibility	
		c) There are two industrial heritage sites with industrial links to each other, a certain possibility	2
		d) Industrial heritage sites with weak industrial links and transport links to each other, a low possibility	1

Table 43. Evaluation Criteria for Social Value

Derived values		**Evaluation criteria**	**Score**
4) Social value	(1) The ability to solve re-employment	a) Over a hundred people to be employed	4
		b) Fifty to a hundred people to be employed	3
		c) Twenty to fifty people to be employed	2
		d) Less than twenty people to be employed	1
	(2) Educational function	a) Rich in scientific knowledge and display methods, with more than five experiential projects available	4
		b) Rich in scientific knowledge and display methods, with three to four experiential projects available	3
		c) Rich in scientific and popular knowledge and presentation, with one or two experiential programmes	2
		d) Limited in scientific and popular knowledge and presentation, with no experiential programmes	1
	(3) The potential to provide a place of leisure for the public	a) The public space available has the conditions of a heritage park	4
		b) The public space available is similar to a street park regulation	3
		c) The public space available can meet the basic requirements of viewing and visitor rest around the industrial heritage landscape	2
		d) The places available are limited, but better than before the reuse	1
	(4) Enhancing the image or symbolism of the city	a) The industrial heritage landscape after reuse has a prominent image and far-reaching meaning, and is the first business card of the city	4

		b) The industrial heritage landscape after reuse has a prominent symbolic meaning and is one of the image cards of the city	3
		c) The industrial heritage landscape after reuse has a beautiful image and can effectively improve the cultural appearance of the city and the streetscape	2
		d) The industrial heritage landscape after reuse has a significantly improved image compared to before	1

Table 44. Evaluation Criteria for Emotional Value

Derived values		**Evaluation criteria**	**Score**
5) Emotional value	(1) Number of people who have an emotional connection to industrial heritage	a) The number is over 10,000	4
		b) The number of people is between two thousand and ten thousand	3
		c) The number of people is between two hundred and one thousand	2
		d) The number of people is under two hundred	1
	(2) The age range of the people who have an emotional connection to industrial heritage	a) The age range includes the five categories above	4
		b) The age range includes the three to four categories above	3
		c) The age range includes the two categories above	2
		d) The age range includes the one category above	1
	(3) Structural characteristics of the careers of people with emotional value	a) People from nearly all careers	4
		b) People from the majority of careers around the industrial heritage	3
		c) People’s jobs related to the industrial heritage	2
		d) Few people	1

5.1.10 Analysis of the Evaluation of the Industrial Heritage Value of the Shaanxi Steel Factory Original Site

5.1.10.1 Historical Value

According to the analysis of the value of industrial heritage in Section 4.1, six main aspects of the historical value of the industrial heritage of the Shaanxi steel factory are evaluated: (1) the date of construction of the heritage; (2) witness to the level of social development; (3) witness to important events; (4) the addition and completion of historical documents; (5) uniqueness and scarcity; (6) completeness.

The construction of Shaanxi Steel Factory started in 1958 (He, Liu and Fan, 2021). 1949-1962 was a period of the initial development of modern industry in China, and industrial development was relatively unstable. This is the period in which the Shaanxi steel factory was constructed. The Shaanxi steel factory belongs to the category of modern industry, and although there have been several ups and downs, the years of its development have been almost uninterrupted (Jin et al., 2016).

(1) Therefore, based on research and visits, it can be concluded that with regard to the historical value of the Shaanxi steel factory, in terms of the date of construction, the factory construction started in 1958 and the production began in 1965. The oldest preserved buildings on the site are the western section of the former heat treatment workshop and the former pickling workshop, built in 1958. These are now Buildings 11 and 12, which have been transformed into the Left and Right Guest Theme Hotel and the Old Steel Factory Art Centre.

The construction date of the other industrial buildings remaining on the site is 1965. The construction date corresponds to the Shaanxi industry at the early stage of development, and its construction date is scored as 2 according to the evaluation criteria.

(2) In terms of witness to the level of social development, Shaanxi Steel Factory has witnessed the development of the steel production sector in Northwest China and the history of industrial development in Shaanxi Province from 1958 to 2001, witnessing three stages of industrial development in China (stages of industrial development

according to Section 2.6.1). The score for being a witness to the level of social development is 3 according to the evaluation criteria.

(3) In terms of being a witness to important events, the buildings of the Shaanxi Steel Factory have witnessed a series of significant historical events in China during the period of great industrial development after the establishment of the People's Republic and up to the reform and opening up of the country, such as the transformation of the economic system, the conversion of enterprises, their relocation, closure and the lay-off of workers (Liu, 2018). The buildings, structures and production equipment built on the site in different historical periods reflect the level of social development of the time. According to the evaluation criteria, the score for being a witness to important events is 3.

(4) Regarding the industrial heritage's addition and improvement of historical documents, the structures and buildings in the current factory site prove the authenticity of historical documents. It is difficult to find an industrial landscape heritage of similar history, scale and achievement within Shaanxi Province. It provides complete information on the technology and processes of steel production during the industrial period. The score for its addition and improvement of historical documents is 2 according to the evaluation criteria.

(5) In terms of uniqueness and scarcity, the Shaanxi steel factory was built in the early days of China's industrial development and was once listed among the top ten steel factories in China. At the time, it was the first and largest steel factory in Northwest China with the most advanced equipment (He, Liu and Fan, 2021). At the Shaanxi provincial level, Shaanxi Steel Factory was the first modern medium-sized steel mill built in Shaanxi, representing the highest level of the steel industry in Shaanxi at the time. Its score for uniqueness and scarcity is 4 according to the evaluation criteria.

(6) As for the completeness, buildings 1 to 8 and 12, which were once the former site of the Shaanxi Steel Factory and are now in the Old Steel Factory Creative Industries Park, were built in 1965 and the main structure is well preserved. Building 9 has collapsed due to age and disrepair. Buildings 10 and 11 were also built in 1958 and the main body of the factory building is well preserved. Overall, the building foundations are in good condition. According to the evaluation criteria, its completeness score is 4.

Table 45. The Historical Value Score Table for the Shaanxi Steel Factory

The factors layer	The detail layer	Score	Weights	Final score
A1 Historical value	**A11** The date of construction of the heritage	2	0.0827	0.82
	A12 Witness to the level of social development	3	0.0464	
	A13 Witness to important events	3	0.0292	
	A14 The addition and completion of historical documents	2	0.0585	
	A15 Uniqueness and scarcity	4	0.0413	
	A16 Completeness	4	0.0368	
Total score	(Total possible score is 24)	18		

In summary, with a total score of 18 (total possible score is 24) for its historical value and a combined each weighting:

$2\times0.0827+3\times0.0464+3\times0.0292+2\times0.0585+4\times0.0413+4\times0.0368$, its final score is 0.8216 (total possible score is 1.1796). To make the statistics more convenient, two decimal places are taken and the final score is 0.82.

5.1.10.2 Scientific and Technological Values

The technological value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in terms of (1) industrial buildings and equipment; (2) production processes; (3) technological representativeness.

At the beginning of the Shaanxi steel factory, the equipment and technology were not perfect, the equipment was lacking and the production line was incomplete (Li and Xu, 1990). Later on, as the Shaanxi steel factory developed, the equipment began to be gradually acquired. During this period, new electric arc furnaces, electroslag furnaces, rolling mills and other production equipment were introduced, and the quantity and quality of the produced steel and steel wire continued to improve (Jin et al., 2016). One fifth of the products produced by the Shaanxi steel factory were also at one time used as raw materials in the research and development of the military industry (Fu, Wu and Yang, 2008). During the development period of the Shaanxi steel factory, new equipment was constantly acquired and the structure and technology were constantly optimised in order to increase the advancement of equipment, processes and operations.

(1) In the area of industrial buildings and equipment, a detailed classification of the industrial buildings remaining on the site of the Shaanxi steel factory allows for an analysis of the production processes of the company during the production period. However, only representative equipment from the Shaanxi steel factory site remains for exhibition. According to the evaluation criteria, the score for industrial buildings and equipment is 3.

(2) In terms of production processes, the main production techniques of the time can be analysed. This gives an insight into relatively advanced steel production processes that were in place in north-western China more than 50 years ago. The production processes are scored as 3 according to the evaluation criteria.

(3) On the aspect of technological representativeness, the Shaanxi steel factory has steadily developed its production since 1965, and the output, quality, variety and efficiency of its products have improved year by year. It has become a high-quality special steel production base in Shaanxi Province and one of the key special steel factories in China. Its technological representativeness was scored as 3 according to the evaluation criteria.

Table 46. The Scientific and Technological Value Score Table for the Shaanxi Steel Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A2 Scientific and technological value	**A21** Industrial buildings and equipment	3	0.0515	0.31
	A22 Production processes	3	0.0204	
	A23 Technological representativeness	3	0.0324	
Total score	(Total possible score is 12)	9		

In summary, with a score of 10 (total possible score is 12) for its technology and combined each weighting:

3×0.0515+3×0.0204+3×0.0324, its final score is 0.3129 (total possible score is 0.4172). To make the statistics more convenient, two decimal places are taken and the final score is 0.31.

5.1.10.3 Cultural Values

In evaluating the cultural value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 is based on three main aspects: (1) positive energy value; (2) negative energy value; (3) neutral energy value.

(1) In terms of positive energy value, the enterprise spirit and steel factory culture of Shaanxi Steel unite all employees within the steel factory. It reflects the ideology, values, moral code and determination of the employees within the steel factory. The identification of the corporate spirit is also the employees' recognition of the overall culture of the steel factory. In the 'Steelmark' Museum located in the Old Steel Factory Creative Park, there are now some work logs and manuscripts of employees from the Wu Er and Xi'an steel factory that reflect the corporate culture and spirit of the employees of the Shaanxi steel factory.

Although the Shaanxi steel factory has undergone several name changes, conversions and relocations, it has gradually grown stronger during decades of business development and become a well-known brand in northwest China. The corporate culture and entrepreneurial spirit have played a role in passing on the company's history, unifying the spirit of industrial struggle and promoting positive social energy. According to the evaluation criteria, its positive energy value score is 3.

(2) In terms of negative energy value, the Shaanxi steel factory is representative of the early development of modern Chinese industry when the road to industrial development was difficult. However, the Shaanxi steel factory in the new Chinese steel development had a glorious history. This in turn inspired a passion for work and for life. Based on the evaluation criteria, its negative energy value is scored as 1.

(3) With respect to neutral energy value, the industrial heritage landscape of the original Shaanxi steel factory site represents the industrial development history of northwest China and can enhance the sense of regional pride and regional identity of the

surrounding citizens. According to the evaluation criteria, it is given score of 1 for neutral energy value.

Table 47. The Cultural Value Score Table for the Shaanxi Steel Factory

The factors layer	The detail layer	Score	Weights	Final score
A3 Cultural value	**A31** Positive energy value	3	0.0865	0.40
	A32 Negative energy value	1	0.0343	
	A33 Neutral energy value	2	0.0545	
Total score	(Total possible score is 12)	6		

In summary, with a cultural value score of 6 (total possible score is 12) and combined each weighting:

3×0.0865+1×0.0343+2×0.0545, its final score is 0.4028 (total possible score is 0.7012). To make the statistics more convenient, two decimal places are taken and the final score is 0.40.

5.1.10.4 Artistic Value

Industrial buildings differ from other types of buildings, such as houses and schools, in terms of massing and form due to their production needs. The large volumes and spans of industrial buildings give them a unique artistic character, and the differences between eras also lead to differences in architectural styling.

The artistic value of industrial heritage, according to the previous analysis of the value of industrial heritage, is evaluated in terms of (1) aesthetic landscape value; (2) the value of artwork; (3) the level of artistic style expression.

(1) In terms of aesthetic landscape value, the original factory area is well landscaped and there is also good greenery in the residential areas or enterprises within the various sites within the area. Reuse is now reflected in numerous details of the industrial park, such as the reuse of industrial waste as information boards or decorative items. This reflects the concept of green, environmentally friendly and recycling development in the park’s recycling process. The differences in architectural style and building colour create

a unique aesthetic value, which reflects the aesthetic concepts of the people at the time. Secondly, the arrangement and spatial combination of buildings, structures and production equipment in industrial plants form an industrial landscape that is distinct from other urban landscapes, becoming a unique landscape element in the city. The score for aesthetic landscape value is 3 according to the evaluation criteria.

(2) In terms of the value of the artwork, most of the industrial elements that remain from the Shaanxi steel factory are reused and turned into large landscape sculptures in the park, integrating the industrial style with the cultural and creative atmosphere. A number of resting seats have also been placed in the square inside the industrial park. The seats are also made from industrial equipment left over from the Shaanxi steel factory, forming a complementary facility with industrial characteristics. The details of these facilities not only meet the functional needs of the people, but also contribute to the industrial cultural atmosphere of the whole industrial park. The value of the artwork score is 3 according to the evaluation criteria.

(3) In terms of the level of artistic style expression, the Shaanxi Steel Factory was built in 1958 by the Chinese government, which deployed experts from various industries from Shanghai, Wuhan and the north-east. The architectural style is simple and atmospheric, the scale of the plant is large and the structure of the plant is varied. It represents the highest level of architecture in China and planning at the time and reflects the changing aesthetic interests and level of artistic appreciation. The former site of the Shaanxi steel factory is favourable empirical evidence for the study of the artistic style of industrial architecture and has a high artistic style value. Some of the production equipment left on the site shows the process of change in industrial art since 1958 from the perspective of industrial plastic art. The level of artistic style expression is scored as 3 according to the evaluation criteria.

Table 48. The Artistic Value Score Table for the Shaanxi Steel Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A4 Artistic value	**A41** Aesthetic landscape value	3	0.0865	0.53
	A42 The value of the artwork	3	0.0343	

	A43 The level of artistic style expression	3	0.0545	
Total score	(Total possible score is 12)	9		

In summary, the artistic value score is 9 (total possible score is 12) and combined each weighting: 3×0.0865+3×0.0343+3×0.0545, its final score is 0.5259 (total possible score is 0.7012). To make the statistics more convenient, two decimal places are taken and the final score is 0.53.

5.1.10.5 Location Values

In evaluating the locational value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 focuses on (1) distance from the city centre; (2) transport connectivity to the city centre; (3) the number of central cities or the number of central cities or tourist areas in the wider regional context.

(1) In terms of distance from the city centre, the project is located in the eastern part of Xi'an, only 9 km from the city centre according to Google Maps. The level of artistic style expression scored 3 according to the evaluation criteria.

(2) In terms of transport situation to the city centre, Shaanxi Steel has obvious transport advantages and good access to the city centre, with 5 major city-level arterial roads in the vicinity. There are 5 bus stops and 2 metro stations in the vicinity, making the transport system very well developed and the distance between bus stops is only a 10-minute walk. The site is connected to the city's main commercial services and industrial production areas to the north, south and west. The site is located on one of the city's major future development axes and offers good opportunities for development (Jin et al., 2016). According to the evaluation criteria, the transport connectivity to the city centre is evaluated with a score of 4.

(3) In terms of the number of central cities or tourist areas in the wider regional context, the old steel factory is located in Xi'an and there are several tourist attractions within a 100 km radius of the city, such as the Terracotta Warriors Museum of Xi'an, the Dahua 1935 Art Zone and the remains of the ancient city wall of Xi'an. The score of 4 is given for the number of central cities or tourist areas in the wider regional context according to the evaluation criteria.

Table 49. The Location Value Score Table for the Shaanxi Steel Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B1 Location value	**B11** Distance from the city centre	3	0.0406	0.29
	B12 Transport connectivity to the city centre	4	0.0161	
	B13 The number of central cities or tourist areas in the wider regional context	4	0.0256	
Total score	(Total possible score is 12)	11		

In summary, its location value score is 11 (total possible score is 12) and combined each weighting: 3×0.0406+4×0.0161+4×0.0256, its final score is 0.2886 (total possible score is 0.3292). To make the statistics more convenient, two decimal places are taken and the final score is 0.29.

5.1.10.6 Environmental value

In evaluating the environmental value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 focuses on: (1) The impact of the original production function of industrial heritage on the environment; (2) The environmental scope of the industrial heritage.

(1) With regard to the impact of the original production function of industrial heritage on the environment, special attention has been paid to the preservation of the original vegetation in the Shaanxi steel factory during its regeneration. It retains most of the trees and shrubs from the previous park to reduce damage to the original ecological balance of the park, and some trees that must be removed will be transplanted at alternative sites. The Shaanxi steel factory has been renovated and the site is relatively green and no significant pollution was found during the assessment period. According to the evaluation criteria, the impact of the original production function of industrial heritage on the environment score is 3.

(2) In terms of the environmental scope of the industrial heritage, the site is adjacent to the campus of Xi'an University of Architecture and Technology and the residential area of Huaqing Xuefu Cheng, and the park has to be reached through the campus, which

is relatively limited in terms of accessibility. The environmental scope of the industrial heritage was scored as 1 according to the evaluation criteria.

Table 50. The Environmental Value Score Table for the Shaanxi Steel Factory

The factors layer	The detail layer	Score	Weights	Final score
B2 Environmental value	**B21** The impact of the original production function of industrial heritage on the environment	3	0.0208	0.07
	B22 The environmental scope of the industrial heritage	1	0.0104	
Total score	(Total possible score is 8)	4		

In summary, the score for environmental value is 4 (total possible score is 8) combined each weighting: 3×0.0208+1×0.0104, its final score is 0.0728 (total possible score is 0.1248). To make the statistics more convenient, two decimal places are taken and the final score is 0.07.

5.1.10.7 Group Value

The group value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in terms of (1) the scale of the group; (2) the relationship of the group; (3) the potential for wide-scale groups of industrial heritage.

Shaanxi steel factory is located in the southeast of Xi’an City, between the East Second Ring Road and the East Third Ring Road, bordered by Xianning Road to the north and Xingfu Road to the west, forming a traditional industrial zone of Xi’an City together with the surrounding building material component factories and Oriental Machinery Factory (Li, 2020). In addition to the traditional industrial areas of the building material components factory, Qinchuan factory and Dongfang machinery factory located to the north and south of the Shaanxi steel factory, there are also technology-based industrial parks such as the High-Tech Development Zone and the New Town Technology Industrial Park to the southwest of the Shaanxi steel factory.

According to the evaluation criteria, it scored 4 for the scale of the group; it scored 2 for the relationships of the group because it belongs to a large industrial category and has high accessibility; it scored 4 for the potential for wide-scale groups of industrial heritage.

Table 51. The Group Value Score Table for the Shaanxi Steel Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B3 Group value	**B31** The scale of the group	4	0.0203	0.15
	B32 Relationship of the group	2	0.0081	
	B33 The potential for wide-scale groups of industrial heritage	4	0.0128	
Total score	(Total possible score is 12)	10		

In summary, its group value has a score of 10 (total possible score is 12) and combined each weighting: 4×0.0203+2×0.0081+4×0.0412, its final score is 0.1486 (total possible score is 0.1648). To make the statistics more convenient, two decimal places are taken and the final score is 0.15.

5.1.10.8. Social Value

The social value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in four main ways: (1) The ability to solve re-employment; (2) Educational function; (3) The potential to provide a place of leisure for the public; and (4) Enhancing the image or symbolism of the city.

(1) In terms of the ability to solve re-employment, the transformed Shaanxi steel factory is currently the Old Steel Factory Creative Industrial Park. It has a total of more than 140 shops, forming an industrial model that combines offices and businesses. The park has absorbed about 2,500 employed people, including nearly 500 design project personnel, cultural and creative personnel, and network technicians. It has formed the most characteristic cultural and creative industry base in the Xi’an area and has a high reputation in the industry. The ability to solve re-employment was scored as 3 according to the evaluation criteria.

(2) With regard to the educational function, the site has a ‘Steelmark’ Museum, which allows people to learn about the history of industrial development in Xi’an and have a basic knowledge of the production process of steel products. However, there is no significant experiential programme. Based on the evaluation criteria, their score for the educational function is 2.

(3) As for the potential to provide a place of leisure for the public, a space for badminton and table tennis has been created in the open space between the grounds of buildings 10# and 11#. According to the evaluation criteria, the score for the potential to provide a place of leisure for the public is 3.

(4) In terms of enhancing the image or symbolism of the city, the reuse of Shaanxi Steel has transformed the depressed and decaying image of the former site and enhanced the quality of the surrounding environment. The transformation has not altered the original appearance, but has preserved it, and a museum has been set up to provide a better understanding of the culture and history of the former site. After the transformation, the Shaanxi steel factory regularly organises special thematic events to integrate the cultural values of the industrial heritage into urban regeneration. On the one hand, it meets the cultural needs of the public, and on the other, it enriches the cultural heritage and spiritual connotations of the regeneration project, leaving the city with an original and landmark urban space. According to the evaluation criteria, its score for enhancing the image or symbolism of the city is 3.

Table 52. The Social Value Score Table for the Shaanxi Steel Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B4 Social value	**B41** The ability to solve re-employment	3	0.0164	0.11
	B42 Educational function	2	0.0097	
	B43 The potential to provide a place of leisure for the public	3	0.0069	
	B44 Enhancing the image or symbolism of the city	3	0.0082	
Total score	(Total possible score is 16)	11		

In summary, the social value score is 11 (total possible score is 16) and combined each weighting: $3\times0.0164+2\times0.0097+3\times0.0069+3\times0.0082$, its final score is 0.1139 (total possible score is 0.1648). To make the statistics more convenient, two decimal places are taken and the final score is 0.11.

5.1.10.9 Emotional Value

The emotional value of industrial heritage, based on the analysis of the value of industrial heritage in Section 4.1, is evaluated it in three main ways: (1) the number of people who have an emotional connection to industrial heritage; (2) the age range of the people who have an emotional connection to industrial heritage; (3) structural characteristics of the careers of people with emotional value

The people who have an emotional attachment to Shaanxi Steel can be divided into the following categories:

The first group is the old employees who have worked in the plant and have devoted decades of time and energy to it. These people are generally between 60 and 80 years old and have the deepest feelings for the plant. The second group are residents who have lived in the neighbourhood for many years, have experienced the changes in the factory and have an affinity for the sights and sounds within the area, and there is no specific age limit for this group.

The third group is the relatives of some of the factory employees and the current workers in the reused factory, whose feelings towards the factory site include curiosity and some affection for the factory, and who range in age from young to old. The fourth group, researchers or industrial heritage enthusiasts with an interest in industrial heritage, is found in each age group.

Therefore, combining the evaluation criteria, the scores for these three areas are 2, 4 and 3 respectively.

Table 53. The Emotional Value Score Table for Shaanxi Steel Factory

The factors layer	The detail layer	Score	Weights	Final score
B5 Emotional value	**B51** Number of people who have an emotional connection to industrial heritage	2	0.0268	0.15
	B52 The age range of the people who have an emotional connection to industrial heritage	4	0.0169	
	B53 Characteristics of the careers of people with emotional value	3	0.0106	
Total score	(Total possible score is 12)	9		

In summary, its emotional value has a score of 9 (total possible score is 12) and combined each weighting: 2×0.0268+4×0.169+3×0.0106, its final score is 0.153 (total possible score is 0.2172). To make the statistics more convenient, two decimal places are taken and the final score is 0.15.

5.1.11 GIS-based Visual Evaluation Process of the Industrial Heritage Value of the Shaanxi Old Steel Factory

Based on the analysis of the process of visualising industrial heritage values using GIS technology in Section 4.9.2, the industrial heritage value of Shaanxi's old steel factory is visualised by GIS in four steps:

(1) The first step is to get the ArcGIS graphics file. (2) This is followed by the collection of GIS data and the creation of a database. The attribute data obtained through field research of the Shaanxi Old Steel Factory, Xi'an, Shaanxi Province, China, such as the Date of construction of the heritage, Area of the building; Building type. will be entered into the GIS platform. (3) Visualisation of each single factor by correlating spatial and attribute data. (4) Based on the multi-factor weights calculated by the Analytic Hierarchy Process in Section 4.7, an overlay analysis was created and visualised in the ArcGIS platform. The specific operation process is shown below.

5.1.11.1 Access to ArcGIS Graphical Files

The existing building condition of the Shaanxi old steel factory was drawn by AutoCAD software through fieldwork and satellite maps. In order to apply ArcGIS technology, the dwg. file format of the AutoCAD file graphics needs to be converted to the shp. file format editable by the GIS system, the basic steps are as follows:

(1) Based on fieldwork and satellite maps downloaded from the Geospatial Data Cloud (a data cloud computing platform built by the Chinese Academy of Sciences Network Information Centre), the AutoCAD platform was used to extract the buildings' borders, road information and study area boundary lines of the Shaanxi Old Steel Factory. This study uses AutoCAD 2022 software version to layer the AutoCAD files and export them into four files: Building Layer, Boundary Line Layer, Road Layer and Plaza Layer. The current CAD of the Shaanxi Old Steel Factory is shown in Figure 31.

(2) The AutoCAD file was exported in layers as a dwg file, and then imported into the GIS platform by right-clicking on the Layer button - Add Data - selecting the four layers of the Old Steel Factory in dwg. format - Add (Figure 32). In addition, AutoCAD exported dwg. file is divided into five forms on the GIS platform: Annotation, Point, Polyline, Polygon, and MultiPatch, choosing Polygon for Buildings, Polyline for Road, Boundary Line and Plaza, and deleting others (Figure 33).

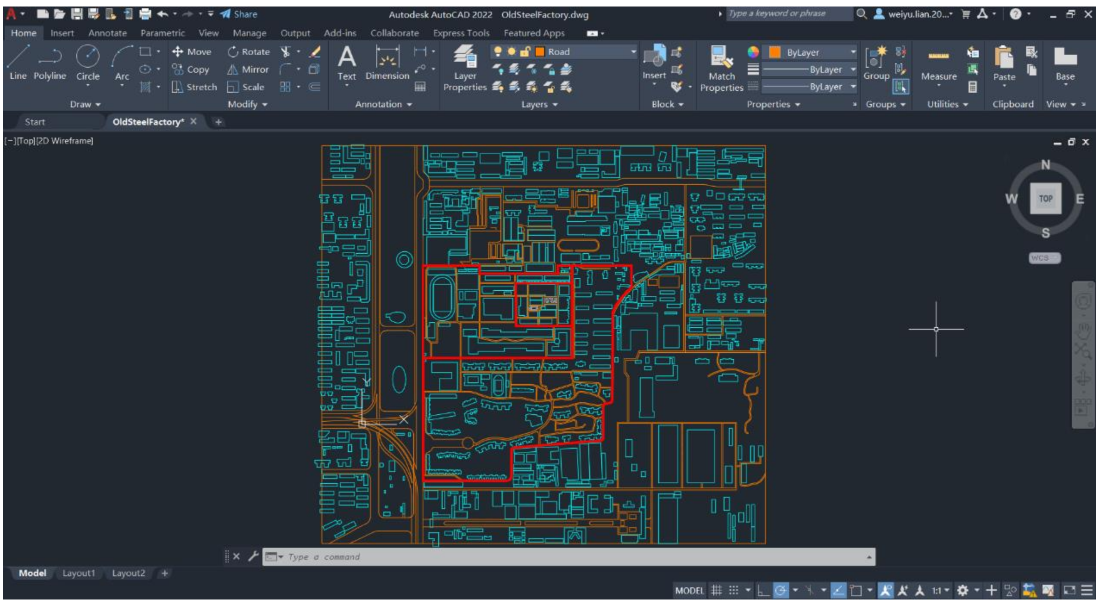


Figure 31. AutoCAD Drawing of the Current State of the Shaanxi Old Steel Factory

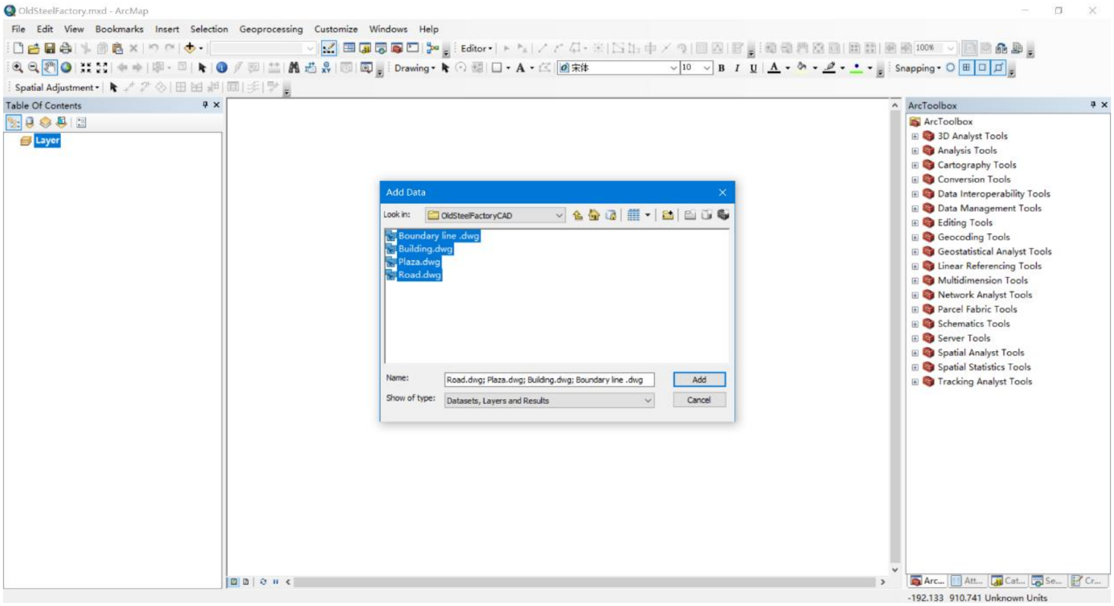


Figure 32. Adding Shaanxi Old Steel Factory CAD Drawings in ArcGIS

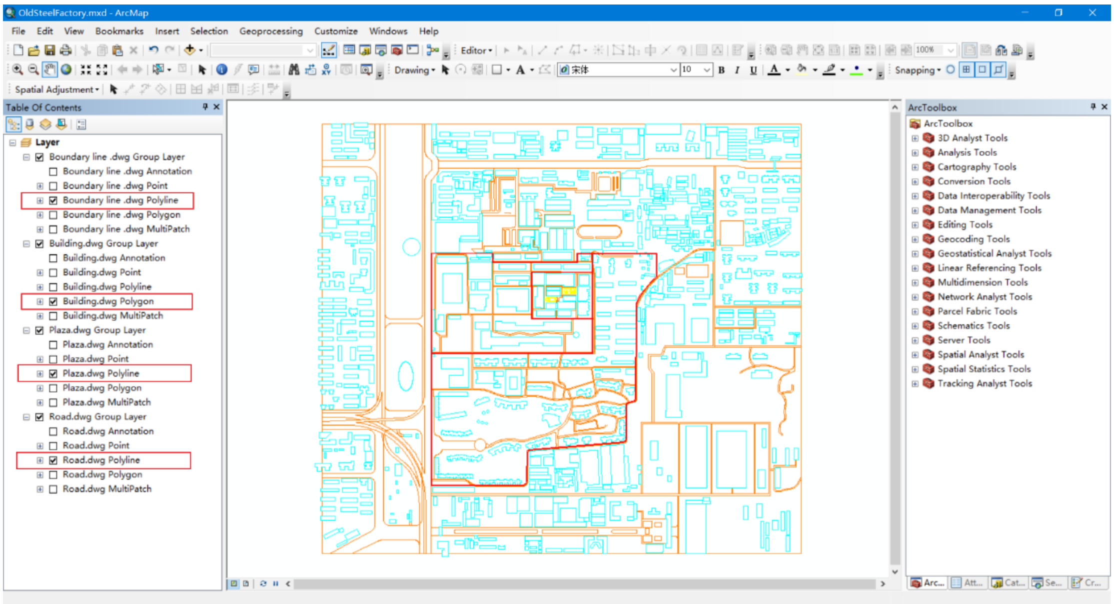


Figure 33. Selecting the Form of the CAD Drawing of the Shaanxi Old Steel Factory in ArcGIS

The next step in the ArcGIS platform is to use the Georeferencing tool to reference the spatial location of the satellite map obtained in the geospatial data cloud to match the AutoCAD drawing (matching the CAD drawing with the actual real geographic coordinates). The operation is to use the Georeferencing command, select the position on the ungeoreferenced Old Steel Factory CAD drawing separately and match it with the same position on the satellite map, click rectify after three points, the drawing of the Old Steel Factory CAD will move to the position of the satellite map, and then delete the reference satellite map. Further, using the Data Management Tools- Features- Feature To Polygon command of the ArcToolbox tool (Figure 34), the CAD file was converted into a shp. file to be used for the multi-factor overlay analysis. The shp. format file imported into the GIS is shown in Figure 35. The organised map is shown in Figure 36.

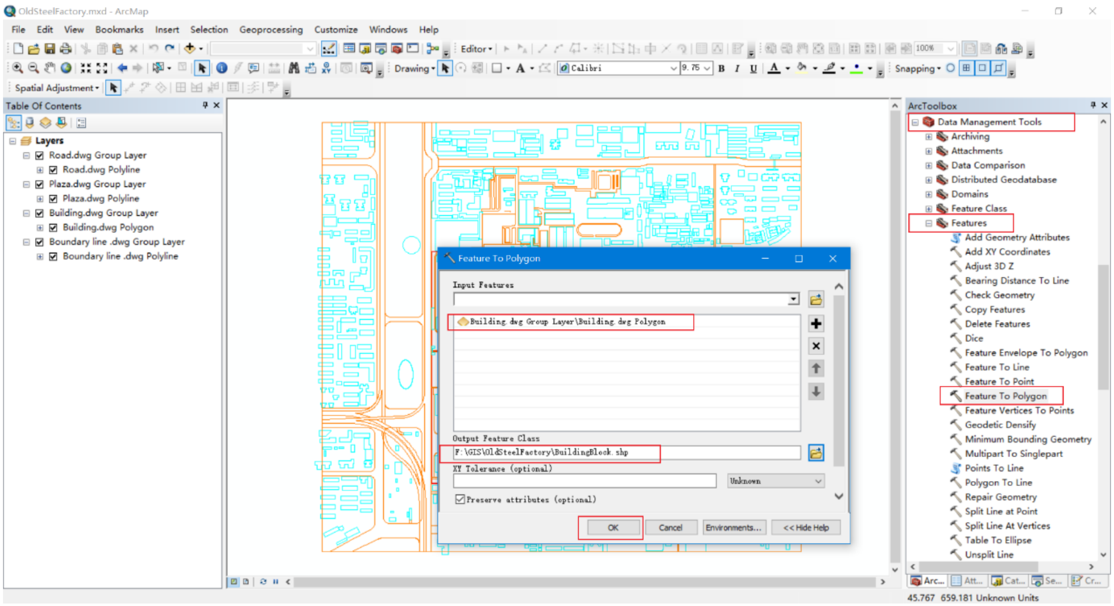


Figure 34. Conversion of dwg. Format Files to shp. Format for Old Steel Factory

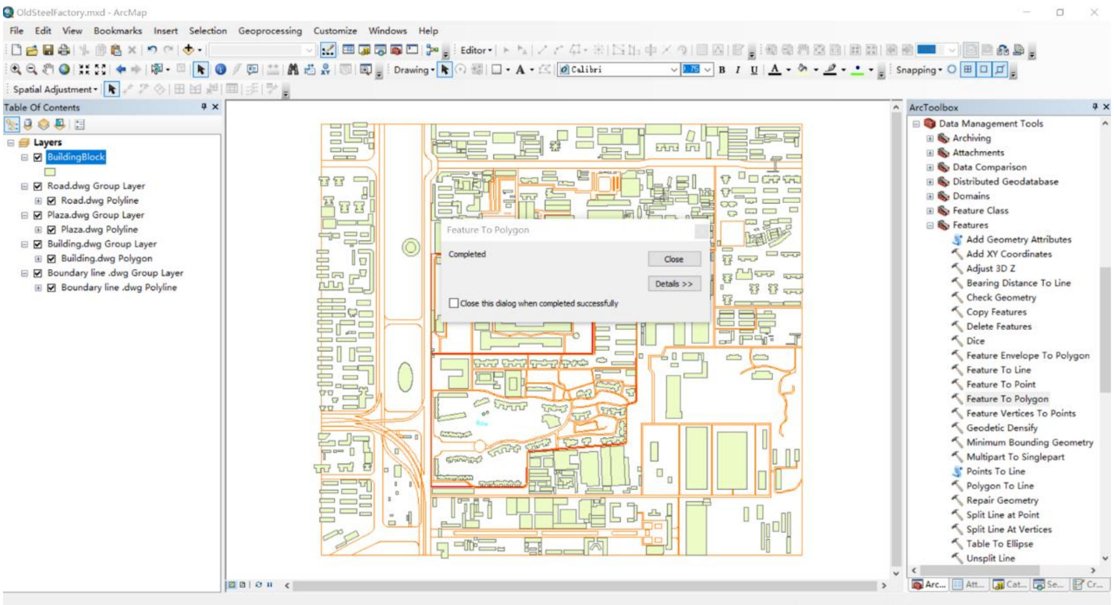


Figure 35. Old Steel Factory Building After Conversion to shp. Format File

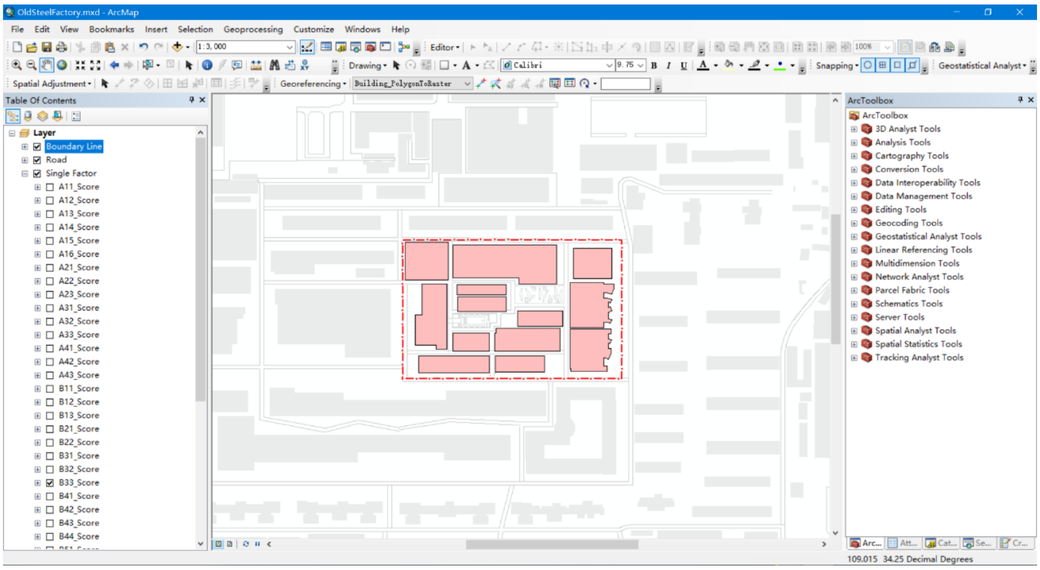


Figure 36. Organised ArcGIS Graphic File of the Old Steel Factory

5.1.11.2 Building Attribute Data of Old Steel Factory Entered into ArcGIS Platform

After the ArcGIS graphic of the old steel factory was accessed, the next step was to enter the attribute data in the ArcGIS platform. Right-click on the Building Layer in ArcGIS, open the Attribute Table, add a Field through the Attribute Table, name it ID (Figure 37), ID the buildings in Shaanxi Old Steel Factory that need to be entered into the attribute data in edit mode. This was followed by using the ArcToolBox tool: Conversion Tools-Excel-Table to Excel (Figure 38) to export to Excel (Figure 39).

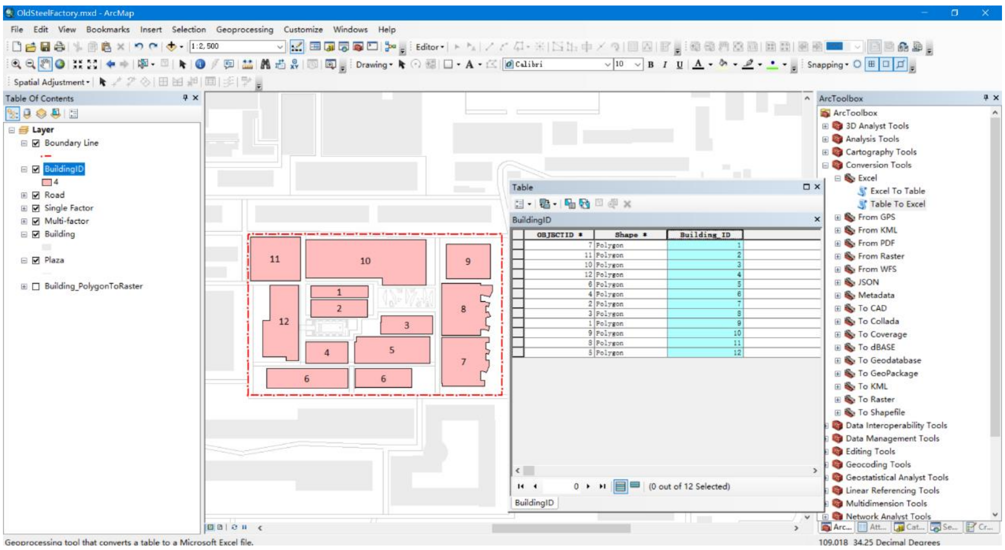


Figure 37. Building ID on the GIS Platform of the Old Steel Factory

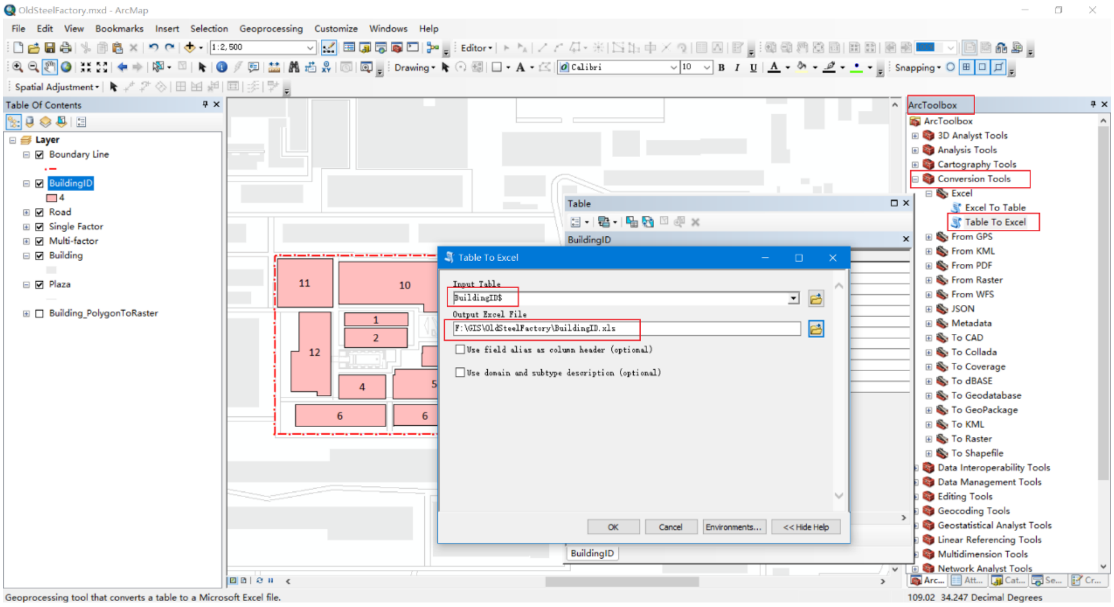


Figure 38. The Process of Exporting the Building ID of Old Steel Factory to Excel

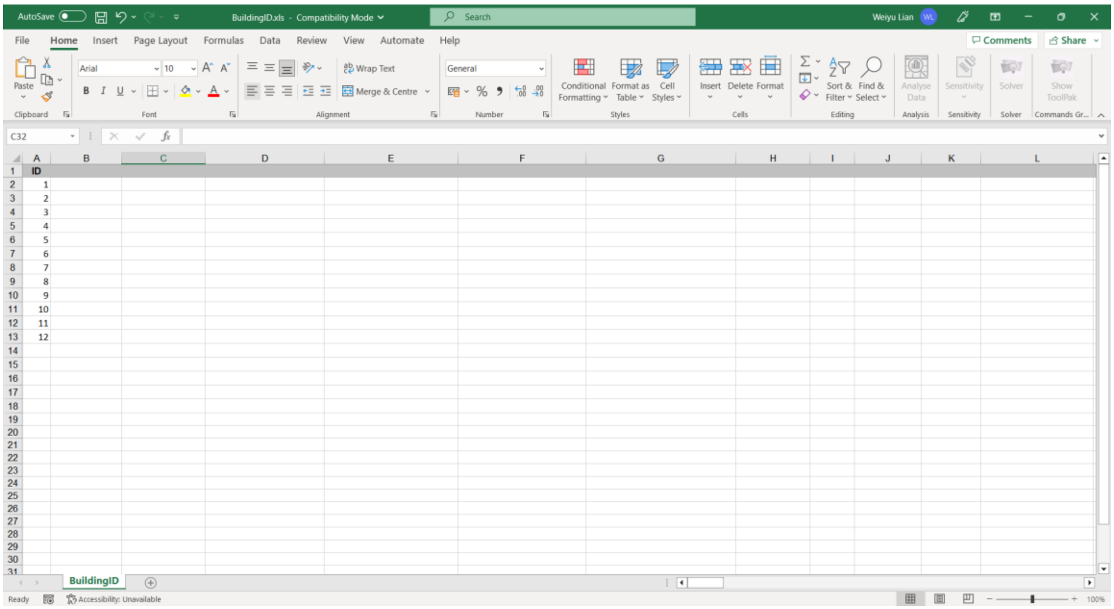


Figure 39. Show the building ID of Old Steel Factory in Excel

Next, after entering the building attribute information for the old steel factory collected from the research in Excel (Figure 40), select the BuildingID sheet in the ArcGIS Catalog and drag it under the Layer (Figure 41). Right-click on the Building Layer and select the command "Joins and Relates-Join" to select the ID field of the building attributes and the ID field of the Building ID Excel sheet so that the two sheets are related based on the ID field (Figure 42).

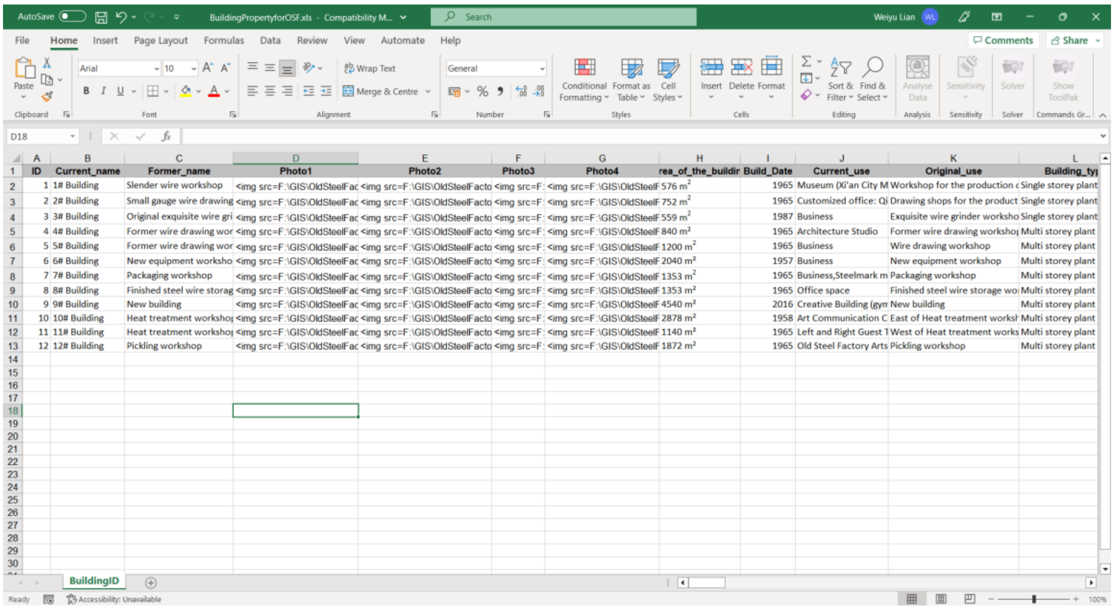


Figure 40. Enter Old Steel Factory Attribute Data in Excel

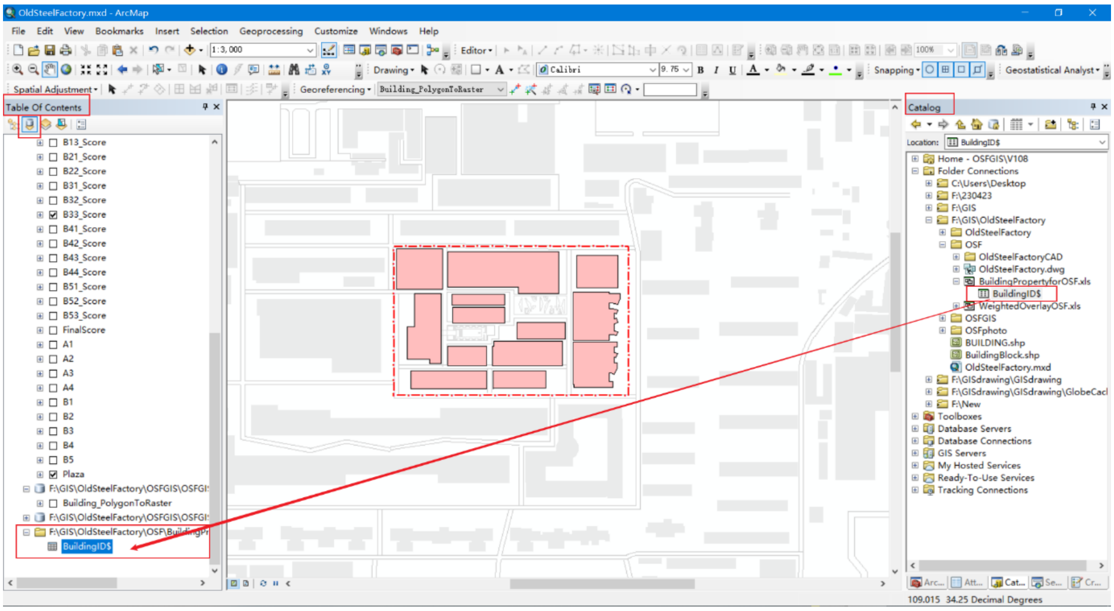


Figure 41. Import the Completed BuildingID Excel Sheet of Old Steel Factory into the ArcGIS Platform

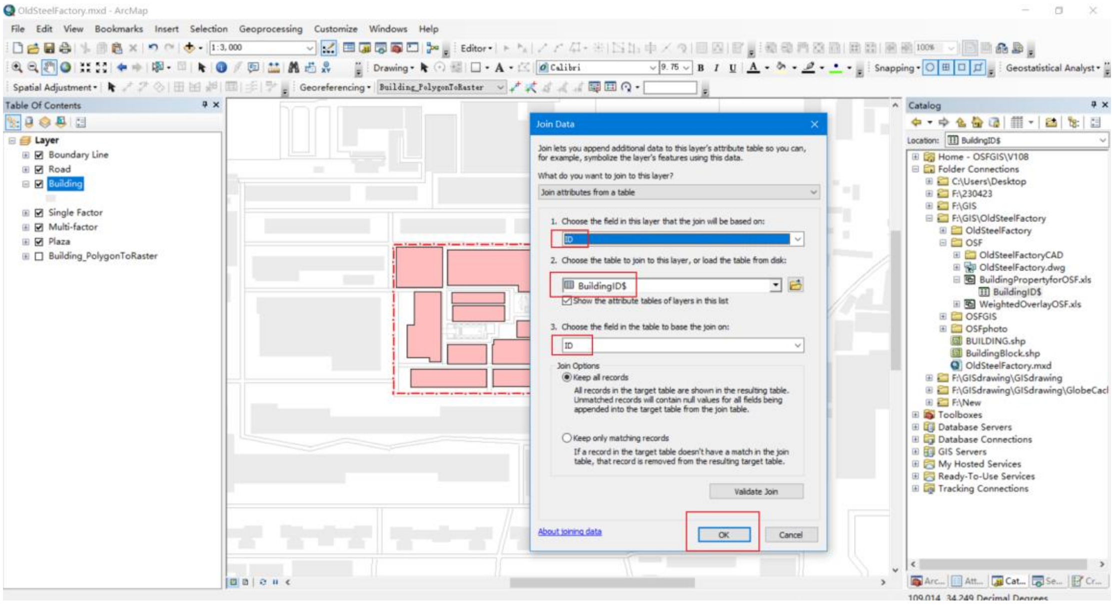


Figure 42. Related to the Building Properties of the Old Steel Factory

In addition, in order to permanently add data to the Building layer in ArcGIS and avoid losing attribute information after Remove Join of the Building layer, the data of the Building layer, after Join attribute data, needs to be exported to the ArcGIS Building database. The operation command is Data-Export Data (Figure 43), which saves the layer’s data as a shp. File (Figure 44). The above operation enables a one-to-one correspondence between the graphical data of the building layer and the attribute data in Excel. The output Attribute Table of the Building Layer is shown in Figure 45.

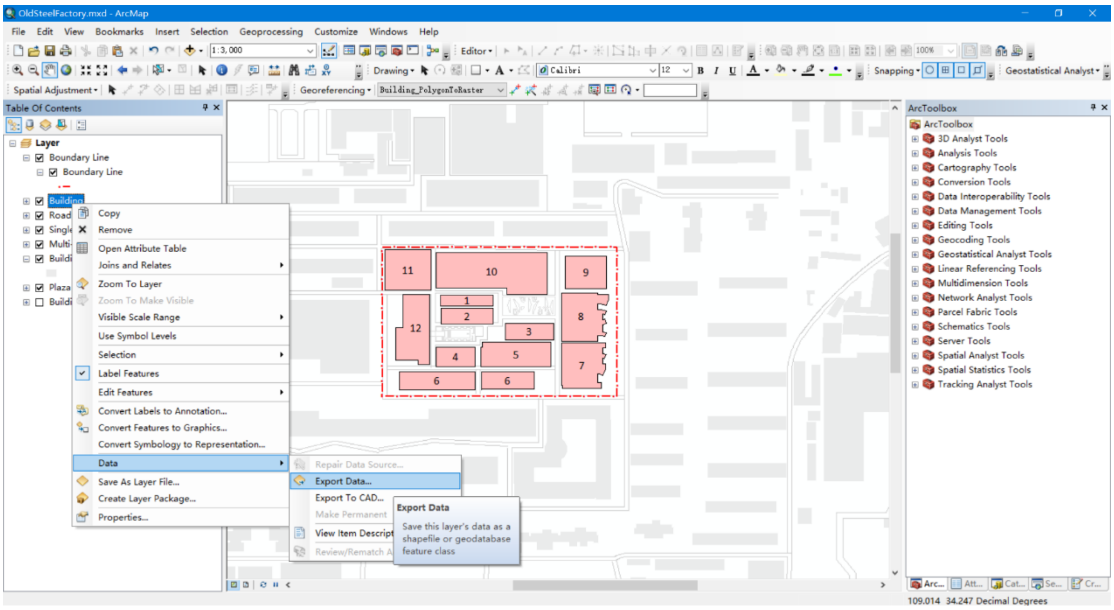


Figure 43. Export Property Data Operation Screen

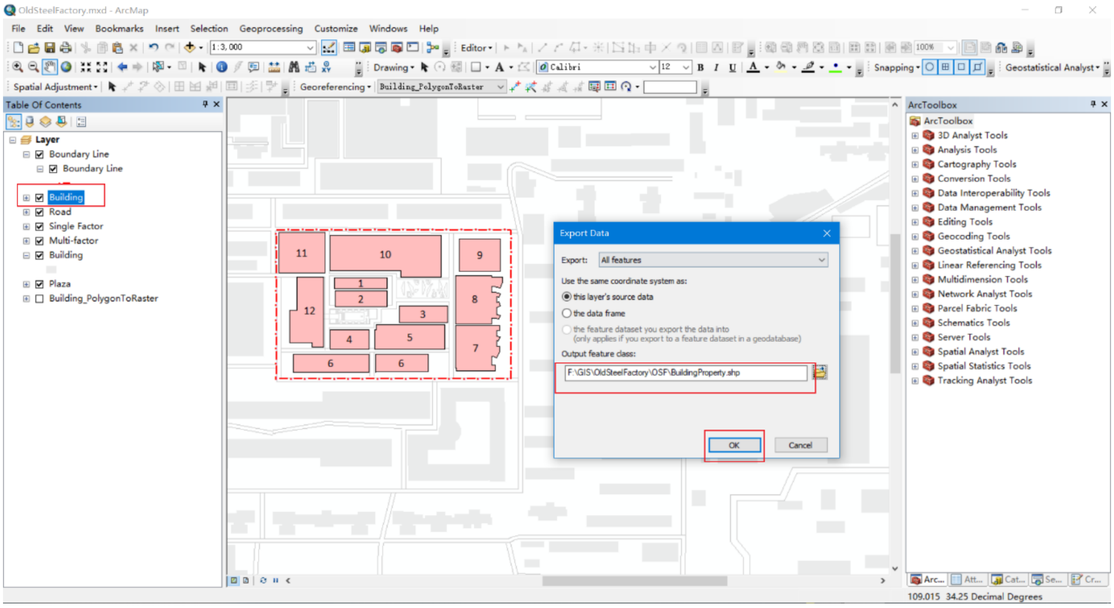


Figure 44. Operational Screen for Exporting Building ID to the Database

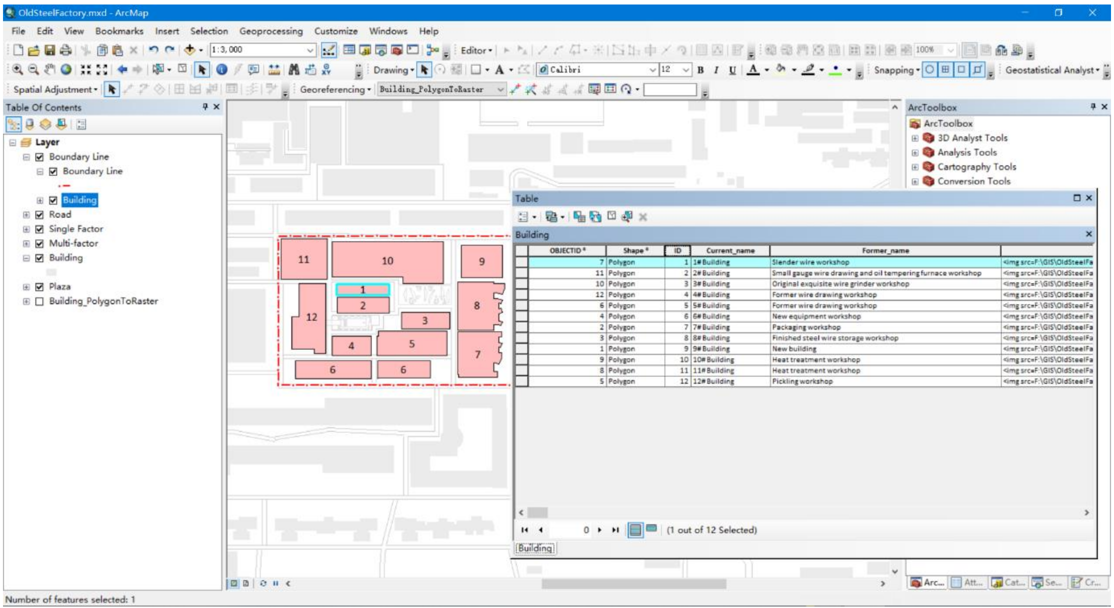


Figure 45. Attribute Table of Building of Old Steel Factory

Furthermore, in order to present more intuitive information about the Building Properties and photos, a new folder of photos of the buildings was created on the computer and named OSFphoto. The current photos taken on site and the old photos collected were renamed 1-1, 1-2, 1-3; 2-1, 2-2; 3-1, 3-2; ..., according to the order of the building IDs and put into the folder. Then use the Layer Properties-HTML Popup command to enter the URL of the image into the URL screen of ArcGIS (Figure 46), and click on the HTML icon to bring up the building's properties and image information.

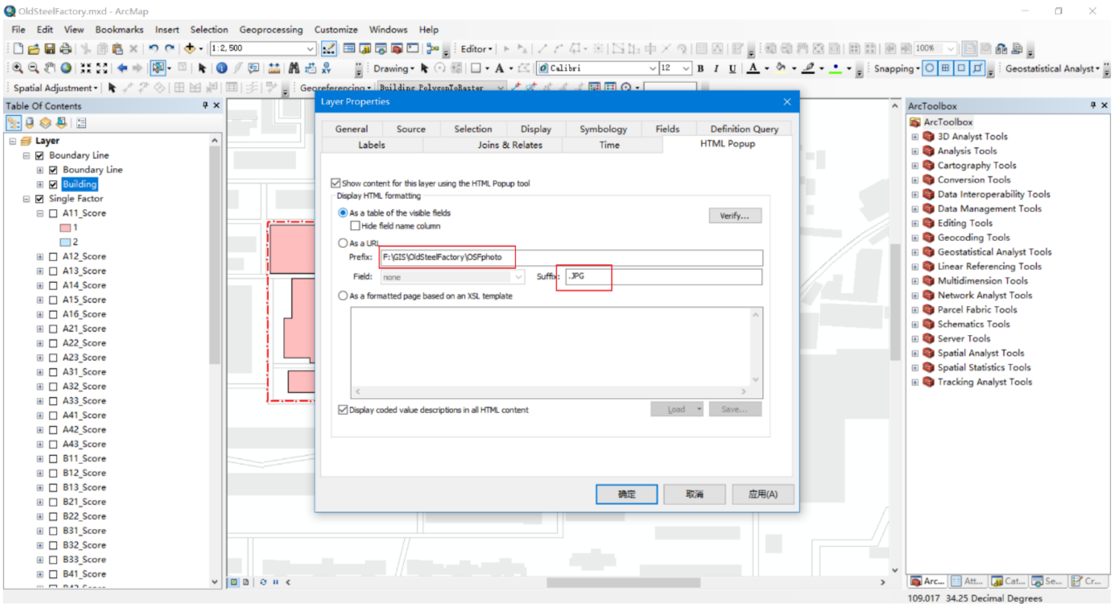
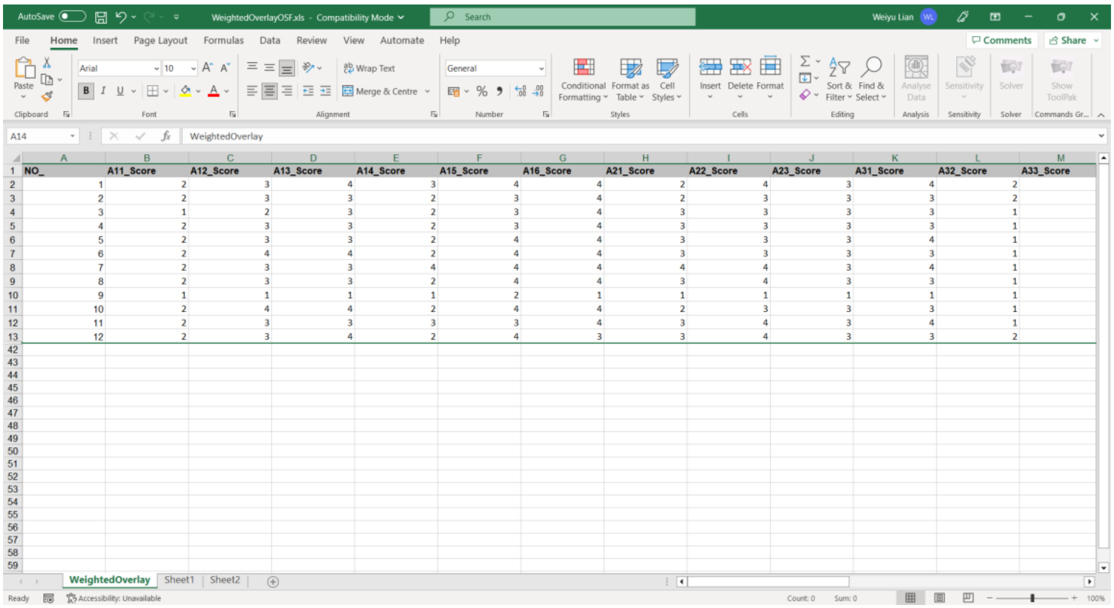


Figure 46. HTML Pop-up Screen Setting for Old Steel Factory Property Information

5.1.11.3 Single Factor Visualisation of Old Steel Factory

With reference to the indicators identified in the industrial heritage value evaluation method proposed in Section 4.6.2, and the evaluation criteria in Section 4.1 and 5.1.9, each factor was given a score by reviewing the literature, fieldwork and interviews with the Shaanxi Old Steel Factory. The criteria are divided into four levels: 4, 3, 2 and 1. The scores for each factor for the old steel factory buildings are shown in Figure 47 by entering them in Excel.



NO_	A11_Score	A12_Score	A13_Score	A14_Score	A15_Score	A16_Score	A21_Score	A22_Score	A23_Score	A31_Score	A32_Score	A33_Score
1	2	3	4	3	4	4	2	4	3	4	2	
2	2	3	3	2	3	4	2	3	3	3	2	
3	1	2	3	2	3	4	3	3	3	3	1	
4	2	3	3	2	3	4	3	3	3	3	1	
5	2	3	3	2	4	4	3	3	3	4	1	
6	2	4	4	2	4	4	3	3	3	3	1	
7	2	3	3	4	4	4	4	4	3	4	1	
8	2	3	3	2	4	4	3	4	3	3	1	
9	1	1	1	1	2	1	1	1	1	1	1	
10	2	4	4	2	4	4	2	3	3	3	1	
11	2	3	3	3	3	4	3	4	3	4	1	
12	2	3	4	2	4	3	3	4	3	3	2	

Figure 47. Different Factor Scores for Each Building of Old Steel Factory

Then import the Excel sheet into ArcGIS. Next, the factors to be visualised are selected through the command Layer Properties-Symbology (Figure 48). The different colours on the map indicate the different scores. For example, in the diagram of the A11 Building construction date factor for the old steel factory, the light blue blocks indicate that the building was built between 1949 and 1977 (2 points) and the pink blocks indicate that the building was built after 1978 (1 point). A diagram of the results of the single factor evaluation of the old steel factory is shown in Table 54 to Table 62.

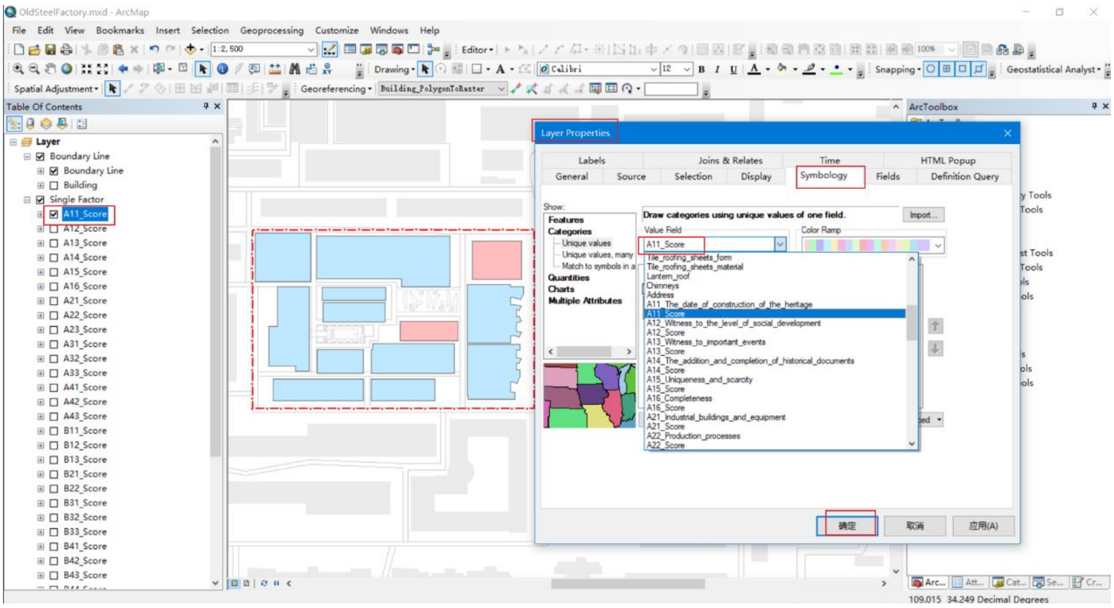
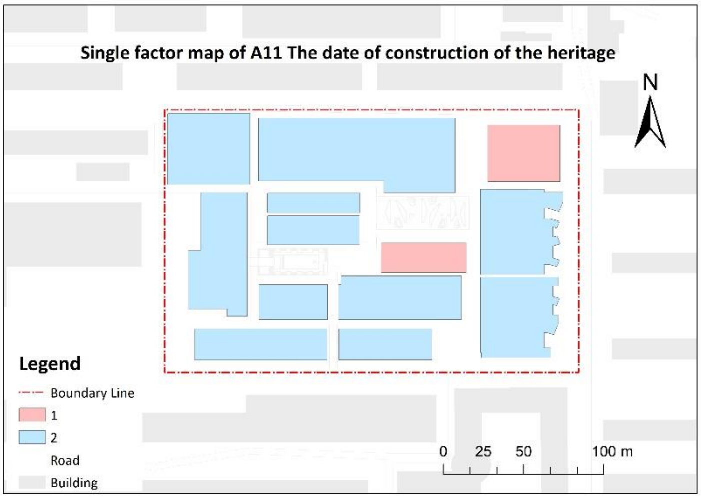
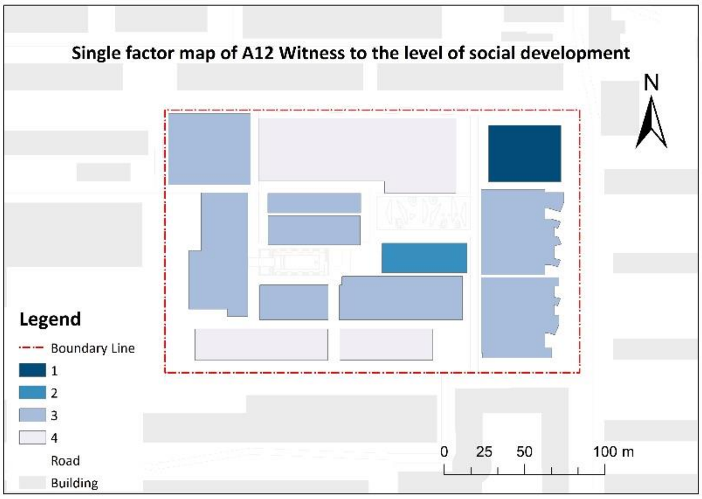
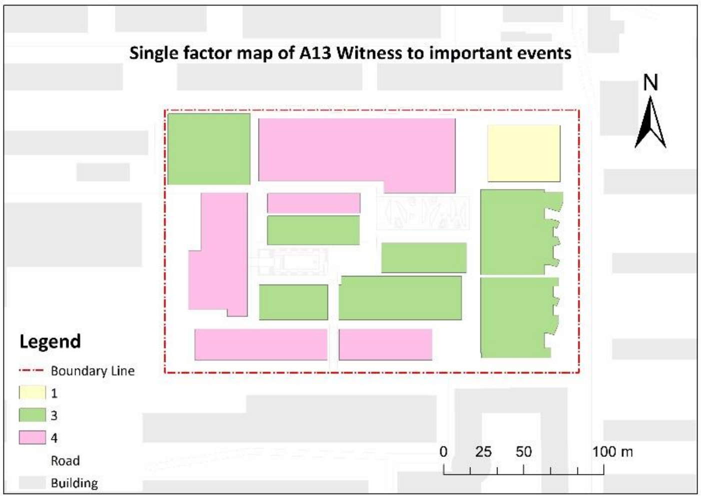


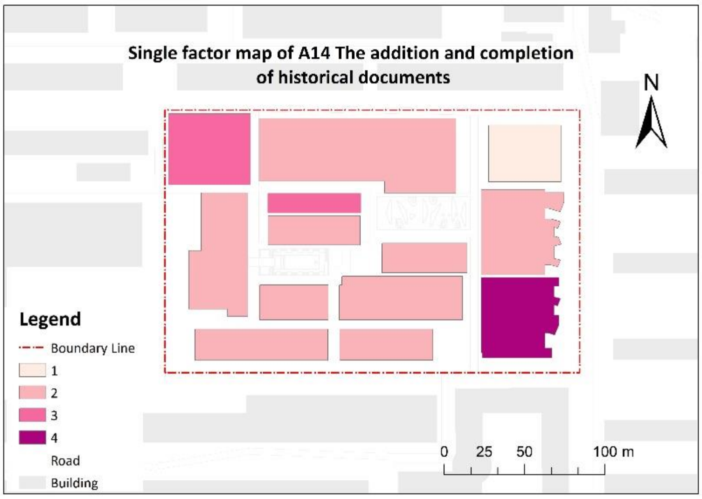
Figure 48. Single Factor Evaluation Operation Process for Old Steel Factory

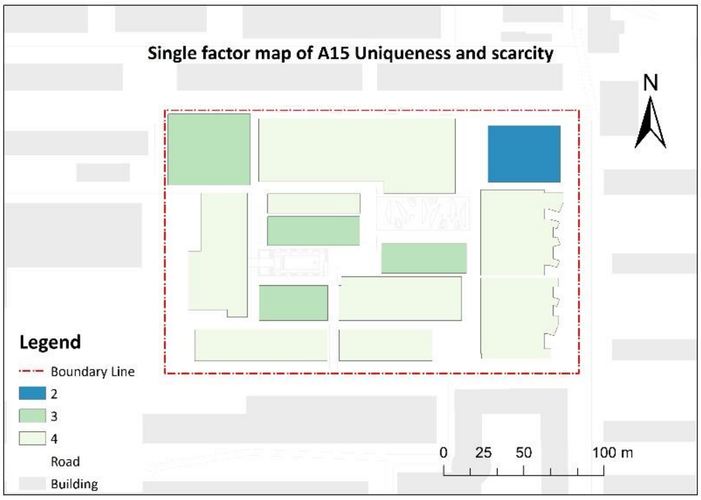
Table 54. Single Factor Evaluation Visualisation of A1 Historical Value











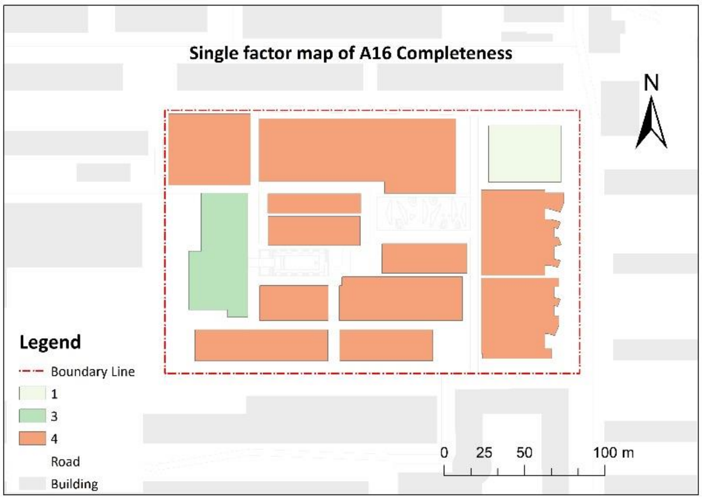


Table 55. Single Factor Evaluation Visualisation of A2 Scientific and Technological Value

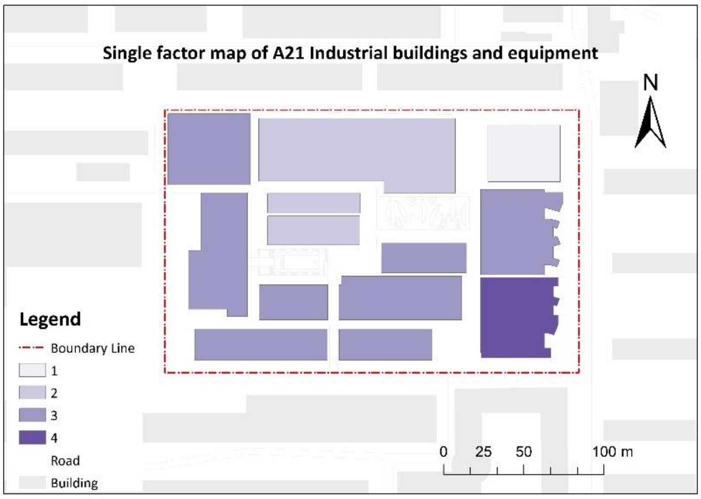
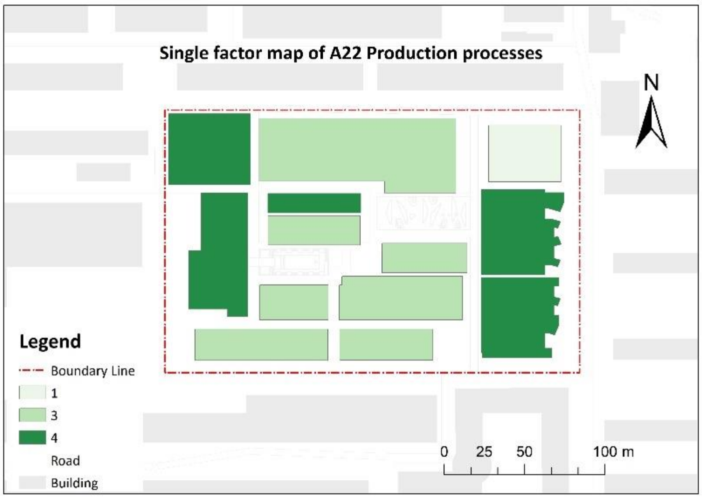
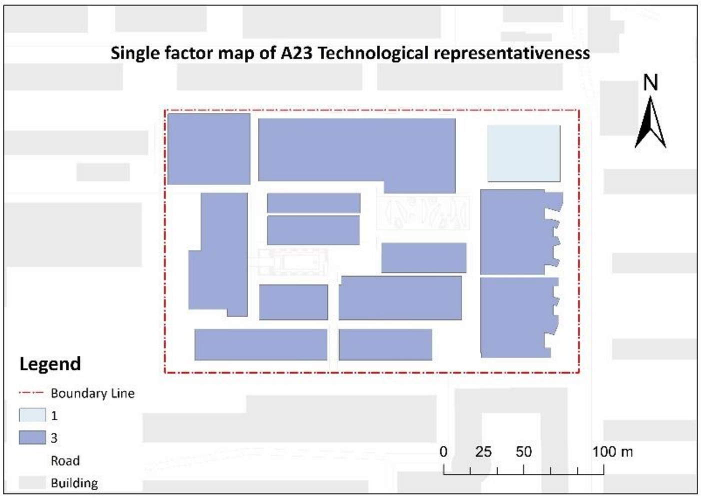
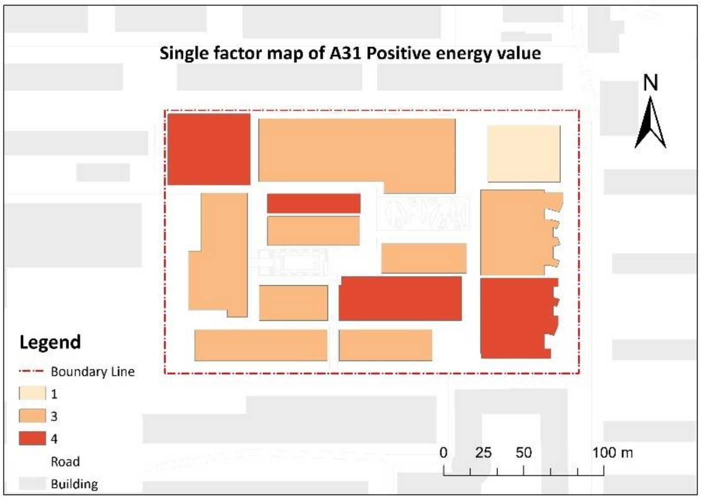
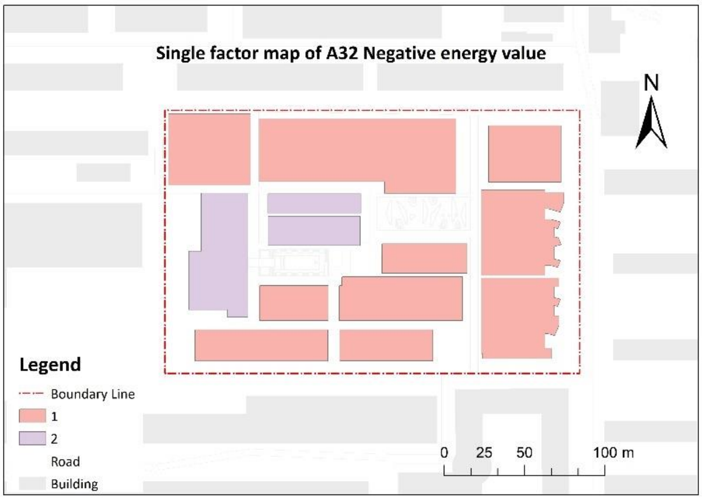
	
	

Table 56. Single Factor Evaluation Visualisation of A3 Cultural Value

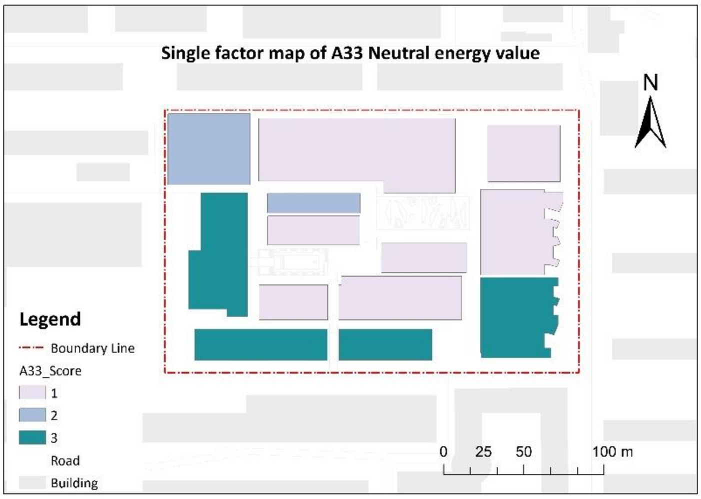
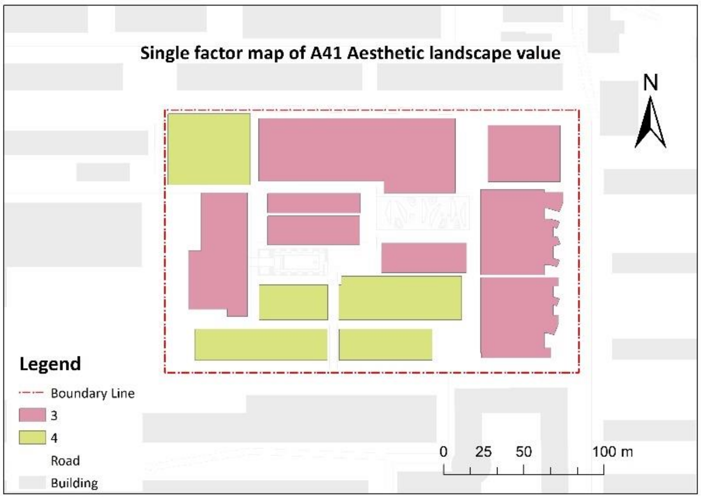
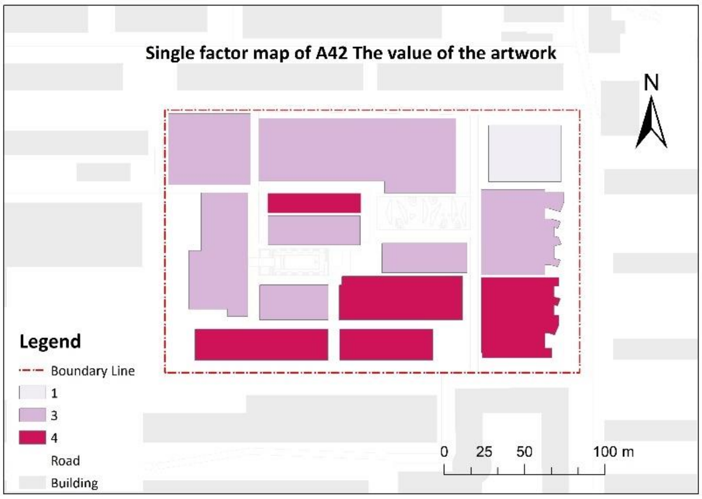


