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Assessing the Adaptive Reuse of Old Industrial Buildings:

Applying Maslow's hierarchy of needs and fuzzy comprehensive evaluation method

by

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Abstract

In many cases, the purpose of reusing old industrial buildings is to meet the needs of the new generation. Converting a building that had a particular function and is unfamiliar to the public to a civic building is a great challenge. Significantly, the public's curiosity towards a special-purpose industrial building alone is not enough to give the building a long life following its conversion and regeneration. To be sustainable in public life, the design of reused old industrial buildings should also meet the needs of users. To do so, this research will draw upon Maslow's Hierarchy of Needs (Maslow, 1943), and translates this psychological theory into the field of architecture to develop an assessment framework for the reuse of old industrial buildings. This assessment framework will be combined with the fuzzy mathematical model to enable a quantitative assessment of reused old industrial buildings. In doing so, the thesis focuses upon Shanghai 1933 Old Millfun, and Dalian Industrial Culture Exhibition Hall as case studies for its demonstration. The cases demonstrate how the assessment methodology created by this study can be used, not only to show the framework's application, but also to make recommendations for the future development of examed cases. The research achieves a multidisciplinary combination, among which, the integration with psychology makes the building more human; the mathematics makes the building assessment comparable. Furthermore, the findings of the assessment framework serve as a reminder of the design of similar buildings in the future, thus enhancing the publicness of the project.

Keywords: old industrial buildings; adaptive reuse; public needs; active participants; Maslow's Hierarchy of Needs; assessment framework; fuzzy comprehensive evaluation method

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Chapter 1

Introduction

When mentioning the reuse of old industrial buildings, most scholars are impressed by industrial heritage. In a way, it is looking backwards, and they focus on the history and culture. However, this research is not only a research of historical culture, but also a proposed approach to the future long-term survival of a reusing project.

1.1. General background

Changes in technical capability, economic opportunity, social and demand awareness, and the understanding of sustainable development have been important factors in determining architectural development in urban areas (Roberts and Sykes, 2000). As a result, urban renewal has often eliminated older buildings and structures without considering their future potential in urban areas. Indeed, old industrial buildings, which are often an inevitable and obsolete product of urban regeneration, are a prime example of this. Although the functional life of the manufacturing has already finished for these buildings, structural and cultural life can still coexist within the built environment. The subsequent demolition of such buildings may not be the most appropriate outcome due to various sustainability issues, such as the embodied energy in the buildings, but also importantly the destruction of the architectural diversity, meaning attachment and urban identity. Adaptive reuse can be an effective way to deal with old industrial buildings in cities (Orange, 2016; Bole, 2021; Zheng, et al., 2022a; Zheng, et al., 2022b). Reused old industrial buildings use their unique value and attractiveness to blossom in the city.

Buildings are designed for human use, especially these transformations from industrial to civil buildings. There is often a conflict in information exchange and understanding between architects and building users. Although both parties do their best in their respective areas of responsibility, the medium of communication between them is not as direct as speaking or writing, but indirectly through the architectural spaces, layout, materials, and atmosphere of the building. It can be important for architects to be able to apply and cater for the demand of the public's ideas for architectural design. Thus, when old industrial buildings that were originally closed are reused and reopened to the public, how to attract the public and gain highly rated from their perspective is a key challenge.

1.2. Research motivation

The research is passionate about the historical and cultural importance of architectural and urban legacies of previous industrial eras. He strongly believes that people need to find suitable strategies for not only bringing life back into these unique places through their conservation and revitalisation, but also reusing these old resources to adapt to the need of contemporary society. The reuse of these old buildings not only maintains the identity of the city, but is also a rational use of resources.

The research in the UK, which is full of monuments left by the ‘Industrial Revolution’, and was the pioneer to realise that the industrial heritage should be given a new life. From the 1980s, the British government restricted the demolition of many important but obsolete industrial buildings. Up to now, the successful achievements of reusing industrial buildings in the UK can be seen everywhere, such as Tate Modern in London, Royal Albert Dock in Liverpool, and Brindley Place in Birmingham. However, in other parts of the world, there are large numbers of old industrial buildings awaiting their fate, especially in China. According to the National Development and Reform Commission of China, from 2013 to 2022, China plans to restructure 120 old industrial cities across the country, covering a total area of 140 km^2 and a population of 390 million; in the future, China will focus on improving the quality of urban regeneration for areas under renovation, involving high technology, education, greenery, humanities and history (Zheng, et al., 2022b). Combined with the power of China, a huge industrial buildings revitalisation market has already been provided to the world in this field.

Although research and practice on the reuse of old industrial buildings have accumulated many achievements, there are still many scientific questions that need to be further explored. For example, the industrial aesthetic has not yet been fully explored, and industrial style is not only synonymous with retro, dark, and rough (Jensen, et al., 2001; Rodgers, 2014). It can be seen that the success of a reused old industrial building can be judged in many dimensions. For example, are the old industrial building transformation projects now able to inspire the public to come? There is often a conflict in information exchange and understanding between architects and building users. After all, although both parties do their best in their respective areas of responsibility, the medium of communication between them is not as direct as speaking or writing, but indirectly through the architectural spaces, layout, materials, and atmosphere of the building. The research presented in this thesis will question whether the many projects, even the so-called successful ones, can still be considered successful in terms of meeting the needs of the users. The study will use the 'world experimental base' of China

as an applied context to judge the success of reused old industrial buildings from a new perspective.

1.3. Research questions

As mentioned above, the study will evaluate the success of the reuse of old industrial buildings from a new perspective. This new perspective, including the research subjects, relevant research achievements, and research questions will be discussed in the following section.

1.3.1. Research subjects

Since the publication of Yi-Fu Tuan's Space and Place (1977), the distinction between the more abstract nature of space and the experienced nature of the place has been understood. As Tuan (1977: 6) observed, *"what begins as undifferentiated space becomes place as we get to know it better and endow it with value."* A space, therefore, becomes a place when it is used and valued by people (Sherry, 1998; Cresswell, 2014), often involving a process of appropriation that leads to a sense of belonging and symbolic meaning (Visconti, et al., 2010). In short, people in the building are the key to determining what this space can be as a place. Architecture is a service to people, and all architecture is determined by the physical and psychological experience of its users. The theories that are dominated by the Phenomenology of Perception are all based on the human experience and perception that drives architectural theory.

Users in a building are often referred to as the participants. They include not only those who come to the building to use architectural functions, but also those who simply stay there for a short time. According to the different functions of the building, the participants can be divided into 2 categories, which are active and passive. Active participants mean the participants are active, they are free to choose whether or not to take part in the building without burden, such as visitors in museums or customers in stores. By contrast, passive participants have much less freedom. To some extent, they 'have to' use the building. Or, if they refuse, it will have some negative impact on their lives. For example, workers in factories and offices, whose lives (income) rely on using the buildings. Therefore, they are passive. In terms of architecture, in most cases, there will be two categories of people involved in the same building at the same time. The proportion of people in the two categories is different depending on the building functions (Figure 1.3.1-1). The participants in the public buildings we commonly see are mostly active participants, they might be customers and visitors. Besides, there are also some people working in the building, like sellers and staff, they are passive participants who 'have to' stay or use the building. In contrast to public buildings, the proportion of participants in private buildings would be the opposite. The private building is dominated by 'insiders', with the rest possibly being a few visitors.



Figure 1.3.1-1 Different proportions of the different buildings (by author, 2020).

Active participants can be seen as free, and they are participating in the building and are more able to experience it wholeheartedly. Passive participants, on the other hand, will pay more attention to what is relevant to their work, many details will be missed as long as they do not impact their work. In public buildings, an increasing number of active participants can demonstrate that the project has sufficient charm to attract participants (Heath, et al., 2011). By contrast, in a private building, the number of passive participants is often greater than the active participants, and they are more likely to have similar backgrounds and experiences, such as colleagues in an office and students in a study place. Studying the perception of human behaviour in relation to architecture is studying a universal phenomenon. The research goes after the most fundamental perceptions within people to the exclusion of other distracting factors. Therefore, the ability to understand the feelings of a diverse group of people about a building is then closer to the true evaluation of the public building's active participants.

1.3.2. Research questions

Following in the footsteps of great scholars, there are now such scholars of architecture who are researching the relationship between architecture and human experience from the perspective of the user. This research illustrates, in a variety of ways, how architecture should serve people. Their research journey has inspired the research presented in this thesis. Although this PhD research cannot create or propose great philosophical theories of experience like the great scholars, the research theories of human cognition and experience can serve as a valuable foundation for PhD research, allowing a young generation of scholars to stand on the shoulders of giants and apply these theories across disciplines to architectural design or urban planning, thus making the future of buildings give better experiences and service to the people. This study wants to start from a more intuitive and fundamental theory and therefore chooses to address the expectations and needs of people for buildings, which are concrete and easy to specify. The needs of the building's users are clearly defined, thus allowing for a clearer indication of the standards they expect from the building. The research argues that the needs of the user need to be met before a deeper architectural experience can be discussed, and thus a philosophical system can be developed. People have different needs for different types of buildings, for example, a person may have approximately the same

needs for different buildings, but with different emphases. The research will focus on the reuse of old industrial buildings for public use.

Combining the spatial, technical, cultural, and historical characteristics of old industrial building revitalisation, the study hopes to explore the public's needs in reused old industrial buildings. There is not much research on the needs of building users, especially for the adaption of old industrial buildings. The significance of the study is therefore to fill a gap, or even to innovate, in the theory of old industrial buildings revitalisation. This has led to a further expansion of research related to the reuse of old industrial buildings from the former 'use of waste', 'restoration as old', and 'integration of the old with the new' (Zheng, et al, 2022b), to services for the public and co-development with urban residents, which include the development of the city for the benefit of the public and its inhabitants. In general, the study will analyse the strengths and weaknesses of reused old industrial buildings from a user level, in order to improve the public's experience quality in the future.

The primary research question can therefore be established as:

How can the reuse of old industrial buildings be assessed in terms of how they meet the needs of the public?

Architectural design tends to result from the application of an architect’s subjective and technical knowledge and understanding, however, the architectural design also needs to consider the needs and desires of the potential building occupants and users (Zheng, et al., 2022a). A new perspective on a renovation project that will hopefully come to resolve the conflict between the designer and the public. For example, is the designer's design what the public wants? Can the ideas that the designer wants to express be recognised by the public? Is there a particular aspect of the project that is being pursued to the neglect of the most fundamental function? and so on. The research begins with the public users (active participants); followed by reused old industrial buildings; and then the needs of the users are a criterion to test the adapted buildings. This enables the fundamental testing of how meaningful the existence of a reused building is to the public.

1.4. Research objectives

Historically, the response to the public's needs in relation to the reuse of old industrial buildings was to treat them as exhibits (Zheng, et al., 2022b). Nowadays, however, old industrial buildings, combined with the tightness of land resources, have become an intrinsic part of people's lives, such as squares, shopping malls, hotels, and so on, and the approach is now to give them a real use or purpose (Roberts and Sykes, 2000; Cheng, et al., 2019). The public tends to increasingly treat reused old industrial projects as they do other public buildings (Liu, et al, 2018). As a result, the public expects similar levels of comfort, environment, and experience, whilst also paying particular attention to the special values that come from the transformation of old industrial buildings, namely its cultural, historical, technical, aesthetic, economic, educational, and social values (Wu, et al., 2022). It is also these characteristics of the reused old industrial buildings that make them different from other public buildings. In other words, the reuse of old industrial buildings for public use contains not only public space attributes but also industrial-related attributes. Any assessment of the reuse of old industrial buildings will therefore need to be comprehensive and complex from the point of view of meeting the needs of the public.

The research question posed in Section 1.3.3 **(How can the reuse of old industrial buildings be assessed in terms of how they meet the needs of the public?)** cannot be easily answered. The PhD research divides the problem into several objectives, which serve as a plan and a step-by-step approach to the research. These objectives will help the research to concentrate and explore small goals at specific stages of the research in order to gradually complete the answers to the research questions. The study will be divided into 3 primary objectives to answer the research question:

- **What are the characteristics of reused old industrial buildings?**
- **What do participants (users) need in a reused project?**
- **How does research evaluate the case studies?**

Firstly, background research on the subject of the study (Old industrial buildings) is necessary. Industrial buildings are distinguished from civil buildings by their special characteristics that effectively arouse people's curiosity. The research is from the public view and helps to identify what the reuse of old industrial buildings brings to the public. Then, it is the other important subject of the research: public users. The research needs to identify the needs of users for these reused projects. Public groups and specific building types (industrial buildings) have their own characteristics, so the relationship between the user and reused old industrial buildings form the focus of the research. Finally, it is important to check the match between

the two, which simply means whether an adapted building can bring what the users want. Here a new assessment framework will be proposed, and its feasibility will then be evaluated with two case studies; and in the future, this theory will be extended for future reference in similar projects.

1.4.1. What are the characteristics of reused old industrial buildings?

Reused old industrial buildings are one of the subjects of this research. The characteristics of reused old industrial buildings involve a wide range of knowledge. Firstly, industrial buildings are very different from the usual civil buildings that people are familiar with. The public is unfamiliar with many industrial manufacturing processes. The buildings that are built for industrial manufacturing are completely designed to follow the needs of the manufacturing process. For example, industrial buildings have special spatial volumes and divisions, as well as huge construction components and manufacturing facilities. Therefore, the use or transformation of industrial buildings will be a new challenge, which could be very innovative, or not accepted by the public; at the same time, the different types of industry, with their own characteristics in terms of building technology, function, space, and facilities, need to be analysed on a case-by-case basis. Secondly, the issue of the reuse of old buildings is a task worthy of in-depth discussion. This, together with the combination of the characteristics and historical value of old industrial buildings, makes the research on the reuse of old industrial buildings once again raise a high level and difficulty. This is not limited to the preservation of old buildings or architectural heritage, but there are more social science issues that deserve further discussion, such as industrial manufacturing techniques, corporate culture, industrial family life, etc. Thirdly, since it involves social science issues, it is unavoidable to discuss regional cultural differences. Theoretical research and practice on the reuse of old industrial buildings vary greatly from one region to another and have distinct characteristics in different parts of the world, due to different development processes. With many influences, each region has developed or will develop its own reuse system and results. Based on the general theory, it is important to adapt it to the specific region. This is a way of respecting the culture of each region and maintaining the theoretical research of acceptability and regional identity.

1.4.2. What do participants (users) need in a reused project?

Exploring how good or bad the participants' experience of reused old industrial buildings was the aim of this study's assessment. There must be a purpose for the active participants to come to the building on their initiative. The needs of the participants become an important part of the purpose, for example, the need for historical knowledge, the need for entertainment,

and so on. The 'needs of the active participants' is therefore the perspective and the breakthrough in answering the research question in this study. Determining what the participants' needs from the building is then the key to this objective.

Maslow's Hierarchy of Needs (Maslow, 1943) is favourable theoretical support for this field of study. The research has followed the example of some scholars who have applied philosophical theories to architecture. This research hopes to use the findings of psychology as a basis for making architecture respond to the public's psychological experience. The research attempts to focus on the public users and how their needs can be satisfied by a building by using Maslow's Hierarchy of Needs as the basis for an evaluation standard. However, this is not a direct transposition of Maslow's theory, and there are many questions that need to be discussed, such as whether there is still such a hierarchical relationship and whether the building can meet all the components of each need. The translation from psychology to architecture is one of the innovative points of this research. Although psychology and architecture seem to be two different disciplines, they are closely linked by the 'human' dimension. The human being is the basis for the study of psychology, while in architecture, it is the object of service, which provides confidence in breaking down the challenge. The research will finally establish an assessment framework (a list of items describing public needs for reused industrial buildings) for reusing old industrial buildings from the perspective of the public's experiences based on Maslow's theory (Maslow, 1943).

1.4.3. How does research evaluate the case studies?

Once the assessment framework has been established, its operationalisation should be applied in real projects and demonstrate the process of application. It is a practice that tests the validity of theories. The first step is to find suitable cases. As the research subject is active participants and the study is based on the context of China, Chinese public buildings after transformation will be the target cases. The subsequent research programme is how to do site surveys and obtain the data; and how to analyse the survey data to obtain evaluation results. The proposed assessment framework will be tested in the cases in order to assess its potential as a foundation for future evaluations. In addition, the reuse of old industrial buildings is nowadays more concerned with looking backwards (historically); however, it is actually very important to look forward to the future development of the project. The assessment methodology created for this study hopes to indicate the strengths and weaknesses of the projects in terms of various public needs. The ultimate aim is to provide a strong reference for future improvements to reusing old industrial buildings.

1.5. Research methods

Research methods are important tools that enable the research to address research objectives and research questions. Thus, appropriate research methods can be effective in overcoming the challenges posed by objectives. Research methods are the fundamental driving force behind the furtherance of research, and they make academic research authentic, scientific, rational, and even innovative. The 3 research objectives in Section 1.4 **(*What are the characteristics of reused old industrial buildings?; What do participants (users) need in a reused project?; How does research evaluate the case studies?*)** can be broadly divided into theoretical and practical dimensions, and are therefore addressed in different methods. They will mainly involve: the literature review; and the case studies.

1.5.1. Literature review

The literature review is an important process in theoretical research. There is little academic research that can be done without a literature review. A literature review discusses published information in a particular subject area, and sometimes information in a particular subject area within a certain period. It aims to situate the research work in relation to existing knowledge. Without a literature review, one will not acquire an understanding of the topic under investigation, what has already been done on it, how it has been researched, and what the key related issues are (Hart,1998; Foundations of Qualitative Research in Education, 2008). Hart (1998) argues that the literature review clarifies the main theories in the subject area, in order to ensure they are applied and developed correctly in the intended research, as well as the main criticisms that have been directed to related studies in the field. The methodology of the literature review is considered to be the foundation of academic research and is useful to the overall study as it can be compared to standing on the shoulders of giants.

Firstly, the literature review is used to complete Section 1.4.1 *What are the characteristics of reused old industrial buildings?* As mentioned therein, the reuse of old industrial buildings has been developed over many years and has already achieved a lot. The study and discussion of the characteristics of reusing old industrial buildings cannot be separated from a review of existing research. From the definition, to the historical development process, to the meaning of transformation, it is no doubt that it is the result of continuous summaries by scholars after decades of exploration and practice. The literature review is the main useful method of obtaining and illustrating these findings. This research requires a search and collation of the relevant literature in order to extract a historical review, a situation description, and a theoretical summary of the reuse of old industrial buildings. The final result is a comprehensive

presentation of the characteristics and background knowledge of the reuse of old industrial buildings by using the literature review method.

Secondly, the literature review is then used in Section 1.4.2 *What do participants (users) need in a reused project?* The research will use Maslow's Hierarchy of Needs (Maslow, 1943) as a basis to develop a framework for evaluating the reuse of old industrial building space. Therefore, a literature review is necessary to interpret Maslow in the early stages of the research. Not only that, but Maslow's theory has also been developed over the years and has been interpreted by numerous scholars from different perspectives and applied in interdisciplinary fields. Such a strong theoretical research base, combined with the interpretation of Maslow's theory by many scholars in various fields, can help the research to find a translation from psychology to architecture, so as to establish an assessment framework with scientific and practical significance. Otherwise, an assessment framework that is imagined without any basis will be followed by a great possibility that it will not be actualised or will be flawed in practice on cases.

The literature review is not limited to learning from giants; it can provide valid academic theoretical support and evidence to prove that the ideas presented by the research have scientific significance and value, thus enhancing their reasonableness and credibility. Overall, a strong literature review ensures the completion of a credible study, which supports and increases the understanding of both the researcher and the reader.

1.5.2. Case studies

A case study can be likened to an experiment, after a certain result of theoretical research has been achieved, it is used to test and continuously improve the theory. This approach is used to understand the practical application of the theories that have been derived from the literature review. The case study is a very effective research method in the humanities and social sciences. It provides an in-depth study of real-world contexts for the purposes of investigation, theory development and testing, which plays an important role in advancing the knowledge base of a field (Gillham, 2000; Yin, 2014). The case study, as the main method, is used to complete Section 1.4.3 *How does research evaluate the case studies?* As such, two case studies will be examined by collecting the relevant information and comparing common and different points, to summarise reusing strategies.

In order to ensure that the research can be carried out normally, the most important prerequisite is case selection. 'Representativeness' is considered to be a standard for case selection (Seawright, and Gerring, 2008; Seawright, 2016; Underwood, et al., 2016). For this

research, a representative case should be a reused old industrial project that reflects a particular era in a region and has historical industrial characteristics. Based on these selection principles, the projects chosen for the research will be the 1933 Old Millfun in Shanghai, and Bingshan Industrial Culture Exhibition Hall in Dalian. They are both products of China, the world's experimental base for the reuse of old industrial buildings. As the industrial and economic centre of China, Shanghai has the most advanced renovation concepts in China. 1933 Old Millfun was one of the first historic industrial buildings to be revitalised in China, in the early 20th century. After almost 20 years of time and market testing, the strengths and weaknesses of the project have been fully exposed. It was a slaughterhouse that has been transformed into a public mixed-use building, a special space that attracts many visitors. Dalian, where the Bingshan Industrial Culture Exhibition Hall project is located, is a city at the heart of China's north-east industrial base and is currently the fastest growing and most economically powerful city in the north-east of China, now investing heavily in tourism and having a full visitor base. Bingshan Group is well known in Dalian, and Bingshan Industrial Culture Exhibition Hall is a project that was recently completed in 2021. It represents a new concept and technology for the reuse of old industrial buildings. Bingshan Industrial Culture Exhibition Hall has transformed an old mill into an exhibition hall showcasing the industrial culture of refrigeration equipment to provide an educational tour of industrial culture for the entertainment and consumer park in which it is located.

The two cases chosen for the research have commonalities. They are all located in the heart of their cities. They all reflect the social context of the time and are well supported by the developed industrial countries (Shanghai 1933 Old Millfun was the period of international settlement in Shanghai and the slaughterhouse was built with British technical support due to the diverse needs; Bingshan Group began with the establishment of New China and received assistance from the Soviet Union to serve the cold chain transport and storage in the port of Dalian, and then developed in cooperation with Japan and Germany, which are the top countries in the field at the time). Today, both cases have been transformed to preserve a large number of historical elements, both focus on cultural presentation and innovation, and are open to the public as important public spaces in the city. Of course, although both projects are old industrial buildings transformed into public spaces, there are differences, for example, in their scale, context, function, and time. However, it must be admitted that it is this difference that better illustrates the wide range of applications of the assessment framework for research. The fundamental aim of the study was to extend this assessment framework, which is supposed to be applied to many different types of projects, and may even be applied in the future to other non-industrial building renovations. In summary, the selection of cases is

successful as long as they demonstrate the application of the theoretical assessment framework.

While the case study method is used, the research prefers to break it down into two steps: case survey and data analysis.

1.5.2.1 Case survey

After establishing the target cases to be researched, the next step is to focus on two cases and plan the survey. The case survey method is an inexpensive way to aggregate existing research. The analyst prepares a set of structured and tightly defined questions and answers--a checklist (assessment framework)--to ascertain information about the outcomes of interest and the alternative determinants of those outcomes (Lucas, 1974). What is done in a case survey is the collection of case data, which is often considered to be the process of surveying. Based on the assessment framework established, the specific objectives of the survey are formed, that is, what data needs to be obtained. The steps of a case survey generally consist of two parts: materials (or documents) collection; and on-site survey.

Collecting materials about the project, such as historical archives, photographs, and information about the surroundings, can help to understand the context of the project. With this contextual knowledge, the on-site data collection can be carried out more in-depth and efficiently. At the same time, it is also possible to reduce confusion. Because industrial buildings are different from civil buildings in that they are characterised by a wide range of features, the understanding of many industrial architectural elements is something that requires a great deal of contextual knowledge of the historical period and industry. It is easy to see that this part of the research will also use the literature review approach. Even, to a large extent, when using the literature review method to study the context of a project, the existing research of the scholars about this case is of the great reference value, which may be theoretical analysis, research data, etc.

Once the contextual materials have been sufficiently collected, the research will have a good understanding of the project and will already know exactly what data the research wants to obtain. The purpose of the on-site survey is to verify the information collected and to obtain the required research data. The main research methods that will be used to obtain the data are field measurements, computer modelling, questionnaires, and observational methods (the detail of each method will be described in Section 5.2). The results of the on-site survey are objective and provide a true description of the situation in the case. These data can then be used to prepare for the following data analysis.

1.5.2.2 Data analysis: fuzzy comprehensive evaluation method

After the research data has been obtained, the data will be analysed and discussed in order to obtain the results, which can be fed back into the proposed new theory. The methodology for this part of the data analysis needs to be determined based on the data obtained from the previous theoretical research and case survey. The assessment framework for the reuse of old industrial buildings based on Maslow's theory is to discuss the extent to which a reused project meets the needs of the public in a variety of sub-items. However, there is still a need for a summative evaluation result of the project. Although it is possible to study the success or otherwise of a project in a variety of items within the assessment framework, it would be irresponsible to give an overall judgement about a complex building only based on the performance of certain items. Hence, it is necessary to find a scientific research method to statistically evaluate the cases in a comprehensive view based on the survey data. With this motivation, the research will use mathematical methods to perform statistics on the data obtained, that is fuzzy comprehensive evaluation method which is developed from a fuzzy set. This method is currently used by scholars to evaluate the environment, geography, green buildings, and other fields (Su, et al., 2008; Bo, et al., 2020; Guo, et al., 2022). The application of this method to the social sciences is now an innovation.

The fuzzy comprehensive evaluation method aims to evaluate the related effectiveness between the multiple factors and the comprehensive results. The basic principle of the fuzzy comprehensive evaluation method is to break down an evaluation problem into multiple influence factors (sub-items); after that, score each sub-item; and finally, calculate the result of the original evaluation problem based on the combined weight of each sub-item (Du and Pang, 2021; Guo, et al., 2022). Since the public is not expert, it is difficult for them to give professional and in-depth opinions during evaluating a comprehensive architectural issue. For example, it is difficult for the public to answer a question like *“Does this building meet your needs?”* this kind of comprehensive question. This needs to be broken down and the questions made specific by asking, *“Does the temperature of this building make you comfortable?”* or *“Are there shops that you like?”*. When the results of these specificity questions are obtained, they are statistically calculated and used to answer the comprehensive question of *“Does this building meet your needs?”,* which demonstrates the fascination of the fuzzy comprehensive evaluation method. There is a further advantage. This method, to a certain extent, can overcome subjective assumptions in the process of evaluation. When scoring each sub-item quantitatively, some of the analysis is unavoidably subjective and may result in inaccurate scoring. However, this method allows some of the subjective errors to be ignored in the fuzzy

calculation process. In layman's terms, even if there is a small error in the scoring of some deviations, it will not affect the final comprehensive result.

1.6. Thesis structure

How to evaluate the adaptive reuse of an industrial building that meets the needs of the public is the main focus of this research. Firstly, Following the introduction, the study will review issues related to the reuse of old industrial buildings, in the context of China (Chapter 2 and 3). Secondly, after understanding public needs based on Maslow's theory, an assessment framework to examine reused old industrial buildings and whether can meet the needs of the users will be established (chapter 4). The proposed assessment framework will then be tested using the case of the 1933 Old Millfun and Bingshan Industrial Culture Exhibition Hall, in order to assess its potential as a foundation for future evaluations; at the same time, ideas and suggestions to guide future design optimisations will be summarised through two case study (Chapter 5-7). Finally, the conclusion (chapter 8) will be a review and summary of the full research.

The thesis is structured as follows (Figure 1.6-1):

- Chapter 2:
  This chapter is the research on the background of old industrial buildings in China. Although 'industry'(economics) and 'industry' (manufacturing) are the same word in English, they have different meanings. 'Industry' (economics) is a generally categorised branch of economic activity (Kaplinsky, 2000); 'industry' (manufacturing) is a specific branch of economic activity, typically in factories with machinery (Gereffi, 1994). The study examines what is included in the so-called manufacturing industry, as well as the definition of industrial buildings. When it comes to the background of the industry, the 'Industrial Revolution' is naturally inseparable. The study will review the historical development of industry in the context of the world's 4 current 'Industrial Revolutions', in order to explore the evolutionary process of industrial buildings and the characteristics of the periods in China. Then, starting from the decline of factories, the causes of forming old industrial buildings are summarised in relation to the historical evolutionary process. These studies contribute to a clear understanding of the subject matter and its characteristics.

- Chapter 3
  Adaptive reuse is the premise of the research. The chapter will focus on the significance and impact analysis of reuse as a way of highlighting the important value of the research's existence. Although there are countless scholars who have studied the reuse of old industrial buildings, the reuse and old industrial buildings do not equate; that is, not all old industrial buildings are worthy of preservation. The research begins by analysing the challenges of building preservation in a practical context. Then, focusing on the reused old industrial

buildings, it analyses the winding journey to identify the development trends and the gaps, at the same time, underlining the value of this study. As an important branch of urban regeneration, adaptive reuse has a positive impact on urban regeneration and has historical, economic, and social significance. From the building itself, the industrial culture is considered as the identifying mark, which is the most discussed by scholars. In this research, the proposal of 'material industrial element' makes the preservation and transmission of industrial culture less abstract. It transfers the intangible culture to the tangible architectural components, allowing the designer to clarify the specific 'position' of the culture. At the same time, it will lay the foundation for the study of cultural needs in the following assessment framework.

- Chapter 4

  This chapter focuses on the process of establishing the assessment framework and, at the same time, is one of the key outcomes and innovations of the whole research. The study borrows from Maslow's Hierarchy of Needs, based on the previously obtained characteristics of the reuse of old industrial buildings, to explore what the reasonable needs of the public should be in a reused old industrial building. Maslow's theory is first analysed and regrouped into three dimensions (basic needs, advanced needs, and challenging needs). This makes it more applicable not only to describe a public building, but also to respond to human needs in a progressive way. Subsequently, the content of people's needs in each dimension is adapted to the space of reused old industrial buildings to discuss: what are the reasonable needs of the active participants in the building, and how the building should be constructed to meet the reasonable needs of the participants while adapting to the local human environment. The study will present an assessment framework that reflects the public's needs for reused old industrial buildings. Ultimately, this framework will develop into a series of sub-items, which will become more specific and precise evaluative components; then, it will guide the subsequent case study.

- Chapter 5 and 6

  This chapter focuses on showing the application of the assessment framework in real projects. It is fair to say that this part brings the thesis to a peak of reading interest. Two cases with rich historical stories will be presented here. Following the guidance of the assessment framework, the details of the cases will be described and presented. This chapter can be seen as the report of the field survey of 1933 Old Millfun in Shanghai and Bingshan Industrial Culture Exhibition Hall in Dalian. Firstly, there is a detailed introduction to the specific research strategy and methodology. The next section starts with the development process of the original industry and the transformation process respectively, in the hope that once the reader has gained some knowledge of the project, the reader will be able to focus on the surveying of the cases in the measuring framework. This is done by describing in detail the current situation of the cases

according to the sub-items listed in the previous section and identifying the faults, which are not meeting the needs of the public. This is then used as data for the next data analysis.

- Chapter 7

  This is a continuation of the previous chapter and is part of the case study of the thesis. After obtaining the research data in the previous chapter, the data is then handled, and the evaluation results will be obtained. In this chapter, the research innovatively combines mathematical and statistical methods to calculate data to obtain separate evaluations of public satisfaction in the two cases by the fuzzy comprehensive evaluation method. Firstly, the chapter provides a detailed introduction to the fuzzy comprehensive evaluation method, including its characteristics and operating principles, thus demonstrating that the method chosen for this study is well-suited. The results of the previous research are then digitised after a qualitative to quantitative conversion, in order to obtain the evaluation result by fuzzy calculation. The results of the evaluation of the two cases will be summarised and compared, and finally, inspiration and guidance will be collated that can be used to improve the projects.

To summarise, Chapters 2 and 3 will mainly use the methodology of the literature review, and will also be a completion of the first objective, ***What are the characteristics of reused old industrial buildings?*** Chapter 4 will be a response to the second objective, ***What do participants need in a reused project,*** where the literature review approach is still dominant. Chapters 5 to 7 are answers to the third objective, ***How does research evaluate the case studies,*** and are also the result of a case study approach.

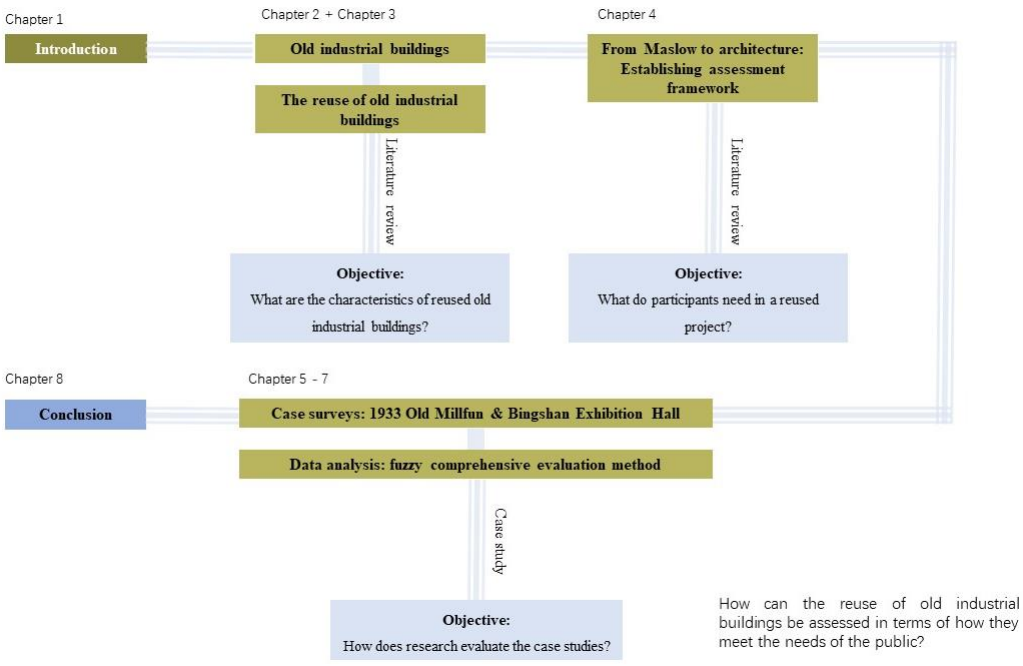


Figure 1.6-1 The structure of the thesis (by author, 2023).

1.7. Summary

This chapter is an introduction to the whole Ph.D thesis. It begins with the background and motivation for the research, describing why the research was chosen for such a topic. This is followed by a scientific research question **(How can the reuse of old industrial buildings be assessed in terms of how they meet the needs of the public?)** based on the orientation of the topic. Three hierarchical research objectives **(*What are the characteristics of reused old industrial buildings?; What do participants (users) need in a reused project?; How does research evaluate the case studies?*)** are established in order to complete the research question as well. In addition, the research methodology, led by literature review and case studies, will be used throughout the doctoral research. Finally, the thesis structure is described to clarify the contents, research methods, and objectives of each chapter.

Chapter 2

Old Industrial Buildings

2.1. Introduction

Since the evolution of the industry has been different in various countries around the world; this chapter reviews the metabolic products of social development, old industrial buildings, via the discussion of the interplay between Eastern representatives (China) and the world's industrial pioneers. The study begins with an introduction from industry to industrial buildings and parallels the history of industrial development in China and the world to explore the historical characteristics of Chinese buildings; it then analyses the reasons for the changing of an industrial building to an old industrial building. The study will use China as an experimental base and will be extended to the world when the time is right. The formation of old industrial buildings cannot be separated from the history of society. People often talk about the industrial culture, which they have acquired in history, and which is preserved in the industrial buildings. The exploration of the formative context of old industrial buildings is therefore an important basis for the subsequent study of characteristics and identification of reusing industrial buildings. The focus of the study is on the use of buildings after the reuse of abandoned industrial buildings. Although they are just an obsolete product of urban development, the context of the former industrial buildings will be concerned with its own identity and values, which will also have a direct impact on future revitalisation. The study is not limited to certain industrial types, and this chapter will discuss the context of old industrial buildings in China in a general way. Each case has its own unique story, which on the other hand illustrates the broad application of this research achievement (assessment framework).

2.2. Identifying industries and industrial buildings

2.2.1. Industry (taking China as an example)

People make products to serve their daily life. Nowadays, industry, which affects people's life extremely, could be the economic pillar of regional development. People have ever extracted raw materials and exploited the minerals and agricultural products resulting in great achievements and grandiose constructions, demonstrating their creative wisdom. Human civilisation is therefore being written continually.

Human beings aim to create a comfortable living environment for themselves. The 'Industry' mainly refers to manufacturing, from production to products. The manufacturing industry is the processing of raw materials or parts into finished products through the use of tools, human labour, machinery, and chemical processing, with optimal process plans using proper precautions and special safety rules to avoid accidents (Singh, 2006). Besides, with the development of human civilisation and new science technology, the meaning of 'Industry' is constantly being extended and improved, even some services have become a sector of industry at present. Therefore, 'Industry' can be defined as the people and activities involved in producing a particular thing, or in providing a particular service (Oxford Learner's Dictionaries, 2021). Industry includes various kinds of manufacturing and businesses which are relevant to national economic activities.

A single industry is often named after its principal product, for example, plastic manufacturing. As the classification of industries differs from country to country, this research will focus on China as the main example. According to the Chinese national standard: *'Industrial classification for national economic activities (UNSD: 2006, International standard industrial classification of all economic activities, NEQ) GB/T 4754—2017'*, the mining industry, manufacturing industry, energy supply industry, and parts of the tertiary sector of the economy are the main components of the industry. The clarified list of the industry in China is shown in Table 2.2.1-1.