Table 57. Single Factor Evaluation Visualisation of A4 Artistic Value





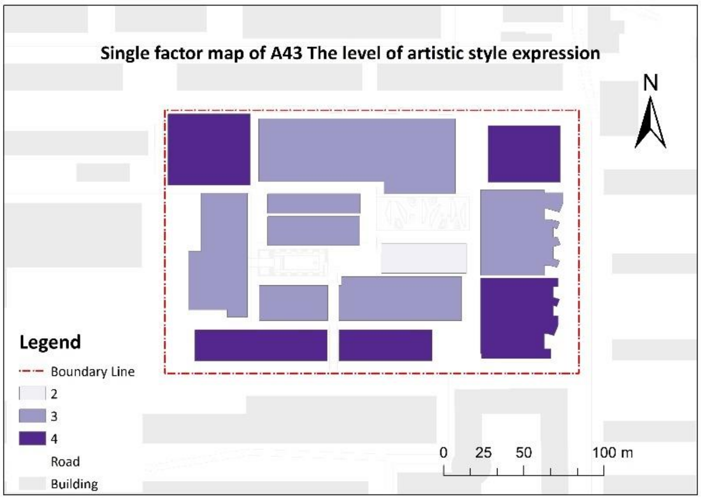


Table 58. Single Factor Evaluation Visualisation of B1 Location Value

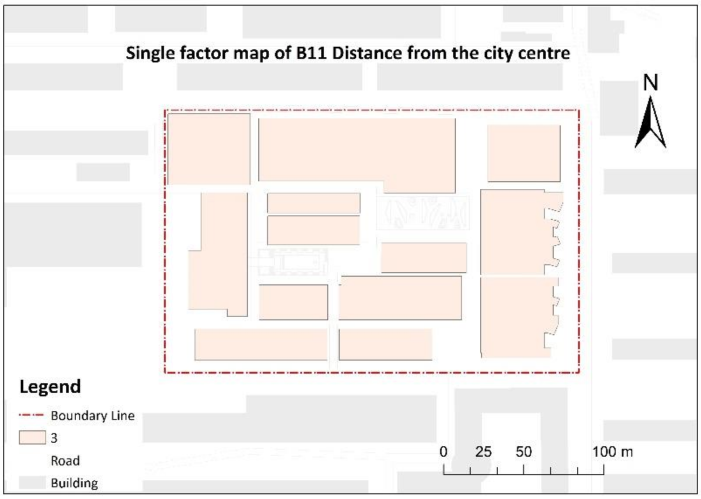
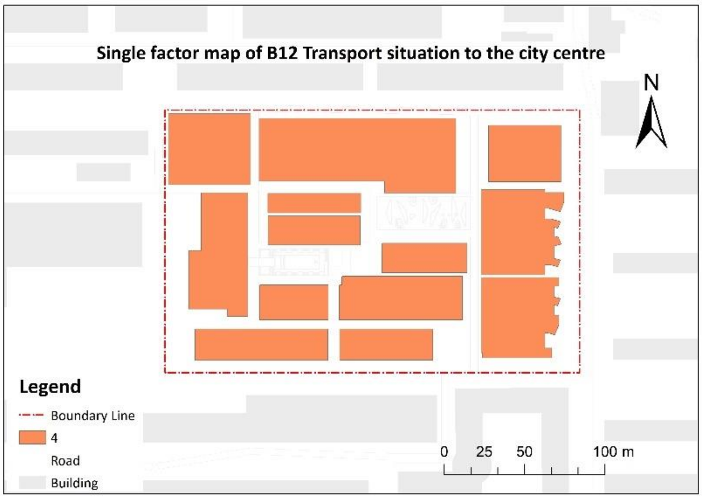
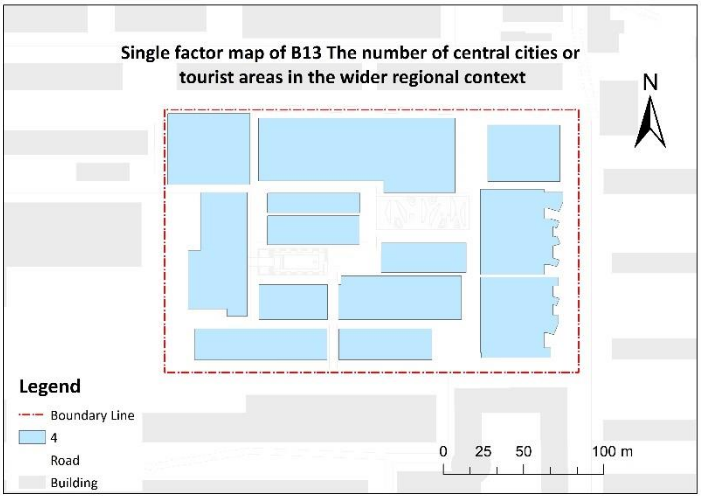
	
	

Table 59. Single Factor Evaluation Visualisation of B2 Environmental Value

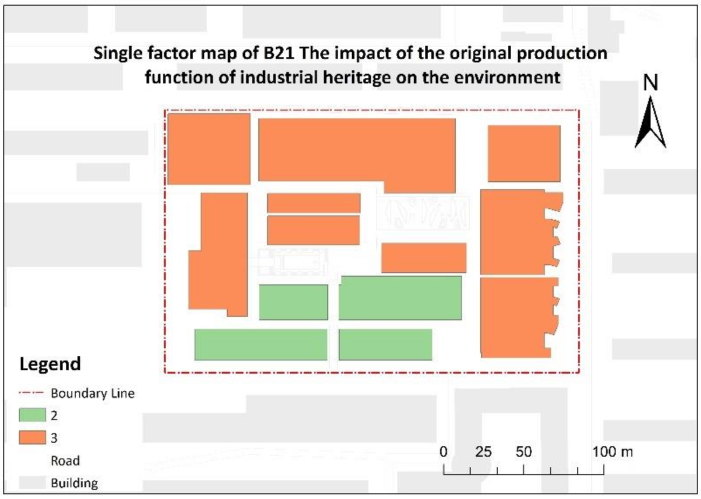
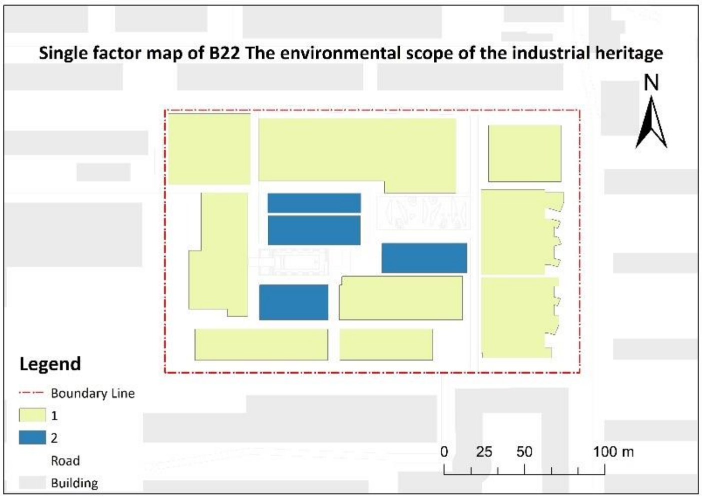
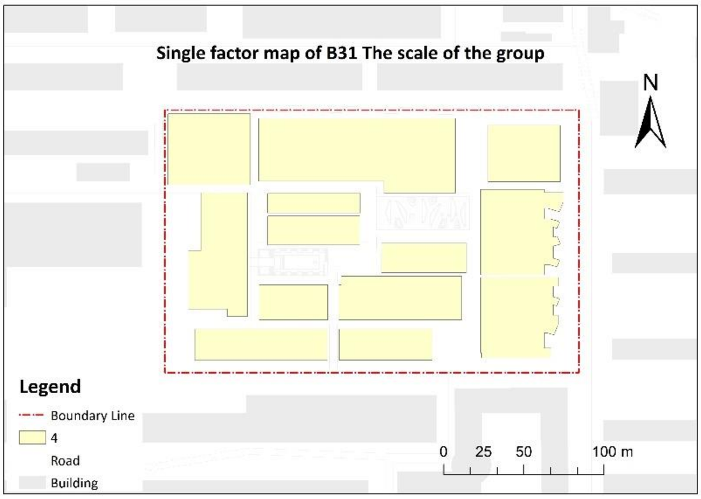
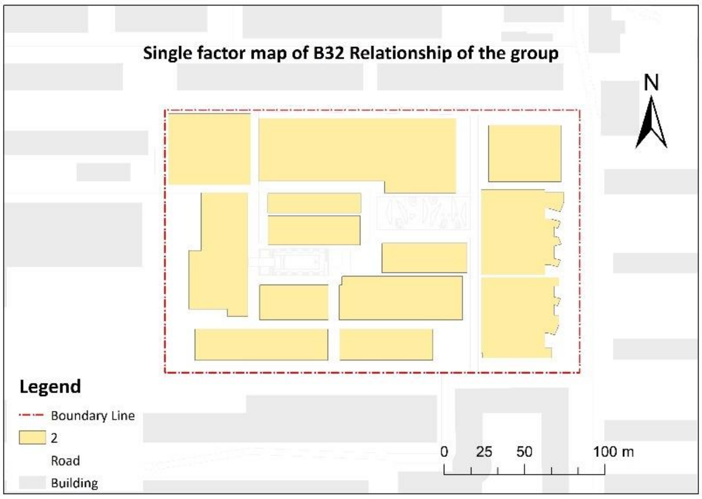
	

Table 60 Single Factor Evaluation Visualisation of B3 Group Value





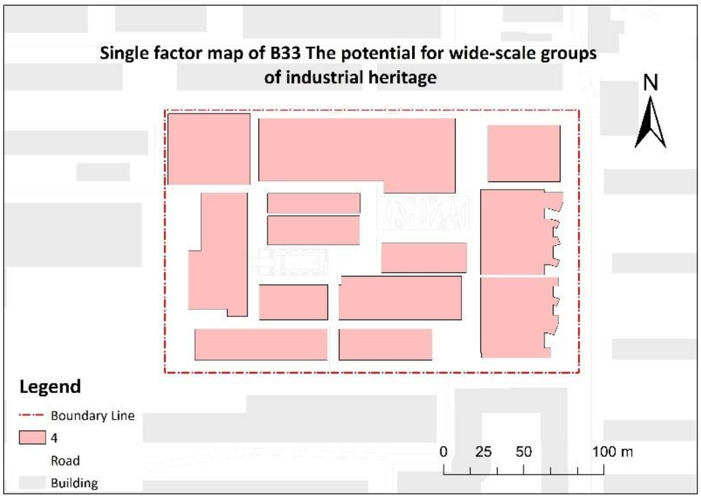
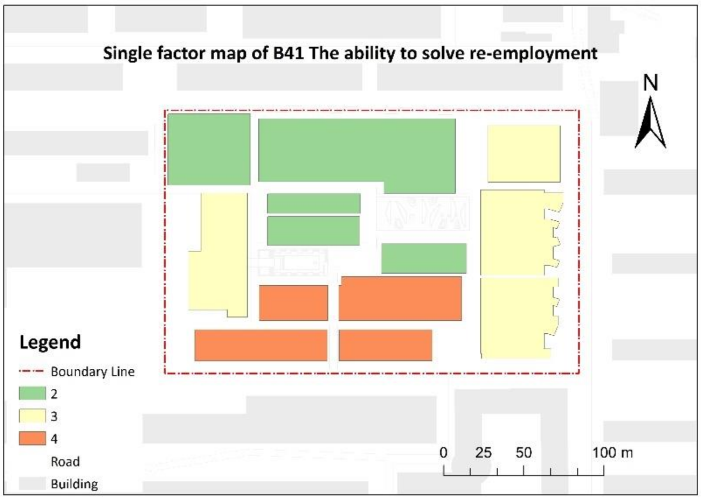
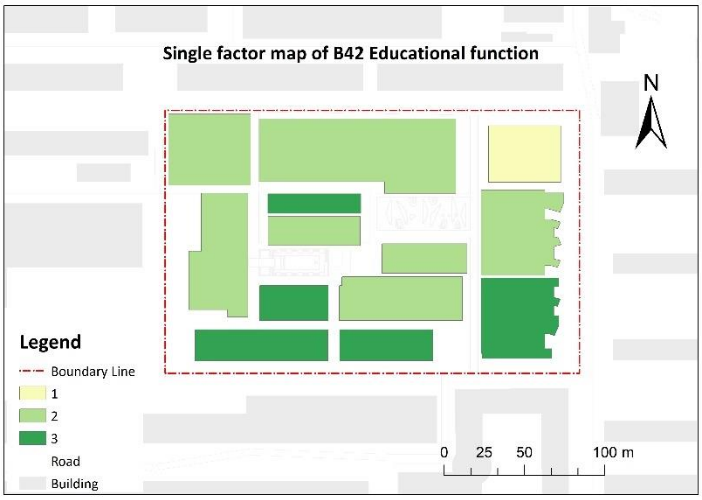
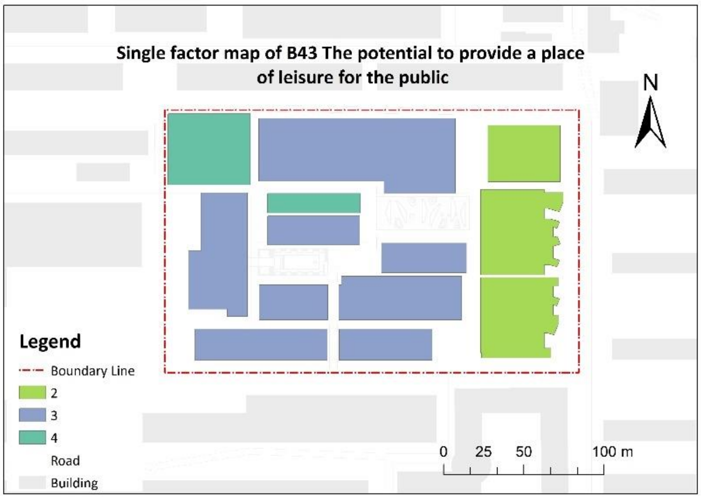


Table 61. Single Factor Evaluation Visualisation of B4 Social Value







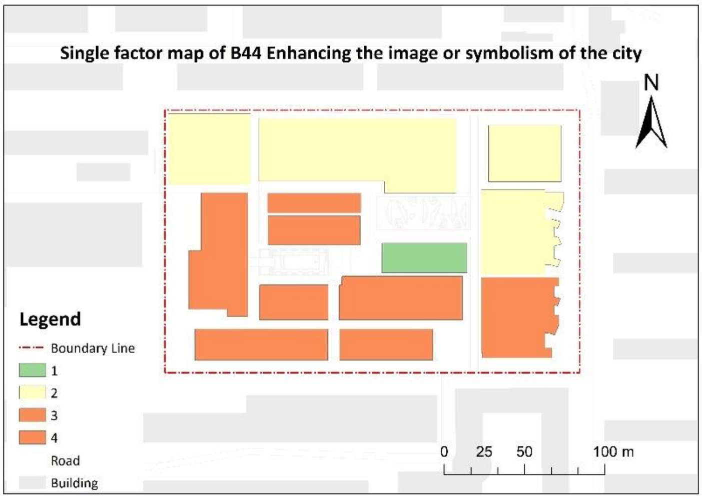
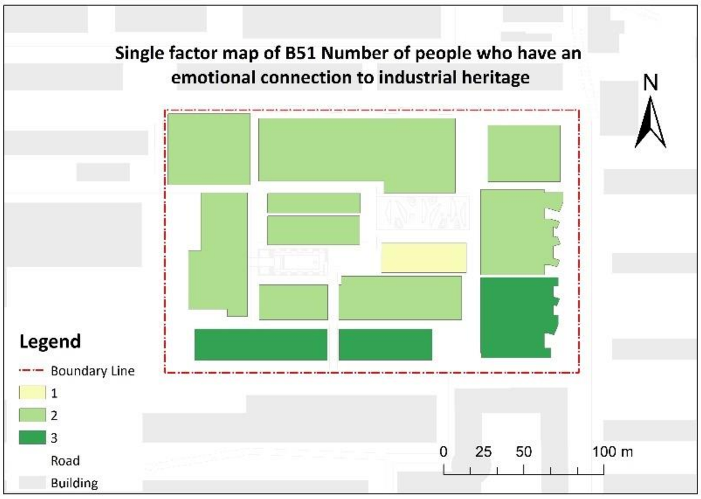
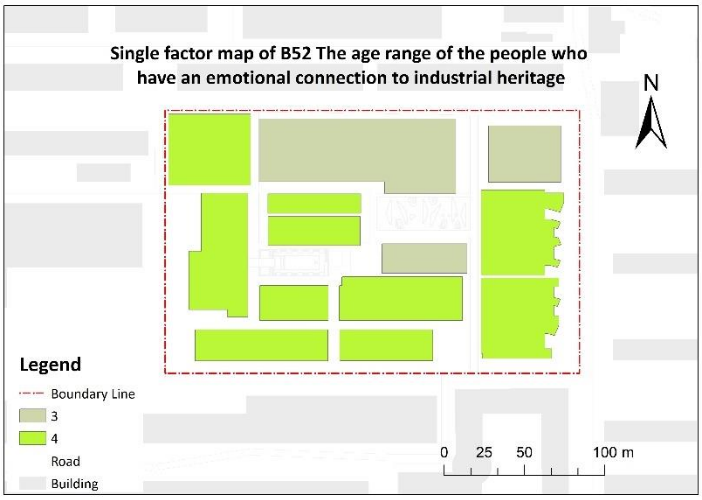
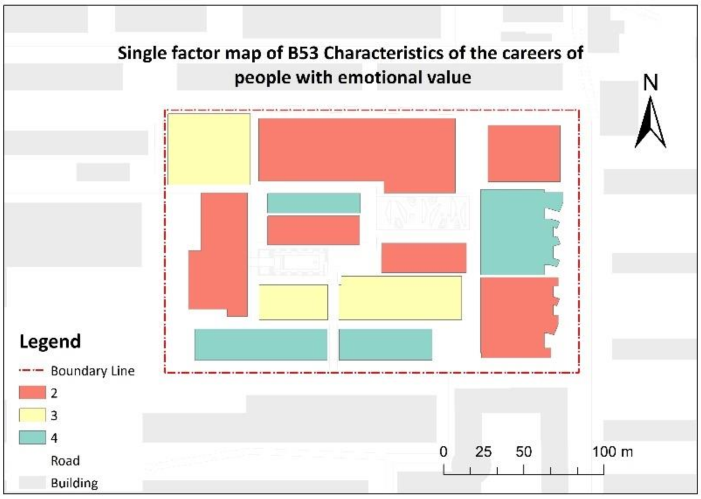


Table 62. Single Factor Evaluation Visualisation of B5 Emotional Value



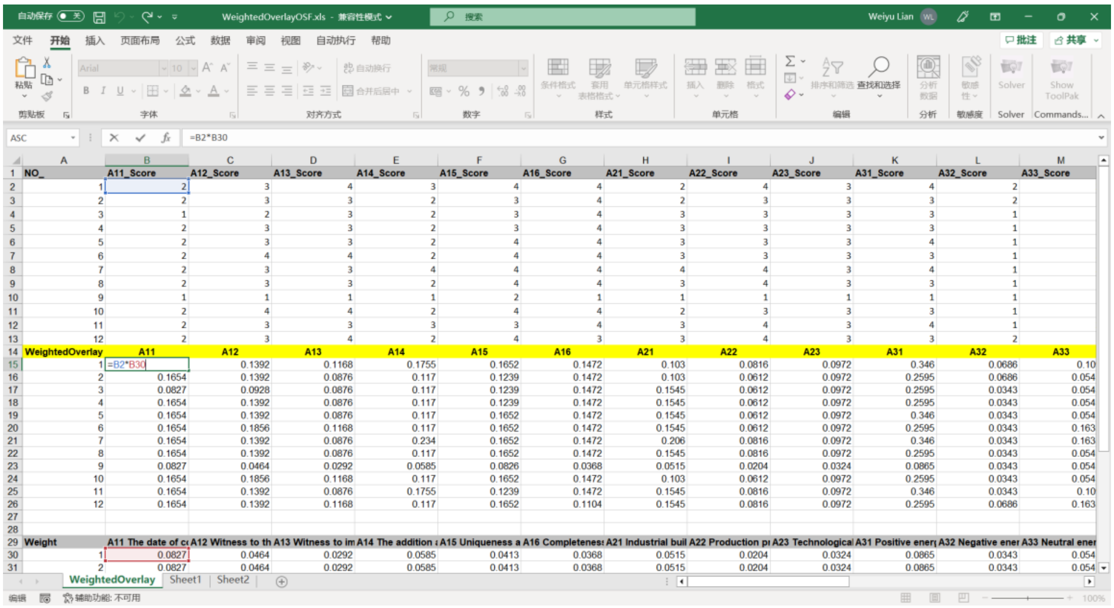




5.1.11.4 Multi-factor Weighted Overlay Evaluation Visualisation of Old Steel Factory

The weights of the different evaluation factors vary considerably for the same building, so it was necessary to overlay all the single factor evaluations for each building to obtain a multi-factor overlay evaluation of the industrial heritage value of the Old Steel Factory. The weights for each factor have been derived from the Analytic Hierarchy Process in Section 4.7, which was entered into an Excel sheet.

Using Excel's data calculation and the spatial analysis function of GIS technology, the scores and weights of the 30 single-factor evaluations of the buildings at Old Steel Factory in Shaanxi were overlaid and calculated (Figure 49) to achieve the multi-factor overlapping evaluation scores. For example, the score of A1 is the sum of the A11-A16 factors after the overlay calculation. Then export to an ArcGIS database using the Conversion tools-Excel to Table method as mentioned above (Figure 50).



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	NO_	A11_Score	A12_Score	A13_Score	A14_Score	A15_Score	A16_Score	A21_Score	A22_Score	A23_Score	A31_Score	A32_Score	A33_Score
2	1	2	3	4	3	4	4	2	4	3	4	2	
3	2	2	3	3	2	3	4	2	3	3	3	2	
4	3	1	2	3	2	3	4	3	3	3	3	1	
5	4	2	3	3	2	3	4	3	3	3	3	1	
6	5	2	3	3	2	4	4	3	3	3	4	1	
7	6	2	4	4	2	4	4	3	3	3	3	1	
8	7	2	3	3	4	4	4	4	4	3	4	1	
9	8	2	3	3	2	4	4	3	4	3	3	1	
10	9	1	1	1	1	2	1	1	1	1	1	1	
11	10	2	4	4	2	4	4	2	3	3	3	1	
12	11	2	3	3	3	3	4	3	4	3	4	1	
13	12	2	3	4	2	4	3	3	4	3	3	2	
14	WeightedOverlay	A11	A12	A13	A14	A15	A16	A21	A22	A23	A31	A32	A33
15	1	=B2*B30	0.1392	0.1168	0.1755	0.1652	0.1472	0.103	0.0816	0.0972	0.346	0.0686	0.10
16	2	0.1654	0.1392	0.0876	0.117	0.1239	0.1472	0.103	0.0612	0.0972	0.2595	0.0686	0.054
17	3	0.0827	0.0928	0.0876	0.117	0.1239	0.1472	0.1545	0.0612	0.0972	0.2595	0.0343	0.054
18	4	0.1654	0.1392	0.0876	0.117	0.1239	0.1472	0.1545	0.0612	0.0972	0.2595	0.0343	0.054
19	5	0.1654	0.1392	0.0876	0.117	0.1652	0.1472	0.1545	0.0612	0.0972	0.346	0.0343	0.054
20	6	0.1654	0.1856	0.1168	0.117	0.1652	0.1472	0.1545	0.0612	0.0972	0.2595	0.0343	0.163
21	7	0.1654	0.1392	0.0876	0.234	0.1652	0.1472	0.206	0.0816	0.0972	0.346	0.0343	0.163
22	8	0.1654	0.1392	0.0876	0.117	0.1652	0.1472	0.1545	0.0816	0.0972	0.2595	0.0343	0.054
23	9	0.0827	0.0464	0.0292	0.0585	0.0826	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
24	10	0.1654	0.1856	0.1168	0.117	0.1652	0.1472	0.103	0.0612	0.0972	0.2595	0.0343	0.054
25	11	0.1654	0.1392	0.0876	0.1755	0.1239	0.1472	0.1545	0.0816	0.0972	0.346	0.0343	0.10
26	12	0.1654	0.1392	0.1168	0.117	0.1652	0.1104	0.1545	0.0816	0.0972	0.2595	0.0686	0.163
27													
28													
29	Weight	A11 The date of co	A12 Witness to th	A13 Witness to im	A14 The addition a	A15 Uniqueness a	A16 Completenes	A21 Industrial buil	A22 Production pr	A23 Technological	A31 Positive energ	A32 Negative ener	A33 Neutral ener
30	1	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
31	2	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054

Figure 49. Excel Data Calculation Chart of Old Steel Factory

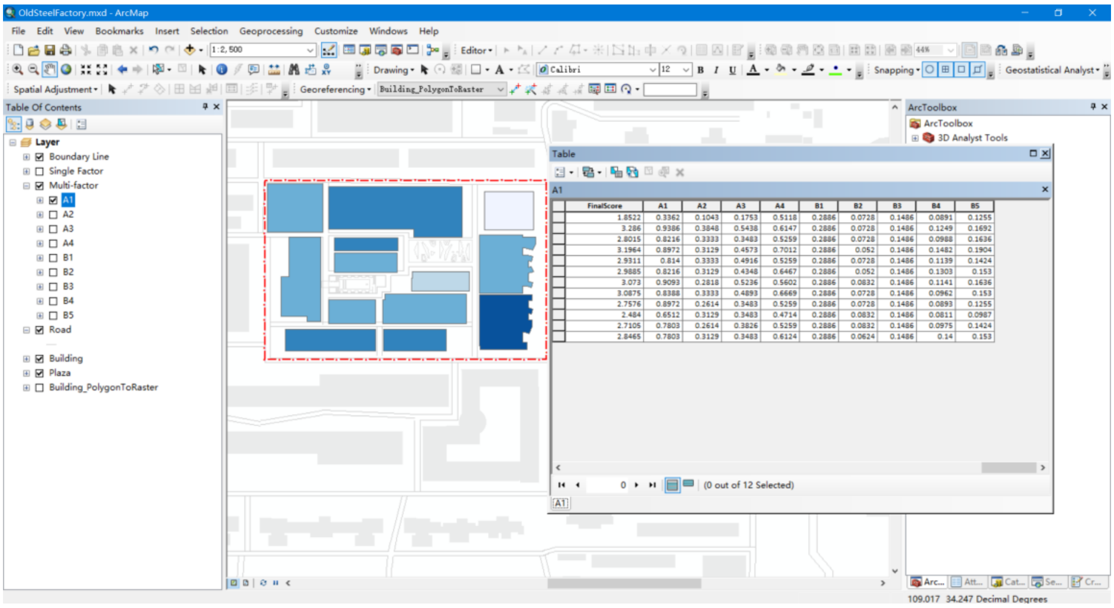


Figure 50. Importing Multi-factor Overlay Scores from Old Steel Factory into ArcGIS

This is followed by the command Layer properties-Symbology-Quantities-Graduated colour, which selects the A1-B5 score and differentiates the colours according to the score (Figure 51). The value visualisation of the multi-factor overlay of A1-B5 for Shaanxi Old Steel Factory is shown in the table below.

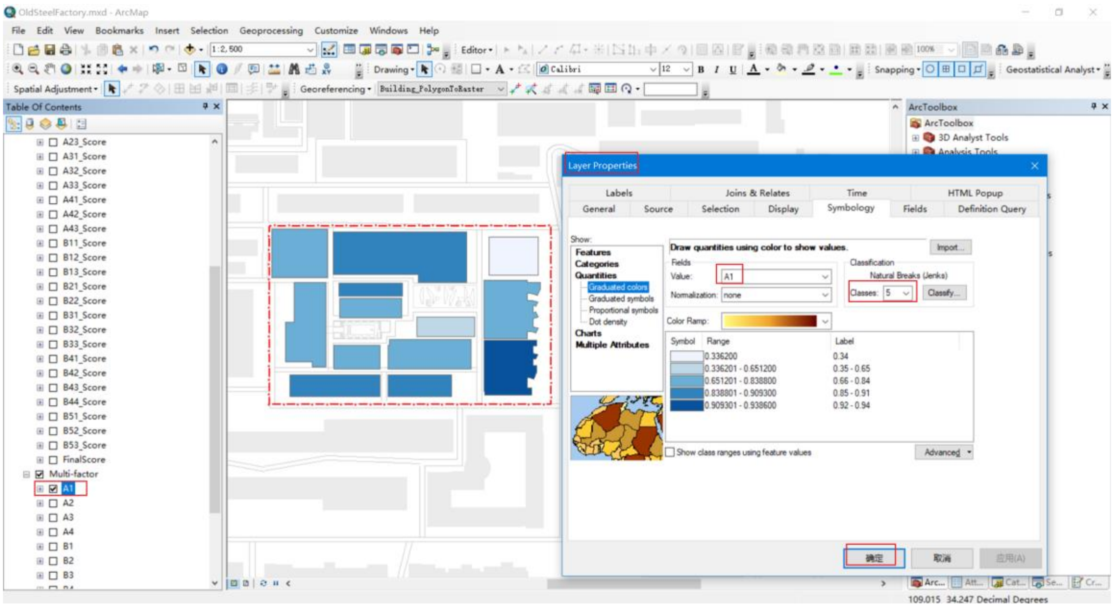
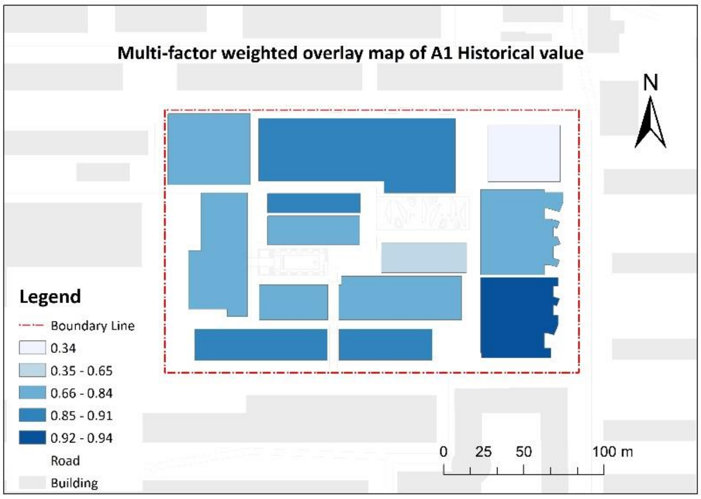
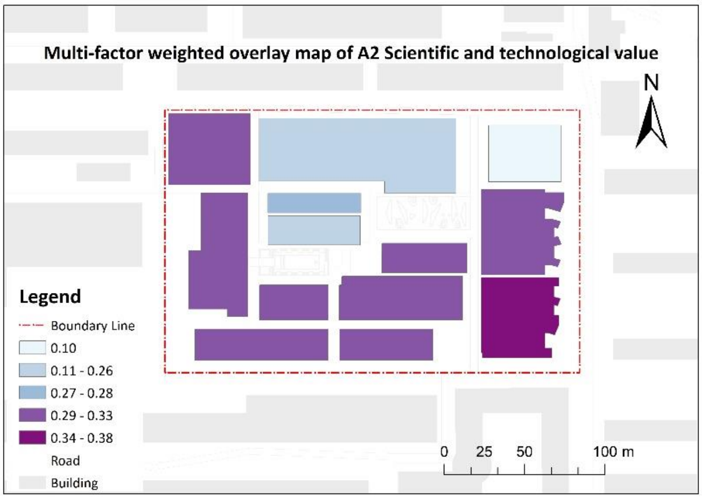
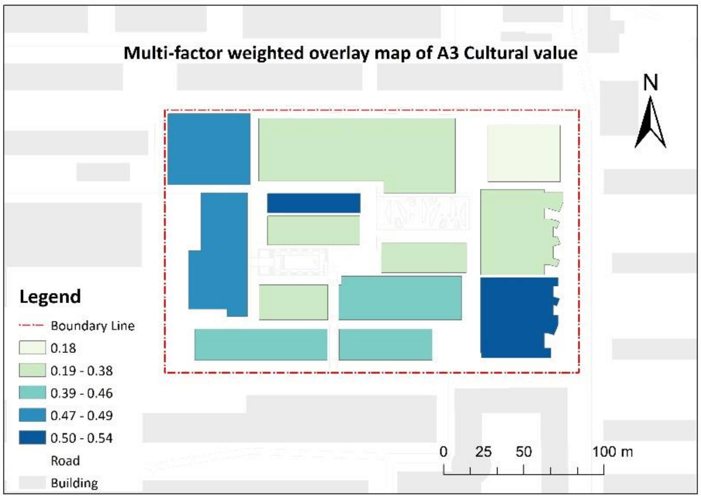


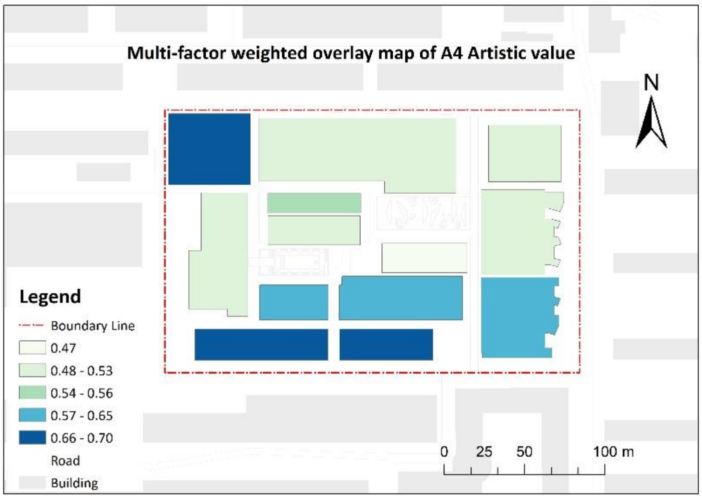
Figure 51. Visualization Screen for Multi-factor Overlay Evaluation in GIS

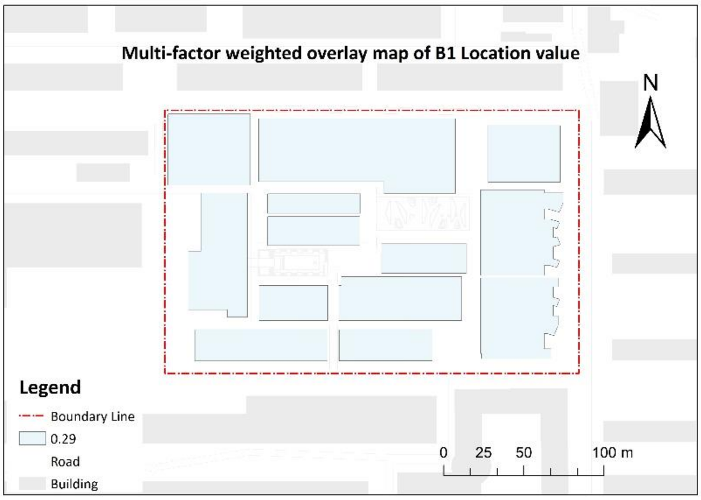
Table 63. Industrial Heritage Value Overlay Analysis Chart of Old Steel Factory

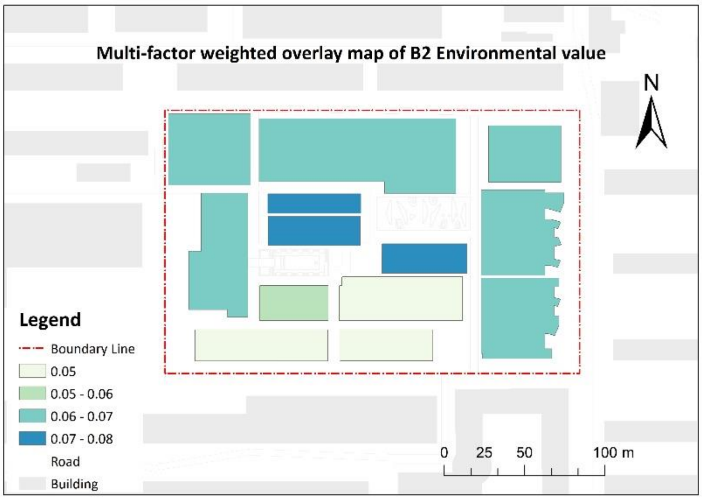


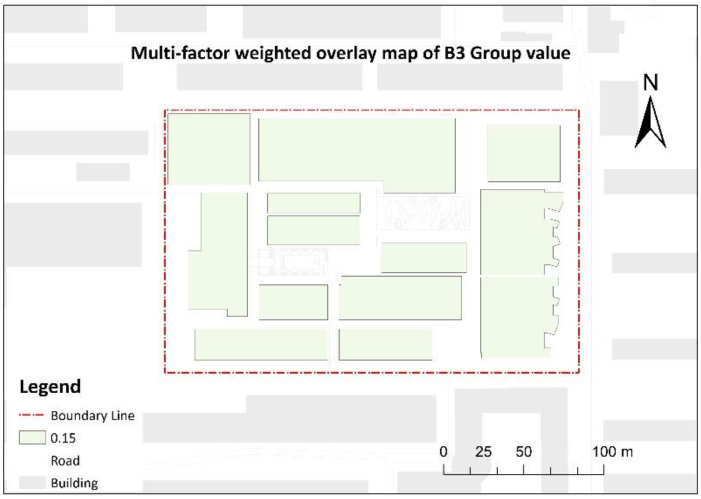


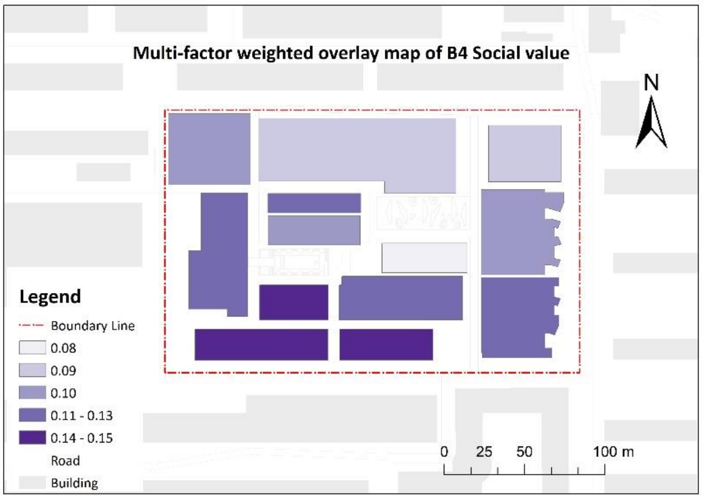


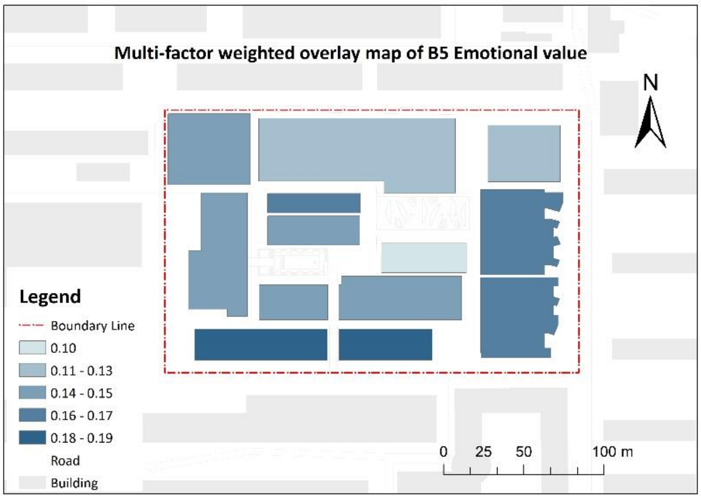












The next step is to visualise the overall value of the industrial heritage of the Shaanxi Old Steel Factory. In order to better reflect the overall value, the obtained Final score was rasterised in ArcGIS using ArcToolBox-Conversion Tools-To Raster-Polygon to Raster. The output of the GIS spatial visualisation analysis of the overall value of the Old Steel Factory is shown in Figure 52.

By visualising the value of the different factors of the Shaanxi Old Steel Factory as described above, it is possible to make a more intuitive judgement on the comprehensive value of its industrial heritage. The shades of colour in the diagram indicate the degree of evaluation of the overall value of the buildings and structures in the Shaanxi Old Steel Factory. The darker the colour indicates the higher their overall value.

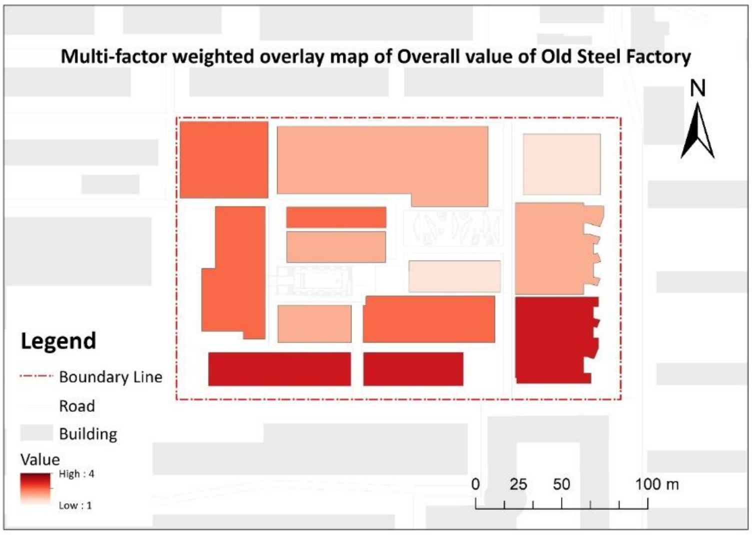


Figure 52. Visualising the Overall Value of Shaanxi Old Steel Factory

5.2 Industrial Heritage of Wang Shi Wa Coal Mine, Tongchuan City, China

The second case study is the Wang Shi Wa coal mine, an important coal mining project in China's Key 156 Projects (1953-1957) (Zhu, Wu and Liu, 2016). It was the main driving force behind the rapid urban development of Tongchuan at the time. As a typical coal mine, the Wang Shi Wa Coal Mine was included in the second list of China's national industrial heritage in November 2018 (MIIT, 2018).

After half a century of mining coal resources, which left behind varying degrees of damage to the ecology of the natural environment, the Wang Shi Wa coal mine is considered as an important example of industrial heritage that contributed to the economic development, that poses new challenges for its conservation and reuse. The current industrial heritage of the Wang Shi Wa coal mine needs further development to present its unique historical and cultural values and to inject new functions to make the region vibrant again.

5.2.1 Background

The Wang Shi Wa coal mine is located in the village of Aobei, 12 km from the eastern outskirts of the Yingtai District of Tongchuan, Shaanxi Province (Figure 53). As a typical coal mining industrial heritage, it was one of China's "156" projects during the first five-year plan period (1953-1957) and was built in December 1957 according to the design of Soviet experts. Afterwards, due to the deterioration of relations between China and the Soviet Union, the subsequent design was carried out independently by the Xi'an Coal Mine Design Institute, which allowed the Wang Shi Wa coal mine to go into production after only four years (Zhang, Cheng and Ming, 2004).

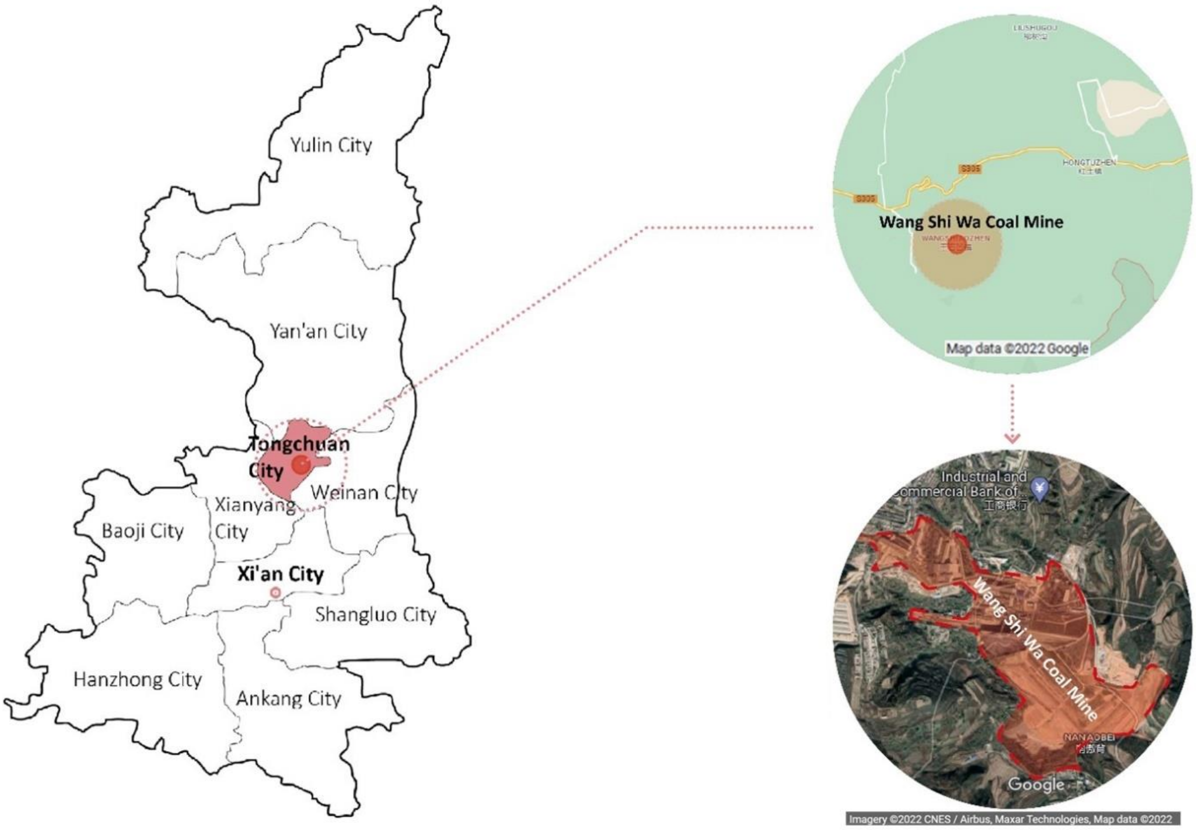


Figure 53. Location Map of Wang Shi Wa Coal Mine in Shaanxi Province, China. Source: Image edited by the author based on Google Maps.

It was not only the main coal mining site in the Tongchuan area, but also the largest mechanised mine in the north-west of China. The entire Wang Shi Wa mine field is about 7.5 kilometres long from east to west and 3.2 kilometres wide from north to south, covering an area of about 24.5 square kilometres. The mine area includes buildings and structures (Figure 54) such as the Miners' Club, the staff apartment building, the office building and the Soviet-style coal processing building (Li, Fang and Wang, 2016).

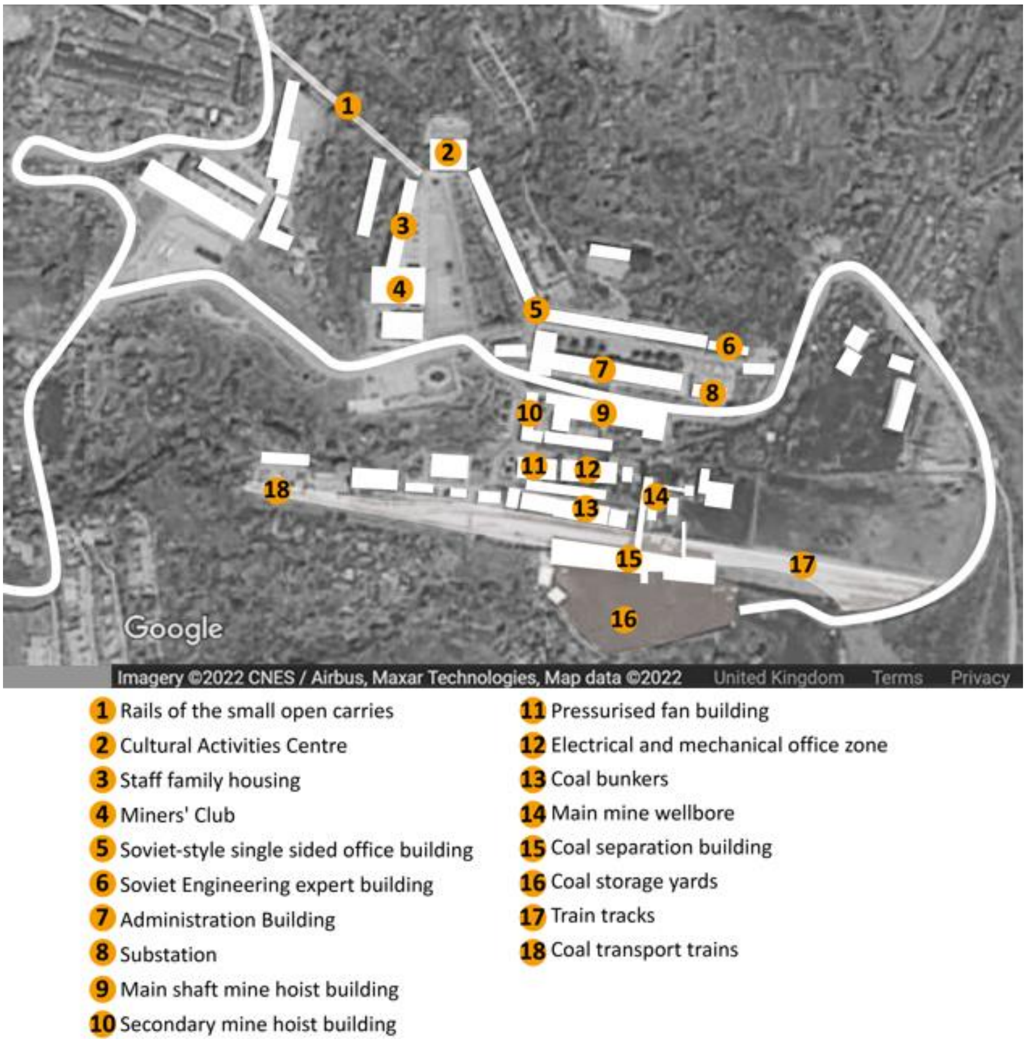


Figure 54. Distribution of Buildings in the Wang Shi Wa Coal Mine. Source: Image edited by the author from Google Maps.

The Wang Shi Wa coal mine represents an important example of China’s coal industry since the founding of the country in 1949, and was a direct contributor to the development of the coal industry in Tongchuan and the rise of the Chinese industry. The development process is shown in Table 64. Much of its industrial heritage that survives today is representative and rare in the domestic coal industry, encompassing the process of coal mining, integrated mining, and main and secondary hoisting shafts. The industrial heritage of Wang Shi Wa Coal Mine demonstrates the different stages of China’s highest coal mining technology and leaves a historical memory in the industrial history of northwest China and the whole country of China.

5.2.2 Development History of Wang Shi Wa Coal Mine

The development and use of Wang Shi Wa coal mine depended on the reserves of coal and the ability of production technology. Its development has gone through five periods: (1) the early stages of site selection and construction, (2) the development of the mine, (3) the heyday of the mine, (4) the decline of the mine and (5) the transition of the mine. The current Wang Shi Wa Mine is in a period of transformation. The industrial heritage of the Wang Shi Wa coal mine has preserved many important historical values, leaving behind historical evidence of the development of China's industry after the founding of the country. The entire development of the Wang Shi Wa coal mine also reflects the arduous journey of the people of China to modernise their industry. The preserved industrial heritage of the coal mine is rich in historical value and calls to mind the memory of history in the form of physical objects.

Table 64. The Development Process of Wang Shi Wa Coal Mine

Coal Mine Development Period	**Time**	**Content**
Site selection and construction period	1953-1954	During the First Five-Year Plan period (1953-1957), Chinese and Soviet experts carried out joint site selection work to prepare for the preliminary construction (Song, 2007).
	December 1957	The Wang Shi Wa coal mine was designed by Soviet experts and the Xi'an Coal Mine Design Institute, and construction began (Zhu, Wu and Liu, 2016).
	1960	The Soviet experts withdrew as a result of the bad relations between China and the Soviet Union, and the Xi'an Coal Mine Design Institute continued to design the mine based on the original general drawings (Zhu, Wu and Liu, 2016).
The period of coal mine development	1960s - 1970s	The Wang Shi Wa Mine was completed and put into operation, becoming the most important mine of the Tongchuan Mining Bureau and the largest modern mechanical shaft in the north-west of China (Yang, 1985)
The heyday of coal mining	1970s-1980s	In the early 1970s, the annual production of the mine exceeded the design mark of 120 tonnes; in the early years of reform and opening up, Wang Shi Wa was the first to use high-grade general mining in the coal industry in China and won the prize for this type of mining for three consecutive years, when the annual production of the mine reached a maximum of 1.33 million tonnes (Song, 2007).

Period of Coal Mine Decline	1990s-2015	The coal resources were gradually depleted, the ageing of the workforce was becoming very serious and the coal market continued to be depressed, leading to the decline of the Wang Shi Wa Mine (Liu, 2020).
Period of mine closure and transformation	October 2015	The depletion of coal resources and the continuing downturn in the market led to the official closure of the Wang Shi Wa Mine (Zhang and Hao, 2019).
	December 2017	Wang Shi Wa Coal Mine Heritage Park became the first and only coal mine industrial heritage park to be selected (Liu, 2020).
	15 November 2018	Wang Shi Wa Coal Mine was successfully selected for the second list of China's National Industrial Heritage (MIIT, 2018).

5.2.3 Current Status Within the Wang Shi Wa Coal Mine

The Wang Shi Wa coal mine is divided into four areas according to the production process: the front area of the plant, the production area, the auxiliary production area and the storage and transportation area, each of which has its responsibilities and is closely interlinked. The planning of the Wang Shi Wa coal mine is based on the unique topography of the original mountainous terrain, with production-related functions and accommodation areas arranged in a centralised manner. It is divided into two main areas (Figure 55), the Upper Mountain area, which is mainly an accommodation area for mine workers and their families, and is currently dominated by residential buildings built in the 1980s, a hospital, a school for the children of mine workers and a supporting marketplace.

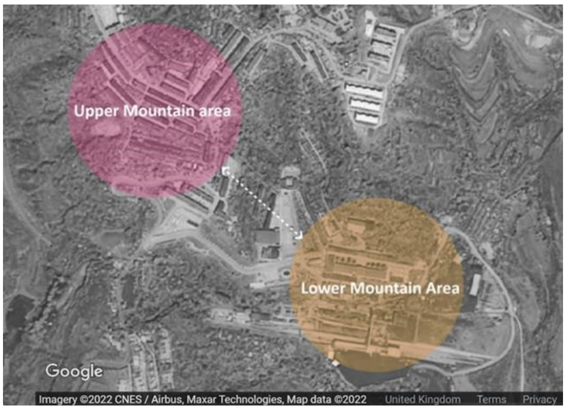


Figure 55. Links Between the Two Areas of the Mine. Source: Image adapted by the author from Google Maps.

One of the main characteristics is the use of the small open carries (Figure 56), which are pulled by iron wire to move to connect the miner's accommodation area on the mountain with the factory area below. The small open carries were the most efficient way to transport 30 people at a time between the upper and lower mountain areas. This was originally designed as a convenient benefit for the workers and is now a part of the industrial heritage of the Wang Shi Wa coal mine.

Figure 56. The Picture of Small Open Carries. Source: Author.

The other area of the Wang Shi Wa coal mine is the Lower Mountain Area, which is mainly laid out for production-related functions and is divided into a front area of the factory, production area, auxiliary production area and storage and transportation area (Figure 57). At present, the front area of the Wang Shi Wa coal mine has become a place representing the culture and image of the company, due to its continuous reconstruction and expansion over the years. The front area is now surrounded by Miners' Club, Cultural Activities Centre, Staff family housing, Soviet-style single sided office building, Soviet expert building used by engineers, and Administration Building, and the whole area is well preserved.

Figure 57. Functional Division Map of Wang Shi Wa Coal Mine. Source: Image adapted by the author from Google Maps.

Due to the plateau topography of the Lower Mountain area, which is intersected by gullies of varying depths on both the south-eastern and western sides, the topography and design of Wang Shi Wa were well combined to build a complete production system in accordance with the topography. At the top of the plateau is the Administration Building, in the middle of the plateau are the equipment rooms such as the main and secondary shafts and the mine hoist. The function of the mine hoist is to lift and transport coal and miners to and from the underground mine to the ground. At the bottom of the plateau are the railway tracks and the coal separation building. The separation building was used to transport and select the coal, and for the final delivery by train. The plant is laid out as an entire production process from south to north. To the south of the mine is the coal storage yard, the machine shop is located on the east side of the production area and on the western side is the railway track's tunnel entrance.

The field survey information sheet of the Wang Shi Wa Coal Mine can be found in Appendix D.

Table 65. Table of Buildings Included in Each Sub-area

Area	Buildings	Map (Source: Image edited by the author based on Google Maps)
The front area of the plant	Miners' Club, Cultural Activities Centre, Staff family housing, Soviet-style single sided office building, Soviet Engineering expert building, Administration Building.	
The production area	Main shaft mine hoist building, Secondary mine hoist building, Coal separation building.	
The auxiliary production area	Pressurised fan building, Substation, Electrical and mechanical office zone, Coal bunkers.	
The storage and transportation area	Coal transport trains, Train tracks, Coal storage yards.	

5.2.4 Analysis and Evaluation of the Value of the Industrial Heritage of the Wang Shi Wa Coal Mine

With the development of the coal industry, the Wang Shi Wa coal mine became one of the most important coal energy sites in Shaanxi Province, China. The existence of the Wang Shi Wa coal mine has witnessed the development of the coal industry since the founding of New China and provides a valuable historical basis for understanding the history of the Chinese coal industry. The Wang Shi Wa coal mine was set as a project in 1951 and completed in 1961, and after more than half a century, the mine was officially closed in September 2015.

The coal mining process at Wang Shi Wa was at the forefront of the whole of China, and around 1970 the mine was leading the industry with annual production of up to 1.33 million tonnes, which was a period of glory. But after the glorious, the decline came quietly. With the depletion of resources, the downturn in the coal market and the inversion of costs and prices making it impossible to continue mining, the question of what the future of the industrial heritage of Wang Shi Wa Coal Mine should be is a priority. It is therefore particularly important to explore the value of Wang Shi Wa's industrial heritage.

5.2.4.1 Historical Value

According to the analysis of the value of industrial heritage in Section 4.1, six main aspects of the historical value of the industrial heritage of the Wang Shi Wa coal mine are evaluated: (1) the date of construction of the heritage; (2) witness to the level of social development; (3) witness to important events; (4) the addition and completion of historical documents; (5) uniqueness and scarcity; (6) completeness.

(1) With regard to the date of construction of the heritage, the present Wang Shi Wa coal mine was established in 1951 and put into operation in 1961. With a development history of more than half a century, it is not only a microcosm of the modern development of China's coal industry, but also a witness to the development of the coal industry in the People's Republic of China. From purely human excavation in the early days of the People's Republic of China to semi-mechanised manual blasting mining; and from high-grade conventional mining, which was first promoted in 1975, to 100% fully mechanised

integrated coal mining process changes, Wang Shi Wa coal mine has been at the forefront of China's industrial development (Yang, 1985). The date of construction of the heritage was scored as 2 according to the evaluation criteria.

(2) In terms of witnessing the level of social development, according to the analysis in Section 2.6.1 Stages of industrial development, the Wang Shi Wa coal mine has witnessed the history of China's social and economic development from 1951 to now, and has witnessed the development of China's coal mining industry. It has an irreplaceable role for future generations to understand the development of coal mining industry, the renewal of technology in different eras, and the transformation and development of industrial values. As an important vehicle for industrial technology and economic and social development in the industrial era, the Wang Shi Wa coal mine reflects the development of the coal mining industry from its initial beginnings to its final decline. The score for being a witness to the level of social development is 4 according to the evaluation criteria.

(3) Regarding being a witness to important events, the former site of the Wang Shi Wa coal mine has witnessed the deep friendship between the Chinese and Soviet people. The 156 Project was a key project of the Soviet Union's assistance in construction during the first five-year plan of our national economy (1953-1957), reflecting the affection of the Soviet working class and the Soviet people for China. 156 projects are the cornerstones of China's industrialisation process, which changed the backwardness of the old Chinese industry and strengthened its economic independence.

Furthermore, the Wang Shi Wa coal mine has experienced a difficult period for Chinese industry. In July 1960, the Soviet government tore up the economic contract for cooperation with China and destroyed the technical drawings, plunging China's industrial development into a difficult period, which the Wang Shi Wa coal mine also experienced. In the absence of funds, technology and personnel, the Wang Shi Wa coal mine was renewed by the Xi'an Coal Mine Design Institute with a revised original design, completing its rapid development from construction to production in just four years (Zhu, Wu and Liu, 2016).

In addition, the Wang Shi Wa coal mine witnessed turbulent times during the Chinese Cultural Revolution of 1966-1976. In the 1960s and 1970s, when the country was experiencing coal shortages due to the turbulent times, the Wang Shi Wa coal mine once again rose to prominence, with annual production exceeding the 100,000-tonnes mark for the first time in 1973 (Liu, 2020; Li, Fang and Wang, 2016). The development of the Wang Shi Wa coal mine is a testimony to the development of the coal industry in New China. The score for being a witness to an important event is 4 points according to the evaluation criteria.

(4) In terms of the addition and completion of historical documents by industrial heritage, the Wang Shi Wa coal mine currently preserves a range of industrial heritage, including coal mining techniques, equipment and main and secondary shaft hoisting equipment from various periods, which is typical and rare in the coal industry (Zhang, Cheng and Min, 2004). This not only reflects the top level of coal mining technology in various historical periods in China, but also provides invaluable historical evidence for understanding the history of the development of the coal industry in Shaanxi Province, China. The score for its addition and improvement of historical documents is 2 according to the evaluation criteria.

(5) In terms of uniqueness and scarcity, the Wang Shi Wa coal mine is the most important coal mine in Shaanxi, supplying a constant flow of energy to the Shaanxi industry, and is a typical representative of the 156 projects, being the only coal project in north-western China built with Soviet aid (Zhu, Wu and Liu, 2016). Furthermore, it was one of the few examples of 156 Projects related to the energy industry. It was also the forerunner of the joint venture between the government and the railway bureau, which greatly advanced the development of the coal industry. According to the evaluation criteria, it scores 3 points for uniqueness and scarcity.

(6) In terms of completeness, the front area of the plant, the production area, the auxiliary production area, and the storage and transportation area of the Wang Shi Wa coal mine, the main body of the buildings and production equipment of the production area are well preserved and provide a good demonstration of the working process and excavation techniques of the coal mine at that time. Overall, the foundations of the buildings are in good condition. According to the evaluation criteria, its completeness score is 4.

Table 66. The Historical Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A1 Historical value	**A11** The date of construction of the heritage	2	0.0827	0.86
	A12 Witness to the level of social development	4	0.0464	
	A13 Witness to important events	4	0.0292	
	A14 The addition and completion of historical documents	2	0.0585	
	A15 Uniqueness and scarcity	3	0.0413	
	A16 Completeness	4	0.0368	
Total score	(Total possible score is 24)	19		

In summary, with a total score of 19 (total possible score is 24) for its historical value and combined each weighting:

2×0.0827+4×0.0464+4×0.0292+2×0.0585+3×0.0413+4×0.0368, its final score is 0.8559 (total possible score is 1.1796). To make the statistics more convenient, two decimal places are taken and the final score is 0.86.

5.2.4.2 Scientific and Technological Values

The technological value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in terms of (1) industrial buildings and equipment; (2) production processes; (3) technological representativeness.

Scientific and technological value is the key to distinguishing industrial heritage from other cultural heritage. The scientific and technological value of the industrial heritage of the Wang Shi Wa coal mine is reflected in the innovation of refined coal production techniques and processes, as well as in the complete preservation of scientific and technological archives from different periods.

(1) In terms of industrial buildings and equipment, the Wang Shi Wa coal mine has distinctive architectural features of its time and region. At the beginning of the mine, the production and auxiliary buildings and facilities were built in reference to the Soviet

design, which reflected the core production processes and technologies of the mine, as well as the advanced and rational construction methods and techniques of the time. Many of the buildings and equipment within the industrial heritage of the Wang Shi Wa coal mine have been well preserved in the prominent Soviet industrial style of the time, such as the Soviet-style office building, which has a symmetrical structure with a regular layout and an internal corridor design. These have the typical characteristics of Soviet-style architecture in the period of the 156 projects construction that the Soviet Union assisted in China, the period also called ‘the 156 period’.

All of these huge industrial production facilities have been efficiently and steadily contributing to the production, processing and transportation of the Wang Shi Wa coal mine, and demonstrate the scientific sophistication and innovation character of the equipment of the time. According to the evaluation criteria, the score for industrial buildings and equipment is 3.

(2) In terms of production processes, the main production processes of the Wang Shi Wa coal mine include vertical transport of the miners, the collection, transportation and selection of the raw coal. The production equipment and buildings associated with these processes are well preserved and provide a good representation of the production techniques and production lines of the time. According to the evaluation criteria, these production processes are scored as 4 points.

(3) Regarding technical representation, the Wang Shi Wa coal mine has accumulated many valuable experiences during its development, which were of great value in promoting the progress of science and technology and the development of the coal industry at that time. During its development, the Wang Shi Wa coal mine boasted leading national technologies in shaft construction, surface blasting and coal mining, as well as widely used scientific research achievements (Zhang and Hao, 2019). In 1958, the main shaft and the winding shaft set national records of 9.66m and 109.44m respectively for single-row operations into the well (Zhu, Wu and Liu, 2016). In 1965, it successfully tested the limestone light surface blasting technology, which was a leading position in China, and the mechanization rate of the mine reached 100%, and was the national champion of high-grade conventional mining four times (Zhang and Hao, 2019; Song, 2007).

Wang Shi Wa coal mine has achieved more than 40 scientific and technological achievements and more than 80 engineering reforms of various kinds, and many of the scientific and production technologies have been promoted and used nationwide in China (Liu, 2020). The industrial heritage of the Wang Shi Wa coal mine provides evidence of the scientific and technological progress of the coal industry in modern China and enables research into the scientific and technological development of the coal industry. Its technological representativeness was scored as 4 according to the evaluation criteria.

Table 67. The Scientific and Technological Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	The detail layer	Score	Weights	Final score
A2 Scientific and technological value	**A21** Industrial buildings and equipment	3	0.0515	0.37
	A22 Production processes	4	0.0204	
	A23 Technological representativeness	4	0.0324	
Total score	(Total possible score is 12)	11		

In summary, with a score of 11 (total possible score is 12) for its technology and combined each weighting: 3×0.0515+4×0.0204+4×0.0324, its final score is 0.3657 (total possible score is 0.4172). To make the statistics more convenient, two decimal places are taken and the final score is 0.37.

5.2.4.3 Cultural Values

In evaluating the cultural value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 is based on three main aspects: (1) positive energy value; (2) negative energy value; (3) neutral energy value.

(1) In terms of positive values, the Wang Shi Wa coal mine has witnessed the development of China and the growth of China’s coal industry. The Wang Shi Wa coal mine has produced scientific research results that lead to the development of the coal industry, such as the divided-stage, cross-stone gate, continuous mining method, and has given birth to a leading process of high-grade general mining. It also set a new record for the highest single-row operation in China for the completion of a shaft. Numerous

miners, braving tough conditions and working hard, embodied the unrelenting spirit of the people of Wang Shi Wa coal mine during the period of industrial backwardness. In addition, the Wang Shi Wa coal mine, one of the 156 projects, is also a testimony to the history of Sino-Soviet friendship. This international friendship of helping each other is also worth remembering.

During the design deepening process, the relationship between China and the Soviet Union broke down and the Soviet engineering experts left, leaving many of the ancillary projects, especially the supporting living buildings, to be completed independently by the Xi'an Coal Mine Design and Research Institute. This also shows that it is important to treat Soviet technology correctly, to learn but not to follow it blindly, and to improve and innovate in the process of digestion and absorption. According to the evaluation criteria, its positive energy value score is 4.

(2) With regard to negative energy values, the Wang Shi Wa coal mine was established at the beginning of the founding of New China, when the level of industrialisation, especially heavy industry, was lagging behind, but this negative energy was inspiring people to work hard. It came in the form of negative energy and spread outwards in the form of positive energy. According to the evaluation criteria, its negative energy value is classified as 1.

(3) In terms of neutral value, the industrial heritage of the Wang Shi Wa coal mine is a witness to the development of China's coal industry, and the advanced technology and equipment as well as the working diary and the layout of the entire mine area imported from the Soviet Union have played a positive role in the subsequent development of the coal in China. According to the evaluation criteria, its neutral energy value score is 4.

Table 68. The Cultural Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A3 Cultural value	**A31** Positive energy value	4	0.0865	0.60
	A32 Negative energy value	1	0.0343	
	A33 Neutral value value	4	0.0545	
Total score	(Total possible score is 12)	9		

In summary, with a cultural value score of 9 (total possible score is 12) and combined each weighting: 4×0.0865+1×0.0343+4×0.0545, its final score is 0.5983 (total possible score is 0.7012). To make the statistics more convenient, two decimal places are taken and the final score is 0.60.

5.2.4.4 Artistic Value

The artistic value of industrial heritage, according to the previous analysis of the value of industrial heritage, is evaluated in terms of (1) aesthetic landscape value; (2) the value of artwork; (3) the level of artistic style expression.

(1) In terms of aesthetic landscape value, the Wang Shi Wa coal mine was planned and designed by a team of Chinese and Soviet designers, so the buildings of the mine are in the style of Soviet architecture and Tongchuan cave architecture of the time. This fusion of the two gives the area of the coal mine's industrial heritage an artistic imprint of both the local Tongchuan regional culture and the foreign culture of the Soviet Union, with a variety of national styles that reflect the unique style of the Chinese and Soviet people of that era. However, the greening rate of Wang Shi Wa Mine is low, with less greenery planted on both sides of the road and only some man-made areas. According to the evaluation criteria, the score for aesthetic landscape value is 4.

(2) Regarding the value of the artwork, the mine, coal separation building, transport trains and tracks in the Wang Shi Wa coal mine site can be used as exhibits in an outdoor museum to enhance people's understanding of the process and history of coal mining. For the Wang Shi Wa coal mine industrial heritage site broken or dismantled equipment can be reused to decorate the environment, turning it into sculptural artefacts. These material scraps embody the grandeur of the industrial era. According to the evaluation criteria, the work was given a score of 2.

(3) In terms of the level of artistic style expression, the Wang Shi Wa coal mine mainly has three architectural styles. The first is the Soviet style of architecture. The main focus is on the Administration Building of Wang Shi Wa coal mine, which is symmetrical, with a five-section structure with the middle slightly higher than the sides, and a 3-4 floors brick and concrete structure with an internal corridor. The building has the typical characteristics of Soviet-style architecture of the '156 period'.

The second category is the combination of Chinese and Soviet styles. The representative is the Soviet Expert Building, which was designed for Soviet engineering experts at the time. It is located on the east side of the Administration Building, relying on the topographical features of the gentle slope on the north side, and is a small two-storey cave building. It is about 40 metres long and 8 metres wide, with an overall mixed brick and stone structure and a total of ten openings on a single floor. It is built on a south-facing hillside, with its back to the slope and overall facing south towards the sun. The overall appearance of the building is relatively well protected and has the character of the central Shaanxi plain caves.

The third category is the modern architectural style. These buildings were mostly within the overall design at the beginning of the mine's construction, but were not built. After the Soviet experts left, they were designed and built to meet the needs of the people in the development of production and life in the Wang Shi Wa coal mine. An example of this is the Miners' Club, built in 1983, which has a symmetrical façade and is approximately 38m wide and 16m high. The level of artistic style expression is scored as 4 according to the evaluation criteria.

Table 69. The Artistic Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A4 Artistic value	**A41** Aesthetic landscape value	4	0.0865	1.9283
	A42 The value of the artwork	2	0.0343	
	A43 The level of artistic style expression	4	0.0545	
Total score	(Total possible score is 12)	10		

In summary, the artistic value score is 10 (total possible score is 12), and combined each weighting: 4×0.0865+2×0.0343+4×0.0545, its final score is 0.6326 (total possible score is 0.7012). To make the statistics more convenient, two decimal places are taken and the final score is 0.63.

5.2.4.5 Location Values

In evaluating the locational value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 focuses on (1) distance from the city centre; (2) transport connectivity to the city centre; (3) the number of central cities or the number of central cities or tourist areas in the wider regional context.

(1) In terms of distance from the city centre, the Wang Shi Wa coal mine is located within the Aobei village in the eastern suburbs of the Yingtai District in Tongchuan, Shaanxi Province. According to Google Maps, it is 18 km from the city centre of the old town and would take 30 minutes by car. It is 57 km from the city centre of Tongchuan New District, which would take 60 minutes by car. The level of distance from the city centre scored 2 according to the evaluation criteria.

(2) Regarding the transport situation to the city centre, The main traffic outside the Wang Shi Wa coal mine site is the Yingbin Road, an urban arterial road with a total length of approximately 14 km, with a two-lane roadway in both directions and a width of 9 m. The available way to reach the site is by car and once-a-day intercity bus, which are not convenient. The internal traffic of the mine is weak, mainly due to the roads designed for production use and the railway lines for external transport. According to the evaluation criteria, the transport connectivity to the city centre is evaluated with a score of 1.

(3) In terms of the number of central cities or tourist areas in the wider regional context, the mine is in the pivotal position of the circular tourism economic belt of Tongchuan, with the ancient town of Chenlu to the south, the Ba Wang Kiln ruins to the east, and four major scenic spots within 100 kilometres, including Yakwang Mountain, Yuhua Palace, Xiangshan Mountain and Yaozhou Kiln. A score of 4 is given for the number of central cities or tourist areas in the wider regional context according to the evaluation criteria.

Table 70. The Location Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B1 Location value	**B11** Distance from the city centre	2	0.0406	0.20
	B12 Transport connectivity to the city centre	1	0.0161	
	B13 The number of central cities or tourist areas in the wider regional context	4	0.0256	
Total score	(Total possible score is 12)	7		

In summary, its location value score is 7 (total possible score is 12), and combined each weighting: 2×0.0406+1×0.0161+4×0.0256, its final score is 0.1997 (total possible score is 0.3292). To make the statistics more convenient, two decimal places are taken and the final score is 0.20.

5.2.4.6 Environmental Value

In evaluating the environmental value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 focuses on: (1) The impact of the original production function of industrial heritage on the environment; (2) The environmental scope of the industrial heritage.

(1) Regarding the impact of the original production function of industrial heritage on the environment, the storage area of the Wang Shi Wa coal mine has a lot of open space, but the surface vegetation has been severely damaged by years of coal storage. To the south of the site is a large valley with a height difference of around 30m between the coal processing building and the valley. The coal ash from the coal processing building has a damaging effect on the ecological balance of the valley, and the ecological damage caused by decades of coal mining at the Wang Shi Wa Mine is prominent. According to the evaluation criteria, the impact of the original production function of industrial heritage on the environment score is 2.

(2) In terms of the environmental scope of the industrial heritage, many buildings have appeared in and around the industrial heritage of the Wang Shi Wa Mine over the years that are not in harmony with the industrial heritage, and the overall architectural appearance is different. The majority of these buildings are either temporary or

abandoned shack-dwellers buildings, most of which are in a state of disrepair. There is a significant difference in style and texture from the buildings within the industrial heritage, resulting in a poor quality of appearance in the overall environment. The environmental scope of the industrial heritage was scored as 3 according to the evaluation criteria.

Table 71. The Environmental Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B2 Environmental value	**B21** The impact of the original production function of industrial heritage on the environment	2	0.0208	0.1248
	B22 The environmental scope of the industrial heritage	3	0.0104	
Total score	(Total possible score is 8)	4		

In summary, the score for environmental value is 5 (total possible score is 8), and combined each weighting: 2×0.0208+3×0.0104, its final score is 0.0728 (total possible score is 0.1248). To make the statistics more convenient, two decimal places are taken and the final score is 0.07.

5.2.4.7 Group Value

The group value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in terms of (1) the scale of the group; (2) the relationship of the group; (3) the potential for wide-scale groups of industrial heritage.

Wang Shi Wa is located in the Yingtai District of Tongchuan City and is part of the Tongchuan Mining Bureau. Nearby are mined such as Jinhuashan Mine, Lijata Mine, Shijiahe Mine and Majiayao Mine, and other industrial enterprises such as Chenxu Ceramics Factory and Xinchuan Cement Factory. According to the evaluation criteria, it scored 4 for the scale of the group; it scored 2 for the relationships of the group because the nearby industries belong to the same industrial categories; it scored 4 for the potential for wide-scale groups of industrial heritage.

Table 72. The Group Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	The detail layer	Score	Weights	Final score
B3 Group value	**B31** The scale of the group	4	0.0203	0.15
	B32 Relationship of the group	2	0.0081	
	B33 The potential for wide-scale groups of industrial heritage	4	0.0128	
Total score	(Total possible score is 12)	10		

In summary, its group value has a score of 10 (total possible score is 12), and combined each weighting: 4×0.0203+2×0.0081+4×0.0128, its final score is 0.1486 (total possible score is 0.1648). To make the statistics more convenient, two decimal places are taken and the final score is 0.15.

5.2.4.8. Social Value

The social value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in four main ways: (1) The ability to solve re-employment; (2) Educational function; (3) The potential to provide a place of leisure for the public; and (4) Enhancing the image or symbolism of the city.

(1) In terms of the ability to solve re-employment, during the normal production phase before bankruptcy and closure, the Wang Shi Wa Mine employed a large number of workers and managers, employing more than 7,000 people, and has a high potential to employ more than 100 people after transformation. The ability to solve re-employment was scored as 2 according to the evaluation criteria.

(2) Regarding the educational function, the underground space and facility at Wang Shi Wa can be used for teaching mine science, turning theoretical knowledge into a visible and tangible entity and becoming a science education base for primary and secondary schools. The underground space of Wang Shi Wa's coal mine industrial heritage can also be reused as a tourist attraction, showcasing a unique underground mine experience and enhancing people's understanding of the process and history of coal mining. It has great potential to be developed as a space for providing science education. Based on the evaluation criteria, their score for the educational function is 3.

(3) As for the potential to provide a recreational space for the public, the site of the Wang Shi Wa coal mine, as well as the industrial production facilities, has great potential to be transformed into an open space for public recreation and entertainment. According to the evaluation criteria, the score for the potential to provide a place of leisure for the public is 3.

(4) In terms of enhancing the image or symbolism of the city, the Wang Shi Wa coal mine is not currently known and understood by the majority of the public. However, since it was identified as a national industrial heritage site in 2018, its popularity has been increasing. However, as the transformation has not yet been completed, most of the mine is still in an abandoned state. According to the evaluation criteria, its score for enhancing the image or symbolism of the city is 3.

Table 73. The Social Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B4 Social value	**B41** The ability to solve re-employment	2	0.0164	0.11
	B42 Educational function	3	0.0097	
	B43 The potential to provide a place of leisure for the public	3	0.0069	
	B44 Enhancing the image or symbolism of the city	3	0.0082	
Total score	(Total possible score is 16)	11		

In summary, the social value score is 11 (total possible score is 16) and combined each weighting: 2×0.0164+3×0.0097+3×0.0069+3×0.0082, its final score is 0.1072 (total possible score is 0.1648). To make the statistics more convenient, two decimal places are taken and the final score is 0.11.

5.2.4.9 Emotional Value

The emotional value of industrial heritage, based on the analysis of the value of industrial heritage in Section 4.1, is evaluated in three main ways: (1) the number of people who have an emotional connection to industrial heritage; (2) the age range of the people who have an emotional connection to industrial heritage; (3) structural characteristics of the careers of people with emotional value.

The group of people who have an emotional value for the Wang Shi Wa Mine is relatively limited. Through random interviews with 30 people, the main reason for this is that the coal mine is located on the edge of the city and is not closely connected to the daily lives of citizens, so it is difficult for people to have emotional empathy for it. After interviewing residents, the people who would have an emotional effect on the Wang Shi Wa coal mine are predominantly those who have worked in iron or coal mines, professionals or non-professionals with an interest in industrial heritage. Their age structure is dominated by people over 20 years of age, with few teenagers being aware of and concerned with the survival and development of the coal mine. Therefore, the people who have an emotional value for the Wang Shi Wa coal mine tend to be singular in terms of occupational structure and age division. Therefore, combining the evaluation criteria, the scores for these three detail layers are 2, 3 and 2 respectively.

Table 74. The Emotional Value Score Table for the Wang Shi Wa Coal Mine

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B5 Emotional value	**B51** Number of people who have an emotional connection to industrial heritage	2	0.0268	0.13
	B52 The age range of the people who have an emotional connection to industrial heritage	3	0.0169	
	B53 Characteristics of the careers of people with emotional value	2	0.0106	
Total score	(Total possible score is 12)	7		

In summary, its emotional value has a score of 7 (total possible score is 12) and combined each weighting: 2×0.0268+3×0.0169+2×0.0106, its final score is 0.1255 (total possible score is 0.2172). To make the statistics more convenient, two decimal places are taken and the final score is 0.13.

5.2.5 A GIS Visualisation Process to Evaluate the Industrial Heritage Value of the Wang Shi Wa Coal Mine

According to the analysis in Section 4.9.2, the GIS visualisation of the industrial heritage value of the Wang Shi Wa coal mine is divided into three stages: (1) The first step was the collection of GIS data and the creation of a database. ArcGIS graphic files are drawn through field research and the attribute data obtained (information on the building's material, roof form, date of construction, structure) are entered into the GIS platform; (2) The single factors are analysed by correlating the spatial and property data; (3) The multi-factor weights calculated from the Analytic Hierarchy Process are overlaid and visualized in the ArcGIS platform.

5.2.5.1 ArcGIS Graphical File Obtaining and Creating a Database

The existing building of the Wang Shi Wa coal mine is drawn by AutoCAD. In order to apply ArcGIS technology, the file format of CAD file graphics (dwg.) needs to be converted to GIS system editable file format (shp.), the basic steps are as follows:

(1) Based on fieldwork and satellite maps downloaded from the Geospatial Data Cloud (a data cloud computing platform built by the Chinese Academy of Sciences Network Information Centre), the border lines of the building units of the Wang Shi Wa coal mine and road information are drawn in AutoCAD software. This study used AutoCAD 2022 software, and the AutoCAD data has been divided into layers and exported respectively: building layer, boundary line layer, and road layer. The current AutoCAD drawing of the Wang Shi Wa Mine is shown in Figure 58.

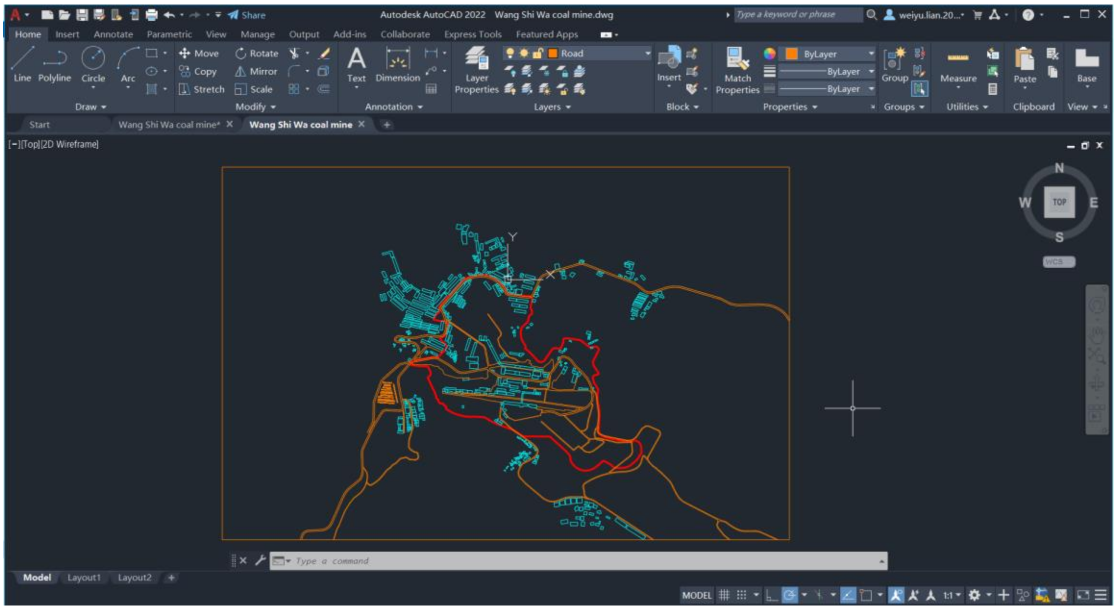


Figure 58. The Figure of Current status of Wang Shi Wa Coal Mine

(2) Export the AutoCAD file in layers as a dwg. file, then import the layers in the ArcGIS platform using the order 'Layer - Add Data' (Figure 59). And in the ArcGIS platform, through the Spatial Adjustment tool, the spatial position of the directly acquired remote sensing image is used as a reference for the spatial correction of the AutoCAD drawing (matching the drawn AutoCAD with the actual real geographic coordinates). AutoCAD files are divided into five forms in the GIS platform: Annotation, Point, Polyline, Polygon, and MultiPatch. Select the buildings as Polygon and select the Polyline for roads and boundary lines and delete the others (Figure 60). This facilitates the subsequent entering of property information and the multifactor overlay analysis. The collated diagram is shown in Figure 61.