General	Particular
Mining industry	Mining and refining of the coal
	Gas and oil mining
	Mining and refining of the ferrous mines
	Mining and refining of non-ferrous metals
	Mining and refining of non-metallic mines
	Ancillary mining activities

Manufacturing industry	Farm and non-staple food processing
	Food manufacturing
	Wine, beverages and refined tea manufacturing
	Tobacco
	Textile industry
	Clothing industry
	Leather, fur, feather manufacturing
	Wood processing and wood, bamboo, rattan, brown, grass products
	Furniture manufacturing
	Papermaking and paper products
	Printing and recording medium reproduction
	Cultural, educational, artistic, sports and entertainment supplies manufacturing
	Petroleum, coal and other fuels processing
	Chemical raw materials and chemical products
	Pharmaceutical manufacturing
	Chemical fibre manufacturing
	Rubber and plastics products
	Non-metallic mineral products
	Ferrous smelting and calendering
	Non-ferrous metal smelting and calendering
	Metal products
	General-purpose equipment manufacturing
	Special-purpose equipment manufacturing
	Automotive industry
	Railway, ship, aerospace and other transportation manufacturing
	Electrical machinery and equipment manufacturing
	Computer, communication and other electronic equipment manufacturing
	Instrument and gauges manufacturing
	Other manufacturing (daily groceries, nuclear radiation processing, etc.)
	Comprehensive utilization of waste resources
	Repair of metal products, machinery and equipment
	Armament manufactory
Electricity, heat, gas, and water production and supply	Electricity and heat production and supply
	Gas production and supply
	Water production and supply

Transportation, warehousing, and postal services	Railway transportation
	Road transportation
	Water transportation
	Air transportation
	Pipeline transportation
	Multimodal transportation and
	Forwarding agency
	Packing and loading services, and warehousing
	Postal service
Hydraulic engineering, environmental and public utility management	Hydraulic management
	Ecological protection and environmental management
	Public utility management

Table 2.2.1-1. The classification of the industry (collected by author, 2021).

Traditionally, geographical differences can occur in different types of industries. Due to the high density of the urban area, old industrial sites are normally under 0.3 square kilometres, the types of which include small-scale light industries, transport and ports, or products of early urban industrialisation. The manufacturing operations and workers' daily life link with the surrounding community functions closely, such as transportation, living, and entertainment. By contrast, suburban industrial types tend to rely on natural resources and vacant land resources, with large areas, often covering dozens of square kilometres, such as the mining industry, hydraulic engineering, steel manufacturing, and parts of military industries. Meanwhile, due to the inadequate infrastructure and inconvenient traffics in suburb, the big area of industrial factory always contains both manufacturing areas and living areas, with a good system of services for life, housing, markets, and health care; it can form a comprehensive community by one factory or by combining several factories.

The study is not limited to certain types of industries, as it focuses on public buildings after the transformation of abandoned buildings. These many types of industries tell their own stories when they operate, and these stories will become part of the cultural inheritance and attraction of the project. At the same time, due to the variety of industries in China and the fact that they cover the entire city, the scope of this study will mainly focus on factory sites in the heart of China's urban centres. Because, as a public space, accessibility is a precondition and there should be enough potential participants. This makes it even more beneficial for the research to go deeper. In contrast, some of the mining sites in the suburbs are difficult to fit into the architectural space of this study. The manufacturing process of such industries is often an extensive modification of the geographical environment, and natural and ecological restoration

will be an important strategy for reuse, and therefore will not be discussed too much in this research.

2.2.2. Characteristics of industrial buildings

Orange (2016) proposes that industrial buildings have conventionally been defined in technological terms: they are the places where industrial activities (specifically working with materials to produce things) occur. Industrial buildings are often a collective term for all constructures within an industrial site. More commonly, an industrial factory is a complex having several buildings; and it can be from several hectares to dozens of million hectares. A (previous) factory or manufacturing plant in one clear bounded area usually consists of multiple industrial workshops, landscapes, and affiliated buildings and facilities (Table 2.2.2-1) (Al-Dujaili, 2015). Furthermore, the concept of architecture tends to become broader in industrial sites. Due to the special needs of industrial manufacturing, huge facilities are often integrated into the building, the size of which can compete with a building, such as gas holders, grain silos, and blast furnaces. These behemoths cannot only be seen as industrial facilities, but also as a kind of building.

Contents	Details
Industrial workshops	The buildings are mainly used to contain manufacturing equipment or organise the industrial process, including workshops, warehouses, energy stations and transportation stations.
Landscapes	The transportation network, water area, squares, and green fields in the industrial site.
Affiliated buildings	Accommodations, offices, exhibition centre etc.
Facilities	The huge equipment or that is hard to remove, such as: ● Mining and refining equipment (e.g. blast furnaces, belt verandas, derricks); ● Energy equipment (e.g. transport pipelines, cooling towers); ● Storage facilities. Transport equipment (e.g. cranes, railways, runways).

Table 2.2.2-1 The content of the industrial site (collected by author, 2019).

Since industrial buildings are designed for specific industrial manufacturing processes, the characteristics of industrial buildings are mainly relative to those of civil buildings. Industrial buildings may turn out to be important regional landmarks, simply due to their huge size and distinctive architectural features. Such buildings tend to be well-proportioned with a satisfying rhythm to the windows and with lofty towers and chimneys (Binney, Machin and Powell, 1990). Stratton (2003: 34) indicates that mills, warehouses, and industrial facilities are the staple-diet

of industrial conservationists. Depending on the varied needs of different industrial manufactories and the space required by machinery, these industrial buildings can be divided into single-storey, multi-storey forms, and facility buildings.

- Single-storey mills:
  The space in single-storey mills emphasises the process of horizontal industrial manufacturing; furthermore, the pillar net can provide larger and more flexible space than multi-storey buildings (Latham, 2016). Single-story buildings are mainly used for the production of big machinery (Liu and Feng, 2009). Stratton (2003) describes single-storey buildings, which derived from agriculture and were used for iron-making in the 18th century, can be seen as one of the most successful of virtually all industrial building forms.
- Multi-storey mills:
  A multi-storey mill is used for industrial manufacturing that often has a lower transport volume and needs to load lighter machinery. Setting up vertical assembly lines means less building area is required. Multi-storey buildings can provide relatively low-cost factory units for manufacturers in terms of land occupation (Karakiewicz, Shelton and Kvan, 2013). Compared with single-storey forms, the partition style of some multi-storey mills is similar to that seen in civil architecture, such that there is a huge potential for multi-storey buildings to experience a functional transformation, such as a transformation to residential or retail function (Douglas, 2006).
- Facility buildings:
  As mentioned in Section 2.2.2, it is a large construction that is both a manufacturing facility and a building. To some degree, a facility building in an industrial site is more attractive to the public than mills would be (Stratton, 2003). Hutton (2006) explains that industrial facilities are more attractive than conventional mills are, because the special facilities can elicit people's curiosity. Just this 'uncommon' architectural form and space will often be preserved in future reuse.

2.2.3. Structures of industrial buildings

The difference in construction techniques will have a direct impact on the decision to reuse them at a later stage. There are many issues, for example, the decision on demolishing and rebuilding a building and preserving it for restoration, which has economic, safety and environmental implications; the spatial flexibility of the building is an important influence on its functional transformation, which depends on the distribution of the column network of the building structure and the materials.

It is easy to see in public impressions and aesthetics that old industrial buildings are often marked by thick enclosures and supporting structures. These are the main elements of the old industrial buildings that have been preserved over the years. For non-facility industrial buildings, which refer to mills, warehouses, energy stations, and transportation stations, large industrial spaces are mainly used for loading manufacturing equipment. Similar to single-storey mills, the column network in these buildings cannot be arranged too densely, and many buildings will be equipped with overhead cranes. Vertical supports are therefore an important part of the structural design of industrial workshops.

According to Liu and Feng's (2009) statistics, the structural forms of industrial buildings are mainly concrete or steel. The early workshops in China preferred to use concrete structures (Figure 2.2.4-1), because concrete materials are easy to get; the shaping process is simple; concrete is long-lasting and fire resistance (Tsinghua University, 2021). Concrete columns are spaced between 6-12m and support a maximum span of 30m (Liu and Feng, 2009). In comparison, the use of steel structures in some countries is relatively early (Figure 2.2.4-2). The lightweight and high strength of steel structures make it possible to construct buildings with a column spacing of 12m and a span of over 30m (ibid). At the same time, the high degree of assembly in the installation has greatly improved construction efficiency. Nowadays, the disassembly and recycling of steel structures well responded to the global concept of energy and environmental sustainability. This is why steel structures are so widely used in contemporary architecture. However, this may seem to lead to a decline in research related to industrial heritage. Material resources are an important part of the industrial heritage (TICCIH, 2003). As these steel structures can be recycled in the future, it is difficult for them to be left as heritage buildings. In other words, there might be fewer and fewer heritage buildings available for research in the future. These issues are explained in depth later in Section 3.3.3.3.



Figure 2.2.4-1 Yuanqi 1983, Dalian, China (by author, 1998). It was once a warehouse of the cement factory with a concrete column structure.

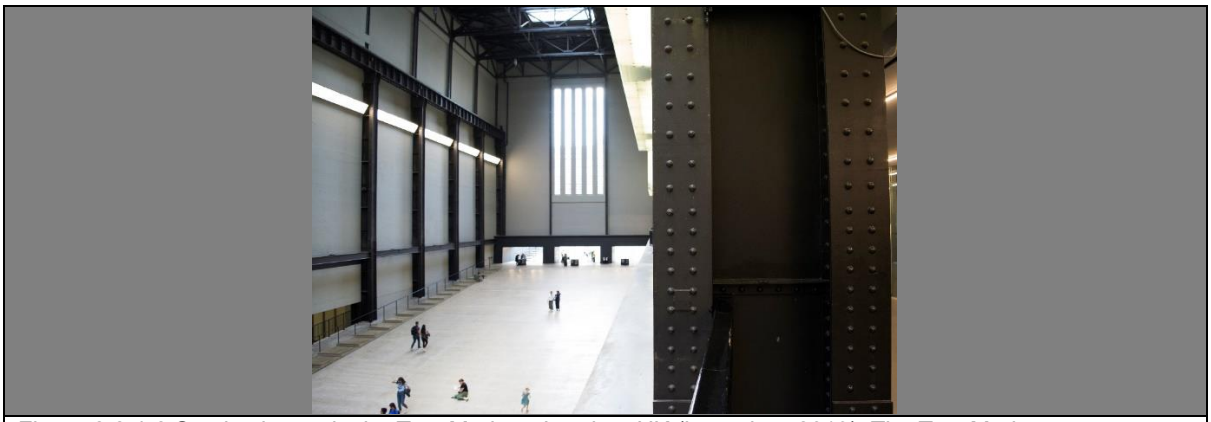


Figure 2.2.4-2 Steel columns in the Tate Modern, London, UK (by author, 2019). The Tate Modern preserves steel columns from the power station's Turbine Hall in the 1940s.

2.3. China’s industrial development

Tracing history not only can explore differences between old and new but also will play a significant role in studying how an industrial building changes to old. It was widely believed that industrialisation used to be the foundation of economic development. Industrial development profoundly modified urban texture and lifestyles (Falser,2001). In history, each ‘Industrial Revolution’ can be seen as a turning point in industrial characteristics, including architecture, manufacturing technique, and enterprise culture. The proper name ‘Industrial Revolution’ mainly stands for revolutionary movements in Western countries. The most widespread turning points in history are ‘The First Industrial Revolution’ and ‘The Second Industrial Revolution’. This was followed by a third and fourth time as time continued to develop. These four times have been summarised as ‘Industry 1.0’, ‘Industry 2.0’, ‘Industry 3.0’, and ‘Industry 4.0’.

The degree of industrial development had ever been the standard for measuring the nation's power. The two world wars could be seen as fighting for resources around the world. Several ‘Industrial Revolutions’ have changed the world pattern. The first and second ‘Industrial Revolution’ enabled some of the Western countries to increase their power rapidly and took the lead in the world. Their success has influenced the countries of the East. Some former developing countries learned and followed the advanced industrial technology of the West to improve their overall national power. Following this way, competition for industrial strength has spread around the world.

In the late 19th century old industrial manufacturing caused a huge crisis for raw materials as well as for the environment. The negative effects of traditional industry were emphasised. The exploration of the North Sea Oil made the energy structure transformed in the West (Robinson and Rowland, 1980). In addition, the ‘Garden City’ ideal, which was a town-planning idea that sought to marry the best of town and country in new urban development, had become a potent legacy of town planning (Clark, 2003). Binney, Machin and Powell (1990) claim that: *‘the evils of the industrial towns – their visual, moral and aesthetic squalor – were underlined’*. The industry is thus further upgraded and transformed. This has led to the third and fourth ‘Industrial Revolution’ as well.

China becoming today's major producer is inseparable from the influence of the world. China's industrial development has not only received significant influence from the ‘Industrial Revolutions’ but also, nowadays, China’s industry has influenced the world. According to organising the relative global industrial development and the influence on China, the following sections will sort out a timeline of China's industrial development, in order to refine the

characteristics of industrial architecture in different periods in China, as shown in Figure 2.3-1.

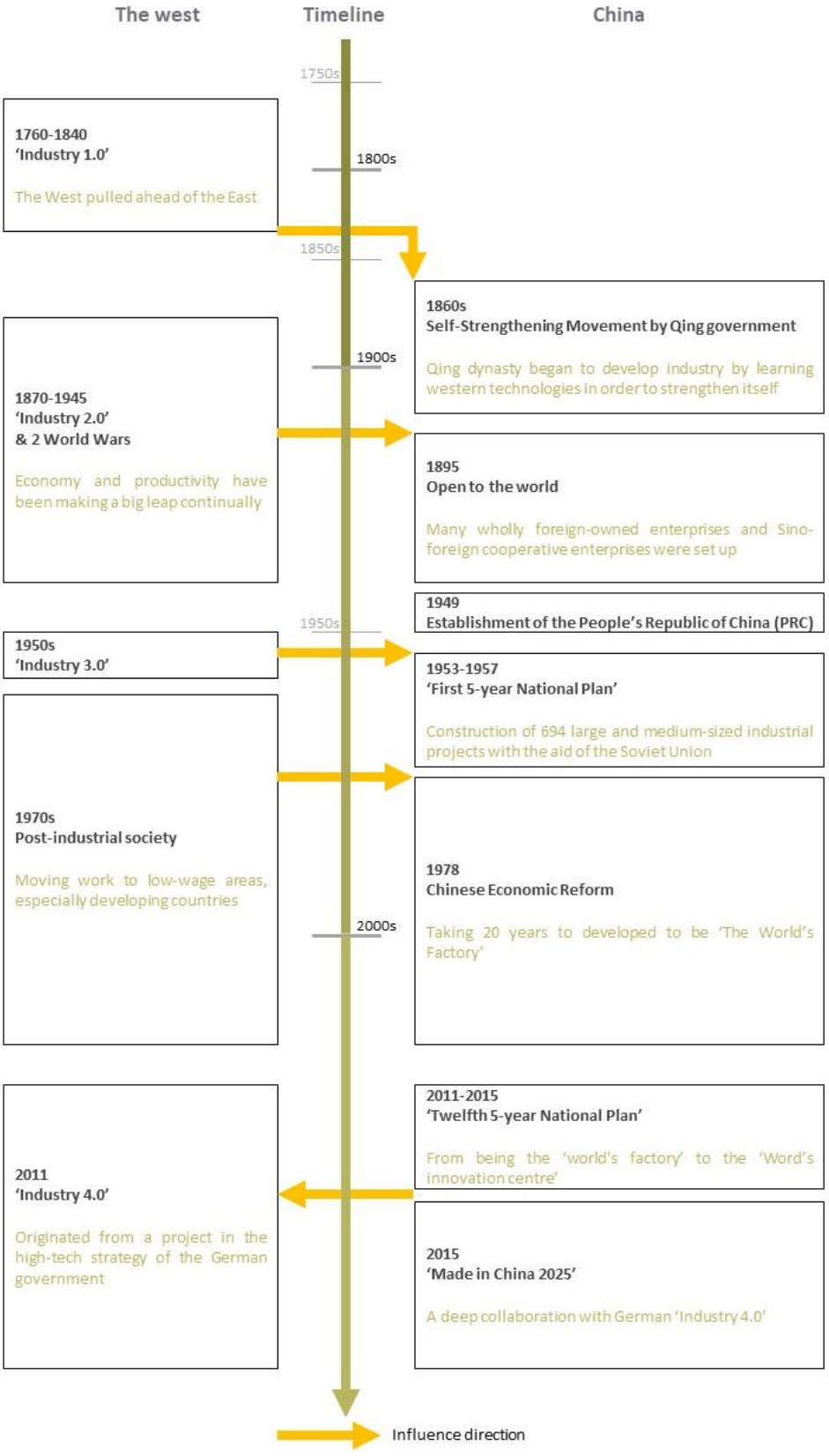


Figure 2.3-1 The timeline of Western and China's industrial development (by author, 2019).

2.3.1. Industry 1.0 (1760-1840)

'Industry 1.0' refers to 'The First Industrial Revolution' from 1760 to 1840. It is marked by a transition from hand production methods to machines through the use of steam power and waterpower (Berlanstein, 2003). The rapid rise of productivity led the West to pull ahead of the East quickly. Subsequently, in the 1860s, the government of the Qing dynasty (previous China) began to establish shipyards, arsenals, and infrastructures by learning Western technologies in order to strengthen itself, which is known as the 'Self-Strengthening Movement' (Liu, 2012). Under the deep influence of the West, China's architecture contains a strong Western style. Additionally, controlled by the government, large-scale industrial buildings and a large number of labours in a factory formed the industrial culture of that period.

During the Self-Strengthening Movement in the late Qing Dynasty, the Viceroy of Jiangnan Province (now: Jiangsu Province, Anhui Province, and Shanghai) and Jiangxi Province, Hongzhang LI, established the Jinling Machine Manufacturing Bureau in Nanjing in 1865, such example marked China started to develop Chinese modern industry and weapon industry (Figure 2.3.1-1). The bureau is designed by British engineers, in light of the style and pattern of British industrial architecture (Gong and Ji, 2010). Until 1889, there are over one thousand various machines and equipment in the Jinling Machine Manufacturing Bureau, and more than 1700 workers, which became the main base of ammunition production in China in that period. Later it was constantly remodelled, until the end of the 19th century, the factory site collected more than 40 distinctive types of buildings corresponding to different years of the Qing Dynasty, the Republic of China, and the People's Republic of China (Wu, 2021).

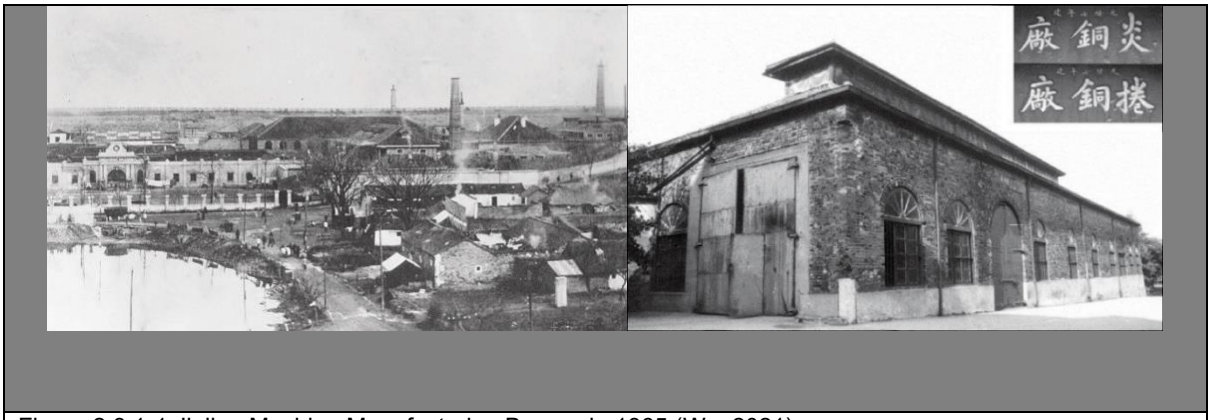


Figure 2.3.1-1 Jinling Machine Manufacturing Bureau in 1865 (Wu, 2021)

2.3.2. Industry 2.0 and Two World Wars (1870-1945)

During 1870 and 1945, ‘The second Industrial Revolution’ and the Two World Wars became the driving force behind the global situation. ‘Industry 2.0’ is known as the technological revolution that started in the 1870s. Electricity, which allowed for factory electrification and the modern production line, made people understand the importance of productivity and the earth's resources (Mokyr, 1998). The two Industrial Revolutions led to a high rate of productivity, and people realized how important resources were as the basis for industry. The Two World Wars that followed can be described as essentially competing for global resources. After 1895, signing the Treaty of Shimonoseki, China was opened to the world by granting western countries and Japan favoured status for foreign trade (Dong and Guo, 2018). As a result, a large number of wholly foreign-owned enterprises and Sino-foreign cooperative enterprises were set up in China. Naturally, the architectural design showed the western culture distinctly in China at that time.

Due to the openness of China to the world and the mixture of Chinese and foreigners in some areas, many industrial projects in this period were of the East-West fusion type. For example, located in the Shanghai International Settlement which is one of the multinational trade hubs in China from 1863 to 1943 (Figure 2.3.2-1), completed in November 1933, the Shanghai Municipal Council Slaughterhouse was made of advanced reinforced concrete and a design by the British architect working with a combination of architectural aesthetics and industrial art (Zheng, 2013) (Figure 2.3.2-2). The Shanghai Municipal Council Slaughterhouse provided meat for Chinese and foreign residents in the area of Shanghai International Settlement. In 1945, it was developed into the largest slaughterhouse in the Far-East Area and provided two-thirds of the fresh meat consumed in Shanghai.



Figure 2.3.2-1 The logo of Shanghai Municipal Council ([Online] <https://europa.unibas.ch/de/forschung/globalgeschichte-europas/the-divisive-power-of-citizenship/> [11 March 2019]). Shanghai Municipal Council consists of international people, which play a role as the government in the area of Shanghai International Settlement.



Figure 2.3.2-2 Shanghai Municipal Council Slaughterhouse (Pendlebury, et al., 2018: 216).

2.3.3. Industry 3.0 (1950s)

'Industry 3.0' occurred around the 1950s, after the end of the Two World Wars. In this process, there was extensive use of computer and communication technologies in the production process (Brünglinghaus, 2015). To some degree, 'Industrial 3.0' is not as famous or as world-changing as 'The First and Second Industrial Revolution'. However, it marked the beginning of high efficiency and precision in industrial production. After the establishment of the People's Republic of China (PRC) in 1949, China started to set up its industrial bases. The Chinese leadership prepared to map strategies for economic development, setting growth targets, and launching reforms, as a result, the 'First 5-year National Plan (1953-1957)' was imposed. The Plan points out that China will concentrate efforts on the construction of 694 large or medium-sized industrial projects, centring on 156 projects with the aid of the Soviet Union (Wang, 2015). A large number of Soviet engineers, technicians, and scientists assisted in developing and installing new heavy industrial facilities, including entire plants and pieces of equipment purchased from the Soviet Union. At that time, industry in China tended to create a 'Soviet-Style', which included design, construction, and operation mode. Then, from 1964 to 1978, China's industrial projects extended to 13 provinces and autonomous regions with its central area in the Northwest (Shanxi Province, Gansu Province, Ningxia Province, and Qinghai Province) and Southwest (Sichuan Province, Chongqing, Yunnan Province, and Guizhou Province) (Liu, 2012).

During the 'Industrial 3.0', with the support of the Soviet Union, China undertook a series of advanced industrial types of the time and tried to catch up with the developed Western countries. The Bingshan project, which is one of the case studies, has a strong Soviet flavour. An example of this is the automotive industry, a highly sophisticated type of industry. Located in Changchun city, First Automobile Works (now named First Automobile Works Group Corporation) is one of the factories that was entirely constructed by the Soviet Union (Figure

2.3.3-1). There are more than 200 Soviet experts who aided to guide production, and 48% of production equipment and 22.8% of production drawings were provided by the Soviet Union (Yang, 2015). From this point, China has had its own automobile production enterprises. Today, First Automobile Works Group Corporation has a number of Chinese and joint venture brands, Such as China Hong qi, China BESTUNE, Audi, VW, Toyota, and Mazda, which are made by First Automobile Works Group Corporation.



Figure 2.3.3-1 First Automobile Works ([Online] <http://news.cnr.cn/special/cscq/pic/201410/t20141026_516664577.shtm> [11 March 2019]).

2.3.4. Post-industrial Society (1970s - 21st Century)

In the 1970s, industry-led countries, like Europe and America, into post-industrial society (Bell, 1974). As a result of post-industry, 'De-industrialisation', a phenomenon of closing factories and losing jobs came to the surface (Bluestone and Harrison, 1982; Rowthorn and Ramaswamy, 1997). The existence of this issue has tended to foster the perception of a causal link from 'globalisation'. Free trade and falling trade barriers have allowed companies to move production virtually anywhere in the world. Thus, companies in developed countries wished to reduce labour costs to move work to low-wage areas, especially move to developing countries (Rowthorn and Ramaswamy, 1997; High and Lewis, 2007; Koistinen, 2013). Taking this opportunity, China established a form of enterprise cooperation trade which was about the trading mix (custom manufacturing with materials, designs or samples supplied and compensation trade). Guangdong Province, as a pioneer in China, started such trade in the 1970s (Liu, 2012).

Fully taking advantage of the post-industrial era, China took 20 years to develop to be 'The World's Factory' now. 'Made in China' has already known worldwide. Western companies have been building production lines and looking for Original Equipment Manufacturer (OEM) in China (Figure 2.3.4-1). For example, Shenzhen Foxconn Technology Group was built in

1988, it became the biggest OEM around the world in the 2010s (Li, 2016). The factory produces 3C products for various famous companies, such as Nokia, HP, Dell, and Apple. However, these world-leading brands are only 'the tip of the iceberg' of Foxconn. It is now the world's largest electronics manufacturer, with more than 1.2 million employees (Guan, 2007).



Figure 2.3.4-1 The old building of the original Foxconn factory in Shenzhen in 1988 ([Online] <http://dy.163.com/v2/article/detail/D8GVJUSF0525QFCN.html> [11 March 2019]).

2.3.5. Industry 4.0 (the present)

'Industry 4.0' originated in 2011 from a project in the high-tech strategy of the German government, which promotes the computerisation of manufacturing. On 8 April 2013 at the Hannover Fair, the final report of the Working Group Industry 4.0 was presented. 'Industry 4.0' is based on advanced digitalisation within factories. The combination of internet technologies and future-oriented technologies in the field of Artificial Intelligence (AI) objects (machines and products) seems to result in a new fundamental paradigm shift in industrial production. The vision of future production contains modular and efficient manufacturing systems and characterises scenarios in which products control their manufacturing process (Lasi, et al., 2014).

At the same time, because of 'The Catch-up Development', China has already become one of the most important manufactories in the world. 'Made in China 2025' has a deep collaboration with German 'Industry 4.0' in 2015, based on advanced digitalisation within factories (The State Council of the People's Republic of China, 2016). The further restructuring in China, Twelfth 5-year National Plan (2011-2015), emphasises moving some regions from being the 'world's factory' to the 'World's innovation centre' which includes creating hubs of research and development, high-end manufacturing, and the service sector. The plan includes promoting more efficient development of nuclear power under the precondition of ensured safety, increasing momentum for large-scale hydropower plants in southwest China, and

making the length of high-speed railways reaching 45,000 km and length of highway networks reaching 83,000 km (National Development and Reform Commission, 2011). Furthermore, the Thirteenth 5-year National Plan (2016-2020) points out that 'Made in China 2025' will be comprehensively carried out. Such plan aims to increase the Chinese-domestic content of core materials in the world products, focusing on high-tech fields including the pharmaceutical industry, automotive industry, aerospace industry, semiconductors, IT, robotics, etc., which were the strengths of foreign companies (National Development and Reform Commission, 2016).

To some extent, learning to become an 'OEM' has partly resulted in excessive technological mimesis that may be part of an unauthorized, underground economy that is based on low-cost technology (Hu, 2008). At that time, combining China's national conditions, such behaviour can boost the development of China's industrial technology as well. In the meanwhile, from learning and analysis to invention and innovation, China is forming its own characteristics of the industry gradually. The construction of Beijing Daxing International Airport and High-Speed Rail (Figure 2.3.5-1,2), for example, can prove China's industrial progress.



Figure 2.3.5-1 Beijing Daxing International Airport ([Online] <https://www.scmp.com/magazines/style/leisure/article/3025055/5-things-we-know-about-beijing-daxing-international-airport> [11 March 2019]).



Figure 2.3.5-2 High-Speed Rail ([Online] < http://www.gov.cn/xinwen/2016-02/28/content_5047086.htm> [11 March 2019]).

2.3.6. Summary: features of China's industrial buildings

From the review of the history, it is clear that China's industrial developments got a big impact from world development, especially the West. Although the rapid development in China stimulated the renewal of human thought, some historic industrial sites, which always remind people not to forget the past, will become traces of industrial development in the long historic journey. As the product of history, historic characteristics are attached to industrial buildings. According to the developing process and characteristics of the different periods, industrial buildings can be summarised into four types:

- Learning style:
  Learning from the West, established by the Qing government.
- Implantation style:
  Wholly foreign-owned or Sino-foreign cooperation, after China opened to the world.
- Soviet Union style:
  After establishing the People's Republic of China, achieving the aid of the Soviet Union.
- Self-innovation style:
  Independent operation by China, the period from the 'World's Factory' to the 'World's Innovation Centre'.

Today, although China has developed an independent industrial culture and system, the surviving old industrial buildings are mainly in the three periods: Qing government (learning from West), China opened to the world (cooperating with foreigners), establishment of the New China (supported by Soviet Union) (Liu and Feng, 2009; Wei, 2015). It is clear that China's industrial development could not have been achieved without foreign support, so many of the surviving industrial remains are clearly marked by the traces of the internationalisation. For example, in the case study later, Shanghai 1933 Old Millfun was a time when China was opening up to the world and the project was supported by the advanced technology of the time in the UK; the Dalian Bingshan Project, on the other hand, was at the time of the establishment of New China and the Soviet form of the building remains today.

2.4. Cause of old industrial buildings

Changes in technical capability, economic opportunity, social and demand awareness, and the understanding of sustainable development have been important factors in determining architectural development in urban areas (Roberts and Sykes,1999; Wu, 2002). This series of renewals will metabolise old legacies, such as the industry, which do not meet the needs of urban development. Old industrial buildings form what is in essence an obsolete product. An old industrial building can be defined as: an industrial building that is unable to satisfy the needs of urban development in a certain period as a result of the building's original industrial activities having ceased (Zheng, et al., 2022).

To some extent, it can be seen that the faster industrial innovation takes place, the more easily old industrial buildings are formed. Around the world, the causes of old industrial buildings are often influenced by complex political, technological, economic, cultural, and environmental factors. The degree of influence varies from place to place, and from time to time. The causes of an old industrial building are not always singular either. Nevertheless, the research has attempted to summarise the most important causes and explain them via the cases. The driving force behind the formation of old industrial buildings mainly refers to advances in technologies, economic and industrial restructuring, and political or event driven.

2.4.1. Advances in technologies

Advances in production technologies, including new production facilities, production processes, and management or operational models, can improve manufacturing efficiency and reduce environmental pollution greatly, leading backward factories to be absorbed or go into liquidation. Traditional infrastructures, which cannot meet the new manufacturing way, will be given up as well. For example, the old mill space or supply facilities will not meet the set of new advanced facilities; more efficient production systems may no longer require huge plant buildings; or the throughput of original transportation (docks and train stations) will not carry the high loaded requirements that produced via advanced technology. These issues about emerged with advanced productivity, are seen as the most common reason for the formation of old industrial buildings (Aydalot and Keeble, 2018). On the other hand, such elimination can force manufactories to effectively improve competitiveness in this rapidly progressing society.

Royal Albert Dock opened in 1846, was the first in Liverpool to be designed with warehouses, with no structural wood. It was one of the most popular docks in England, cargoes such as brandy, tea, cotton, silk, tobacco, and sugar were unloaded from ships which then moved to the warehouse to load up with export goods (Moss and Stammers, 1980). However, by the

1860s, since the dock was designed for sailing ships, not the prevalent large and screw-propelled steamships. The basin and dock entrance were too small to dock; as a result, Albert Dock started to decline (Jones, 2004). This example proves that the old industrial sites were unable to meet the demands of new technological developments, and declined. In terms of China, the establishment of High-Speed Rail Stations appears from new technologies, which High-Speed Rail trains cannot use the old rails (Zheng, 2017). Nearly every city, where the High-Speed Rail stops, would construct new train stations for the High-Speed Rail. As a result, some of the old train stations become abandoned.

2.4.2. Economic and industrial restructuring

Economic and industrial restructuring refers to the phenomenon of urban areas shifting from traditional manufacturing and energy, transportation and storage to service, finance, trade, IT, and culture-industry economic base (Collaton and Bartsch, 1996). A great demand for various services becomes necessary for people's social life. The term 'product' is understood in a wider range, and people started to treat any form that contains inventive and imaginative energy and service as a target to purchase. Such issues, together with competing for urban land use, push some industries, which may not meet people's demand for new lifestyle, to give a way to new industries, such as service, IT, and culture-industry, which have a higher return rate at present. In short, it means that the development of society will make some industrial projects obsolete. For example, the discovery of the North Sea Oil has directly or indirectly led to the decline of some traditional energy industries in Europe, as in the case of the coal mining industry (Bailey, 1974; Dawson, 1980). The decline of these industries created the opportunity for the appearance of old industrial buildings.

Meanwhile, some 'astute' buildings have been transformed into other productive projects to keep them from being abandoned after the decline of the original industry. Many cases have been forced to transform to keep the building alive because of this economic pressure. For instance, the Dogpatch Ropewalk is located in San Francisco's Dogpatch Historic District, the original ropemaking factory operated from 1856 to 1963, but was transformed in the late 1970's to accommodate Muni's 'John M. Woods Motor Coach Centre' (Fletcher Studio, 2018); Shanghai 1933 Old Millfun, too, had been ever transformed from a slaughterhouse into a pharmaceutical factory (Zhao, 2007).

2.4.3. Political or event force

Political plans and large events can lead to industrial factories' closures or relocations suddenly, which could be without any warning. This aspect is closely linked to the national

conditions and historical development of different countries. Due to the rich historic experience, most industrial factories were state-owned enterprises before the 1960s in China. After the Chinese Economic Reform, under the stimulation of the market economic system, the behaviour of enterprise property transfer makes industrial enterprises lose state-owned 'backer' and get into the market economy. Marketing competition not only promotes industrial development, but also eliminates some laggards; as a result, they will face bankruptcy and annexation which can lead to an increasing number of old industrial sites (Li and Chen, 2015). China's policy of 'suppressing the second industry and developing the third industry' can be described as an industrial restructuring policy planned by the government as a means of promoting the transformation of a large number of industrial enterprises (Fang, 1997).

Besides, during the development of the country, it is hard to avoid the sudden important events which involve wars, political activities, and public events (such as the Olympics and the World's fair). Political or event force can be seen as a sudden force which may be without the process of decline. In most cases, such issues happen can come down to the location and specific architectural form of industrial buildings. For instance, the Expo 2010 Shanghai China was held on both banks of the Huangpu River. The Expo event promotes the old industrial buildings transform to be pavilions, which concerned more than 200 factories (Liu and Feng, 2009).

2.5. Summary

This chapter has focused on the concept of old industrial buildings, including the definition of industrial buildings and old industrial buildings, the characteristics of China's historical industrial buildings in the influence of the world's industrial development, and the reasons for the formation of old industrial buildings. Industrial buildings are an important category in the field of architecture because of their specific functionality, which is different from the buildings that are normally used by the public. Industrial buildings, therefore, take a wide range of different forms, depending on the production purpose they serve. A review of history shows that China has been influenced by the world's industrial development and has tried to keep in step with the world. This has led to a diversity of industrial architectural styles at different times in history. The main reasons for the change from industrial buildings to old industrial buildings are the development of technology, the market, and political factors. Simply put, old industrial buildings are a product of development. The rapid development of China at the end of the 20th century contributed to the formation of a large number of old industrial buildings. So, are they disposed of like waste? The next chapter will discuss the treatment of old industrial buildings in depth.

Chapter 3

The Adaptive Reuse

3.1. Introduction

Old industrial buildings in cities may have fallen into abandonment and become grey areas of the city, or they may occupy vantage points for urban development, to name but a few of the issues that are calling on the urban community to do something. Today, the reuse of old industrial buildings is widely practised around the world. However, research on this topic varies from country to country because of the different national contexts. For example, the reuse of old industrial buildings may play an important role in the large-scale and multi-generational urban regeneration brought about by China's rapid development. Old industrial buildings are not only an important material resource for urban regeneration, but also a cultural resource. They should not be wasteful ones, but should be treated as a gift from the past. Therefore, the reuse of old industrial buildings is a complex subject, which contains impacts of technology, society, culture, etc. This chapter will be combined with chapter 2 to answer the objective, *What are the characteristics of reused old industrial buildings?* (Figure 3.1-1)

The issue of the preservation of old industrial buildings is the precondition for this study, and the study of reuse is discussed on the basis of the old industries that could be kept. This chapter reviews the achievements of the world and China in the conservation and reuse of relevant historical buildings. Then, it identifies the role of adaptive reuse as a driving force for urban regeneration, and identifies its historical, economic, and social significance for the region. Finally, industrial culture is analysed as an identifying marker for the reuse of an industrial building. The new concept of ‘material industrial elements’ is proposed for the preservation of industrial history and culture. It is worth pointing out that the temporary material of modern building structures is a shock to future heritage issues. To respond to this issue, the concept of ‘cultural circulation' is created.