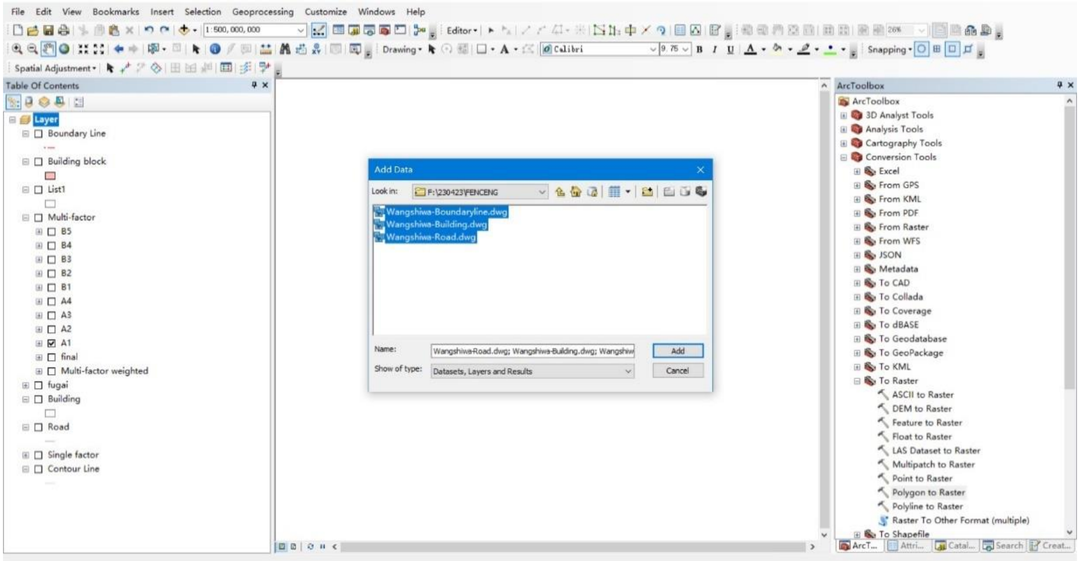


Figure 59. ArcGIS Add Data Screen

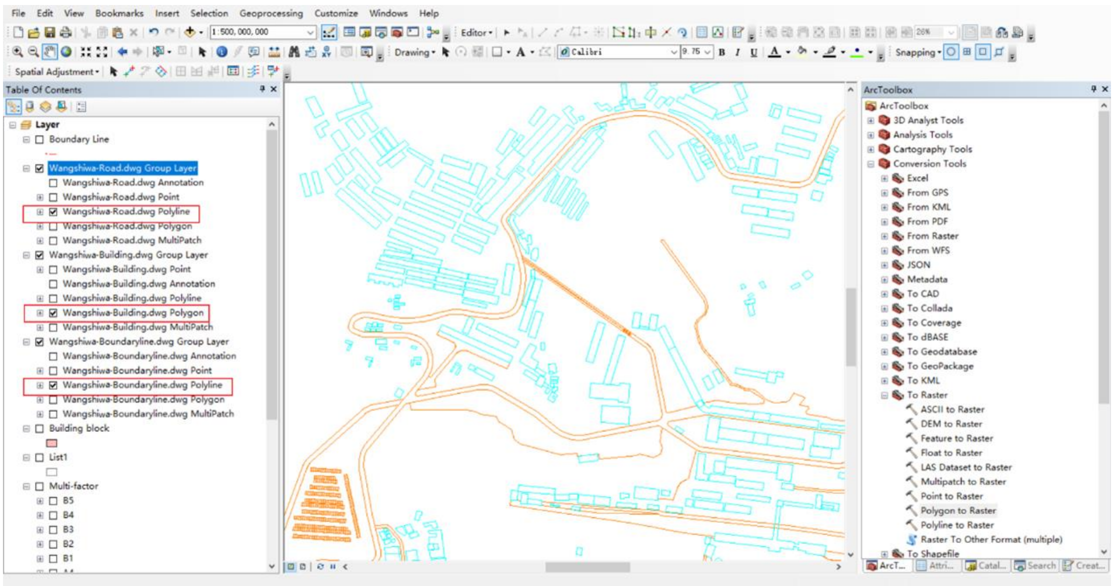


Figure 60. Format Options for AutoCAD Files on the ArcGIS Platform

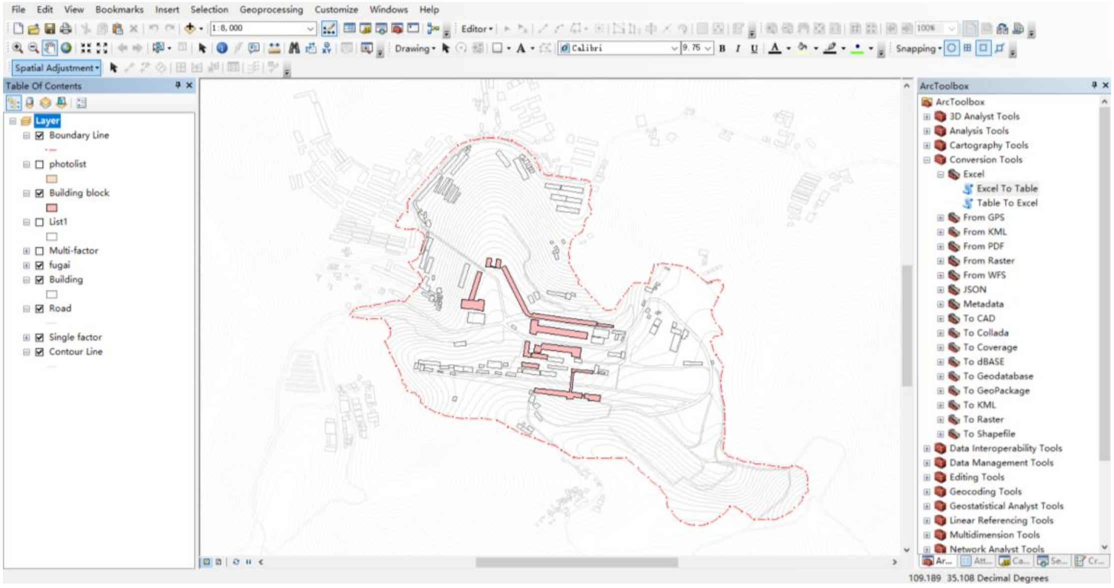


Figure 61. Organised Graphical Data

(3) The next step is to enter the property data. Add a field through the attribute table in ArcGIS, named ID (Figure 62). The buildings in Wang Shi Wa that need to be entered into the property data will be ID numbered in Editor mode, using the ArcToolBox tool: Conversion Tools-Excel-Table to Excel (Figure 63), and the edited IDs will be exported to an Excel file (Figure 64).

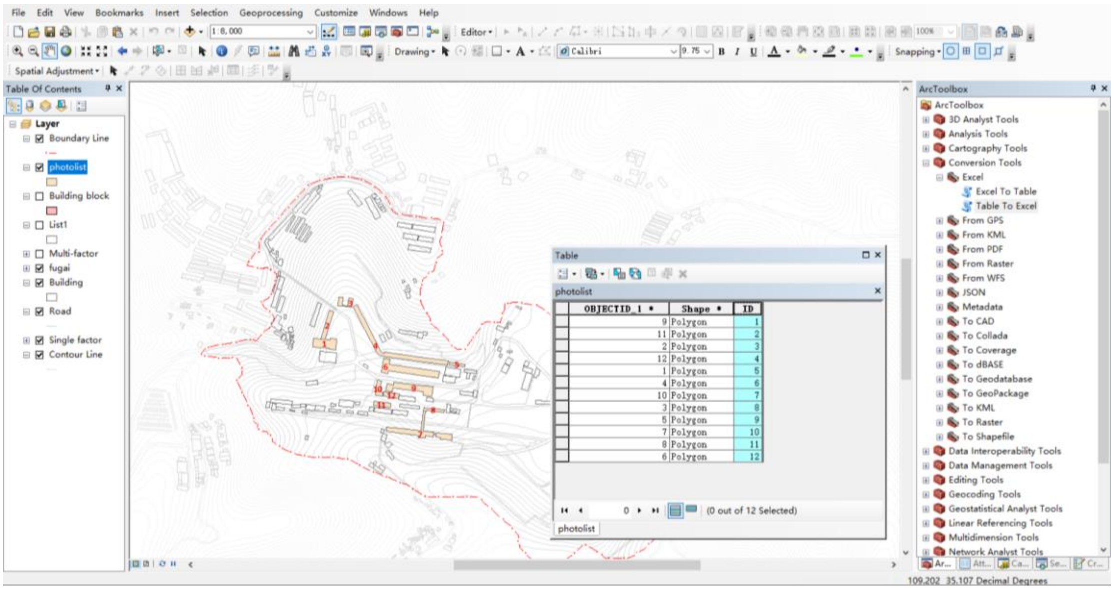


Figure 62. GIS Platform for ID Numbering of Wang Shi Wa Buildings

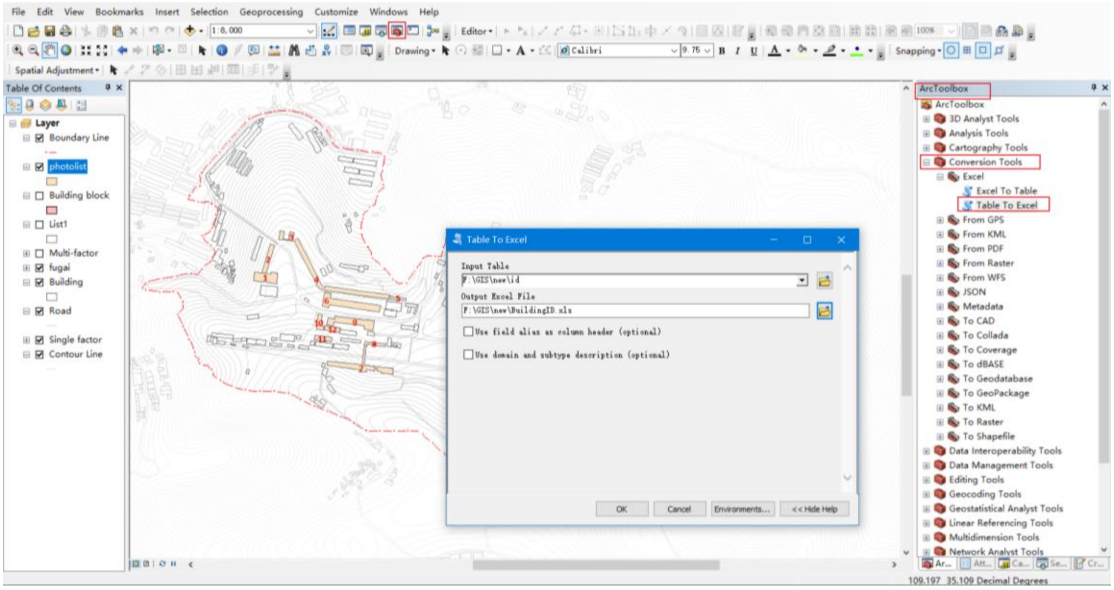


Figure 63. Process of Export Excel

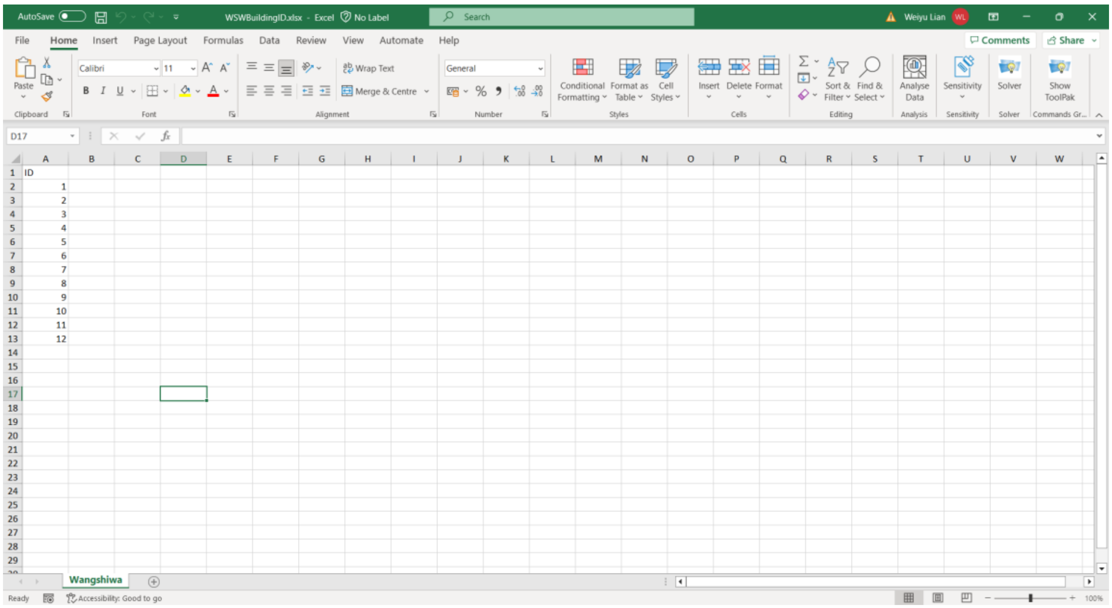
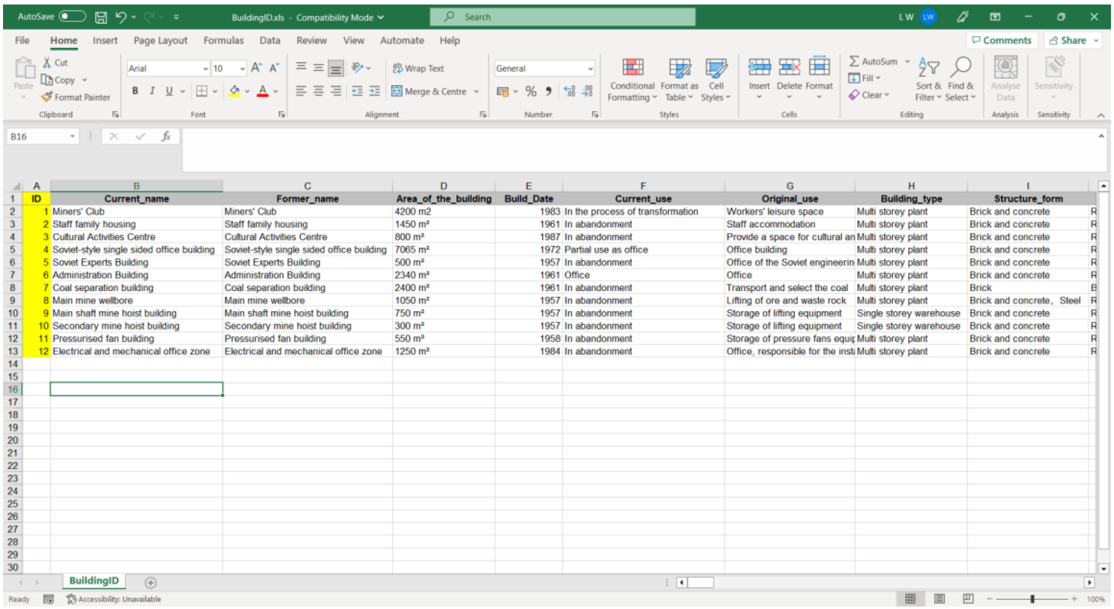


Figure 64. Building ID in Excel

After entering the attribute information collected from the field research into Excel (Figure 65), it was imported into ArcGIS software using the ArcToolBox tool: Conversion Tools-Excel- Excel to Table. Then use the Join and Relates-Join command (Figure 66) to relate the imported Excel data to the building layers in ArcGIS based on ID (Figure 67). Then, in order to write the attribute data thoroughly into the building layers of ArcGIS, the joined data needs to be exported as a new building database with attribute data to achieve a one-to-one correspondence between the graphical data and the attribute data. The command is Data-Export Data, which saves the building level data to the shapefile in a pop-up window (Figure 68). The exported table of building properties is shown in the Figure 69.



ID	Current_name	Former_name	Area_of_the_building	Build_Date	Current_use	Original_use	Building_type	Structure_form
1	Miners' Club	Miners' Club	4200 m2	1983	In the process of transformation	Workers' leisure space	Multi storey plant	Brick and concrete
2	Staff family housing	Staff family housing	1450 m²	1961	In abandonment	Staff accommodation	Multi storey plant	Brick and concrete
3	Cultural Activities Centre	Cultural Activities Centre	800 m²	1987	In abandonment	Provide a space for cultural an	Multi storey plant	Brick and concrete
4	Soviet-style single sided office building	Soviet-style single sided office building	7065 m²	1972	Partial use as office	Office building	Multi storey plant	Brick and concrete
5	Soviet Experts Building	Soviet Experts Building	500 m²	1957	In abandonment	Office of the Soviet engineerin	Multi storey plant	Brick and concrete
6	Administration Building	Administration Building	2340 m²	1961	Office	Office	Multi storey plant	Brick and concrete
7	Coal separation building	Coal separation building	2400 m²	1961	In abandonment	Transport and select the coal	Multi storey plant	Brick
8	Main mine wellbore	Main mine wellbore	1050 m²	1957	In abandonment	Lifting of ore and waste rock	Multi storey plant	Brick and concrete, Steel
9	Main shaft mine hoist building	Main shaft mine hoist building	750 m²	1957	In abandonment	Storage of lifting equipment	Single storey warehouse	Brick and concrete
10	Secondary mine hoist building	Secondary mine hoist building	300 m²	1957	In abandonment	Storage of lifting equipment	Single storey warehouse	Brick and concrete
11	Pressurised fan building	Pressurised fan building	550 m²	1958	In abandonment	Storage of pressure fans equi	Multi storey plant	Brick and concrete
12	Electrical and mechanical office zone	Electrical and mechanical office zone	1250 m²	1984	In abandonment	Office, responsible for the inst	Multi storey plant	Brick and concrete

Figure 65. Building Properties Table in Excel

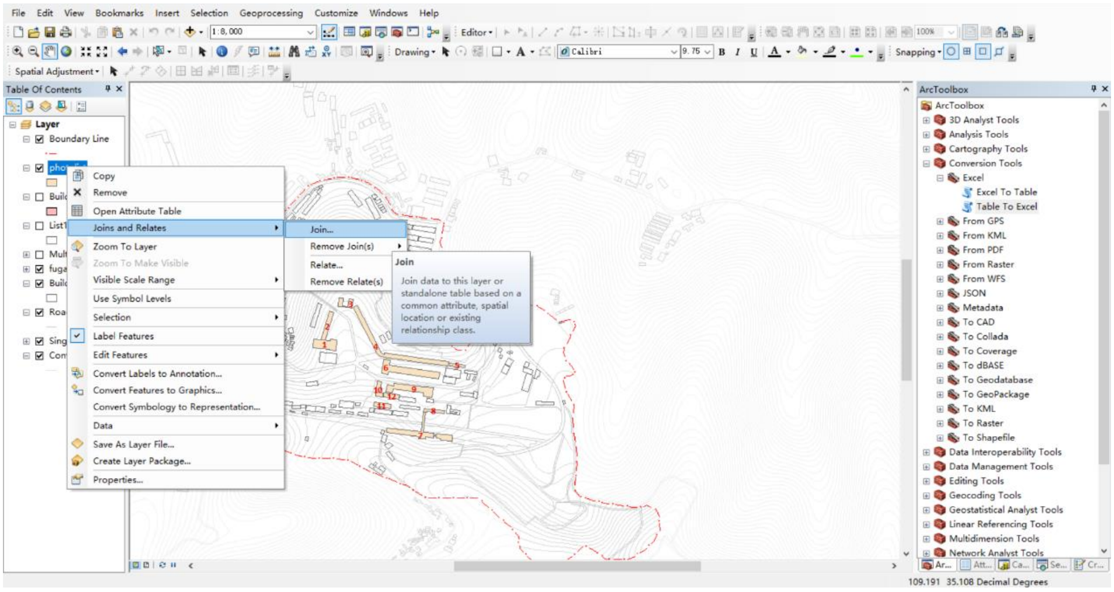


Figure 66. The Join Data Screen Step 1 for ArcGIS

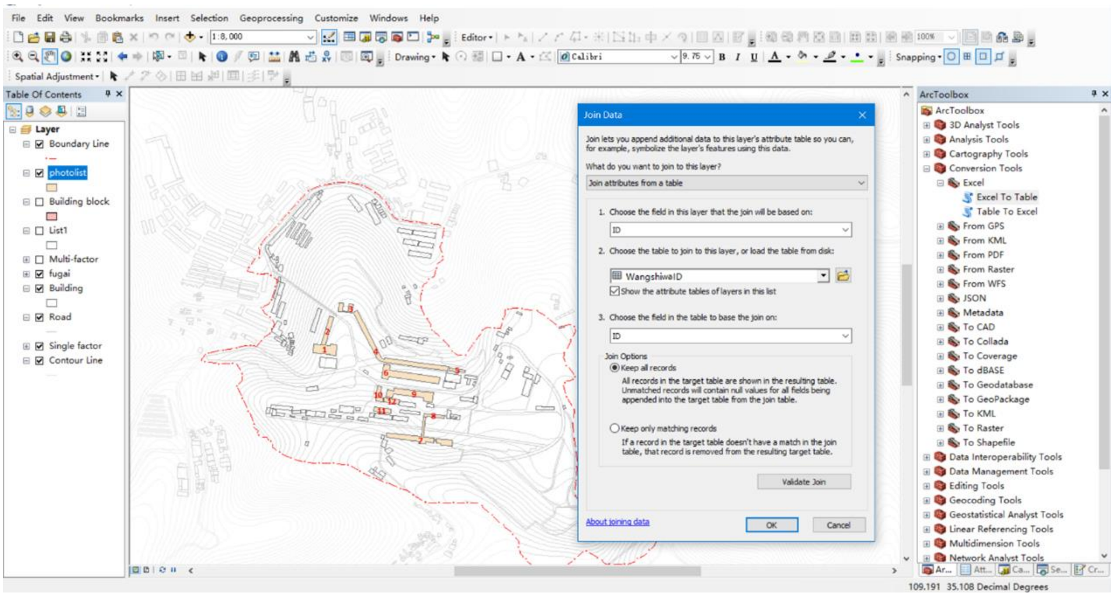


Figure 67. The Join Data Screen Step 2 for ArcGIS

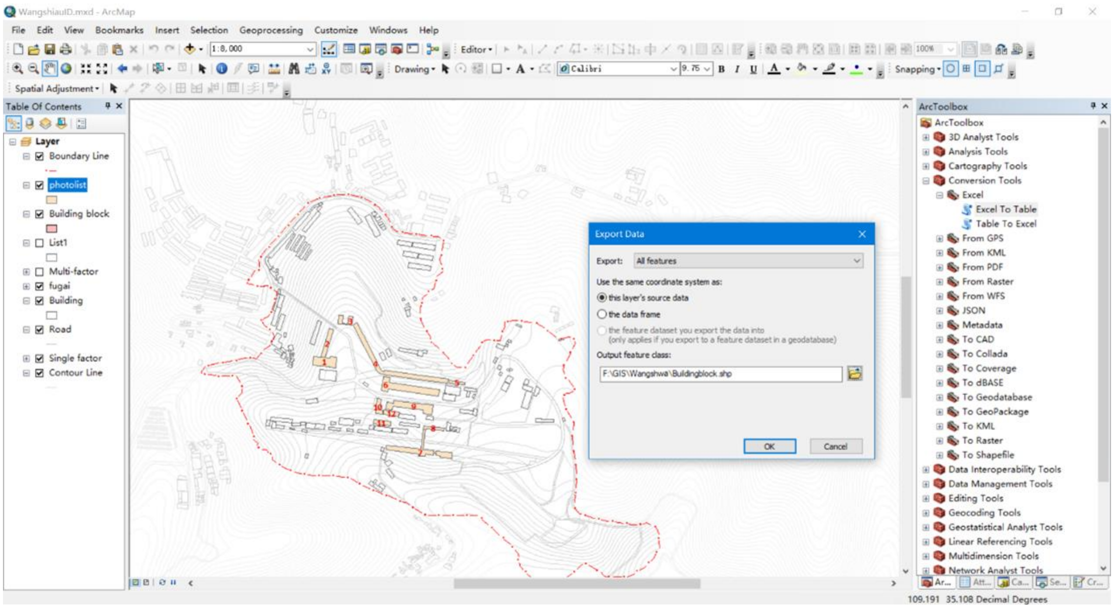


Figure 68. Export Data Screen for ArcGIS

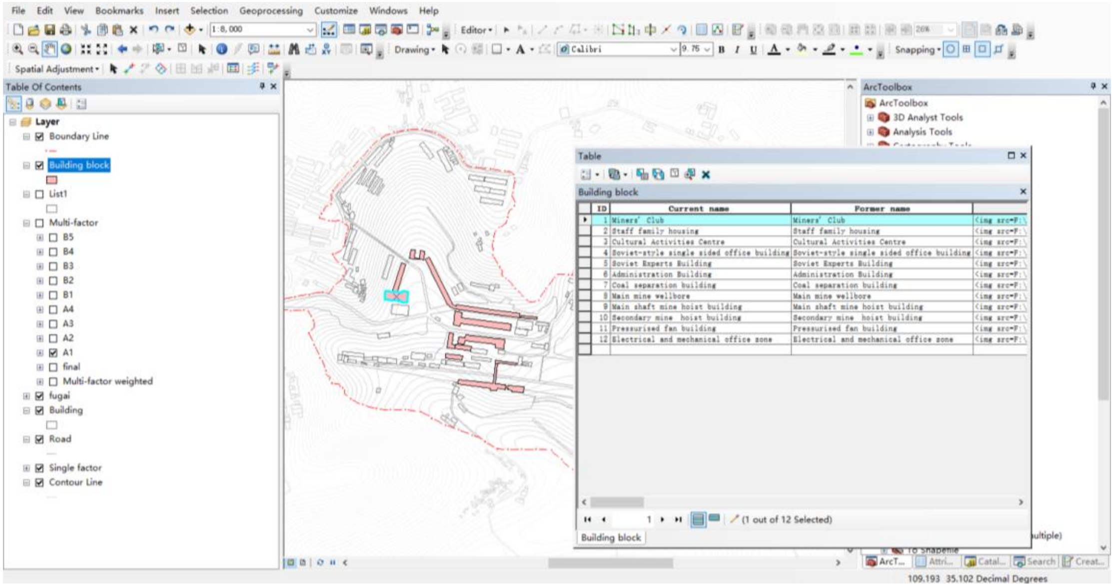


Figure 69. List of Building Attributes of Wang Shi Wa Coal Mine

In addition, in order to better visualise the building properties and current photos, the building photos are named according to the building ID in the format 1-1, 2-1 and entered into the building properties table. Then use the Layer Properties-HTML Popup command to enter the address of the image into the URL (Figure 70), and click on the HTML icon to bring up the building's properties and image information (Figure 71).

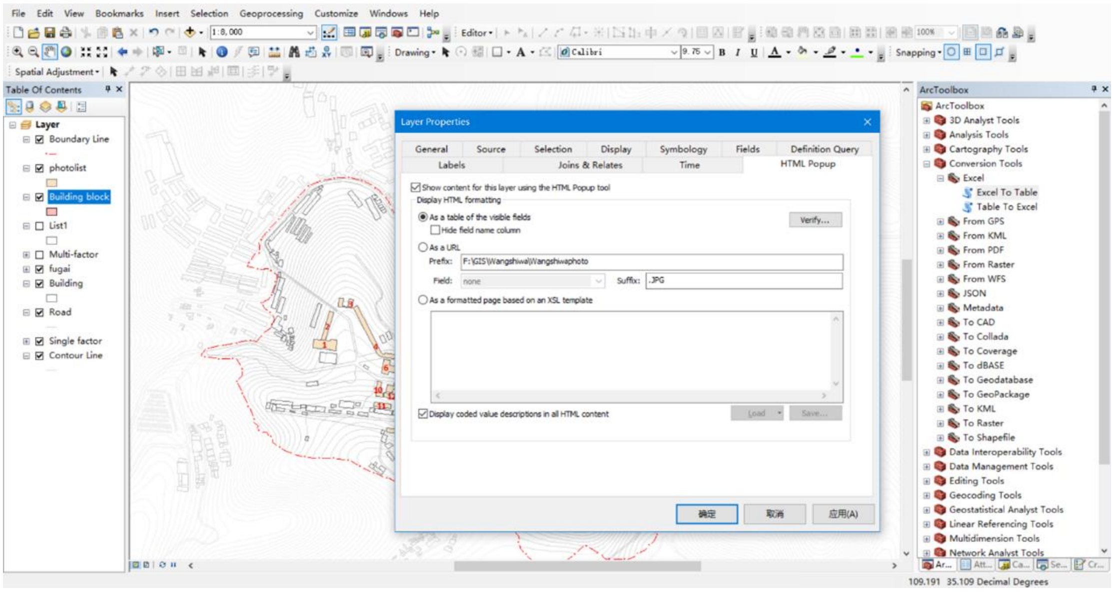


Figure 70. HTML Popup Setup Screen

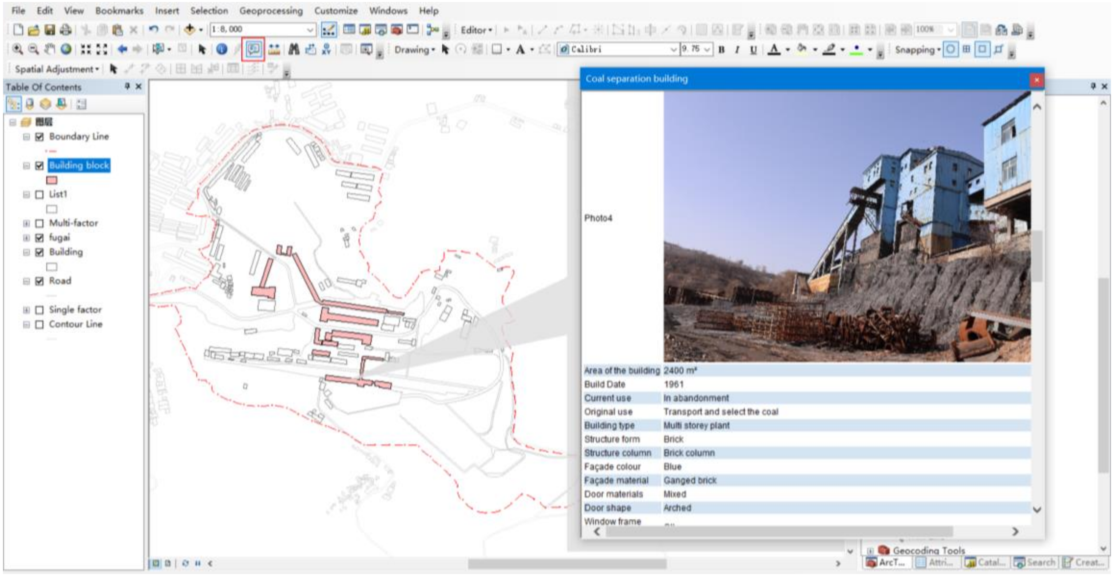


Figure 71. Properties Pop-up Screen

5.2.5.2 Single Factor Evaluation Visualisation

Based on the indicators identified in the industrial heritage value evaluation method proposed in Section 4.6, and the evaluation criteria in Section 5.1.9, values were assigned to each factor by reviewing relevant local literature, fieldwork and interviews. The criteria were divided into four levels of 4, 3, 2 and 1. By entering the scores in Excel, the scores for each factor are shown in Table (Figure 72).

NO_	A11_Score	A12_Score	A13_Score	A14_Score	A15_Score	A16_Score	A21_Score	A22_Score	A23_Score	A31_Score	A32_Score	A33_Score
1	1	3	4	2	2	4	3	3	3	4	2	
2	2	4	3	2	2	4	3	3	4	4	1	
3	1	3	3	2	2	4	3	3	4	4	2	
4	2	3	3	2	4	4	4	4	4	4	1	
5	2	4	4	2	4	4	4	4	4	3	1	
6	2	4	3	2	2	4	3	4	4	4	1	
7	2	4	3	3	3	4	4	4	4	4	1	
8	2	4	4	3	4	3	4	4	4	4	1	
9	2	4	4	3	2	4	4	4	4	4	1	
10	2	4	4	3	2	4	4	4	4	4	1	
11	2	4	4	2	2	4	2	4	4	4	1	
12	1	3	4	2	2	4	2	4	3	3	2	

Figure 72. Table of Different Factor Scores for each Building

Then import it into ArcGIS. Select the factor scores to be presented for visual representation in the Layer Properties – Symbology (Figure 73). The different colours in the chart show the different scores. For example, in the A11 The date of construction of the heritage single factor evaluation diagram, the rose blocks represent buildings constructed between 1949-1977 (scoring 2) and the light purple blocks represent buildings constructed after 1978 (scoring 1).

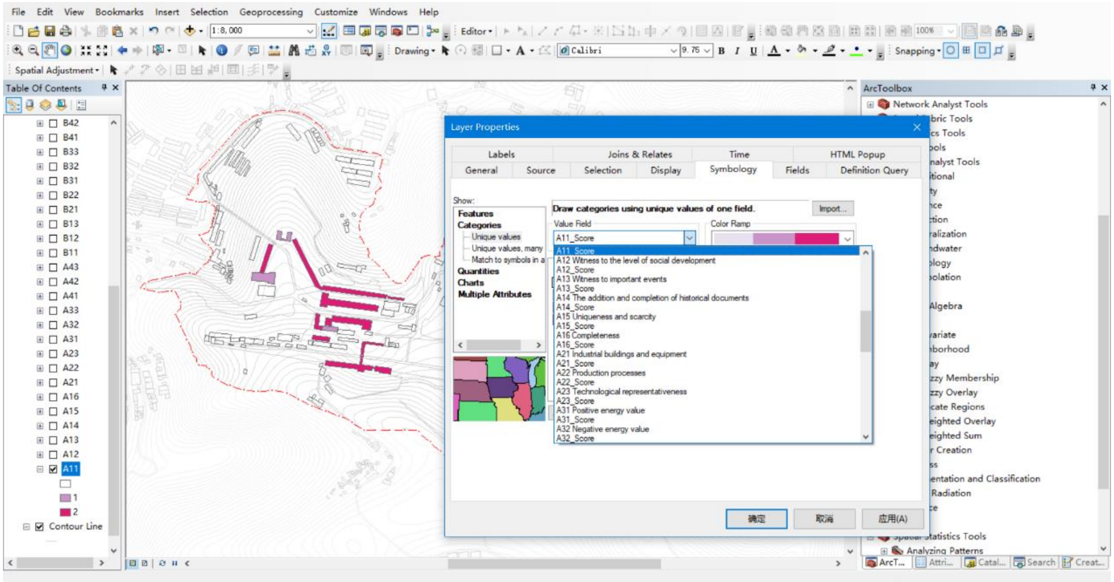
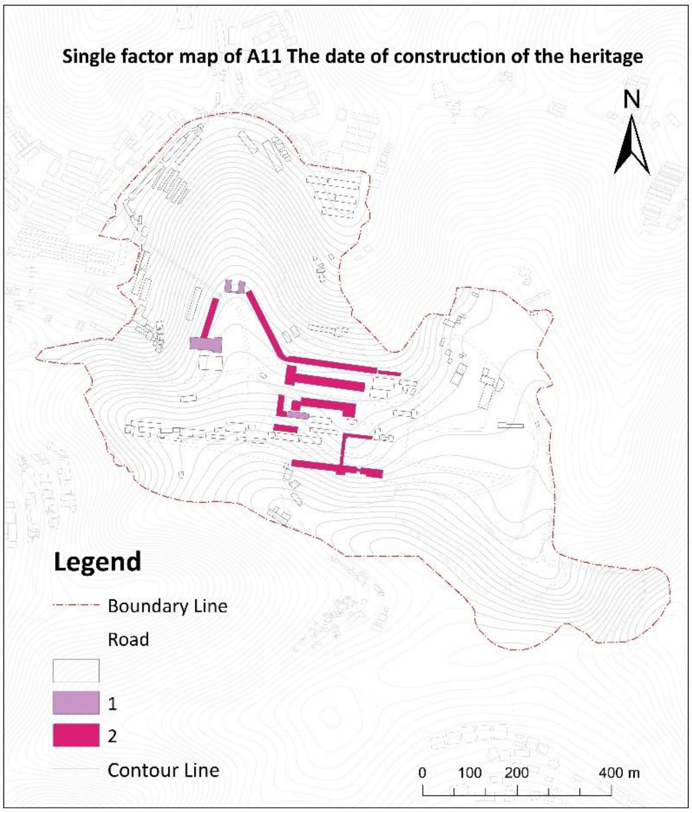
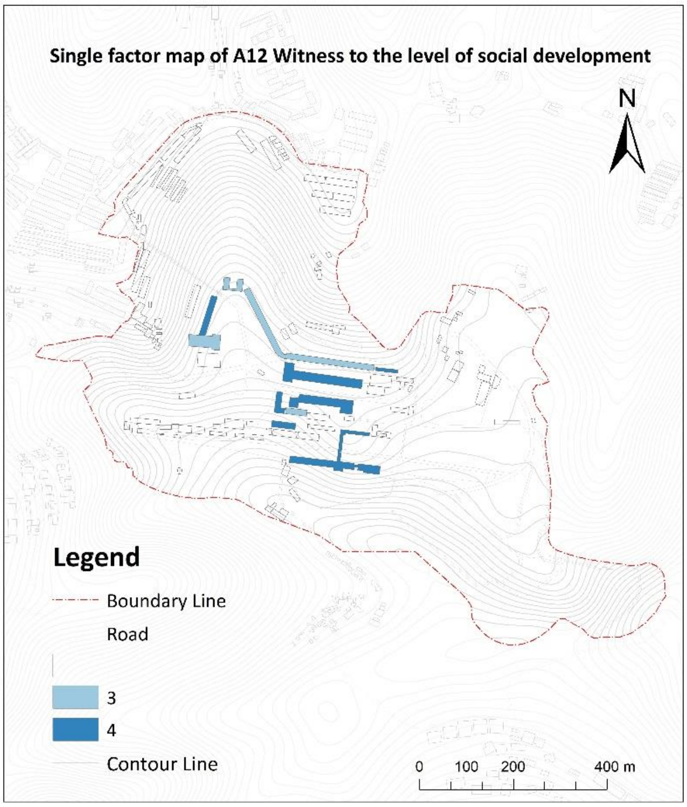
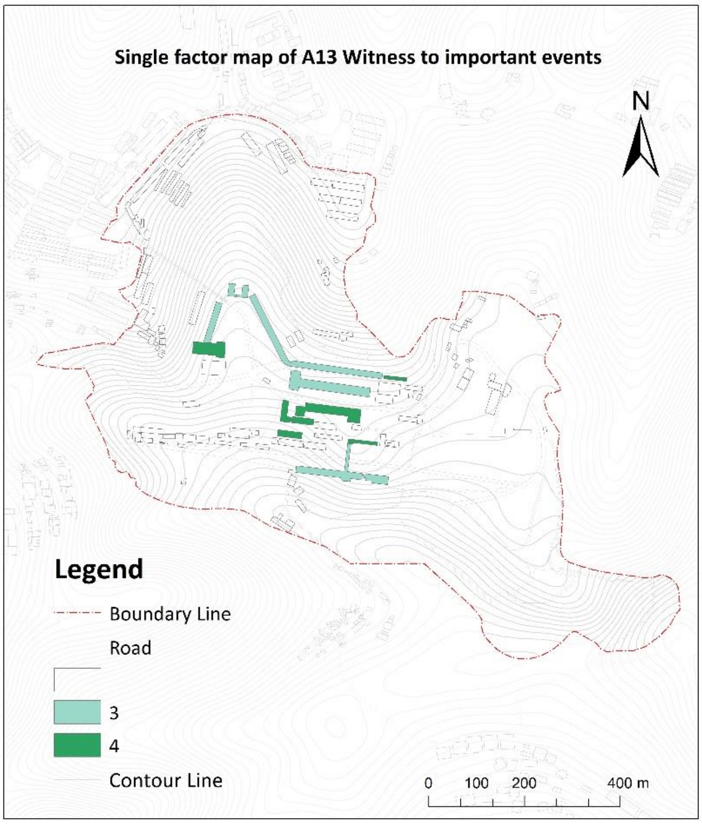
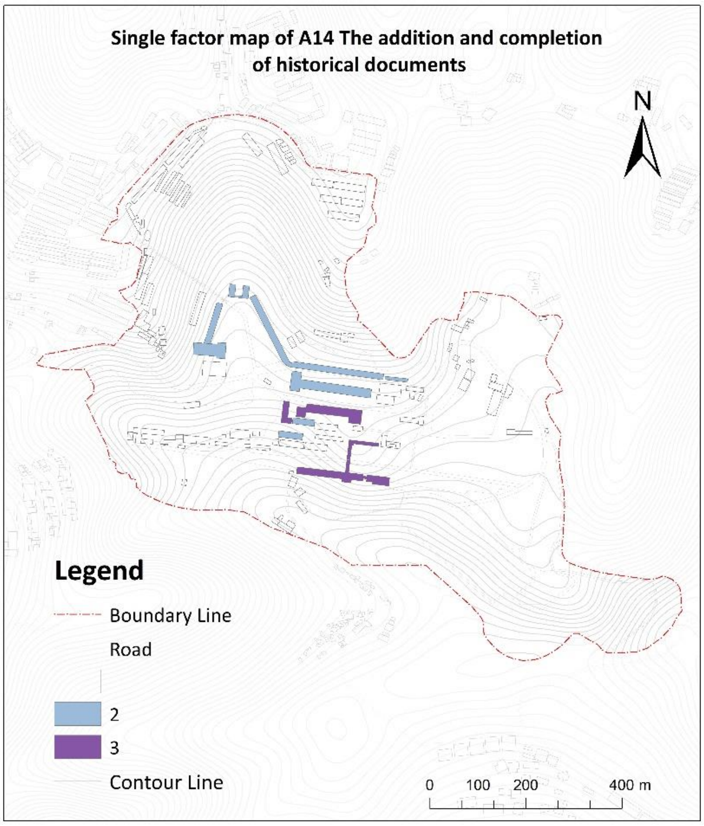
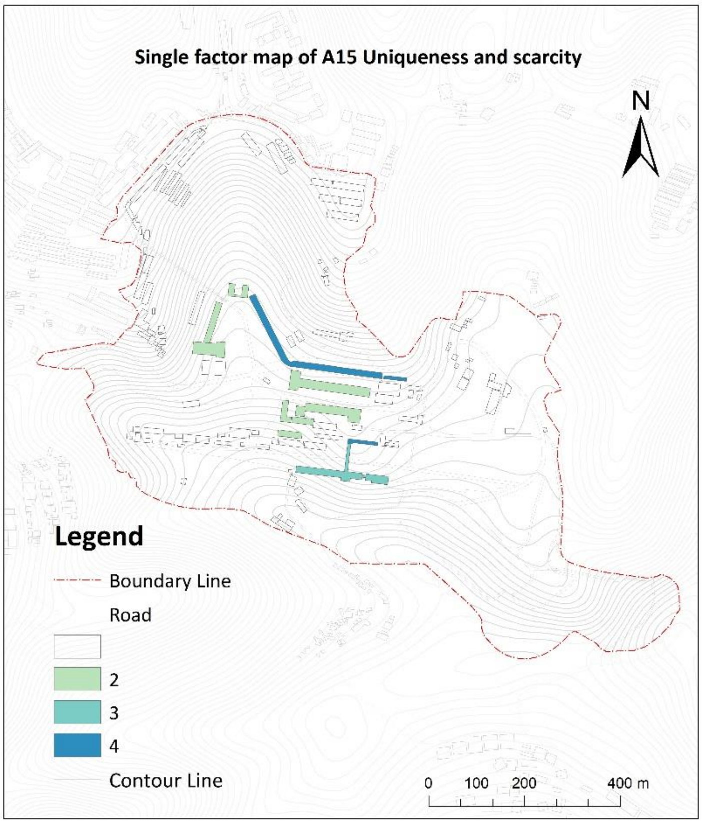


Figure 73. Visual Operational Diagram for Single Factor Evaluation

The results of the single factor evaluation are visualised in the table below:

Table 75. Single Factor Evaluation Visualisation of A1 Historical Value


Single factor map of A15 Uniqueness and scarcity
N
Legend
Boundary Line
Road
2
3
4
Contour Line
0 100 200 400 m

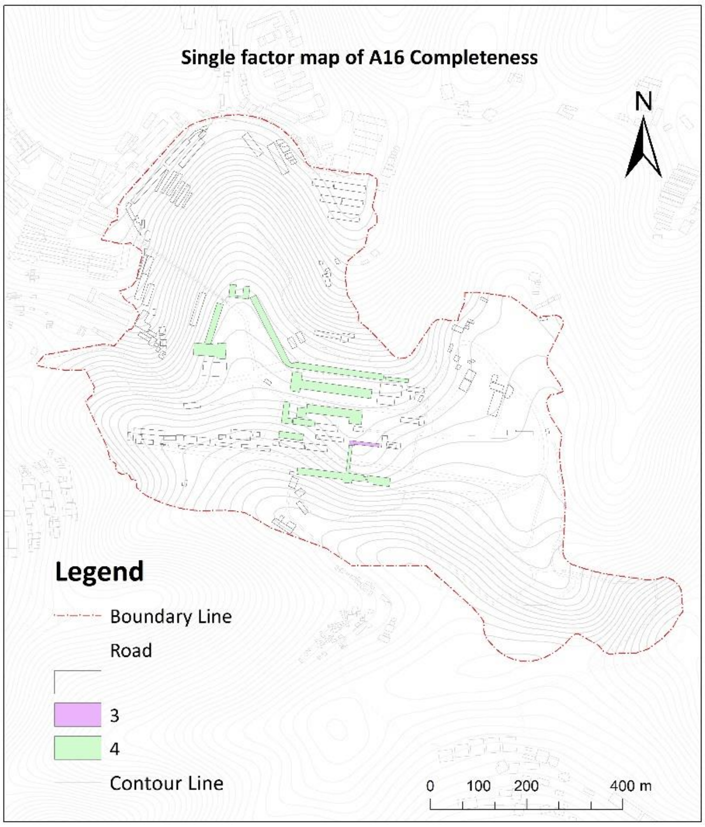
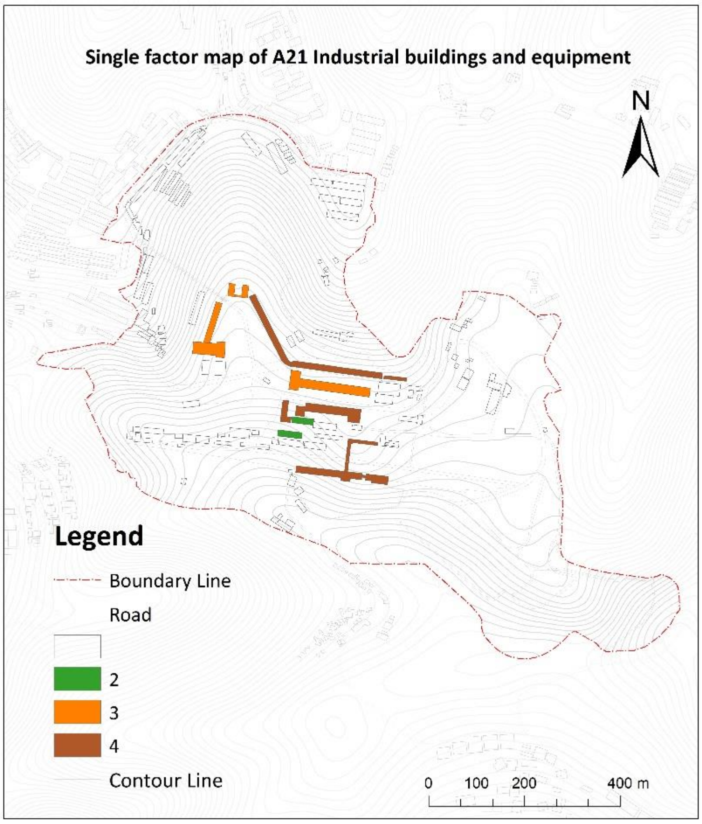
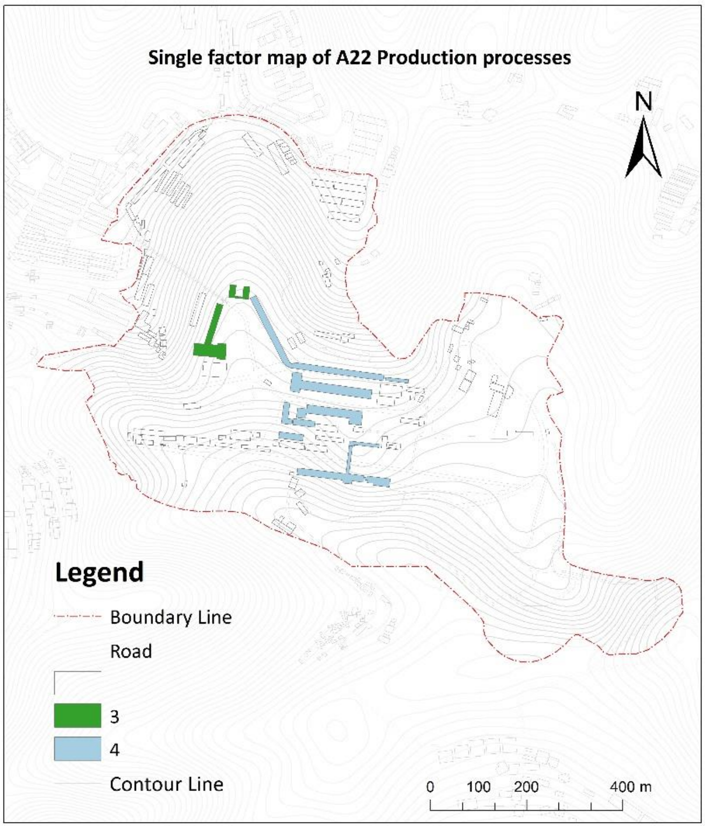

Single factor map of A16 Completeness
N
Legend
Boundary Line
Road
3
4
Contour Line
0 100 200 400 m

Table 76. Single Factor Evaluation Visualisation of A2 Scientific and Technological Value





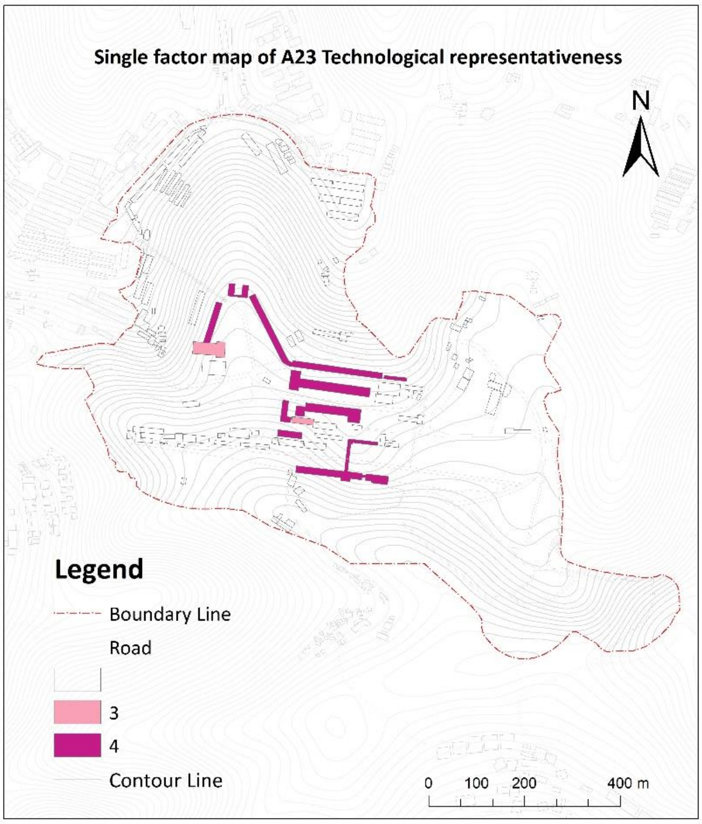
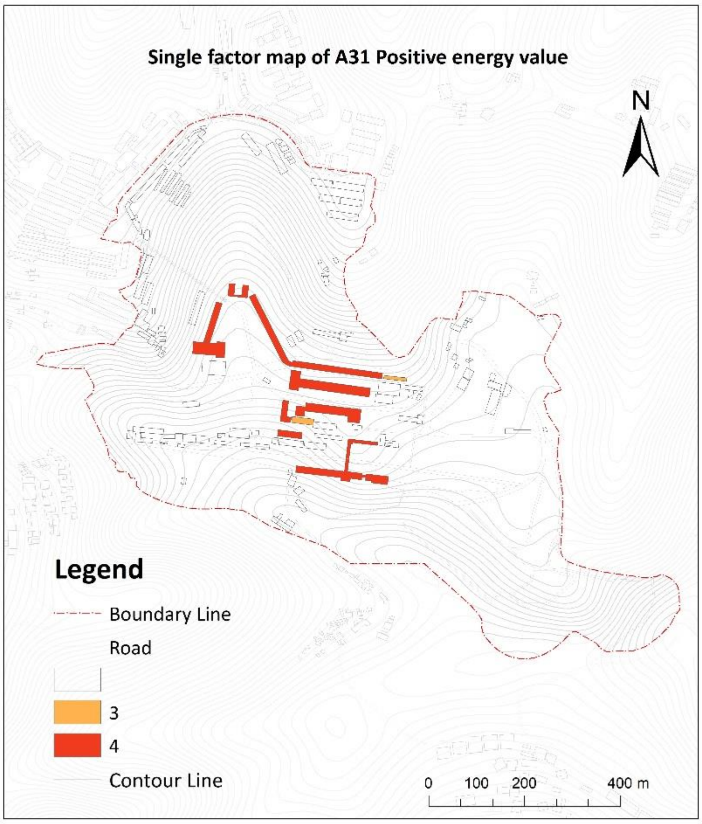
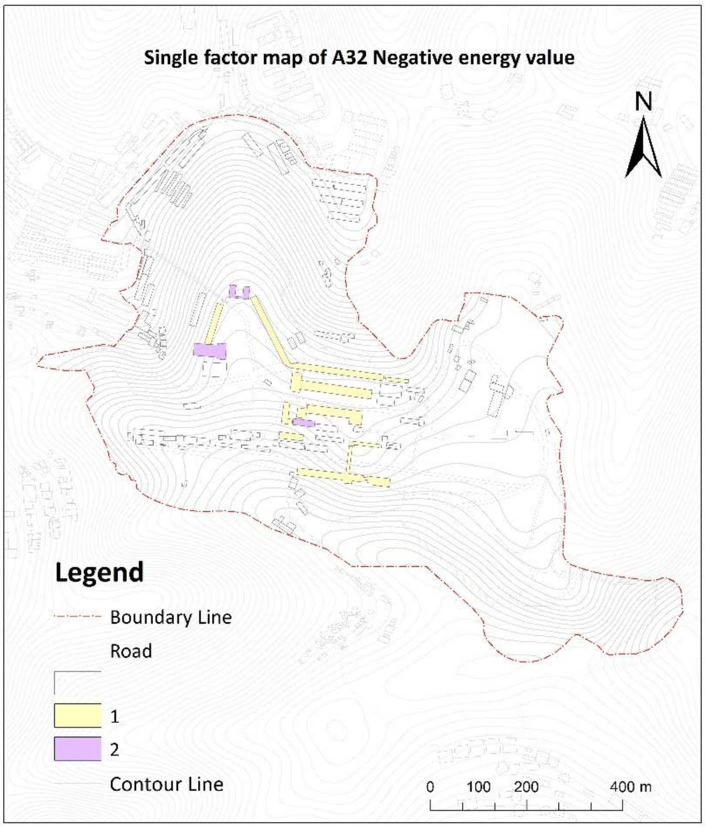


Table 77. Single Factor Evaluation Visualisation of A3 Cultural value





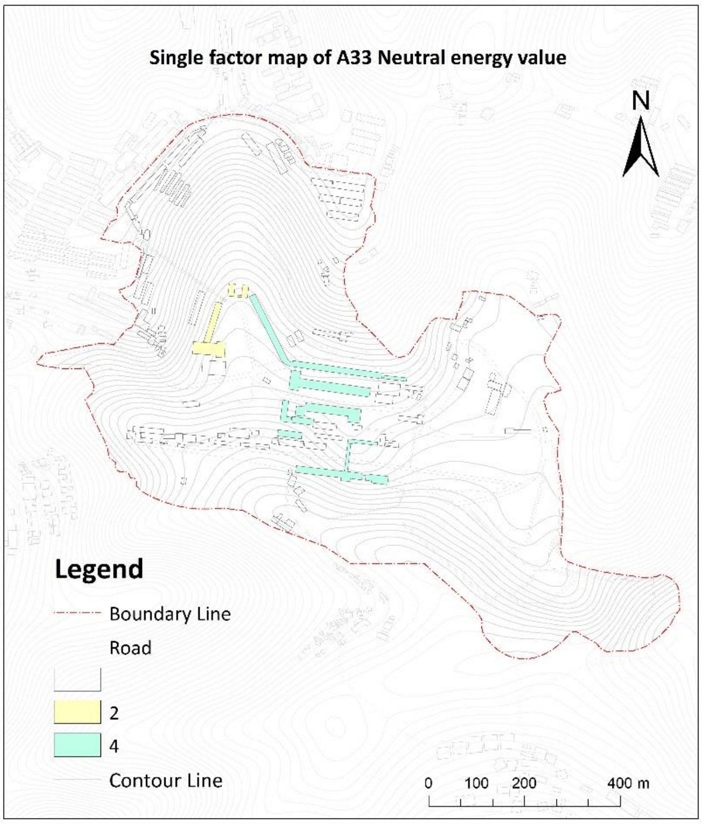
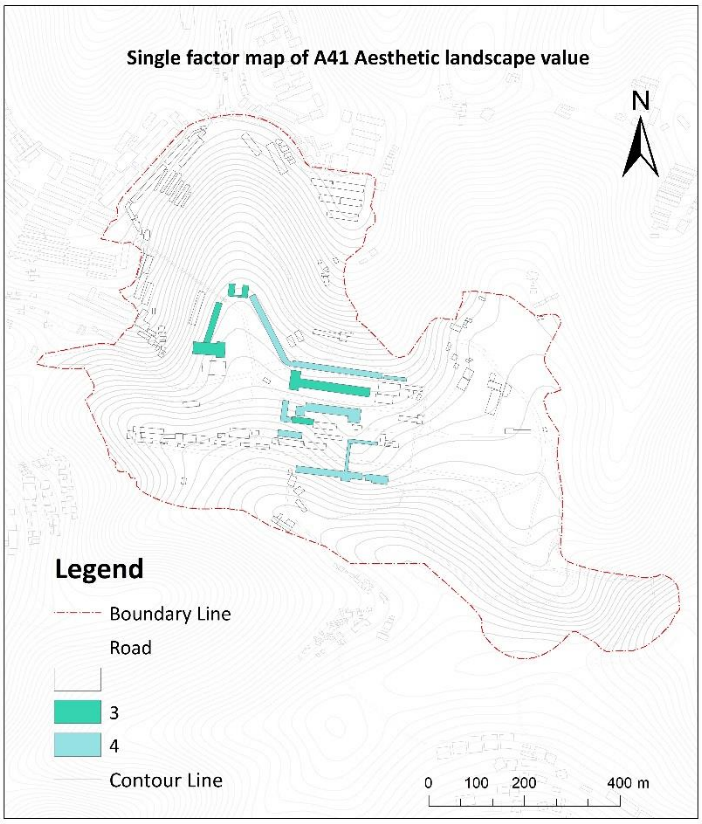
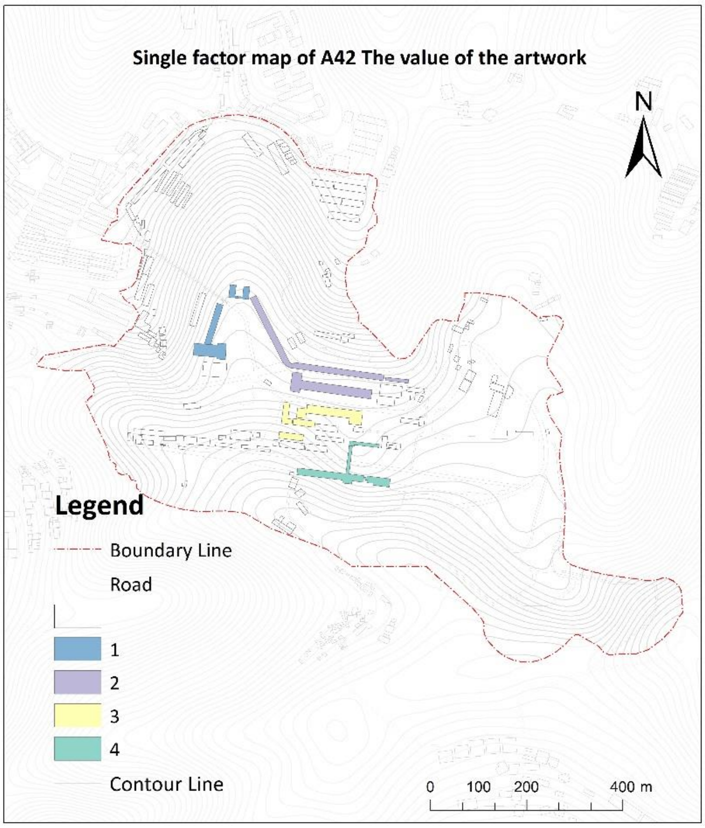


Table 78. Single Factor Evaluation Visualisation of A4 Artistic value





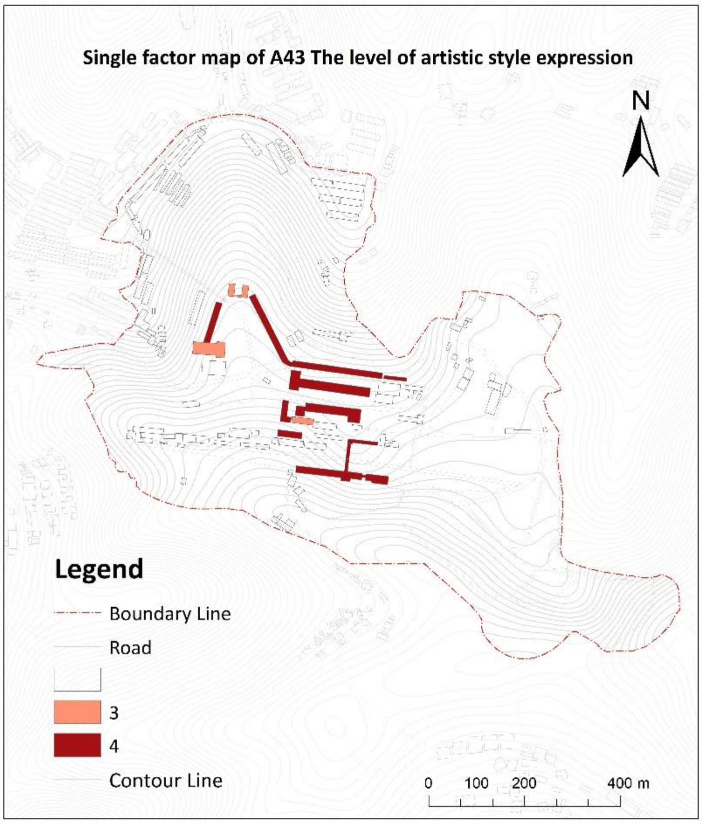
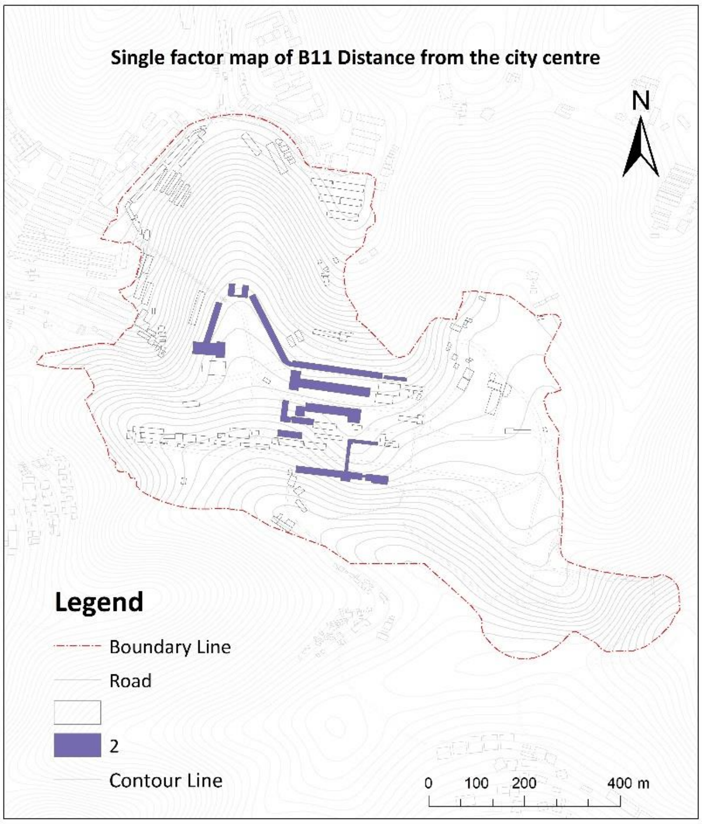
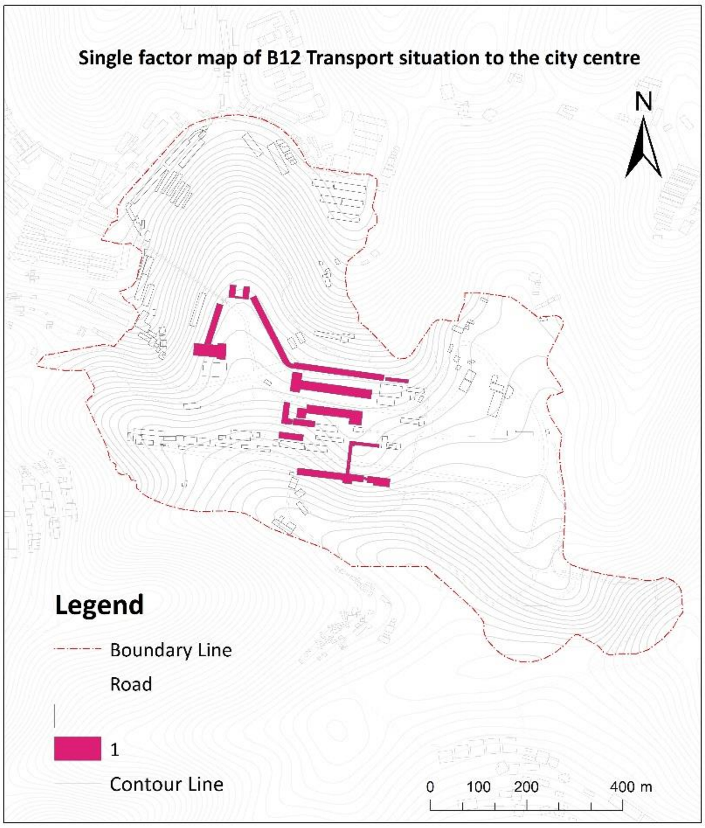


Table 79. Single Factor Evaluation Visualisation of B1 Location Value





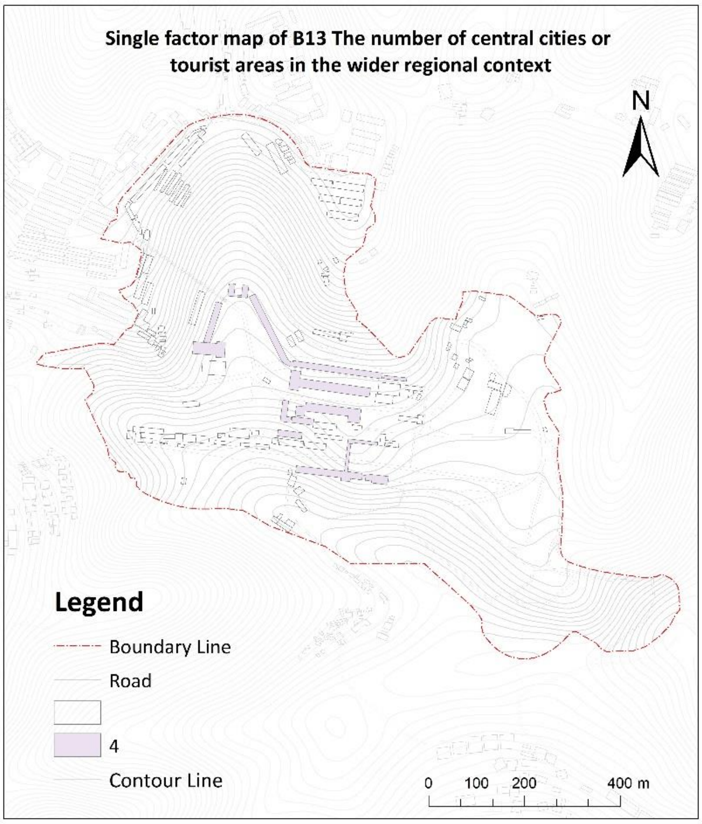
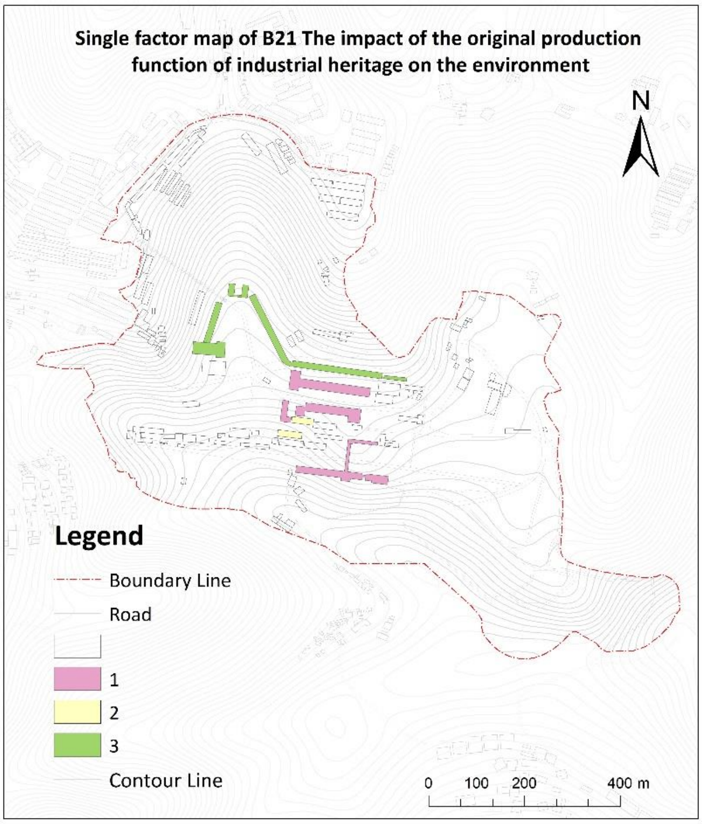


Table 80. Single Factor Evaluation Visualisation of B2 Environmental Value



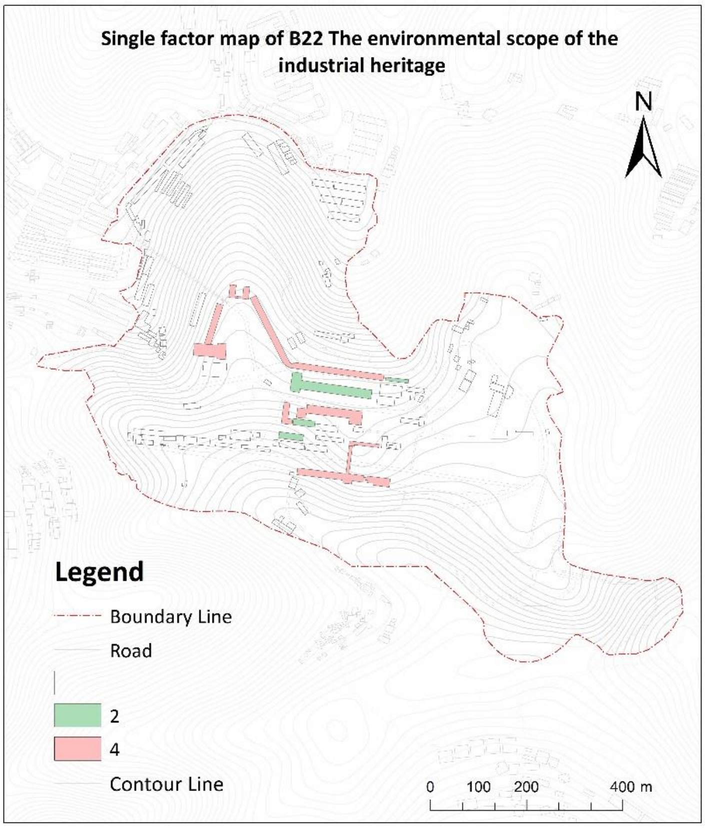
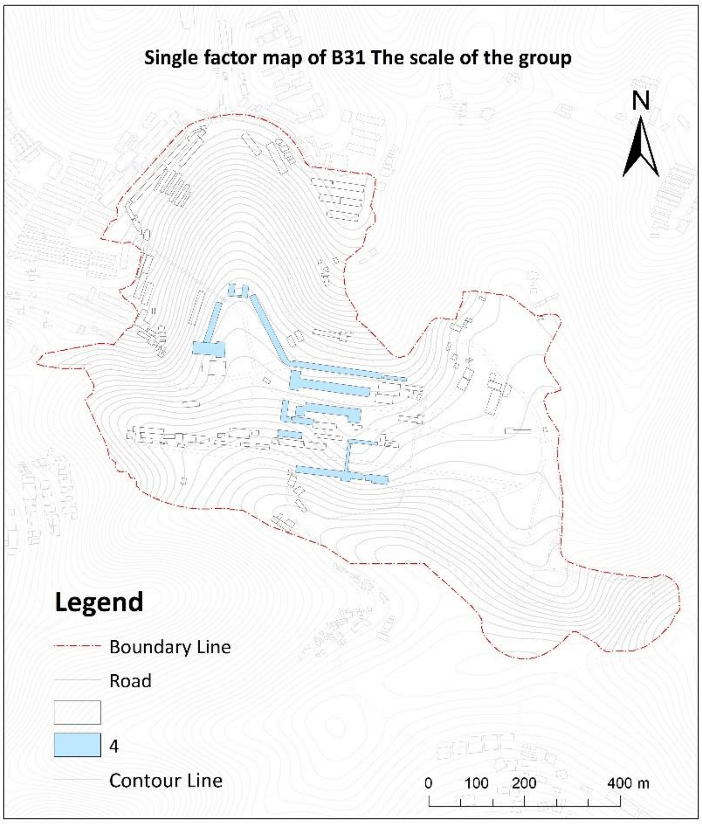
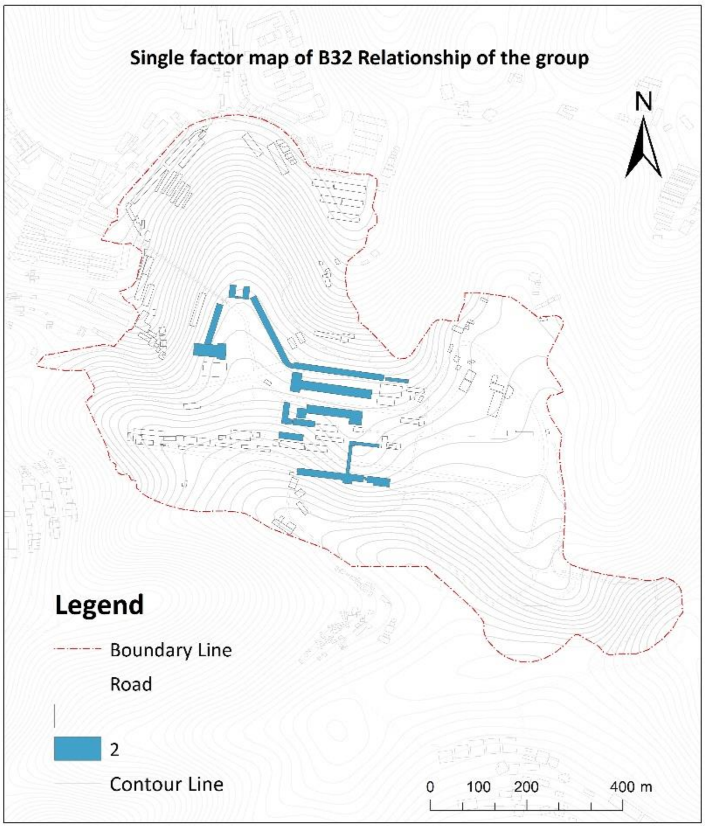


Table 81. Single Factor Evaluation Visualisation of B3 Group Value





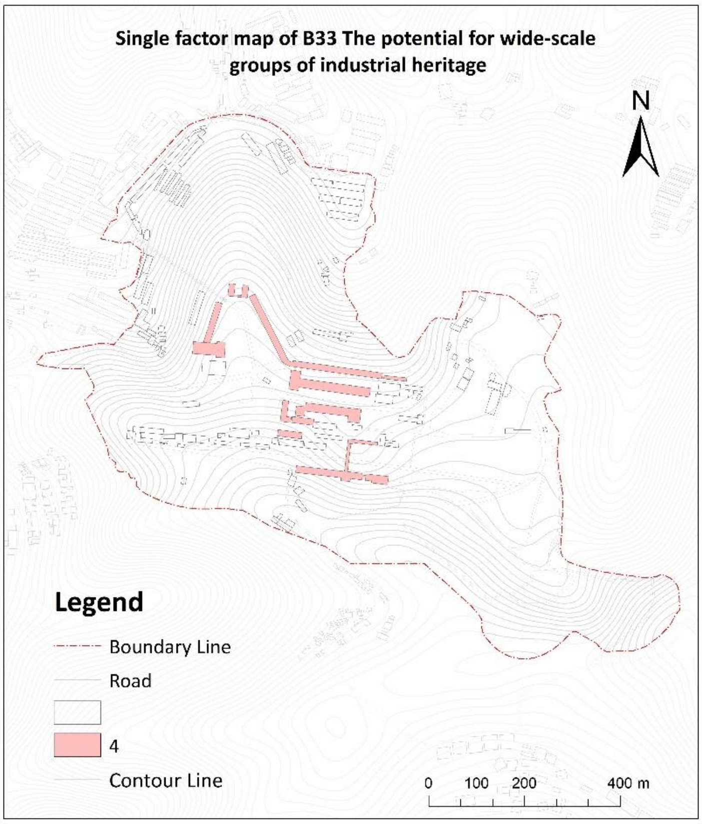
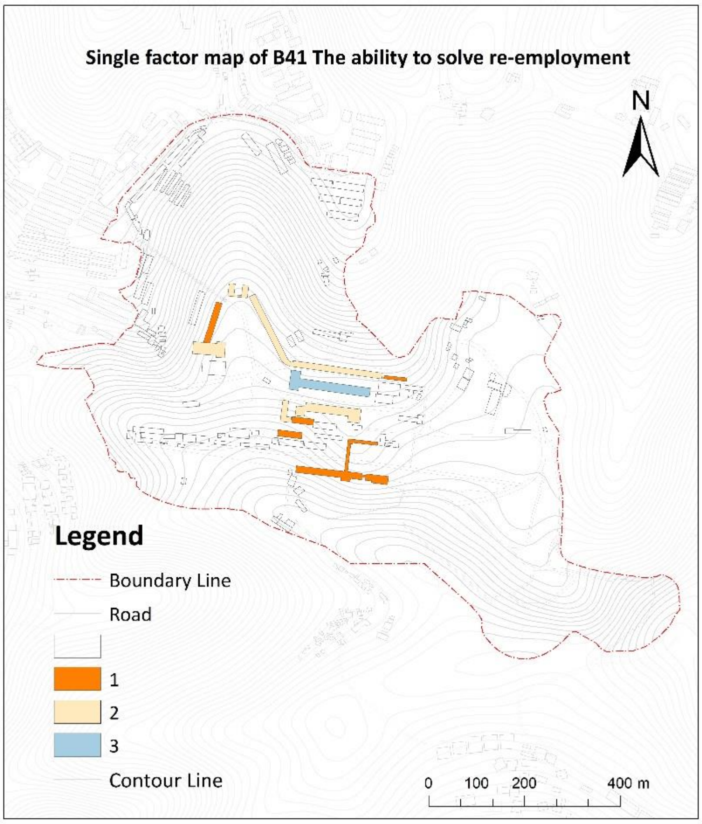
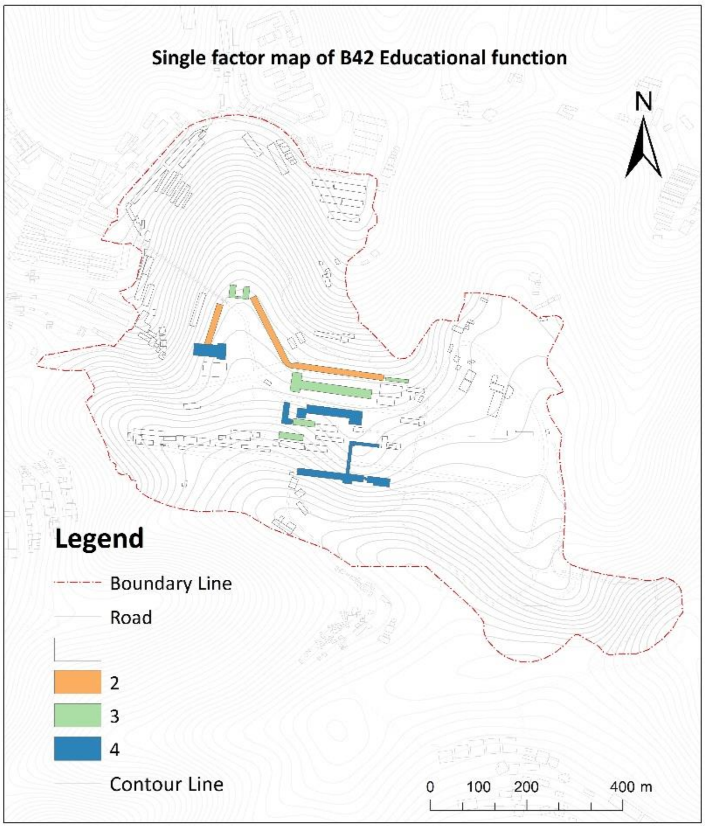
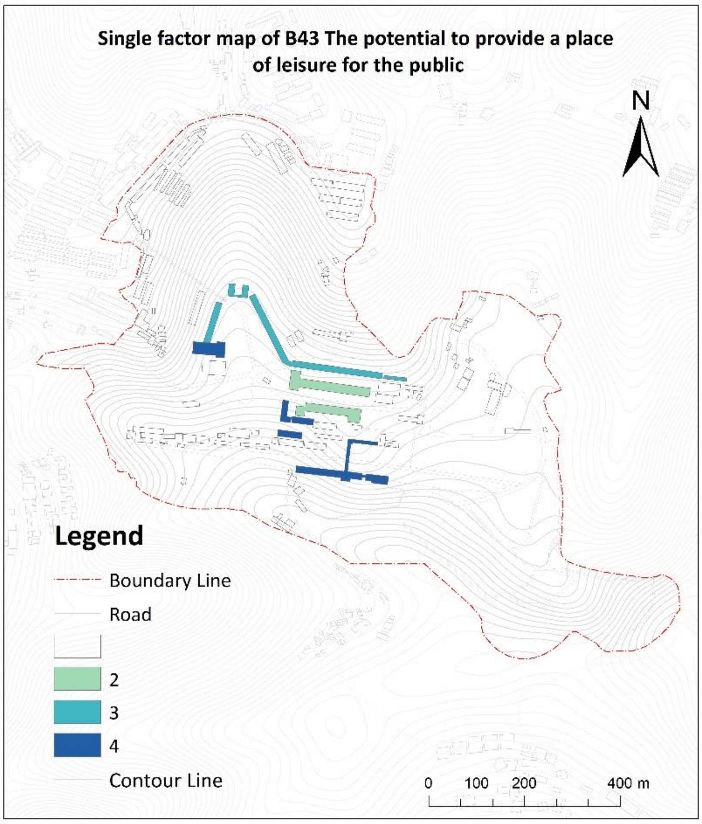


Table 82. Single Factor Evaluation Visualisation of B4 Social Value







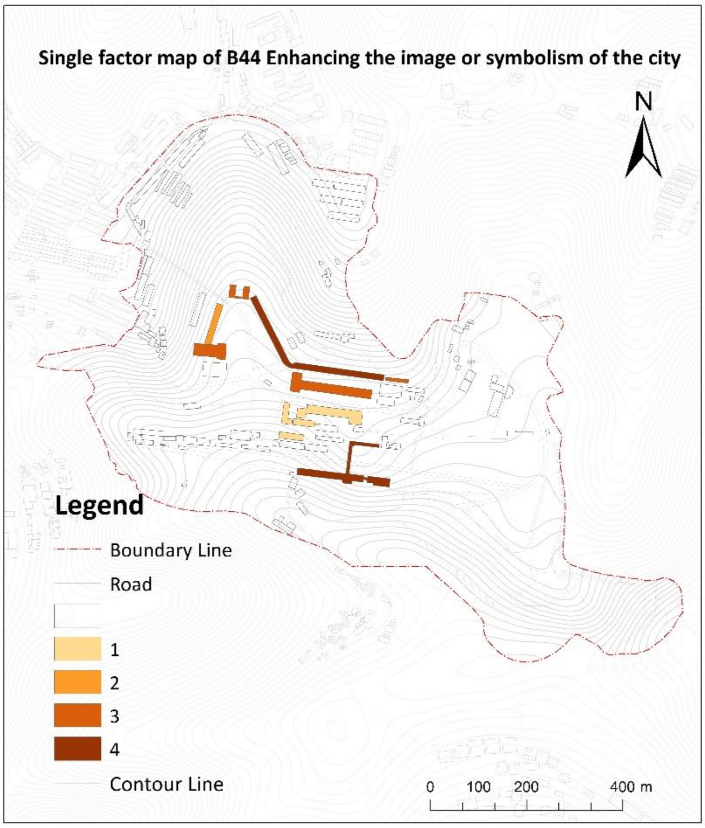
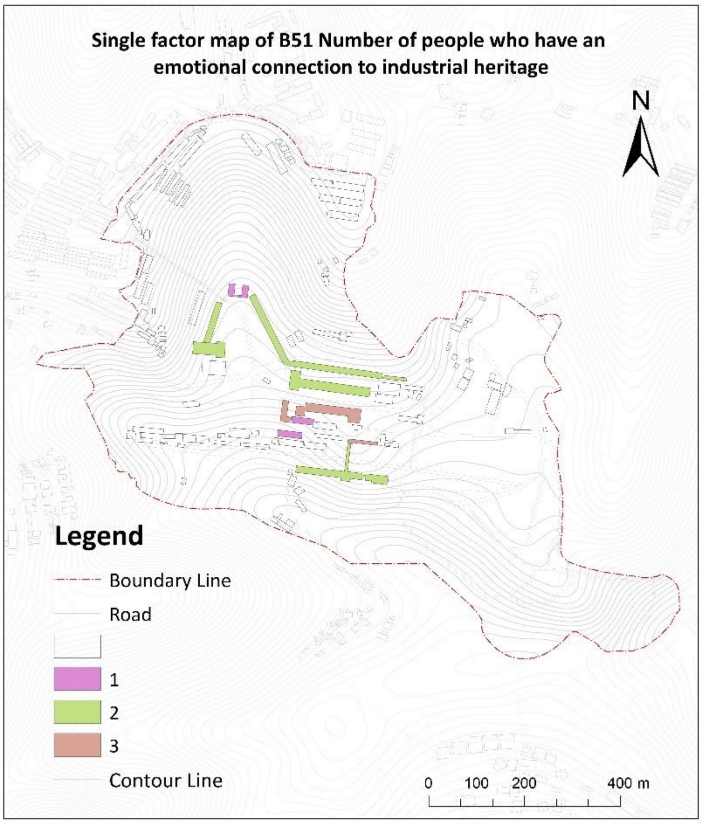
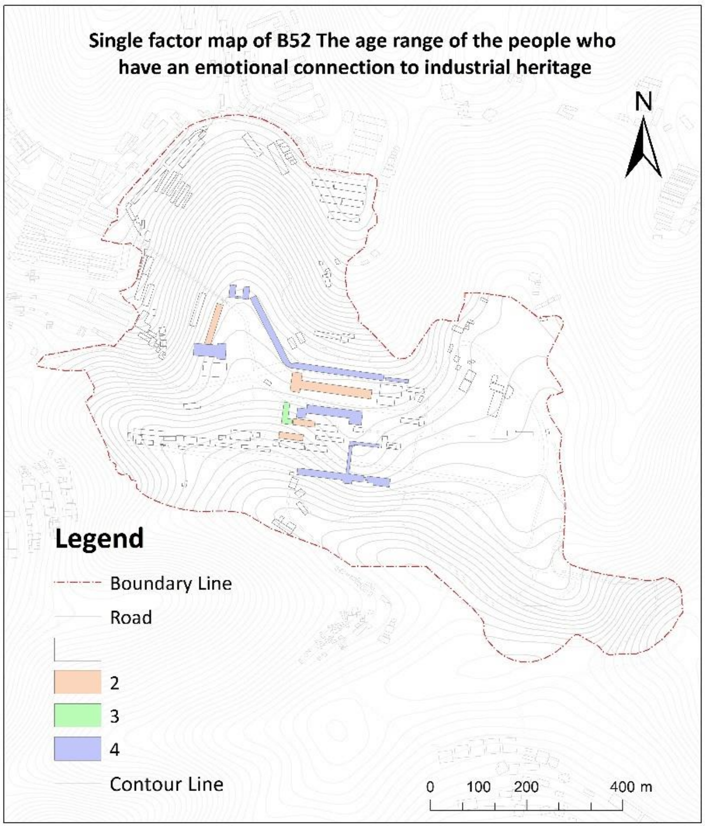
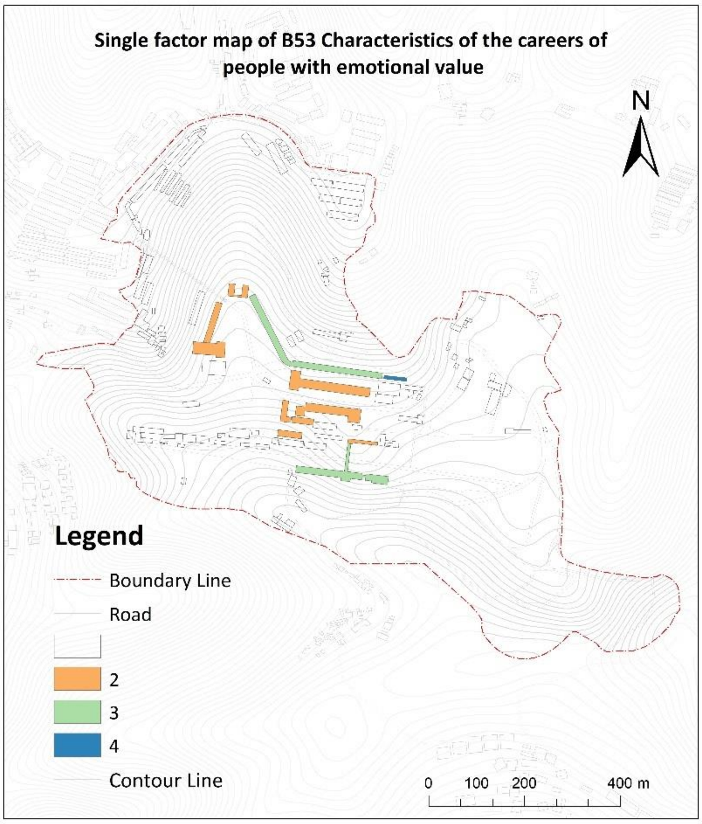


Table 83. Single Factor Evaluation Visualisation of B5 Emotional Value

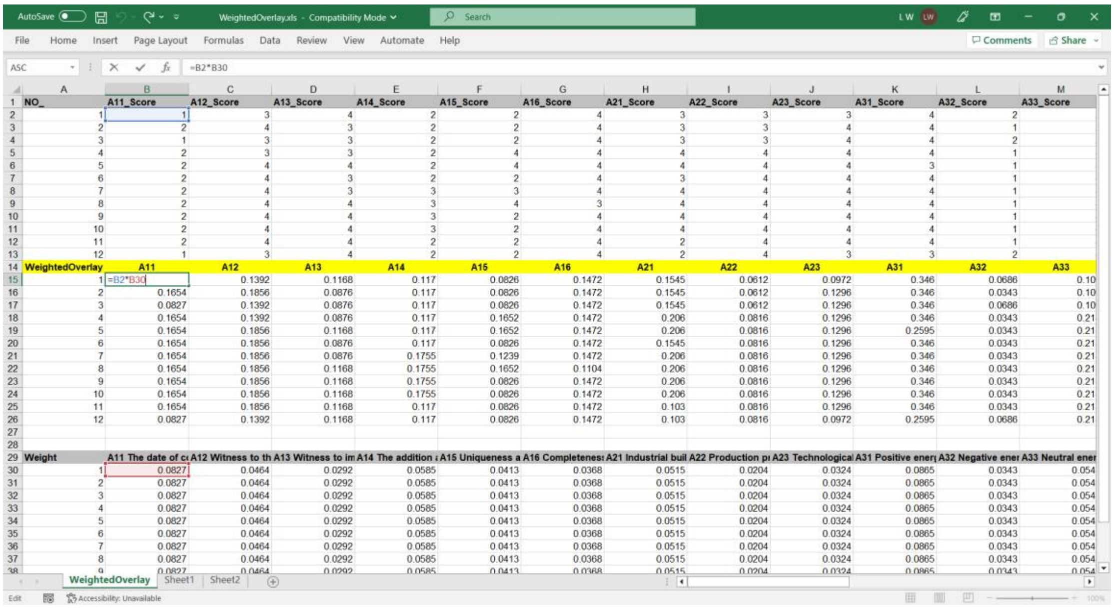






5.2.5.3 Multi-factor Weighted Overlay Evaluation Visualisation

For the same indicator, the value of different buildings varies widely across their different evaluation indicators, so it is necessary to overlay all the single-factor evaluations of each building to obtain a comprehensive evaluation of the value of Wang Shi Wa's industrial heritage. Using the data calculation of EXCEL and the spatial analysis function of GIS technology, the scores of the 30 individual factors evaluated in the above analysis and the weights obtained from the Analytic Hierarchy Process in Section 4.7 were overlaid to obtain the overall evaluation score (Figure 74). The weighted score Excel was then converted to a table and written to the ArcGIS database using the table import to ArcGIS method as described above (Figure 75).