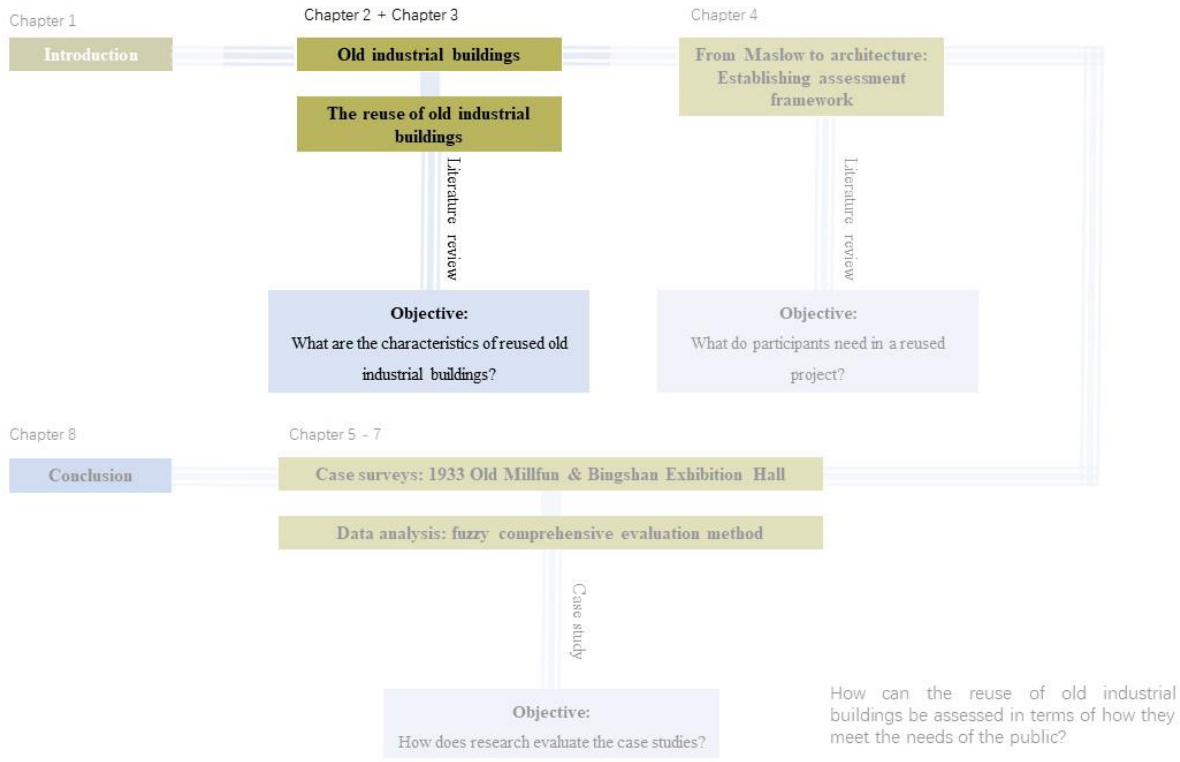


Figure 3.1-1 The structure role of Chapter 2 and 3 (by author, 2023).

3.2. The context of reusing old industrial buildings

3.2.1. Challenge of saving old buildings

For most of the world's major urban areas, land use is often efficient to cater to the high speed of urban development. The urban land resources occupied by these old industrial buildings will undoubtedly be reused soon. As for the buildings left on the land, they may be demolished and replaced with new buildings, or they may be retained and reused.

Although the subject of this research is the reuse of buildings and it is a hot topic these days, it should still be pointed out that not all old buildings have to be saved. Whether or not an old building should be used, depends largely on the degree of its value. Various factors are involved, such as the economy and the market, the prevailing national conditions, political issues, public acceptance, etc., which will determine whether the building should be saved. Thus, saving behaviour will be influenced by complex social factors. For example, in this age of rapid development and stressed urban resources, high-rise buildings that make the most of vertical space are considered as a sign of economy and efficiency; the old industrial buildings with low floor area ratios that have been replaced by high-rises are to some extent no longer suitable for the needs of urban regeneration, in the society. In conclusion, the subject of measuring the preservation of old industrial buildings is complex and requires comprehensive and forward-looking consideration.

Trying to make reuse an old industrial building without demolishing it is not an easy task. This will be a lengthy project, involving long hours filled with many meetings with various departments. It could cost hundreds of thousands of pounds, or much more. And in the end, it might not be able to save the building from being torn down. But, if successful, it will be giving new life to a beautiful historic building, and will give the gift of history, culture, and education to future generations. It will be preserving a link to the past, while improving the region's future as well. If facing an old industrial building and wanting to save it from demolition, the following 4 aspects should be considered.

3.2.1.1. Determine the significance of the building

To determine an old industrial building’s significance (value) to the community or region could be considered as a first step (De Jonge and Van Balen, 2002). Some questions will be asked to measure it, for example, did a historical event occur here, or what is the impact of this industrial manufacturing project on the region? Some old industrial buildings have the significance of historic landmarks. They might have witnessed the highs and lows of the

community, and they may be a symbol of the region. Some old industrial buildings have cultural significance. It is a culture that is responsive to a specific period or a specific place (Mason, 2004). Rich architectural features, design details, and unique layouts have long disappeared from contemporary architecture. The reservation of some old industrial buildings could bring the basis for regional identity.

3.2.1.2. Discover the building's future purpose

Over time, old buildings that were originally used for industrial manufacturing purposes have lost their function. If people want to save an old industrial building, they have to find a new function to meet future needs that allow it to exist in today's world (Velthuis and Spennemann, 2007; Conejos, et al., 2017). Therefore, old industrial buildings need a renewed function to avoid the buildings falling into disrepair and dereliction. However, this is not an easy task, and it requires the involvement and assessment of the community. Moreover, whoever the investor is, this is an investment which is subject to many uncertainties: may be lasting and prosperous for a long time or maybe closed in a very short period. If identifying a new purpose for old buildings and giving them a new life, there are plenty of options: a new industry, a residential, an apartment, an office, a museum, a visitor's centre, etc. It is only after identifying the new purpose that people may proceed with the physical steps of preservation.

3.2.1.3. Multi-disciplinary involvement

Preserving old industrial buildings is not a job that can be done by a single discipline. It requires the participation of several disciplines and the collaborative efforts of relevant academics or specialists, such as architecture, urban planning, historiography, and city council (Liu, 2007). Historical groups will have a better understanding of the state of historic preservation and take a professional approach to find and collect the stories behind the buildings (Aigwi, et al., 2019). They have saved buildings in the past, they have the experience, knowledge, and connections with the right people to make the project much easier. It may even be beneficial to have their organisation take the lead in the project, as they can collect investments and contact officials with greater ease. Old industrial buildings that have been given new functions should be recognised locally, either to fill a gap or to enhance spiritual pursuits. Local government's support in laws and regulations is invaluable to a historic building project as well.

3.2.1.4. Funding

The developer and the investment are the driving force behind the 'theory to practice' that will determine the success of a project. In addition to paying for the land occupied because of the

preservation, restoring a historic building can be expensive, especially if it involves restoring, renovating, or even moving the building. Potential sources for financing projects could firstly include state grants in the form of government investment, or the government driving the conservation and reuse process. Many projects in China have had government-sponsored projects, for example, Beijing 798 Art Zone is the result of a government initiative run in collaboration with local enterprises (Wei, 2015). Further, the tax credits will often support the non-profit-organised restoration buildings; and the project can seek out various tax breaks and exemptions to reduce the costs. Finally, private funding and donations are common sources of costs for the conservation of old buildings. Investors invest in projects by measuring their future development and returns. Old industrial reuse projects can be seen as a risky investment, so that their saving is challenging.

3.2.2. Achievements in the world

A century after the birth of 'The First Industrial Revolution', a large number of old industrial buildings have sprung up in the city, as the pioneer countries begin to move towards a post-industrial society, when the service sector generates more wealth than the manufacturing sector of the economy (Bell, 1974). Naturally, these old industrial buildings were faced with the problem of what should be the treatment at the time. Adaptive reuse has become an important form of urban regeneration to absorb these existing resources.

3.2.2.1. International attitudes

The path of reusing old industrial buildings around the world is step-by-step. Most countries had experienced the process from neglect and demolition behaviour to the adaptive reuse of old buildings. Like the pioneer of leading the 'Industrial Revolution', Western countries were the first to propose the preservation and the reuse ideas, and also to use the concept of 'Heritage' to emphasise the significance of the industrial cultural value. For over half a century, people have already realised that reusing old industrial buildings is a part of urban development. These reused buildings could coexist with historic and modern architectural forms in the urban area. This is, of course, the result of a joint effort by scholars and experts. International attitudes towards the conservation of old buildings are also growing, while reuse is becoming the future destiny of these buildings. In history, conferences and charters related to the preservation and reuse of old industrial buildings have constantly been launched, shown in Figure 3.2.2.1-1. This illustrates the importance and achievements of the international community concerning this relevant subject. At the same time, the international orientation

influences the current development process in China, and China will gradually develop into a system with independent characteristics under this influence (details in Chapter 3.2.3)

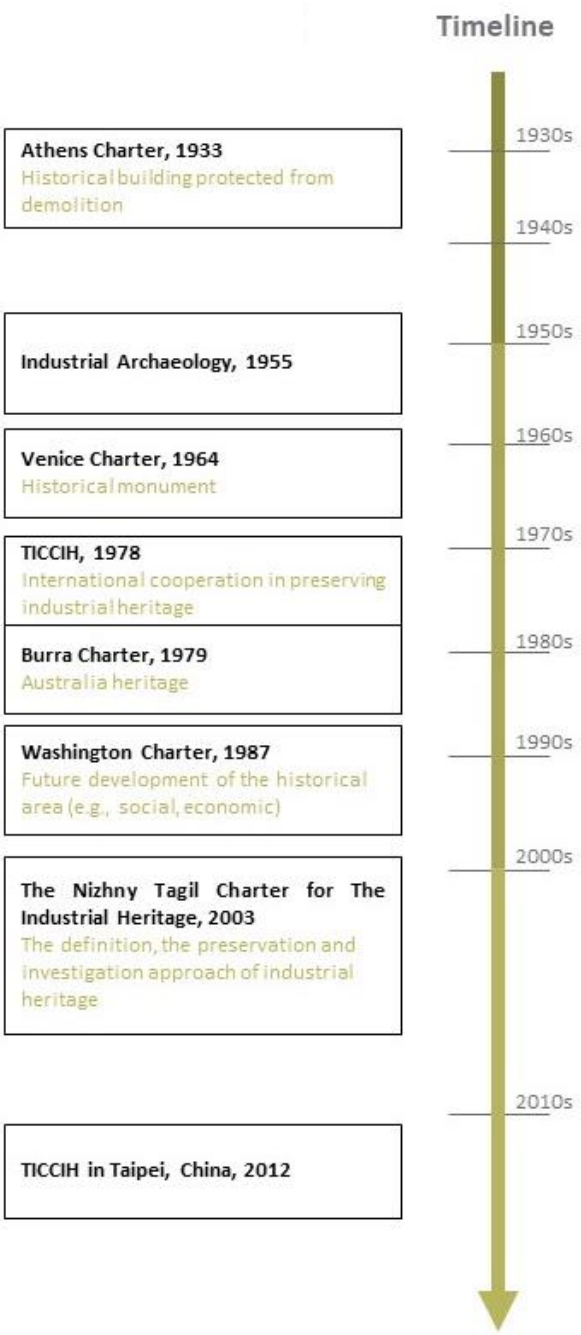


Figure 3.2.2.1-1 The timeline of important conferences and charters related to the preservation and reuse of old industrial buildings (by author, 2021).

Athens Charter, 1933

Athens Charter emerged from the Fourth International Congresses of Modern Architecture (CIAM) in 1933. The Athens Charter was purported to be a consensual statement of how modern architects thought about the task of designing the future city. In the Athens Charter, item 65-70 recommends that historic buildings, especially those can express an earlier culture, should be protected from demolition; it also points out that the preservation should not lead that people being obliged to live in insalubrious conditions (Corbusier and Eardley, 1973).

Industrial Archaeology, 1955

The field of industrial archaeology developed in Great Britain during the 1950s, at a time when many historic industrial buildings and artifacts were being lost throughout that country. Scholars have realised that old industrial buildings may not be so useless and that they are as worthy of studying past civilisations as the fossils left behind by extinct dinosaurs. Michael Rix proposed 'Industrial Archaeology' in 1955, which is the systematic study of material evidence associated with the industrial past and stresses on leading public to make more attention to the old industrial culture (Neaverson and Palmer, 2012). At this moment, the exploration of preserving historic industrial buildings became a specialised subject.

The Venice Charter for the Conservation and Restoration of Monuments and Sites, 1964

The Venice Charter for the Conservation and Restoration of Monuments and Sites, which can be seen as the extension of the Athens Charter, is a set of guidelines, drawn up in 1964 by a group of conservation professionals in Venice, that provides an international framework for the conservation and restoration of historic buildings. Such charter emphasises a historic monument embraces not only the architectural work but also the urban or rural setting in which can be found the evidence of a particular civilisation or a historic event; furthermore, the intention in conserving and restoring monuments is to safeguard them no less as works of art than as historical evidence (Jokilehto, 1998). Some of the important charters that followed were based on the Venice Charter.

The International Committee for the Conservation of the Industrial Heritage (TICCIH), 1978

The International Committee for the Conservation of the Industrial Heritage, better known by the more manageable TICCIH, found in Sweden, in 1978, is the world organisation for researching on industrial heritage. Its goals are to promote international cooperation in preserving, conserving, investigating, documenting, researching, interpreting, and advancing

the education of industrial heritage. This wide-field includes the material remains of industrial buildings, plants, machinery, and equipment; as well as housing, industrial settlements, industrial landscapes, products and processes, and documentation of the industrial society (Seely and Martin, 2006; TICCIH, 2022).

Burra Charter, 1979

Burra Charter was adopted by International Council on Monuments and Sites (ICOMOS) in Australia in 1979. The Charter was developed as an Australian adaptation of the Venice Charter, but with the introduction of a new analytical conservation model of heritage assessment that recognised forms of cultural heritage beyond tangible and physical forms. It defines the basic principles and procedures to be followed in the conservation of Australian heritage places (Gilmour, 2007). The charter has been constantly updated and is still in use today and has been internationally influential in providing standard guidelines for heritage conservation practice (Australia ICOMOS, 2022).

Charter for the Conservation of Historic Towns and Urban Areas (Washington Charter), 1987

The Washington Charter, adopted by the ICOMOS General Assembly in Washington, DC, in 1987, established the principles and guidelines for the protection and conservation of historic towns. The charter seeks to complement the Venice Charter, whose emphasis is on the historic urban areas, large and small, including cities, towns and historic centres or quarters, together with their natural and man-made environments (ICOMOS, 1987). In addition to preservation, the charter proposes the future development of the historic area as well, such as the participation of residents in the preservation process, and the social and economic aspects of the historic town (ibid).

The Nizhny Tagil Charter for the Industrial Heritage, 2003

The Nizhny Tagil Charter for The Industrial Heritage was originated by TICCIH in Russia, in 2003, and was presented to ICOMOS for ratification and eventual approval by United Nations Educational, Scientific and Cultural Organization (UNESCO). It emphasises that the buildings and structures built for industrial activities, the processes and tools used within them and the towns and landscapes in which they are located, along with all their other tangible and intangible manifestations, are of fundamental importance. One of the most significant implications of the charter is to clarify the definition, preservation and investigation approach of industrial heritage. *'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' (TICCIH, 2003). It is a sign that marks the research of industrial heritage comes to maturity.

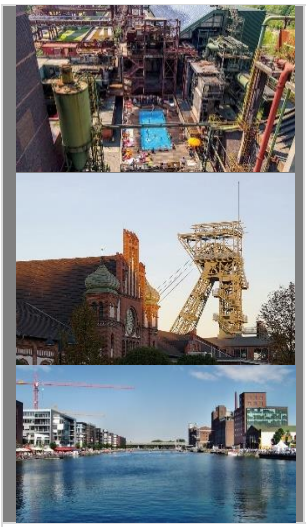
Taipei Declaration for Asian Industrial Heritage, 2012

The Fifteenth TICCIH General Assembly was held in Taipei, China, in 2012. This is a sign that Asia's industrial heritage has come to the attention of the world. The participants have reached a mutual agreement that adopting a declaration based on Asian industrial heritage to promote their conservation and preservation is appropriate and necessary, in order to save Asian industrial heritage, which is now under increasing threat. As a result, Taipei Declaration for Asian Industrial Heritage was born. As industrial development in Asia is different from its counterparts in the West, TICCIH Congress agree that it is necessary to establish an Asian network for industrial heritage within the framework of TICCIH (TICCIH, 2012). Hence, such a declaration proves that Asian industrial heritage is playing a significant role in the world.

3.2.2.2. List of cases

After nearly a century of research and effort, there is a rich practical achievement in the reuse of old industrial buildings in Europe and USA. These countries were early entrants into the post-industrial era and also early explorers of the reuse of old industrial buildings, as can be seen from these examples, most of which were completed before the 21st century. Table 3.2.2.2-1 shows some examples, these are the achievements in the renovation of old industrial buildings. The cases have been largely preserved in their historical architectural form and transformed into important cultural public spaces in the city.

	Name	Manufacturing functions	New functions
UK			
	**Battersea Power Station**	1930s Power station	2021 Residential units, restaurants, office space, shops, and entertainment spaces
	In 1980 the whole structure was given Grade II listed status; over the years Battersea Power Station has become a treasured icon in the London skyline. Now, it's the centre of a massive regeneration plan by Malaysian developers who are enlisting architects from around the globe to transform it into a luxury retail, office and living complex.		
Battersea Power Station (Available from: <https://www.pbctoday.co.uk/news/planning-construction-news/battersea-power-station-closes/74232/>, 20 May 2018).			
	**Tate Modern London**	1940s Power station	2000 Art museum
	Since its opening in 2000, more than 40 million people have visited the Tate Modern. It is one of the British top-three tourist attractions, bringing £100 million in economic benefits to London annually.		
Tate Modern (by author, 2021).			
	**Royal Albert Dock**	1864 Warehouse	1984 restaurants, museums, hotel
	Today the Royal Albert Dock is a major tourist attraction in the city and the most visited multi-use attraction in the United Kingdom, outside London. The docking complex and warehouses also comprise the largest single collection of Grade I listed buildings anywhere in the UK.		
Royal Albert Dock (Available from: <https://www.cultureliverpool.co.uk/tall-ships-albert-dock-dublin/>, 20 May 2018).			
	**Liverpool and Manchester Railway, Manchester**	1830 Railway station	1983 Science and industry museum
	The museum is an anchor point of the European Route of Industrial Heritage and is on the site of the world's first passenger railway station – Manchester Liverpool Road – which opened as part of the Liverpool & Manchester Railway in 1830.		
Liverpool Road (Available from: <https://en.wikipedia.org/wiki/Manchester_Liverpool_Road_railway_station#/media/File:Liverpool_Road_railway_station,_Manchester.jpg>, 20 May 2018).			
	**National Mining Museum Scotland**	1890 Mining industry	1984 Mining museum
	The colliery is listed in category 'A' by Historic Scotland. In 2008, to mark the 100th anniversary of the Royal Commission on the Ancient and Historical Monuments of Scotland, a drawing of Lady Victoria Colliery won an online vote as Scotland's Most Treasured place.		
National Mining Museum Scotland (Available from: <https://nationalminingmuseum.com/the-colliery/>, 20 May 2018).			
Germany			
	Ruhr area	Mid-19th century Mining, steel industry, chemicals, mechanical engineering, etc.	1960s Modern metropolitan area

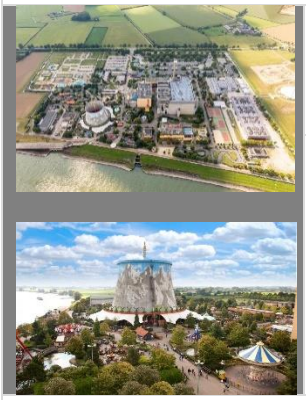


The area consists of several large cities bordered by the rivers Ruhr to the south, Rhine to the west, and Lippe to the north. As a huge industrial district with a large number of old industrial buildings, the Ruhr area has shocked the world with its dramatic urban changes. So many cases in this area have been studied and analysed by scholars, such as Zollverein Coal Mine Industrial Complex in Essen, Zeche Zollern in Dortmund, and Duisburg Inner Harbour.

Zollverein Coal Mine Complex, Essen (Available from: <https://www.open-iba.de/en/geschichte/1989-1999-iba-emscher-park/zeche-und-kokerei-zollverein-essen/>, 20 May 2018).

Zeche Zollern in Dortmund (Available from: <https://en.wikipedia.org/wiki/Ruhr#/media/File:Dortmund_Zollern_IMGP0620.jpg>, 20 May 2018).

Duisburg Inner Harbour (Available from: <https://en.wikipedia.org/wiki/File:Innenhafen_Duisburg.jpg>, 20 May 2018).



Wunderland Kalkar	1972 Nuclear power plant (never went online)	2011 Amusement Park

The project makes use of the huge nuclear power plant equipment building to create an amusement park. Many of the facilities constructed for the plant have been integrated into the park and its attractions, including the cooling tower, which features a swing ride and a climbing wall.

Wunderland Kalkar (Available from: <https://www.open-iba.de/en/geschichte/1989-1999-iba-emscher-park/zeche-und-kokerei-zollverein-essen/>, 20 Feb 2020).



HafenCity	1980s Port warehousing	From 1997 Science, education, culture, hotels, office, residential, retails, food, etc.

HafenCity, as a part of Hamburg, covers an area of 157 hectares, including 126 hectares of land. The aim is to break up the current business and shopping area in the inner city and to return it to the Hamburg city centre with a more contemporary urban appearance. It will return to the Hamburg city centre and expand Hamburg's urban area by 40%.

HafenCity (Available from: <http://www.bjcsghxh.com/data/file/5e8ed2ea2ce221c5613286c8.pdf>, 19 Feb 2020).

France



Orsay museum	1900 Railway station	1986 Art museum

The building was originally a railway station. Now the museum holds mainly French art dating from 1848 to 1914, including paintings, sculptures, furniture, and photography.

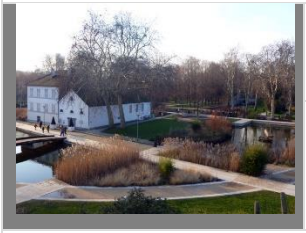
Orsay museum (Available from: <https://thegoodlifefrance.com/music-in-paris-at-the-musee-dorsay/>, 20 May 2018).

	**Parc André Citroën**	1915 Citroën automobile manufacturing plant	1992 City park
	Paris has started to buy back these brownfield sites for regeneration as part of the city's re-beautification process. There are six serial gardens which are each associated with a metal, a planet, a day of the week, a state of the water and a sense.		

Parc André Citroën (Available from: <https://fr.wikipedia.org/wiki/Fichier:Parc_Andr%C3%A9-Citro%C3%ABn.jpg>, 10 May 2019).

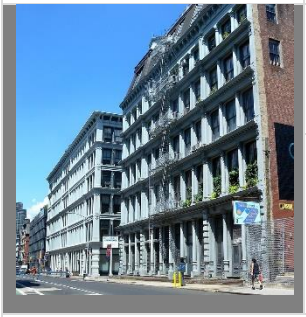
	**Parc de la Villette**	1960s Slaughterhouses, wholesale meat market	1987 Cultural venues
	The park houses one of the largest concentration of cultural venues in Paris, including the City of Science and Industry, Europe's largest science museum, three major concert venues, and the prestigious Conservatoire de Paris.		

Parc de la Villette (Available from: <https://www.triphobo.com/places/paris-france/parc-de-la-villette>, 10 May 2019).

	**Parc de Bercy**	18th century Wine depot	1994 Public park
	Composed of three different gardens on different themes connected by footbridges, the Parc de Bercy is Paris's tenth largest park.		

Parc de Bercy (Available from: <https://www.baladesauxjardins.fr/visite-guidee-du-jardin-de-bercy/>, 10 May 2019).

USA	

	**SoHo, Manhattan, USA**	Mid-19th century Iron foundries	20th century Artists' lofts, art galleries, shops
	Almost all of SoHo are included in the SoHo–Cast Iron Historic District. It consists of 26 blocks and approximately 500 buildings, many of them incorporating cast-iron architectural elements.		

SoHo (Available from: <https://en.wikipedia.org/wiki/SoHo,_Manhattan#/media/File:Cast_Iron_Grand_Crosby_jeh_crop.jpg>, 10 May 2019).

	**Ghirardelli Square, USA**	1864 Woollen mills and chocolate factory	1964 Shops and restaurants, a 5-star hotel
	Ghirardelli Square is a landmark public square and plaza. It became the nation's first factory-turned-open-air shopping centre.		

Ghirardelli Square (Available from: <https://www.sfgate.com/local/article/Ghirardelli-sign-removal-landmark-preservation-15377263.php>, 10 May 2019).

	Gas Works Park, USA	1906 Coal gasification plant	1975 City park

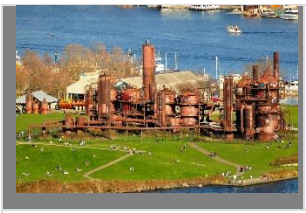
	Gas Works Park is a park located in Seattle, Washington, United States. It is a 77,000 m2 public park on the site of the former Seattle Gas Light Company gasification plant.
Gas Works Park (Available from: <https://green.uw.edu/blog/2015-11/uw-professor-pushed-revolutionary-design-gas-works-park>, 10 May 2019).	

Table 3.2.2.2-1 Cases in Europe and USA (collected by author, 2021).

3.2.3. The path in China

The West, which pioneered the industrial revolutions and post-industrial society, has by now seen the results of excellent practice everywhere. Now abandoned and unused factory buildings are hard to be seen in the West. Compared to them, China's industrial development started late. China's policy: 'suppress the second industry and develop the third industry in the urban area,' in 2001, marked the country's entry into the post-industrial era (Wu and Li, 2020). The renewal of industrial buildings in China has seen a jump in numbers in this regard. Thanks to the guidance of the pioneers in the West, this process was compressed, and the time was very short. Of course, due to the different national conditions, China's path to industrial building reuse cannot be a copy of the West. It should translate and create a transformation method that meets the Chinese (Peng, 2017).

3.2.3.1. Achievements in China

The reuse of abandoned industrial sites in China has experienced a bumpy ride. In the 1980s, urban sprawl dominated the direction of urban design in China. Demolition transformed industrial land into civil districts in the urban area. The relevant experts started to explore the value of reusing old industrial buildings in the middle of the 1990s. However, at that time, the reused projects were concentrated in Beijing and Shanghai; and the approach was limited to the concept of 'waste utilisation' (Qi, 2010). Then, the 'Beijing Charter', which was adopted in 1999 by the Union International des Architectes (UIA), emphasised the importance of discovering old architectural culture (Wu, 1999). Subsequently, the reuse of old industrial sites focused on cultural construction for facilities such as art centres, lofts, and mixed-use industries. In addition, the geographic scope of these projects extended to the northeast and the south of China. In short, China learned from advanced Western ideas and developed its own system of reuse in a short period (Figure 3.2.3.1-1).

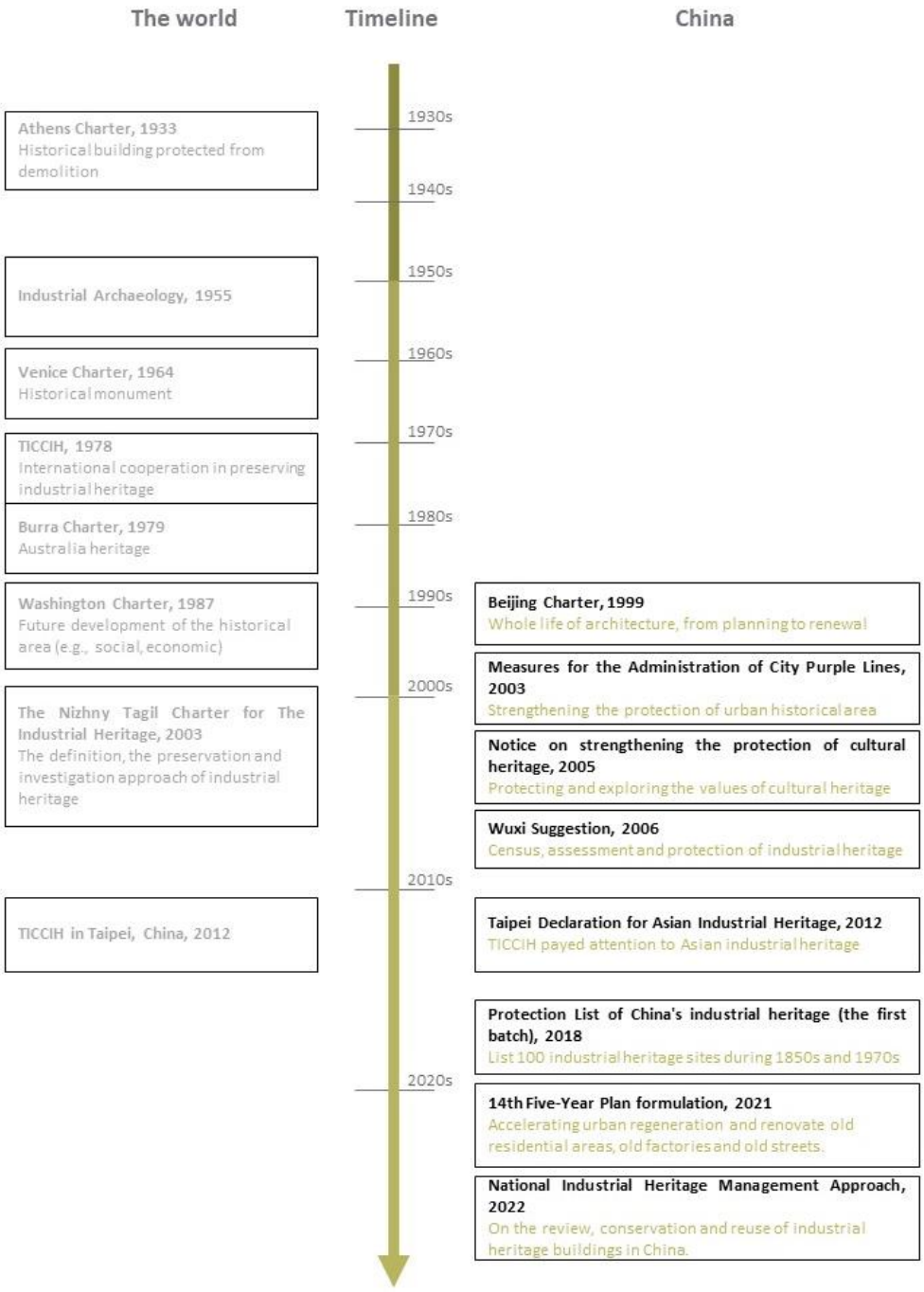


Figure 3.2.3.1-1 The comparison timeline of conferences and charters achievements in the world and China (by author, 2022).

Beijing Charter, 1999

Beijing Charter, which was adopted in 1999 by the 20th Congress of the Union International des Architectes (UIA), was drafted by Liangyong Wu, a Member of the Chinese Academy of Engineering and Member of the Chinese Academy of Sciences. The charter points out architecture as a recycling process, which relates to not only a continuous process of planning, design, construction, and maintenance, but also adapt reuse, rehabilitation, and renewal (Wu, 2000). It represents that the research of architectural renewal had an important position in China's field of architecture and urban design.

Measures for the Administration of City Purple Lines, 2003

Measures for the Administration of City Purple Lines, which were deliberated and adopted at the 22nd Executive Meeting of the Ministry of Construction on November 15, 2003, came into force on February 1, 2004. A city purple line means the demarcation line of the protection scope of sites within a city of historical and cultural significance. These Measures are formulated in accordance with the '*Law of the People's Republic of China on Urban Planning*', the '*Cultural Relics Protection Law of the People's Republic of China*' and other relevant provisions of the State Council for the purpose of strengthening the protection of urban historical and cultural street blocks and historical buildings (The State Council the People's Republic of China, 2003).

Notice on strengthening the protection of cultural heritage, 2005

The State Council published a Notice on strengthening the protection of cultural heritage in 2005, to enhance people's consciousness about protecting and exploring the values of cultural heritage. The notice emphasises the importance and urgency of protecting cultural heritage; raising the awareness of the population; finally making the idea of protecting heritage into action. In the process of urbanisation, it is important to protect the historical and cultural environment, and to preserve old buildings and to explore their cultural value (The State Council of the People's Republic of China, 2005).

Wuxi Suggestion, 2006

Wuxi Suggestion was drafted by State Administration of Cultural Heritage (SACH) and experts and scholars related to industrial heritage in Wuxi, in 2006. Such a suggestion can be seen as a response to The Nizhny Tagil Charter for The Industrial Heritage. It pushed China to carry out a census and assessment of industrial heritage as soon as possible, and prepared special plans for the protection of industrial heritage and incorporate them into the overall urban plan

(Yu, 2006). This is a suggestion entirely dedicated to old industrial buildings, and marks a time when China is starting to preserve and reuse a large number of old industrial remains, and also a time when a number of excellent cases of the reuse of industrial buildings have emerged.

Protection List of China's Industrial Heritage (the first batch), 2018

In 2018, the ‘National Academy of Innovation Strategy’ and the ‘Urban Planning Society of China’ released the Protection List of China's industrial heritage (the first batch), which includes 100 industrial heritage sites built between the 1850s and 1970s. The list includes government-run enterprises founded during the Self-Strengthening Movement, as well as ‘156 key construction projects’ since the founding of New China, covering shipbuilding, military, railway, and other categories of industrial heritage with representative and outstanding value (National Academy of Innovation Strategy and Urban Planning Society of China, 2018). In 2019, the second list of 100 industrial heritage projects was published. This list is continuing to be developed in the future.

14th Five-Year Plan Formulation, 2021

The 14th Five-Year Plan Formulation is the national plan of the People's Republic of China for the period from 2021 to 2025 and it is for the formulation of national economic and social development. This time, the 5-year plan clearly sets out the development strategy for urban regeneration. It promotes the transformation of old buildings and strengthens the control of new high-rise buildings, transforms and upgrades old residential areas, and old factories and old streets (The State Council of the People's Republic of China, 2021).

National Industrial Heritage Management Approach, 2022

National industrial material (tangible) heritage includes plants, workshops, mines, other production storage and transportation facilities, industry-related management and scientific research sites, other living service facilities and machinery, production tools, offices, products, archives, etc.; further, intangible heritage includes production processes, rules and regulations, corporate culture, industrial spirit, etc. (Ministry of Industry and Information Technology of the People’s Republic of China, 2022). The management approach involves the declaration of China's industrial heritage and the evaluation system for industrial heritage, which focuses on encouraging the protective reuse of industrial heritage.

3.2.3.2. List of cases

The charters are only a general direction for China, which has a huge land area and diverse human culture environments. The specific strategies for implementation should be discovered and summarised by scholars and experts in their research and practice of the specific project. China has caught up with research in related fields in a short period of time to the world and has accumulated numerous excellent cases. A selection of cases is listed below (Table 3.2.3.2-1). It is easy to see in these cases that public space is still the most popular target for the transformation of old industrial buildings in China today.

	Name	Manufacturing functions	New functions
North China			
	**798 Art Zone, Beijing**	1957 Radio Industry	2002 Mixed-use: Art studios, bars, offices, and shops
	By 2003, an artistic community of over 30 artists, designers, and publishers had developed. With government support, 798 quickly became one of the most famous reused projects in China.		
798 Art Zone (Available from: <https://en.wikipedia.org/wiki/798_Art_Zone#/media/File:798%E5%B7%A5%E5%8E%82%E5%B1%95%E5%8E%85.jpg>, 20 May 2018).			
	**751D·PARK, Beijing**	1957 Gas plant	2008 Mixed-use: Art studios, bars, offices, and shops
	Next to the 798 Art Zone, 751D became a cultural zone with art and fashion. This provides opportunities and space for public events, art experiences and exhibitions for urban regeneration.		
752D·Park (Available from: <http://cwhung.blogspot.com/2016/08/751d-park.html>, 20 May 2018).			
 	**Shougang Group, Beijing**	1919 Steel company	2011 The venue of the 2022 Winter Olympics, and integrated financial industry centre
	In 2015 the East Gate of the Shougang Factory was protected and demolished, such as glazed tiles, and wooden beams, were preserved. In the same year, Beijing's bid to host the 2022 Winter Olympics was successful, and in 2017, the site for the Beijing Winter Olympics snowboarding ski jumping event was identified as being within Shougang park.		
Snowboarding ski jumping (Available from: <https://www.sohu.com/a/358824065_114988>, 20 May 2018). Shougang art exhibition (Available from: <https://zhuanlan.zhihu.com/p/95740791>, 20 May 2018).			
	**Huajin 3526, Tianjin**	1970s Military pharmaceuticals	2005 Mixed-use
	3526 Creative Industries Park is mainly for lease, except for restaurants, baths, nursing homes, noisy and polluting enterprises can be located in the park.		
Huajin 3526 (Available from: < http://xiangxuetang.ezweb1-3.35.com/htdocs/6/9/xiangxuetang/resource/rich/3f8f566b40477d3f5f2c8f9b58e6d2df.jpg>, 20 May 2018).			
East China			
 	**InterContinental Shanghai Wonderland, Shanghai**	1959 Mining pit	2018 Hotel
	The hotel is 18 stories, 16 of which are below ground level including two projected underwater floors; two of the floors are above the 88m deep quarry. The abandoned quarry is partially filled with water to create an artificial lake.		
InterContinental Shanghai Wonderland (Available from: <https://www.dzzyisp.com/news/ent/2019/0827/1752.html>, 20 May 2018).			
	**Tianzi Fang, Shanghai**	1930 Food Industry Machinery Factory	2002 Retail street and diverse small business
	Tianzi Fang is located in one of the most expensive areas in Shanghai. It has become a major tourist attraction and has more than 200 diverse		

	small businesses such as cafes, bars, restaurants, art galleries, craft stores, design houses and studios, and even French bistros.		