WeightedOverlay.xls - Compatibility Mode

ASC | =B2*B30

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	NO_	A11_Score	A12_Score	A13_Score	A14_Score	A15_Score	A16_Score	A21_Score	A22_Score	A23_Score	A31_Score	A32_Score	A33_Score
2	1	1	3	4	2	2	4	3	3	3	4	2	
3	2	2	4	3	2	2	4	3	3	4	4	1	
4	3	1	3	3	2	2	4	3	3	4	4	2	
5	4	2	3	3	2	4	4	4	4	4	4	1	
6	5	2	4	4	2	4	4	4	4	4	3	1	
7	6	2	4	3	2	2	4	3	4	4	4	1	
8	7	2	4	3	3	3	4	4	4	4	4	1	
9	8	2	4	4	3	4	3	4	4	4	4	1	
10	9	2	4	4	3	2	4	4	4	4	4	1	
11	10	2	4	4	3	2	4	4	4	4	4	1	
12	11	2	4	4	2	2	4	2	4	4	4	1	
13	12	1	3	4	2	2	4	2	4	3	3	2	
14	WeightedOverlay	A11	A12	A13	A14	A15	A16	A21	A22	A23	A31	A32	A33
15	1	=B2*B30	0.1392	0.1168	0.117	0.0826	0.1472	0.1545	0.0612	0.0972	0.346	0.0686	0.10
16	2	0.1654	0.1856	0.0876	0.117	0.0826	0.1472	0.1545	0.0612	0.1296	0.346	0.0343	0.10
17	3	0.0827	0.1392	0.0876	0.117	0.0826	0.1472	0.1545	0.0612	0.1296	0.346	0.0686	0.10
18	4	0.1654	0.1392	0.0876	0.117	0.1652	0.1472	0.206	0.0816	0.1296	0.346	0.0343	0.21
19	5	0.1654	0.1856	0.1168	0.117	0.1652	0.1472	0.206	0.0816	0.1296	0.2595	0.0343	0.21
20	6	0.1654	0.1856	0.0876	0.117	0.0826	0.1472	0.1545	0.0816	0.1296	0.346	0.0343	0.21
21	7	0.1654	0.1856	0.0876	0.1755	0.1239	0.1472	0.206	0.0816	0.1296	0.346	0.0343	0.21
22	8	0.1654	0.1856	0.1168	0.1755	0.1652	0.1104	0.206	0.0816	0.1296	0.346	0.0343	0.21
23	9	0.1654	0.1856	0.1168	0.1755	0.0826	0.1472	0.206	0.0816	0.1296	0.346	0.0343	0.21
24	10	0.1654	0.1856	0.1168	0.1755	0.0826	0.1472	0.206	0.0816	0.1296	0.346	0.0343	0.21
25	11	0.1654	0.1856	0.1168	0.117	0.0826	0.1472	0.103	0.0816	0.1296	0.346	0.0343	0.21
26	12	0.0827	0.1392	0.1168	0.117	0.0826	0.1472	0.103	0.0816	0.0972	0.2595	0.0686	0.21
27													
28													
29	Weight	A11 The date of c	A12 Witness to th	A13 Witness to im	A14 The addition	A15 Uniqueness a	A16 Completenes	A21 Industrial buil	A22 Production p	A23 Technological	A31 Positive ener	A32 Negative ener	A33 Neutral ener
30	1	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
31	2	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
32	3	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
33	4	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
34	5	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
35	6	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
36	7	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
37	8	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054
38	9	0.0827	0.0464	0.0292	0.0585	0.0413	0.0368	0.0515	0.0204	0.0324	0.0865	0.0343	0.054

WeightedOverlay | Sheet1 | Sheet2

Figure 74. Excel Data Calculation Chart

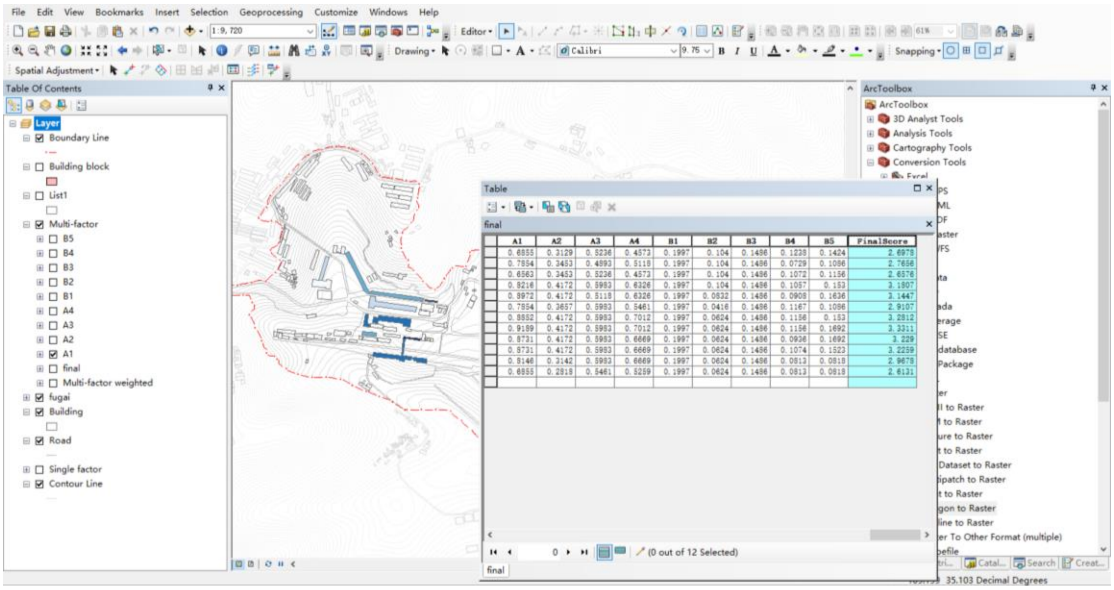


Figure 75. Overall Weighted Scores Imported into ArcGIS

The next step is to apply the imported scores to a raster in ArcGIS using ArcToolBox-Conversion Tools-To Raster-Polygon to Raster (Figure 76). The GIS visualisation analysis output of the comprehensive value of Wang Shi Wa's industrial heritage is shown in the figure.

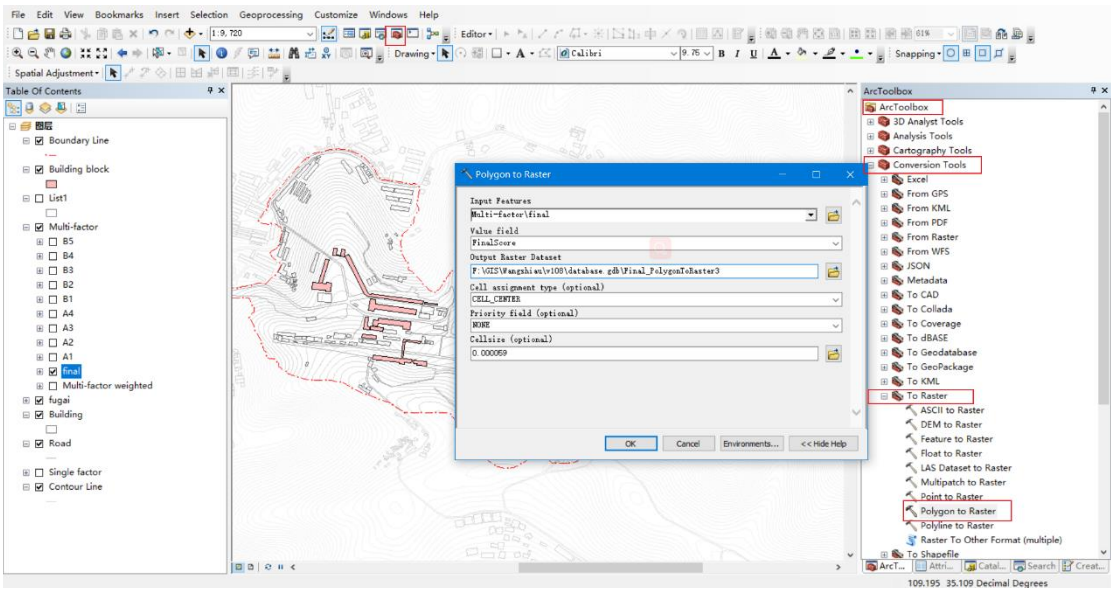
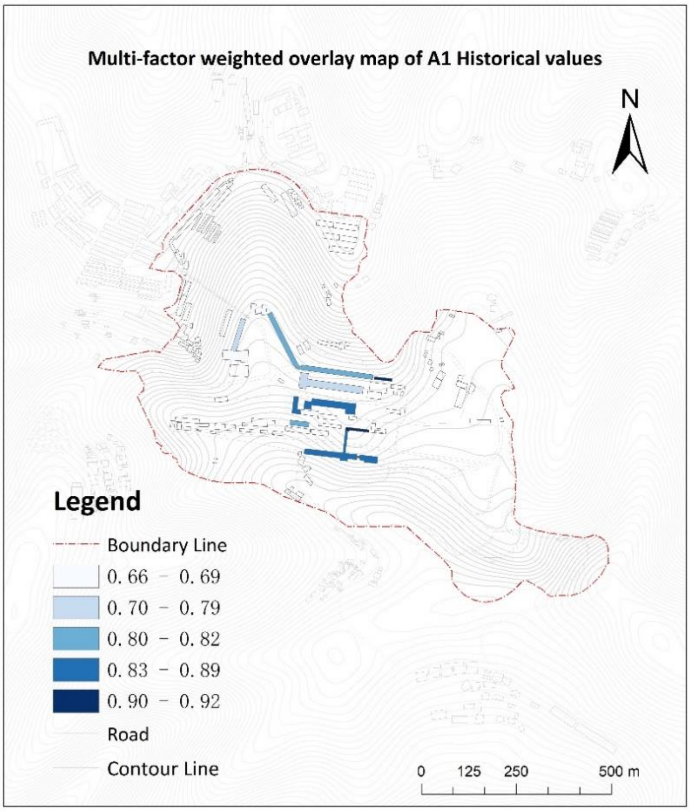
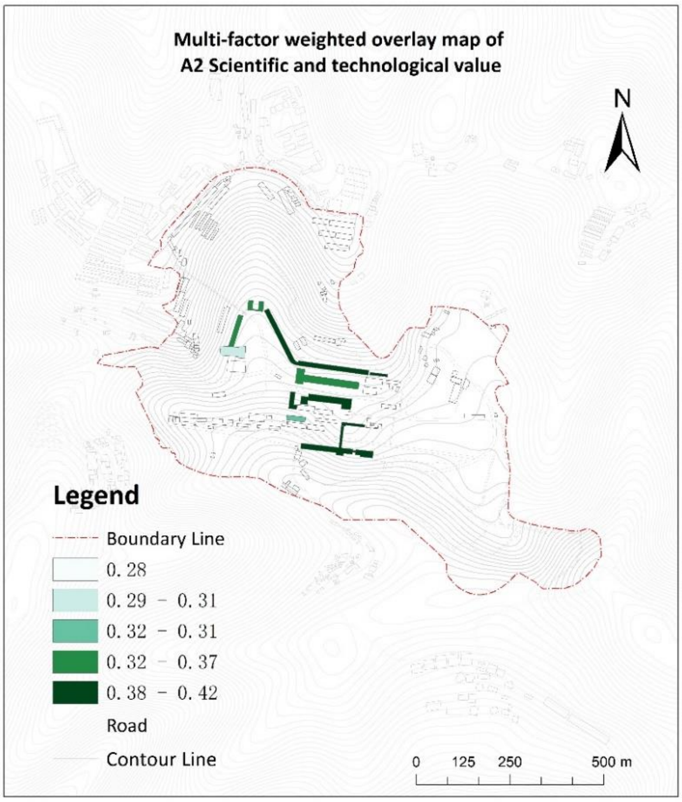
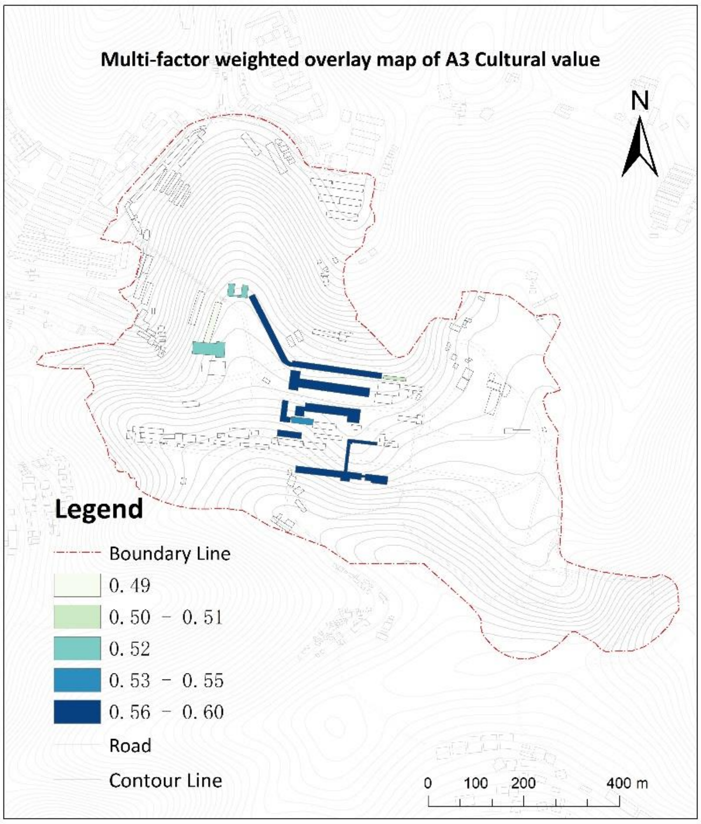


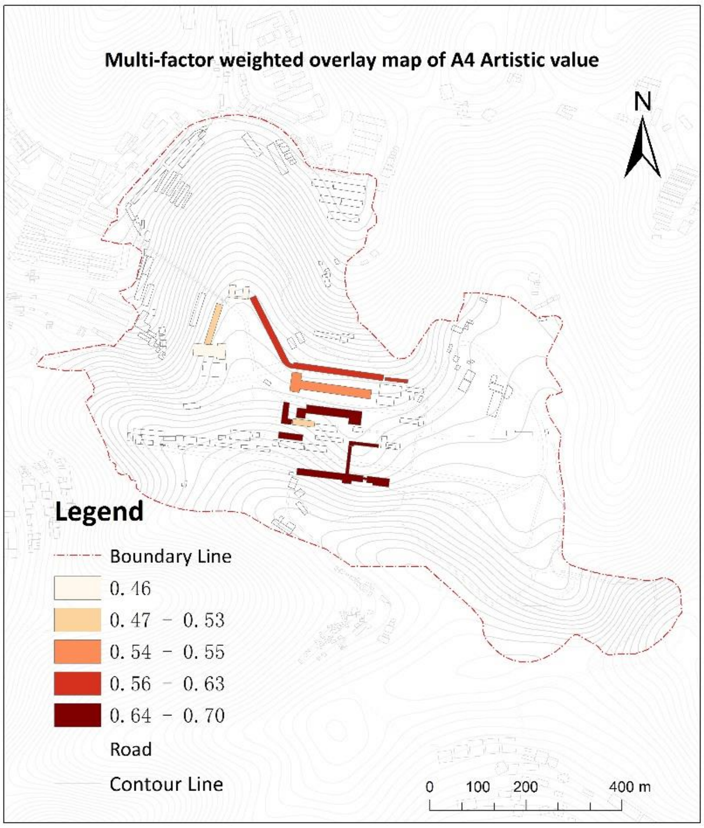
Figure 76. Raster Processing Maps in ArcGIS

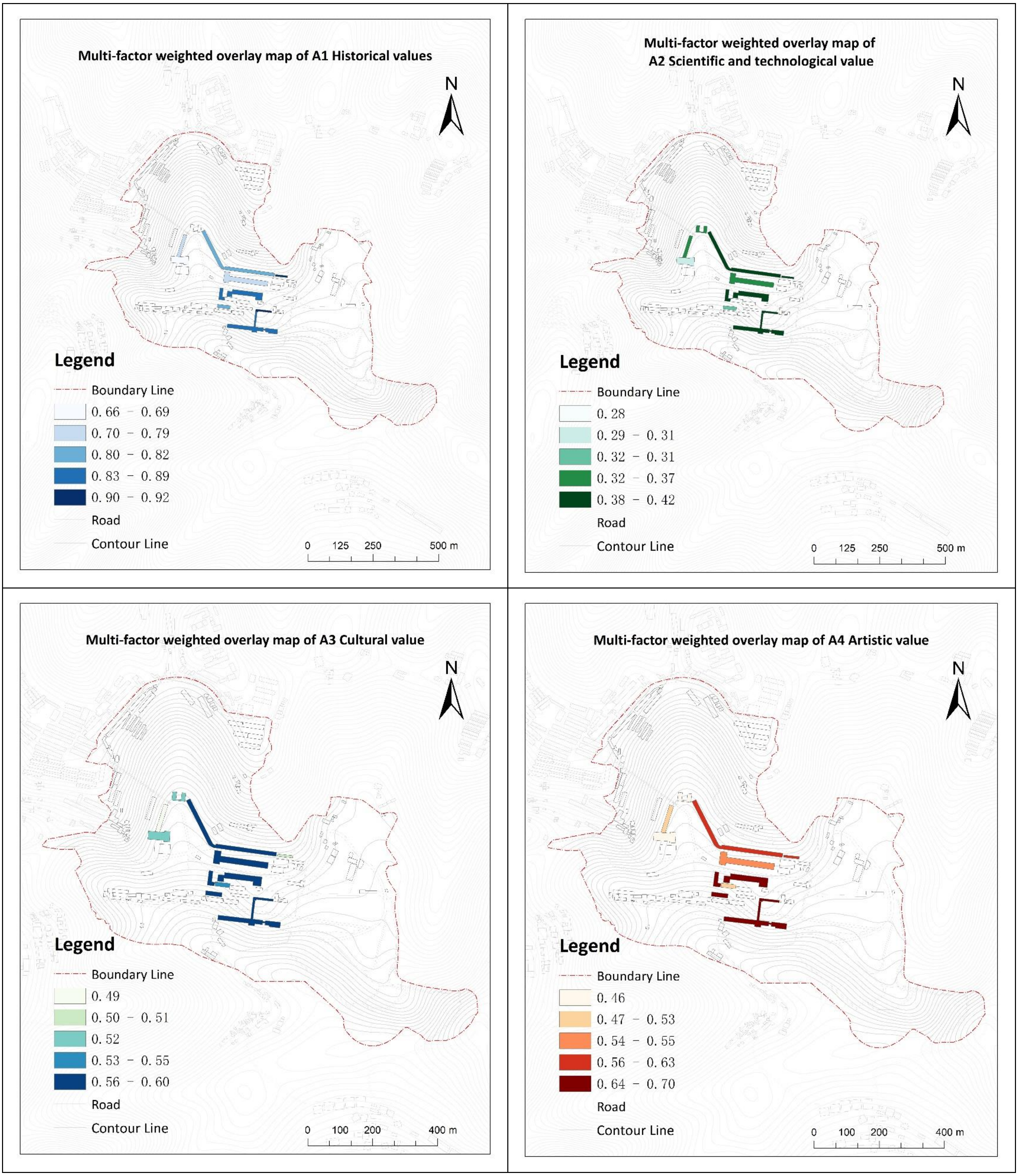
Table 84. Wang Shi Wa Coal Mine Industrial Heritage Value Overlay Analysis Chart

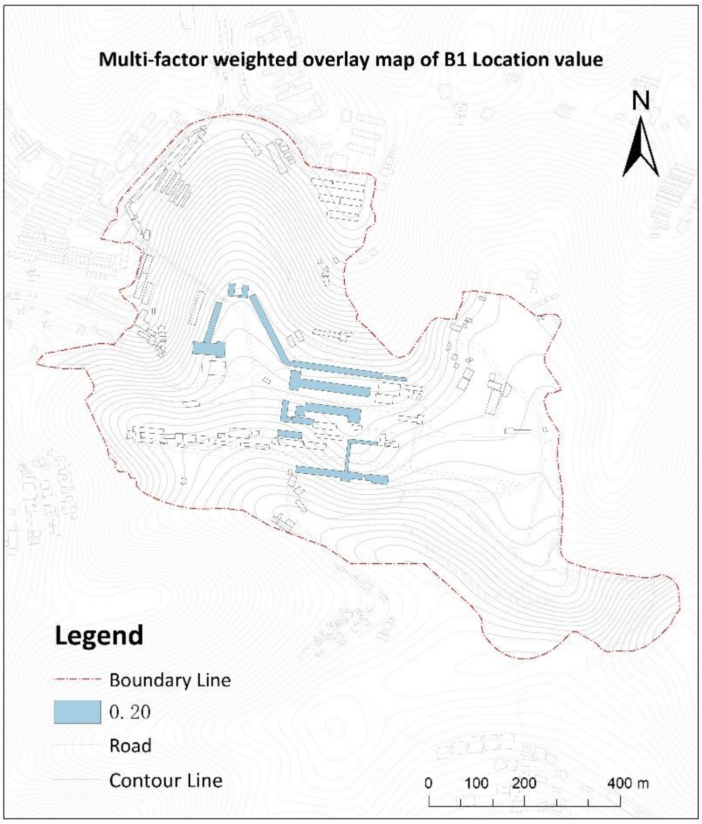


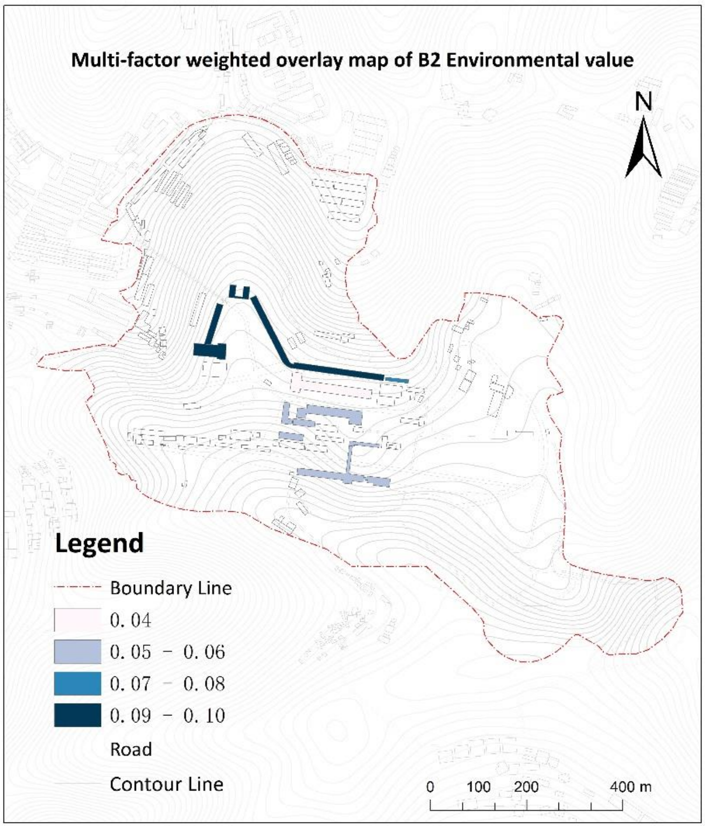


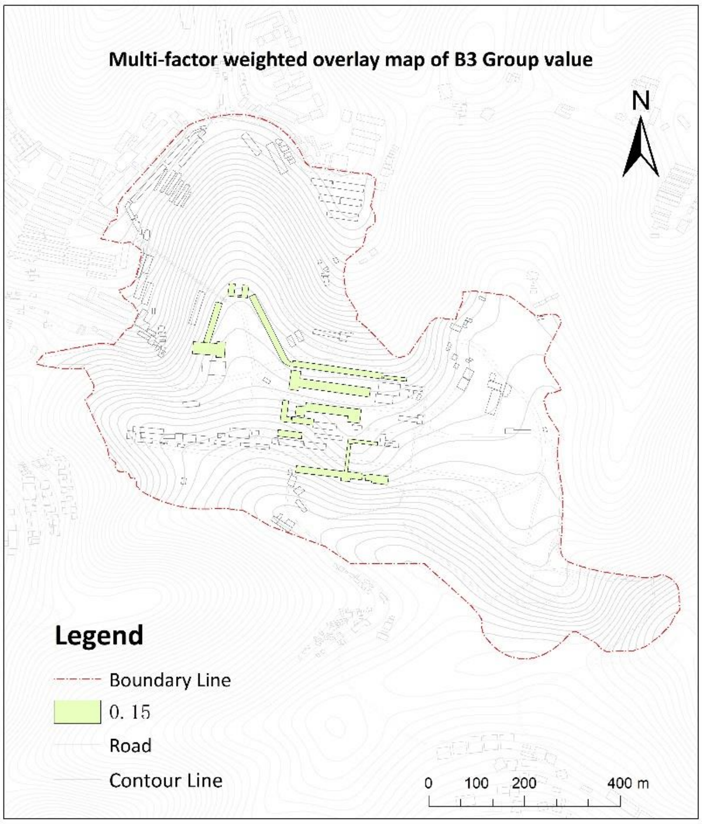


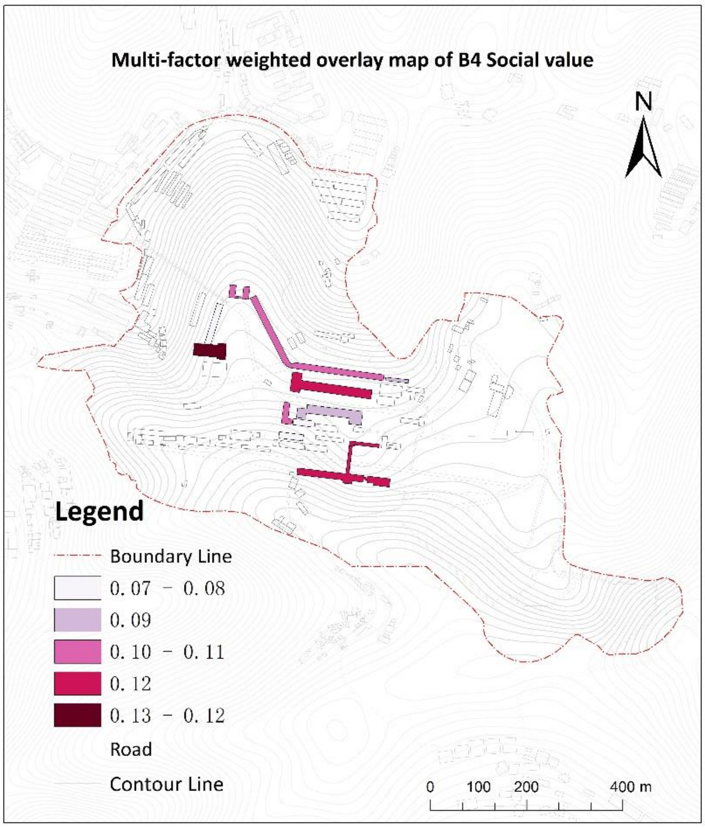


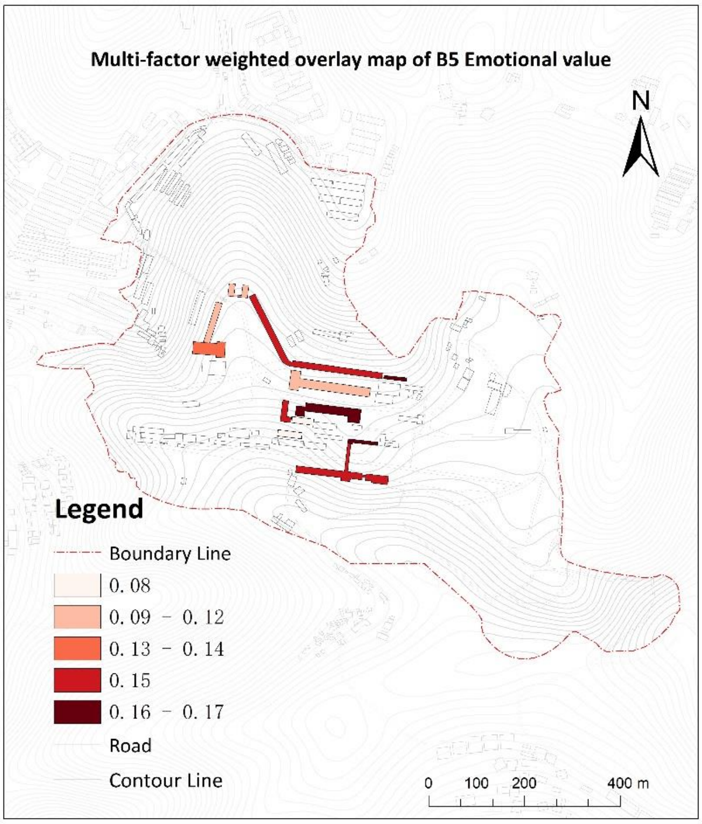

Multi-factor weighted overlay map of A1 Historical values
N
Legend
Boundary Line
0. 66 – 0. 69
0. 70 – 0. 79
0. 80 – 0. 82
0. 83 – 0. 89
0. 90 – 0. 92
Road
Contour Line
0 125 250 500 m
Multi-factor weighted overlay map of
A2 Scientific and technological value
N
Legend
Boundary Line
0. 28
0. 29 – 0. 31
0. 32 – 0. 31
0. 32 – 0. 37
0. 38 – 0. 42
Road
Contour Line
0 125 250 500 m
Multi-factor weighted overlay map of A3 Cultural value
N
Legend
Boundary Line
0. 49
0. 50 – 0. 51
0. 52
0. 53 – 0. 55
0. 56 – 0. 60
Road
Contour Line
0 100 200 400 m
Multi-factor weighted overlay map of A4 Artistic value
N
Legend
Boundary Line
0. 46
0. 47 – 0. 53
0. 54 – 0. 55
0. 56 – 0. 63
0. 64 – 0. 70
Road
Contour Line
0 100 200 400 m


Multi-factor weighted overlay map of B1 Location value
N
Legend
Boundary Line
0. 20
Road
Contour Line
0 100 200 400 m

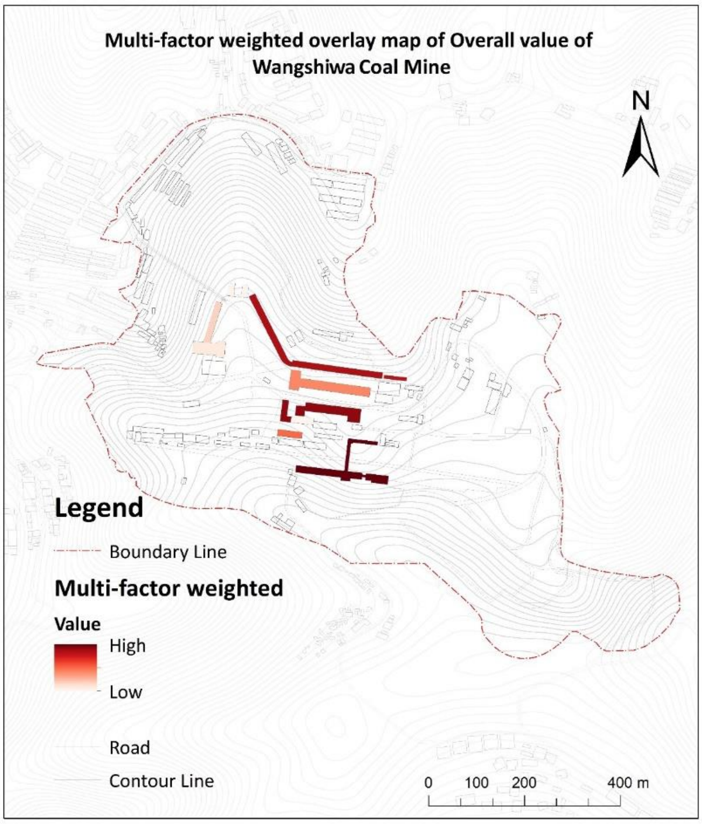

Multi-factor weighted overlay map of B2 Environmental value
N
Legend
Boundary Line
0. 04
0. 05 – 0. 06
0. 07 – 0. 08
0. 09 – 0. 10
Road
Contour Line
0 100 200 400 m


Multi-factor weighted overlay map of B3 Group value
N
Legend
Boundary Line
0. 15
Road
Contour Line
0 100 200 400 m


Multi-factor weighted overlay map of B4 Social value
N
Legend
Boundary Line
0. 07 – 0. 08
0. 09
0. 10 – 0. 11
0. 12
0. 13 – 0. 12
Road
Contour Line
0 100 200 400 m



Multi-factor weighted overlay map of B5 Emotional value
N
Legend
Boundary Line
0. 08
0. 09 – 0. 12
0. 13 – 0. 14
0. 15
0. 16 – 0. 17
Road
Contour Line
0 100 200 400 m



Multi-factor weighted overlay map of Overall value of Wangshiwa Coal Mine
N
Legend
Boundary Line
Multi-factor weighted
Value
High
Low
Road
Contour Line
0 100 200 400 m

Through the above visual analysis and assessment, the comprehensive value of the industrial heritage of the Wang Shi Wa coal mine is reflected more intuitively. The shades of colour in the diagram indicate the degree of evaluation of the comprehensive value of the buildings and structures within the Wang Shi Wa coal mine, with darker colours indicating a higher comprehensive value.

5.3 Industrial Heritage of Shenxin Yarn Factory, Baoji City, China

5.3.1 Background

As a country with a late start in industrialisation, China's industrial development in recent times has been very imbalanced. Compared to the eastern region, the industrial development of the west (including twelve provinces, municipalities and autonomous regions such as Chongqing, Sichuan, Guizhou, Yunnan, Guangxi, Shaanxi, Gansu, Qinghai, Ningxia, Tibet, Xinjiang and Inner Mongolia) is even more relatively poorly developed (Tao, 2011). Because the war of resistance against Japan broke out in 1937, many enterprises from the coastal region moved to the mainland. The completion of the Xi'an to Baoji section of the Longhai Railway in December 1936 also stimulated and promoted the development of recent industries in the western region of China (Song, 2018).

Baoji is an important industrial city in Shaanxi Province, one of the western regions of China. The industry is of great importance to Baoji and it can be said that the city's rise was based on its industrial development. In addition to the opening of the Longhai Railway from Zhengzhou to Baoji, Baoji became one of the ideal destinations for wartime industries to move from coastal cities to mainland cities. The Shenxin Yarn Factory was the most famous factory to move to Baoji at this time (Sun and Yang, 2020). It is also the first time that Baoji has been listed as a cultural heritage unit in Shaanxi Province in its capacity as an industrial heritage site. The preservation of the Shenxin Yarn Factory will provide experience and set an example for the preservation of industrial heritage in Baoji in the future. Baoji's cultural and creative industries are relatively underdeveloped, and through the reuse of the Shenxin Yarn Factory, the development of creative industries will help drive the city's innovative industries.

5.3.2 History of Shenxin Yarn Factory

The original site of the Baoji Shenxin Yarn Factory is located at No. 7 Xinfeng Lane, Hongwen Road, Jintai District, Baoji City, Shaanxi Province. It covers an area of 8,670.37 square metres. The predecessor of Baoji Shenxin Yarn Factory was the Shenxin Fourth Yarn Factory founded by the brothers Desheng Rong and Zongjing Rong, the largest national capitalists in China, in Wuhan City (Xiao, 1992).

The Shenxin Fourth Yarn Factory was established in April 1922 and suffered losses in the early years of its operation. After the outbreak of the war in 1931, Rongs' enterprise in the Yangtze River Delta region (Shanghai, Zhejiang, Anhui Province and Jiangsu Province) were severely damaged, when the Wuhan economy experienced a brief boom. Rongs' enterprise grasped the opportunity to make the Shenxin Fourth Yarn Factory in Wuhan at this time to get rapid development, gain a good profit and turn a loss into a profit (Zhang, 2007; Xu and Huang, 1985).

But this prosperity did not remain for a long time. At the beginning of 1938, the Chinese National Government ordered that all factories located in Wuhan had to be relocated internally to Sichuan and Shaanxi. In September of the same year, the Rong enterprise decided to relocate most of its equipment to Baoji through visits to Chongqing and Baoji. The construction of the Shenxin Yarn Factory in Baoji began in April 1939 and was completed and put into operation in August 1939 (Xiao, 1992).

Due to the limitations of human and material resources in the early construction of the factory, the size of the Baoji factory was not large, with only 2,000 spindles at the beginning (Qin, 2020). In 1931, after the outbreak of the Anti-Japanese War, Xi'an was the focus of the Japanese bombing campaign, which was carried out several times. The Baoji Shenxin Yarn Factory, less than 200 kilometres from Xi'an, was not spared. For this reason, the Rong Brothers organised workers to build cave dwellings on the earthen cliffs inside the factory and moved the production lines into the cave-dwelling to escape the Japanese bombing, these were called cave-dwelling workshops (Zhang, 2007). These cave-dwelling workshops have a total of 500,000 cubic metres of space and contain 20,000 spindles (Xiao, 1992).

Benefiting from the low price of labour in Baoji at the time and the opening of the Longhai Railway from Zhengzhou to Baoji, which made it easy to sell products to the central Shaanxi plain (central Shaanxi Province, including the five cities and one district of Xi'an, Xianyang, Baoji, Weinan, Tongchuan and Yangling), the Baoji Shenxin Yarn Factory had an outstanding performance (Song, 2018). After the victory in the war of resistance against Japan, the Chinese national government mismanaged the country's economy to the extent that inflation was serious. Coupled with the oppression of national enterprises by the Chinese government capital, the development of Baoji Shenxin Yarn Factory came to a standstill (Li, 2017).

In 1951, Rongs' Enterprise initiated an application to convert the Baoji Shenxin Yarn Factory into a public-private partnership, the New Qin Enterprise Company, which was approved (Xu and Huang, 1985). The Baoji Shenxin Yarn Factory became one of the first public-private partnership enterprises after the founding of China. After the public-private partnership, the Chinese government invested and expanded the merged New Qin enterprise. With over 20,000 square metres of new concrete buildings and 34,200 new spindles, the profits of the New Qin Yarn Factory also rose sharply (Xiao, 1992). In 1953, the factory's annual profits were 1.5 times higher than in 1952, and the new Qin yarn factory was on the road to rapid development. As the mill grew, so did the ancillary facilities, with the establishment of a school and hospital and the expansion of the staff dormitory (Xu and Huang, 1985). The public-private partnership ended in 1966, and the New Qin factory thus became a state-owned enterprise and was renamed the state-owned Shaanxi Twelfth Cotton Textile Factory.

In 2000, the Factory was restructured into the Da Rong Textile Company. The old factory building of the Shenxin Yarn Factory is no longer used as a production site, and the cave-dwelling workshop and thin-shell factory have been preserved as industrial heritage (Song, 2018). The factory was restructured in 2016 and renamed the BaoFang Group. On 11 December 2017, the former site of Baoji Shenxin Yarn Factory was selected as a cultural heritage park in Shaanxi Province, and on 22 December 2017, the site was selected as the first list of the national industrial heritage of China (Song, 2018; MIIT, 2017).

The preservation and presentation of the Shenxin Yarn Factory, a precious industrial heritage of the anti-Japanese war period, has been increasingly valued. It is urgent and important to preserve and present the Shenxin Yarn Factory. As it was elected to the first list of industrial heritage in China under the name of Shenxin Yarn Factory (MIIT, 2017), it is collectively referred to as Shenxin Yarn Factory afterwards.

Table 85. Name Changes Form for Shenxin Yarn Factory

Date	**Name**	**Location**
April 1922	Shenxin Fourth Yarn Factory	Wuhan City, China
1939	Baoji Shenxin Yarn Factory	Baoji City, China
1951	New Qin Yarn Factory	Baoji City, China
1966	Shaanxi Twelfth Cotton Textile Factory	Baoji City, China
2000	Da Rong Textile Company	Baoji City, China
2016	BaoFang Group	Baoji City, China

5.3.3 Location

The Baoji Shenxin Yarn Factory (now Da Rong Textile Company) is located at Changle plateau, 112 Hongwen Road, Jintai District, Baoji City, Shaanxi Province, covering an area of approximately 100,000 square metres (Tao, 2011). The factory is located in the eastern part of the Jintai district, with a large number of factories and enterprises in the vicinity, and well-developed commerce and industry. Education, health and financial institutions are well developed (Figure 77). It is bordered by the Panglong Plateau to the north and the Weishui River to the south (Song. 2018). The industrial heritage of the Shenxin Yarn Factory consists of four parts: the cave-dwelling workshop, the thin shell workshop, the Shen Fuxin office building and the Le Nong villa (MIIT, 2017).

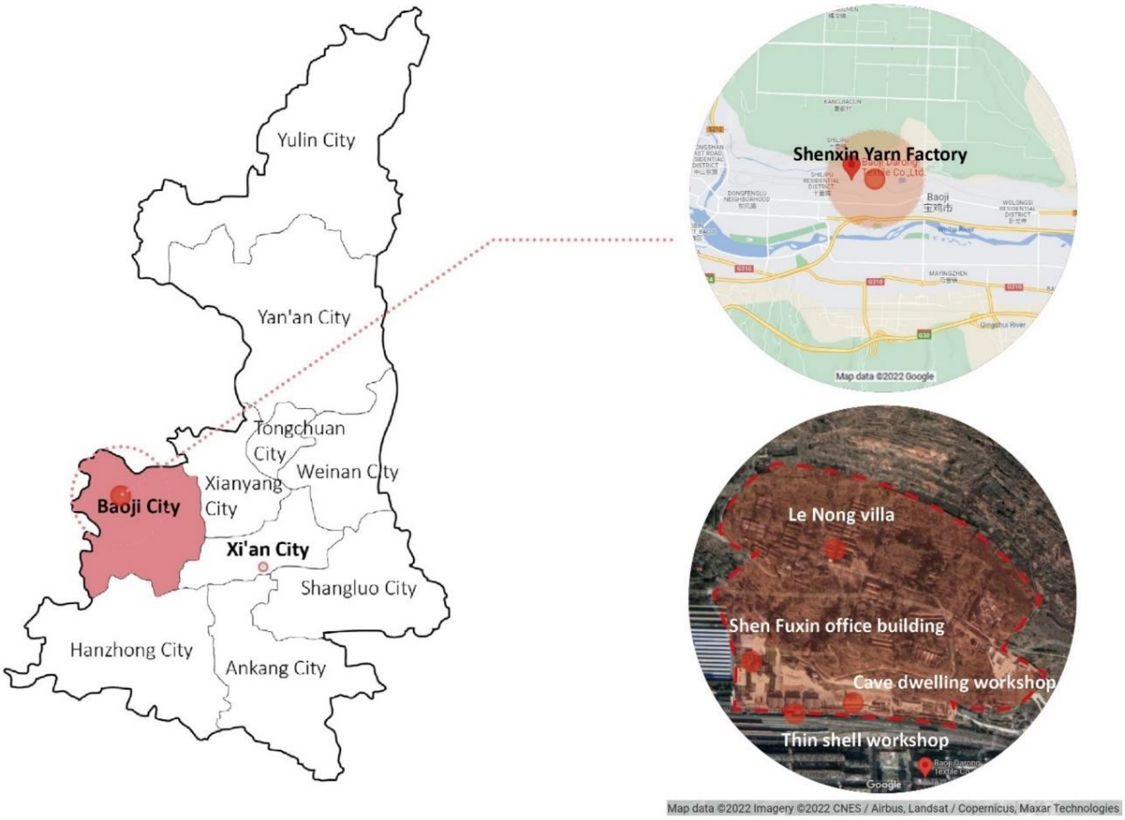


Figure 77. Location of Shenxin Yarn Factory. Source: Image edited by the author from Google Maps.

5.3.4 Scope of the Survey of Shenxin Yarn Factory

According to interviews with the project management staff of the second phase under construction, it is understood that the Changle plateau site transformation project is planned to be divided into four phases.

The first phase of the project is to repair the four heritage sites at the former site of the Baoji Shenxin Yarn Factory including the cave workshop, thin shell workshop, Shenxin office building, and Le Nong villa. The model restoration of the hair guard building, power plant shape and clock tower. Through documents, historical materials and physical relics, it presents the history of industrial relocation (the large-scale relocation of industries from the eastern coast of China to the mainland after the outbreak of the Anti-Japanese War in 1937), the history of the Shenxin Yarn Factory, the industrial cooperation movement (the industrial cooperation movement that emerged during the Anti-Japanese War in 1937) and the history of industrial development in Baoji.

The second phase of the project will rely on the disused buildings remaining on the site of the former Shenxin Yarn Factory, with the cultural and creative area of Changle plateau and Yitai plateau as the design scope, and the project is currently under construction.

The third phase of the project is planned to be designed to cover the Changle residential area in Ertai plateau, mainly covering the transformation of some abandoned residences such as the workers' dormitory area.

The fourth phase of the project is planned to hand over the land involved in the project area to the Jintai District after the bankruptcy of the Baofang Group, to support the construction of the Changle plateau Industrial heritage Site project.

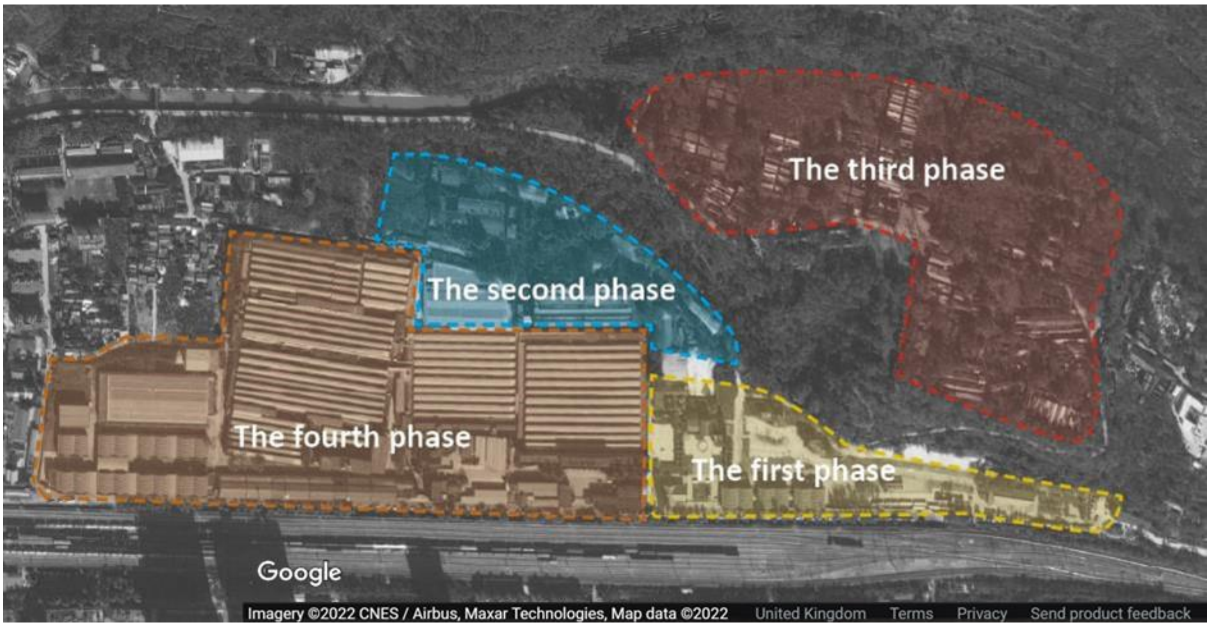


Figure 78. The Four Phases of the Changle Plateau Transformation Project. Source: Image edited by the author based on Google Maps.

The current status survey form and analyses of the four phases of transformation for Shenxin Yarn Factory are shown in Appendix E.

5.3.5 Existing Issues Around the Site

The Baoji Shenxin Yarn Factory is of outstanding conservation significance as an important industrial heritage from the war of resistance against Japan and as a witness of modern industrial civilisation. However, there are many complex issues and challenges in the actual conservation and renovation. Firstly, the types of industrial heritage in the old site are abundant, covering a wide range of building types and functions for production, office and living, requiring targeted conservation and utilisation measures. The transformation is not yet comprehensive, and the workers' dormitories are still in an abandoned condition. Secondly, the above-mentioned remains are distributed in a complex topographical environment with an elevation difference of approximately 60 metres, and the overall environment of the site, therefore, lacks an orderly organisation of traffic. Thirdly, the old site is adjacent to the Longhai Railway, which greatly contributed to the rapid development of the enterprise in the early days of the factory. However, as the city developed and adjusted its industrial and urban layout, Shenxin Yarn Factory was not only far from the development centre of the city where it is currently located, but also relatively inconvenient to connect with the city because of the blockage of the Longhai Railway line to the south. In addition, the hills to the north bordering Changle plateau are constrained by both traffic and topography, causing the site to gradually decay and lose its vitality.

5.3.6 Evaluation and Analysis of the Industrial Heritage Value of the Shenxin Yarn Factory

The former site of the Shenxin Yarn Factory has a variety of industrial heritage, including the main production workshops and office buildings of the earliest construction, and retains living quarters and related facilities, presenting a more comprehensive view of the complete production and living activities of the enterprise at the time (Tao, 2011). As one of the earliest industrial enterprises built in the western region after the opening of the Longhai Railway, it is important evidence of the development of industrial civilisation in the region and has outstanding heritage value.

5.3.6.1 Historical Value

According to the analysis of the value of industrial heritage in Section 4.1, six main aspects of the historical value of the industrial heritage of the Shenxin Yarn Factory are evaluated: (1) the date of construction of the heritage; (2) witness to the level of social development; (3) witness to important events; (4) the addition and completion of historical documents; (5) uniqueness and scarcity; (6) completeness.

(1) With regard to the historical value of the Shenxin Yarn Factory, the construction of the factory began in 1939 and production started in the same year. The oldest preserved buildings in the factory are the sawtooth factory building and the cave workshop, built in 1939 and 1940 respectively. The date of construction of the heritage was scored as 2 according to the evaluation criteria.

(2) In terms of witnessing the level of social development, according to the analysis in Section 2.6.1 Stages of industrial development, Shenxin Yarn Factory has not only witnessed the development of the textile production sector in Northwest China, but has also witnessed the history of the development of the textile industry in Shaanxi Province from 1939 to the present day, witnessing the five stages of industrial development in China.

As a representative of the important industrial heritage of the war of resistance in the Baoji area, the Shenxin Yarn Factory has significant historical merit for the military logistics production tasks it undertook back then as an industrial production line in support of the war of resistance in the northwest. The office building and the Le Nong villa from the same period are important physical evidence of modern industrial development in the northwest region of China during the war of resistance against Japan. At the same time, Shenxin Yarn Factory was one of the earliest industrial enterprises to be built in the north-western region after the extension of the Longhai Railway, witnessing the process of modern industry in Shaanxi Province from scratch (Qiao, Zhang and Shi, 2020). The score for being a witness to the level of social development is 3 according to the evaluation criteria.

(3) Regarding being a witness to important events, the former site of the Baoji Shenxin Yarn Factory is the best preserved industrial site of the War of Resistance against Japan in China. The factory has witnessed the history of national entrepreneurs' industrial salvation and is a witness of the Baoji Gonghe Movement and is also the birthplace of modern industry in Baoji (Li, 2017). The movement was established during the War of Resistance against Japan by domestic patriots and overseas friends who sympathised with the Chinese revolution, and was an organisation dedicated to providing military and civilian supplies. Shenxin Yarn Factory was relocated to Baoji, Shaanxi Province in 1938. Mr. Desheng Rong, the founder of Shenxin Yarn Factory, was a famous Chinese national capitalist and industrialist, known as the "King of Flour" and "King of Cotton

Yarn”, and is also the father of Rong Yiren, the former Vice-President of China (Xu and Huang, 1985; Liu and Lei, 2020).

The buildings of the Shenxin Yarn Factory have witnessed a series of major historical events from the Anti-Japanese War period to the present day, such as the internal relocation of the enterprise, the bombing during the Anti-Japanese War, the surrender of Japan, the founding of the people’s Republic of China and the reform and opening up of China. The buildings, structures and production equipment constructed on the site in different historical periods reflect the level of social development at the time. The score for being a witness to an important event is 3 points according to the evaluation criteria.

(4) In terms of the addition and completion of historical documents by industrial heritage, the Shenxin Yarn Factory has significant historical merit as a representative of the important industrial heritage of the war of resistance in the Baoji area. This is due to the fact that the Shenxin Yarn Factory undertook military logistics production tasks during the war period as an industrial production line in support of the resistance in the northwest of China. In addition, the Shenxin Yarn Factory also retains valuable pictures of workers’ work notes, factory history documents, and layout maps of the cave workshops, which are beneficial to its research. The score for its addition and improvement of historical documents is 3 according to the evaluation criteria.

(5) In terms of uniqueness and scarcity, the Shenxin Yarn Factory is one of the representatives of national industry in the interior of China during the war period and is extremely typical. During the war, national capitalism was in decline and most factories closed down during this period, while the Baoji Shenxin Yarn Factory, under the leadership of Li Guowei, survived and developed rapidly, becoming a typical example of the unyielding development of national factories during this period and was described by famous Chinese writer Mr Lin Yutang as a miracle of War of Resistance industry (Song, 2018).

The cave workshop and the thin-shell workshop are both unique to industrial buildings of the same period. The cave workshop was excavated during the war to escape the bombing of Japanese aircraft and was a product of wartime industry and the first of its kind. The cave-dwelling workshop was built to withstand many large-scale Japanese air raids, and its internal structure was basically intact. The thin-shell workshop uses the eggshell principle, a thin-shell building with a large but very stable roof, such as the famous Sydney Opera House. But the use of thin-shell buildings for industrial production in China is also exemplified by the Shenxin Yarn Factory. According to the evaluation criteria, it scores 3 points for uniqueness and scarcity.

(6) In terms of completeness, the main structure of the Phase I building is well preserved, but the kiln factory is located in a key landslide zone in Baoji, and the cave is dark and damp, with cracks and weathering in some of the wall bricks. In addition, most of the walls and roofs of the Phase II and Phase III residential areas are in disrepair, but the main body of the building is well preserved. The main structure of the Phase IV buildings is relatively intact and the walls are largely unbroken, allowing the buildings to be reused in a protected manner. Overall, the foundations of the buildings are in good condition. According to the evaluation criteria, its completeness score is 4.

Table 86. The Historical Value Score Table for the Shenxin Yarn Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A1 Historical value	**A11** The date of construction of the heritage	2	0.0827	0.84
	A12 Witness to the level of social development	3	0.0464	
	A13 Witness to important events	3	0.0292	
	A14 The addition and completion of historical documents	3	0.0585	
	A15 Uniqueness and scarcity	3	0.0413	
	A16 Completeness	4	0.0368	
Total score	(Total possible score is 24)	18		

In summary, with a total score of 18 (total possible score is 24) for its historical value and combined each weighting:

2×0.0827+3×0.0464+3×0.0292+3×0.0585+3×0.0413+4×0.0368, its final score is 0.8388 (total possible score is 1.1796). To make the statistics more convenient, two decimal places are taken and the final score is 0.84.

5.3.6.2 Scientific and Technological Values

The technological value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in terms of (1) industrial buildings and equipment; (2) production processes; (3) technological representativeness.

The industrial remains at the site of the Shenxin Yarn Factory are various, containing the main production workshops and office buildings of the earliest construction, and preserving the living quarters and related facilities, presenting a more comprehensive picture of the complete production and living activities of the enterprise at that time.

(1) In terms of industrial buildings and equipment, as an important industrial building in the early stages of China's national industrial development, the building of the Shenxin Yarn Factory has distinctive characteristics of the time and region in terms of construction techniques. The cave-dwelling workshop was constructed during the war to escape the bombing of Japanese aircraft (Tao, 2011; Qin, 2020). The unique form of sheltered earth building combines the very local character of cave architecture with the need to conceal the production workshop. The site and design are a product of a specific time and situation, and it is the only cave-dwelling production workshop in China. The thin-shell workshop, which uses a thin-shell double-curved arch structure with a large top span, solves the problem of spans that cannot be achieved with timber structures (Song, 2018; Qin, 2020). It also meets the need to provide a large span of production space in the face of material shortages. The above two groups of production workshops are both rare forms of industrial building construction from the same period and are the first of their kind at that particular time. It has scientific value for the research of the development of industrial architecture at that time. According to the evaluation criteria, the score for industrial buildings and equipment is 3.

(2) In terms of production processes, the cave workshops contain a large amount of production equipment, as well as production images, which are useful for research into the production techniques and production lines of the time. It is possible to analyse the main production techniques of textiles of the time. This gives information about the textile production processes in northwest China more than 80 years ago. According to the evaluation criteria, these production processes are scored as 3 points.

(3) Regarding technical representation, Shenxin Yarn Factory survived tenaciously during the war period when most factories were closing down, and grew rapidly in a short period of time. It was one of the national enterprises in the interior of China during the war period, supplying military supplies for civilian use, and became a typical example of the indomitable pursuit of development at the time. Its technological representativeness was scored as 3 according to the evaluation criteria.

Table 87. The Scientific and Technological Value Score Table for the Shenxin Yarn Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A2 Scientific and technological value	**A21** Industrial buildings and equipment	3	0.0515	0.31
	A22 Production processes	3	0.0204	
	A23 Technological representativeness	3	0.0324	
Total score	(Total possible score is 12)	9		

In summary, with a score of 9 (total possible score is 12) for its technology and combined each weighting: 3×0.0515+3×0.0204+3×0.0324, its final score is 0.3129 (total possible score is 0.4172). To make the statistics more convenient, two decimal places are taken and the final score is 0.31.

5.3.6.3 Cultural Values

In evaluating the cultural value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 is based on three main aspects: (1) positive energy value; (2) negative energy value; (3) neutral energy value.

(1) In terms of positive values, the construction of the cave workshop set a precedent for the development of the yarn industry in wartime, meeting wartime military needs for civilian use and making an indelible contribution to the victory of the war of resistance against Japan and social stability. There were more than 200 employees at the beginning of the factory, and 1,778 when Baoji was liberated on July 14, 1949. The underground ventilation of the cave-dwelling workshop was not good, so for the sake of the health of the workers, the kiln factory started to implement an eight-hour working system with two shifts of production (Xiao, 1992; Qin, 2020). More than seven decades of development have formed the enterprise spirit of “fine spinning and weaving, scientific management,

dedication and love for work, and the courage to create the best" (Xiao, 1992, p.254-260). As a yarn factory during the war period, the culture and the enterprise spirit of Shenxin Yarn Factory united the employees of the company.

Although the Shenxin Yarn Factory has experienced name changes and relocations, it has continued to grow and become a famous spinning factory in the northwest of China. The Shenxin Yarn Factory, as the representative of the moving to mainland enterprises, has laid the foundation for the development of recent industry in Baoji, demonstrating the tenacious and unyielding spirit of the Chinese people, their love for their work, their courage to share the national tragedy, their determination to keep improving, and their indomitable perseverance. According to the evaluation criteria, its positive energy value score is 4.

(2) With regard to negative energy values, the former site of the Baoji Shenxin Yarn Factory is the best preserved anti-war industrial site in China, and was the front line of industrial production in support of the war in the northwest. The cave workshop was built to escape the Japanese bombing. The dim lighting and harsh environment of the kiln workshop tell the story of the hard conditions and humiliating history. The production tools placed in the kiln workshop also recreate to a certain extent the production environment of the time. These negative values remind people of the history of being bullied, and at the same time inspire people to think about hard work and enthusiasm for work and life today. According to the evaluation criteria, its negative energy value is classified as 3.

(3) In terms of neutral value, the industrial heritage landscape of the Shenxin Yarn Factory represents the history of the development of the yarn industry in northwest China and can enhance the sense of regional pride and regional identity of the surrounding citizens. According to the evaluation criteria, its neutral energy value score is 3.

Table 88. The Cultural Value Score Table for the Shenxin Yarn Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A3 Cultural value	**A31** Positive energy value	4	0.0865	0.61
	A32 Negative energy value	3	0.0343	

	A33 Neutral value	3	0.0545	
Total score	(Total possible score is 12)	10		

In summary, with a cultural value score of 10 (total possible score is 12) and combined each weighting: 4×0.0865+3×0.0343+3×0.0545, its final score is 0.6124 (total possible score is 0.7012). To make the statistics more convenient, two decimal places are taken and the final score is 0.61.

5.3.6.4 Artistic Value

The artistic value of industrial heritage, according to the previous analysis of the value of industrial heritage, is evaluated in terms of (1) aesthetic landscape value; (2) the value of artwork; (3) the level of artistic style expression.

(1) In terms of aesthetic landscape value, the completed transformation of Shensin Yarn Factory Phase 1 has a good greening, extracting yarn spindle forms as directional signs and reusing industrial waste as decorations and exhibits. The Shenxin Yarn Factory’s cave workshop and thin-shell workshop form a unique architectural image while reflecting the scientific value of the building. The Shenfu Xin office building, Le Nong villa and staff dormitories of the same period reflect the fusion of southern residential and local architecture in details such as building techniques, line footings, doors and windows, and are a unique reflection of the architectural form and art of the time. Phase 2 and 3 have inadequate landscape effects due to the ongoing transformation, with trees cluttering the area and discarded production tools as well as random storage. The factory buildings in Phase IV are full of strong industrial architectural features, are simple but quite imposing, and the main structure of the factory buildings is relatively well preserved. According to the evaluation criteria, the score for aesthetic landscape value is 2.

(2) Regarding the value of the artwork, most of the industrial elements remaining from the Shenxin Yarn Factory have been reused and turned into landscape sculptures in the zone, such as the disused production machines. The details of these facilities not only meet the functional needs of the people, but also contribute to the industrial cultural atmosphere of the whole industrial park. However, there is still a lot of waste equipment

in an abandoned state, discarded in corners and not reused. According to the evaluation criteria, the work was given a score of 3.

(3) In terms of the level of artistic style expression, the Le Nong Villa was designed by Wang Bing Chen, a well-known architect in recent China who was a director of the Chinese Institute of Architecture (Song, 2018). The architectural form is characteristic of the Chinese Republican period, with minimalist architectural forms and elegant shapes. On the building façade, the brickwork is concave and convex in shape, with brick columns in the southeast corner of the external wall, and each house has multiple square windows with small glass and many panes, a popular style in those days. The use of decorative lines in the green brick masonry adds to the building's dynamism. It uses the form of symmetrical vertical and horizontal rows of windows to fully reveal the building's simple façade. The building also focuses on symmetrical composition, repetitive sequences and geometric pattern decoration effects. The outline of the building is clear and powerful, with a European architectural style, epitomising the art of Chinese and foreign architecture in the Republican period. The cave-dwelling workshop is a special product of wartime industrial development, combining traditional Shaanxi ancient housing forms with industrial production functions, with great local characteristics of Shaanxi and unique artistic value. The level of artistic style expression is scored as 3 according to the evaluation criteria.

Table 89. The Artistic Value Score Table for the Shenxin Yarn Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
A4 Artistic value	**A41** Aesthetic landscape value	2	0.0865	0.44
	A42 The value of the artwork	3	0.0343	
	A43 The level of artistic style expression	3	0.0545	
Total score	(Total possible score is 12)	8		

In summary, the artistic value score is 8 (total possible score is 12) and combined each weighting: 2×0.0865+3×0.0343+3×0.0545, its final score is 0.4394 (total possible score is 0.7012). To make the statistics more convenient, two decimal places are taken and the final score is 0.44.

5.3.6.5 Location Values

In evaluating the locational value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 focuses on (1) distance from the city centre; (2) transport connectivity to the city centre; (3) the number of central cities or the number of central cities or tourist areas in the wider regional context.

(1) In terms of distance from the city centre, the project is located in the north of Baoji City, near Baoshi Road. The distance from the city centre is only 3.2 km as measured by Google Maps. The level of distance from the city centre scored 3 according to the evaluation criteria.

(2) In terms of the transport situation to the city centre, there is no underground, it is in an old city centre and the roads are relatively narrow and congested. There are 3 bus stations nearby and the distance between bus stops is only 7 minutes on foot. The site is 2.5 km from the Xibao highway entrance and exit, which can be reached in 5 minutes by car. According to the evaluation criteria, the transport connectivity to the city centre is evaluated with a score of 3.

(3) In terms of the number of central cities or tourist areas in the wider regional context, there are more than 4 tourist attractions within a 100 km radius of the Shenxin Yarn Factory, such as the Ancient Chenchang City Ruins Park, the Aoshan Ski Resort and the Baoji Folklore Museum. A score of 4 is given for the number of central cities or tourist areas in the wider regional context according to the evaluation criteria.

Table 90. The Location Value Score Table for the Shenxin Yarn Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B1 Location value	**B11** Distance from the city centre	3	0.0406	0.27
	B12 Transport connectivity to the city centre	3	0.0161	
	B13 The number of central cities or tourist areas in the wider regional context	4	0.0256	
Total score	(Total possible score is 12)	10		

In summary, its location value score is 10 (total possible score is 12), and combined each weighting: 3×0.0406+3×0.0161+4×0.0256, its final score is 0.2725 (total possible score is 0.3292). To make the statistics more convenient, two decimal places are taken and the final score is 0.27.

5.3.6.6 Environmental Value

In evaluating the environmental value of industrial heritage, the analysis of the value of industrial heritage in Section 4.1 focuses on: (1) The impact of the original production function of industrial heritage on the environment; (2) The environmental scope of the industrial heritage.

(1) About the impact of the original production function of industrial heritage on the environment, the noise and pollution from the Shenxin Yarn Factory was low and minor environmental pollution was found during the visit, such as pollution from corporate exhaust emissions and soil contamination, except for some waste instruments that were exposed during the transformation process and affected the aesthetics. In addition, during the transformation process, the original trees, such as the Sophora japonica, were protected. The first phase of the Shenxin Yarn Factory has been transformed and the site is well greened, no significant pollution was found during the visit of the second, third and fourth phases. According to the evaluation criteria, the impact of the original production function of industrial heritage on the environment score is 3.

(2) In terms of the environmental scope of the industrial heritage, the site is located in a complex terrain with a height difference of approximately 60 metres and the overall environment of the site, therefore, lacks a structured traffic organisation. The accessibility is relatively limited. The environmental scope of the industrial heritage was scored as 4 according to the evaluation criteria.

Table 91. The environmental value score table for the Shenxin Yarn Factory

<table>
<tr><th>The factors layer</th><th>The detail layer</th><th>Score</th><th>Weights</th><th>Final score</th></tr>
<tr><td rowspan="2">B2 Environmental value</td><td>B21 The impact of the original production function of industrial heritage on the environment</td><td>3</td><td>0.0208</td><td rowspan="3">0.1</td></tr>
<tr><td>B22 The environmental scope of the industrial heritage</td><td>4</td><td>0.0104</td></tr>
<tr><td>Total score</td><td>(Total possible score is 8)</td><td>7</td><td></td></tr>
</table>

In summary, the score for environmental value is 7 (total possible score is 8), and combined each weighting: 3×0.0208+4×0.0104, its final score is 0.104 (total possible score is 0.1248). To make the statistics more convenient, two decimal places are taken and the final score is 0.1.

5.3.6.7 Group Value

The group value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in terms of (1) the scale of the group; (2) the relationship of the group; (3) the potential for wide-scale groups of industrial heritage.

Shenxin Yarn Factory is located in the Jintai District of Baoji, which is part of the Shilipu Industrial Zone of Baoji City. There are industrial companies nearby such as Baoji Forklift Manufacturing Company Factory No.5, Baoji No.1 Dyeing and Weaving Factory, Baoji Machine Tool Factory, Baoji Electrical Machinery General Factory and Xinqin Paper Factory. According to the evaluation criteria, it scored 4 for the scale of the group; it scored 2 for the relationships of the group because the nearby industries belong to different industrial categories and are less connected; it scored 2 for the potential for wide-scale groups of industrial heritage.

Table 92. The Group Value Score Table for the Shenxin Yarn Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B3 Group value	**B31** The scale of the group	4	0.0203	0.12
	B32 Relationship of the group	2	0.0081	
	B33 The potential for wide-scale groups of industrial heritage	2	0.0128	
Total score	(Total possible score is 12)	8		

In summary, its group value has a score of 8 (total possible score is 12), and combined each weighting: 4×0.0203+2×0.0081+2×0.0128, its final score is 0.123 (total possible score is 0.1648). To make the statistics more convenient, two decimal places are taken and the final score is 0.12.

5.3.6.8. Social Value

The social value of industrial heritage, according to the analysis of the value of industrial heritage in Section 4.1, is evaluated in four main ways: (1) The ability to solve re-employment; (2) Educational function; (3) The potential to provide a place of leisure for the public; and (4) Enhancing the image or symbolism of the city.

(1) In terms of the ability to solve re-employment, the Shenxin Yarn Factory employed a large number of workers and managers during its normal production phase in different historical periods before it was closed down, providing employment for over 3,000 people (Shaanxi Cotton Twelfth Factory Journal Compilation Committee, 1998). The transformation of the four phases will continue to provide more jobs for the community, and at the same time will enable the public to understand an integral part of the history of the development of the yarn industry in Baoji and to have a basic knowledge of the production process of yarn spinning. The ability to solve re-employment was scored as 2 according to the evaluation criteria.

(2) Regarding the educational function, after the first phase of transformation, the cave workshop now functions as the Baoji Industrial Heritage Museum, which provides an opportunity to learn about the history of industrial development in Baoji and a basic understanding of the production process of spinning yarn. It has also become an excellent base for patriotic education. However, the display is only in a few ways, through pictures, videos and physical displays. In the future, interactive experiences could be added. The Shenfu Xin office building which is now the Shenxin Corporate History Exhibition Hall provides an insight into the history and background of the relocation of the Shenxin Yarn Factory. Based on the evaluation criteria, their score for the educational function is 2.

(3) As for the potential to provide a recreational space for the public, the transformation of the Shenxin Yarn Factory is divided into four phases, which will provide a place for recreation, entertainment and gathering for the surrounding citizens. According to the evaluation criteria, the score for the potential to provide a place of leisure for the public is 3.

(4) In terms of enhancing the image or symbolism of the city, the Shenxin Yarn Factory witnessed Chinese national enterprises moving to the mainland during the war

of resistance against Japan, also witnessing the progress of working together to save the country in time of national crisis. The Shenxin Yarn Factory laid the foundation for the growth of Baoji from a small agricultural county with only a few thousand people to the second largest city in Shaanxi Province with a population of over three million, after the city of Xi'an, and an important industrial city in northwest China. It has preserved a relatively complete industrial heritage from the war period, presenting a more comprehensive view of the layout and architecture of early industrial enterprises in China. Following the reuse of the first phase, the project has been able to provide a better understanding of the culture and history of the old site and has enhanced the quality of the surrounding environment. However, it is still not recognized and known by the wider public, and is little known even to residents in Baoji City.

In the future, if it can be well protected and reasonably reused to expand the popularity of the Shenxin Yarn Factory, it will be used as a visiting card for the Baoji City, so that more people can understand the history of Baoji's textile development and the abundant historical and humanistic connotations that Baoji has, which will play a role in promoting the image of the city and driving regional economic development. According to the evaluation criteria, its score for enhancing the image or symbolism of the city is 3.

Table 93. The Social Value Score Table for the Shenxin Yarn Factory

The factors layer	**The detail layer**	**Score**	**Weights**	**Final score**
B4 Social value	**B41** The ability to solve re-employment	2	0.0164	0.1
	B42 Educational function	2	0.0097	
	B43 The potential to provide a place of leisure for the public	3	0.0069	
	B44 Enhancing the image or symbolism of the city	3	0.0082	
Total score	(Total possible score is 16)	10		

In summary, the social value score is 10 (total possible score is 16) and combined each weighting: 2×0.0164+2×0.0097+3×0.0069+3×0.0082, its final score is 0.0975 (total possible score is 0.1648). To make the statistics more convenient, two decimal places are taken and the final score is 0.1.

5.3.6.9 Emotional Value

The emotional value of industrial heritage, based on the analysis of the value of industrial heritage in Section 4.1, is evaluated in three main ways: (1) the number of people who have an emotional connection to industrial heritage; (2) the age range of the people who have an emotional connection to industrial heritage; (3) structural characteristics of the careers of people with emotional value.

The people who have an emotional attachment to the Shenxin Yarn Factory can be divided into the following categories:

The first category is the old employees who have worked in the factory and have devoted decades of time and energy to it. These people are generally between 60 and 80 years old and have the deepest feelings for the Shenxin Yarn Factory. According to interview the manager, these numbers are around 300 people.

The second category is residents who have lived in the neighbourhood for many years, have experienced the changes in the factory, and there is no specific age limit for this group. According interview the residents and ask manager, these numbers are around 500 people.

The third category is the relatives of some of the factory employees and the current workers in the reused factory, whose feelings towards the factory site include curiosity and affection for the factory, and who range in age from young to old. The number of these people was around 200 according to the visit.

The fourth category are researchers or industrial heritage enthusiasts with an interest in industrial heritage. Through random interviews with 30 people, it was found that most of them were above the age of 20.

The fifth category, they are currently employed staff, and these are generally between 20 and 50 years old. According to interview with the manager, the number is around 50.

Therefore, combining the evaluation criteria, the scores for these three detail layers are 2, 3 and 3 respectively.

Table 94. The Emotional Value Score Table for the Shenxin Yarn Factory

The factors layer	The detail layer	Score	Weights	Final score
B5 Emotional value	**B51** Number of people who have an emotional connection to industrial heritage	2	0.0268	0.14
	B52 The age range of the people who have an emotional connection to industrial heritage	3	0.0169	
	B53 Characteristics of the careers of people with emotional value	3	0.0106	
Total score	(Total possible score is 12)	8		

In summary, its emotional value has a score of 8 (total possible score is 12) and combined each weighting: 2×0.0268+3×0.0169+3×0.0106, its final score is 0.1361 (total possible score is 0.2172). To make the statistics more convenient, two decimal places are taken and the final score is 0.14.

5.3.7 A GIS-based Visualization Process for Evaluating Industrial Heritage Values - Baoji Shenxin Yarn Factory

According to the analysis of the process of visualising industrial heritage values using GIS technology in Section 4.9.2, the GIS visualisation of the industrial heritage values of the Baoji Shenxin Yarn Factory is divided into three steps:

(1) The first step is to collect the GIS data and create a database. The first thing is to obtain the ArcGIS graphic file. Then input into the GIS platform the attribute data that was obtained through the field research of Shenxin Yarn Factory, Baoji City, Shaanxi Province, China, such as The date of construction of the heritage, building function; Building type; (2) Each single factor was first analysed by correlating spatial and attribute data; (3) The weights of the factors calculated in Section 4.7 and the scores of the different factors of each building in the Shenxin Yarn Factory are overlaid to obtain the multi-factor analysis and visualised in the ArcGIS platform. The detailed operation process is shown below.

4.3.7.1 Obtaining ArcGIS Graphical Files

The existing building condition of the Shenxin yarn factory was obtained through site visits and satellite maps, and was represented as a Graphics file drawn by AutoCAD software. In order to apply ArcGIS technology, the AutoCAD file graphics dwg. file format needs to be switched to the GIS system editable shp. file format, the basic steps are as follows:

(1) Based on the field study of the Shenxin Yarn Factory and the satellite map downloaded from the Geospatial Data Cloud (a data cloud computing platform built by the Chinese Academy of Sciences Network Information Centre), drawing the building blocks and road information as well as the scope of the research of the Shenxin Yarn Factory on the AutoCAD platform. The AutoCAD 2022 software was used to layer the AutoCAD files and export them as four dwg. files: building layer, boundary line layer, road layer and Plaza layer. The current CAD situation of the Shenxin Yarn Factory is shown in Figure 79.

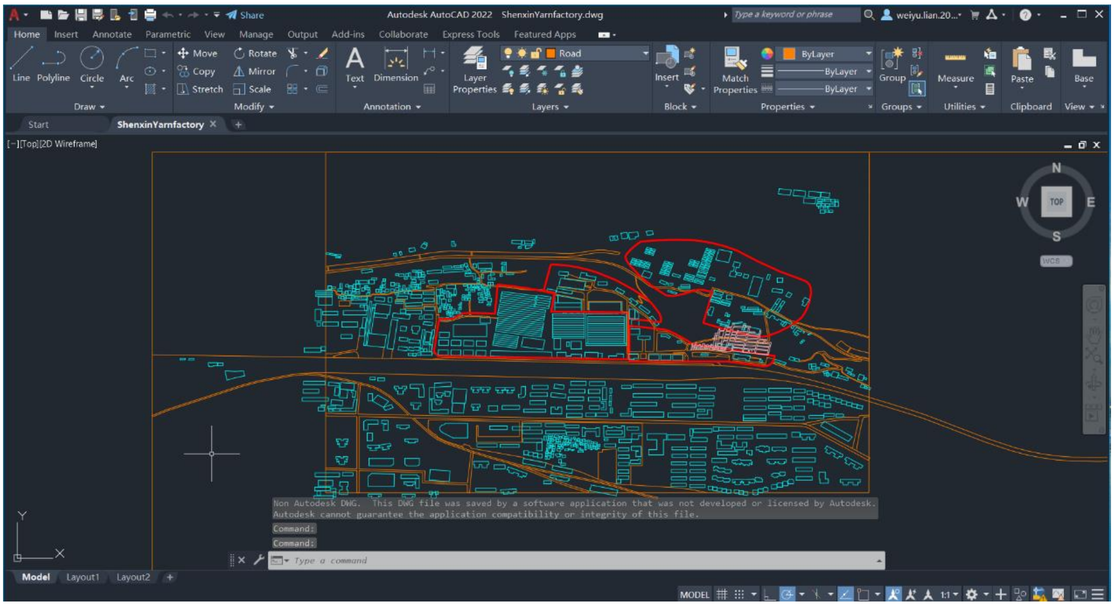


Figure 79. AutoCAD Drawing of the Current State of the Shenxin Yarn Factory

(2) The AutoCAD file was exported in layers as a dwg. format file, and then the AutoCAD file was imported into the GIS platform by Right-clicking on the Layers - Add Data - Selecting the four layered dwg. format files of the Shenxin – Add (Figure 80).

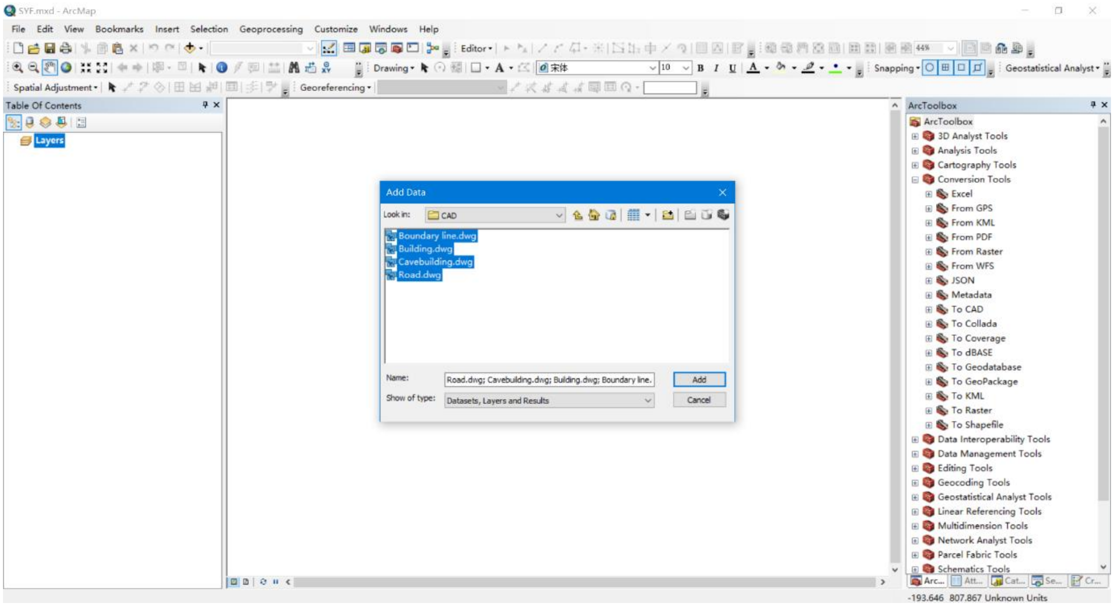


Figure 80. Adding Shenxin Yarn Factory CAD Drawings in ArcGIS

Alternatively, the AutoCAD exported dwg. file is divided into five forms in the GIS platform - Annotation, Point, Polyline, Polygon, and MultiPatch. Select Polygon for buildings and cave buildings, Polyline for roads and boundaries (Figure 81), then delete the other forms. The next step is adjusting the location of the AutoCAD drawing (matching the drawn CAD with the actual real geographic coordinates) by using the Georeferencing tool in the ArcGIS platform, referencing the spatial location of the directly acquired remote sensing image.

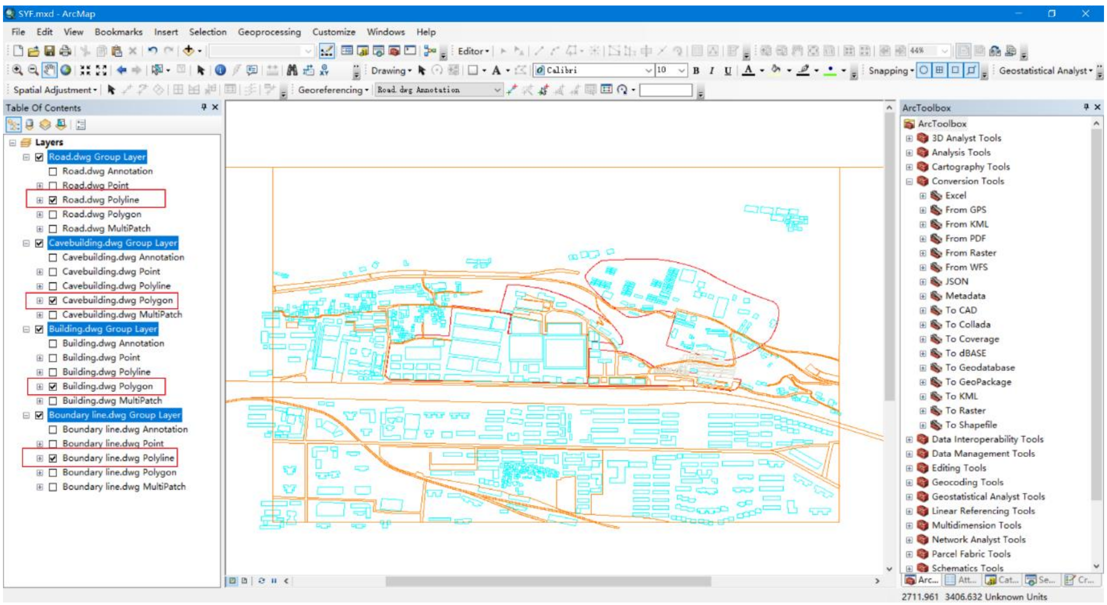


Figure 81. Selecting the Form of the CAD Drawing in ArcGIS

Furthermore, using the "Data Management Tools - Features - Feature To Polygon" command of the ArcToolbox tool, the CAD file was converted into a shp. file for subsequent multi-factor overlay analysis. The shp. format file obtained by importing the GIS is shown in Figure 82 and Figure 83. The organised figure is shown in Figure 84.

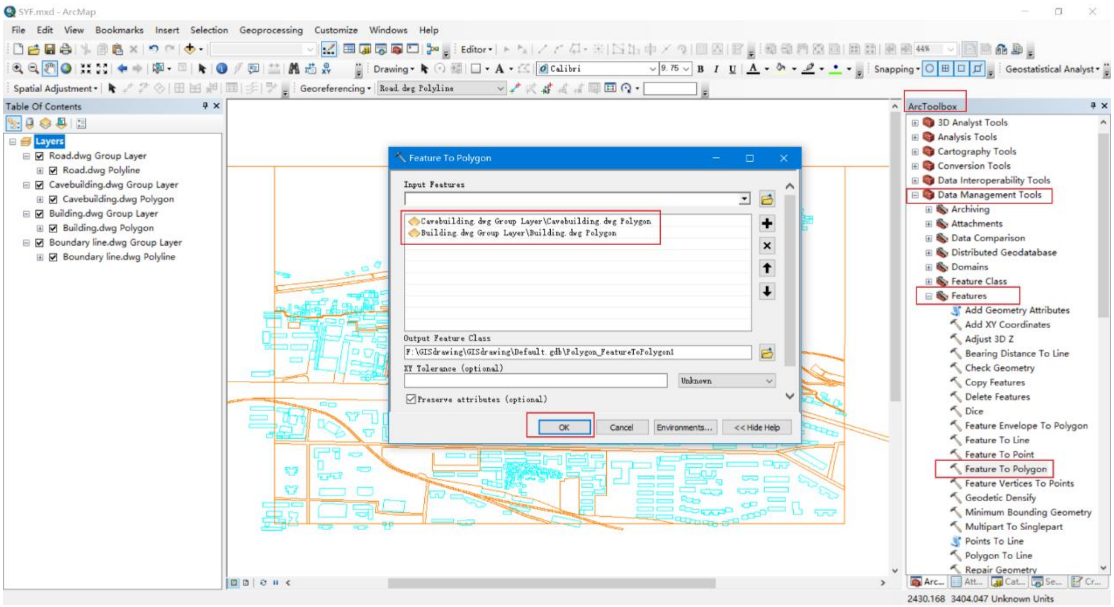


Figure 82. Conversion of dwg. Format Files to shp. Format for Shenxin Yarn Factory

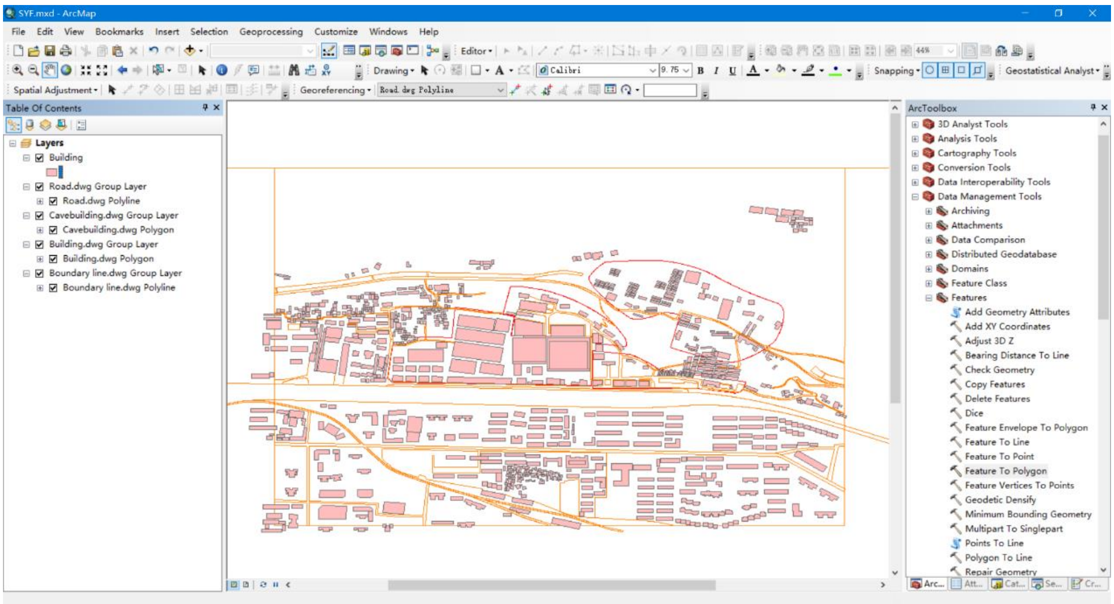


Figure 83. Building after Conversion to shp. Format File

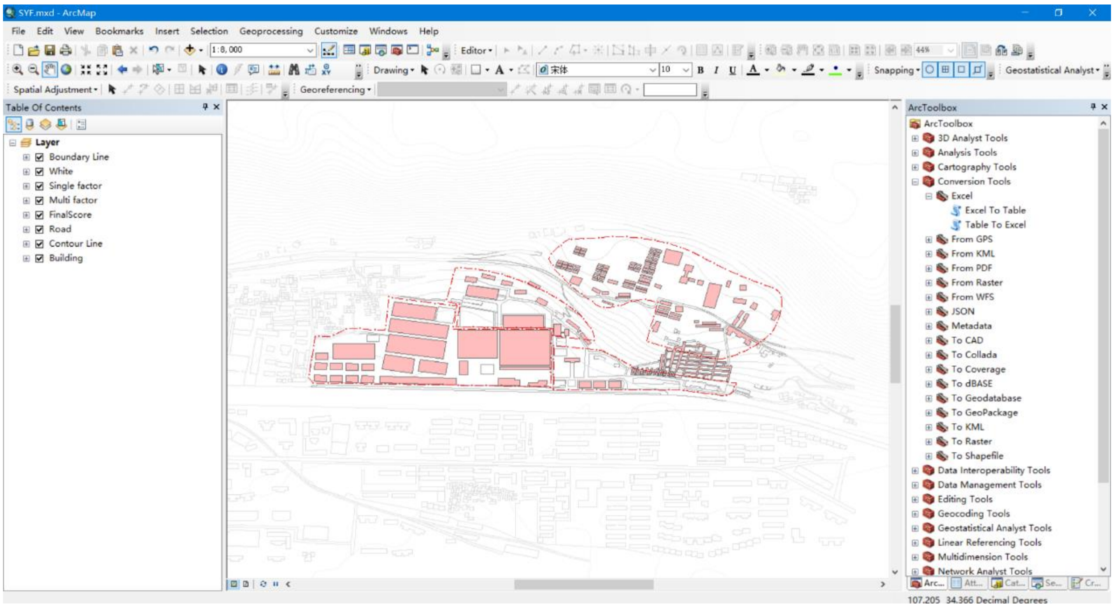


Figure 84. Organised ArcGIS Graphic File of the Shenxin Yarn Factory

4.3.7.2 Building Attribute Data of Shenxin Yarn Factory Entered into ArcGIS Platform

After the Shenxin Yarn Factory's ArcGIS graphics are acquired, the next step is to enter the attribute data in the ArcGIS platform. Right-click on the Building layer in ArcGIS to open the attribute table and add a field through the attribute table named ID (Figure 85). ID the buildings that need to be entered into the property data for the Shenxin Yarn Factory in edit mode. Then select Conversion Tools-Excel-Table to Excel (Figure 86) from the ArcToolBox tool to export to an Excel file (Figure 87).

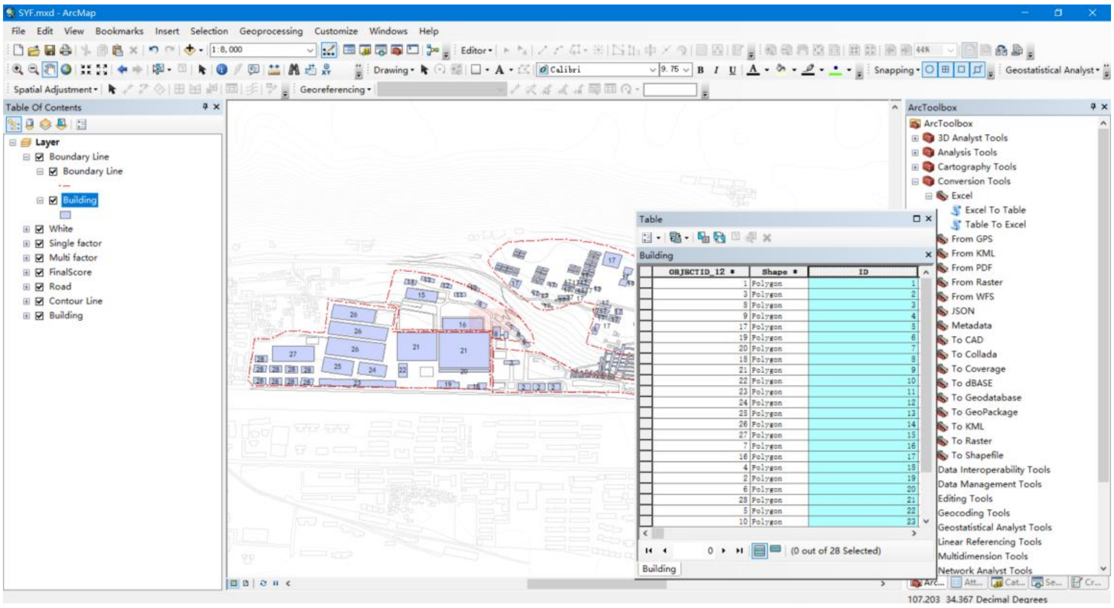


Figure 85. Building ID on the GIS Platform of the Shenxin Yarn Factory

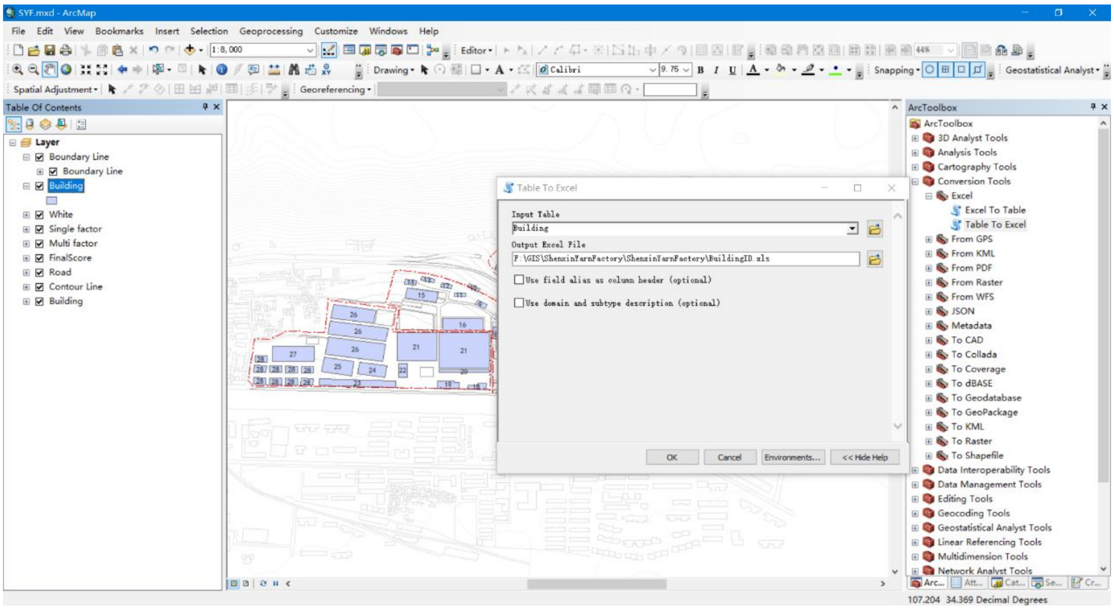


Figure 86. The Process of Exporting the Building ID of Shenxin Yarn Factory to Excel

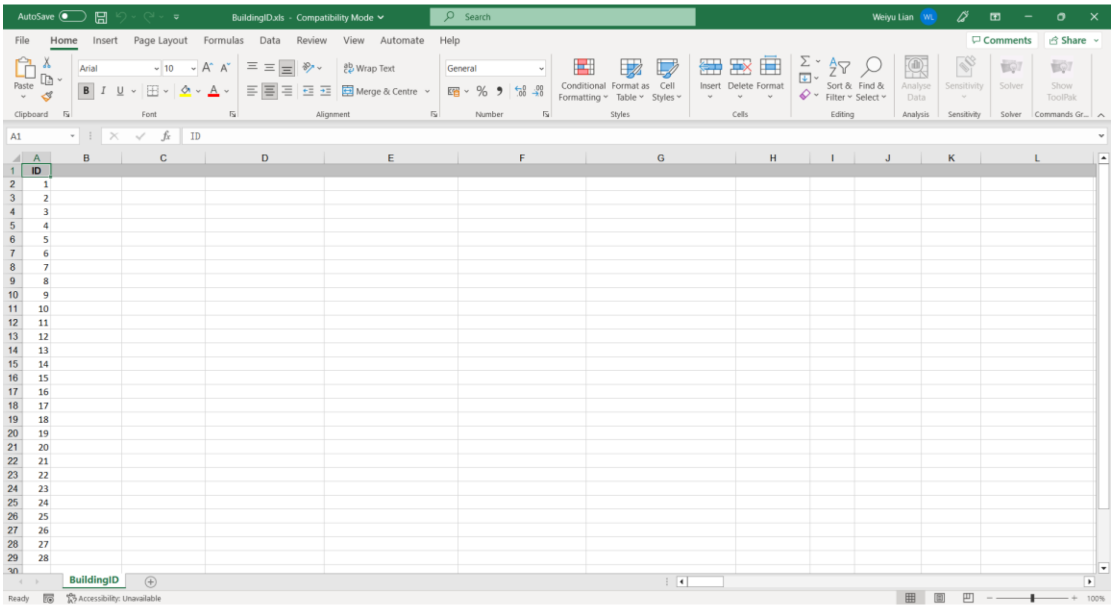


Figure 87. Show the Building ID of Shenxin Yarn Factory in Excel

After entering the property information collected from the field research in Excel (Figure 88), select the BuildingID file in the ArcGIS Catalog and drag and drop it under the Layer (Figure 89).

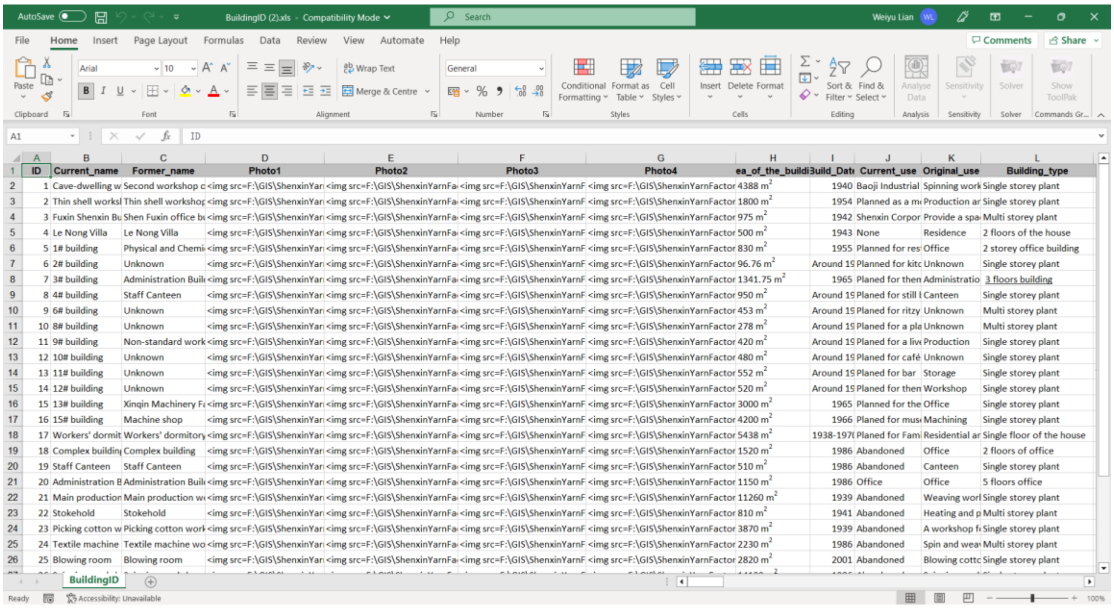


Figure 88. Enter Shenxin Yarn Factory Attribute Data in Excel

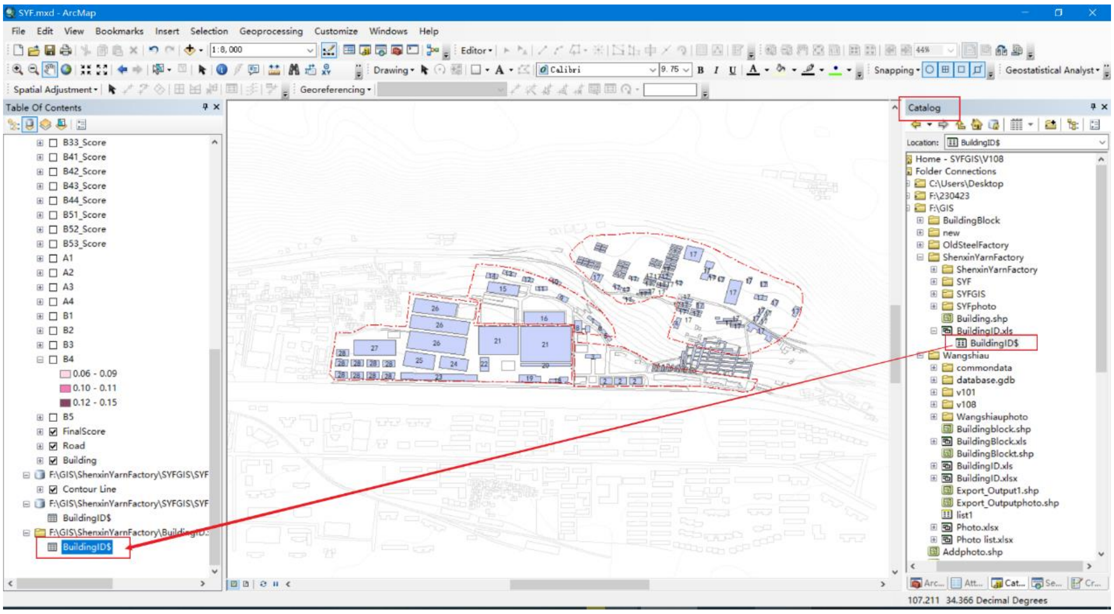


Figure 89. Import the Completed Excel Sheet into the ArcGIS Platform

Right-click on the Building layer and use Joins and Relates-Join, select the ID field of the Building Properties and the ID field of the Building ID Excel table to correlate the two forms based on the ID field (Figure 90).

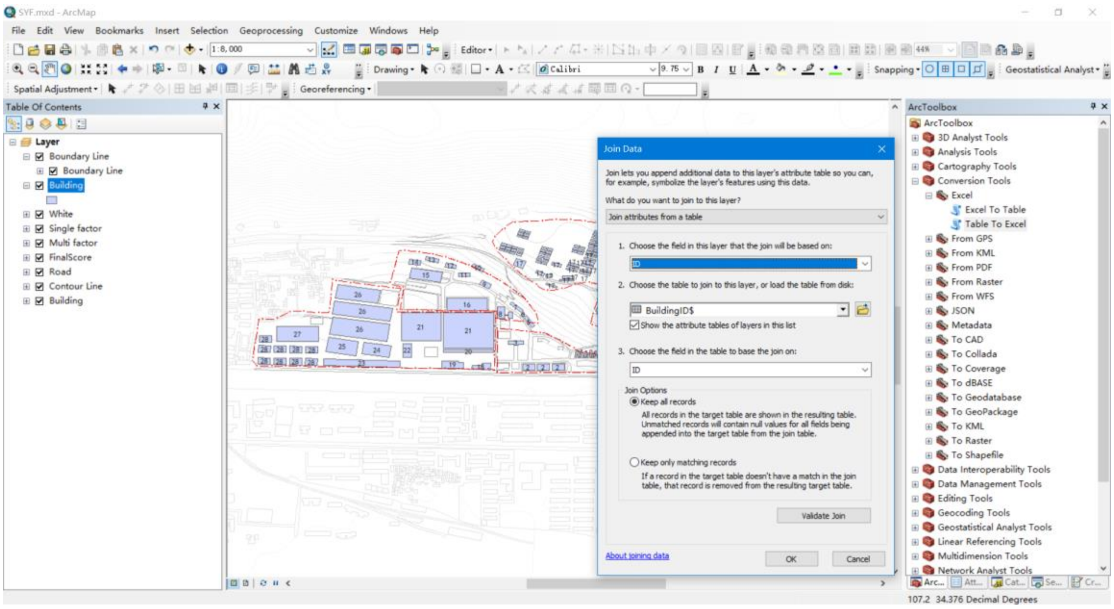


Figure 90. Related to the Building Properties of the Shenxin Yarn Factory

In addition, in order to permanently add the data to the ArcGIS building layer and avoid losing the attribute information after Remove Join, the data of the building layer after linking the attribute data needs to be exported to the ArcGIS building database. The command is to right-click on the Building layer and select Data-Export Data to save the layer's data as a shp. file (Figure 91).

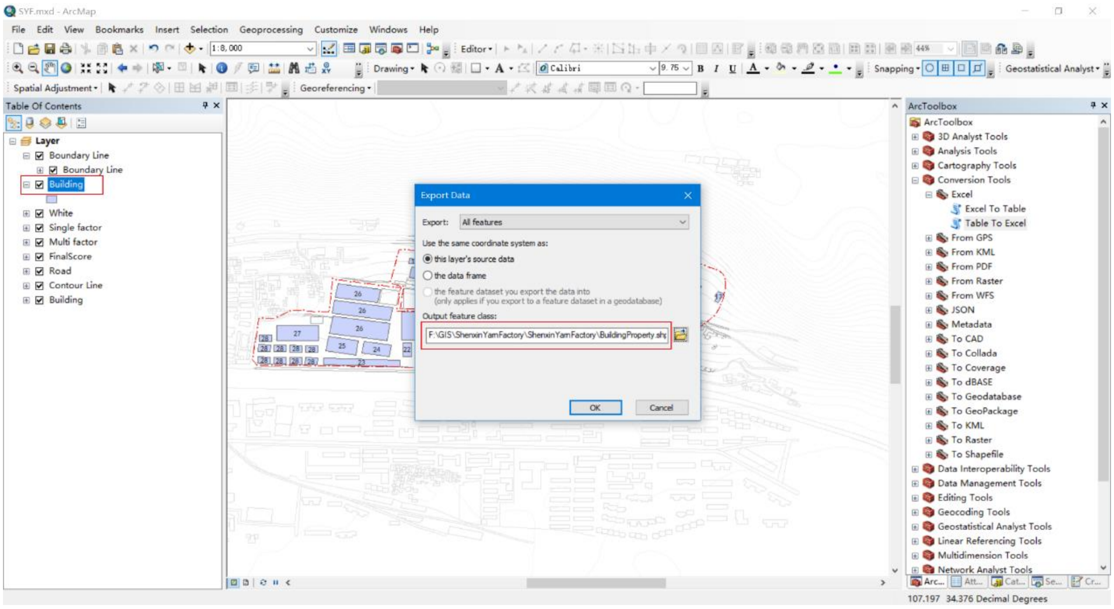


Figure 91. Exporting Building Property Data to the Database

Through the above operation, a one-to-one correspondence between the graphical data of the building layer and the attribute data of excel is achieved. The output building attribute table with data is shown in the Figure 92.

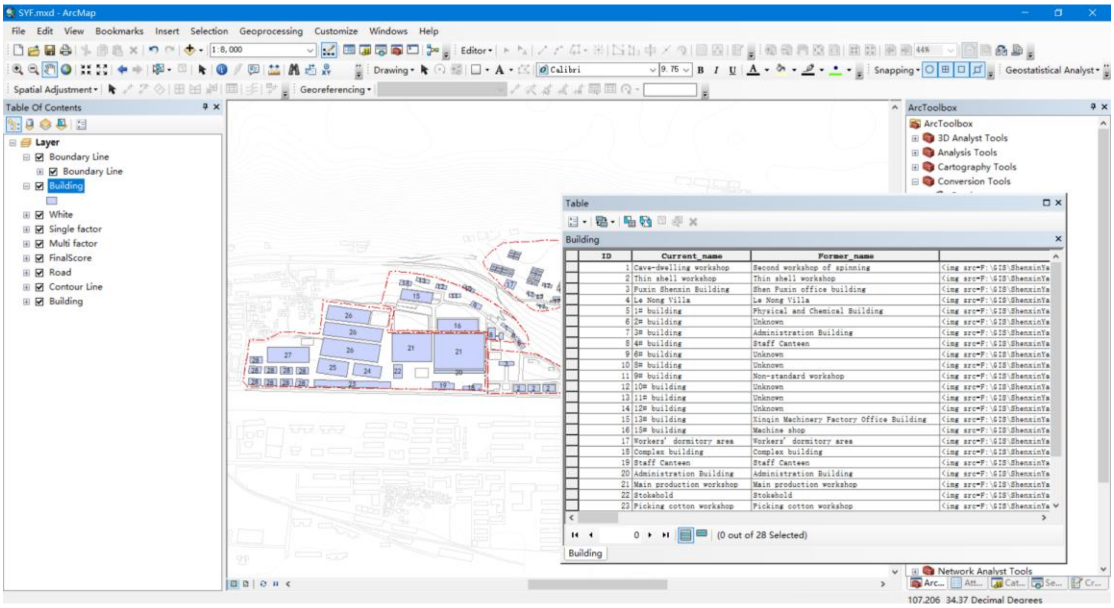


Figure 92. List of Building Properties of Shenxin Yarn Factory

In addition, in order to present more visual information about the building properties and current photos of the Shenxin Yarn Factory, a new folder was created on the computer named SYFphoto. Rename the current photos taken at the Shenxin Yarn Factory site according to the Building IDs as 1-1, 1-2, 1-3; 2-1, 2-2, ..., and add them to this folder. Next, enter their photo paths into the Building Properties table above. Then use the Layer Properties - HTML Popup command to enter the URL where the image is located (Figure 93). Click on the HTML icon to bring up the building's properties and image information.

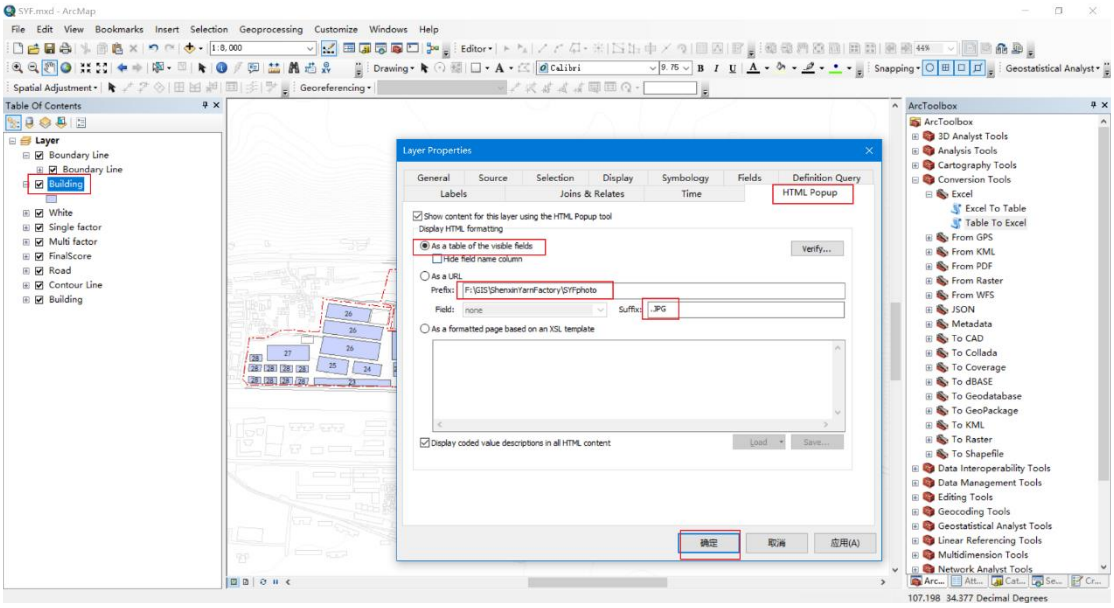
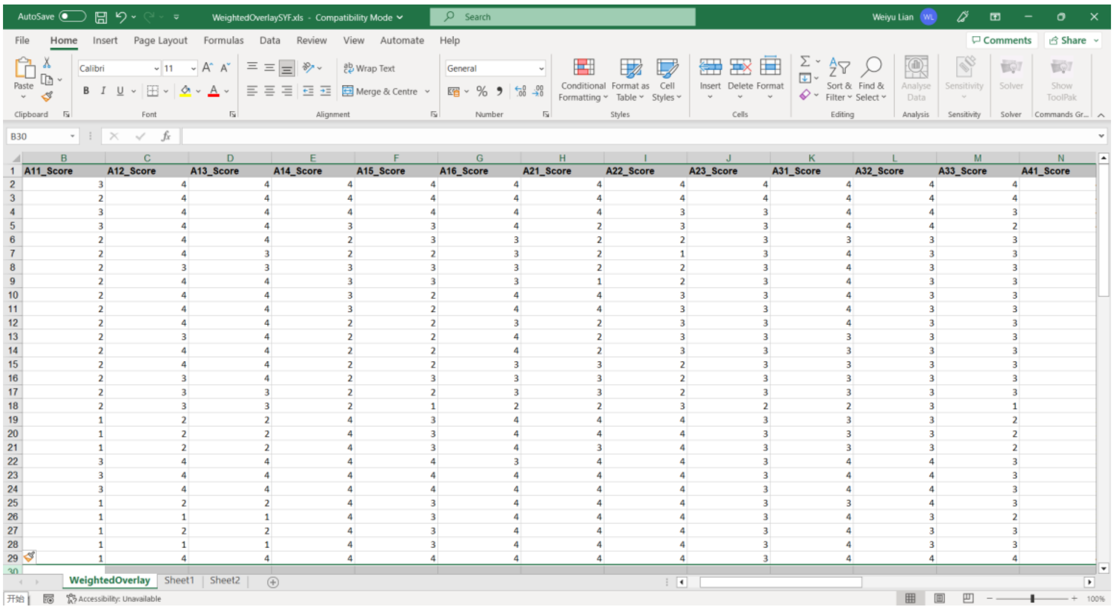


Figure 93. HTML Pop-up Screen Setting for Shenxin Yarn Factory Property Information

4.3.7.3 Single Factor Visualisation

With reference to the indicators identified in the industrial heritage value evaluation method proposed in Section 4.6, and the evaluation criteria in Section 5.1.9, each factor is assigned a score through a review of literature, field visits and interviews with Shenxin Yarn Factory. The criteria were divided into four levels: 4, 3, 2 and 1. By entering the scores in Excel, the scores for each factor are shown in Figure 94.

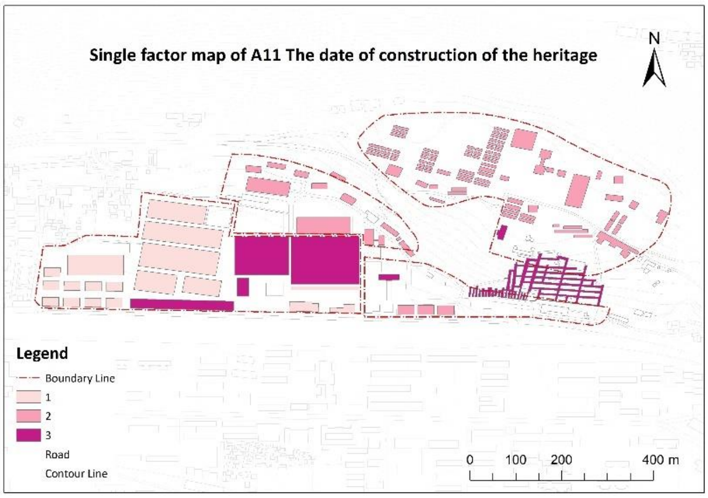


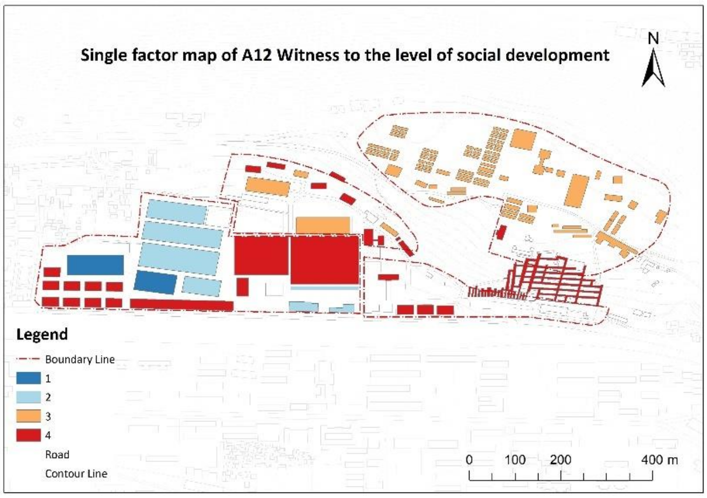
	A11_Score	A12_Score	A13_Score	A14_Score	A15_Score	A16_Score	A21_Score	A22_Score	A23_Score	A31_Score	A32_Score	A33_Score	A41_Score
2	3	4	4	4	4	4	4	4	4	4	4	4	
3	2	4	4	4	4	4	4	4	4	4	4	4	
4	3	4	4	4	4	4	4	3	3	4	4	3	
5	3	4	4	3	3	4	2	3	3	4	4	2	
6	2	4	4	2	3	3	2	2	3	3	3	3	
7	2	4	3	2	2	3	2	1	3	4	3	3	
8	2	3	3	3	3	3	2	2	3	4	3	3	
9	2	4	4	3	3	3	1	2	3	4	3	3	
10	2	4	4	3	2	4	4	3	3	4	3	3	
11	2	4	4	3	2	4	4	3	3	4	3	3	
12	2	4	4	2	2	3	2	3	3	4	3	3	
13	2	3	4	2	2	4	2	3	3	3	3	3	
14	2	4	4	2	2	4	2	3	3	3	3	3	
15	2	4	4	2	2	3	3	2	3	3	3	3	
16	2	3	4	2	3	3	3	2	3	3	3	3	
17	2	3	3	2	2	3	3	2	3	3	3	3	
18	2	3	3	2	1	2	2	3	2	2	3	1	
19	1	2	2	4	3	4	4	4	3	3	3	2	
20	1	2	2	4	3	4	4	4	3	3	3	2	
21	1	2	2	4	3	4	3	4	3	3	3	2	
22	3	4	4	4	4	3	4	4	3	4	4	3	
23	3	4	4	4	4	4	4	4	3	4	4	3	
24	3	4	4	4	4	4	4	4	3	4	4	3	
25	1	2	2	4	3	4	4	4	3	3	4	3	
26	1	1	1	4	3	4	4	4	3	4	3	2	
27	1	2	2	4	3	4	4	4	3	4	3	3	
28	1	1	1	4	3	4	4	4	3	4	3	3	
29	1	4	4	4	4	4	4	4	3	4	4	4	

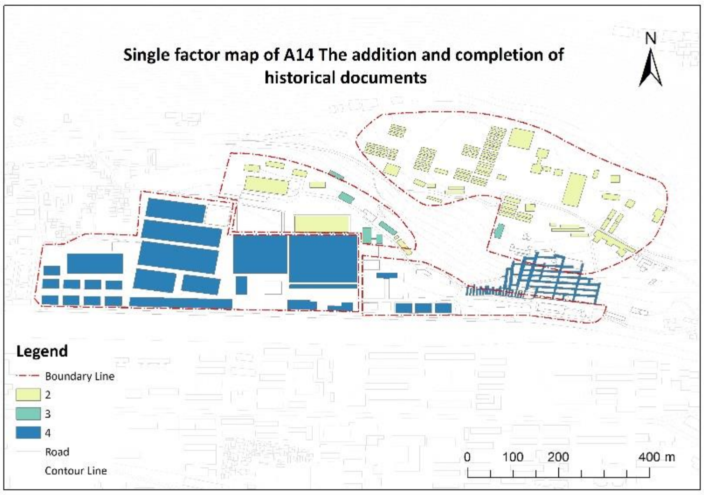
Figure 94. Different Factor Scores for Each Building of Shenxin Yarn Factory

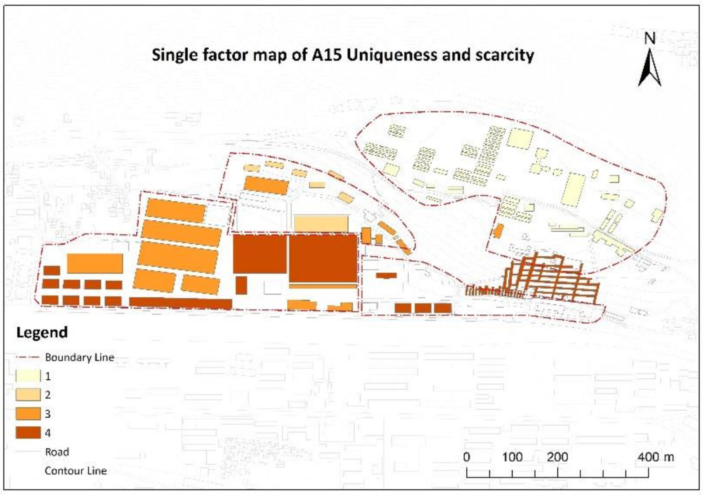
This is then imported into ArcGIS and the factors to be expressed are selected in the Layer Properties - Symbology system for visual representation. The different colours on the map indicate the difference in scores. The results of the single factor evaluation for the Shenxin Yarn Factory are shown in the following table:

Table 95. Single Factor Evaluation Visualisation of A1 Historical Value









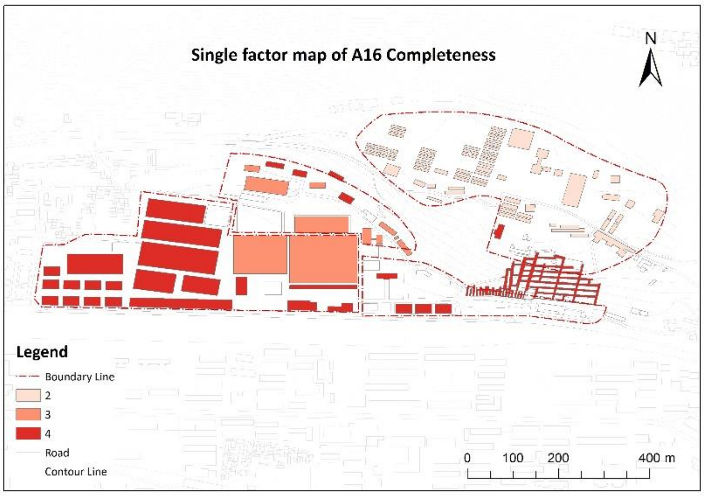
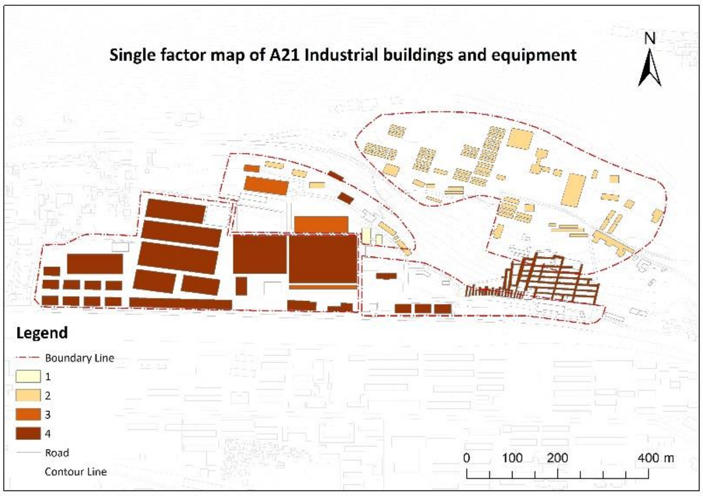
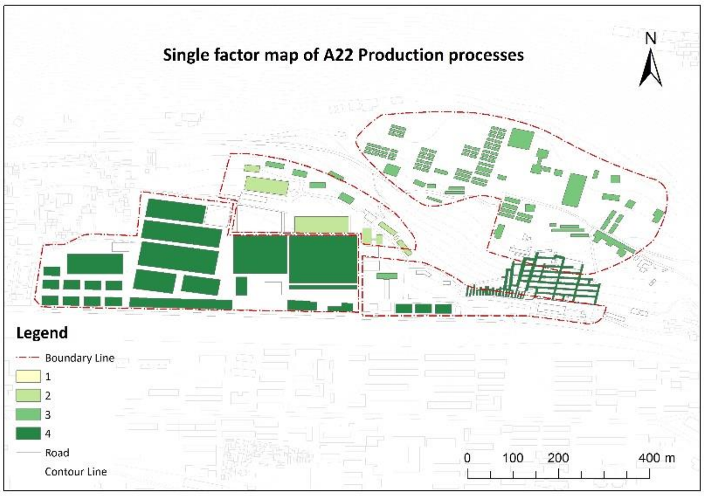
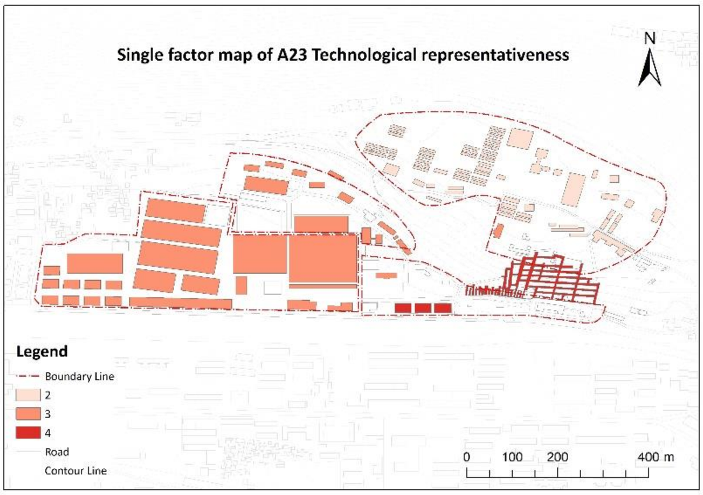


Table 96. Single Factor Evaluation Visualisation of A2 Scientific and Technological Value





<table>
<tr><td>
</td><td></td></tr>
</table>

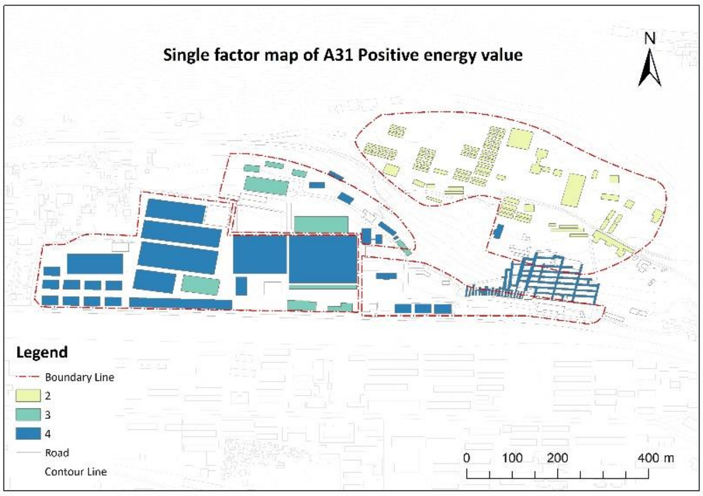
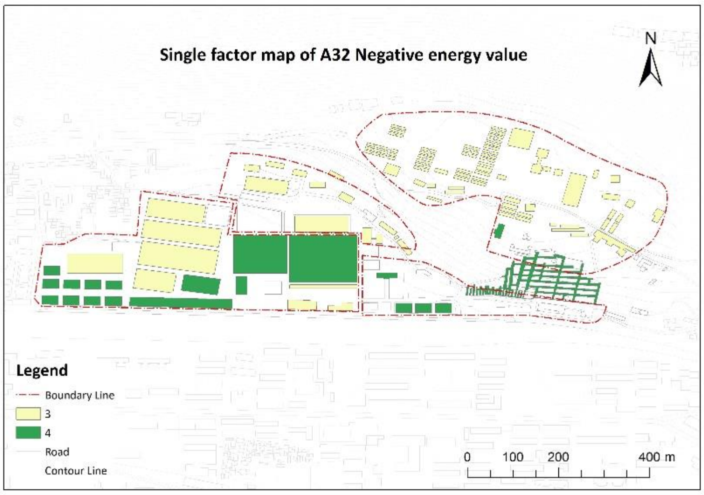
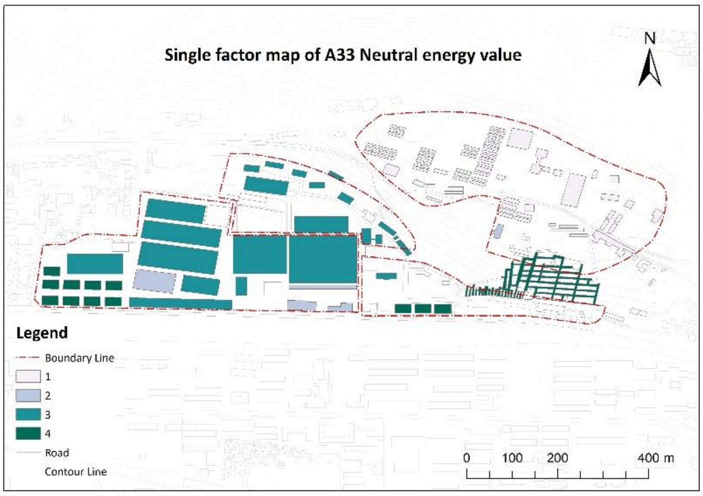
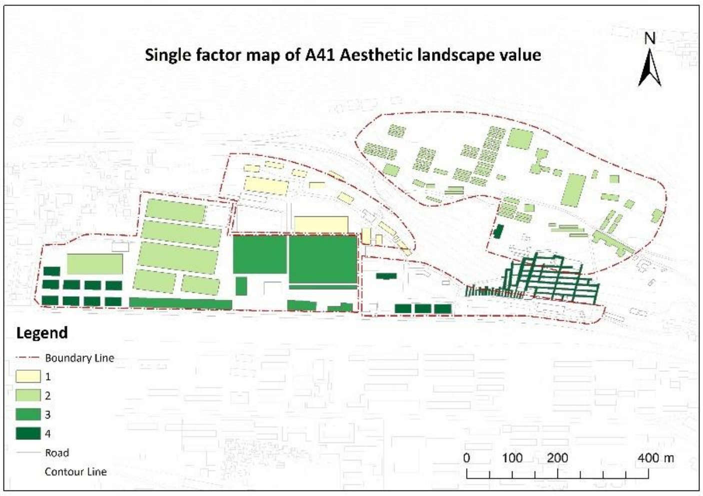
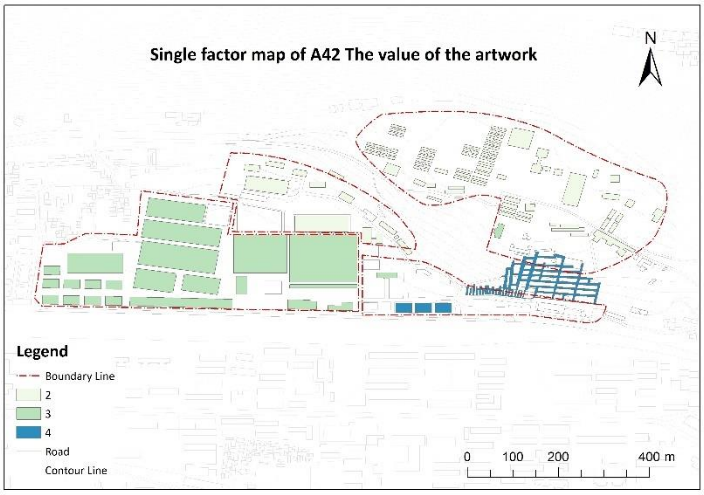
<table>
<tr><td colspan="2">Table 97. Single Factor Evaluation Visualisation of A3 Cultural Value</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>
</td><td></td></tr>
</table>

Table 98. Single Factor Evaluation Visualisation of A4 Artistic Value





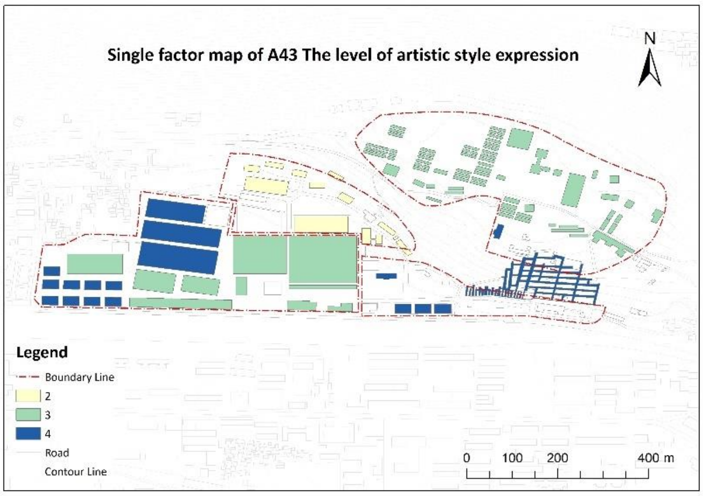
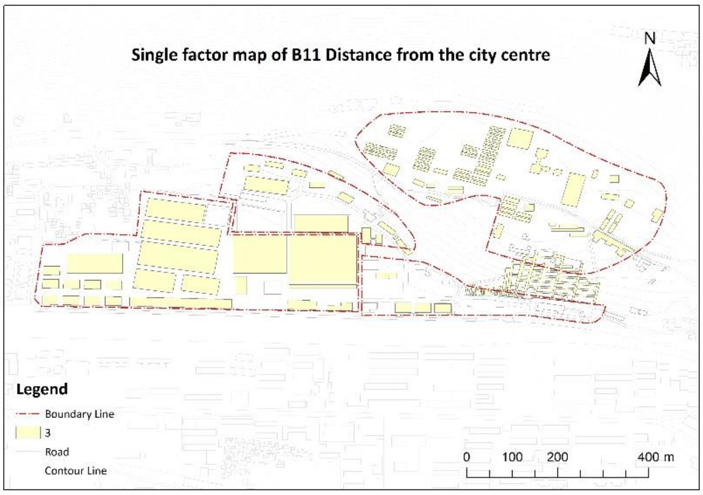
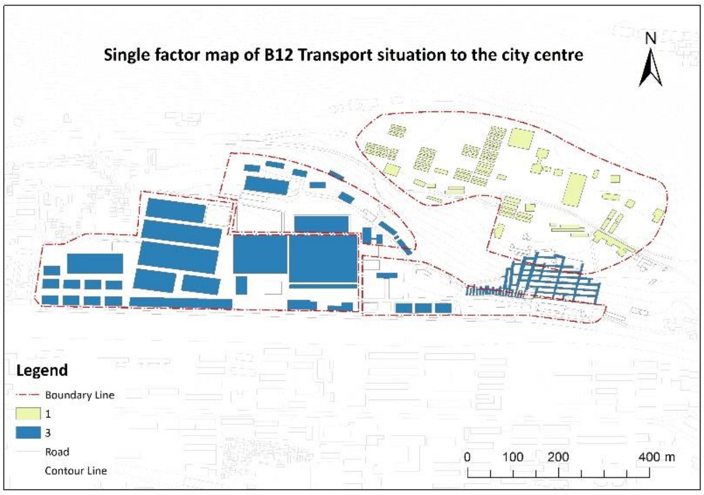


Table 99. Single Factor Evaluation Visualisation of B1 Location Value





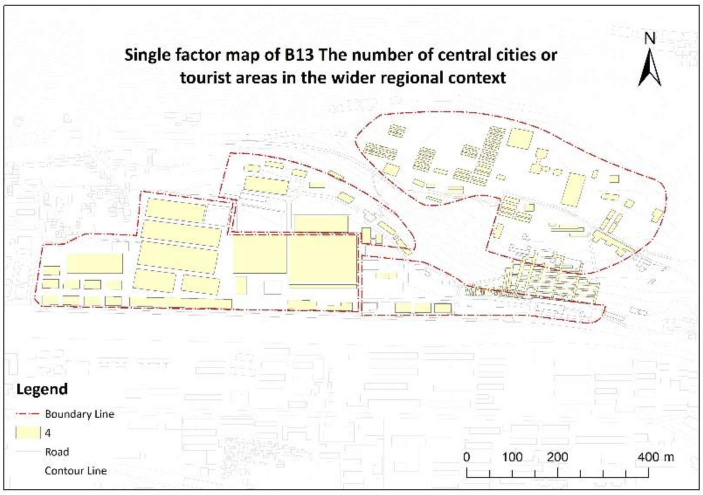
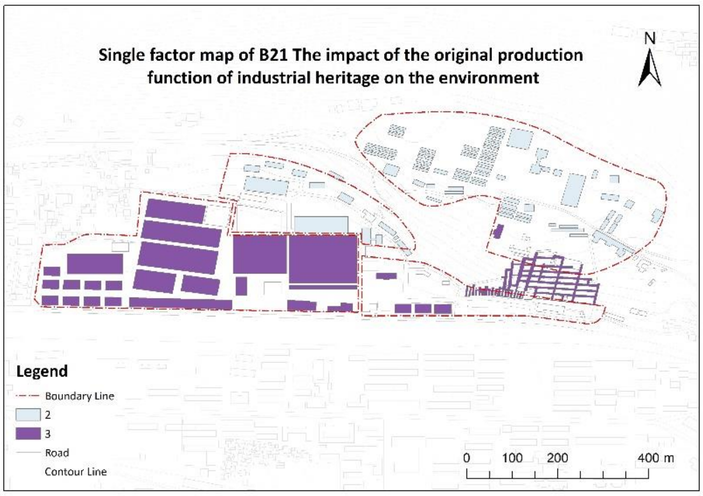


Table 100. Single Factor Evaluation Visualisation of B2 Environmental Value



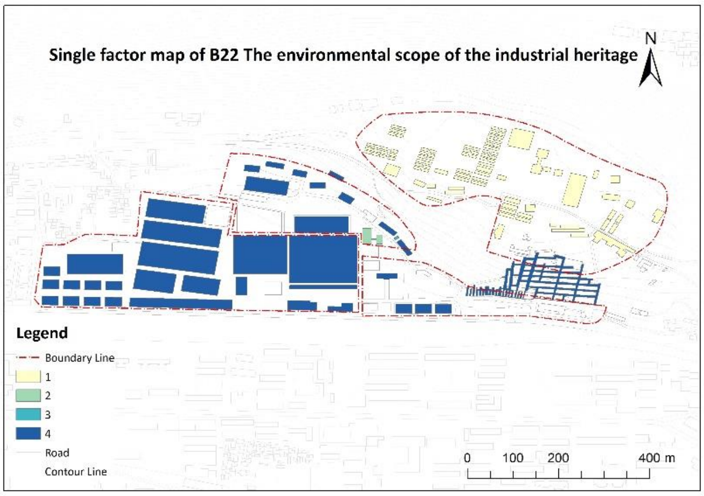
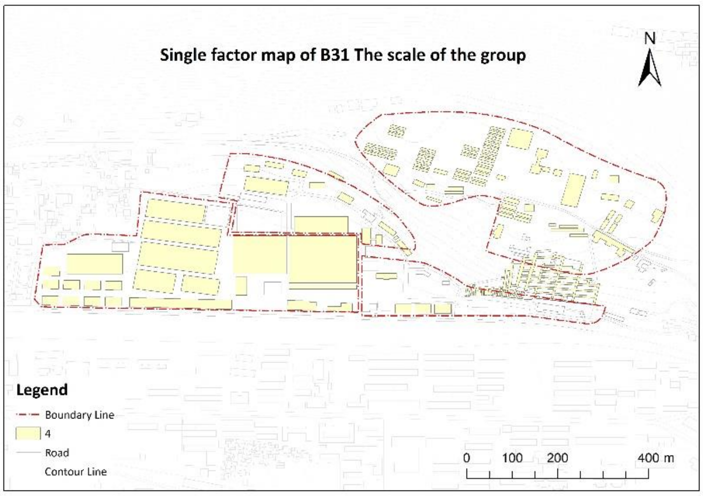
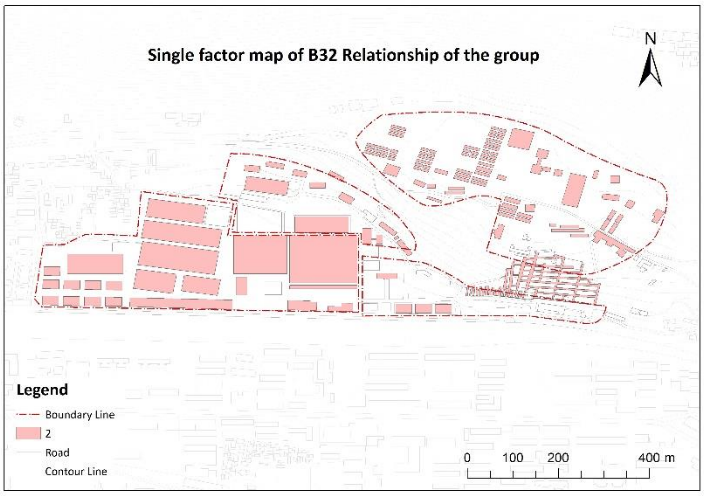


Table 101. Single factor evaluation visualisation of B3 Group value





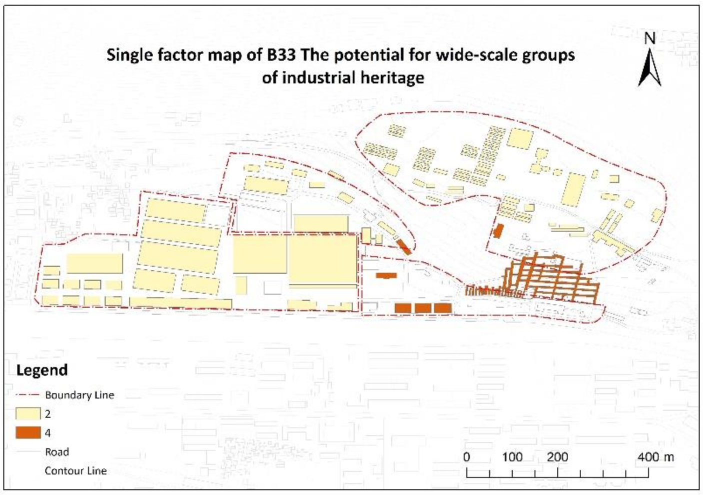
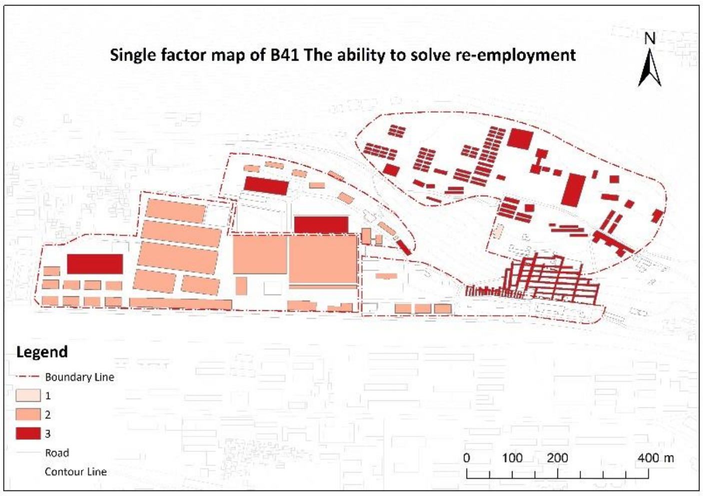
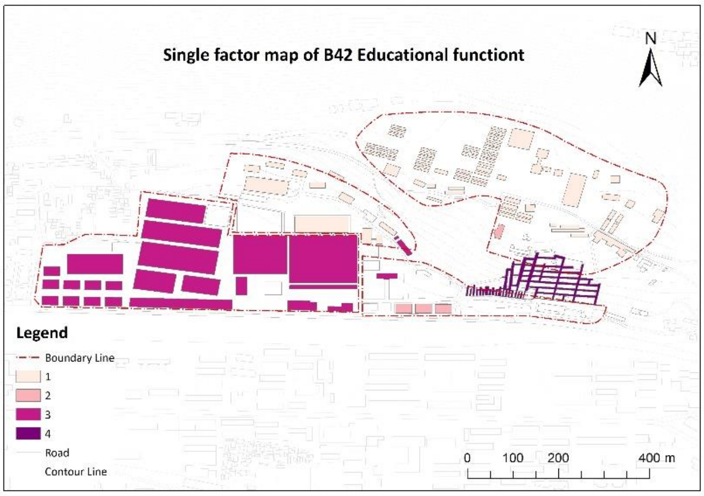
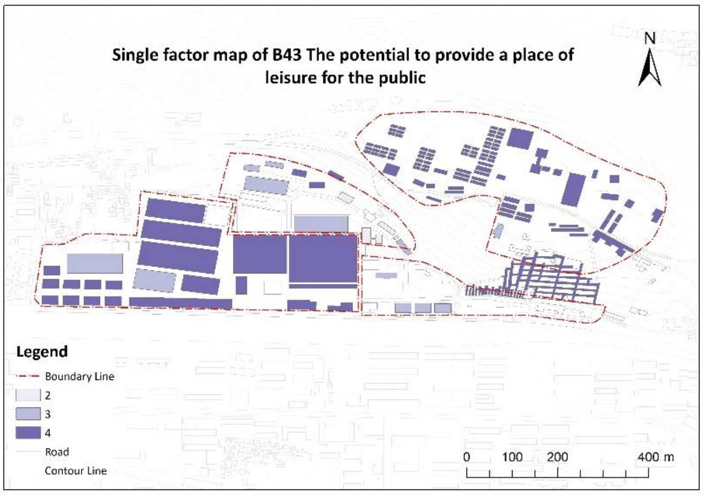


Table 102. Single Factor Evaluation Visualisation of B4 Social Value







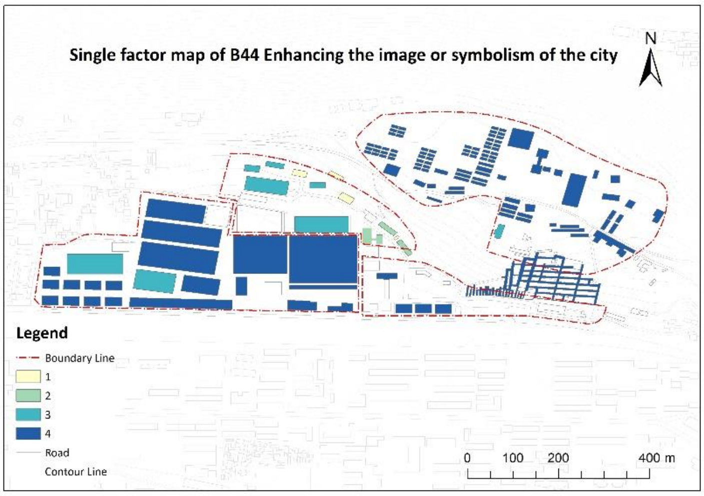
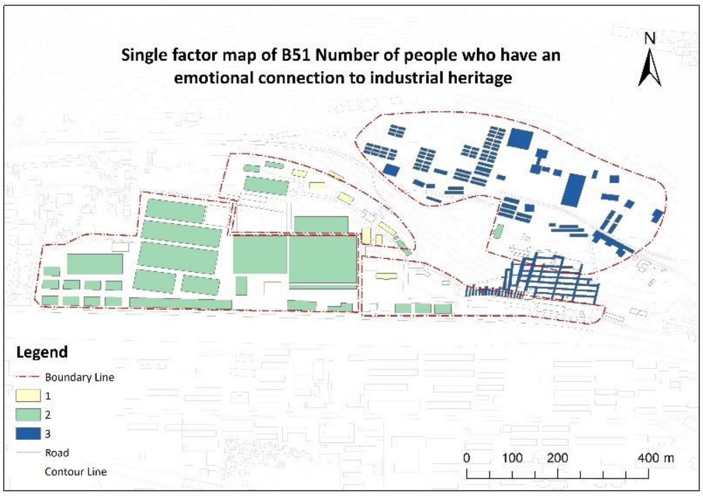
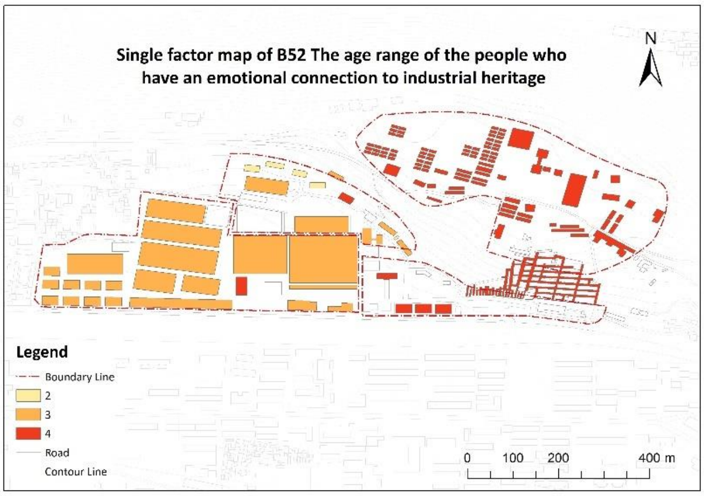
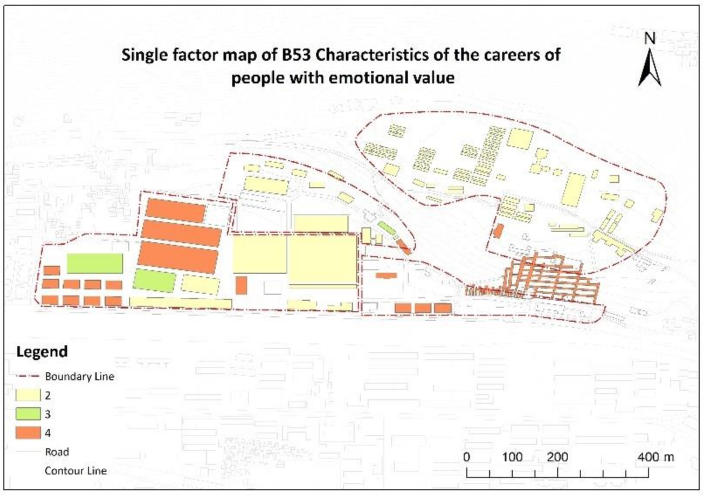


Table 103. Single Factor Evaluation Visualisation of B5 Emotional Value







4.3.7.4 Multi-factor Weighted Overlay Evaluation Visualisation of Shenxin Yarn Factory

The results of the comprehensive evaluation of the Shenxin Yarn Factory's industrial heritage value are based on the weights of the individual factors obtained in Section 4.7 and overlaid with all the individual factor scores for each Shenxin Yarn Factory building. Using the data calculation of Excel and the spatial analysis function of GIS technology, the scores and weights of the 30 individual factor evaluations of the Shenxin Yarn Factory's buildings are overlaid and calculated to get a comprehensive evaluation score (Figure 95). For example, the score of A1 is the sum of the A11-A16 factor scores after the overlay calculation. Then import into the ArcGIS database using the Excel to Table method as described above (Figure 96). Next, use the command of Layer properties-

Symbology-Quantities-Graduated colour to select the score of the A1 score and distinguish the colours according to the score. The multi-factor weighted evaluation visualisation of A1-B5 for Shenxin Yarn Factory is shown in Table 104.