Tianzi fang (Available from: <https://www.tripstoshanghai.com/attractions/show/tian_zi_fang.htm>, 20 May 2018).

	**No. 8 Bridge, Shanghai**	1970 Automotive Brake Systems	2004 Mixed-use
	Over the past years, The Bridge 8 has gained much attention from people in fashion, economy, entertainment, and tourism industries, and becomes a model for industrial design in China, and has also made contribute to the development of the high-end modern service industry in Shanghai. Shanghai's industrial transformation projects are dominated by creative industrial parks, represented by works such as No. 8 Bridge and M50.		

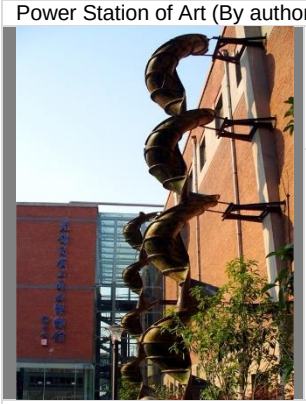
No. 8 Bridge (Available from: <https://www.easytourchina.com/scene-v1322-the-bridge-no-8-creative-industrial-zone--shanghai>, 20 May 2018).

	**1933 Old Millfun, Shanghai**	1933 Slaughterhouse	2006 Mixed-use: office and retails
	The transformation from a slaughterhouse full of killings to an urban public space allows the art of architecture to be used to its fullest advantage. Curved staircases, bridged walkways, and thick walls give the complex a unique industrial aura, especially for an area aspiring to house cuisine and the arts.		

Shanghai 1933 (By author, 2019).

	**Power Station of Art, Shanghai**	1985 Power station	2009 Art gallery
	The gallery is on the site of the Expo 2010 and on the left bank of the Huangpu River. Housed in a former power station, it is China's first state-run contemporary art gallery.		

Power Station of Art (By author, 2021).

	**China national industry and commerce museum of Wuxi**	1900 Flour mill	2005 Museum
	The flour mill has witnessed changes in China's national industry and commerce over the past 100 years. The museum built on this basis, will play a positive role in researching the history of the development of Chinese national industry and commerce, protecting and preserving historical relics of the modern era, and educating and playing a positive role for the general public.		

China national industry and commerce museum of Wuxi (Available from: <https://www.wxit.edu.cn/2013/0724/c1336a18131/page.htm>, 20 May 2018).

	**1865 Creative and Industry Park, Nanjing**	1865 Machine manufacturing	2007 Mixed-use
	In 2017, 1865 was included in The Second List of China's 20th Century Architectural Heritage Projects; in 2018, it was included in Protection List of China's industrial heritage (the first batch); in 2018, it was included in The Second Batch of National Industrial Heritage List.		

1865 Creative and Industry Park (Available from: <http://njrc.gov.cn/data/cynj/pic/2016/05/30/20160530164609_6105.jpg>, 20 May 2018).

Central China			
	Wuhan Boiler Plant	1956 Boiler plant	2008 Comprehensive community



It is an integrated community with a strong focus on industrial culture. A comprehensive community with living space for over 30,000 people, a mixed-use park, an industrial history museum, and an industrial heritage park.

Wuhan Boiler Plant (Available from: <http://5b0988e595225.cdn.sohucs.com/images/20171030/050763423c7a4a7797c71aceb90ce2c9.jpeg>, 20 May 2018).



Exhibition centre of CZT resources-conserving and environment-friendly society construction, Changsha	1948 Paper mill	2007 Exhibition hall

Exhibition centre of CZT resources-conserving and environment-friendly society construction, using the former TianLun paper mill sit, is the first exhibition hall in China to focus on the construction of a resource-saving and environment-friendly society.

Exhibition centre of CZT resources-conserving and environment-friendly society construction (Available from: <https://p1-q.mafengwo.net/s10/M00/D7/EC/wKgBZ1m1ZeOAGIxTABOxKqpyKsQ15.jpeg?imageView2%2F2%2Fw%2F680%2Fq%2F90>, 20 May 2018).



National Cotton Mill No.3, Zhengzhou	1954 Cotton mill	2021 Museum, historical streets, and residential area

The main construction content of the project includes old building renovation works, demolition works, alteration of commercial works, construction of textile industry museum works, and outdoor landscape renovation works.

National Cotton Mill No.3 (Available from: < https://www.163.com/dy/article/FPI2C6TJ05149FAT.html>, 20 May 2018).

South China



Xinyi international club, Guangzhou	1960s Hydropower and hydraulic construction	2001 Mixed-use

Xinyi international club has been transformed into a cultural, commercial and exhibition space by several property developers who studied architecture. The overall design of the building retains the basic structure of the factory, but adapts the windows, doors, walls and many details of the house in a contemporary style.

Xinyi international club (Available from: < http://b1-q.mafengwo.net/s3/M00/82/00/wKgBt09mxeexVVhlAAudnCMBM9s99.jpeg?imageView2%2F2%2Fw%2F600%2Fq%2F90|imageMogr2%2Fstrip%2Fquality%2F90>, 20 May 2018).



Butterfield & Swire's Godowns & Wharf, Guangzhou	1904 Warehouse and dock	2010 Comprehensive zone: yacht marina, commercial, exhibition, and hotel

The transformation of the project was fully recognised at the Guangdong Province ‘Three Olds’ Transformation Site Meeting in 2010. It is currently being revitalised for cultural and mixed-use, exhibition and trade, convention and exhibition, leisure and entertainment, and tourism.

Butterfield & Swire's Godowns & Wharf (Available from: <https://chejiahao.autohome.com.cn/info/6969065>, 20 May 2018).

Nanhai Ecool, Shenzhen	1980s Electrical manufacturing	2008 Mixed-use



There are 146 domestic and international creative enterprises in Nanhai Ecool, including architecture, industrial design, art creation, and landscape planning enterprises.

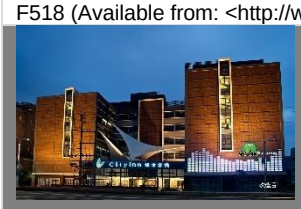
Nanhai Ecool (Available from: <https://weibo.com/ttarticle/p/show?id=2309404167135197802741>, 20 May 2018).



F518, Shengzhen	1990s 75 processing plants	2007 Mixed-use

The F518 Fashion & Creative Park brings together the most creative-minded organisations through a strong and comprehensive service platform, filling up the competitive value of products with original ideas and actions.

F518 (Available from: <http://www.cnf518.com/uploadfile/2012/0606/20120606063443703.jpg>, 20 May 2018).



CityInn, Zhuhai	1990s Workshop office building	2009 Hotel

As the first successful example of Zhuhai's ‘three-old’ transformation, the hotel function not only provides employment opportunities, but also enhances the accessibility of the city for tourism.

CityInn (Available from: <http://www.sidd.com.cn/sanjiugaizao/142.htm>, 20 May 2018).

Northeast China



Shenyang Foundry Museum	1539 Foundry	2007 Museum

The building on the side of the Foundry Museum is based on the old factory building. The roof of the area consists of three large rectangular 'iron blocks' of a rusty colour, which serve as the entrance.

Shenyang Foundry Museum (Available from: <https://p1.ssl.qhimg.com/t0125227cb46d73f98a.jpg>, 20 May 2018).



Workers village, Shenyang	1950s Accommodation	2007 Museum

The ‘Exhibition centre of Worker's Village’, through the objects, pictures and text descriptions of the year, restoring the living and living scenes of the old residents of the Worker's Village, preserves the memories of the 1950s, 1960s, 1970s, 1980s, and 1990s.

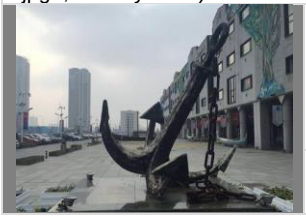
Workers village (Available from: <https://dimg04.c-ctrip.com/images/100j11000000rgjmj518D_R_800_10000_Q90.jpg?proc=autoorient>, 20 May 2018).



Westred Square, Harbin	1958 Mechanical manufacturing	2017 Commercial Complex (mall)

The four old Bauhaus-style factory buildings remaining at the old industrial site are a historical witness to Harbin's industrial development after the founding of New China, and are the most valuable spiritual treasure of the Westred Square.

Westred Square (Available from: <https://gss0.baidu.com/9fo3dSag_xI4khGko9WTAnF6hhy/zhidao/pic/item/2fdda3cc7cd98d1083e9d4e52a3fb80e7bec9021.jpg>, 20 May 2018).



15th, Dalian	1929 Warehouse	2007 Commercial Services: culture, tourism, and entertainment

After the renovation, the 15th will be positioned with the theme of culture, creativity and fashion, becoming a mixed-use area combining various

	cultural and commercial forms such as urban leisure, culture and art, exhibition and display, theme club, creative office and fashion consumption.		
15th (Available from: <https://youimg1.c-ctrip.com/target/100o060000001pqtcCF18.jpg>, 20 May 2018).			
	**Bingshan Wisdom Park, Dalian**	1930 Refrigeration equipment manufacturing	2021 Mixed-use commercial services: culture, tourism, and entertainment
	With 46 old factory buildings and a total area of 180,000 square metres, Bingshan Project is one of the few remaining industrial sites in Dalian. After renovation, the area has become a new tourist hit, and the old industrial area has shown new vitality.		
Bingshan wisdom park (by author, 2022).			
Other area			
	**Xian University of Architecture and Technology Huaqing College , Xi'an**	1958 Steel plant	2009 University campus
	This project is a renovation for a university campus, which adds an architectural and cultural dimension to the hardware facilities of an already architecture-based university.		
Xian University of Architecture and Technology Huaqing College (Available from: <http://www.jdxzz.com/uploads/allimg/190929/7-1Z929161440.jpg>, 20 May 2018).			
	**No.35 Hongxing Road, Chengdu**	1980s Printing house	2007 Mixed-use
	This project features the creative design industry and provides a platform for the cultural and mixed-use industries in the western region of China.		
No.35 Hongxing Road (Available from: <http://i1.ce.cn/ce/culture/whtzgg/5/5-6/sc/201103/17/W020110317375407073308.jpg>, 20 May 2018).			

Table 3.2.3.2-1 Chinese cases (collected by author, 2022).

3.2.4. Spiritual pursuits

Looking back at the achievements of the world, it can be seen that there is a varying degree of 'nostalgia' for the adaptation of old industrial buildings, both in terms of retaining the appearance of the old buildings, the spatial layout, etc. Traces of history can easily be found in most of the projects. However, this is not simply a case of using waste, not simply a new activity within an old house. Because buildings that were once designed for manufacturing may not be suitable today for the new activities people are doing in them. There is also no need or reason for users to force themselves to adapt to a built environment that is against the new activity. The reuse of old industrial buildings is therefore something that needs to be carefully designed by designers. Retaining historical culture well while meeting the needs of people using the contemporary built environment are two important elements pursued by the users and designers.

As can be seen from the cases in the previous section, especially as public spaces, the new life of these renovation projects depends on the activities of people in them. We can venture a hypothesis: if a project (apart from the industrial museum function) is not a reused industrial building, will the number of people who come to use it decrease significantly? A hotel, an art gallery, an office block, a shopping mall, etc., what the real purpose or motivation is for people to come and use these buildings is a complex sociological topic. For example, a hotel with a great location and reasonable prices is still very popular. If at the same time it is an industrial renovation project with a rich industrial culture, then it will be even more popular. At this point, the ‘nostalgia’ of the industrial renovation becomes an added attraction to the project. Of course, this is not absolute. For users, there may be only one motivation for coming to a project. But it must stand out and impress the users, who may even put up with other bad factors in order to pay for this motivation.

People's spiritual needs are complex and vary from person to person. This study, considered from a general perspective, considers people's motivation to a reused project. For such a study, Maslow's “A Theory of Human Motivation” naturally would be an important theoretical support (to be developed in the Chapter 4).

3.3. Adaptive reuse

From the view of urban development, old industrial buildings have become one of the objects of urban construction and development. In this way, they become a material resource for urban regeneration. The spaces and structures of the old industrial buildings were created specifically for an industrial manufacturing process, so that their functional transformation will be different from other types of old buildings. This also highlights their implications for adaptive reuse.

The essence of the transformation of old industrial buildings is the 'selective preservation and strategic addition' of architectural elements (Zheng, et al., 2022a). This section will thus analyse and discuss the potential and meaning of the reuse of old industrial buildings in terms of industrial culture. The researcher published the core content in Section 3.3.3 in a Chinese journal in 2022, Citation: Zheng, X.; Guo, S.; Heath, T. (2022) The Research on the Strategy of Reusing Industrial Buildings under the 'Material Industrial Elements'. *Urbanism and Architecture*, Chinese, 17, 142-145. DOI:10.19892/j.cnki.csjz.2022.17.31.

3.3.1. Reusing old industrial buildings under urban regeneration

Due to the rapid expansion of urbanisation, there is no specific definition of the urban area. Normally, an urban area can be seen as a highly integrated economic area which basing on urbanisation, informatisation and industrialisation; the characteristic can be embodied by a high-density population and economy, comprehensive infrastructure, and low proportion of primary sector and a high proportion of service sector (Gottmann, 1957; Imhoff, et al., 1997; Yang, 2008).

Urban regeneration can be seen as a comprehensive vision and action which leads to the resolution of urban problems and which seeks to bring about a lasting improvement in the economic, physical, social, and environmental condition of an area that has been subject to change; urban regeneration is an outcome of the interplay between these sources (physical, social, environmental, and economic transition) of influence and, more importantly, it is also a response to the opportunities and challenges which are presented by urban regeneration in a particular place at a specific moment (Roberts and Sykes, 1999). For the architect, the design refers to such activities as sketching, planning, arranging, colouring, and patternmaking, which is based on physical outcomes (Heath, et al., 2011). From the view of urban design, urban regeneration is primarily concerned with shaping and adjusting urban spaces. Urban regeneration, in short, is the design activity to meet the new demands of human beings through upgrading urban spaces and functions.

3.3.1.1. The organic process of urban regeneration

The adaptive reuse of old industrial buildings creates new spaces and functions, while preserving the original construction. The reused projects are mainly on the 'new-within-old' and 'old-within-new' dimensions. This will also respond to the 'organic urban regeneration'. The concept of organic urban regeneration illustrates that regeneration in urban area occurs following the urban fabric step by step, instead of jumping into big urban planning changes (Wu, 1991; Jin, 2013; Furlan and Faggion, 2017).

The word 'organic' itself is mainly used to describe the growth of organisms without using artificial chemicals (Cambridge Dictionary, 2021). Putting into urban regeneration, of course, it is not possible to develop without human intervention, but rather it means adapting an appropriate scale, and properly managing the relationship between the past, the present, and the future, according to the content and requirements of the transformation (Wu, 1991). In other words, it is to follow the law of urban development under the ensuring of the original urban fabric, instead of large-scale demolition and construction. The aim is to guarantee the continuity of cultural development. Sometimes urban planning can be described as painting. Organic urban regeneration is like colouring or revising an existing painting to produce a better work. In contrast, redevelopment and the re-planning of large areas of open space are like painting on a blank sheet of paper, with fewer constraints. The reuse of old industrial buildings is then more like a transformation of an existing painting, in most cases, based on the preservation of the fabric of the original building.

3.3.1.2. Objects of urban regeneration

Old industrial buildings are the foundation of the research, and it is playing a resource role in urban regeneration. Urban spaces are limited. The division of commercial areas and the variations in property prices are emphasising the limitation of urban spaces. One of the most important aims of urban regeneration is to ensure the maximum beneficial use of land already within the urban area, in order to adapt to urban sprawl (Roberts and Sykes, 1999). This is considerable importance and provides an immediate stimulus for land use. Specifically, in terms of practical applications, urban regeneration is usually fragmented, which can be short-term, and project-based without an overall strategic framework for city-wide development. This proves once again that old industrial buildings scattered throughout the city will become an important resource and object of urban regeneration.

Urban regeneration can be divided into 2 stages: firstly, the progress of human thought will precede physical matter; then, the material updating will catch up with human thought. The

mind always precedes matter, and people use their intelligence to create new physical matter to serve humanity. From a certain point on, new needs emerge, and existing industrial buildings are no longer able to meet them (as described in Section 2.4). They were therefore made obsolete and became old industrial buildings. Later, people use their wisdom to transform old industrial buildings so that these buildings can be reused to meet contemporary or future urban needs (Figure 3.3.1.2-1). In this process, the physical object is that industrial building that has been eliminated and then reused. Unlike ordinary civil buildings, an old industrial building has a high degree of flexibility in its transformation, allowing it to fill the gap of people's new demands. Thus, old industrial buildings, as objects of study, can also be seen as valuable physical resources and objects in the process of urban regeneration.



Figure 3.3.1.2-1 Wisdom-led urban regeneration (by author, 2021).

3.3.2. The implications of the adaptive reuse

The life of architecture can be divided into three aspects: functional life, structural life, and cultural life. Although the functional life of the manufacturing has already finished for these buildings, structural and cultural life still coexist within the built environment. Although trying to save an old building is not an easy task, pulling down a building could not be the best way either which may lead to the appropriation expenditure, environmental pollution, and destroying the urban diversity and urban identity. Normally, in terms of old industrial buildings (except prefabricated buildings), without any advisable excuse such as the quality of building construction, the site value, land pollution etc., the reuse is often more meaningful than the demolition.

Although old industrial buildings can be seen as obsoleted products of urban development, and some abandoned buildings already became 'ruins' or urban grey areas, they still have potential values to reuse. Just as Bollack (2013: 9) said: "*Old buildings can be thrilling or modest architectural works; they can be high art or vernacular; they can be interesting or banal. But they are always complex cultural objects, whose value lies in their very existence. An old*

building is not an obstacle but rather a foundation for continued action. In fact, designing with old buildings is an exhilarating enterprise; adding to them, graft, inserting, knitting new pieces into the existing built fabric is endlessly stimulating". At the same time, the reuse of old industrial buildings is also the revitalisation of a region with improving sustainability, such meanings may involve various aspects, such as improving the city image; increasing vibrancy; improving safety; attracting investment; attracting people to live, work, play via creating new homes, jobs, etc.; saving the regional historic culture. In the following section, the implication of reusing old industrial buildings instead of demolition, will be discussed.