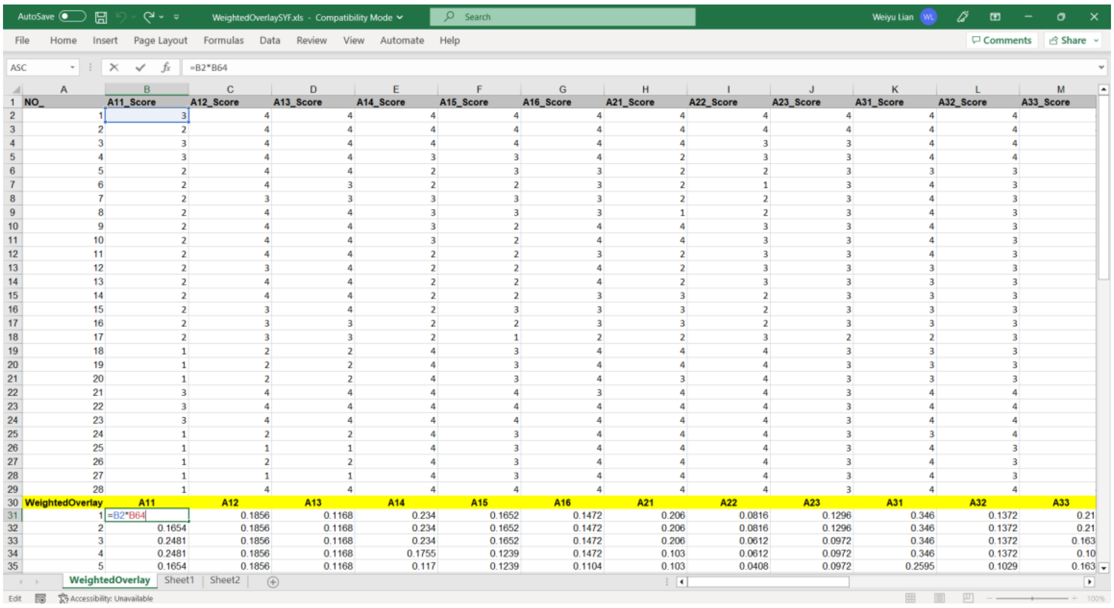


Figure 95. Excel Data Calculation Chart of Shenxin Yarn Factory

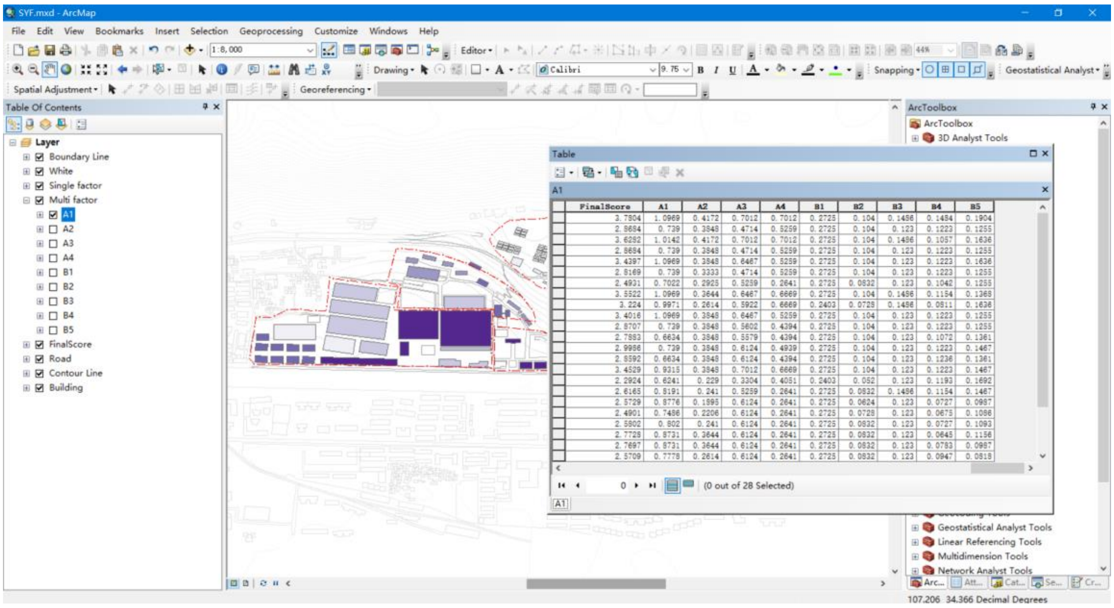
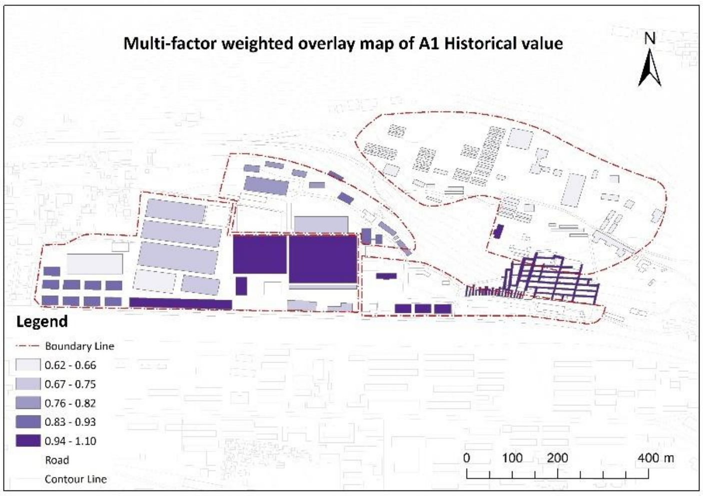
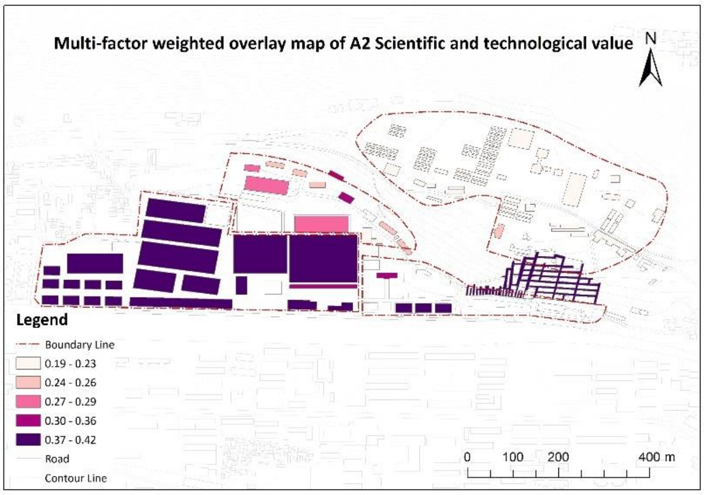
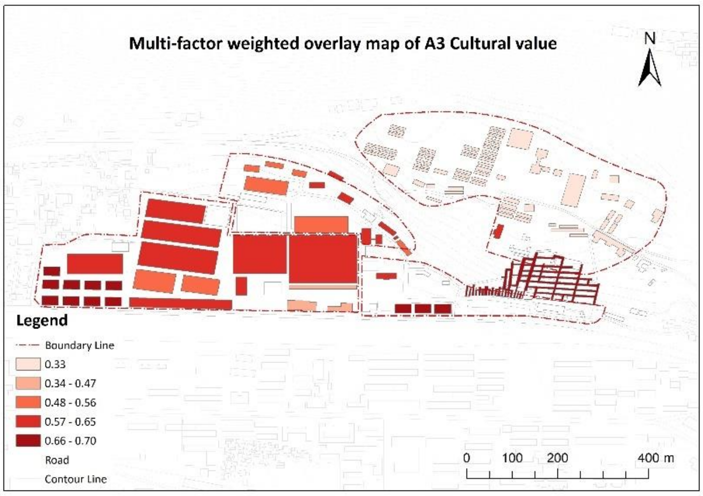


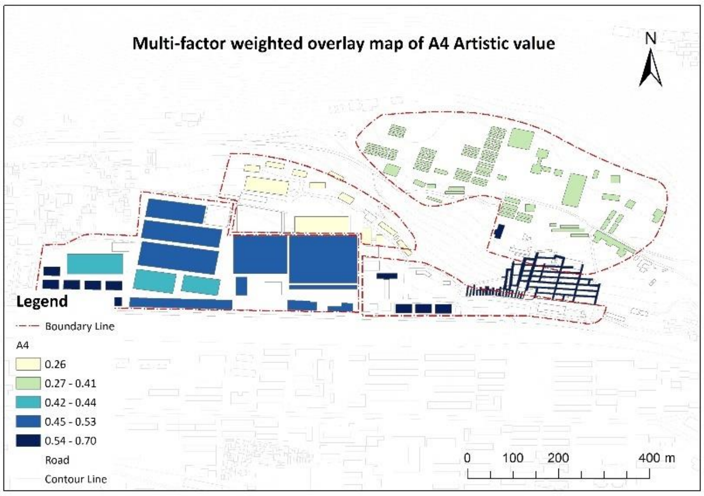
Figure 96. Overall Weighted Scores of Shenxin Yarn Factory Imported into ArcGIS

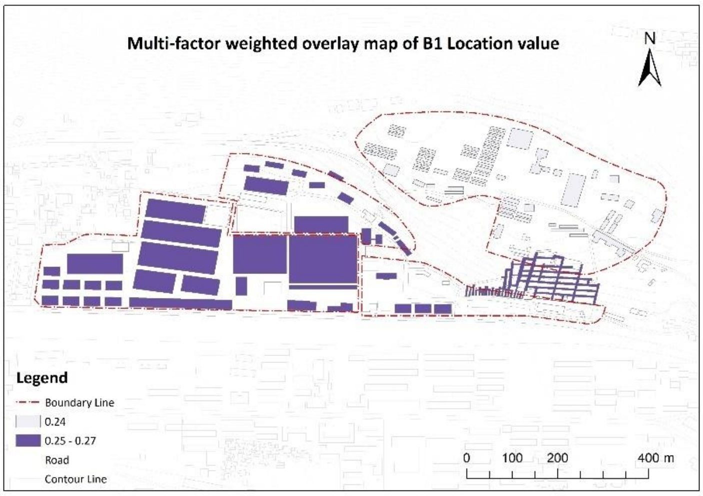
Table 104. Industrial Heritage Value Overlay Analysis Chart of Shenxin Yarn Factory

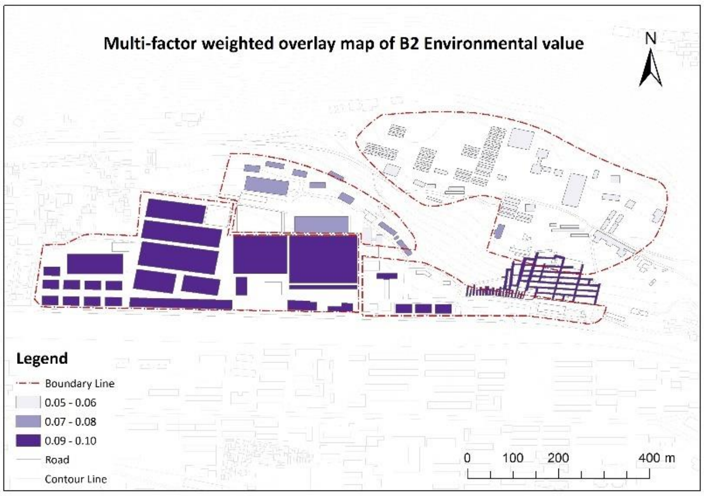


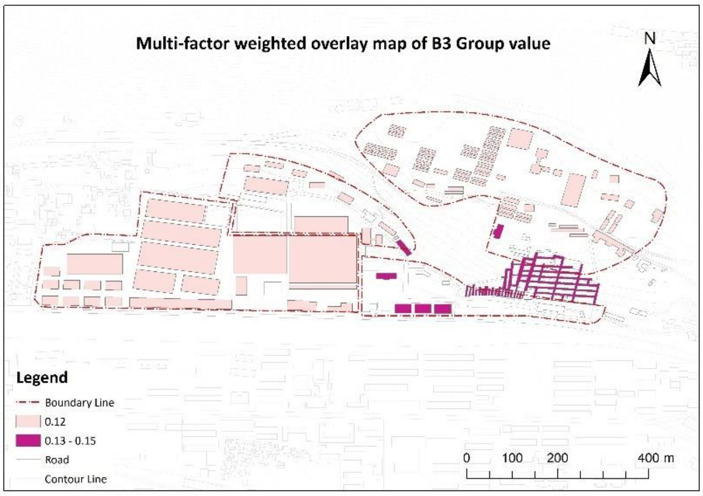


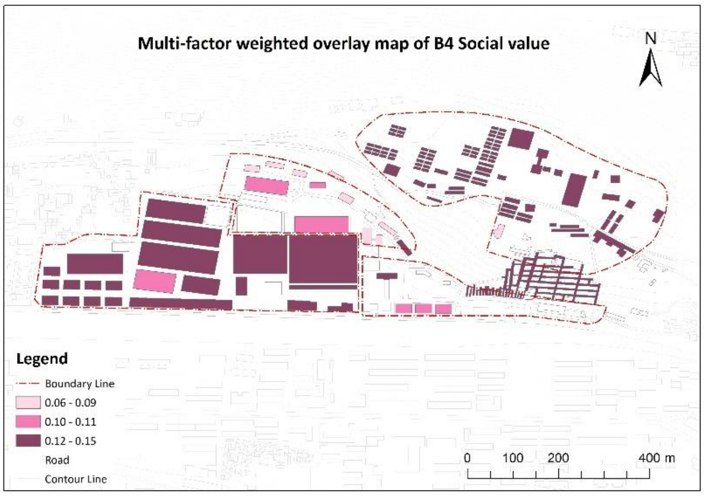


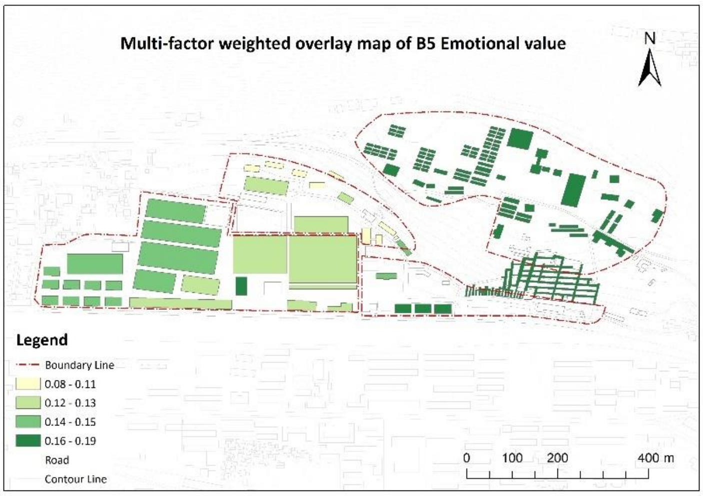












The next step is the visualisation of the Overall value overlay evaluation. In order to better reflect the overall value, the Final score has been rasterised in ArcGIS using the ArcToolBox-Conversion Tools-To Raster-Polygon to Raster (Figure 97). The visualisation of the overall value of the Shenxin Yarn Factory enables a more intuitive view of the overall value of the industrial heritage of Shenxin Yarn Factory, with darker colours in the graph indicating a higher overall value. The exported results of the GIS spatial visualisation analysis of the Shenxin Yarn Factory’s Overall value are shown in Figure 98.

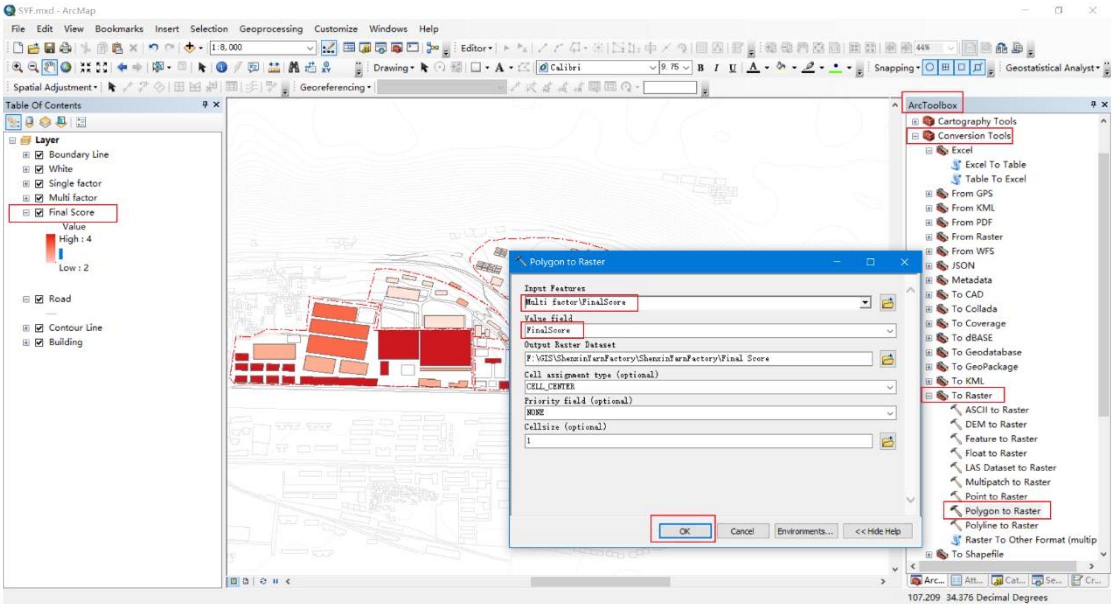


Figure 97. Rasterising the Overall Value of Shenxin Yarn Factory in ArcGIS

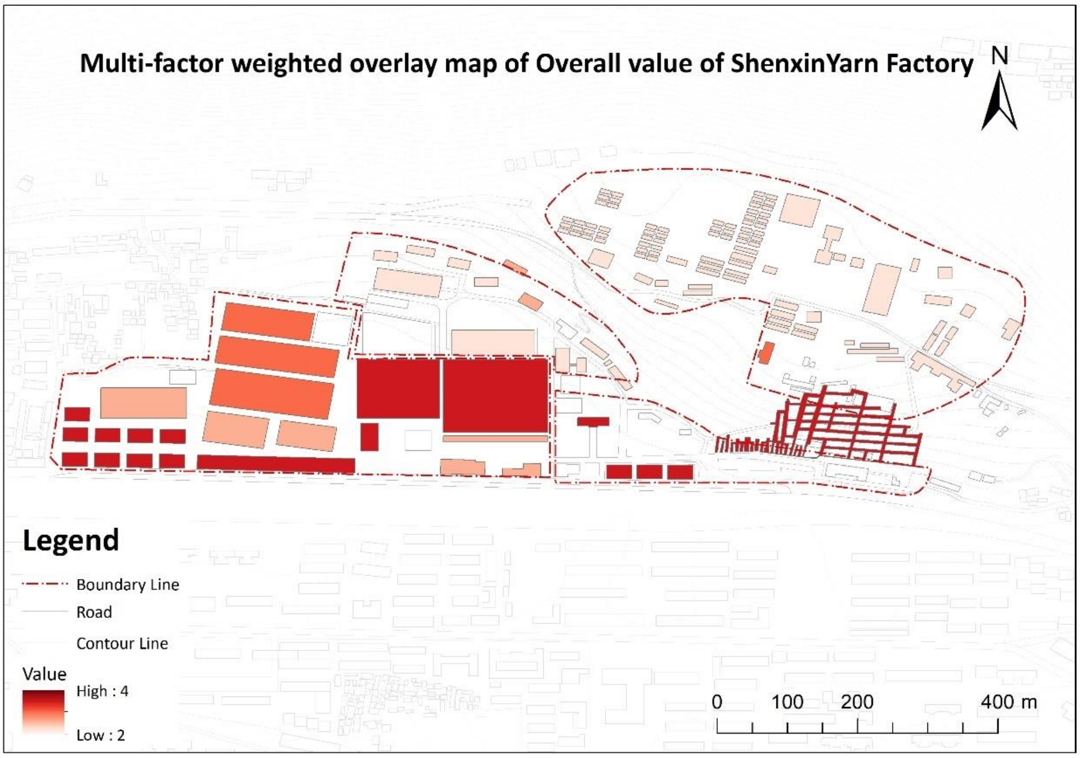


Figure 98. Visualising the Overall Value of the Shenxin Yarn Factory

5.4 Analysis of Evaluation Results

By evaluating the value of the three industrial heritage landscapes in Shaanxi Province, Shaanxi Old Steel Factory in Xi'an City, Tongchuan Wang Shi Wa Coal Mine in Tongchuan City and Shenxin Yarn Factory in Baoji City, which are of different dates, cities, regions and industry types, it is found that these differences have a direct impact on the value evaluation results of industrial heritage.

5.4.1 A Common Regularity in the Distribution of Value Scores for Cases

Comparing the three different industrial heritage value evaluations of each representative case, some common regularities are found in the distribution of their scores. The historical value of the three cases is generally higher than the other values, the artistic value is relatively low, and the intrinsic value of the representative cases is close to each other. These common regularities are related to the region where the heritage is located and the type of industry of cases.

5.4.1.1 The Historical Value is Generally High

In the intrinsic value of industrial heritage, the historical value can be reflected through the date of construction, historical events and historical activities. In the selection of cases, this study has chosen three industrial heritage sites that are representative of the industrial development process in Shaanxi and have a long history and more complete preservation, thus resulting in a generally high historical value in the evaluation.

5.4.1.2 The Artistic Value is Generally Low

The industrial heritage landscape in Shaanxi Province is characterised by a large proportion of textile light industry and metal heavy industry, whose plants and structures are characterised by their straightforward and pragmatic architectural forms. On the one hand, the tall, spacious interiors, and structures such as railway tracks and industrial facilities all reflect the value of industrial aesthetics. However, the architectural style is not evident in some of the dilapidated factory buildings, which results in the generally low artistic value of the selected industrial heritage landscapes.

5.4.1.3 Intrinsic Value is Close

The close intrinsic value scores of the three cases indicate that there are some common features in the selected cases in terms of history, technology, culture and art. This is related to the fact that this study takes the industrial heritage landscape in Shaanxi Province as the research object. Most of the industrial heritage in Shaanxi Province exists in three main periods of industrial development: the modern industrial period before and after the War of Resistance against Japan in 1937 and the “China’s First Five-Year Plan Period” from 1953 to 1957 and the industrial period of the Third Line Construction from 1965-1978. Thus, the scores given to these weighted values of the construction years of the heritage and the social development and historical events witnessed are approximate.

In order to escape the war, a large number of Chinese coastal industries moved to Shaanxi from August 1937 onwards, and the industrial structure was dominated by military heavy industry, followed by light industry. Many of the industrial heritage landscapes preserved from this period are mostly small buildings such as office buildings and structures, which reflect the characteristics of recent buildings in Shaanxi. The industrial heritage remaining from the period of great industrial development after the establishment of the People’s Republic of China is mainly in the form of factories and plant sites. Shaanxi accounted for 24 of the 156 projects built with Soviet aid during the First Five-Year Plan. Influenced by the Soviet culture of the time, the factory buildings reflect the characteristics of Soviet-style architecture.

Industrial heritage contains a great amount of scientific and technical information that reflects the state and level of scientific and technological development of the time. Besides written records, its scientific and technological value is dependent on the existence of industrial buildings, machinery and equipment to be able to express it. Due to the age and ignorance of the value of the industrial heritage, these factory buildings and equipment of the two periods have not been well preserved and only a few have been used rationally and effectively. This has led to most of the heritage having a low artistic value and scientific and technical value. Therefore, the historical industrial background of Shaanxi Province and the characteristics and forms of regional industrial development have led to the phenomenon of the province’s industrial heritage landscapes scoring close to each other in the intrinsic value score.

5.4.2 The Differential Regularity of the Distribution of Marks for Cases

5.4.2.1 The Wide Difference in Location Values

The area and location of the industrial heritage affect the evaluation of the location and environmental values, and therefore the evaluation results. As industrial heritage is located in the city centre area or the suburbs of the city, the distance to the city centre is shorter and the transport connection is close (as part of the location value), it is easier for people to discover, pay attention to and participate in the site. It is also more likely that it would be accepted in future development and use, and can gather popularity in a short period when used appropriately.

Conversely, for example, the industrial heritage of the Wang Shi Wa coal mine in Tongchuan is located far from the city centre and access to the industrial heritage site is limited, with only one daily coach or visitors travelling by car. This transport limitation directly affects its future development, limiting the forms of reuse and reducing the enthusiasm of people to participate.

The impact of the area in which the industrial heritage is located on its environmental value is mainly reflected in the extent of the surrounding environment that can belong to the industrial heritage. When industrial heritage landscapes are located in city centre areas, it is usually in an area of dense surrounding residential or public buildings, limiting the expansion of industrial heritage landscapes to the outside and restricting their adaptive use, the scale of transformation and form of reuse.

Also, city centre areas usually have high land prices, leading to higher development costs. When the industrial heritage landscape is located on the urban fringe or in areas further away from the city centre, its potential for transformation is greater. It has more space for transformation, and the natural environment around it is richer than that of the city centre. The transformation process facilitates the combination of artificial industrial landscapes and natural landscapes, which can create a landscape environment more suitable for people to relax and enjoy. It has more environmental and ecological benefits than the combination of urban and industrial landscapes in the city centre.

5.5 A Proposal for the Conservation, Use and Renewal of Industrial Heritage Guided by Evaluation Values

The three case selections are based on different reuse situations; the reuse of Shaanxi Old steel factory is complete, the reuse of the Baoji Shenxin Yarn Factory is partially complete, and the Wang Shi Wa coal mine in Tongchuan is not yet reused. For those that have already been reused, the value-based assessment can be converted to a satisfaction assessment, and for those with low scores, the focus should be on them in the subsequent improvement process.

In the case of the old steel factory creative park, which was created from the regeneration of industrial heritage, these scores are closely related to its characteristics. In the future secondary improvement process, these scores will continue to be a key focus area for reuse. For those that are not reused, different reuse measures can be applied depending on the score.

5.5.1 Renovation Optimization Strategies of Shaanxi Old Steel Factory

Based on the previous section, a systematic value analysis and evaluation of the Shaanxi Old steel factory creative park is carried out from various aspects such as the protection situation, artistic value and cultural value of the industrial heritage. Based on the evaluation results, the following industrial heritage renovation optimization strategies are proposed.

5.5.1.1 Design Strategies for Traffic Planning

Traffic is an extremely important factor for any industrial park, and in reality, the accessibility and safety of traffic can have a great impact on the flow of visitors. The following factors should be taken into account in the later development of the park:

(1) The transport planning of the park does not only consider the internal transport space. It should focus on thinking about how to reach the park from the outside and consider the transport conditions of the whole area where the park is located, especially the public transport routes. For example, in Xi’an, which is actively building a metro in the hope of achieving city-wide coverage, a direct bus route can be planned between the

industrial park and the nearest metro station for the convenience of those working in the park.

If properly planned, more people would prefer public transport to drive a car, which would greatly increase the footfall on the route. It is also possible to use additional road signs to direct the flow of people and to achieve a diversion to other surrounding areas.

(2) Rationalisation of static traffic in the park

The most important aspect of static traffic in the park is the setting of the car park. On the whole, the car park in the industrial park still has areas that need to be improved:

Firstly, the parking space is set to match the scale of the park: during the actual research process, it was found that the parking demand of the park was largely unsatisfactory. The failure to meet the demand for parking spaces is likely to affect the investment effect of the park and hinder its development, so it is urgent to expand the parking area to meet the demand of the staff. As the park was converted from a factory, there are existing buildings that affect the park's ability to provide parking. The park is currently dominated by multi-storey buildings, so most of the parking spaces are arranged on the ground. In order to improve the parking rate of the industrial park, multi-storey mechanical parking equipment can be installed and full use can be made of the ground level of the park to establish a parking building to accommodate a greater number of cars. The overall appearance of the park should also be taken into account when meeting parking requirements, for example by using landscaping such as greenery to beautify the multi-storey parking facility.

Secondly, to improve the convenience of the parking space to reach the park: during the site visit, it was found that there is a long distance between the exit of the car park and the entrance of the park, which invariably increases the cost and travel time and is very inconvenient for visitors such as the elderly and children. The park should therefore plan to shorten this distance as possible.

5.5.1.2. Strategies for Optimising the External Spatial Environment

During our field visits, it was found that a signage system existed in the park, but that the system was not updated promptly, resulting in discrepancies between internal changes and the actual situation, which did not guide the actual situation. For example, some of the companies in the park have changed, but the signage system still has the old company names. After visiting the park, it was discovered that there is still space for improvement in the planning and design of the exterior of the buildings and the overall perception of the park, so the following suggestions were made:

(1) Improve the signage and guidance system

The following ways can be used to improve the signage system in the park. Firstly, the colour guidance mode: the industrial park covers a large area and has complex functional partitions, so different functional partitions can be divided by using colours with a high degree of differentiation, so that visitors can have a corresponding concept of the partition with intuitive visual feelings and be guided by other means, which is more intuitive and clear than a simple route map. Second, directional guidance mode: set up text, images and other signs in places where visitors can easily see, which can clearly and distinctly play a role in guiding visitors in the direction. Thirdly, graphic guidance mode: set up pictures and text signs to guide the direction at important traffic intersections or park entrances. In addition, the shape of the guidance system should be integrated into the whole design of the park, maintaining consistency of style and also requiring some stylistic innovation in order to match the industrial character of the park.

(2) Enhancing the recognition of the park

To enhance the overall recognition of the park, elements such as large logos or sculptures can be added to form a unique iconic symbol of the park. Graffiti and façade modelling can also be used to create an industrial atmosphere in the old factory buildings, forming a unique design symbol to distinguish the park from other parks, thus enhancing the park’s recognition and attracting more visitors.

(3) Improving the tidiness of the park

In recent years, the transformation of old factory buildings into cultural parks has become quite popular, and there are many caterers in the parks, but there are also more follow-up problems arising from catering. For example, there are problems with the disposal of food and drink waste. This requires the park to improve the level of service of such facilities to minimise or avoid such problems and thus keep the environment clean and enhance its environmental value. This can be improved by cleaning the park or by choosing materials that are durable and easy to clean.

5.5.1.3. Industrial Culture Optimisation Strategies

Due to the uniqueness of the Old Steel Factory Creative Park, which was formerly known as the Shaanxi Old Steel Factory, its historical continuity and heritage cannot be ignored. Therefore, whether the historical heritage can be grasped is also the key to the success of the reuse of industrial heritage and the shaping of the park's external image, and the following methods can be used to maintain the park's historical continuity and create a cultural atmosphere:

(1) Organising industrial culture events

Industrial heritage sites are characterised by the historical culture of industrial development, so it is important to strengthen the historical and cultural publicity of industrial parks when upgrading them. For example, holding promotional activities to showcase the industrial culture spirit of the park's predecessor, Shaanxi Old Steel Factory, will not only raise the park's profile and increase its patronage, but will also enable the crowd to understand the history of industrial culture and can effectively pass on and promote its history and culture.

Also, by designing and producing some relevant landscapes, exhibition boards, industrial objects and sculptures in the park, the industrial atmosphere of the park can be enhanced and its original characteristics preserved. In addition, through research and visits, it is found that few industrial facilities in the park showcase industrial production processes or allow visitors to experience them, so more ways to showcase industrial culture can be added later.

(2) Developing industrial heritage tourism

Industrial heritage tourism is a new type of heritage tourism that focuses on and is based on industrial history. This type of tourism allows people to learn about the history and culture of the industry through visits and tours of machines, equipment, buildings and factories in former industrial sites. Visitors can participate in the site and experience it. It will not only increase the motivation of visitors, but will also reinforce the industrial culture and spirit of the park. In addition to this, it will also help to form the brand IP (Intellectual Property) of the park, providing an opportunity to create industrial-related peripheral products that will attract visitors to the park and at the same time give it a good publicity effect. This will help the park to maintain sustainable development.

(3) Public participation

The neighbourhood and the people who work in the park have a high usage rate of the park. The specific suggestions and evaluations of the users have a great influence on the development and improvement of the park. Therefore, surveys and interviews can be conducted at regular intervals, for example through questionnaires, random interviews, or the collection of information from review apps and online voting, to collect and organise the relevant suggestions and opinions of the users. In this way, the park will be able to make timely and objective proposals for the renovation of the park and to reflect them to the park management and relevant departments in order to improve the sustainability of the park design and the quality of the park environment.

(4) Balancing commercial and original industrial atmosphere

The old steel factory creative park currently has more than 140 enterprises, the main types of industry are cultural exhibition and commercial development. At present, catering and commercial enterprises account for a large proportion of the park, and the original industrial atmosphere is gradually overshadowed, which is also inconsistent with the cultural and creative positioning of the industrial park. In the future, it is necessary to integrate the same type of industries, reduce the commercial atmosphere of the industrial park and strengthen the presence of high-quality cultural and creative enterprises, so as to balance the commercial atmosphere with the original industrial atmosphere.

(5) Transformation and upgrading to an intelligent park

At present, the construction of the old steel factory creative park has been basically completed. With the improvement of the social and economic level, the smart park has become a development trend. This means adding intelligent elements to the development and management of the park, for example by integrating new technologies such as the Internet of Things, the Internet, big data and AI. A smart park can combine technologies such as big data and cloud computing to utilise integration and analysis models to fully integrate resources inside and outside the park and improve the efficiency of enterprises in the park. The smart park can provide enterprises and the public with a comprehensive management application system that integrates multiple types of information technology such as park guiding, intelligent office, parking management and e-commerce.

It is conducive to strengthening the planning and management of the industrial park, improving the service system of the industrial park and enhancing the value level of the industrial park.

5.5.2 Renovation Optimization Strategies of Shenxin Yarn Factory

The Shenxin Yarn Factory is divided into four parts, one of which has already been reused. The analysis of the value of the Shenxin Yarn Factory in the previous sections has been divided into protection and renovation measures to analyse its upgrading strategy.

5.5.2.1 Protection Measures for Shenxin Yarn Factory

(1) Repair of historic buildings with safety hazards

The Shenxin Yarn Factory is a precious industrial heritage that survived the war and the ravages of time, and many of the buildings on the site have fallen into disrepair and are in urgent need of restoration. The maintenance of the historic industrial buildings of the Shenxin Yarn Factory should be carried out with a holistic conservation vision.

The repair of historic buildings should be carried out using the original building materials as far as possible, or in the absence of the original materials, using the same or the closest materials to the original materials. The repair of the historic building of the Shenxin Yarn Factory should also prepare it for reuse, so that the building is robust enough to meet the needs of reuse.

(2) Enhancing the environment of the former Shenxin Yarn Factory site

The area of the former Shenxin Yarn Factory is located in a traditional industrial area of Baoji. The former site of the Shenxin Yarn Factory has been used as a textile industrial area, where sewage was discharged when the textile industry was in production, and there is a possibility of soil contamination caused by sewage seeping into the ground. Therefore, a suitability assessment should be carried out on the soil of the Shenxin Yarn Factory site and if there are areas where the soil is not up to standard, then soil treatment should be carried out.

Removal of domestic rubbish and construction debris from the area of the old Shenxin Yarn Factory, as well as the removal of weeds and bushes that obstruct the movement of people and vehicles within the factory should be planned. There are also important nodal areas where lawns and landscape shrubs are planted to create a good recreational environment. Protecting the existing arbor forests within the factory area and planting the same species of trees (mainly Sophora japonica Linn) artificially in the areas that need vegetation restoration in order to restore the original vegetation appearance of the area are recommended.

(3) Enhancing public participation and heritage education

The Shenxin Yarn Factory was turned into a state-owned textile enterprise after the founding of the People’s Republic of China and was taken over by private capital after its decline. Although it is now ready to be declared bankrupt, most of the old employees and their descendants continue to live in the vicinity of the factory. Some of these workers have experienced the development and changes of the Shenxin Yarn Factory and have a deep affection for the old factory. In implementing the conservation of the old Shenxin Yarn Factory site, the demands and opinions of the people who have emotional connection with the factory should be widely consulted, and a communication channel between the residents and the government should be established to ensure that the future conservation policy can be implemented successfully. The former site of the Shenxin Yarn Factory is not well known in Baoji and many locals are not aware of its history, so it is essential to strengthen education about the heritage site and even the industrial heritage of the whole city of Baoji. The first thing that can be done is to strengthen heritage promotion, with advertisements and slogans on TV, in the streets and other places easily accessible to the public, so that they are aware of this industrial heritage around them. Secondly, heritage education for primary and secondary school students should be strengthened, for example, by developing teaching materials and increasing the number of heritage education classes.

5.5.2.2 Reuse Strategy for Shenxin Yarn Factory

(1) Establishment of the Shenxin Yarn Factory industrial museum

The analysis of the previous values shows that the Shenxin Yarn Factory has a relatively high historical value but a low educational value in terms of social value. Therefore, it is important to establish an industrial museum for the Shenxin factory. The Shenxin Yarn Factory has historical, scientific, artistic and many other values, and a museum is often the most direct and effective way to show the public the value of the heritage and make them understand the industrial heritage. But museums should not be monotonous, same and uninteresting. There should be a combination of display tools and the introduction of multimedia display technologies such as VR technology and hands-on experience.

The display can include the production equipment of Shenxin Yarn Factory during the war period, restoring the production line at that time; the physical materials documenting the history of Shenxin Yarn Factory, such as account books, factory diaries, and so on. The multimedia display technology allows visitors to recreate the working scenes of the textile workshops and the tortuous development of the Shenxin Yarn Factory. As a representative of Baoji's factories during the war period, the Shensin Yarn Factory's Industrial Museum can also display any exhibits and materials related to Baoji's wartime industrial development, in order to enrich its exhibits in terms of variety and quantity.

(2) Built as an urban industrial culture park

There is a lack of large parks in the vicinity of the Shenxin Yarn Factory site and very limited public open space. The former site of the Shenxin Yarn Factory, originally a dilapidated and abandoned industrial area, could be transformed into an industrial cultural park for local people and other visitors to visit to explore and enjoy.

(3) Introduction of tertiary industries such as cultural and creative industries and the arts

The reuse of the former site of the Shenxin Yarn Factory can be introduced into the cultural and creative industries. The cultural and creative industries introduced should incorporate the characteristics of the industrial area of Baoji where they are located, and their products should ideally reflect the characteristics of the industrial heritage. A series of conservation and display tools for industrial heritage can spread its value to those who visit the site, while incorporating the characteristics of the heritage into creative products for sale across the country or even the world can make more people aware of Baoji's industrial heritage.

5.5.3 Wang Shi Wa Coal Mine Renovation Optimisation Strategy

5.5.3.1. Principles for the Reuse of the Industrial Heritage of the Wang Shi Wa Coal Mine

(1) Priority protection of core values

The reuse of coal mining heritage requires the prioritisation of core values and the consideration of the value that can be derived from reuse. It is also a matter of respect for history to insist on the priority of preserving the value of the coal mining heritage. It is only through prioritising conservation that the value of the coal mining industry can be maximised.

The industrial heritage of the Wang Shi Wa coal mine retains many important heritage values, mainly in the form of texts, pictures and multimedia, leaving historical information for future generations about the various periods of development of China's coal mining industry after the founding of the country. These materials show the history of the country's industrial rise. The entire development of the Wang Shi Wa coal mine also reflects the arduous journey of the Chinese people to modernise the coal industry. The industrial heritage of the Wang Shi Wa coal mine has a very rich artistic value.

The Wang Shi Wa coal mine was planned and designed by a team of Chinese and Soviet designers, so the architecture of the mine is a mixture of Soviet and Tongchuan cave architecture of the time. This blend of styles gives the area of the coal mine's industrial heritage an artistic imprint of both the local Tongchuan culture and the foreign culture of the Soviet Union, with a variety of national styles that reflect the unique character of the Chinese and Soviet peoples of the era. These historical industrial buildings contrast and harmonise with the unique natural landscape. Over the past few decades, Wang Shi Wa Coal Mine has been the leader in the development of the coal industry in China, with many outstanding scientific achievements, including comprehensive mining technology and blasting technology. The primary principle in the reuse of the industrial heritage of the Wang Shi Wa coal mine is not only the protection of the buildings, structures and production equipment of high value in the area, but also the protection of the overall pattern and form of the industrial heritage, which is important for the complete presentation of the overall appearance of the industrial heritage of the Wang Shi Wa coal mine.

(2) Reinforcing the overall environmental integration of the mine site

Rapid urbanisation has led to a need to continue the original values and innovative thinking in the reuse of the industrial heritage of coal mines. There is also a need to consider how the old and the new can be harmoniously developed in the future. The overall environmental reuse of the coal mine's industrial heritage means considering both the industrial heritage of Wang Shi Wa and the surrounding environment, which are inextricably linked. The two work together to create an environmentally unified and functionally integrated industrial heritage environment. Over the years, many buildings have emerged within and around the Wang Shi Wa coal mine's industrial heritage that are extremely incongruous with the industrial heritage, and the overall architectural appearance is uneven. Most of these buildings are either temporary or abandoned shanty buildings, most of which are in a state of disrepair. There is a significant difference in style and texture from the buildings within the industrial heritage, resulting in the overall quality of the appearance of the environment.

The industrial heritage of the Wang Shi Wa coal mine should be considered from a holistic perspective to achieve consistency in overall appearance and character. It is important to systematically consider the influential elements of Wang Shi Wa's coal mining industrial heritage, such as the environment, architecture, production equipment and production processes, and to integrate these elements in order to ensure the continuity of the overall appearance of Wang Shi Wa's coal mining industrial heritage and the harmony of the surrounding space. It is necessary to clean the ground of the external spatial environment of the industrial heritage of the Wang Shi Wa coal mine of rubbish and discarded materials. Similarly, the new buildings added to the Wang Shi Wa Coal Mine industrial heritage need to be designed as a whole, not only to maintain the traditions of the industrial heritage, but also to continue the sense of harmony and unity of the original environment.

(3) Continuing the memory of the coal mining industry

The reuse of the industrial heritage of coal mines requires not only the conservation and reuse of the external spatial environment, buildings and production equipment, but also the enhancement and continuation of the original historical values, cultural spirit, spatial scale and ecological environment, as many elements of the industrial heritage carry the historical memory associated with them. The Wang Shi Wa coal mine was the only one of 156 key projects in northwest China in the coal category, and it was designed with the assistance of the Leningrad Design Institute of the former Soviet Union. It represents a model of the national coal industry after the founding of the People's Republic of China, and at the same time participated in the history of the rise and development of the coal mining industry in Tongchuan and Chinese industry. The industrial heritage of the Wang Shi Wa coal mine is representative and rare in China's coal industry, including the process of coal mining, integrated mining, and the main and secondary hoist shafts. The industrial heritage of the Wang Shi Wa coal mine demonstrates to the world the various stages of China's highest mining technology, and leaves a historical memory in the industrial history of northwest China and the country as a whole.

The reuse of Wang Shi Wa's coal mining industrial heritage can be enhanced by shaping the external environment and architecture to extend its coal mining industrial memory. The entire development of the Wang Shi Wa coal mine also reflects the arduous journey of the people of China to modernise their industry, and the industrial heritage of the coal mine that has been preserved today is rich in historical value. This industrial heritage carries the memory of people's history in the form of physical evidence. As an important source for the study of China's industrial history, the industrial heritage of the Wang Shi Wa coal mine can be used as a practical base for the study of historical science.

The overall atmosphere of Wang Shi Wa's industrial heritage should be in keeping with its industrial history and culture.

Through the method of recreating historical scenarios of the spatial environment, architecture, industrial equipment and production processes, the strong industrial atmosphere of the Wang Shi Wa coal mine will be shown and become a practical classroom for the dissemination of industrial history and culture. The exhibition will showcase the equipment and architecture of the Wang Shi Wa coal mine's industrial heritage and play a role in promoting the reuse of China's national coal mine industrial heritage.

(4) Multifaceted sustainability

In order to realise the principle of sustainable development in the process of reusing the industrial heritage of coal mines, the current resources should be fully considered and integrated. The current buildings and structures, landscape and ecological resources and production equipment within the industrial heritage should be fully considered and utilised, so that the value of their reuse can be explored in depth and each element can be used to the best of its ability to achieve the aim of sustainable development. The reuse of the industrial heritage of the Wang Shi Wa coal mine pursues sustainable development in many aspects, mainly in two ways: the coordination of the industrial heritage of the coal mine with economic development, that is, the balance between the preservation of industrial culture and the provision of economic benefits; and the coordination of the infrastructure of the mining area with economic development. This refers to Should consider the number of visitors the site can receive/provide services, avoid some situations such as having very little accommodation so that a lot of tourists without a place to stay.

The creation of an atmosphere for the industrial heritage of the Wang Shi Wa coal mine requires comprehensive consideration of various aspects such as history and culture. Based on this premise, economic conditions that is to say Current financial support and Social fundraising that can be given to the development of the Wang Shi Wa coal mine are considered to shape the characteristics of the industrial heritage of the Wang Shi Wa coal mine.

The infrastructure of the Wang Shi Wa coal mine's industrial heritage should be improved on the premise of meeting the needs of the original staff of the mine and the interests of the surrounding residents. It should also consider the economic development of Tongchuan and reasonably optimise the supplementary infrastructure. The design of the reuse of the industrial heritage of the Wang Shi Wa coal mine needs to be based on the premise that economic development conditions are suitable, such as local government or state funding, because some places may have industrial heritage but no local funding to support its improvement. It's not only for the development of the present time, but also for the inheritance of industrial history and the creation of a unique spatial atmosphere with the industrial heritage of the Wang Shi Wa coal mine.

5.5.3.2 Key Elements of the Reuse of the Wang Shi Wa Coal Mine Industrial Heritage

(1) Improving environmental functions

The optimisation and integration of environmental functions in the reuse of the Wang Shi Wa coal mine include two main aspects: the optimisation and enhancement of the spatial environment and the reuse of the buildings. Firstly, the optimisation and enhancement of the spatial environment include the adjustment of the functional zoning of the industrial heritage of the Wang Shi Wa coal mine, the upgrading of the traffic and road system and the optimisation of the ecological greening of the space. Secondly, the reuse of buildings is a key element of the reuse process, which includes the preservation of buildings and the incorporation of new functions.

(2) Enhancing the creation of a coal place spirit

As a product of the combination of urban development and industrial history, it is necessary to consider the characteristics, history, culture and traditions of the urban area in which the coal mining industrial heritage is located. The public space formed by the existing buildings is used to create a unique industrial heritage atmosphere and regional identity for the entire coal mining heritage. This will enable people to not only understand the history and culture of the coal mining industry when they visit the Wang Shi Wa coal mine, but also enhance their sense of identity with the industrial heritage of the coal mine, which will have a positive long-term impact on the conservation and reuse of the industrial heritage.

The architectural features and spatial system of the industrial heritage of the Wang Shi Wa coal mine can be illustrated through the streets and the building facades and structures. Various forms of landscape artwork can be added to show the Soviet-style architectural features of the Wang Shi Wa coal mine. The flow of the site is presented in relation to the plateau topography and the planning layout of the production process. Through multimedia and live performances, the exhibition will showcase the technologies related to the production and construction, environmental management and disaster management of the coal industry in Wang Shi Wa coal mine, including the exploration layout, digging methods, high-grade general mining, and integrated mining. It is also possible to use the existing building as a museum and exhibition hall for the performance. The exhibition could showcase the spirit of the Wang Shi Wa coal mine and its improving and progressive management system during the early years of China's development. The exhibition will show the spirit of the people of the Wang Shi Wa coal mine who worked hard during these special times. It is also possible to enhance the fun by restoring the underground tunnels so that people can experience the coal digging scene.

Chapter 6. Findings and Discussion

6.1 Summary of Findings

Industrial heritage is an important part of the world's cultural heritage, and its conservation and regeneration is a worldwide issue for sustainable development. It is also an urgent issue for the majority of industrial cities in China, including Shaanxi Province, in the process of renewal and development.

The development of industry has seen the progress of the city. As times develop, once-glorious industries undergo corporate relocation, bankruptcy or restructuring, leaving behind a large number of industrial heritage landscapes in the city. Shaanxi Province is not only abundant in historical and cultural resources, it is also one of the important gathering places of modern Chinese national industries with a rich industrial heritage legacy. These industrial heritage landscapes are an important resource for urban regeneration. How to effectively conserve and utilise these industrial sites is a pressing issue in industrial heritage conservation. The study found that the key to the reuse of industrial heritage is the comprehensive and accurate classification and assessment of its value.

Therefore, the main aim of this research was to find the most effective method of classifying and evaluating industrial heritage landscapes and to provide new and comprehensive guidance for the classification, evaluation and presentation of industrial heritage landscapes. In line with this aim, the research process undertaken was split into three main stages:

(1) This thesis takes industrial heritage as the research object, and first proposes the necessity, urgency and feasibility of establishing a classification and evaluation method for industrial heritage in Shaanxi Province, and clarifies and explains the relevant concepts and research scope (see Chapter 1). It also provides a systematic analysis and collation of the value composition and evaluation criteria of industrial heritage landscapes (see Sections 2.3 and 4.1). Moreover, it analyses the approach to the treatment and reuse of industrial heritage (see Section 2.5).

(2) The research analyses and summarises the history of the modern and recent industries and industrial heritage in Shaanxi, as well as the types and characteristics of Shaanxi's recent industrial heritage, and on this basis determines the value evaluation indicators. The data were collected using questionnaires; the weights of the corresponding values were calculated using the analytic hierarchy process method, and visualized data were used in GIS to develop the industrial heritage value evaluation method (see Section 5.1).

(3) The study selected three different types of industrial heritage in Shaanxi Province as case studies to test the evaluation methodology. It also relies on the GIS platform and its multi-factor overlay analysis function to provide a comprehensive value assessment and value visualisation of the cases, so that the evaluation results can be presented visually. Possible measures for reuse and enhancement are proposed depending on their scores (see Sections 5.5). In this regard, the approach to the evaluation of industrial heritage explored through this study is a key contribution to knowledge in this thesis. The key findings are as follows.

6.1.1 A Systematic Analysis and Collation of the Value Components and Evaluation Criteria of Industrial Heritage Landscapes

Based on extensive literature reading, this study provides a comprehensive introduction and systematic analysis of research on the perception and evaluation of industrial heritage values. On this basis, the article systematically examines changes in the perception of heritage values. It finds that scholars have explored the perception of heritage values through a variety of disciplines including art history, archaeology, architectural history and economics. Research concerns have changed from a focus on the historical commemorative value of heritage to a consideration of the balance between the intrinsic and extrinsic value of heritage and culture capital. The development and changes in the understanding of heritage values have also contributed to the formation of relevant policies and systems, from theoretical discussions to practical guidelines that can be implemented. Through an analysis of relevant literature, this study summarises the history of development and changes in the evaluation criteria for industrial heritage, providing guidance and reference for the evaluation and conservation of industrial heritage.

In addition, the study has analysed the institutional policy changes regarding the value of industrial heritage and the criteria for its evaluation. This includes documents from international organisations and different countries with different criteria for classifying the value of industrial heritage.

By reviewing the relevant documents, it was found that although the UK, USA and Canada have different understandings of the individual values of cultural heritage, they share a similar understanding of the overall range of heritage values. The statistics of the relevant key documents show that authenticity, integrity, representativeness and scarcity appear more frequently, while advancement, endangerment and uniqueness appear less frequently (see Section 2.3.4.1 and Section 2.3.4.2).

The study also analyses the value characteristics of industrial heritage. It is also found that the classification of industrial heritage is basically based on the value composition of cultural heritage, without highlighting the industrial characteristics of industrial heritage (see Section 2.3.4.3). Furthermore, the study proposes the establishment of a targeted and operable value evaluation method for industrial heritage, and points out that such a value evaluation system has an important role and practical significance for the value assessment of industrial heritage (see Section 2.3.5).

Moreover, the study analyses the different ways in which industrial heritage can be treated and reused, suggesting that after identifying its value, targeted reuse solutions should be developed according to its characteristics, so that the industrial heritage can be renewed and adapted to the requirements of future urban development (see Section 2.5). This part of the research has laid the most fundamental theoretical foundation for the establishment of a system for evaluating the value of the industrial heritage landscape.

6.1.2 A Systematic Review of the Development of Modern Industrial Heritage in Shaanxi Province, China

Based on extensive reading of the literature on industrial heritage, local literary sources in Shaanxi and fieldwork, the thesis systematically composes the main stages of development and characteristics of industrial architecture in Shaanxi Province. This study divides recent and modern Shaanxi’s industry into six periods: (1) 1840-1934, The beginning of the modern industry in Shaanxi Province, China; (2) 1935-1945, The period of initial development; (3) 1945-1949, Period of Decline; (4) 1949-1962, Initial development; (5) 1963-1978, unstable development; (6) 1978-now, Stable development stage. It summarises the four main stages of development of industrial buildings in Shaanxi Province and their corresponding characteristics: Stage 1: 1840-1934, The beginning of recent industrial architecture in Shaanxi; Stage 2: 1935-1949, The development of recent industrial architecture in Shaanxi; Stage 3: 1949-1962, The beginnings of modern industrial architecture in Shaanxi; Stage 4: 1963-1978, The unstable development of modern industrial development in Shaanxi (see Section 2.6.1).

6.1.3 The Study Presents the Local Characteristics of Industrial Heritage in Shaanxi Province

By reviewing historical data and conducting field research on Shaanxi's industrial heritage, this study has systematically analysed the current types and characteristics of Shaanxi's industrial heritage, which forms the basis for determining the value of Shaanxi's industrial heritage. The characteristics of Shaanxi's industrial heritage are mainly in three aspects: architectural distribution characteristics, structural features of the building and architectural style characteristics. In terms of industry distribution, Shaanxi's industrial remains are mainly concentrated in the mechanical, light and textile industries; in terms of regional distribution, they are mainly located in Xi'an, Baoji and Xianyang; in terms of temporal distribution, the smallest proportion of industrial heritage is found in Stage 1, with a more even split between Stage 2, Stage 3 and Stage 4. With regard to the structural characteristics of the buildings, most of the industrial buildings in Shaanxi Province are bent structures, which are timber structures, steel framed structures and reinforced concrete structures. Regarding the character of the architectural style, Shaanxi's modern architecture is characterised by its Recent Western style, Traditional Chinese style, Traditional Chinese style and General style (see Section 2.3.4.2).

6.1.4 Development and Validation of a Method for Evaluating the Value of Modern Industrial Heritage in Shaanxi Province, China

Based on the theoretical basis of the value composition of industrial heritage (see Chapter 2), the study constructs a modern urban industrial heritage landscape classification and evaluation method based on the value assessment of Shaanxi's modern industrial heritage, which is used to assess the value of existing buildings and landscapes within industrial heritage factories. The study uses three different categories of industrial heritage in Shaanxi Province as practice cases to verify the applicability, accuracy and operability of the evaluation method.

This study proposes a comprehensive evaluation method for industrial heritage values based on the Analytic Hierarchy Process (AHP), and proposes a method for determining indicator values. This provides a basis for the selection of industrial heritage landscapes, architectural renewal and conservation strategies. Based on the theoretical basis of the analysis of the value of industrial heritage, this study divides the value of industrial heritage into intrinsic value, including its historical value, scientific and technological value, cultural value and artistic value, and derived values, including location value, environmental value, group value, social value and emotional value (see Section 4.1).

In addition, this study used the AHP method to identify the value composition of the industrial heritage landscape into four layers, which are an objective layer, 2 feature layers, 9 factor layers and 30 detail layers. The main objective was to compare the importance of the indicators by questionnaire, to determine the weights by using Analytic Hierarchy Process and finally to verify the consistency, in order to make a comprehensive and reasonable evaluation. The evaluation criteria for each indicator are also explained in accordance with the evaluation principles (see Sections 4.4 and 5.1.9).

6.1.5 Validation and Visualization of the Industrial Heritage Value Evaluation System in Shaanxi Province, China

As the final step in constructing the complete value evaluation method, the study takes three representative industrial heritage sites in Shaanxi Province, namely Shaanxi Old Steel Factory, Xi'an, Shenxin Yarn Factory, Baoji, Wang Shi Wa Coal Mine and Tongchuan, as examples, and practice tests the application of this industrial heritage value evaluation method. It is also visualised through ArcGIS software (see Chapter 5).

In this process, the study has carried out the whole process of determining the weights of the indicators, the determination of the value of the buildings being assessed (by completing the site inspection form as a basis for value determination through field visits), and the analysis of the assessment results, to obtain the total value levels of these three industrial heritage sites and the levels of each layer of indicators, as well as their value distribution (see Section 5.4). This verifies the operability and accuracy of the theoretical model, and provides a solid foundation for further research on modern industrial heritage landscape in Shaanxi Province.

The introduction of GIS technology in the conservation and reuse of industrial heritage can intuitively present the current situation of industrial heritage resources in the factory area, efficiently integrate research data, and scientifically and effectively assist in value assessment. This study will have a positive impact on the digitalisation and standardisation of industrial heritage conservation work, and provide a quantitative and rational reference basis for industrial heritage renewal planning. Based on the value evaluation, this study also proposes recommendations for the conservation and renovation of industrial heritage that are implementable.

6.2 Relation of Findings to Research Objectives

(1) Research objective No. 1 sought to find out the multifaceted value of the industrial heritage landscape. The aim was to more accurately determine and identify the value of industrial heritage. In order to achieve this objective, this study is based on the collection and study of relevant information on the study of industrial heritage landscapes in Shaanxi Province, such as literature related to the value of industrial heritage, e.g. like relevant charters and policy documents of various countries, combined with the research results of relevant disciplines on the value composition of industrial heritage and industrial heritage landscapes. By following national and local regulations and normative documents, referring to relevant research results and fieldwork, this study summarises and analyses the various aspects of value contained in Shaanxi's industrial heritage

The study established two feature layers, intrinsic value and derived value, to create nine factor layers, namely historical value, technological value, cultural value and artistic value, location value, environmental value, group value, social value and emotional value, and refine them according to the evaluation criteria to obtain 30 detail layers. The indicators for each value are also explained and illustrated.

(2) Research objective No. 2 sought to identify classification, evaluation and presentation methods used for the industrial heritage landscape. The aim was to establish

a systematic and comprehensive assessment method, to explore the potential of industrial heritage for functional renewal, to provide references and suggestions for the conservation and reuse of industrial heritage in China, and to provide support for future development decisions on the conservation and reuse of industrial buildings to achieve sustainable urban development. In order to achieve this objective, based on the previous literature and the realistic needs of industrial heritage evaluation in Shaanxi Province, this study firstly compared several evaluation methods and then chose the Analytic Hierarchy Process (AHP) as the method for calculating the weights in the construction of the value evaluation method. This study introduced the method and reviewed the research results on the application of the AHP method to the evaluation of industrial heritage in China.

This is followed by a discussion of the principles and process of constructing the value methodology, and the selection and explanation of the evaluation indicators. The weighting of the indicators is calculated based on the results of the questionnaires collected, and the value evaluation method is established through a consistency test. Finally, the evaluation criteria for each indicator are defined and the classification of the evaluation results is analysed.

(3) Research objective No. 3 sought to investigate the ways in which the above methods can be combined and used in the selected research area. In order to achieve this objective, this study combines the AHP method with GIS technology used in both landscape character assessment (LCA) and historical landscape characterisation (HLC). By utilising the advantages of GIS in spatial analysis and data processing, the analysis of industrial heritage values is presented as statistical and visualised, and a method of industrial heritage evaluation is developed that combines GIS technology with the AHP method.

In terms of GIS technology, the study firstly analyses the necessity and possibility of applying GIS technology to industrial heritage and systematically presents how to classify data and establish an industrial heritage database, taking into account the current situation and characteristics of industrial heritage. On this basis, the AHP method is combined with the spatial analysis function of GIS technology, and the process and specific methods of industrial heritage value evaluation are proposed. It provides a foundation for the design of renewal and conservation planning for industrial heritage projects, so as to better promote the development of industrial heritage conservation through the scientific approach and appropriate technical solutions to improve operability of industrial heritage conservation.

(4) Research objective No. 4 sought to validate the new method. The aim was to be able to test the realistic operability of the factors in the evaluation method in practice. In order to achieve this objective, three different types of industrial heritage sites in Shaanxi Province were selected for the application of the evaluation method, namely Shaanxi Old Steel Factory (1965) in Xi'an, Wang Shi Wa Coal Mine (1957) in Tongchuan and Shenxin Yarn Factory (1939) in Baoji. Through research and analysis of the current situation of these three industrial heritage sites, a value questionnaire was completed as a basis for evaluation, and the strengths and weaknesses of their current situation were elaborated. Using these three industrial heritage sites as research objects, a comprehensive evaluation of the value of the buildings and structures within the plant area was carried out in combination with the industrial heritage value evaluation method.

The study first focuses on a number of factors affecting the comprehensive value of industrial heritage, and each influencing factor is analysed and scored based on the value survey form for a single-factor evaluation. Then, the weights of the factors obtained through the AHP method were overlaid with multiple factors to obtain the final results of the comprehensive value evaluation of these three industrial heritage sites.

Using the results of this evaluation as a basis, the graded conservation measures for the industrial heritage landscapes were determined, and the overlay analysis of the GIS was used to assess and visualise the comprehensive value of the three industrial heritage sites and to verify the validity of the evaluation method. The evaluation results are then analysed and recommendations for conservation and reuse are made. Based on practical evidence, the combination of GIS technology and evaluation system in the conservation and reuse of industrial heritage is a scientific, reasonable and effective approach, and is worthy of further study and research.

Chapter 7. Conclusion

7.1 Introduction

As mentioned in this thesis, the study of classification and evaluation is a process of bringing together multiple perspectives and sources of knowledge in order to sort out the complexity of industrial heritage values and find solutions to achieve accurate positioning of industrial heritage. This study provides insight into how to identify whether an industrial heritage site has heritage value, whether the original composition of industrial heritage values is still relevant in the current context, and how to objectively assess the value of industrial heritage.

The literature review describes the evolution of the meaning of cultural heritage and the relationship between it and industrial heritage, as well as the value composition and evaluation criteria of industrial heritage, and the currently existing methods of evaluating and reusing industrial heritage, and also the current status and evaluation of industrial heritage in China. This study aims to provide a comprehensive categorisation and evaluation of industrial heritage that can effectively intervene and contribute to the redesign and transformation of industrial heritage. It is a novel approach aimed at enhancing the analysis of policy responses to industrial heritage conservation and urban heritage management.

On the basis of studying the policy background and current status of local industrial heritage in China and Shaanxi Province, this thesis analyses and finds that there are deficiencies in the work of local industrial architectural heritage in Shaanxi, such as the lack of grading evaluation standards, inability to grasp the value of industrial heritage of the same kind, and the misalignment of the protection level. After analysing the basic features and protection status of the existing typical modern industrial heritage in Shaanxi Province, this study tries to establish a scientific and comprehensive set of evaluation methods for the value of modern industrial heritage in Shaanxi Province, that is to say, on the basis of excellent research results, reflecting the regional nature of Shaanxi Province, to construct an industrial heritage evaluation system suitable for the reality of Shaanxi Province.

Before the modern industrial heritage is demolished or transformed, it is possible to carry out a relatively accurate evaluation of its comprehensive value to provide a basis for scientific decision-making, thus minimising the waste of resources and achieving the effective use of resources and sustainable development. In order to carry out this research, the thesis chooses Shaanxi Province as a research case, and analyses the selection of its industrial heritage classification and evaluation criteria, as well as the value characteristics and influencing factors of industrial heritage in Shaanxi Province, and the principles of constructing the criteria and the basic process and way of establishing the evaluation method.

To test the scientificity, rationality and operability of the evaluation and classification methods, the three industrial heritage sites (Shaanxi Old Steel Factory in Xi'an City, Wang Shi Wa Coal Mine in Tongchuan City and Shenxin Yarn Factory in Baoji City) in Shaanxi Province, China, were classified and evaluated using the criteria and methods established by this study, with a view to providing reference significance for the work of grading and assessing industrial heritage in Shaanxi.

7.2 The Relation to Existing Theoretical Frameworks

Industrial heritage, as an important part of cultural heritage in cities, has important connotations and values such as history, society and science. In the process of rapid urban development and renewal, it is a very important topic to evaluate the comprehensive value of industrial heritage objectively and scientifically on time. Although there are many evaluation methods, an evaluation system for industrial heritage has not yet been formed that is generally recognised in conservation of industrial heritage. In order to solve the problem of over-reliance on subjective evaluation and lack of objective data quantification in the evaluation process of industrial heritage in the past, this thesis tries to build up a completely new set of subjective-objective industrial heritage value evaluation system, which integrates the advantages of both subjective and objective evaluation methods based on analysing the respective characteristics of both methods.

In addition, after studying the relevant literature and theories and summarising the development trend and characteristics of the evaluation of industrial heritage in recent years, it is found that the comprehensive evaluation of industrial heritage has gradually shifted from the previous subjective judgement that favours experience and feelings to the mode that combines both subjective and objective evaluation. The proportion of advanced technological tools used in the evaluation process is also on the rise, such as GIS geographic information systems and big data on the Internet, making the evaluation results more scientific.

The specific evaluation contents of industrial heritage are also becoming more diversified, from the earlier common reference to the three major values (historical, cultural and scientific) of heritage building evaluation to the later more diversified consideration of social, environmental and usage aspects. At the same time, the evaluation methods are also actively drawing on the research results and utilisation of other disciplines, such as statistics, sociology of valuation and evaluation, mathematics, sociology and other disciplines, to achieve multidisciplinary crossover and enrich the evaluation system of industrial heritage.

However, there are also many imperfections in the research on comprehensive evaluation of industrial heritage at this stage. For example, many Chinese scholars mainly draw on foreign architectural evaluation theories and methods, lack analyses on the specific status and protection of industrial heritage in China and localities, and the proposed evaluation system of industrial heritage is more inclined to theories, which is relatively thin in terms of combination with practice and operability.

After clarifying the research objectives, this study first explains the theoretical foundation of industrial heritage evaluation in the literature review part of Chapter 2. The study also integrates the value composition of industrial heritage based on the analysis of its value system. For the heritage value system, the initial exploration of the system, the establishment of the basic system, the improvement of the system and the extension of the system are comprehensively sorted out with time as the clue. This study provides a detailed description of the research on China's heritage value system at the policy level and academic levels.

Through the overview of the above contents, the representative results of the development of the scope of cultural heritage, industrial heritage and architectural heritage as well as the definition of the value composition are summarised, with a view to providing reference to the construction of the value system of the modern industrial heritage in Shaanxi later on. In addition, the study illustrates the industrial heritage value composition of typical countries, focusing on the typical criteria for identifying industrial heritage value in the UK. The study provides ideas for the construction of the comprehensive evaluation system of this thesis by describing the international industrial heritage system, from which relevant experiences are summarised.

Finally, the study explains the criteria and factors to be taken into consideration when making value judgements on industrial heritage from the levels of the degree of criteria and the system of criteria for evaluating the value of industrial heritage, which serves as a guideline for the selection of indicators and the evaluation of the value of industrial heritage in the following part of the study.

The formation and development of Shaanxi's industrial heritage is closely related to Shaanxi's development history, and the special era and locality have given the modern industrial heritage a special value connotation.

Therefore, Section 2.6 provides a basic analysis of the value connotations of modern industrial heritage in Shaanxi in terms of its development lineage, current heritage status and local characteristics, to provide the basis and source of value judgement for the construction of the value evaluation system and the value evaluation of specific industrial heritage in the following part. Based on the theoretical foundation presented in the previous three chapters, the classification and evaluation method of industrial heritage in Shaanxi Province is constructed, and the core content includes two parts, which are system construction and quantification of value evaluation.

Before entering the core work, the author firstly carried out the logical idea combing of the system construction, clarified the purpose, content, main points, principles as well as methods of the evaluation system established by this topic, and made a detailed planning of the technical route of the whole evaluation system. Regarding the construction of the evaluation system, the author first determined the three major construction logics of the system, such as the juxtaposition, the hierarchical relationship and the clarity of the inclusion relationship.

Secondly, the preliminary selection of indicators was carried out through the literature research method, and the indicator items of the objective layer, the feature layer, the factors layer, and the detail layer were determined, and the indicator items of the comprehensive value evaluation system of Shaanxi industrial heritage were introduced and explained.

Regarding the quantification of the value evaluation, the author determines the questionnaire designed with a 9-point scale based on the Analytic Hierarchy Process, and the scoring criteria of the specific index items are explained in detail. Next, the thesis describes the principles and calculation steps of the Analytic Hierarchy Process, and analyses the results of the Questionnaire on the Weighting of Indicators for Hierarchical Analysis of Overall Industrial Heritage Values. On the basis of the successive hierarchical structure constructed, the study sequentially carries out the establishment of judgement matrix, expert scoring, and consistency test, and comes up with the results of the calculation of the weighting of each indicator.

In addition, the study also explores how to realise the evaluation index system and evaluation method of industrial heritage value in Chapter 3 with GIS technology. Firstly, it analyses the necessity and feasibility of applying GIS technology to the planning of industrial heritage, how to classify the data in light of the reality and characteristics of industrial heritage, and how to establish the planning spatial database of industrial heritage projects. Based on this, the evaluation method of industrial heritage value is combined with the spatial analysis function of GIS technology, and the evaluation process and specific method of industrial heritage value based on GIS technology are proposed. Thus, a value evaluation system specifically for industrial heritage is built, and the author verified the applicability of this system through specific industrial heritage examples in the next chapter.

Chapter 5 mainly verifies the applicability of the evaluation method system of Shaanxi industrial heritage established in the previous part, and puts forward corresponding protection and renewal reuse strategies according to the evaluation results. First of all, the author selected three industrial heritage sites in Shaanxi Province based on the purposive sampling method to carry out fieldwork and collate literature information.

According to the Building Survey Form (Table 27), the architectural scoring was carried out and calculated according to the evaluation methods in the above chapters, and the comprehensive value level of each industrial heritage was derived. The information from the research and the evaluation results of the industrial heritage were then entered into GIS to differentiate between high and low scores by colour block brightness, and finally the results of the comprehensive value evaluation of the industrial heritage were obtained. Finally, the thesis introduces the guidance value of the comprehensive evaluation results and the evaluation results of single index for the protection, renewal and reuse of industrial heritage.

Through the whole process of calculating the above examples, the study fully verifies the operability and reasonableness of the evaluation system, and the evaluation results also provide the basis for the subsequent protection, renewal and reuse. Thus, this study has completed the whole process from theoretical preparation, system construction to system application and verification.

7.3 Novelty of Research Results and Findings

The introduction and reference to the theoretical achievements of the international heritage community is an important foundation for enriching and speeding up the theoretical construction of Chinese heritage conservation in the process of theoretical research on heritage conservation.

However, such introduction should not only be limited to a few terms and expressions. It should also include the understanding of the development history of the international heritage cause and the evolution of conservation concepts, the understanding of the differences in the concepts and practices of heritage conservation in different countries, nationalities and cultures, as well as the understanding of the different backgrounds and propositions of different schools of thought in the heritage field. At the same time, it is also necessary to correctly grasp the applicability of international theories to China, and to improve or innovate them according to Chinese characteristics.

Based on this understanding, this research provides an in-depth study of the cultural contexts involved in heritage conservation. By sorting out the concepts related to the research propositions and analysing the inheritance and application of the concepts of culture and value in heritage studies, it is possible to interpret more clearly the association and interaction between heritage studies and other disciplines in the understanding of value, as well as the process of change in the concepts and values of heritage.

The study refers to the literature on methods and frameworks for assessing cultural and architectural heritage, and combines it with field research to determine the evaluation criteria for industrial heritage in Shaanxi, so as to lay a theoretical foundation for the classification and evaluation of industrial heritage in Shaanxi. In addition, the study analyses the basic information and characteristics of industrial heritage. It clarifies the information to be collected in the process of industrial heritage survey in Shaanxi Province, and formulates the standard form for field survey and tries it out in the field research. This has greatly improved the working efficiency and accuracy of the survey.

In view of the fact that the existing industrial heritage value profiles are more general, the value identification is incomplete. The study also proposes a research on industrial heritage value system. The thesis establishes a theoretical framework for the evaluation of the value of industrial heritage and derives the various weights of the value of industrial heritage landscapes in terms of value subdivision.

Value evaluation is one of the important steps in the renewal and reuse of industrial heritage. This study finds that the various values of industrial heritage landscapes should no longer be generalised into a broad range of values such as historical value, technological value and artistic value. Broad concepts are prone to a range of problems such as inconsistent evaluation criteria. Therefore, this study uses a value splitting approach to deduce the various weights of industrial heritage landscape values. The original broad range of value criteria is refined and broken down into weighting factors that are consistent with the current development of the times and can be objectively evaluated, thus making the evaluation results more scientific, objective and rigorous.

Secondly, the theory of sociology of valuation and evaluation has been introduced into the study of industrial heritage evaluation. The use of sociology of valuation and evaluation makes the establishment of the industrial heritage value evaluation indicator system logical and regular, and changes the original evaluation indicator construction process, which generally relies on the subjective preference of the relevant evaluators and industry experience. The research initially establishes a classification protection mode based on value evaluation, and strengthens the scientific nature of heritage protection. In this thesis, a breakthrough has been made in the key difficulty in the technical research of heritage conservation management in China, which is the classification and standardisation of heritage conservation.

Based on the main achievements of the Western heritage conservation management system, the study proposes its own viewpoints on how to effectively carry out the comprehensive value assessment of heritage and the classification of heritage conservation measures at the stage of conservation design research. In other words, it takes the value band as a reference to derive the protection and renewal methods of industrial heritage landscape. The value of industrial heritage landscapes is graded by calculating the value of points, so that the value of different industrial heritage landscapes can be seen at a glance, which can be used as a reference basis for the relevant departments in the protection and reuse.

The study considers heritage value assessment as a necessary part of heritage classification and evaluation. The specific operational methods and processes of comprehensive heritage value assessment are proposed. It also evaluates representative industrial heritage landscapes in many different cities in Shaanxi Province, and divides the evaluation results into several value bands. According to the characteristics, attributes and problems of industrial heritage landscapes in each band, the application of the comprehensive assessment method in conservation planning and later conservation and reuse processes, a number of suggestions are made to formulate targeted conservation and utilisation methods, so as to make the conservation work more in line with the actual situation and practicable.

Furthermore, the method of industrial heritage value evaluation is established and validated, and the application aspects and specific application methods of GIS in industrial heritage value evaluation are clarified. In the process of establishing the evaluation method, the interdisciplinary methods of the AHP method and GIS technology were introduced to reduce the subjectivity of the previous traditional analysis methods and to make the results more credible and convincing. This evaluation method uses the AHP method to build a mathematical model and the data collected through the questionnaire to derive the weights of the indicators. The study provides a detailed analysis of each indicator factor.

A comprehensive evaluation of the value indicators was carried out in combination with field surveys, and a comprehensive value assessment of the industrial heritage was undertaken by relying on the data storage of the GIS platform and its multi-factor overlay analysis function. Based on the results of the evaluation, a solution for the reuse of industrial heritage is proposed. The feasibility of the industrial heritage evaluation method is verified in practice through the example of three industrial heritage sites in different provinces of Shaanxi Province.

7.4 Contribution to the Theories and Practice

7.4.1 Contribution to the Theories

At present, in the field of architecture, the research on industrial heritage mainly focuses on the renewal and protection and utilisation of buildings, and there is a relative lack of research on the evaluation of the value of industrial heritage before its protection and renewal. The protection of industrial heritage is mainly based on the subjective perception and qualitative evaluation of experts to judge whether it has protection value and the level of value, which has not formed a unified standard and lacks operability and replicability in practical application. The current research focuses on the key industrial heritage with outstanding value in the core protection zone, but lacks attention to the industrial heritage with general value, and has not yet established a quantitative evaluation system applicable to all industrial heritage in the zone.

This study is a systematic research on three typical industrial heritage sites in Shaanxi Province. It establishes a basic information file of industrial heritage through basic research on the value of the current situation, and carries out a detailed characterisation and value summary of industrial heritage buildings and landscapes based on this information file. The study analyses the value connotation of the existing buildings in the area, and establishes the value evaluation system of Shaanxi industrial heritage.

The evaluation system is not only a theoretical support that can intuitively reflect the heritage value situation of these three regions, but also a theoretical guide for the construction of the heritage value system of other modern industrial heritage in Shaanxi, and at the same time, it can be used as a theoretical reference for similar industrial heritage evaluation fields in other cities and regions in China.

By sorting out the concepts related to the study and analysing the application of the concepts of culture and value in heritage studies, it is possible to interpret more clearly the linkages and interactions between the heritage community and other disciplines in terms of the understanding of values. The process of change in the concepts and values of industrial heritage can thus be organised.

This thesis absorbs and learns on the relevant research results in the field of sociology of valuation and evaluation and statistics, and tries to establish a set of systematic scientific, quantitative and qualitative methods of classification and evaluation methods by combining the existing industrial heritage status characteristics under the historical and cultural conditions of Shaanxi. This helps to understand and grasp the comprehensive situation of modern industrial heritage, and provides a theoretical basis for fully exploring the value and utilisation potential of industrial heritage. At the same time, the collection and organisation of the research data of the three regions in Shaanxi will also provide convenience for the subsequent researchers.

7.4.2 Contribution to the Practice

The valuation of industrial heritage is the basis and prerequisite for its conservation and renewal. In a broad sense, as a key part of industrial heritage conservation and renewal practice, value evaluation itself belongs to the scope of practice. In a narrow sense, the value evaluation in the early stage has a practical guiding role for the later protection and application, which is specifically shown in the following: on the one hand, the value evaluation system constructed in this study for the modern industrial heritage in Shaanxi is able to quantitatively analyse the value of the industrial heritage in the factory area. The evaluation results can clearly and intuitively reflect the distribution of the architectural value of industrial heritage sites and the value of specific sub-indicators of individual buildings or landscapes; on the other hand, the value grading of Shaanxi's industrial heritage in this study directly affects whether the subsequent architectural heritage needs to be protected and the formulation of corresponding protection strategies.

The study is of great significance to the study of industrial history and the protection and utilisation of industrial cultural heritage in Shaanxi Province.

This research can be carried out simultaneously with the actual project of overall protection of industrial heritage in Shaanxi, and the formulation of the thesis on the evaluation standard of industrial heritage landscape value can provide the theoretical basis for the selection of the way and method of heritage protection of the practical project, to better guide the actual industrial heritage related engineering practice. So the systematic and comprehensive evaluation of industrial heritage undoubtedly has important theoretical significance and application prospect. Its conclusions are important for industrial heritage protection projects in Shaanxi.

In China, there is still a lack of evaluation of industrial heritage in comparison with cultural relics and buildings. The evaluation study of cultural relic buildings can still have the Law of the People's Republic of China on the Protection of Cultural Relics as a reference basis, but the relevant regulations and standards for industrial heritage are not yet perfect. The specific evaluation results of the indicators of industrial heritage can provide a decision-making basis for the engineering practice of upgrading and reuse of industrial heritage. Before the implementation of the industrial heritage, the industrial heritage value evaluation system can be used to know the current situation and value composition of the industrial heritage.

The evaluation is carried out before and after the transformation of the industrial heritage, and the comparison of the evaluation results before and after the transformation can lead to the evaluation conclusion of the transformation effect. In the dynamic protection and updating of industrial heritage, real-time evaluation can also be used to grasp the specific situation of industrial heritage and make corresponding adjustments to the situation. Therefore, the evaluation system of modern industrial heritage in Shaanxi can be based on evaluation to promote the scientific decision-making of industrial heritage-related practices.

7.5 Research Limitations

(1) Industrial heritage involves many people, including government, industrial enterprises, developers and the public, and there are few opportunities to communicate with developers and government when researching industrial heritage. In addition, access to government records and archives is very limited and requires the support of primary source material from companies. However, access to these corporate archives is not available due to the state of secrecy and formalities involved. It is hoped that future research on industrial heritage will be conducted with the assistance of the relevant government departments, so that more people can participate in the research and contribute to the rational conservation and reuse of industrial heritage.

(2) The number of case studies is small and the advantages of GIS technology are not obvious. As the focus of this study was on finding typical cases, a comprehensive survey of all of Shaanxi's industrial heritage was not conducted, and the number of cases was small, while the advantages of GIS technology can be reflected in the application of large sample size and large scale space. Therefore, it is hoped that the study will increase the number of cases to reflect the advantages of GIS.

(3) During the field survey of this study, the fourth phase of the Baoji Shenxin Yarn Factory faced bankruptcy, therefore, it was not possible to get inside the factory to conduct the survey, which is a clear regret in this survey. In addition, due to the COVID-19 epidemic, the fieldwork for this study was mainly based on the current situation, due to the restrictions on in-person communication under the COVID-19 epidemic, which had a greater impact on local opinion surveys. Therefore, the initial plan was that the method would include some in-person interviews. However, this was not possible and only interviews with a few factory managers and very few people took place.

7.6 Recommendations for Future Research

By establishing the classification and evaluation method of industrial heritage landscape, this study hopes to effectively and reasonably solve the current problems of industrial heritage protection and reuse, and to quantify the data from the value level to achieve the maximisation of the comprehensive benefits of industrial heritage use. However, the protection and reuse of industrial heritage is not only a theoretical issue, but should be established under the multiple efforts of the government, enterprises and civilian forces, with a guarantee system, so that the industrial heritage landscape can be better protected and reused to create more value in the future.

(1) In terms of methods

Based on literature review and field research, this study constructs an industrial heritage value evaluation method and verifies the feasibility through value evaluation of modern industrial heritage in Shaanxi Province. The study introduces the analytic hierarchy process into the value evaluation of industrial architectural heritage, and explores an effective way to quantify the qualitative problems. Nevertheless, due to the diversity of the value of industrial heritage, more detailed research and analysis can be carried out, and there is still space for further refinement of the grades of the evaluation criteria in the evaluation method, so that the results of the evaluation can be more detailed.

In this evaluation method, the analytic hierarchy process (AHP) is used to calculate the value of industrial heritage and the collected research data and final scores are organised and visualised through GIS. The process includes the following steps: construction of multi-level evaluation indices - determination of the weight set of each evaluation index - data collection - single-factor evaluation - multi-factor overlay evaluation - analysis and summary of the evaluation results. When multiple buildings need to be evaluated for value, the amount of calculation will be relatively large. Future research could be based on this evaluation method and automate its calculation, for example, by combining Python and developing a specialised program for calculating the value of industrial heritage according to the step-by-step logic of the calculation, which would make it more convenient to calculate its value.

In addition, the application of GIS technology in industrial heritage protection is still in the exploratory stage, and in the future application process, it is necessary to grasp and understand the principles of GIS application, to combine GIS technology and industrial heritage protection well, and to give full play to the functions of its database.

(2) About the practice

This study establishes a methodology for evaluating the value of industrial heritage and verifies its applicability through three cases in Shaanxi Province, China. The fundamental purpose of the evaluation method is to provide a basis for the protection and transformation of industrial heritage. Through the field research, evaluation and analysis of the industrial heritage of Shaanxi Old Steel Factory, Wang Shi Wa Coal Mine and Shenxin Yarn Factory, preliminary strategies and suggestions for the conservation and renovation of their industrial heritage based on the value of the heritage are given.

Future research in this field would be of great help in exploring methods for developing conservation and renovation strategies based on the high and low value distribution of the buildings evaluated and specific ways in which these conservation and renovation strategies can be implemented.

Many industrial cities in the world today are transforming, for example, into ecological cities. In the process of changing, a large number of abandoned industrial sites will inevitably be left behind. How to deal with these post-industrial modern industrial sites and determine their value will be a problem facing the industrial heritage landscape in the future.

The classification and evaluation index system and judgement model of Shaanxi industrial heritage constructed in this thesis have universality, but when it is promoted to be used in different places, it is necessary to combine the background and characteristics of the historical development of local industries and industrial buildings, and to modify the grading values of the quantitative value criteria and the focus description of the qualitative value criteria, so as to improve the applicability of the present methodology.

Moreover, in the study of industrial heritage in Shaanxi Province, apart from proposing relevant conservation and reuse strategies, it is hoped that there will be opportunities to develop detailed conservation and reuse designs for industrial heritage with outstanding heritage value in Shaanxi in the future, to effectively protect the core industrial heritage.

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Appendix A

Questionnaire on the Weighting of Indicators for Hierarchical Analysis of Overall Industrial Heritage Values

Hi! I am Weiyu Lian, a PhD student at the University of Strathclyde, Glasgow, United Kingdom, and I would like to invite you to take part in my survey. This survey is about the importance of the landscape value of industrial heritage. The industrial heritage referred to in the survey means abandoned industrial sites, old industrial buildings and plants, disused machinery and equipment in cities and industrial-type areas in cities where there was once a large concentration of factory enterprises.

• The aim of the survey is to identify the importance of different factors for the evaluation of industrial heritage.

• Please note that your participation and the answers you provide will be used for research purposes only. For this survey, all responses are anonymous and will be treated in strict confidence.

**This study divides the values into three layers, The feature layer, The factors layer, The detail layer. The feature layer is divided into two main categories, namely A-intrinsic value and B- derived value.*

Intrinsic value refers to the value of industrial heritage itself. It includes four factors layers: A1 Historical value, A2 Scientific and technological value, A3 Cultural value and A4 Artistic value.

Derived values are subject to changes in people's perceptions of industrial heritage and the elements associated with it. It includes five factors layers: B1 Location value, B2 Environmental value, B3 Group value, B4 Social value and B5 Emotional value.

Part1.

Q1. Your Gender

☐Male

☐Female

☐Prefer not to say

Other

Q2. Your Age

☐ Under 18

☐ 18-24 years old

☐ 25-34 years old

☐ 35-44 years old

☐ 45-54 years old

☐ 55-64 years old

☐ Over 65 years old

☐Prefer not to say

Q3. Your current occupation

☐Full-time students

☐Production staff

☐Sales staff

☐Marketing/PR personnel

☐Customer service personnel

☐Administrative/Logistic personnel

☐Human Resources

☐Finance/Audit personnel

☐Clerical/clerical staff

☐Technical/R&D personnel

☐Management staff

☐Teachers

☐Advisors/consultants

☐Professionals (e.g. accountants, lawyers, architects, health care professionals, journalists, etc.)

☐Other

Part2: Please give a score for the importance of each indicator.

For example, the important relationship between intrinsic and derived values is

1/9	1/7	1/5	1/3	1	3	5	7	9
○	○	○	○	○	○	○	○	○

If you think the intrinsic value is important, choose 3, 5, 7 or 9. If you think the derived value is important choose 1/3, 1/5, 1/7 or 1/9. If you think that they are equally important choose 1.

The weights and their meanings are shown below：

Intensity of importance	**Definition**
1	A and B are equally important
3	A is slightly more important than B
5	A is strongly more important than B
7	A is very strongly more important than B
9	A is extremely more important than B
1/3	B is slightly more important than A
1/5	B is strongly more important than A
1/7	B is very strongly more important than A
1/9	B is extremely more important than A

Q1. The importance of the relationship between intrinsic and derived values in the feature layer is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
A Intrinsic value /B Derived value	○	○	○	○	○	○	○	○	○

Q2. The importance of the relationship between the indicators (A1 Historical value, A2 Scientific and technological value, A3 Cultural value and A4 Artistic value) under the intrinsic value is :

	1/9	1/7	1/5	1/3	1	3	5	7	9
A1 Historical value /**A2** Scientific and technological value	○	○	○	○	○	○	○	○	○
A1 Historical value / **A3** Cultural value	○	○	○	○	○	○	○	○	○
A1 Historical value / **A4** Artistic value	○	○	○	○	○	○	○	○	○
A2 Scientific and technological value / **A3** Cultural value	○	○	○	○	○	○	○	○	○
A2 Scientific and technological value / **A4** Artistic value	○	○	○	○	○	○	○	○	○
A3 Cultural value / **A4** Artistic value	○	○	○	○	○	○	○	○	○

Q3. The importance of the relationship between derived value (B1 Location value, B2 Environmental value, B3 Group value, B4 Social value, B5 Emotional value) in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
B1 Location value / **B2** Environmental value	○	○	○	○	○	○	○	○	○
B1 Location value / **B3** Group value	○	○	○	○	○	○	○	○	○
B1 Location value / **B4** Social value	○	○	○	○	○	○	○	○	○
B1 Location value / **B5** Emotional value	○	○	○	○	○	○	○	○	○
B2 Environmental value / **B3** Group value	○	○	○	○	○	○	○	○	○
B2 Environmental value / **B4** Social value	○	○	○	○	○	○	○	○	○
B2 Environmental value / **B5** Emotional value	○	○	○	○	○	○	○	○	○
B3 Group value / **B4** Social value	○	○	○	○	○	○	○	○	○
B3 Group value / **B5** Emotional value	○	○	○	○	○	○	○	○	○
B4 Social value / **B5** Emotional value	○	○	○	○	○	○	○	○	○

Q4. The importance of the relationship between the indicators (A12 Witness to the level of social development, A13 Witness to important events, A14 The addition and completion of historical documents, A15 Uniqueness and scarcity, A16 Completeness) under the first factor layer-A1 historical value in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
A11 The date of construction of the heritage / **A12** Witness to the level of social development	○	○	○	○	○	○	○	○	○
A11 The date of construction of the heritage / **A13** Witness to important events	○	○	○	○	○	○	○	○	○
A11 The date of construction of the heritage / **A14** The addition and completion of historical documents	○	○	○	○	○	○	○	○	○
A11 The date of construction of the heritage / **A15** Uniqueness and scarcity	○	○	○	○	○	○	○	○	○
A11 The date of construction of the heritage / **A16** Completeness	○	○	○	○	○	○	○	○	○
A12 Witness to the level of social development / **A13** Witness to important events	○	○	○	○	○	○	○	○	○
A12 Witness to the level of social development / **A14** The addition and completion of historical documents	○	○	○	○	○	○	○	○	○

A12 Witness to the level of social development / **A15** Uniqueness and scarcity	○	○	○	○	○	○	○	○	○
A12 Witness to the level of social development / **A16** Completeness	○	○	○	○	○	○	○	○	○
A13 Witness to important events / **A14** The addition and completion of historical documents	○	○	○	○	○	○	○	○	○
A13 Witness to important events / **A15** Uniqueness and scarcity	○	○	○	○	○	○	○	○	○
A13 Witness to important events / **A16** Completeness	○	○	○	○	○	○	○	○	○
A14 The addition and completion of historical documents / **A15** Uniqueness and scarcity	○	○	○	○	○	○	○	○	○
A14 The addition and completion of historical documents / **A16** Completeness	○	○	○	○	○	○	○	○	○
A15 Uniqueness and scarcity / **A16** Completeness	○	○	○	○	○	○	○	○	○

Q5. The importance of the relationship between the indicators (A21 Industrial buildings and equipment, A22 Production processes, A23 Technological representativeness) under the 2nd factors layer-A2 Scientific and technical values in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
A21 Industrial buildings and equipment / **A22** Production processes	○	○	○	○	○	○	○	○	○
A21 Industrial buildings and equipment / **A23** Technological representativeness	○	○	○	○	○	○	○	○	○
A22 Production processes / **A23** Technological representativeness	○	○	○	○	○	○	○	○	○

Q6. The importance of the relationship between the indicators under the third factors layer-A3 cultural values (A31 Positive energy value, A32 Negative energy value, A33 Neutral energy value) in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
A31 Positive energy value / **A32** Negative energy value	○	○	○	○	○	○	○	○	○
A31 Positive energy value / **A33** Neutral energy value	○	○	○	○	○	○	○	○	○
A32 Negative energy value / **A33** Neutral energy value	○	○	○	○	○	○	○	○	○

Q7. The importance of the relationship between the indicators (A41 Aesthetic landscape value,

A42 The value of the artwork, A43 The level of artistic style expression) under the fourth factor layer-A4 artistic value in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
A41 Aesthetic landscape value /A42 The value of the artwork	○	○	○	○	○	○	○	○	○
A41 Aesthetic landscape value / **A43** The level of artistic style expression	○	○	○	○	○	○	○	○	○
A42 The value of the artwork / **A43** The level of artistic style expression	○	○	○	○	○	○	○	○	○

Q8. The importance of the relationship between the indicators (B11 Distance from the city centre, B12 Transport situation to the city centre and B13 The number of central cities or tourist areas in the wider regional context) under the 5th factor layer -B1 Location value in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
B11 Distance from the city centre / **B12** Transport situation to the city centre	○	○	○	○	○	○	○	○	○
B11 Distance from the city centre / **B13** The number of central cities or tourist areas in the wider regional context	○	○	○	○	○	○	○	○	○
B12 Transport situation to the city centre / **B13** The number of central cities or tourist areas in the wider regional context	○	○	○	○	○	○	○	○	○

Q9. The importance of the relationship between the indicators (B21 The impact of the original production function of industrial heritage on the environment and B22 The environmental scope of the industrial heritage) under the 6th factor layer-B2 Environmental values in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
B21 The impact of the original production function of industrial heritage on the environment / **B22** The environmental scope of the industrial heritage	○	○	○	○	○	○	○	○	○

Q10. The importance of the relationship between the indicators (B31 The scale of the group, B32 Relationship of the group and B33 The potential for wide-scale groups of industrial heritage) under of the 7th factor layer - B3 Group value in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
B31 The scale of the group / **B32** Relationship of the group	○	○	○	○	○	○	○	○	○
B31 The scale of the group / **B33** The potential for wide-scale groups of industrial heritage	○	○	○	○	○	○	○	○	○
B32 Relationship of the group / **B33** The potential for wide-scale groups of industrial heritage	○	○	○	○	○	○	○	○	○

Q11. The importance of the relationship between the indicators (B41 The ability to solve re-employment, B42 Educational function, B43 The potential to provide a place of leisure for the public, B44 Enhancing the image or symbolism of the city) under the 8th factor layer- B4 Social Value in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
B41 The ability to solve re-employment / **B42** Educational function	○	○	○	○	○	○	○	○	○
B41 The ability to solve re-employment / **B43** The potential to provide a place of leisure for the public	○	○	○	○	○	○	○	○	○
B41 The ability to solve re-employment / **B44** Enhancing the image or symbolism of the city	○	○	○	○	○	○	○	○	○
B42 Educational function / **B43** The potential to provide a place of leisure for the public	○	○	○	○	○	○	○	○	○
B42 Educational function / **B44** Enhancing the image or symbolism of the city	○	○	○	○	○	○	○	○	○
B43 The potential to provide a place of leisure for the public / **B44** Enhancing the image or symbolism of the city	○	○	○	○	○	○	○	○	○

Q12. The importance of the relationship between the indicators (B51 Number of people who have an emotional connection to industrial heritage, B52 The age range of the people who have an emotional connection to industrial heritage, B53 Characteristics of the careers of people with emotional value) under the 9th factor layer - B5 emotional value in this hierarchy is:

	1/9	1/7	1/5	1/3	1	3	5	7	9
B51 Number of people who have an emotional connection to industrial heritage / **B52** The age range of the people who have an emotional connection to industrial heritage	○	○	○	○	○	○	○	○	○
B51 Number of people who have an emotional connection to industrial heritage / **B53** Characteristics of the careers of people with emotional value	○	○	○	○	○	○	○	○	○
B52 The age range of the people who have an emotional connection to industrial heritage / **B53** Characteristics of the careers of people with emotional value	○	○	○	○	○	○	○	○	○

Appendix B

In terms of gender (Figure B. 1), there were 91 males and 107 females. There is no pre-determined number of male and female respondents in the gender selection, and the final results show that the number of female respondents is slightly higher than the number of male respondents, but the gender ratio is basically evenly distributed.

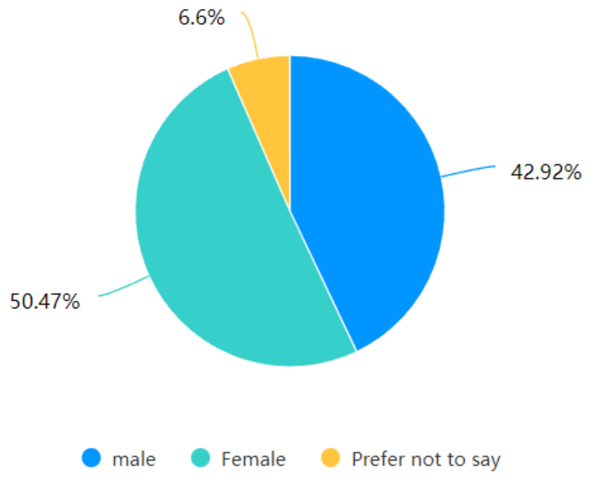


Figure B. 1. Gender Composition of Respondents

In terms of age (Figure B. 2), the respondents were distributed in all age groups. The majority of respondents were in the 25-34 age group with 104, 1 in the under 18 age group, 2 in the 18-24 age group, 19 in the 35-44 age group, 18 in the 45-54 age group, 42 in the 55-64 age group and 11 in the over 65 age group.

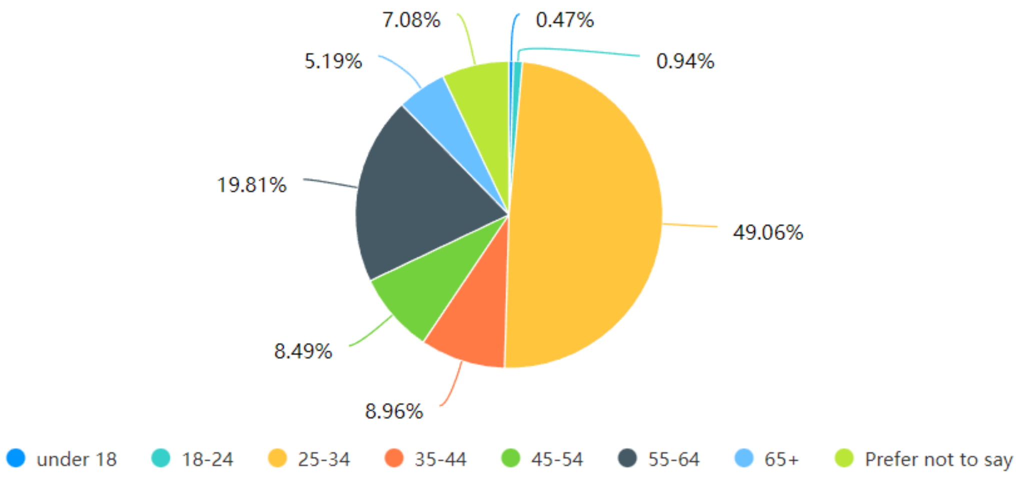


Figure B. 2. Age Composition of Respondents

From the point of view of the professions, the number of responses from architecture, planning and landscape design-related professions is 70 (33%); from the point of view of education, 134 (63.22%) are from undergraduates and below, 50 (23.6%) are from masters and 28 (13.2%) are from PhD students.

According to the 1-9 scale method, the meaning and description of the numerical scale are shown in Table 22 (see Section 4.7.2), and the actual situation of the questionnaire consultation is collated, according to the comparison of the importance of each indicator, so as to obtain the judgment matrix of the target level (Table B. 2). The numbers in the matrix are calculated by rounding off the arithmetic average of the questionnaire results.

The first question was about the important relationship between feature layers (intrinsic value and derived value). Among these (Table B. 1), there were 125 people selecting 3, meaning that 125 people thought that intrinsic value is strongly more important than derived value, representing 58.96% of the total number of participants in the survey. Only one person (0.47% of the total) chose 9 (intrinsic value is extremely more important than derived value), while three people (1.42%) each chose 1/9 (derived value is extremely more important than intrinsic value), 1/7 (derived value is very strongly more important than intrinsic value) and 7 (intrinsic value is very strongly more important than derived value). Thirteen people each chose 1/5 (derived value is strongly more important than intrinsic value) and 1/3 (derived value is slightly more important than intrinsic value), representing 6.13% of the total number of participants in the survey. 31 people chose 1 in which they considered intrinsic value and derived value are equally important, and 20 people chose 5 in which they believed intrinsic value is strongly more important than derived value. After calculation, the arithmetic mean of intrinsic value/derived value is 2.58, rounded off as 3.

Table B. 1. Questionnaire Results for Important Relationships Between Feature Layers

(1) A intrinsic value/B derived value

Options	Subtotal	Proportion
1/9	3	1.42%
1/7	3	1.42%
1/5	13	6.13%
1/3	13	6.13%
1	31	14.62%
3	125	58.96%
5	20	9.43%
7	3	1.42%
9	1	0.47%
Number of valid fills in this question	**212**	

Table B. 2. Judgment Matrix of the Feature Layer

Evaluation indicators	**A** Intrinsic value	**B** Derived value	W_i
A Intrinsic value	1	3	0.7500
B Derived value	1/3	1	0.2500

From Table B. 2, λ_{max}=2.0000, CI=0.0000, RI=0 and CR = 0.0000, with satisfactory agreement.

The table shows that intrinsic value is three times that of derived value, which gives a weighting of 0.75 and 0.25 respectively.

Intrinsic value contains a total of 4 factor layers (A1 Historical value, A2 Scientific and technological value, A3 Cultural value and A4 Artistic value). This question was a comparison of the importance of the elements in intrinsic value (Table B. 3). In the comparison of historical value to technological and scientific value, 80 people chose 3, followed by 47 people who chose 1, which means that they think A1 and A2 are equally important. One person each selected 7 and 9. The arithmetic mean was calculated to be 2.01, rounded off as 2.

In the comparison between A1 Historical value and A3 Cultural value, 66 people chose 3, 56 people chose 1 and only 1 person chose 9. The arithmetic mean is calculated to be 1.87, by rounding off to 2. Comparing A1 Historical value and A4 Artistic value, 69 people chose 3 and 54 people chose 1. The same number of people chose 1/9 and 9, both 3. According to the calculation, its arithmetic mean is 2.00, rounded off as 2. In the comparison between A2 Scientific and technological value and A3 Cultural value, 59 people chose 1/3 and only 2 people chose 1/9. The arithmetic mean was calculated to be 1.42, rounded off as 1. For the comparison between A2 Scientific and technological value and A4 Artistic value, 74 people chose 3 and 2 people each chose 1/9 and 9. The arithmetic mean was calculated to be 2.02, rounded off the number to 2. In a comparison of A3 Cultural value and A4 Artistic value, 77 people chose 3. The same number of people chose 1/9 as 1/7, both 5. The arithmetic mean is calculated to be 1.84, rounded off the number to 2.

The judgement matrix of which is shown below (Table B. 4) based on the questionnaire data and its importance comparison.

Table B. 3. Questionnaire results on the importance of intrinsic value

Topic\Options	1/9	1/7	1/5	1/3	1	3	5	7	9
A1 Historical value /**A2** Scientific and technological value	4 (1.89%)	2 (0.94%)	17 (8.02%)	39 (18.4%)	47 (22.17%)	80 (37.74%)	21 (9.91%)	1 (0.47%)	1 (0.47%)
A1 Historical value / **A3** Cultural value	3 (1.42%)	6 (2.83%)	14 (6.6%)	46 (21.7%)	56 (26.42%)	66 (31.13%)	16 (7.55%)	4 (1.89%)	1 (0.47%)

A1 Historical value / **A4** Artistic value	3 (1.42%)	6 (2.83%)	12 (5.66%)	44 (20.75%)	54 (25.47%)	69 (32.55%)	15 (7.08%)	6 (2.83%)	3 (1.42%)
A2 Scientific and technological value / **A3** Cultural value	2 (0.94%)	5 (2.36%)	19 (8.96%)	59 (27.83%)	50 (23.58%)	55 (25.94%)	14 (6.6%)	5 (2.36%)	3 (1.42%)
A2 Scientific and technological value / **A4** Artistic value	2 (0.94%)	4 (1.89%)	14 (6.6%)	41 (19.34%)	54 (25.47%)	74 (34.91%)	15 (7.08%)	6 (2.83%)	2 (0.94%)
A3 Cultural value / **A4** Artistic value	5 (2.36%)	5 (2.36%)	18 (8.49%)	44 (20.75%)	47 (22.17%)	77 (36.32%)	10 (4.72%)	6 (2.83%)	0 (0%)

Table B. 4. Judgement Matrix for Factor Layer A

Evaluation indicators	**A1** Historical value	**A2** Scientific and technological value	**A3** Cultural value	**A4** Artistic value	W_i
A1 Historical value	1	2	2	2	0.3933
A2 Scientific anc technological value	1/2	1	1/2	1/2	0.1390
A3 Cultural value	1/2	2	1	1	0.2338
A4 Artistic value	1/2	2	1	1	0.2338

From Table B. 4, λ_{max}=4.0604, CI=0.0201, RI=0.9, CR=0.0224, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [8.0000, 0.1250, 1.0000, 1.0000]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.6818, 0.5946, 1.0000, 1.0000]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.3933, 0.1390, 0.2338, 0.2338]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{\max} = \frac{1}{\mathrm{n}} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/416.2417 = 4.0604$$

In the formula, Bw_i=[1.6067, 0.5695, 0.9424, 0.9424]

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{\max} - n}{n-1} = (4.0604-4)/(4-1) = 0.0201$$

The RI table shows that when the judgement matrix n=4, the RI is 0.9.

The average consistency was calculated to be,

$CR = \frac{CI}{RI}$ =0.0201/0.9=0.0224<0.1. It is known to have passed consistency.

Derived value contains a total of 5 factor layers, which are B1 Location value, B2 Environmental value, B3 Group value, B4 Social value, and B5 Emotional value.

The results of the questionnaire (Table B. 5) on the comparison of the detail layer under Derived value show that in the comparison of locational and environmental values, 81 people (38.21% of the total) chose 3 and 42 people answered 1. There was one person answered 9 and one person answered 1/9. Their arithmetic mean is 2.13, rounded off the number to 2.

In the comparison between the B1 Location value and B3 Group value, 68 people chose 3, 48 people chose 1, 47 people chose 1/3 and the least number of people chose 1/9 with 3 people. Their arithmetic mean is 1.94, rounded off the number to 2.

Comparing B1 Location value and B5 Emotional value, 68 people chose 3, 49 people chose 1 and 44 people chose 1/3. 2 people each chose 9 and 1/9. Their arithmetic mean is 1.67, rounded off the number to 2. In the comparison of B2 Environmental value and B3 Group value, 56 people thought 3, 51 people thought 1 and 48 people thought 1/3. Their arithmetic mean is 1.91, rounded off the number to 2.

In the comparison between the B2 Environmental value and B4 Social value, only 2 people answered 9, 61 people answered 3 and 54 people answered 1/3. The arithmetic mean is calculated to be 2.06, rounded off to 2. For the comparison between the B2 Environmental value and B5 Emotional value, 70 people chose 3 and 43 people chose 1. One more person thought 1/3 than 1, at 44 people. The least number of people thought 9, at 2 people. The arithmetic mean is calculated to be 1.96, rounded off the number to 2. In the comparison between the B3 Group value and B4 Social value, a higher number of people thought 3, with 60 people. The number of people who thought 1 was 44. According to the results of the questionnaire, its arithmetic mean is 1.93, rounded off to 2.

In the comparison between the B3 Group value and B5 Emotional value, 73 people chose 3 and only 3 chose 9. According to the questionnaire results, its arithmetic mean is 2.11, rounded off to 2. In the comparison between the B4 Social value and B5 Emotional value, 73 people chose 3, 50 people chose 1 and the least number of people chose 9, which was 1. The arithmetic mean was calculated to be 2.14, rounded off the number to 2.

The judgement matrix of which is shown below (Table B. 6) based on the questionnaire data and its importance comparison.

Table B. 5. Questionnaire Results on the Importance of Derived Value

Topic\Options	1/9	1/7	1/5	1/3	1	3	5	7	9
B1 Location Value/B2 Environmental Value	1 (0.47%)	5 (2.36%)	20 (9.43%)	38 (17.92%)	42 (19.81 %)	81 (38.21%)	14 (6.6%)	10 (4.72%)	1 (0.47%)
B1 Location value/B3 Group value	3 (1.42%)	7 (3.3%)	17 (8.02%)	47 (22.17%)	48 (22.64 %)	68 (32.08%)	12 (5.66%)	6 (2.83%)	4 (1.89%)
B1 Location Value/B4 Social Value	4 (1.89%)	4 (1.89%)	22 (10.38%)	58 (27.36%)	39 (18.4%)	61 (28.77%)	14 (6.6%)	7 (3.3%)	3 (1.42%)
B1 Location value/B5 emotional value	2 (0.94%)	7 (3.3%)	19 (8.96%)	44 (20.75%)	49 (23.11 %)	68 (32.08%)	16 (7.55%)	5 (2.36%)	2 (0.94%)
B2 Environmental Value/B3 Group Value	2 (0.94%)	9 (4.25%)	17 (8.02%)	48 (22.64%)	51 (24.06 %)	56 (26.42%)	21 (9.91%)	6 (2.83%)	2 (0.94%)
B2 Environmental Value/B4 Social Value	6 (2.83%)	4 (1.89%)	20 (9.43%)	54 (25.47%)	45 (21.23 %)	61 (28.77%)	15 (7.08%)	5 (2.36%)	2 (0.94%)
B2 Environmental Value/B5 Emotional Value	3 (1.42%)	6 (2.83%)	20 (9.43%)	44 (20.75%)	43 (20.28 %)	70 (33.02%)	17 (8.02%)	7 (3.3%)	2 (0.94%)
B3 Group Value/B4 Social Value	4 (1.89%)	5 (2.36%)	24 (11.32%)	48 (22.64%)	44 (20.75 %)	60 (28.3%)	16 (7.55%)	8 (3.77%)	3 (1.42%)

B3 Group Value/B5 Emotional Value	4 (1.89%)	5 (2.36%)	14 (6.6%)	46 (21.7%)	40 (18.87 %)	73 (34.43%)	23 (10.85 %)	4 (1.89%)	3 (1.42%)
B4 Social Value/B5 Emotional Value	4 (1.89%)	5 (2.36%)	17 (8.02%)	34 (16.04%)	50 (23.58 %)	73 (34.43%)	18 (8.49%)	10 (4.72%)	1 (0.47%)

Table B. 6. Judgement Matrix for Factor Layer A

Evaluation indicators	**B1** Location value	**B2** Environmental value	**B3** Group value	**B4** Social value	**B5** Emotional value	Wi
B1 Location value	1	2	2	2	2	0.3291
B2 Environmental value	1/2	1	1	1/2	1/2	0.1247
B3 Group value	1/2	1	1	1	1	0.1645
B4 Social value	1/2	2	1	1	1/2	0.1645
B5 Emotional value	1/2	2	1	2	1	0.2171

From Table B. 6, λ_{max}=5.1359, CI=0.0340, RI=1.12, CR=0.0303, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [16.0000, 0.1250, 0.5000, 0.5000, 2.0000]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.7411, 0.6598, 0.8706, 0.8706, 1.1487]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.3291, 0.1247, 0.1645, 0.1645, 0.2171]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/5 \times 25.6797 = 5.1359$$

In the formula, Bw_i=[1.6709, 0.6446, 0.8355, 0.8516, 1.1247]

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{\max} - n}{n-1} = (5.1359-5)/(5-1) = 0.0340$$

The RI table shows that when the judgement matrix n=5, the RI is 1.12.

The average consistency was calculated to be,

$$CR = \frac{CI}{RI} = 0.0340/1.12 = 0.0303 < 0.1$$. It is known to have passed consistency.

The detail layer of historical value contains a total of six factor layers, namely A11 The date of construction of the heritage, A12 Witness to the level of social development, A13 Witness to important events, A14 The addition and completion of historical documents, A15 Uniqueness and scarcity, A16 Completeness.

The results of the questionnaire (Table B. 7) on the comparison of the detail layer of historical value can be found in the comparison of A11 The date of construction of the heritage and A12 Witness to the level of social development, where 81 people chose 3, representing a total of 37.74%. The least number of people chose 1/9, at 1. The arithmetic mean was calculated to be 2.22, rounded off the number to 2. In the comparison between

A11 The date of construction of the heritage and A13 Witness to important events, 62 people chose 1/3 and the least number of people chose 1/9 at 2. Their arithmetic mean is 1.73, rounded off the number to 2. In comparing the importance of A11 The date of construction of the heritage and A14 The addition and completion of historical documents, the largest number of people chose 3, which was 69, 3 people chose 9, and twice as many people chose 1/9, which was 6. The arithmetic mean is 2.26, rounded off the number to 2. For the comparison of A11 The date of construction of the heritage and A15 Uniqueness and scarcity, 59 people chose 1/3, one more than those who chose 3. The minimum number of people choosing 9 was 1. The arithmetic mean is 1.79, rounded off to 2.

In the comparison between A11 The date of construction of the heritage and A16 Completeness, 57 people thought 3, 49 people chose 1 and 54 people chose 1/3. The arithmetic mean is 1.85, rounded off to 2. For the comparisons of A12 Witness to the level of social development and A13 Witness to important events, 63 people chose 3, 49 people chose 1/3, the same number of people chose 1/9 as chose 1/7 at 3, and the same number of people chose 7 and 9 at 4. Their arithmetic mean is 2.02, rounded off to 2. In the comparison of A12 Witness to the level of social development and A14 The addition and completion of historical documents, 70 people chose 3, and 20 more people chose 1. Only 3 people chose 1/9. Their arithmetic mean is 2.02, rounded off the number to 2. In the comparison between A12 Witness to the level of social development and A15 Uniqueness and scarcity, 60 people chose 1/9, 58 people chose 3 and 1 person chose 9. The arithmetic mean is 1.72, rounded off the number to 2.

In the comparison of A12 Witness to the level of social development and A16 Completeness, 62 people chose 1/3, 2 people more than those who chose 3, and the least number of people chose 1/9, which was 2 people. Their arithmetic mean is 1.89, rounded off to 2. For the comparison of A13 Witness to important events and A14 The addition and completion of historical documents, 58 people chose 3 and the least number of people chose 9, which was 2. The arithmetic mean was calculated to be 2.01, rounded off to 2. In the comparison between A13 Witness to important events and A15 Uniqueness and scarcity, 56 people chose 1/3 and 4 people chose 1/7. The arithmetic mean was calculated to be 1.73, rounded off to 2.

For the comparison between A13 Witness to important events and A16 Completeness, 60 people chose 3 and one person chose 9. The arithmetic mean was calculated to be 1.93, rounded off the number to 2. In the comparison between A14 The addition and completion of historical documents and A15 Uniqueness and scarcity, 77 people thought 1/3 and 2 people thought 9. The arithmetic mean was calculated to be 1.76, rounded off number to 2. For the comparison between A14 The addition and completion of historical documents and A16 Completeness, 68 people thought 3 and only 1 thought 9. The arithmetic mean was calculated to be 1.96, rounded off the number to 2. In the comparison of A15 Uniqueness and scarcity and A16 Completeness, 55 people thought 1, 56 people chose 3 and two people chose 9. The arithmetic mean was calculated to be 1.94, rounded off to 2.

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 8).

Table B. 7. Questionnaire Results on the Importance of Derived Value

Topic\ Options	**1/9**	**1/7**	**1/5**	**1/3**	**1**	**3**	**5**	**7**	**9**
A11 Date of construction of heritage/A12 Witness of social development level	1 (0.47%)	3 (1.42%)	14 (6.6%)	48 (22.64%)	34 (16.04%)	80 (37.74%)	25 (11.79%)	5 (2.36%)	2 (0.94%)
A11 The date of construction of the heritage /A13 Witness of important events	2 (0.94%)	7 (3.3%)	22 (10.38%)	62 (29.25%)	42 (19.81%)	55 (25.94%)	13 (6.13%)	6 (2.83%)	3 (1.42%)
A11 Date of construction of heritage /	6 (2.83%)	4 (1.89%)	15 (7.08%)	47 (22.17%)	32 (15.09%)	69 (32.55%)	29 (13.68%)	7 (3.3%)	3 (1.42%)

A14 The addition and completion of historical documents									
A11 The date of construction of the heritage / A15 Uniqueness and Scarcity	3 (1.42%)	6 (2.83%)	16 (7.55%)	59 (27.83%)	48 (22.64%)	58 (27.36%)	11 (5.19%)	10 (4.72%)	1 (0.47%)
A11 The date of construction of the heritage /A16 Integrity	5 (2.36%)	3 (1.42%)	18 (8.49%)	54 (25.47%)	49 (23.11%)	57 (26.89%)	17 (8.02%)	8 (3.77%)	1 (0.47%)
A12 Witness of social development level/A13 Witness of important events	3 (1.42%)	3 (1.42%)	19 (8.96%)	49 (23.11%)	45 (21.23%)	63 (29.72%)	22 (10.38%)	4 (1.89%)	4 (1.89%)
A12 Witness of social development level/A14 A14 The addition and completion of historical documents	3 (1.42%)	5 (2.36%)	21 (9.91%)	36 (16.98%)	50 (23.58%)	70 (33.02%)	19 (8.96%)	8 (3.77%)	0 (0%)
A12 Witness of social development level/A15 Uniqueness and scarcity	4 (1.89%)	5 (2.36%)	19 (8.96%)	60 (28.3%)	46 (21.7%)	58 (27.36%)	11 (5.19%)	8 (3.77%)	1 (0.47%)

A12 Witness of social development level/A16 Integrity	2 (0.94%)	7 (3.3%)	13 (6.13%)	62 (29.25%)	45 (21.23%)	60 (28.3%)	14 (6.6%)	5 (2.36%)	4 (1.89%)
A13 Witness of important events/ A14 The addition and completion of historical documents	5 (2.36%)	7 (3.3%)	17 (8.02%)	54 (25.47%)	38 (17.92%)	58 (27.36%)	22 (10.38%)	9 (4.25%)	2 (0.94%)
A13 Witness of important events/A15 Uniqueness and scarcity	5 (2.36%)	4 (1.89%)	24 (11.32%)	56 (26.42%)	46 (21.7%)	53 (25%)	15 (7.08%)	9 (4.25%)	0 (0%)
A13 Witness of Significant Events/A16 Integrity	4 (1.89%)	9 (4.25%)	19 (8.96%)	48 (22.64%)	43 (20.28%)	60 (28.3%)	20 (9.43%)	8 (3.77%)	1 (0.47%)
A14 The addition and completion of historical documents /A15 Uniqueness and scarcity	3 (1.42%)	5 (2.36%)	16 (7.55%)	77 (36.32%)	36 (16.98%)	47 (22.17%)	17 (8.02%)	9 (4.25%)	2 (0.94%)
A14 The addition and completion of historical documents /A16 Integrity	3 (1.42%)	6 (2.83%)	17 (8.02%)	47 (22.17%)	46 (21.7%)	68 (32.08%)	16 (7.55%)	8 (3.77%)	1 (0.47%)
A15 Uniqueness and scarcity/A16 Integrity	6 (2.83%)	5 (2.36%)	12 (5.66%)	50 (23.58%)	55 (25.94%)	56 (26.42%)	16 (7.55%)	10 (4.72%)	2 (0.94%)

Table B. 8. The Historical Value of the Detail Layer

Evaluation indicators	A11	A12	A13	A14	A15	A16	Wi
A11	1	2	2	2	2	2	0.2803
A12	1/2	1	1	1/2	2	2	0.1573
A13	1/2	1	1	1/2	1/2	1/2	0.0991
A14	1/2	2	2	1	2	1	0.1982
A15	1/2	1/2	2	1/2	1	2	0.1402
A16	1/2	1/2	2	1	1/2	1	0.1249

From Table B. 8, λ_{max}=6.3808, CI=0.0762, RI=1.24, CR=0.0614, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [32.0000, 1.0000, 0.0625, 4.0000, 0.5000, 0.2500]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.7818, 1.0000, 0.6300, 1.2599, 0.8909, 0.7937]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.2803, 0.1573, 0.0991, 0.1982, 0.1402, 0.1249]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/6 \times 38.2849 = 6.3808$$

In the formula,

Bw_i=[1.7197, 1.0258, 0.6282, 1.2564, 0.9060, 0.8102]

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{\max} - n}{n-1} = (6.3808-6)/(6-1) = 0.0762$$

The RI table shows that when the judgement matrix n=6, the RI is 1.24.

The average consistency was calculated to be,

$CR = \frac{CI}{RI}$ =0.0762/1.24=0.0614<0.1. It is known to have passed consistency.

The detail layer of scientific and technological value contains a total of three factor layers (A21 Industrial buildings and equipment, A22 Production processes, and A23 Technological representativeness).

The results of the questionnaire (Table B. 9) on the comparison of the detail layer of scientific and technological value show that in the comparison of A21 Industrial buildings and equipment and A22 Production processes, 76 people chose 3 and the same number of people chose 1, with 3. The number of people who chose 1 and 3 was the same, with 43 people. The smallest number of people chose 1/9, at 3. Their arithmetic mean is 2.30, rounding off to 2.

In the comparison between A21 Industrial buildings and equipment and A23 Technological representativeness, 65 people chose 1/3, 49 chose 3 and only 3 people chose 9. Their arithmetic mean is 1.80, rounding off to 2.

In comparing A22 Production processes and A23 Technological representativeness, the same number of people think 1/3 as 3, which is 58, and the least number of people think 9, which is 2. The arithmetic mean is calculated to be 1.99, by rounding off to 2.

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 10).

Table B. 9. Questionnaire Results on the Importance of Scientific and Technological Value

Topic\Options	1/9	1/7	1/5	1/3	1	3	5	7	9
A21 Industrial Buildings and Equipment/A22 Production Processes	3 (1.42%)	6 (2.83%)	8 (3.77%)	43 (20.28%)	43 (20.28%)	76 (35.85%)	20 (9.43%)	9 (4.25%)	4 (1.89%)
A21 Industrial Buildings and Equipment/A23 Technical Representation	4 (1.89%)	7 (3.3%)	17 (8.02%)	65 (30.66%)	42 (19.81%)	49 (23.11%)	18 (8.49%)	7 (3.3%)	3 (1.42%)
A22 Production Process/A23 Technical Representation	4 (1.89%)	3 (1.42%)	14 (6.6%)	58 (27.36%)	45 (21.23%)	58 (27.36%)	17 (8.02%)	11 (5.19%)	2 (0.94%)

Table B. 10. The Scientific and Technological Value of the Detail Layer

Evaluation indicators	**A21** Industrial buildings and equipment	**A22** Production processes	**A23** Technological representativeness	Wi
A21 Industrial buildings and equipment	1	2	2	0.4934
A22 Production processes	1/2	1	1/2	0.1958
A23 Technological representativeness	1/2	2	1	0.3108

From

Table B. **10**, λ_{max}=3.0536, CI=0.0268, RI=0.58, CR=0.0462, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [4.0000, 0.2500, 1.0000]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.5874, 0.6300, 1.0000]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.4934, 0.1958, 0.3108]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/3 \times 9.1609 = 3.0536$$

In the formula,

$$Bw_i = [1.5066, 0.5979, 0.9491]$$

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{max} - n}{n - 1} = (3.0536-3)/(3-1) = 0.0268$$

The RI table shows that when the judgement matrix n=3, the RI is 0.58.

The average consistency was calculated to be,

$CR = \frac{CI}{RI}$ = 0.0268/0.58=0.0462<0.1. It is known to have passed consistency.

The detail layer of cultural value contains a total of three layers (A31 Positive energy value, A32 Negative energy value, and A33 Neutral energy value).

Regarding the results of the questionnaire (Table B. 11) comparing emotional value, it can be found that in the comparison between A31 Positive energy value and A32 Negative energy value, 74 people chose 3, 2 persons of each choose 9 and 1/9. The arithmetic mean is calculated to be 2.27, rounded off to 2. In the comparison between the A31 Positive energy value and A33 Neutral energy value, 60 people thought 3 and 1 person thought 9. The arithmetic mean was calculated to be 1.92, rounded off the number to 2. For a comparison of the A32 Negative energy value and A33 Neutral energy value, 71 people thought 1/3 and only 1 person thought 1/9. The arithmetic mean was calculated to be 1.82, rounded off the number to 2.

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 12).

Table B. 11. Questionnaire Results on the Importance of Cultural Value

Topic\Options	1/9	1/7	1/5	1/3	1	3	5	7	9
A31 Positive energy value/A32 Negative energy value	2 (0.94%)	7 (3.3%)	17 (8.02%)	42 (19.81%)	35 (16.51%)	74 (34.91%)	22 (10.38%)	11 (5.19%)	2 (0.94%)
A31 Positive energy value/A33 Other cultural value	3 (1.42%)	8 (3.77%)	16 (7.55%)	57 (26.89%)	38 (17.92%)	60 (28.3%)	23 (10.85%)	6 (2.83%)	1 (0.47%)
A32 Negative energy values/A33 Other cultural values	1 (0.47%)	3 (1.42%)	22 (10.38%)	71 (33.49%)	38 (17.92%)	51 (24.06%)	13 (6.13%)	8 (3.77%)	5 (2.36%)

Table B. 12. The Cultural Value of the Detail Layer

Evaluation indicators	**A31** Positive energy value	**A32** Negative energy value	**A33** Neutral energy value	Wi
A31 Positive energy value	1	2	2	0.4934
A32 Negative energy value	1/2	1	1/2	0.1958
A33 Neutral energy value	1/2	2	1	0.3108

From Table B. 12, λ_{max}=3.0536, CI=0.0268, RI=0.58, CR=0.0462, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [4.0000,\ 0.2500,\ 1.0000]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.5874,\ 0.6300,\ 1.0000]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.4934,\ 0.1958,\ 0.3108]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{\max} = \frac{1}{\mathrm{n}} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/3 \times 9.1609 = 3.0536$$

In the formula,

$$Bw_i=[1.5066, 0.5979, 0.9491]$$

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{max} - n}{n-1} = (3.0536-3)/(3-1)=0.0268$$

The RI table shows that when the judgement matrix n=3, the RI is 0.58.

The average consistency was calculated to be,

$CR = \frac{CI}{RI}$ =0.0268/0.58=0.0462<0.1. It is known to have passed consistency.

The detail layer of artistic value contains a total of three factor layers (A41 Aesthetic landscape value, A42 The value of the artwork and A43 The level of artistic style expression).

Regarding the results of the questionnaire (Table B. 13) comparing the detail layer in artistic value, it can be found that in the comparison of A41 Aesthetic landscape value and A42 The value of the artwork, 73 people chose 3, 55 people chose 1/3 and 2 people chose 9. The arithmetic mean is calculated to be 2.45, rounded off the number to 2.

In the comparison between A41 Aesthetic landscape value and A43 The level of artistic style expression, 71 people chose 1/3. Only 1 person chose 1/9. The arithmetic mean was calculated to be 1.17, rounded off the number to 1. For the comparison of A42 The value of the artwork and A43 The level of artistic style expression, 71 people chose 1/3 and the least number of people chose 9, which was 2. The arithmetic mean is calculated to be 1.86, rounded off the number to 2.

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 14).

Table B. 13. Questionnaire Results on the Importance of Artistic Value

Topic\Options	1/9	1/7	1/5	1/3	1	3	5	7	9
A41 Aesthetic Value of Landscape / A42 Value of Artwork	3 (1.42%)	5 (2.36%)	10 (4.72%)	55 (25.94%)	34 (16.04%)	73 (34.43%)	22 (10.38%)	8 (3.77%)	2 (0.94%)
A41 Aesthetic Value of Landscape / A43 Level of Expression of Artistic Style	1 (0.47%)	6 (2.83%)	23 (10.85%)	71 (33.49%)	48 (22.64%)	36 (16.98%)	17 (8.02%)	8 (3.77%)	2 (0.94%)
A42 Value of artwork / A43 Level of expression of artistic style	4 (1.89%)	6 (2.83%)	11 (5.19%)	71 (33.49%)	47 (22.17%)	45 (21.23%)	17 (8.02%)	9 (4.25%)	2 (0.94%)

Table B. 14. The Artistic Value of the Detail Layer

Evaluation indicators	**A41** Aesthetic landscape value	**A42** The value of the artwork	**A43** The level of artistic style expression	Wi
A41 Aesthetic landscape value	1	2	2	0.4934
A42 The value of the artwork	1/2	1	1/2	0.1958
A43 The level of artistic style expression	1/2	2	1	0.3108

From Table B. 14, λ_{max}=3.0536, CI=0.0268, RI=0.58, CR=0.0462, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [4.0000,\ 0.2500,\ 1.0000]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.5874,\ 0.6300,\ 1.0000]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.4934,\ 0.1958,\ 0.3108]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{\max} = \frac{1}{\mathrm{n}} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/3 \times 9.1609 = 3.0536$$

In the formula,

$$Bw_i = [1.5066,\ 0.5979,\ 0.9491]$$

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{\max} - n}{n - 1} = (3.0536-3)/(3-1) = 0.0268$$

The RI table shows that when the judgement matrix n=3, the RI is 0.58.

The average consistency was calculated to be,

$CR = \frac{CI}{RI} = 0.0268/0.58 = 0.0462 < 0.1$. It is known to have passed consistency.

The detail layer of location value contains a total of 3 factor layers (B11 Distance from the city centre, B12 Transport situation to the city centre and B13 The number of central cities or tourist areas in the wider regional context).

The results of the questionnaire (Table B. 15) on the comparison of the indicator layers under locational value show that in the comparison between B11 Distance from the city centre and B12 Transport situation to the city centre, 74 people chose 3 and 58 people chose 1/3. There are the same number of people choosing 1/9 and 9, respectively 2. According to the calculation, its arithmetic mean is 2.08, rounded off the number to 2. In the comparison of B11 Distance from the city centre and B13 The number of central cities or tourist areas in the wider regional context, the highest number of choices was 3, with 60 people, and 50 people chose 1/3. The least number of people chose 1/9 with 1. The arithmetic mean is calculated to be 2.00, rounded off the number to 2. Comparing B12 Transport situation to the city centre and B13 The number of central cities or tourist areas in the wider regional context, the largest number of people chose 1/3 with 60 people, which is 2 more than those who chose 3. The number of people choosing 1/9 was the lowest, which was 2. The arithmetic mean is calculated to be 1.96, rounded off the number to 2.

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 16).

Table B. 15. Questionnaire Results on the Importance of Location Value

Topic\Options	1/9	1/7	1/5	1/3	1	3	5	7	9
B11 distance to city center/B12 traffic conditions to city center	2 (0.94%)	5 (2.36%)	11 (5.19%)	58 (27.36%)	34 (16.04%)	74 (34.91%)	19 (8.96%)	7 (3.3%)	2 (0.94%)
B11 Distance to city center/B13 Number of central cities or tourist areas	1 (0.47%)	10 (4.72%)	18 (8.49%)	50 (23.58%)	43 (20.28%)	60 (28.3%)	17 (8.02%)	11 (5.19%)	2 (0.94%)

within a larger area									
B12 Traffic conditions to the city center/B13 Number of central cities or tourist areas within a larger area	2 (0.94%)	7 (3.3%)	12 (5.66%)	60 (28.3%)	45 (21.23%)	58 (27.36%)	17 (8.02%)	6 (2.83%)	5 (2.36%)

Table B. 16. The Location Value of the Detail Layer

Evaluation indicators	**B11** Distance from the city centre	**B12** Transport situation to the city centre	**B13** The number of central cities or tourist areas in the wider regional context	Wi
B11 Distance from the city centre	1	2	2	0.4934
B12 Transport situation to the city centre	1/2	1	1/2	0.1958
B13 The number of central cities or tourist areas in the wider regional context	1/2	2	1	0.3108

From Table B. 16, λ_{max}=3.0536, CI=0.0268, RI=0.58, CR=0.0462, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [4.0000, 0.2500, 1.0000]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.5874, 0.6300, 1.0000]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.4934, 0.1958, 0.3108]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/3 \times 9.1609 = 3.0536$$

In the formula,

$$Bw_i = [1.5066, 0.5979, 0.9491]$$

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{\max} - n}{n-1} = (3.0536-3)/(3-1) = 0.0268$$

The RI table shows that when the judgement matrix n=3, the RI is 0.58.

The average consistency was calculated to be,

$CR = \frac{CI}{RI}$ =0.0268/0.58=0.0462<0.1. It is known to have passed consistency.

The detail layer of environmental value contains a total of 2 factor layers (B21 The impact of the original production function of industrial heritage on the environment and B22 The environmental scope of the industrial heritage).

The results of the questionnaire (Table B. 17) regarding the comparison of the detail layer under environmental values can be found that in the comparison of B21 The impact of the original production function of industrial heritage on the environment and B22 The environmental scope of the comparison of the industrial heritage, 72 people chose 3, which is 33.96% of the total number of people, and 1 person thought 1/9. The arithmetic mean is calculated to be 1.99, rounded off the number to 2

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 18).

Table B. 17. Questionnaire Results on the Importance of Environmental Value

Topic\Options	**1/9**	**1/7**	**1/5**	**1/3**	**1**	**3**	**5**	**7**	**9**
B21 The environmental impact of the original productive functions of the industrial heritage/B22 The extent of the industrial heritage	1 (0.47%)	10 (4.72%)	12 (5.66%)	57 (26.89%)	35 (16.51%)	72 (33.96%)	14 (6.6%)	11 (5.19%)	0 (0%)

Table B. 18. The Environmental Value of the Detail Layer

Evaluation indicators	**B21** The impact of the original production function of industrial heritage on the environment	**B22** The environmental scope of the industrial heritage	Wi
B21 The impact of the original production function of industrial heritage on the environment	1	2	0.6667
B22 The environmental scope of the industrial heritage	1/2	1	0.3333

From Table B. 18, λ_{max}=2.0000, CI=0.0000, RI=0, CR=0.0000, with satisfactory agreement.

The table shows that the B21 is twice as large as B22, which gives a weighting of 0.67 and 0.33 respectively.

The detail layer of group value contains of 3 factor layers (B31 The scale of the group, B32 Relationship of the group and B33 The potential for wide-scale groups of industrial heritage).

According to the results of the questionnaire (Table B. 19) on the comparison of the detail layer under group value, it can be found that in the comparison between B31 The scale of the group and B32 Relationship of the group, 67 people chose 3 and 58 people chose 1/3. The least number of people who chose 9 was 1. According to the calculation, its arithmetic mean is 1.99, rounded off the number to 2. In the comparison of B31 The scale of the group and B33 The potential for wide-scale groups of industrial heritage, 73 people chose 1/3, 51 people chose 3 and only 1 person chose 9. The arithmetic mean is 1.63, rounded off the number to 2. In the comparison between B32 Relationship of the group and B33 The potential for wide-scale groups of industrial heritage, 70 people chose 1/3, 40 people chose 1 and only 2 people chose 9. The arithmetic mean was calculated as 1.78, rounded off the number to 2.

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 20).

Table B. 19. Questionnaire Results on the Importance of Group Value

Topic\Options	**1/9**	**1/7**	**1/5**	**1/3**	**1**	**3**	**5**	**7**	**9**
B31 The scale of the group / B32 Relationship of the group	2 (0.94%)	6 (2.83%)	14 (6.6%)	58 (27.36%)	38 (17.92%)	67 (31.6%)	19 (8.96%)	7 (3.3%)	1 (0.47%)

B31 The scale of the group / B33 The potential for wide-scale groups of industrial heritage	3 (1.42%)	8 (3.77%)	14 (6.6%)	73 (34.43%)	43 (20.28%)	51 (24.06%)	11 (5.19%)	8 (3.77%)	1 (0.47%)
B32 Relationship of the group / B33 The potential for wide-scale groups of industrial heritage	4 (1.89%)	4 (1.89%)	15 (7.08%)	70 (33.02%)	40 (18.87%)	56 (26.42%)	11 (5.19%)	10 (4.72%)	2 (0.94%)

Table B. 20. The Group Value of the Detail Layer

Evaluation indicators	**B31** The scale of the group	**B32** Relationship of the group	**B33** The potential for wide-scale groups of industrial heritage	Wi
B31 The scale of the group	1	2	2	0.4934
B32 Relationship of the group	1/2	1	1/2	0.1958
B33 The potential for wide-scale groups of industrial heritage	1/2	2	1	0.3108

From Table B. 20, λ_{max}=3.0536, CI=0.0268, RI=0.58, CR=0.0462, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [4.0000, 0.2500, 1.0000]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.5874, 0.6300, 1.0000]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.4934, 0.1958, 0.3108]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{\max} = \frac{1}{\text{n}} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/3 \times 9.1609 = 3.0536$$

In the formula,

$$Bw_i = [1.5066, 0.5979, 0.9491]$$

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{\max} - n}{n-1} = (3.0536-3)/(3-1) = 0.0268$$

The RI table shows that when the judgement matrix n=3, the RI is 0.58.

The average consistency was calculated to be,

$CR = \frac{CI}{RI} = 0.0268/0.58 = 0.0462 < 0.1$. It is known to have passed consistency.

The detail layer of social value contains 4 factor layers (B41 The ability to solve re-employment, B42 Educational function, B43 The potential to provide a place of leisure for the public and B44 Enhancing the image or symbolism of the city).

The results of the questionnaire (Table B. 21) on the comparison of the detail layer under social values show that in the comparison between B41 The ability to solve re-employment and B42 Educational function, 62 people chose 3 and 56 people chose 1/3.

One person chose 9. The arithmetic mean was calculated as 1.92, rounded off the number to 2. In the comparison of B41 The ability to solve re-employment and B43 The potential to provide a place of leisure for the public, 57 people thought 1/3, the same number of people thought 1 and 3 which was 49, and one person chose 9. According to the calculation, their arithmetic mean is 1.85, rounded off the number to 2. Among the comparisons of B41 The ability to solve re-employment and B44 Enhancing the image or symbolism of the city, 64 people chose 1/3 and only 1 person thought 1/9. According to the calculation, their arithmetic mean is 1.86, rounded off the number to 2.

In the comparison between B42 Educational function and B43 The potential to provide a place of leisure for the public, 65 people chose 3 and 59 chose 1/3 and only 2 people chose 1/9. According to the calculation, their arithmetic mean is 2.10, rounded off the number to 2. In the comparison of B42 Educational function and B44 Enhancing the image or symbolism of the city, 64 people chose 3 and 56 chose 1/3. The same number of people chose 9 as 7, which was 4. The arithmetic mean is calculated to be 2.10, rounded off the number to 2. In the comparison of B43 The potential to provide a place of leisure for the public and B44 Enhancing the image or symbolism of the city, 57 people chose 1/3. The same number of people chose 9 and 1/9, which was 2. According to the calculation, its arithmetic mean is 1.84, rounded off the number to 2.

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 22).

Table B. 21. Questionnaire Results on the Importance of Social Value

Topic\Options	1/9	1/7	1/5	1/3	1	3	5	7	9
B41 Ability to solve reemployment/B42 Educational function	0 (0%)	11 (5.19 %)	13 (6.13 %)	56 (26.42%)	43 (20.28%)	62 (29.25%)	18 (8.49 %)	8 (3.77 %)	1 (0.47 %)
B41 Ability to address reemployment/B43 Potential to provide leisure to the public	3 (1.42 %)	5 (2.36 %)	20 (9.43 %)	57 (26.89%)	49 (23.11%)	49 (23.11%)	16 (7.55 %)	12 (5.66 %)	1 (0.47 %)

B41 Ability to address reemployment/B44 Enhance the city’s image or symbolism	1 (0.47 %)	7 (3.3%)	17 (8.02 %)	64 (30.19%)	39 (18.4%)	56 (26.42%)	19 (8.96 %)	7 (3.3%)	2 (0.94 %)
B42 Educational functions/B43 Potential to provide recreational spaces for the public	2 (0.94 %)	5 (2.36 %)	14 (6.6%)	59 (27.83%)	36 (16.98%)	65 (30.66%)	18 (8.49 %)	8 (3.77 %)	5 (2.36 %)
B42 Educational function/B44 Enhance the image or symbolism of the city	0 (0%)	6 (2.83 %)	15 (7.08 %)	56 (26.42%)	37 (17.45%)	64 (30.19%)	26 (12.26 %)	4 (1.89 %)	4 (1.89 %)
B43 Potential to provide leisure to the public/B44 Enhance the image or symbolism of the city	2 (0.94 %)	9 (4.25 %)	18 (8.49 %)	57 (26.89%)	47 (22.17%)	53 (25%)	13 (6.13 %)	11 (5.19 %)	2 (0.94 %)

Table B. 22. The social value of the detail layer

Evaluation indicators	**B41** The ability to solve re-employment	**B42** Educational function	**B43** The potential to provide a place of leisure for the public	**B44** Enhancing the image or symbolism of the city	Wi
B41 The ability to solve re-employment	1	2	2	2	0.3976
B42 Educational function	1/2	1	1	2	0.2364
B43 The potential to provide a place of leisure for the public	1/2	1	1	1/2	0.1672
B44 Enhancing the image or symbolism of the city	1/2	1/2	2	1	0.1988

From Table B. 22, λ_{max}=4.1836, CI=0.0612, RI=0.9, CR=0.0680, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_{\mathrm{i}} = \prod_{j=1} b_{ij} = [8.0000, 1.0000, 0.2500, 0.5000]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.6818, 1.0000, 0.7071, 0.8409]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.3976, 0.2364, 0.1672, 0.1988]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{\max} = \frac{1}{\mathrm{n}} \sum_{i=1}^{n} \frac{(Bw)_i}{w_i} = 1/4 \times 16.7343 = 4.1836$$

In the formula,

Bw_i=[1.6024, 1.0000, 0.7018, 0.8502]

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{\max} - n}{n-1} = (4.1836-4)/(4-1) = 0.0612$$

The RI table shows that when the judgement matrix n=4, the RI is 0.9.

The average consistency was calculated to be,

$CR = \frac{CI}{RI}$ =0.0612/0.9=0.0680<0.1. It is known to have passed consistency.

The detail layer of emotional value contains 3 factor layers (B51 Number of people who have an emotional connection to industrial heritage, B52 The age range of the people who have an emotional connection to industrial heritage and B53 Characteristics of the careers of people with emotional value).

The results of the questionnaire (Table B. 23) regarding the comparison of the detail layer of emotional values can be found in the comparison between B51 and B52, where 77 people chose 3 and 45 chose 1/3. The same number of people chose 9 as 9/1 which is 1. According to the calculation, its arithmetic mean is 2.23, rounded off the number to 2. In the comparison between B51 and B53, 62 people chose 1/3 and 52 people chose 3. The arithmetic mean was calculated to be 1.86, rounded off the number to 2.

In the comparison between B52 and B53, 64 people chose 3, 60 people chose 1/3 and the least number of people chose 9, which was 2. The arithmetic mean of this is calculated to be 1.86, rounded off the number to 2.

The judgement matrix, based on the questionnaire data and its importance comparison, is as follows (Table B. 24).

Table B. 23. Questionnaire Results on the Importance of Emotional Value

Topic\Options	1/9	1/7	1/5	1/3	1	3	5	7	9
B51 Number of people who have an emotional connection to industrial heritage /B52 The age range of the people who have an emotional connection to industrial heritage	1 (0.47%)	4 (1.89%)	15 (7.08%)	45 (21.23%)	40 (18.87%)	77 (36.32%)	14 (6.6%)	15 (7.08%)	1 (0.47%)

B51 Number of people who have an emotional connection to industrial heritage / B53 Characteristics of the careers of people with emotional value emotional value	1 (0.47%)	7 (3.3%)	16 (7.55%)	62 (29.25%)	44 (20.75%)	52 (24.53%)	21 (9.91%)	8 (3.77%)	1 (0.47%)
B52 The age range of the people who have an emotional connection to industrial heritage / B53 Characteristics of the careers of people with emotional value	4 (1.89%)	6 (2.83%)	12 (5.66%)	60 (28.3%)	44 (20.75%)	64 (30.19%)	12 (5.66%)	8 (3.77%)	2 (0.94%)

Table B. 24. The Emotional Value of the Detail Layer

Evaluation indicators	**B51** Number of people who have an emotional connection to industrial heritage	**B52** The age range of the people who have an emotional connection to industrial heritage	**B53** Characteristics of the careers of people with emotional value	Wi
B51 Number of people who have an emotional connection to industrial heritage	1	2	2	0.4934
B52 The age range of the people who have an emotional connection to industrial heritage	1/2	1	2	0.3108
B53 Characteristics of the careers of people with emotional value	1/2	1/2	1	0.1958

From Table B. 24, λ_{max}=3.0536, CI=0.0268, RI=0.58, CR=0.0462, CR<0.1, with satisfactory agreement.

The detailed procedure for calculating the weights of this judgement matrix is shown below.

Firstly, the product of the elements of each row of the judgement matrix is first calculated,

$$m_i = \prod_{j=1} b_{ij} = [4.0000, 1.0000, 0.2500]$$

Then, calculate the Nth root of,

$$w_i^* = \sqrt[n]{m_i} = [1.5874, 1.0000, 0.6300]$$

Further, normalise the vectors,

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* = [0.4934, 0.3108, 0.1958]$$

Where the maximum eigenvalue λmax is calculated as,

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(Bw)_i}{w_i} = 1/3 \times 9.1609 = 3.0536$$

In the formula,

$$Bw_i = [1.5066, 0.9491, 0.5979]$$

The consistency indicator CI was obtained as,

$$CI = \frac{\lambda_{max} - n}{n-1} = (3.0536-3)/(3-1) = 0.0268$$

The RI table shows that when the judgement matrix n=3, the RI is 0.58.

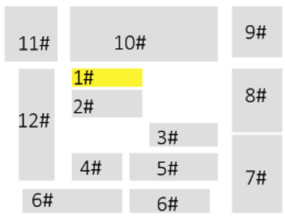
The average consistency was calculated to be,

$CR = \frac{CI}{RI} = 0.0268/0.58 = 0.0462 < 0.1$. It is known to have passed consistency.

Appendix C

Appendix C shows the Field Survey Sheet for the Shaanxi Old Steel Factory.

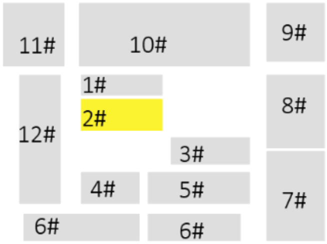
Table C. 1. Table of a Survey of the 1# Building of the Shaanxi Old Steel Factory

Name of building	Current name	1# Building	Physical condition
	Former name	Slender wire workshop	
Area of the building (m^2)	570 m^2 (Length 47.9m, Width 11.9m, Height 9.1m) (Data accessed through factory signage on 20 May 2022)		
Build Date	1965		
Date of reuse	02/2014		
Current use	Museum (Xi'an City Memory Museum)		
Original use	Workshop for the production of slender steel wire		
Location			
Current photo (Source: Author)			
Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber ☒ Brick □ Brick and concrete □ Reinforced concrete □Steel □Other	☒ No observed damage □ Minor damages

	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other		□ Significant damage □_________________
Facade	Colour	Stone Gray		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper ⊠Steel □Wood □Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	⊠Steel □Wood □Other		⊠No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	⊠Gable Roof □Mansard Roof □Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Brick red	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

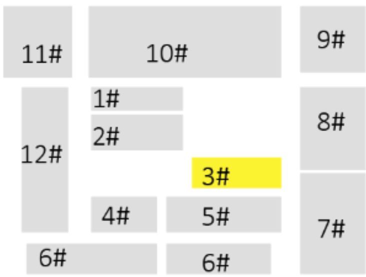
Table C. 2. Table of a Survey of the 2# Building of the Shaanxi Old Steel Factory

Name of building	Current name	2# Building	Physical condition
	Former name	Small gauge wire drawing and oil tempering furnace workshop	
Area of the building (m^2)	774 m^2 (Length 47.2m, Width 16.4m, Height 11.52m) (Data accessed through factory signage on 20 May 2022)		
Build Date	1965		
Date of reuse	03/2015		
Current use	Customized office: Qingkong Mutual Entertainment; Shaanxi Huarui Survey and Design Co.; Basketball training		

Original use	Drawing shops for the production of 2-4 cm diameter wire and tempering of small gauge wire in oil tempering furnaces		
Location			
Current photo (Source: Author)	 		
Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □ Brick ☒ Brick and concrete □ Reinforced concrete □Steel □Other	☒ No observed damage □ Minor damages □ Significant damage □________________
	Column	□ Wooden column ☒ Brick column □ Steel column □ Reinforced concrete column □ Other	
Facade	Colour	White	☒ No observed damage □ Minor damages □ Significant damage □________________
	Material	□Ganged brick □Ceramic tile □Cement □Plastering ☒Other _Clay brick_	

Main entrance/exit	Door materials	□Copper □Steel □Wood □Mixed □Other __Glass___		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	□Rectangular □Round ⊠Arched □Other		
Main facade window	Window frame material	⊠Steel □Wood □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	⊠Gable Roof □Mansard Roof □Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Brick red	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

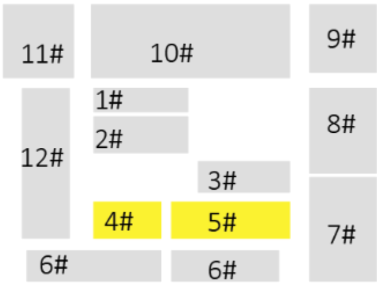
Table C. 3. Table of a Survey of the 3# Building of the Shaanxi Old Steel Factory

Name of building	Current name	3# Building	Physical condition
	Former name	Original exquisite wire grinder workshop	
Area of the building (m^2)	559 m^2 (Length 43m, Width 13m, Height 3.15m) (Data accessed through factory signage on 20 May 2022)		
Build Date	1965		
Date of reuse	02/2015		
Current use	Business		
Original use	Exquisite wire grinder workshop		
Location			

Current photo (Source: Author)			
Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber ☒Brick □ Brick and concrete □ Reinforced concrete □Steel □Other	☒ No observed damage □ Minor damages □ Significant damage □________________
	Column	□ Wooden column ☒ Brick column □ Steel column □ Reinforced concrete column □ Other	
Facade	Colour	Brick red	☒ No observed damage □ Minor damages □ Significant damage □________________
	Material	□Ganged brick □Ceramic tile □Cement □Plastering ☒Other _Clay brick_	
Main entrance/exit	Door materials	□Copper □Steel □Wood □Mixed □Other __Glass____	☒ No observed damage □ Minor damages □ Significant damage □________________
	Shape	☒Rectangular □Round □Arched □Other	
Main facade window	Window frame material	☒Steel □Wood □Other	☒ No observed damage □ Minor damages □ Significant damage □________________
	Shape	☒Rectangular □Round □Arched □Other	
Roof	Form	☒Gable Roof □Mansard Roof □Flat Roof □Other	☒ No observed damage □ Minor damages □ Significant damage □________________
	Roof frame	□Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other	
	Tile/roofing sheets	Colour: Brick red Form: Rectangular	

		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

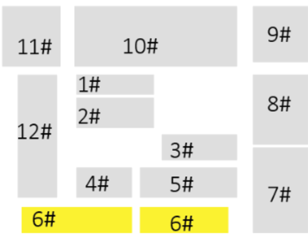
Table C. 4. Table of Survey of the 4# and 5# Building of the Shaanxi Old Steel Factory

Name of building	Current name	4# and 5# Building	Physical condition
	Former name	Former wire drawing workshop	
Area of the building (m^2)	Around 2000 m^2 (Data accessed through factory signage on 20 May 2022)		
Build Date	1965		
Date of reuse	05/2014		
Current use	Business		
Original use	Wire drawing workshop		
Location			
Current photo (Source: Author)			

<table>
<tr><td></td><td colspan="3"></td><td></td></tr>
<tr><td>Building type</td><td colspan="3">□Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other</td><td></td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td colspan="2">□Timber □Brick □ Brick and concrete ⊠ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Column</td><td colspan="2">□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td colspan="2">Brick red</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Material</td><td colspan="2">⊠Ganged brick □Ceramic tile □Cement □Plastering □Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel □Wood □Mixed ⊠ Other __Glass____</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">⊠Steel □Wood □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="3">Roof</td><td>Form</td><td colspan="2">⊠Gable Roof □Mansard Roof □Flat Roof □Other</td><td rowspan="3">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Roof frame</td><td colspan="2">□Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td></td><td>Colour</td><td>Brick red</td></tr>
</table>

	Tile/roofing sheets	Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

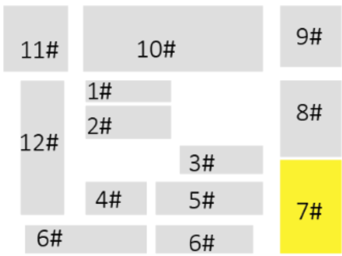
Table C. 5. Table of a Survey of the 6# Building of the Shaanxi Old Steel Factory

<table>
<tr><td rowspan="2">Name of building</td><td>Current name</td><td>6# Building</td><td>Physical condition</td></tr>
<tr><td>Former name</td><td>New equipment workshop</td><td rowspan="8"></td></tr>
<tr><td>Area of the building (m^2)</td><td colspan="2">2040 m^2 (Data accessed through factory signage on 20 May 2022)</td></tr>
<tr><td>Build Date</td><td colspan="2">1965</td></tr>
<tr><td>Date of reuse</td><td colspan="2">10/2013</td></tr>
<tr><td>Current use</td><td colspan="2">Business</td></tr>
<tr><td>Original use</td><td colspan="2">New equipment workshop</td></tr>
<tr><td>Location</td><td colspan="2">
</td></tr>
<tr><td>Current photo (Source: Author)</td><td colspan="2"></td></tr>
</table>

				
Building type	□Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other			
Structure	Form	□Timber □Brick □ Brick and concrete ⊠ Reinforced concrete □Steel □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other		
Facade	Colour	Brick red		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel □Wood □Mixed ⊠ Other __Glass____		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	⊠Steel □Wood □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	⊠Gable Roof □Mansard Roof □Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	□Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Brick red	
		Form	Rectangular	
		Material	Clay tile	

	Lantern roof	□Yes ⊠No	
	Chimneys	□Yes, Quantity:______ ⊠No	

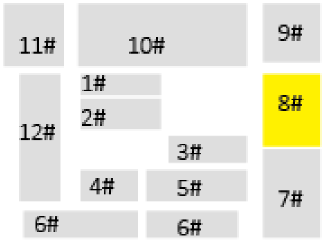
Table C. 6. Table of a Survey of the 7# Building of the Shaanxi Old Steel Factory

Name of building	Current name	7# Building	Physical condition
	Former name	Packaging workshop	
Area of the building (m^2)	1369.5 m^2 (Length 41.5m, Width 33m, Height 8.9m and 10.8m) (Data accessed through factory signage on 22 May 2022)		
Build Date	1965		
Date of reuse	01/2015		
Current use	Business		
Original use	Packaging workshop		
Location			
Current photo (Source: Author)			
Building type	□Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □Brick □ Brick and concrete ⊠ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages

	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other		□ Significant damage □_________________
Facade	Colour	Brick red		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel □Wood □Mixed ⊠ Other __Glass____		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	⊠Steel □Wood □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof ⊠Other M Shaped Roof		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Roof frame	□Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Brick red	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

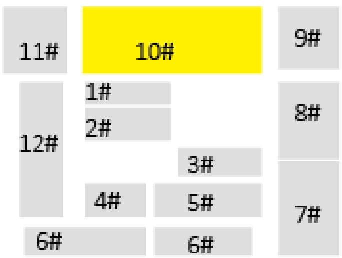
Table C. 7. Table of Survey of the 8# Building of the Shaanxi Old Steel Factory

Name of building	Current name	8# Building	Physical condition
	Former name	Finished steel wire storage workshop	
Area of the building (m^2)	1353 m^2 (Data accessed through factory signage on 22 May 2022)		
Build Date	1965		
Date of reuse	01/2015		
Current use	Office space		
Original use	Finished steel wire storage workshop		

Location			
Current photo (Source: Author)			
Building type	□Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □Brick □ Brick and concrete ⊠ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other	
Facade	Colour	Brick red	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other ____	

Main entrance/exit	Door materials	□Copper □Steel □Wood □Mixed ⊠ Other __Glass____		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	⊠Steel □Wood □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Brick red	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

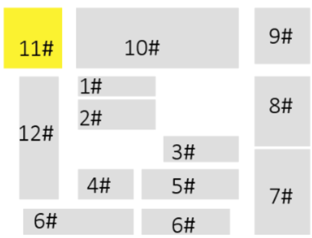
Table C. 8. Table of Survey of the 10# Building of the Shaanxi Old Steel Factory

Name of building	Current name	10# Building	Physical condition
	Former name	Heat treatment workshop	
Area of the building (m^2)	2878 m^2 (Data accessed through factory signage on 22 May 2022)		
Build Date	1958		
Date of reuse	04/2015		
Current use	Art Communication Centre		
Original use	East of Heat treatment workshop		
Location	 		

Current photo (Source: Author)			
Building type	☐Single storey plant ⊠ Multi storey plant ☐ Single storey warehouse ☐ Multi storey warehouse ☐ Other		
Structure	Form	☐Timber ☐Brick ☐ Brick and concrete ⊠ Reinforced concrete ☐Steel ☐Other	⊠ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Column	☐ Wooden column ☐ Brick column ☐ Steel column ⊠ Reinforced concrete column ☐ Other	
Facade	Colour	Brick red	⊠ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Material	⊠Ganged brick ☐Ceramic tile ☐Cement ☐Plastering ☐Other	
Main entrance/exit	Door materials	☐Copper ☐Steel ☐Wood ☐Mixed ⊠ Other __Glass____	⊠ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Shape	⊠Rectangular ☐Round ☐Arched ☐Other	
Main facade window	Window frame material	⊠Steel ☐Wood ☐Other	⊠ No observed damage ☐ Minor damages

	Shape	☒Rectangular ☐Round ☐Arched ☐Other		☐ Significant damage ☐_________________
Roof	Form	☐Gable Roof ☐Mansard Roof ☒Flat Roof ☐Other		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_________________
	Roof frame	☒Timber Roof Frame ☐Steel Roof Frame ☐Steel Reinforced Concrete Roof Frame ☐Other		
	Tile/roofing sheets	Colour	Brick red	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	☐Yes ☒No		
	Chimneys	☐Yes, Quantity:_____ ☒No		

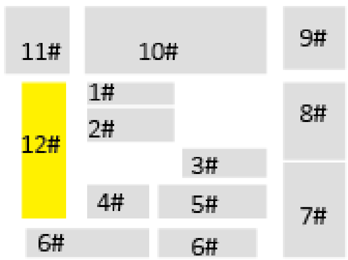
Table C. 9. Table of Survey of the 11# Building of the Shaanxi Old Steel Factory

Name of building	Current name	11# Building	Physical condition
	Former name	Heat treatment workshop	
Area of the building (m^2)	1140 m^2 (Data accessed through factory signage on 20 May 2022)		
Build Date	1965		
Date of reuse	04/2015		
Current use	Business		
Original use	West of Heat treatment workshop		
Location			

Current photo (Source: author)	 		
Building type	□Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □Brick □ Brick and concrete ⊠ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other	
Facade	Colour	Brick red	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering ⊠Other Steel	
Main entrance/exit	Door materials	□Copper □Steel □Wood □Mixed ⊠ Other __Glass____	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other	
Main facade window	Window frame material	⊠Steel □Wood □Other	⊠ No observed damage □ Minor damages

	Shape	☒Rectangular ☐Round ☐Arched ☐Other		☐ Significant damage ☐_______________
Roof	Form	☐Gable Roof ☐Mansard Roof ☒Flat Roof ☐Other		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Roof frame	☐Timber Roof Frame ☐Steel Roof Frame ☐Steel Reinforced Concrete Roof Frame ☐Other		
	Tile/roofing sheets	Colour	Brick red	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	☐Yes ☒No		
	Chimneys	☐Yes, Quantity:_____ ☒No		

Table C. 10. Table of Survey of the 12# Building of the Shaanxi Old Steel Factory

Name of building	Current name	12# Building	Physical condition
	Former name	Pickling workshop	
Area of the building (m^2)	1872 m^2 (Data accessed through factory signage on 20 May 2022)		
Build Date	1965		
Date of reuse	11/2014		
Current use	Old Steel Factory Arts Centre		
Original use	Pickling workshop		
Location			

Current photo (Source: Author)			
Building type	□Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □Brick □ Brick and concrete ⊠ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other	
Facade	Colour	Brick red	⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other	
Main entrance/exit	Door materials	□Copper □Steel □Wood □Mixed ⊠ Other __Glass____	⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other	

Main facade window	Window frame material	⊠Steel □Wood □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Brick red	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:______ ⊠No		

Appendix D

Appendix C shows the Field Survey Sheet for the Wang Shi Wa Coal Mine from the front area of the plant, the production area and the auxiliary production area.

(1) The front area of the plant

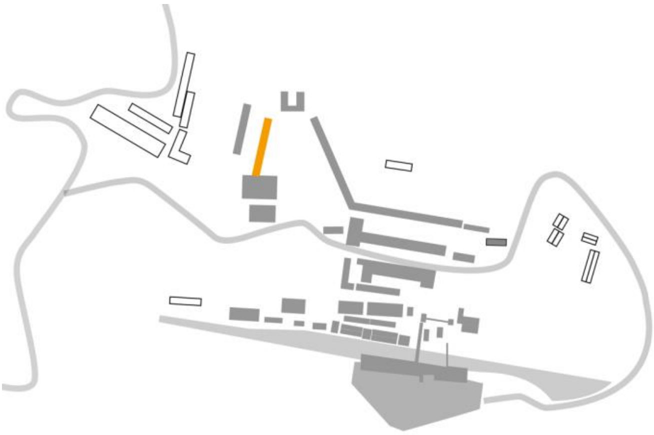
Table D. 1. Table of a Survey of the Miners' Club of the Wang Shi Wa Coal Mine

Name of building	Current name	Miners' Club	Physical condition
	Former name	Miners' Club	
Area of the building (m^2)	4200 m^2. It is approximately 38m wide and 16m high. (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1983		
Date of reuse	In the process of transformation		
Current use	In the process of transformation		
Original use	Workers' leisure space		
Location			

Current photo (Source: Author)				
Building type	☐ Single storey plant ☒ Multi storey plant ☐ Single storey warehouse ☐ Multi storey warehouse ☐ Other			
Structure	Form	☐Timber ☐ Brick ☒ Brick and concrete ☐ Reinforced concrete ☐Steel ☐Other		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Column	☐ Wooden column ☐ Brick column ☐ Steel column ☒ Reinforced concrete column ☐ Other		
Facade	Colour	Light yellow and green		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Material	☐Ganged brick ☒Ceramic tile ☐Cement ☐Plastering ☐Other		
Main entrance/exit	Door materials	☐Copper ☐Steel ☐Wood ☒Mixed ☐Other		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Shape	☒Rectangular ☐Round ☐Arched ☐Other		
Main facade window	Window frame material	☐Steel ☐Wood ☒Other		☒No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Shape	☒Rectangular ☐Round ☐Arched ☐Other		
Roof	Form	☐Gable Roof ☐Mansard Roof ☒Flat Roof ☐Other		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Roof frame	☐Timber Roof Frame ☐Steel Roof Frame ☒Steel Reinforced Concrete Roof Frame ☐Other		
	Tile/roofing sheets	Colour	White	
		Form	Rectangular	
		Material	Brick and concrete	
	Lantern roof	☐Yes ☒No		

	Chimneys	□Yes, Quantity:_____ ⊠No	

Table D. 2. Table of a Survey of the Staff Family Housing of the Wang Shi Wa Coal Mine

Name of building	Current name	Staff family housing	Physical condition
	Former name	Staff family housing	
Area of the building (m^2)	1450 m^2 (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1961		
Date of reuse	In the process of transformation		
Current use	In abandonment		
Original use	Staff accommodation		
Location			
Current photo (Source: Author)			
Building type	□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete	⊠ No observed damage

		□Steel □Other		□ Minor damages □ Significant damage □_______________
	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other		
Facade	Colour	Red		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Material	⊠ Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel □Wood ⊠Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel □Wood ⊠Other		⊠No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Gray	
		Form	Rectangular	
		Material	Brick and concrete	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

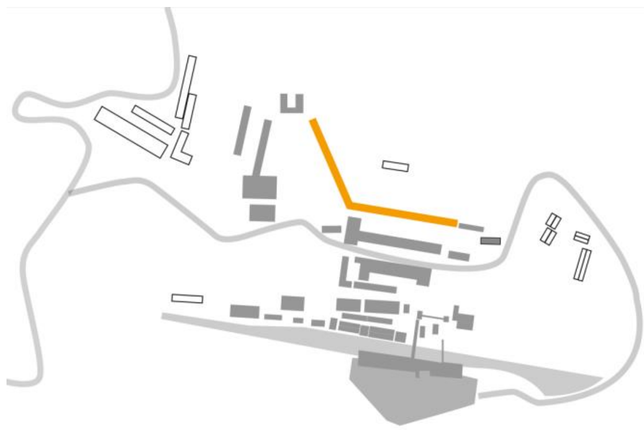
Table D. 3. Table of a Survey of the Cultural Activities Centre of the Wang Shi Wa Coal Mine

Name of building	Current name	Cultural Activities Centre	Physical condition
	Former name	Cultural Activities Centre	
Area of the building (m^2)	It is approximately 800 m^2. (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1987-2007		
Date of reuse	In the process of transformation		

<table>
<tr><td>Current use</td><td colspan="2">In abandonment</td><td rowspan="5"></td></tr>
<tr><td>Original use</td><td colspan="2">Provide a space for cultural and sporting activities</td></tr>
<tr><td>Location</td><td colspan="2"></td></tr>
<tr><td>Current photo (Source: Author)</td><td colspan="2"></td></tr>
<tr><td>Building type</td><td colspan="2">□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other</td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td>□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_________________</td></tr>
<tr><td>Column</td><td>□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td>White and yellow</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_________________</td></tr>
<tr><td>Material</td><td>□Ganged brick ⊠Ceramic tile □Cement □Plastering □Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td>□Copper □Steel □Wood ⊠Mixed □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_________________</td></tr>
<tr><td>Shape</td><td>⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td>Main facade window</td><td>Window frame material</td><td>□Steel □Wood ⊠Other</td><td>⊠No observed damage
□ Minor damages</td></tr>
</table>

	Shape	⊠Rectangular □Round □Arched □Other		□ Significant damage □_______________
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	White	
		Form	Rectangular	
		Material	Brick and concrete	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

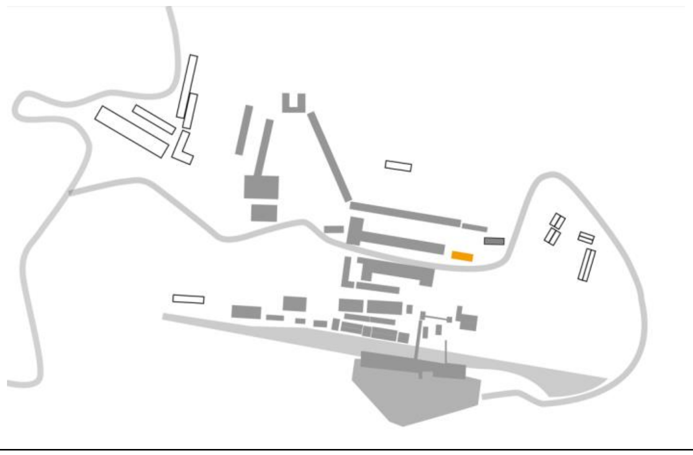
Table D. 4. Table of a Survey of the Soviet-style Single-sided Building of the Wang Shi Wa Coal Mine

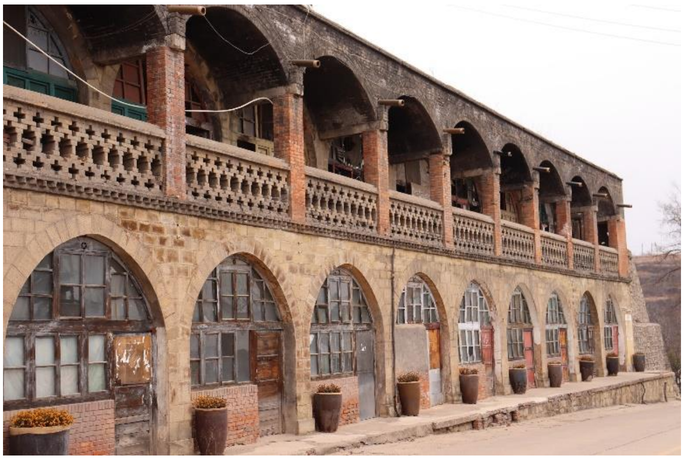
Name of building	Current name	Soviet-style single-sided office building	Physical condition
	Former name	Soviet-style single-sided office building	
Area of the building (m^2)	7065 m² (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1972		
Date of reuse	Partial in use		
Current use	Partial use as office		
Original use	Office building		
Location			

<table>
<tr><td>Current photo (Source: Author)</td><td colspan="2">
</td><td rowspan="2"></td></tr>
<tr><td>Building type</td><td colspan="2">□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other</td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td>□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Column</td><td>□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td>Red</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Material</td><td>□Ganged brick □Ceramic tile □Cement □Plastering ⊠Other <u>Red brick</u></td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td>□Copper □Steel □Wood ⊠Mixed □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td>⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td>□Steel □Wood ⊠Other</td><td rowspan="2">⊠No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td>⊠Rectangular □Round □Arched □Other</td></tr>
</table>

Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Red	
		Form	Rectangular	
		Material	Brick and concrete	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

Table D. 5 Table of a Survey of the Soviet Expert Building of the Wang Shi Wa Coal Mine

Name of building	Current name	Soviet Experts Building	Physical condition
	Former name	Soviet Experts Building	
Area of the building (m^2)	500 m² (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1957		
Date of reuse	In the process of transformation		
Current use	In abandonment		
Original use	Office of the Soviet engineering experts		
Location			

<table>
<tr><td>Current photo (Source: Author)</td><td colspan="3"></td><td rowspan="2"></td></tr>
<tr><td>Building type</td><td colspan="3">□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other</td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td colspan="2">□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Column</td><td colspan="2">□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td colspan="2">Brick Red</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Material</td><td colspan="2">⊠Ganged brick □Ceramic tile □Cement □Plastering □Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel □Wood ⊠Mixed □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel □Wood ⊠Other</td><td rowspan="2">⊠No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">□Rectangular □Round ⊠Arched □Other</td></tr>
<tr><td rowspan="6">Roof</td><td>Form</td><td colspan="2">□Gable Roof □Mansard Roof ⊠Flat Roof □Other</td><td rowspan="6">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Roof frame</td><td colspan="2">□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>Brick Red</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
<tr><td>Material</td><td>Brick and concrete</td></tr>
<tr><td>Lantern roof</td><td colspan="2">□Yes ⊠No</td></tr>
</table>

	Chimneys	□Yes, Quantity:______ ⊠No	

Table D. 6. Table of a Survey of the Administration Building of the Wang Shi Wa Coal Mine

Name of building	Current name	Administration Building	Physical condition
	Former name	Administration Building	
Area of the building (m^2)	2340 m² (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1961		
Date of reuse	In use		
Current use	Office		
Original use	Office		
Location			
Current photo (Source: Author)			
Building type	□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages

<table>
<tr><td></td><td>Column</td><td colspan="2">□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other</td><td>□ Significant damage
□________________</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td colspan="2">White</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Material</td><td colspan="2">□Ganged brick ⊠Ceramic tile □Cement □Plastering □Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel □Wood ⊠Mixed □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel □Wood ⊠Other</td><td rowspan="2">⊠No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="7">Roof</td><td>Form</td><td colspan="2">□Gable Roof □Mansard Roof ⊠Flat Roof □Other</td><td rowspan="7">⊠ No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Roof frame</td><td colspan="2">□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>White</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
<tr><td>Material</td><td>Brick and concrete</td></tr>
<tr><td>Lantern roof</td><td colspan="2">□Yes ⊠No</td></tr>
<tr><td>Chimneys</td><td colspan="2">□Yes, Quantity:______
⊠No</td></tr>
</table>

(2) The production area

Table D. 7. Table of a Survey of the Coal Separation Building of the Wang Shi Wa Coal Mine

<table>
<tr><td rowspan="2">Name of building</td><td>Current name</td><td>Coal separation building</td><td>Physical condition</td></tr>
<tr><td>Former name</td><td>Coal separation building</td><td rowspan="3"></td></tr>
<tr><td>Area of the building (m^2)</td><td colspan="2">2400 m² (Data obtained through interviews with the project manager on 15/12/2022)</td></tr>
<tr><td>Build Date</td><td colspan="2">1961</td></tr>
</table>

Date of reuse	In abandonment		
Current use	In abandonment		
Original use	Transport and selection of the coal		
Location			
Current photo (Source: Author)	 		
Building type	□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber ⊠ Brick □ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages

	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other		□ Significant damage □_________________
Facade	Colour	Blue		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel □Wood ⊠Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Shape	□Rectangular □Round ⊠Arched □Other		
Main facade window	Window frame material	□Steel □Wood ⊠Other		⊠No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	⊠Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Blue	
		Form	Rectangular	
		Material	Brick and concrete	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:______ ⊠No		

Table D. 8. Table of a Survey of the Main Mine Wellbore of the Wang Shi Wa Coal Mine

Name of building	Current name	Main mine wellbore	Physical condition
	Former name	Main mine wellbore	
Area of the building (m^2)	1050 m² (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1957		
Date of reuse	In abandonment		
Current use	In abandonment		

<table>
<tr><td>Original use</td><td colspan="2">Lifting of ore and waste rock</td><td rowspan="4"></td></tr>
<tr><td>Location</td><td colspan="2"></td></tr>
<tr><td>Current photo (Source: Author)</td><td colspan="2">
</td></tr>
<tr><td>Building type</td><td colspan="2">□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other</td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td>□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete
⊠Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□___________________</td></tr>
<tr><td>Column</td><td>□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other</td></tr>
<tr><td>Facade</td><td>Colour</td><td>Red brick</td><td>⊠ No observed damage</td></tr>
</table>

	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other		□ Minor damages □ Significant damage □__________________
Main entrance/exit	Door materials	□Copper □Steel □Wood ☒Mixed □Other		☒ No observed damage □ Minor damages □ Significant damage □__________________
	Shape	☒Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel □Wood ☒Other		☒No observed damage □ Minor damages □ Significant damage □__________________
	Shape	☒Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ☒Flat Roof □Other		☒ No observed damage □ Minor damages □ Significant damage □__________________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ☒Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Red brick	
		Form	Rectangular	
		Material	Brick and concrete	
	Lantern roof	□Yes ☒No		
	Chimneys	□Yes, Quantity:_____ ☒No		

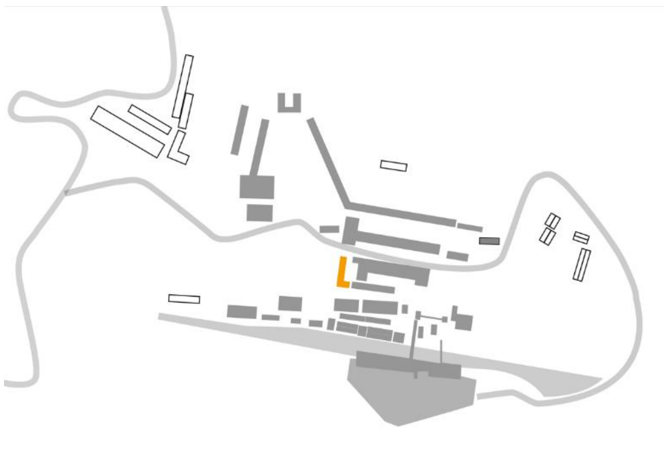
Table D. 9. Table of a Survey of the Main Shaft Mine Hoist Building of the Wang Shi Wa Coal Mine

Name of building	Current name	Main shaft mine hoist building	Physical condition
	Former name	Main shaft mine hoist building	
Area of the building (m^2)	750 m^2 (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1957		
Date of reuse	In abandonment		
Current use	In abandonment		
Original use	Storage of lifting equipment		

Location			
Current photo (Source: Author)			
Building type	⊠ Single storey plant □ Multi storey plant ⊠Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other	
Facade	Colour	Pink	⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Material	□ Ganged brick □ Ceramic tile □Cement ⊠Plastering □Other	
Main entrance/exit	Door materials	□Copper ⊠Steel □Wood □Mixed □Other	□ No observed damage ⊠ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other	
Main facade window	Window frame material	⊠Steel □Wood □Other	⊠No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other	

Roof	Form	⊠Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Pink	
		Form	Rectangular	
		Material	Brick and concrete	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

Table D. 10. Table of a Survey of the Secondary Mine Hoist building of the Wang Shi Wa Coal Mine

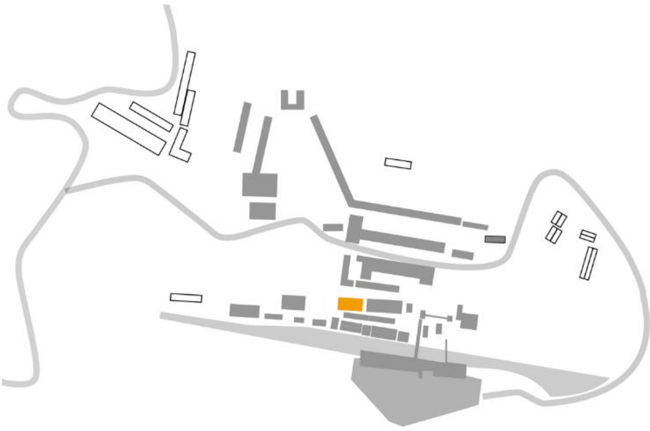
Name of building	Current name	Secondary mine hoist building	Physical condition
	Former name	Secondary mine hoist building	
Area of the building (m^2)	300 m² (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1957		
Date of reuse	In abandonment		
Current use	In abandonment		
Original use	Storage of lifting equipment		
Location			

Current photo (Source: Author)				
Building type	□ Single storey plant □ Multi storey plant ⊠ Single storey warehouse □ Multi storey warehouse □ Other			
Structure	Form	□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other		⊠ No observed damage □ Minor damages □ Significant damage □___________
	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other		
Facade	Colour	Pink		⊠ No observed damage □ Minor damages □ Significant damage □___________
	Material	□ Ganged brick □Ceramic tile □Cement ⊠Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel □Wood ⊠Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □___________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel □Wood ⊠Other		⊠No observed damage □ Minor damages □ Significant damage □___________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	⊠Gable Roof □Mansard Roof □Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □___________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Pink	
		Form	Rectangular	
		Material	Brick and concrete	

	Lantern roof	□Yes ⊠No	
	Chimneys	□Yes, Quantity:_____ ⊠No	

(3) The auxiliary production area

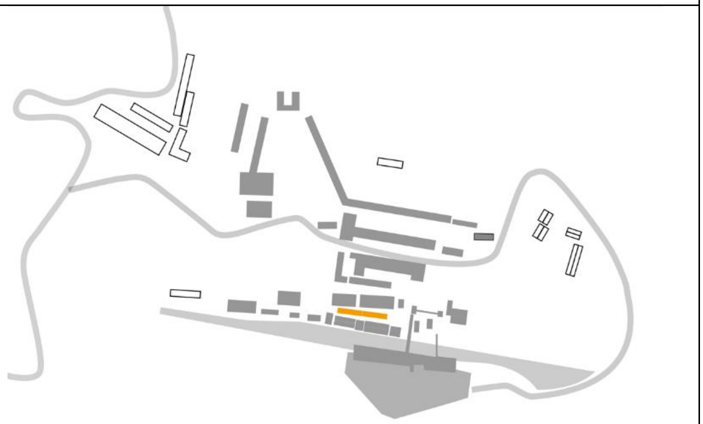
Table D. 11. Table of a Survey of the Pressurised Fan Building of the Wang Shi Wa Coal Mine

Name of building	Current name	Pressurised fan building	Physical condition
	Former name	Pressurised fan building	
Area of the building (m²)	550 m² (Data obtained through interviews with the project manager on 15/12/2022)		
Build Date	1958		
Date of reuse	In abandonment		
Current use	In abandonment		
Original use	Storage of pressure fans equipment (the function to supply fresh air flow into the mine)		
Location			
Current photo (Source: Author)			

Building type	□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other	
Facade	Colour	Gray	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other	
Main entrance/exit	Door materials	□Copper □Steel □Wood ⊠Mixed □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other	
Main facade window	Window frame material	□Steel □Wood ⊠Other	⊠No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other	
Roof	Form	⊠Gable Roof □Mansard Roof □Flat Roof □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other	
	Tile/roofing sheets	Colour: Gray	
		Form: Rectangular	
		Material: Brick and concrete	
	Lantern roof	□Yes ⊠No	
	Chimneys	□Yes, Quantity:_____ ⊠No	

Table D. 12. Table of a Survey of the Electrical and Mechanical Office Zone of the Wang Shi Wa Coal Mine

Name of building	Current name	Electrical and mechanical office zone	Physical condition
	Former name	Electrical and mechanical office zone	

<table>
<tr><td>Area of the building (m²)</td><td colspan="2">1250 m² (Data obtained through interviews with the project manager on 15/12/2022)</td><td rowspan="8"></td></tr>
<tr><td>Build Date</td><td colspan="2">1984</td></tr>
<tr><td>Date of reuse</td><td colspan="2">In abandonment</td></tr>
<tr><td>Current use</td><td colspan="2">In abandonment</td></tr>
<tr><td>Original use</td><td colspan="2">Office, responsible for the installation and maintenance of electrical and mechanical equipment throughout the coal mine (except the underground area which was being mined).</td></tr>
<tr><td>Location</td><td colspan="2"></td></tr>
<tr><td>Current photo (Source: Author)</td><td colspan="2"></td></tr>
<tr><td>Building type</td><td colspan="2">□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other</td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td>□Timber □ Brick ⊠ Brick and concrete □ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Column</td><td>□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td>Gray</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage</td></tr>
<tr><td>Material</td><td>□Ganged brick □Ceramic tile ⊠Cement □Plastering □Other</td></tr>
</table>

				□_________________
Main entrance/exit	Door materials	□Copper ⊠Steel □Wood □Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel □Wood ⊠Other		⊠No observed damage □ Minor damages □ Significant damage □_________________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_________________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ⊠Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Gray	
		Form	Rectangular	
		Material	Brick and concrete	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

Appendix E

Appendix E shows the survey of the current status of the conversion in four stages of the Shenxin Yarn Factory.

(1) Current status of the first phase of the transformation of the Shenxin Yarn Factory

Shaanxi Provincial Cultural Relics Bureau approved the Baoji Shenxin Yarn Factory old site cultural preservation and repair project in February 2019. Through public bidding, the development and construction management committee of the Changle Plateau area in Baoji City identified Shaanxi historic style building & garden construction group company Ltd. as the general construction contractor. The first phase of the renovation project began on March 1, 2019, and was completed on November 10, 2019, lasting 254 days. Project was passed by the Baoji Cultural Relics Bureau on 21 July 2020 for the initial inspection, and passed the final inspection by the Shaanxi Provincial Cultural Relics Bureau on 1 December 2021. The first phase of the project was opened to the public on 26 November 2020. The above information was provided by Xiaoyu Niu of Shaanxi historic style building & garden construction group company Ltd.

a) Cave-dwelling workshop

There are 24 holes (Figure E. 1) in the cave-dwelling workshop. From August 1940 to 1941, the cave-dwelling workshop was built at the foot of the Changle plateau. The caves are arranged in sequence from west to east along the northern cliff, with a total of 24 holes and a floor area of about 4,388 square metres (Liu and Lei, 2020). There are six horizontal holes running east to west inside the caves, forming a network, which was used as a transport channel between the caves and also for air circulation.

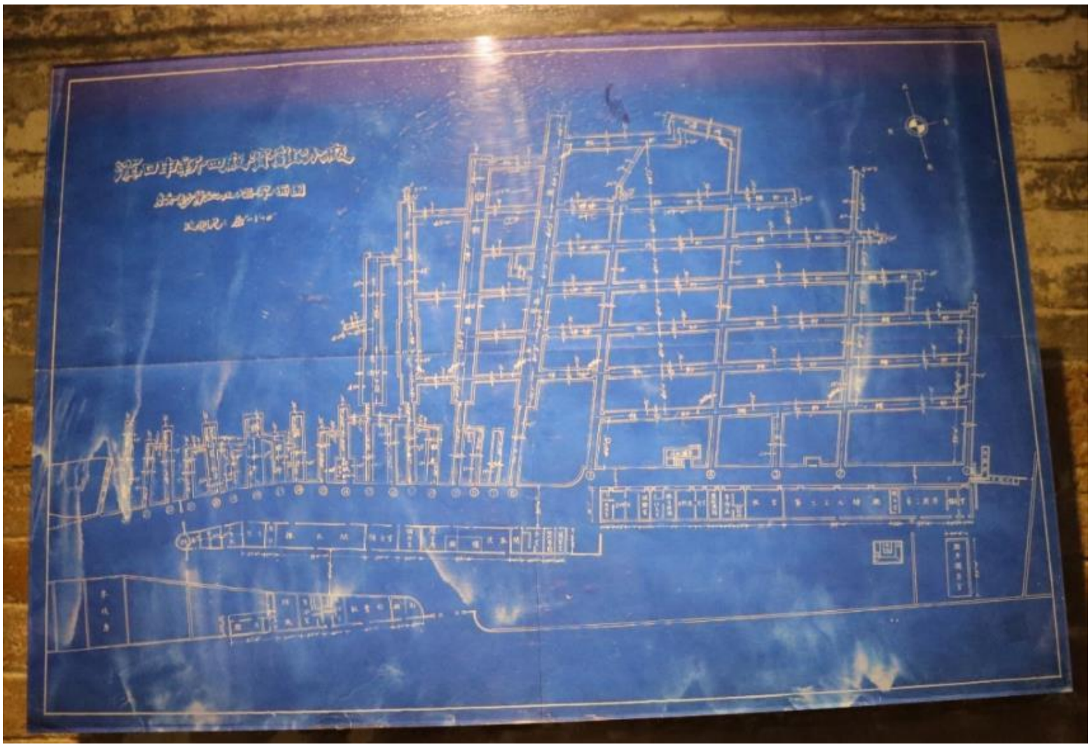
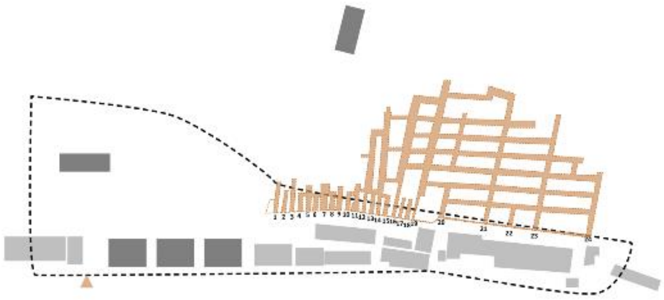


Figure E. 1. Layout of the Cave-dwelling Workshop (Source: Taken by author at the Baoji Industrial Heritage Museum)

One of them, No. 19, is divided into two sections, the front and the back. The front section is 18 metres long, with a width of 1.92 metres and a height of 2.9 metres, and the walls are 0.48 metres thick. The hole is built with handmade green bricks, bonded with white lime, and the roof of the cave is built longitudinally with an arched roof. The latter section is approximately 100 metres long, 4.5 metres wide and 5 metres high (Xiao, 1992). There are six groups of east-west horizontal caves on either side that connect to other caves. 13, 15, 17 and 19 are of similar shape and size. At the rear end of No. 17, there is a brick rectangular ventilated patio, each about 2 metres long and wide. At the back end of No. 13 is a brick circular ventilation shaft, 1.8 metres in diameter and about 37 metres high (Liu and Lei, 2020). Since it was built it has been subjected to numerous Japanese air raids, but has resiliently withstood the massive bombardment and the internal structure is largely intact. This project set a precedent for wartime industry and has been described as one of the greatest wonders of the Chinese war effort (Shaanxi Cotton Twelfth Factory Journal Compilation Committee, 1998).

Table E. 1. Table of a Survey of the Cave-dwelling Workshop of the Shenxin Yarn Factory

Name of building	Current name	Cave-dwelling workshop	Physical condition
	Former name	Second workshop on spinning	
Area of the building (m^2)	4388 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	1940		
Date of reuse	11/2020		
Current use	Baoji Industrial Heritage Museum		
Original use	Spinning workshop		
Location			
Current photo (Source: Author)			
Building type	☒ Single storey plant ☐ Multi storey plant ☐ Single storey warehouse ☐ Multi storey warehouse ☐ Other		
Structure	Form	☐Timber ☒ Brick ☐ Brick and concrete ☐ Reinforced concrete ☐Steel ☐Other	☒ No observed damage ☐ Minor damages ☐ Significant damage ☐________________
	Column	☐ Wooden column ☒ Brick column ☐ Steel column ☐ Reinforced concrete column ☐ Other	
Facade	Colour	Brick Red	

<table>
<tr><td></td><td>Material</td><td colspan="2">☒Ganged brick ☐Ceramic tile ☐Cement ☐Plastering ☐Other</td><td>☒ No observed damage
☐ Minor damages
☐ Significant damage
☐_________________</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">☐Copper ☐Steel ☒Wood ☐Mixed ☐Other</td><td rowspan="2">☒ No observed damage
☐ Minor damages
☐ Significant damage
☐_________________</td></tr>
<tr><td>Shape</td><td colspan="2">☐Rectangular ☐Round ☒Arched ☐Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">☐Steel ☐Wood ☒Other No windows, ventilation openings only</td><td rowspan="2">☒No observed damage
☐ Minor damages
☐ Significant damage
☐_________________</td></tr>
<tr><td>Shape</td><td colspan="2">☐Rectangular ☐Round ☐Arched ☐Other</td></tr>
<tr><td rowspan="7">Roof</td><td>Form</td><td colspan="2">☐Gable Roof ☐Mansard Roof ☐Flat Roof ☒Other Built within a mountain, Internal arches</td><td rowspan="7">☒ No observed damage
☐ Minor damages
☐ Significant damage
☐_________________</td></tr>
<tr><td>Roof frame</td><td colspan="2">☐Timber Roof Frame ☐Steel Roof Frame ☐Steel Reinforced Concrete Roof Frame ☒Other Brick</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>Brick red</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
<tr><td>Material</td><td>Brick</td></tr>
<tr><td>Lantern roof</td><td colspan="2">☐Yes ☒No</td></tr>
<tr><td>Chimneys</td><td colspan="2">☐Yes, Quantity:_____
☒No</td></tr>
</table>

The bombing by aircraft during the war, the erosion of the natural environment and the artificial alterations for later use have caused localised water seepage in the cave workshops, cracking and bulging of the cave faces, weathering of the walls, deterioration of the floors and damage to the doors.

In response to the deterioration of the cave workshop, Shaanxi historic style building & garden construction group company Ltd. used a traditional process of restoring the concrete floor by removing the rotten wooden floor and cleaning and maintaining the more intact floor. As well as demolishing and rebuilding the severely outwardly bulging and cracked kiln faces, the tiny cracks in the walls are repaired by grouting with an ultra-fine high performance grout.

Then, it was repaired the damaged door and window partitions, and was replace the missing door panels and windows with the existing remaining door and window patterns. In addition, the surface of the collapsed cave was reinforced with wall anchors and lattice beams to restore the surface of the brick structure. Furthermore, the interior of the cave was cleaned and drained and connected to the outside.

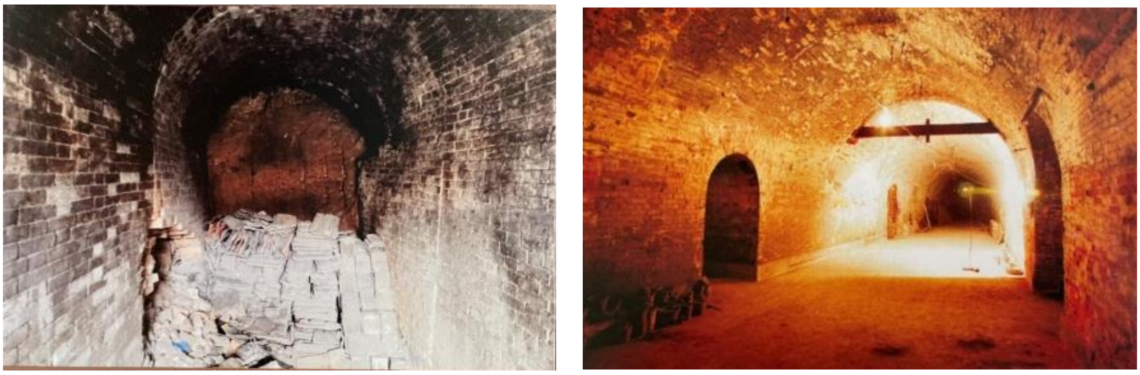


Figure E. 2. Interior of the Cave-dwelling Workshop - Before Transformat. Source: Taken by author at the Baoji Industrial Heritage Museum.

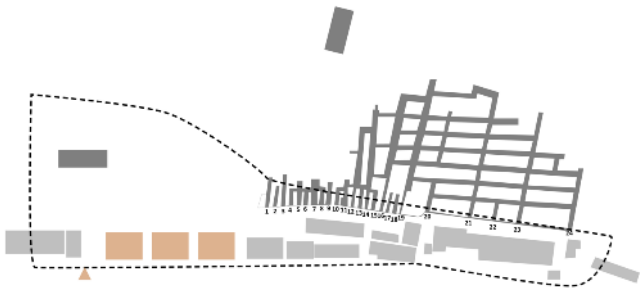
Figure E. 3. Interior of the Cave-dwelling Workshop - After Transformation. Source: Author.

b) Thin shell workshop

The thin shell workshop is only 50 metres away from the cave-dwelling workshop, the workshop construction materials are all green bricks, with no concrete and steel and other materials. The roof is bow-shaped, without beams, and the six workshops are connected. Each workshop is around 15m long, 20m wide and about 10m high (Xiao, 1992). The building area is 1800 square metres. The thin-shell workshop was built in April 1954 with reference to the Soviet Union's aid drawings (Chen, Wang and Zhang, 2021).

Through field research it was found that there are now 12 similar thin-shell workshops in the production area of the BaoFang Group. The roofs of the thin-shell workshops have large but very stable spans and are mainly of reinforced concrete construction., and it is due to this structural design that the workshop is still intact and rarely seen in China. The workshop faces north and south. It was mainly used for production and storage at the time. The workshop has a south door and a north door, the south door facing the Longhai Railway to facilitate the loading and transportation of goods from the Shenxin Yarn Factory.

Table E. 2. Table of a Survey of the Thin Shell Workshop of the Shenxin Yarn Factory

Name of building	Current name	Thin shell workshop	Physical condition
	Former name	Thin shell workshop	
Area of the building (m^2)	1800 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	1954		
Date of reuse	11/2020		
Current use	Planned as a modern industrial showroom		
Original use	Production and storage		
Location			
Current photo (Source: Author)			

Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other			
Structure	Form	□Timber ☒ Brick □ Brick and concrete □ Reinforced concrete □Steel □Other		☒ No observed damage □ Minor damages □ Significant damage □__________
	Column	□ Wooden column □ Brick column □ Steel column □ Reinforced concrete column ☒ Other None		
Facade	Colour	Stone Gray		☒ No observed damage □ Minor damages □ Significant damage □__________
	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper ☒Steel □Wood □Mixed □Other		☒ No observed damage □ Minor damages □ Significant damage □__________
	Shape	☒Rectangular □Round □Arched □Other		
Main facade window	Window frame material	☒Steel □Wood □Other		☒No observed damage □ Minor damages □ Significant damage □__________
	Shape	☒Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof □Flat Roof ☒Other Double curved arch construction		□ No observed damage ☒ Minor damages □ Significant damage □__________
	Roof frame	□Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame ☒Other Brick		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Double curved arch	
		Material	Waterproof coating	
	Lantern roof	□Yes ☒No		
	Chimneys	□Yes, Quantity:_____ ☒No		

Before the renovation of the thin-shell workshop, the roof waterproofing failed, the post-change window hole affected the structural safety, the canopy was broken, the post-built structures changed their original appearance, the walls were contaminated, and the floor was cracked.

In response to the characteristics of the thin-shell factory damage, Shaanxi historic style building & garden construction group company Ltd. used measures and techniques to restore the reduced and later enlarged window openings, replace steel doors and windows with wooden ones, eradicate and restore the damaged ground, replace the drainage facilities and repair the damaged waterproofing membrane on the roof to repair the damage. As the thin-shell workshop is not open to the public at the moment, Figure E. 5 was provided by Xiaoyu Niu of Shaanxi historic style building & garden construction group company Ltd.

Figure E. 4. Interior of the Thin Shell Workshop - Before Transformation. Source: Taken by author at the introduction signage.

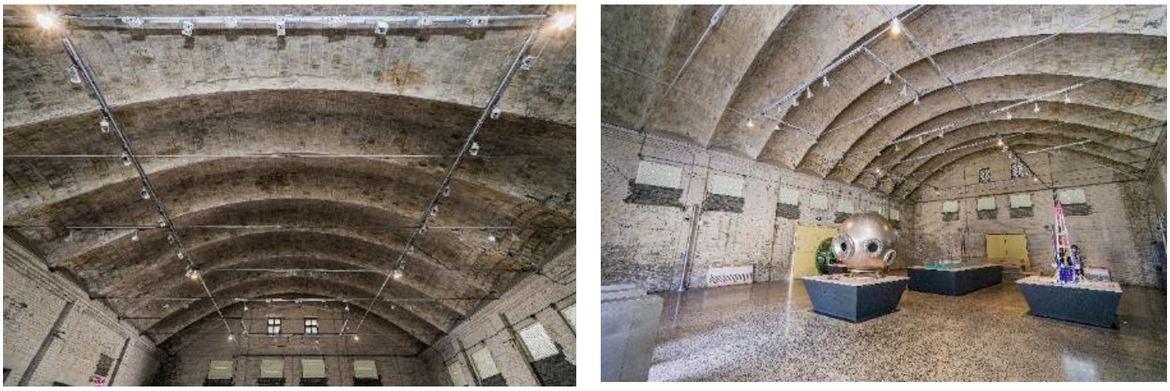


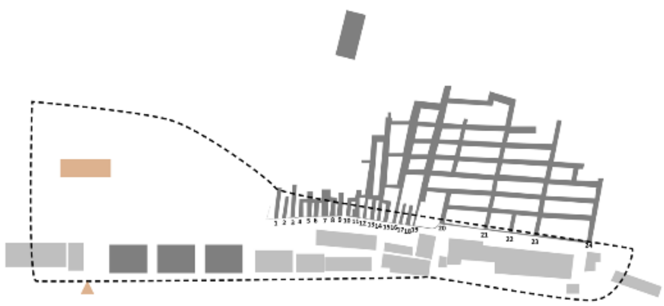
Figure E. 5. Interior of the Thin Shell workshop - After Transformation. Source: Provided by Xiaoyu Niu of Shaanxi historic style building & garden construction group company Ltd.

c) Shen Fuxin office building

The office building is a single building of excellent design and construction in the factory, designed by architect Wang Bingzhen and built in January 1942 and completed on 14 April 1943. It is a two-storey building of brick construction with a basement. The building is 9.5 metres high, 37.5 metres long from east to west and 13 metres long from north to south, with a floor area of 975 square metres (Chen Wang and Zhang, 2021).

The Shen Fuxin office building is located on the east side of the Shenxin Yarn Factory, the appearance is basically intact, with part of the water pipe leakage. The flooring in the building is wooden, and some of the flooring is cracked. In 2018, the Baoji City Government carried out repairs to the Shen Fuxin office building (Qin, 2020) and has now completed the repair work.

Table E. 3. Table of a Survey of the Fuxin Shenxin Building of the Shenxin Yarn Factory

Name of building	Current name	Fuxin Shenxin Building	Physical condition
	Former name	Shen Fuxin office building	
Area of the building (m^2)	975 m^2 (Chen, Wang and Zhang, 2021)		
Build Date	1942		
Date of reuse	11/2020		
Current use	Shenxin Corporate History Exhibition Hall		
Original use	Shenxin Yarn Factory Office Building		
Location			

<table>
<tr><td>Current photo (Source: Author)</td><td colspan="3"></td><td rowspan="2"></td></tr>
<tr><td>Building type</td><td colspan="3">□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other</td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td colspan="2">□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Column</td><td colspan="2">□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td colspan="2">Stone Gray</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Material</td><td colspan="2">⊠Ganged brick □Ceramic tile □Cement □Plastering □Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel ⊠Wood □Mixed □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel ⊠Wood □Other</td><td rowspan="2">⊠No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="4">Roof</td><td>Form</td><td colspan="2">□Gable Roof □Mansard Roof ⊠Flat Roof □Other</td><td rowspan="4">□ No observed damage
⊠ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Roof frame</td><td colspan="2">⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="2">Tile/roofing sheets</td><td>Colour</td><td>Stone Gray</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
</table>

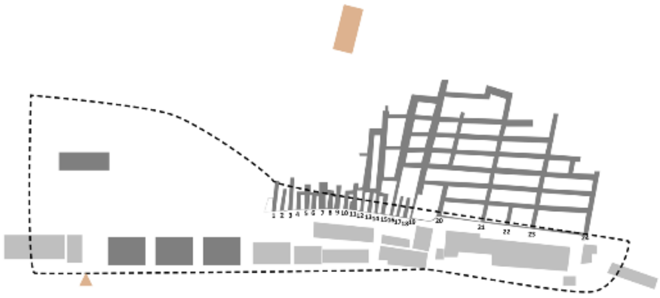
		Material	Clay tile	
	Lantern roof	□Yes ☒No		
	Chimneys	□Yes, Quantity:_____ ☒No		

d) Le Nong Villa

The Le Nong Villa was designed by the famous Chinese architect Wang Bing Chen in February 1943 and was completed on the 3rd of August of the same year. It covers an area of approximately 500 square metres (Chen, Wang and Zhang, 2021). Through interviews with local residents, it was revealed that the house was originally intended for Desheng Rong to come and live in Baoji. But Desheng Rong never came to Baoji and the house fell into abandonment. After the liberation of Baoji in July 1949, the building became the office of the First Field Army Logistics Department of the People's Liberation Army, and after the evacuation of the troops, it became the factory's guest house. Later, it also housed a kindergarten, and then, gradually, it fell into disuse. The villa not only records the history of the westward relocation of Wuhan Shenxin Yarn Factory during the war, but also witnessed the development of the national industry of China.

Table E. 4. Table of a Survey of the Le Nong Villa of the Shenxin Yarn Factory

Name of building	Current name	Le Nong Villa	Physical condition
	Former name	Le Nong Villa	
Area of the building (m^2)	500 m^2		
Build Date	1943		
Date of reuse	The transformation began in 2018 and has not yet been completed		
Current use	None		
Original use	Residence		

Location			
Current photo (Source: Author)			
Building type	□ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse ⊠Other <u>2 floors of the house</u>		
Structure	Form	□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other	
Facade	Colour	Stone Gray	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other	
Main entrance/exit	Door materials	□Copper □Steel ⊠Wood □Mixed □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other	
Main facade window	Window frame material	□Steel ⊠Wood □Other	⊠No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other	

Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

(2) Current status of the second phase of the transformation of the Shenxin Yarn Factory

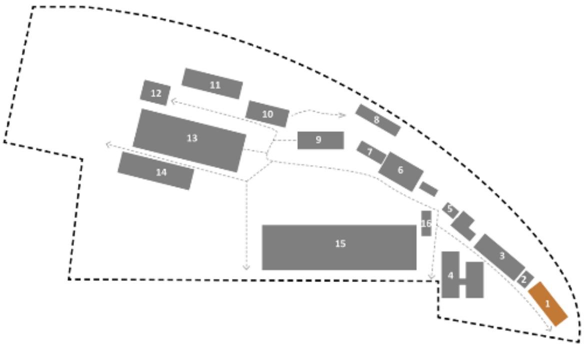
The second phase of the Changle Plateau transformation project consists of 16 main buildings. With the exception of the 5# building, 7# building, 14# building and 16 building, which is a new building, the rest of the buildings are transformed from the remaining buildings of the Shenxin Yarn Factory. The aim is to preserve its industrial character as a physical testimony to the development of Chinese industry.

a) Physical and chemical building

The physical and chemical building was built in 1955 and is of brick construction. It is approximately 37 metres long and 11 metres wide. It is a two-floor building with a balcony on the first floor. The interior is divided into 42 rooms of the same size. It has been abandoned and is now in the process of reconstruction. Through interviews with the construction team, the restoration strategy was to replace the timber roof frame with a steel roof frame, reinforce the internal walls with high ductility concrete and remove and re-surface the floor.

Table E. 5. Table of a Survey of the Physical and Chemical Building of the Shenxin Yarn Factory

Name of building	Current name	1# building	Physical condition
	Former name	Physical and Chemical Building	

Area of the building (m^2)	830 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	1955		
Date of reuse	Under construction		
Current use	None		
Original use	Office		
Location			
Current photo (Source: Author)	 		
Building type	□ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse ⊠Other <u>2 storey office building</u>		
Structure	Form	□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages

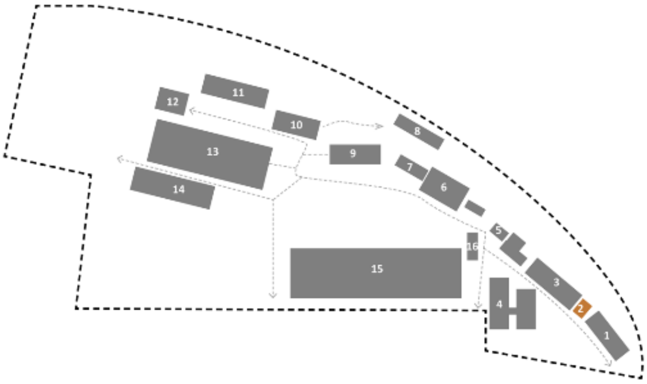
	Column	□ Wooden column ☒ Brick column □ Steel column □ Reinforced concrete column □ Other		□ Significant damage □__________________
Façade	Colour	Stone Gray		☒ No observed damage □ Minor damages □ Significant damage □__________________
	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel □Wood □Mixed ☒ Other Totally damaged		□ No observed damage □ Minor damages ☒Significant damage □__________________
	Shape	☒Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel ☒Wood □Other		☒No observed damage □ Minor damages □ Significant damage □__________________
	Shape	☒Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ☒Flat Roof □Other		☒ No observed damage □ Minor damages □ Significant damage □__________________
	Roof frame	□Timber Roof Frame □Steel Roof Frame ☒Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ☒No		
	Chimneys	□Yes, Quantity:______ ☒No		

b) 2# building

The roof of 2# building was damaged and during the renovation it was replaced by a steel roof frame. The floor is planned to be re-surfaced. Through interviews, it was revealed that this building is planned to be used as a supporting kitchen for Building 1 in subsequent renovations, as well as a convenience store.

Table E. 6. Table of a Survey of the Physical and Chemical Building of the Shenxin Yarn Factory

	Current name	2# building	Physical condition

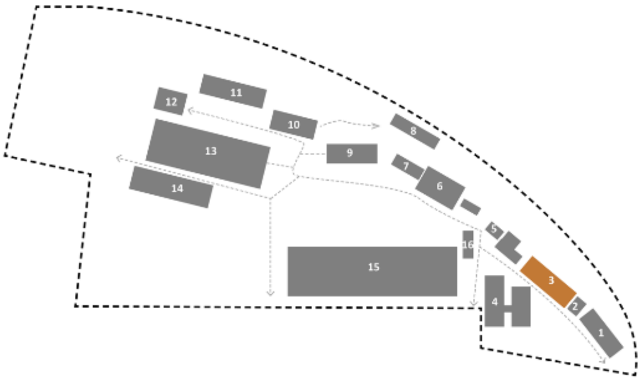
Name of building	Former name	Unknown	
Area of the building (m^2)	96.76 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	Unknown		
Date of reuse	Under construction		
Current use	Planned for kitchen/convenience shop		
Original use	Unknown		
Location			
Current photo (Source: Author)	 		

Building type	☒ Single storey plant ☐ Multi storey plant ☐ Single storey warehouse ☐ Multi storey warehouse ☐ Other		
Structure	Form	☐Timber ☐Brick ☒ Brick and concrete ☐ Reinforced concrete ☐Steel ☐Other	☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Column	☐ Wooden column ☒ Brick column ☐ Steel column ☐ Reinforced concrete column ☐ Other	
Facade	Colour	Brick red	☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Material	☐Ganged brick ☐Ceramic tile ☐Cement ☐Plastering ☒Other Red brick	
Main entrance/exit	Door materials	☐Copper ☐Steel ☒Wood ☐Mixed ☐Other	☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Shape	☒Rectangular ☐Round ☐Arched ☐Other	
Main facade window	Window frame material	☐Steel ☒Wood ☐Other	☒No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Shape	☒Rectangular ☐Round ☐Arched ☐Other	
Roof	Form	☒Gable Roof ☐Mansard Roof ☐Flat Roof ☐Other	☐ No observed damage ☐ Minor damages ☒ Significant damage ☐_______________
	Roof frame	☐Timber Roof Frame ☒Steel Roof Frame ☐Steel Reinforced Concrete Roof Frame ☐Other	
	Tile/roofing sheets	Colour:	
		Form:	
		Material:	
	Lantern roof	☐Yes ☒No	
	Chimneys	☐Yes, Quantity:_____ ☒No	

c) Administration building

The building is located to the west of the Physical and Chemical Building and was built in late 1965. It is about 37 metres long and 12 metres wide.

Table E. 7. Table of a Survey of 3# Building of the Shenxin Yarn Factory

Name of building	Current name	3# building	Physical condition
	Former name	Administration Building	
Area of the building (m^2)	1341.75 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	1965		
Date of reuse	Under construction		
Current use	Planed for theme hotels		
Original use	Administration		
Location			
Current photo (Source: Author)			

	  		
Building type	□ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse ⊠Other 3 floors building		
Structure	Form	□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other	
Façade	Colour	Stone Gray	

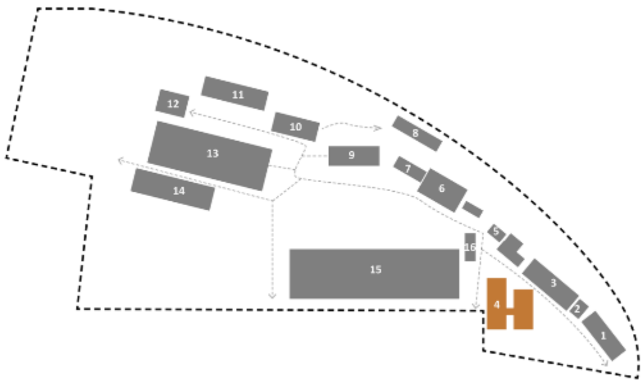
<table>
<tr><td></td><td>Material</td><td colspan="2">⊠Ganged brick □Ceramic tile □Cement □Plastering □Other</td><td>⊠ No observed damage
□ Minor damages
□ Significant damage
□__________________</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel □Wood □Mixed □Other</td><td rowspan="2">□ No observed damage
□ Minor damages
⊠Significant damage
□__________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel □Wood □Other</td><td rowspan="2">□No observed damage
□ Minor damages
⊠ Significant damage
□__________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="7">Roof</td><td>Form</td><td colspan="2">⊠Gable Roof □Mansard Roof □Flat Roof □Other</td><td rowspan="7">⊠ No observed damage
□ Minor damages
□ Significant damage
□__________________</td></tr>
<tr><td>Roof frame</td><td colspan="2">⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>Stone Gray</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
<tr><td>Material</td><td>Clay tile</td></tr>
<tr><td>Lantern roof</td><td colspan="2">□Yes ⊠No</td></tr>
<tr><td>Chimneys</td><td colspan="2">□Yes, Quantity:_____
⊠No</td></tr>
</table>

d) Staff canteen

4# building, formerly the staff canteen, is mainly for group meals, taking into account the consumption of casual customers. When completed, it will solve the problem of catering for groups as well as catering for casual tourists and enterprises based in the park.

Table E. 8. Table of a Survey of 4# Building of the Shenxin Yarn Factory

<table>
<tr><td rowspan="2">Name of building</td><td>Current name</td><td>4# building</td><td>Physical condition</td></tr>
<tr><td>Former name</td><td>Staff Canteen</td><td></td></tr>
</table>

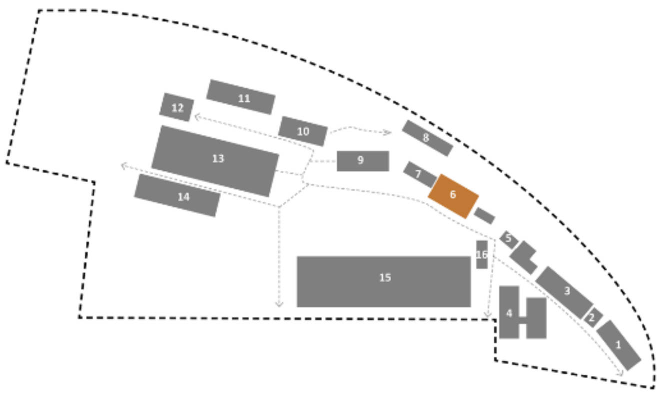
Area of the building (m^2)	950 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	Unknown		
Date of reuse	Under construction		
Current use	Planed for still being a canteen		
Original use	Canteen		
Location			
Current photo (Source: Author)			
Building type	☒ Single storey plant ☐ Multi storey plant ☐ Single storey warehouse ☐ Multi storey warehouse ☐Other		
Structure	Form	☐Timber ☐Brick ☒ Brick and concrete ☐ Reinforced concrete ☐Steel ☐Other	☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Column	☐ Wooden column ☒ Brick column ☐ Steel column ☐ Reinforced concrete column ☐ Other	
Façade	Colour	Stone Gray	☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Material	☒Ganged brick ☐Ceramic tile ☐Cement ☐Plastering ☐Other	

<table>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel □Wood □Mixed □Other</td><td rowspan="2">□No observed damage
□ Minor damages
⊠ Significant damage
□__________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel □Wood □Other</td><td rowspan="2">□No observed damage
□ Minor damages
⊠ Significant damage
□__________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="7">Roof</td><td>Form</td><td colspan="2">⊠Gable Roof □Mansard Roof □Flat Roof □Other</td><td rowspan="7">□ No observed damage
□ Minor damages
⊠Significant damage
□__________________</td></tr>
<tr><td>Roof frame</td><td colspan="2">□Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td></td></tr>
<tr><td>Form</td><td></td></tr>
<tr><td>Material</td><td></td></tr>
<tr><td>Lantern roof</td><td colspan="2">□Yes ⊠No</td></tr>
<tr><td>Chimneys</td><td colspan="2">□Yes, Quantity:______
⊠No</td></tr>
</table>

e) 6# building

Table E. 9. Table of a Survey of 6# Building of the Shenxin Yarn Factory

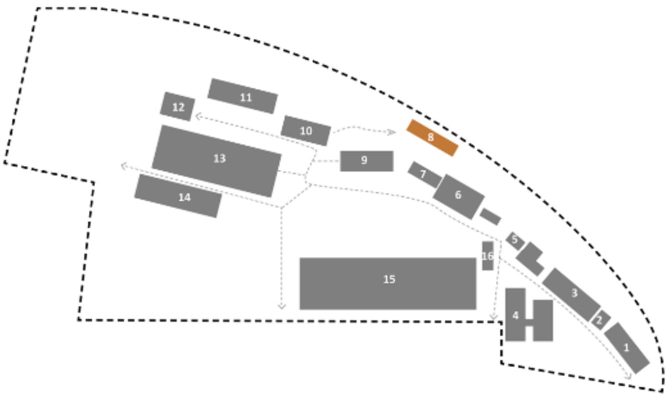
<table>
<tr><td rowspan="2">Name of building</td><td>Current name</td><td>6# building</td><td>Physical condition</td></tr>
<tr><td>Former name</td><td>Unknown</td><td rowspan="6"></td></tr>
<tr><td>Area of the building (m^2)</td><td colspan="2">453 m^2 (Data obtained through interviews with the project manager on 09/12/2022)</td></tr>
<tr><td>Build Date</td><td colspan="2">Unknown</td></tr>
<tr><td>Date of reuse</td><td colspan="2">Under construction</td></tr>
<tr><td>Current use</td><td colspan="2">Planed for ritzy restaurants</td></tr>
<tr><td>Original use</td><td colspan="2">Unknown</td></tr>
</table>

Location			
Current photo (Source: Author)			
Building type	□ Single storey plant ⊠Multi storey plant □ Single storey warehouse □ Multi storey warehouse □		
Structure	Form	□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other	
Facade	Colour	Stone Gray	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other	
Main entrance/exit	Door materials	□Copper □Steel ⊠Wood □Mixed □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other	
Main facade window	Window frame material	□Steel ⊠Wood □Other	⊠No observed damage □ Minor damages □ Significant damage
	Shape	⊠Rectangular □Round □Arched □Other	

				☐________________
Roof	Form	☒Gable Roof ☐Mansard Roof ☐Flat Roof ☐Other		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐________________
	Roof frame	☒Timber Roof Frame ☐Steel Roof Frame ☐Steel Reinforced Concrete Roof Frame ☐Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	☐Yes ☒No		
	Chimneys	☐Yes, Quantity:_____ ☒No		

f) 8# building

Table E. 10. Table of a Survey of 8# Building of the Shenxin Yarn Factory

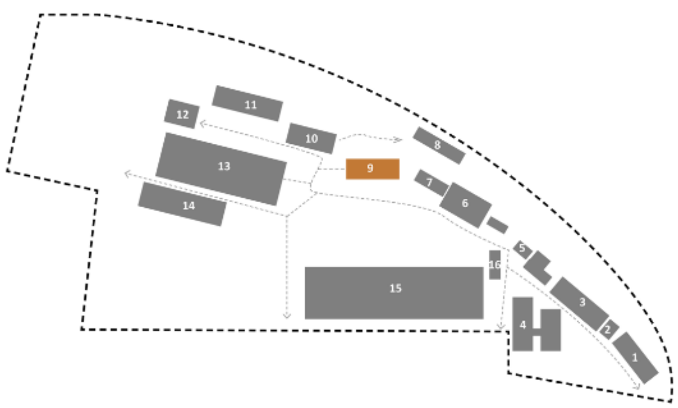
Name of building	Current name	8# building	Physical condition
	Former name	Unknown	
Area of the building (m^2)	278 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	Unknown		
Date of reuse	Under construction		
Current use	Planed for a place for team building activity, annual corporate meeting and training.		
Original use	Unknown		
Location			

Current photo (Source: Author)				
Building type	□Single storey plant ⊠Multi storey plant □ Single storey warehouse □ Multi storey warehouse □Other			
Structure	Form	□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other		
Façade	Colour	Stone Gray		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel ⊠Wood □Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel ⊠Wood □Other		⊠No observed damage □ Minor damages □ Significant damage □________________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	□ Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Stone Gray	

		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ☒No		
	Chimneys	□Yes, Quantity:_____ ☒No		

g) 9# building

Table E. 11. Table of a Survey of 9# Building of the Shenxin Yarn Factory

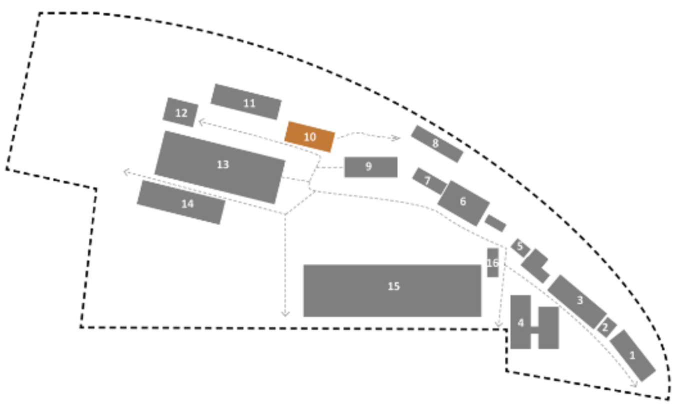
Name of building	Current name	9# building	Physical condition
	Former name	Non-standard workshop	
Area of the building (m^2)	420 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	Around 1960		
Date of reuse	Under construction		
Current use	Planed for a live internet celebrity studio		
Original use	Production		
Location			
Current photo (Source: Author)			

				
Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other			
Structure	Form	□Timber □Brick ☒ Brick and concrete □ Reinforced concrete □Steel □Other		☒ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column ☒ Brick column □ Steel column □ Reinforced concrete column □ Other		
Façade	Colour	Stone Gray		☒ No observed damage □ Minor damages □ Significant damage □_______________
	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel □ Wood □Mixed □Other		□ No observed damage □ Minor damages ☒ Significant damage □_______________
	Shape	☒Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel □ Wood □Other		□ No observed damage □ Minor damages ☒ Significant damage □_______________
	Shape	☒Rectangular □Round □Arched □Other		
Roof	Form	☒Gable Roof □Mansard Roof □ Flat Roof □Other		□ No observed damage □ Minor damages ☒ Significant damage □_______________
	Roof frame	□Timber Roof Frame ☒Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour		
		Form		
		Material		

	Lantern roof	□Yes ⊠No	
	Chimneys	□Yes, Quantity:_____ ⊠No	

h) 10# building

Table E. 12. Table of a Survey of 10# Building of the Shenxin Yarn Factory

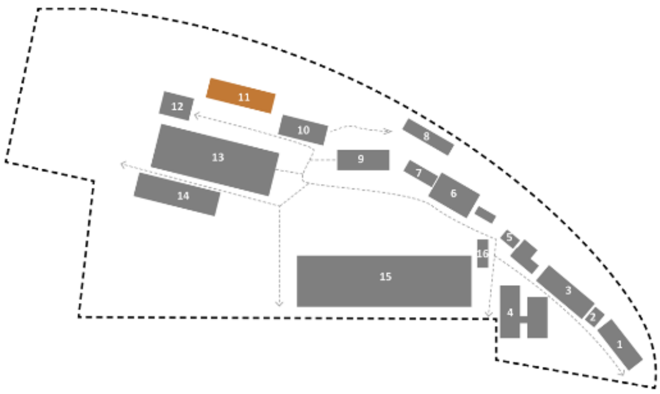
Name of building	Current name	10# building	Physical condition
	Former name	Unknown	
Area of the building (m^2)	480 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	Around 1960		
Date of reuse	Under construction		
Current use	Planed for café		
Original use	Unknown		
Location			
Current photo (Source: Author)			
Building type	⊠ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □Other		
Structure	Form	□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete	⊠ No observed damage

		□Steel □Other		□ Minor damages □ Significant damage □________________
	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other		
Façade	Colour	Stone Gray		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel ⊠Wood □Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel ⊠Wood □Other		⊠No observed damage □ Minor damages □ Significant damage □________________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

i) 11# building

Table E. 13. Table of a Survey of 11# Building of the Shenxin Yarn Factory

Name of building	Current name	11# building	Physical condition
	Former name	Unknown	
Area of the building (m^2)	552 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		

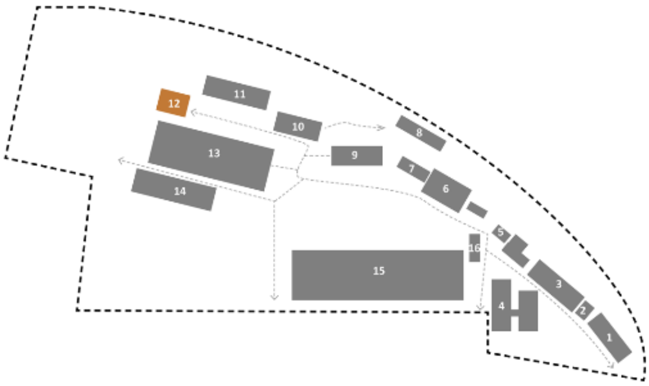
Build Date	Around 1960		
Date of reuse	Under construction		
Current use	Planed for bar		
Original use	Storage		
Location			
Current photo (Source: Author)	 		
Building type	⊠ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □Other		
Structure	Form	⊠Timber □Brick □ Brick and concrete □ Reinforced concrete □Steel □Other	□ No observed damage □ Minor damages

	Column	⊠ Wooden column □ Brick column □ Steel column □ Reinforced concrete column □ Other		⊠ Significant damage □__________
Façade	Colour	Stone Gray		⊠ No observed damage □ Minor damages □ Significant damage □__________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel ⊠Wood □Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □__________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel ⊠Wood □Other		⊠No observed damage □ Minor damages □ Significant damage □__________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	⊠Gable Roof □Mansard Roof □Flat Roof □Other		□ No observed damage □ Minor damages ⊠ Significant damage □__________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Red brick	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

j) 12# building

Table E. 14. Table of a Survey of 12# Building of the Shenxin Yarn Factory

Name of building	Current name	12# building	Physical condition
	Former name	Unknown	
Area of the building (m^2)	520 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	Around 1960		

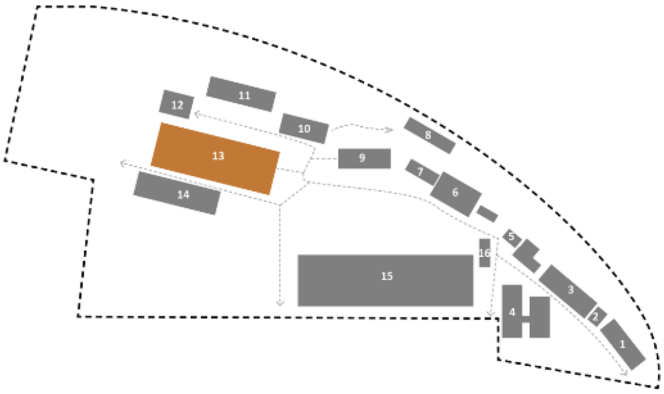
Date of reuse	Under construction		
Current use	Planed for theme theatres, music festivals, children's theatres		
Original use	Workshop		
Location			
Current photo (Source: Author)			
Building type	☒Single storey plant ☐ Multi storey plant ☐ Single storey warehouse ☐ Multi storey warehouse ☐ Other		
Structure	Form	☐Timber ☐Brick ☒ Brick and concrete ☐ Reinforced concrete ☐Steel ☐Other	☒ No observed damage ☐ Minor damages ☐ Significant damage ☐____________
	Column	☐ Wooden column ☐Brick column ☐ Steel column ☒ Reinforced concrete column ☐ Other	
Façade	Colour	Red brick	☒ No observed damage ☐ Minor damages ☐ Significant damage ☐____________
	Material	☐Ganged brick ☐Ceramic tile ☐Cement ☐Plastering ☒Other Red brick	
Main entrance/exit	Door materials	☐Copper ☐Steel ☐Wood ☐Mixed ☐Other	☐ No observed damage ☐ Minor damages ☒ Significant damage
	Shape	☒Rectangular ☐Round ☐Arched ☐Other	

			□___________
Main facade window	Window frame material	□Steel ⊠Wood □Other	⊠No observed damage □ Minor damages □ Significant damage □___________
	Shape	⊠Rectangular □Round □Arched □Other	
Roof	Form	□Gable Roof □Mansard Roof □Flat Roof ⊠Other Arched	⊠ No observed damage □ Minor damages □ Significant damage □___________
	Roof frame	□Timber Roof Frame ⊠Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other	
	Tile/roofing sheets	Colour: Stone Gray	
		Form: Rectangular	
		Material: Clay tile	
	Lantern roof	□Yes ⊠No	
	Chimneys	□Yes, Quantity:_____ ⊠No	

k) 13# building

Table E. 15. Table of a survey of 13# building of the Shenxin Yarn Factory

Name of building	Current name	13# building	Physical condition
	Former name	Xinqin Machinery Factory Office Building	
Area of the building (m^2)	3000 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	1965		
Date of reuse	Under construction		
Current use	Planned for theatre		
Original use	Office		

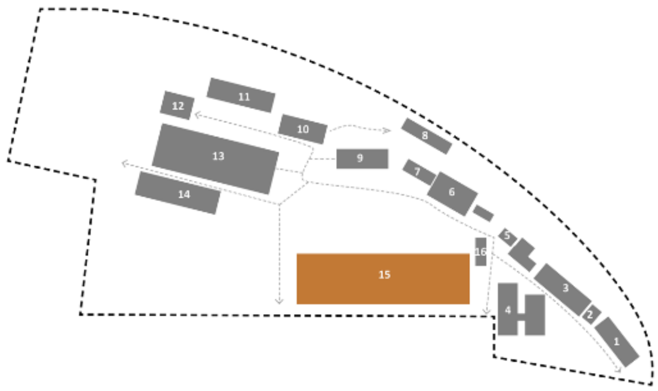
Location			
Current photo (Source: Author)	 		
Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □Brick □ Brick and concrete ☒ Reinforced concrete □Steel □Other	☒ No observed damage □ Minor damages □ Significant damage □ ________________
	Column	□ Wooden column □ Brick column □ Steel column ☒ Reinforced concrete column □ Other	
Façade	Colour	Stone Gray	☒ No observed damage □ Minor damages
	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other	

			□ Significant damage □________________
Main entrance/exit	Door materials	□Copper □Steel □ Wood □Mixed □Other	□ No observed damage □ Minor damages ⊠Significant damage □________________
	Shape	⊠Rectangular □Round □Arched □Other	
Main facade window	Window frame material	□Steel □Wood □Other	□No observed damage □ Minor damages ⊠ Significant damage □________________
	Shape	⊠Rectangular □Round □Arched □Other	
Roof	Form	□Gable Roof □Mansard Roof □ Flat Roof ⊠Other Arched	□ No observed damage □ Minor damages ⊠ Significant damage □________________
	Roof frame	□ Timber Roof Frame ⊠Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other	
	Tile/roofing sheets	Colour	
		Form	
		Material	
	Lantern roof	□Yes ⊠No	
	Chimneys	□Yes, Quantity:_____ ⊠No	

l) 15# building

Table E. 16. Table of a Survey of 15# Building of the Shenxin Yarn Factory

Name of building	Current name	15# building	Physical condition
	Former name	Machine shop	
Area of the building (m^2)	4200 m^2 (Data obtained through interviews with the project manager on 09/12/2022)		
Build Date	1966		
Date of reuse	Under construction		
Current use	Planed for museum		
Original use	Machining		

Location			
Current photo (Source: Author)	 		
Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □Other		
Structure	Form	□Timber □Brick □ Brick and concrete ☒ Reinforced concrete □Steel □Other	☒ No observed damage □ Minor damages □ Significant damage □ ________________
	Column	□ Wooden column □ Brick column □ Steel column ☒ Reinforced concrete column □ Other	
Façade	Colour	Stone Gray	☒ No observed damage □ Minor damages □ Significant damage
	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other	

<table>
<tr><td></td><td></td><td colspan="2"></td><td>□__________________</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel □Wood □Mixed □Other</td><td rowspan="2">□ No observed damage
□ Minor damages
⊠ Significant damage
□__________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel □Wood □Other</td><td rowspan="2">□ No observed damage
□ Minor damages
⊠Significant damage
□__________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="7">Roof</td><td>Form</td><td colspan="2">⊠Gable Roof □Mansard Roof □Flat Roof □Other</td><td rowspan="7">□ No observed damage
□ Minor damages
⊠Significant damage
□__________________</td></tr>
<tr><td>Roof frame</td><td colspan="2">□Timber Roof Frame ⊠Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td></td></tr>
<tr><td>Form</td><td></td></tr>
<tr><td>Material</td><td></td></tr>
<tr><td>Lantern roof</td><td colspan="2">□Yes ⊠No</td></tr>
<tr><td>Chimneys</td><td colspan="2">□Yes, Quantity:_____
⊠No</td></tr>
</table>

(3) Current status of the third phase of the transformation of the Shenxin Yarn Factory

Table E. 17. Table of a Survey of the Dormitory Area of the Shenxin Yarn Factory

<table>
<tr><td rowspan="2">Name of building</td><td>Current name</td><td>Workers’ dormitory area</td><td>Physical condition</td></tr>
<tr><td>Former name</td><td>Workers’ dormitory area</td><td rowspan="6"></td></tr>
<tr><td>Area of the building (m^2)</td><td colspan="2">5438 m^2 (Data obtained through interviews with the project manager on 11/12/2022)</td></tr>
<tr><td>Build Date</td><td colspan="2">1938-1970</td></tr>
<tr><td>Date of reuse</td><td colspan="2">Abandoned</td></tr>
<tr><td>Current use</td><td colspan="2">Planed for Family Hotels</td></tr>
<tr><td>Original use</td><td colspan="2">Residential area</td></tr>
</table>

Location		
Current photo (Source: Author)	  	

<table>
<tr><td></td><td colspan="3"></td><td rowspan="2"></td></tr>
<tr><td>Building type</td><td colspan="3">□ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse ⊠Other <u>Single floor of the house</u></td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td colspan="2">□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Column</td><td colspan="2">□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Façade</td><td>Colour</td><td colspan="2">Red brick</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Material</td><td colspan="2">□Ganged brick □Ceramic tile □Cement □Plastering ⊠Other <u>Red brick</u></td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel ⊠Wood □Mixed □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel ⊠Wood □Other</td><td rowspan="2">⊠No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="5">Roof</td><td>Form</td><td colspan="2">□Gable Roof □Mansard Roof ⊠Flat Roof □Other</td><td rowspan="5">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Roof frame</td><td colspan="2">⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>Stone Gray</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
<tr><td>Material</td><td>Clay tile</td></tr>
</table>

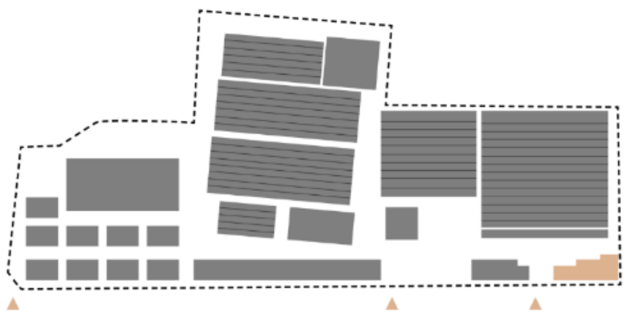
	Lantern roof	☐Yes ☒No	
	Chimneys	☒Yes, Quantity :__1___ ☐No	

(4) Current Status of the Fourth Phase of the Transformation of the Shenxin Yarn Factory

Through interviews with the staffer, it was learned that the Baofang Group is now in a state of shutdown and plans to declare bankruptcy. The fourth phase of the Changle Plateau transformation project is planned to take place after Baofang Group declared bankruptcy. The roads in the factory are simple and spacious, with paving in the form of concrete and slate. The factory building is divided into three main forms: single-storey sawtooth factory, thin shell factory with double curved structure and unequal height multi-span factory.

a) Complex building

Table E. 18. Table of a Survey of the Complex Building of the Shenxin Yarn Factory

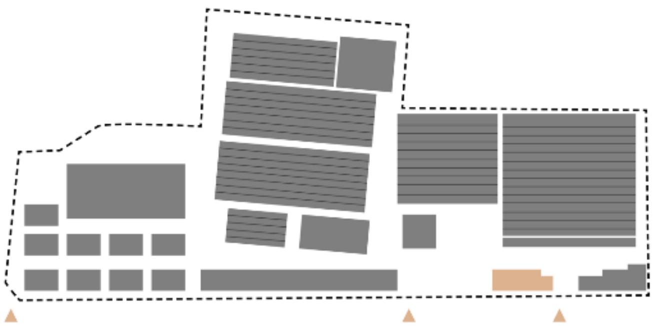
Name of building	Current name	Complex building	Physical condition
	Former name	Complex building	
Area of the building (m^2)	1520 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	1986		
Date of reuse	Abandoned		
Current use	Abandoned		
Original use	Office		
Location			

<table>
<tr><td>Current photo (Source: Author)</td><td colspan="3"></td><td></td></tr>
<tr><td>Building type</td><td colspan="3">□ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse ⊠Other <u>2 floors of office</u></td><td></td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td colspan="2">□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Column</td><td colspan="2">□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Façade</td><td>Colour</td><td colspan="2">White</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Material</td><td colspan="2">□Ganged brick ⊠Ceramic tile □Cement □Plastering □Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper ⊠Steel □Wood □Mixed □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel □Wood ⊠Others <u>Plastic steel</u></td><td rowspan="2">⊠No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="5">Roof</td><td>Form</td><td colspan="2">□Gable Roof □Mansard Roof ⊠Flat Roof □Other</td><td rowspan="5">⊠ No observed damage
□ Minor damages
□ Significant damage
□_______________</td></tr>
<tr><td>Roof frame</td><td colspan="2">⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>Gray</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
<tr><td>Material</td><td>Concrete</td></tr>
</table>

	Lantern roof	□Yes ⊠No	
	Chimneys	□Yes, Quantity:_____ ⊠No	

b) Staff canteen

Table E. 19. Table of a Survey of Staff Canteen of the Shenxin Yarn Factory

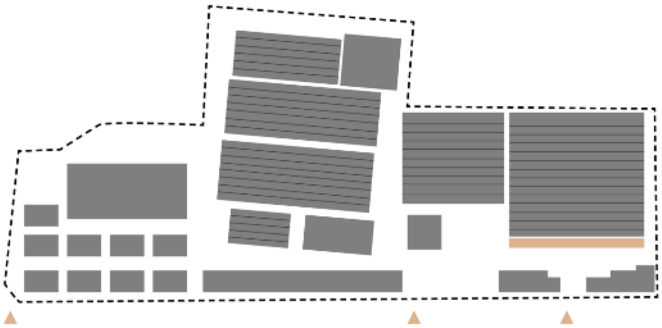
Name of building	Current name	Staff Canteen	Physical condition
	Former name	Staff Canteen	
Area of the building (m^2)	510 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	1986		
Date of reuse	Abandoned		
Current use	Abandoned		
Original use	Canteen		
Location			
Current photo (Source: Author)			
Building type	⊠ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □Brick □ Brick and concrete ⊠ Reinforced concrete	⊠ No observed damage

		□Steel □Other		□ Minor damages □ Significant damage □___________________
	Column	□ Wooden column □ Brick column □ Steel column ☒Reinforced concrete column □ Other		
Facade	Colour	Stone Gray		☒ No observed damage □ Minor damages □ Significant damage □___________________
	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel ☒Wood □Mixed □Other		☒ No observed damage □ Minor damages □ Significant damage □___________________
	Shape	☒Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel ☒Wood □Other		☒No observed damage □ Minor damages □ Significant damage □___________________
	Shape	☒Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ☒Flat Roof □Other		☒ No observed damage □ Minor damages □ Significant damage □___________________
	Roof frame	☒Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ☒No		
	Chimneys	□Yes, Quantity:______ ☒No		

c) Administration building

Table E. 20. Table of a survey of the Administration Building of the Shenxin Yarn Factory

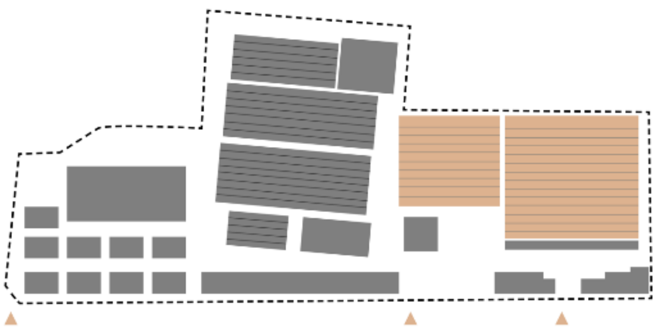
Name of building	Current name	Administration Building	Physical condition
	Former name	Administration Building	
Area of the building (m^2)	1150 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		

<table>
<tr><td>Build Date</td><td colspan="2">1986</td><td rowspan="7"></td></tr>
<tr><td>Date of reuse</td><td colspan="2"></td></tr>
<tr><td>Current use</td><td colspan="2">Office</td></tr>
<tr><td>Original use</td><td colspan="2">Office</td></tr>
<tr><td>Location</td><td colspan="2"></td></tr>
<tr><td>Current photo (Source: Author)</td><td colspan="2">
</td></tr>
<tr><td>Building type</td><td colspan="2">□ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse ⊠Other <u>5 floors office</u></td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td>□Timber □Brick □Brick and concrete ⊠ Reinforced concrete
□Steel □Other</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□______________</td></tr>
<tr><td>Column</td><td>□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td>Yellow</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□______________</td></tr>
<tr><td>Material</td><td>□Ganged brick □Ceramic tile □Cement □Plastering ⊠Other <u>Paint</u></td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td>□Copper □Steel □Wood □Mixed ⊠ Other <u>Glass door</u></td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□______________</td></tr>
<tr><td>Shape</td><td>⊠Rectangular □Round □Arched □Other</td></tr>
</table>

Main facade window	Window frame material	☐Steel ☒Wood ☐Other		☒No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Shape	☒Rectangular ☐Round ☐Arched ☐Other		
Roof	Form	☐Gable Roof ☐Mansard Roof ☒Flat Roof ☐Other		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Roof frame	☒Timber Roof Frame ☐Steel Roof Frame ☐Steel Reinforced Concrete Roof Frame ☐Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Concrete	
	Lantern roof	☐Yes ☒No		
	Chimneys	☐Yes, Quantity:_____ ☒No		

d) Main production workshop

Table E. 21. Table of a Survey of Main Production Workshop of the Shenxin Yarn Factory

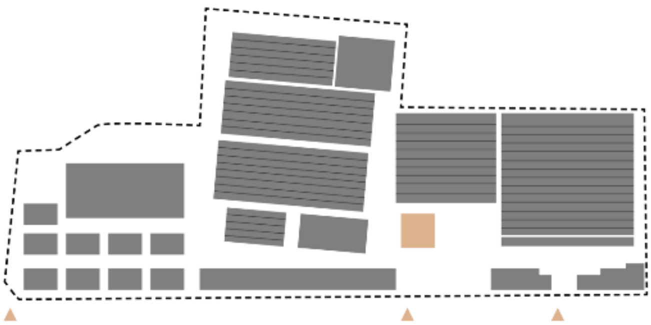
Name of building	Current name	Main production workshop	Physical condition
	Former name	Main production workshop	
Area of the building (m^2)	11260 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	1939		
Date of reuse			
Current use	Abandoned		
Original use	Weaving workshop		
Location			

Current photo (Source: Author)	 		
Building type	☒Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □Other		
Structure	Form	□Timber □Brick □ Brick and concrete ☒ Reinforced concrete □Steel □Other	☒ No observed damage □ Minor damages □ Significant damage □__________________
	Column	□ Wooden column □ Brick column □ Steel column ☒Reinforced concrete column □ Other	
Facade	Colour	Gray orange	☒ No observed damage □ Minor damages □ Significant damage □__________________
	Material	□Ganged brick □Ceramic tile □Cement □Plastering ☒Other Granitic plaster	
Main entrance/exit	Door materials	□Copper □Steel ☒Wood □Mixed □Other	☒ No observed damage □ Minor damages □ Significant damage □__________________
	Shape	☒Rectangular □Round □Arched □Other	
Main facade window	Window frame material	□Steel ☒Wood □Other	☒No observed damage □ Minor damages

	Shape	☒Rectangular ☐Round ☐Arched ☐Other		☐ Significant damage ☐_______________
Roof	Form	☐Gable Roof ☐Mansard Roof ☐Flat Roof ☒Other Sawtooth Roof		☒ No observed damage ☐ Minor damages ☐ Significant damage ☐_______________
	Roof frame	☒Timber Roof Frame ☐Steel Roof Frame ☐Steel Reinforced Concrete Roof Frame ☐Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Corrugated iron sheet	
	Lantern roof	☐Yes ☒No		
	Chimneys	☐Yes, Quantity:_____ ☒No		

f) Stokehold

Table E. 22. Table of a Survey of Stokehold of the Shenxin Yarn Factory

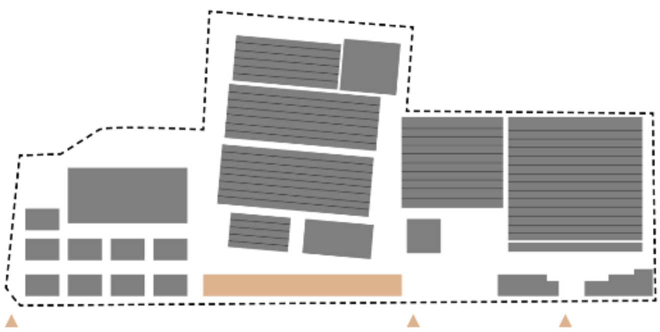
Name of building	Current name	Stokehold	Physical condition
	Former name	Stokehold	
Area of the building (m^2)	810 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	1941		
Date of reuse			
Current use	Abandoned		
Original use	Heating and production		
Location			

Current photo (Source: Author)	 		
Building type	□ Single storey plant ⊠Multi storey plant □ Single storey warehouse □ Multi storey warehouse □Other		
Structure	Form	□Timber □Brick ⊠ Brick and concrete □ Reinforced concrete □Steel □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column ⊠ Brick column □ Steel column □ Reinforced concrete column □ Other	
Facade	Colour	Stone Gray	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Material	⊠Ganged brick □Ceramic tile □Cement □Plastering □Other	
Main entrance/exit	Door materials	□Copper □Steel ⊠Wood □Mixed □Other	⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other	
Main facade window	Window frame material	□Steel ⊠Wood □Other	⊠No observed damage □ Minor damages □ Significant damage □_______________
	Shape	⊠Rectangular □Round □Arched □Other	

Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

g) Picking cotton workshop

Table E. 23. Table of a Survey of Picking Cotton Workshop of the Shenxin Yarn Factory

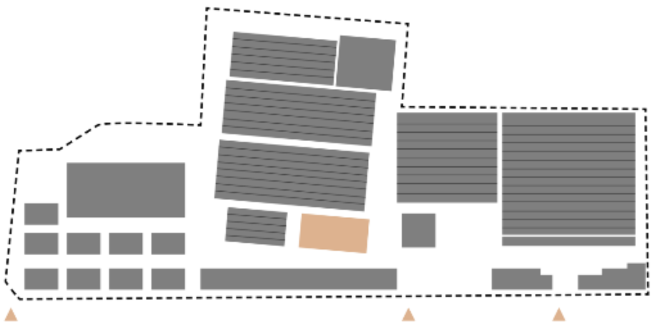
Name of building	Current name	Picking cotton workshop	Physical condition
	Former name	Picking cotton workshop	
Area of the building (m^2)	3870 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	1939		
Date of reuse			
Current use	Abandoned		
Original use	A workshop for picking cotton		
Location			

<table>
<tr><td>Current photo (Source: Author)</td><td colspan="3">
</td><td rowspan="2"></td></tr>
<tr><td>Building type</td><td colspan="3">☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other</td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td colspan="2">□Timber □Brick ☒ Brick and concrete □ Reinforced concrete
□Steel □Other</td><td rowspan="2">☒ No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Column</td><td colspan="2">□ Wooden column ☒ Brick column □ Steel column □ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td colspan="2">Stone Gray</td><td rowspan="2">☒ No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Material</td><td colspan="2">☒Ganged brick □Ceramic tile □Cement □Plastering □Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel ☒Wood □Mixed □Other</td><td rowspan="2">☒ No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Shape</td><td colspan="2">☒Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel ☒Wood □Other</td><td rowspan="2">☒No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Shape</td><td colspan="2">☒Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="6">Roof</td><td>Form</td><td colspan="2">□Gable Roof □Mansard Roof ☒Flat Roof □Other</td><td rowspan="6">☒ No observed damage
□ Minor damages
□ Significant damage
□________________</td></tr>
<tr><td>Roof frame</td><td colspan="2">☒Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>Stone Gray</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
<tr><td>Material</td><td>Clay tile</td></tr>
<tr><td>Lantern roof</td><td colspan="2">□Yes ☒No</td></tr>
</table>

	Chimneys	□Yes, Quantity:_____ ⊠No	

h) Textile machine workshop

Table E. 24. Table of a Survey of Textile Machine Workshop of the Shenxin Yarn Factory

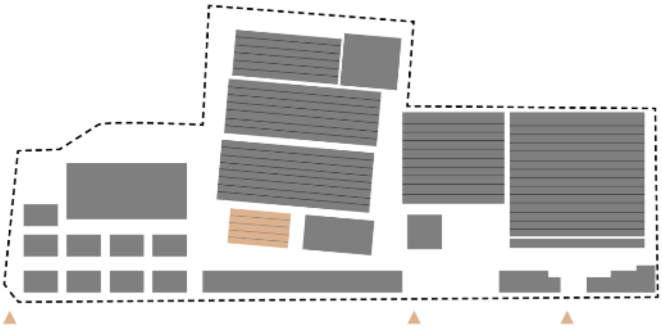
Name of building	Current name	Textile machine workshop	Physical condition
	Former name	Textile machine workshop	
Area of the building (m^2)	2230 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	1986		
Date of reuse			
Current use	Abandoned		
Original use	Spin and weave cloth		
Location			
Current photo (Source: Author)			
Building type	□ Single storey plant ⊠ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □ Brick □ Brick and concrete ⊠Reinforced concrete	⊠ No observed damage

		□Steel □Other		□ Minor damages □ Significant damage □________________
	Column	□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other		
Facade	Colour	Gray orange		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Material	□Ganged brick □Ceramic tile □Cement □Plastering ⊠Other Granitic plaster		
Main entrance/exit	Door materials	□Copper □Steel ⊠Wood □Mixed □Other		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Shape	⊠Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel ⊠Wood □Other		⊠No observed damage □ Minor damages □ Significant damage □________________
	Shape	⊠Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □________________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

i) Blowing room

Table E. 25. Table of a Survey of Blowing Room of the Shenxin Yarn Factory

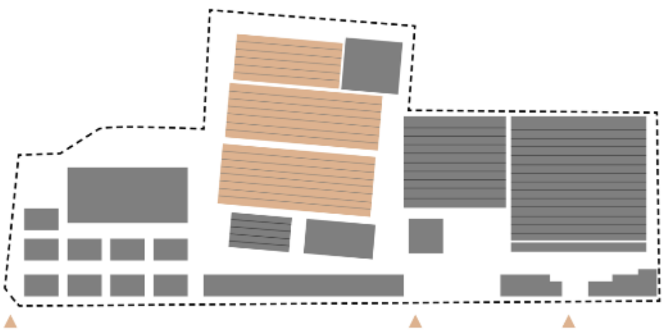
Name of building	Current name	Blowing room	Physical condition
	Former name	Blowing room	
Area of the building (m^2)	2820 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	2001		
Date of reuse			

Current use	Abandoned		
Original use	Blowing cotton		
Location			
Current photo (Source: Author)			
Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □ Other		
Structure	Form	□Timber □Brick ☒ Brick and concrete □ Reinforced concrete □Steel □Other	☒ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column ☒ Brick column □ Steel column □ Reinforced concrete column □ Other	
Facade	Colour	Stone Gray	☒ No observed damage □ Minor damages □ Significant damage □_______________
	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other	
Main entrance/exit	Door materials	□Copper □Steel ☒Wood □Mixed □Other	☒ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	☒Rectangular □Round □Arched □Other	
Main facade window	Window frame material	□Steel ☒Wood □Other	☒No observed damage □ Minor damages

	Shape	⊠Rectangular □Round □Arched □Other		□ Significant damage □_______________
Roof	Form	□Gable Roof □Mansard Roof ⊠Flat Roof □Other		⊠ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	⊠Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Stone Gray	
		Form	Rectangular	
		Material	Clay tile	
	Lantern roof	□Yes ⊠No		
	Chimneys	□Yes, Quantity:_____ ⊠No		

j) Spinning workshop

Table E. 26. Table of a Survey of Spinning Workshop of the Shenxin Yarn Factory

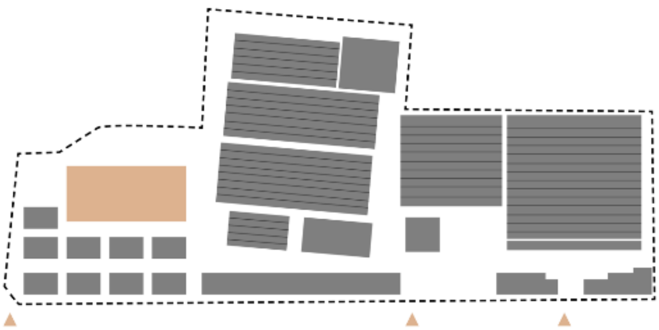
Name of building	Current name	Spinning workshop	Physical condition
	Former name	Spinning workshop	
Area of the building (m^2)	14100 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	1986		
Date of reuse			
Current use	Abandoned		
Original use	Spinning workshop		
Location			

Current photo (Source: Author)				
Building type	☒ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □Other			
Structure	Form	□Timber □Brick ☒ Brick and concrete □ Reinforced concrete □Steel □Other		☒ No observed damage □ Minor damages □ Significant damage □_______________
	Column	□ Wooden column ☒ Brick column □ Steel column □ Reinforced concrete column □ Other		
Facade	Colour	Stone Gray		☒ No observed damage □ Minor damages □ Significant damage □_______________
	Material	☒Ganged brick □Ceramic tile □Cement □Plastering □Other		
Main entrance/exit	Door materials	□Copper □Steel ☒Wood □Mixed □Other		☒ No observed damage □ Minor damages □ Significant damage □_______________
	Shape	☒Rectangular □Round □Arched □Other		
Main facade window	Window frame material	□Steel ☒Wood □Other		☒No observed damage □ Minor damages □ Significant damage □_______________
	Shape	☒Rectangular □Round □Arched □Other		
Roof	Form	□Gable Roof □Mansard Roof □ Flat Roof ☒Other Sawtooth Roof		☒ No observed damage □ Minor damages □ Significant damage □_______________
	Roof frame	☒Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other		
	Tile/roofing sheets	Colour	Blue	
		Form	Rectangular	
		Material	Granitic plaster	
	Lantern roof	□Yes ☒No		

	Chimneys	□Yes, Quantity:_____ ⊠No	

k) Manufacturing workshop

Table E. 27. Table of a Survey of Manufacturing Workshop of the Shenxin Yarn Factory

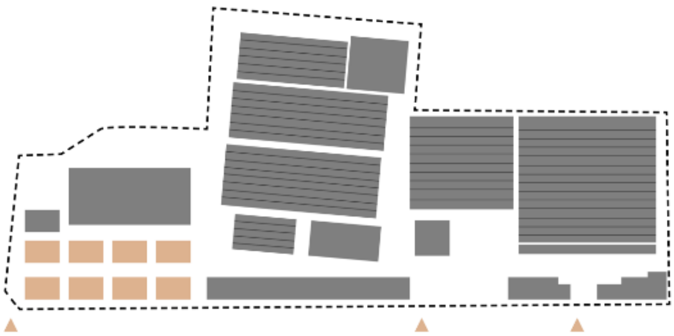
Name of building	Current name	Manufacturing workshop	Physical condition
	Former name	Manufacturing workshop	
Area of the building (m^2)	4430 m^2 (Data obtained through interviews with the project manager on 11/12/2022)		
Build Date	2000		
Date of reuse			
Current use	Abandoned		
Original use	Finished products workshop		
Location			
Current photo (Source: Author)			
Building type	⊠ Single storey plant □ Multi storey plant □ Single storey warehouse □ Multi storey warehouse □Other		
Structure	Form	□Timber □Brick □ Brick and concrete ⊠ Reinforced concrete	⊠ No observed damage

<table>
<tr><td rowspan="2"></td><td></td><td colspan="2">□Steel □Other</td><td rowspan="2">□ Minor damages
□ Significant damage
□__________________</td></tr>
<tr><td>Column</td><td colspan="2">□ Wooden column □ Brick column □ Steel column ⊠ Reinforced concrete column □ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td colspan="2">White and light yellow</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□__________________</td></tr>
<tr><td>Material</td><td colspan="2">□Ganged brick ⊠Ceramic tile □Cement □Plastering □Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td colspan="2">□Copper □Steel □Wood □Mixed ⊠ Other Glass door</td><td rowspan="2">⊠ No observed damage
□ Minor damages
□ Significant damage
□__________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="2">Main facade window</td><td>Window frame material</td><td colspan="2">□Steel □Wood ⊠Other Plastic steel</td><td rowspan="2">⊠No observed damage
□ Minor damages
□ Significant damage
□__________________</td></tr>
<tr><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td></tr>
<tr><td rowspan="7">Roof</td><td>Form</td><td colspan="2">□Gable Roof □Mansard Roof ⊠Flat Roof □Other</td><td rowspan="7">⊠ No observed damage
□ Minor damages
□ Significant damage
□__________________</td></tr>
<tr><td>Roof frame</td><td colspan="2">□Timber Roof Frame ⊠Steel Roof Frame □Steel Reinforced Concrete Roof Frame □Other</td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>Bule</td></tr>
<tr><td>Form</td><td>Rectangular</td></tr>
<tr><td>Material</td><td>Coloured steel sheet roof</td></tr>
<tr><td>Lantern roof</td><td colspan="2">□Yes ⊠No</td></tr>
<tr><td>Chimneys</td><td colspan="2">□Yes, Quantity:______
⊠No</td></tr>
</table>

l) Warehouse

Table E. 28. Table of a Survey of the Warehouse of the Shenxin Yarn Factory

<table>
<tr><td rowspan="2">Name of building</td><td>Current name</td><td>Warehouse</td><td>Physical condition</td></tr>
<tr><td>Former name</td><td>Warehouse</td><td rowspan="4"></td></tr>
<tr><td>Area of the building (m^2)</td><td colspan="2">4240 m^2 (Data obtained through interviews with the project manager on 11/12/2022)</td></tr>
<tr><td>Build Date</td><td colspan="2">1939</td></tr>
<tr><td>Date of reuse</td><td colspan="2"></td></tr>
</table>

<table>
<tr><td>Current use</td><td colspan="2">Abandoned</td><td rowspan="5"></td></tr>
<tr><td>Original use</td><td colspan="2">Storage space</td></tr>
<tr><td>Location</td><td colspan="2"></td></tr>
<tr><td>Current photo (Source: Author)</td><td colspan="2"></td></tr>
<tr><td>Building type</td><td colspan="2">☒ Single storey plant ☐ Multi storey plant ☐ Single storey warehouse ☐ Multi storey warehouse ☐Other</td></tr>
<tr><td rowspan="2">Structure</td><td>Form</td><td>☐Timber ☒ Brick ☐ Brick and concrete ☐ Reinforced concrete
☐Steel ☐Other</td><td rowspan="2">☒ No observed damage
☐ Minor damages
☐ Significant damage
☐ ________________</td></tr>
<tr><td>Column</td><td>☐ Wooden column ☒ Brick column ☐ Steel column ☐ Reinforced concrete column ☐ Other</td></tr>
<tr><td rowspan="2">Facade</td><td>Colour</td><td>Stone Gray</td><td rowspan="2">☒ No observed damage
☐ Minor damages
☐ Significant damage
☐ ________________</td></tr>
<tr><td>Material</td><td>☒Ganged brick ☐Ceramic tile ☐Cement ☐Plastering ☐Other</td></tr>
<tr><td rowspan="2">Main entrance/exit</td><td>Door materials</td><td>☐Copper ☒Steel ☐Wood ☐Mixed ☐Other</td><td rowspan="2">☒ No observed damage
☐ Minor damages
☐ Significant damage
☐ ________________</td></tr>
<tr><td>Shape</td><td>☒Rectangular ☐Round ☐Arched ☐Other</td></tr>
<tr><td>Main facade window</td><td>Window frame material</td><td>☒Steel ☐Wood ☐Other</td><td>☒No observed damage
☐ Minor damages</td></tr>
</table>

<table>
<tr><td></td><td>Shape</td><td colspan="2">⊠Rectangular □Round □Arched □Other</td><td>□ Significant damage
□__________________</td></tr>
<tr><td rowspan="7">Roof</td><td>Form</td><td colspan="2">□Gable Roof □Mansard Roof □Flat Roof ⊠Other <u>Double curved arch construction</u></td><td rowspan="7">⊠ No observed damage
□ Minor damages
□ Significant damage
□__________________</td></tr>
<tr><td>Roof frame</td><td colspan="2">□Timber Roof Frame □Steel Roof Frame □Steel Reinforced Concrete Roof Frame ⊠Other <u>Brick</u></td></tr>
<tr><td rowspan="3">Tile/roofing sheets</td><td>Colour</td><td>Stone Gray</td></tr>
<tr><td>Form</td><td>Double curved arch</td></tr>
<tr><td>Material</td><td>Waterproof coating</td></tr>
<tr><td>Lantern roof</td><td colspan="2">□Yes ⊠No</td></tr>
<tr><td>Chimneys</td><td colspan="2">□Yes, Quantity:_____
⊠No</td></tr>
</table>

The heritage is representative of the times. The former site of the Shenxin Yarn Factory was one of the most important national industries during the War of Resistance against Japan in China and was well-known throughout the country at the time. The textile production of the Shenxin Yarn Factory can be witnessed in the level of development of China's textile industry during the war of resistance. The cave-dwelling workshops and the thin shell workshop were both innovations in a specific wartime historical context. The cave-dwelling workshop, in particular, was a production workshop carved out by the Shenxin Yarn Factory in the face of Japanese bombardment and is a unique innovation in the country.