3.3.2.1. Historical value

Old industrial buildings can be seen as senior citizens. They have ever made contributions to the country and society, and their current retirement means that their roles for the country have reclined. However, these cannot hide old industrial buildings' glory, meanwhile, their history should be traced.

The old industrial buildings that survived in the West were mainly built after 'The Second Industrial Revolution', while those in China are mainly referred to a little later, in the 20th century. Industrial buildings are built for industrial manufacturing life. Historically, it can be a historical monument that witnesses the early industrial development of the region. Industrial buildings can therefore reflect historical specificity to some extent, and can be a physical carrier of a region's industrial development and historical processes, which contain comprehensive information. The historical value of the old industrial buildings should be recognised, as the industrial history they contain is of great value to the development of current or future research.

The industrial elements are a true reflection and important witness of the development process of industrial history and the historical environment: the correlation with important historical events, turning points, or historical personage (Liu, et al., 2018). Orange (2016) proposes that industrial buildings have conventionally been defined in technological terms: that, they are places where industrial activities (specifically working with materials to produce things) occurred. Most industrial buildings are the products of the historical society, which could be a war, a technological revolution, a political struggle, etc. Witnessing the historic development, old industrial buildings are not only limited to industrial development, but also related to the development of various aspects of society, like economic, political, and technological (Liu, et al., 2018). For example, Jiangnan Manufacturing Bureau was a shipbuilding industry established during the Qing Dynasty to develop China's early naval power, which was closely linked to the Sino-Japanese War of the time (Liu, 2016).

3.3.2.2. Economic value

One of the reasons for reusing old industrial buildings is mainly to rely on the land value. At present, the issue of the location value of urban land is more and more serious, and it directly impacts business development. Some old industrial sites have promising locations. In history, some cities' development was dependent on local factories, so a large number of old warehouses and mills are located in the heartland in the urban area. It is clear that efficient transportation and urban living facilities (like transport stations, museums, retail, etc.) are important factors when enhancing the vitality of new functions in a reusing project (Drake, 2003). Thus, old industrial buildings in promising locations can attract investment. The arrival of new investment projects will be beneficial to fill the vacancy of surrounding commerce and jobs, improve the surrounding's living standards and commercial value, and drive the economic development of the whole community ultimately (Jacobs, 1992; Peng and Tzeng, 2019).

Jane Jacobs (2011) emphasised in her famous book, '*The Death and Life of Great American Cities*', originally published in 1961, that city diversity relies on small enterprises, because of their convenient services, such as a small bars and convenience stores. "*In the urban area, the district must mingle buildings that vary in age and condition including a good proportion of old ones so that they vary in the economic yield they must produce*" (Jacobs, 2011:196). The cost of building use is a natural advantage of old buildings compared with new buildings, especially the rental costs. If an urban area has only new buildings, the enterprises that can exist there are automatically limited to those that can support the high costs of new buildings. However, time can make the high building costs of one generation the bargains of the following generation; time pays off original capital costs, and this depreciation can be reflected in the yields required from a building (ibid). For new entrepreneurs, the origin of small enterprises, old buildings will be one of the best choices to start their careers. The cheaper costs can make entrepreneurs flexible to be sensitive to quickly adapt business strategies in this competitive market. Meanwhile, a promising location will help to collect talent, creating a foundation for sustainable development in the future. For example, it is for this reason that China has numerous cases, where old buildings in city centres are reused as mixed-use areas.

In terms of the technology of the building itself, many industrial buildings were built to last; their load-bearing structures are solid and made to carry massive floor loads. Although most people will associate old industrial buildings with a poor working environment, most of these structures are of high quality, particularly those constructed of strong materials and with high-tech structures (Ball, 1999; Liu, 2007; Liu and Feng, 2009). Such remnants cannot only

provide part ready-made resources for redevelopment, but also save the time and cost of pre-construction works such as demolishing constructions and the cleaning site. Some mechanical, electrical, and plumbing facilities (MEP) might be ready to use. The long-lasting building structure will save a lot of money in later transformations. Further, as industrial buildings often have large span column networks, their structures are highly included. The large column spacing and good lighting are features that offer great possibilities for the transformation of spaces. Reusing old industrial buildings can bring the newly created functions to explore the great potential of the building structure, such as warehouse buildings, gas storage tanks, water towers, etc. These unique spaces and shapes allow the building to become an advertisement and thus obtain more economic benefits.

3.3.2.3. Community welfare development

Individuals' activities and needs are essentially linked with their community development. Combining the aspect of history and economy above, the reuse of old industrial buildings can bring positive effects on people's welfare in the community. Compared with a new building, reusing an old industrial building could keep the old memory of the region. Since the reused project can fill the community vacancy and stimulate economic vitality, local people will achieve welfare, such as providing jobs and enhancing living standards. All of these are the driving force for enhancing residents' self-confidence and sense of belonging in the community (Williamson, et al., 2003; Sani and Mahasti, 2012).

The community implication and publicity will be extended by keeping the characteristic of the community culture under globalisation. The culture localism reflects the deeper feeling about the inscription of human lives in the past. The continuities of identity and community through local memory and heritage form a resistance against the homogenisation of an increasingly global culture, which is related to sociological concerns about the lack of individuality and the anonymity of the modern city (Tiesdell, et al.,1996). The preservation of community culture can give residents a greater sense of belonging and regional confidence. They will see this culture, which they have followed for many years, as valuable and something that can be continued. This will not result in a cultural discontinuity due to the regeneration of the area. Besides, the uniqueness of community culture is the foundation of tourism, whereby distinctiveness is used to attract tourists. At the same time, the reuse of the site will be accompanied by environmental improvement, from a polluted site to a tourist site with a special landscape. Tourists travel to different regions to satisfy their appetite for discovery or their curiosity regarding different cultures. Agaliotou (2015) states that tourism provides benefits for the development of a community economy and for the improvement of the standard of local

life. Tourism fuels the local economy as tourists require products and services and are willing to pay for them (Law, 1992). Thus, it can be seen that a good circle is built in the region.

3.3.2.4. Environmental value

The process of reusing old industrial buildings is a recycling process of existing resources. Firstly, old industrial buildings that are structurally well maintained, safe and reliable are themselves physical resources for reuse. These ready-to-use items can be used directly, it will save resources in a way such as construction materials, labour and materials needed for new buildings. Secondly, the reuse of old industrial buildings avoids the demolition of existing buildings and saves resources such as labour and material resources consumed in the demolition process. According to statistics, China's building energy consumption accounts for 1/3 of total social energy consumption, 40% of which is produced by the manufacture of building materials and building construction (Yang, et al., 2019). Compared to new buildings, the reuse of existing industrial buildings largely reduces the solid waste produced during construction and manufacturing, and decreases environmental pollution to save energy. This is a way to save on carbon emissions, as less material is manufactured and used, and less construction work is done, which can be seen as the contribute to a better global climate.

In addition, the existing old industrial plants contain highly polluting industries such as the chemical industry. They may still have serious land pollution after they have been abandoned. Scientific and rational planning and design of them can not only improve the site environment, but also protect the environment of the surrounding area. Some of the old industrial buildings had a low environmental value before the transformation, and some of them even had no environmental value or had a damaging effect on the environment. After reuse, their environmental value will be enhanced and will even contribute to other values (Yu and Wang, 2016). In short, the transformation could give a new birth to the site, which is not only to an already damaged environment, but also to a natural environment that needs to be enhanced.

3.3.3. Culture in detail: ‘material industrial elements’

3.3.3.1. Culture of old industrial buildings

The historical aspect seems to be one of the important sections of culture. However, industrial culture is a comprehensive subject that involves many aspects. Facing the ruins of old industrial buildings that have been obsoleted from society, industrial culture is most worthy of being explored. The history of the past, modern industrial aesthetics, and the future of organic urban regeneration are all aspects of industrial culture that scholars will focus on exploring.

Culture is abstract. It exists in the minds or habits of the members of society. Culture is the shared ways of doing and thinking. There are degrees of visibility of cultural behaviour, ranging from the regularised activities of persons to their internal reasons for so doing. Culture can be seen as social assumptions that are shared by a specific region. These unconscious assumptions will influence how people in this region make decisions and behave in working and living (Schein, 1984). Individuals and organisations will conform to these societal assumptions, behaving in a method that is acceptable to the region (Powell and DiMaggio, 2012; Fredin and Jogmark, 2017). Industrial culture is also defined as a dynamic phenomenon in which past and present industrial manufacturing are embedded in the human physical environment, social structures, cognitive abilities, and institutions (Bole, 2021). It can be understood simply as industrial culture is the assumption or phenomenon, and industrial buildings are the product of that assumption or phenomenon.

Playing the same role as the text, image, and video data, some old industrial buildings are the recorder and the evidence of the cultural facts. In the future, the new generation can get the historic culture from these old industrial buildings which play a significant role in inheritance. This is the reason for the proposal of 'Industrial Archaeology' in 1955, which is a way to unravel the industrial culture (Neaverson and Palmer, 2012). However, unlike the text, image, and video data, the information delivered by reused industrial buildings is indirect. It is necessary for participants to use imaginations or attached introductions if they want to get full knowledge of the background culture.

The culture of old industrial buildings can bring surprises for future redevelopment. Since industrial buildings are made for manufacturing and are considerably different from normal civil buildings, this brings more possibilities for the reuse of old industrial buildings, making these unique elements a new visual attraction for the reused project. The industrial style, which is now popular, is the best explanation of industrial culture in an aesthetic sense. This is a piece of good evidence that the industrial aesthetic has reached the hearts of the public. In addition, there are spaces that only industry can make. For example, the Turbine Hall of Tate Modern London is intended to house massive turbo machines, the huge size provides a quality of space that can be used for large, specially commissioned artworks, which is very rare in ordinary civil buildings. The empty vertical space creates a variety of possibilities for the curators' designs, such as 'The Weather Project' in the winter of 2003 (Figure 3.3.3.1-1). Another example is in Shanghai, China. Built in 2018, situated in an 88-meter-deep, water-filled, disused quarry, the InterContinental Shanghai Wonderland hotel, for instance, contains only two levels above ground, with 16 more storeys plunging into the quarry pit below (Figure

3.3.3.1-2). The incredible landscape comes from the alteration that industrial activity did to the environment.

The exploration of industrial culture is comprehensive and endless. It is worth pointing out that industrial culture has different values in the minds of different people. The original definition of industrial heritage was in The Nizhny Tagil Charter for The Industrial Heritage in 2003 (mentioned in Section 3.2.2.1). There are many industrial buildings whose cultural significance may exist only in the minds of a small, specific community, or a small group of people. These buildings do not qualify as an industrial heritage; however, their industrial culture and the value of their existence cannot be ignored. For instance, as mentioned in 3.2.3.1, the Protection List of China's Industrial Heritage (the first batch) in 2018, from 2018 to the present, there are 200 old industrial buildings and sites recognised as industrial heritage and this data is still being updated (National Academy of Innovation Strategy and Urban Planning Society of China, 2018). Therefore, it can be simply understood that those old industrial buildings that have not yet been recognised as industrial heritage may also contain an important or unique industrial culture.



Figure 3.3.3.1-1 The artist Olafur Eliasson, 'The Weather Project'. A huge and dazzling sun hung in mid-air, making the whole Turbine Hall appear warm and producing a strong contrast with the rigours of the London winter outside (Available from: <http://olafureliasson.net/archive/exhibition/EXH101069/the-weather-project#slideshow>, 4 Aug 2018).



Figure 3.3.3.1-2 InterContinental Shanghai Wonderland hotel (Available from: <https://www.ihg.com/intercontinental/hotels/us/en/shanghai/shghe/hoteldetail>, 4 Aug 2018).

3.3.3.2. ‘Material industrial elements’

The buildings, facilities, and landscapes on old industrial sites left behind by industrial activities, and even the way of manufacturing and life of residents under the influence of industrial activities, are valuable resources for urban regeneration. Some specific architectural elements can be understood as important symbols of the evolution of the cultural development of the area. Industrial culture has been the subject of so much discussion, people may ask: where can it be found in an old industrial building? To answer this question, it is necessary to materialisation the abstract concept of culture and to search for and refine the carriers of culture in the whole industrial building or site. Culture consists of two types: tangible and intangible (Munjeri, 2004; Yao, 2018; Vecco, 2010). In most cases, the tangible elements are the evidence of the intangible culture. In short, the industrial culture referred to should be found in the material evidence that corresponds to it in the old industrial buildings that remain.

In response to this issue, the research proposed the concept of ‘material industrial elements’, which was published in the journal of Urbanism and Architecture in Chinese in 2022. This study collectively refers to these carriers as 'material industrial elements'. In an old industrial building, there are architectural elements, such as spaces, forms, landscapes, facilities, and equipment that can carry the industrial culture; at the same time, the material industrial elements can be seen as a more specific unit than the industrial building as a whole, and exists in a variety of forms which can be different sizes, dynamic or fixed, etc. These elements can be a piece of machinery, a landscape, a kind of architectural form, or even a brick. Material industrial elements can be considered a branch of industrial elements, which are the material components of architecture and the built environment. And they are distinguished from non-

material or intangible industrial elements such as production techniques and enterprise culture (Yao, 2018).

Material industrial elements can be divided into two layers of meaning. The first layer presents an immediate using function; the second layer has symbolic meaning. Industrial culture is often expressed by the second layer. A language is a tool used in human communication; on a related topic, architectural elements such as space, types, and surface, are a particular language with which architecture can set up a medium to share with people. With the closure of a factory, the industrial culture is stored in architectural elements; these become the key to historic places to help people identify their past in the future. The concept of material industrial elements translates abstract concepts into material terms. As a medium and carrier, it can be used to better express the city's personality through architectural design and help to refine specific industrial cultures from the large industrial buildings, thus helping architects to better identify design breakthroughs in order to propose efficient transformation solutions in actual projects.

In general, the material industrial element is the heart of the building's revitalisation, from its preservation, to transformation, to expression, which will revolve around these elements. These elements will be constantly renewed as the building changes, and will be present as long as the building exists.

3.3.3.3. ‘Cultural circulation’ and ‘Hybrid culture’

The current study of old industrial buildings is always 'looking backwards' (Liu, 2012). However, the fact is that more attention should be paid to the future of the reuse of old industrial buildings. It is undeniable that, with the rapid development of human civilisation, the number of heritage industrial buildings is decreasing because prefabricated buildings replaced heavy and lasting masonry and reinforced concrete buildings (Figure 3.3.3.3-1). In addition, as society develops, people's perceptions and needs are also changing, so how do these reusing projects meet the changing tastes of people in the future? Following these thoughts, then, it is possible to guess that research on the transformation of industrial buildings may lose its value after the reuse of the existing old industrial buildings.

The proposal of ‘cultural recycling’ by research is developed based on the material industrial element for industrial reuse 'looking backwards'. It is a way of renovating today's reusing projects into valuable old buildings again in the future, in order to achieve a long-term industrial and reusing culture. As an elimination, old industrial buildings that are being reused today is an inevitable product of urban regeneration. Due to the constant development of society,

decades or even centuries from now, today's fashionable reused projects will also become obsolete in time. At that time, they will once again become the material basis for the reuse in urban regeneration. In the future, when looking back at the old industrial building that has now been reused, the culture contains a combination of the former industrial manufacturing and a culture of reused functions, called ‘hybrid culture’. It is possible to make the bold assumption, taking the example of Tate Modern in London: in the year 2070, 50 years from now, the gallery will no longer be suitable for urban development and will need to be adapted for other uses. For the functional transformation in 2000, the designers focused on the material industrial elements that represented the old industrial culture of the power plant between 1963 and 1981, while in the 2070 functional transformation, the designers explored not only the industrial culture of 1963-1981, but also the exhibition culture created by the Tate Modern between 2000 and 2070. Thus, under the concept of ‘cultural circulation’, it is possible to store a longer and more diverse culture of urban development than a single reuse of old industrial buildings. The presentation of this theory can enhance the confidence of scholars in research on the reuse of old buildings under the pressure of 'de-heritagisation'.



Figure 3.3.3.3-1 John Lewis, Magna Park, UK. A modern industrial building with an all-lightweight steel frame, easy to equip and match (Available from: < https://www.winvic.co.uk/case-studies/john-lewis-magna-park-milton-keynes/>, 4 Aug 2018).

3.4. Summary

The preservation of old industrial buildings is a challenge in a rapidly developing city, where their future destiny, demolition or preservation, will be determined by their own value. Through continuous development, the world's research into the reuse of old industrial buildings has been uneven, allowing Western countries to provide the practical accumulation of China's achievements. As an important material resource in urban regeneration, the reuse of old industrial buildings is still of great significance for historical, cultural, economic, and social development. The cultural potential of old industrial buildings is immense and can be the highlight of a reuse project. This section also emphasises the need to look at the reuse of old industrial buildings through a developmental perspective. The reuse of old industrial buildings is an effort by designers to transform not only the physical space of the building into a service for the public, but also an important contributor to cultural transmission, economic development, educational promotion, and environmental enhancement. By the end of this chapter, the interpretation of the reuse of old industrial buildings from their own characteristics to their impact on the city shows the completion of the objective, *What are the characteristics of reused old industrial buildings?* The following study will be discussed how a successful project will serve the public.

Chapter 4

Methodology:

The establishment of assessment framework

4.1. Introduction

The public's curiosity towards a special-purpose industrial building alone is not enough to give the building a long life following its conversion and regeneration. In other words, the public needs for a reused old industrial project today are no longer satisfied with an industrial-flavoured visual experience. The precondition for meeting people's needs is to know what they want from architecture, and this will involve responding to the objective, *What do participants (users) need in a reused project?* (Figure 4.1-1). The clarity of public needs also logically establishes criteria for '*How can the reuse of old industrial buildings be assessed in terms of how they meet the needs of the public?*' to be measured. This chapter will therefore analyse whether Abraham Maslow's (1943) famous psychological theory, the Hierarchy of Needs, which not only summarised the content of human needs, but also divided them into levels, can be applied to the reuse of former industrial buildings. The research translates this into the field of architecture to develop an assessment framework for the reuse of old industrial buildings.

This chapter is one of the key innovations in the research throughout the PhD study. The research uses Maslow's psychological theory as a basis for establishing a framework for the evaluation of public service spaces in reused industrial buildings. The main findings have been published in the following journal, which is indexed within Scopus, SCIE, Inspec, etc.:

Citation: Zheng, X.; Heath, T.; Guo, S. (2022) From Maslow to Architectural Spaces: The Assessment of Reusing Old Industrial Buildings. *Buildings*, 12, 2033. https://doi.org/10.3390/buildings12112033.

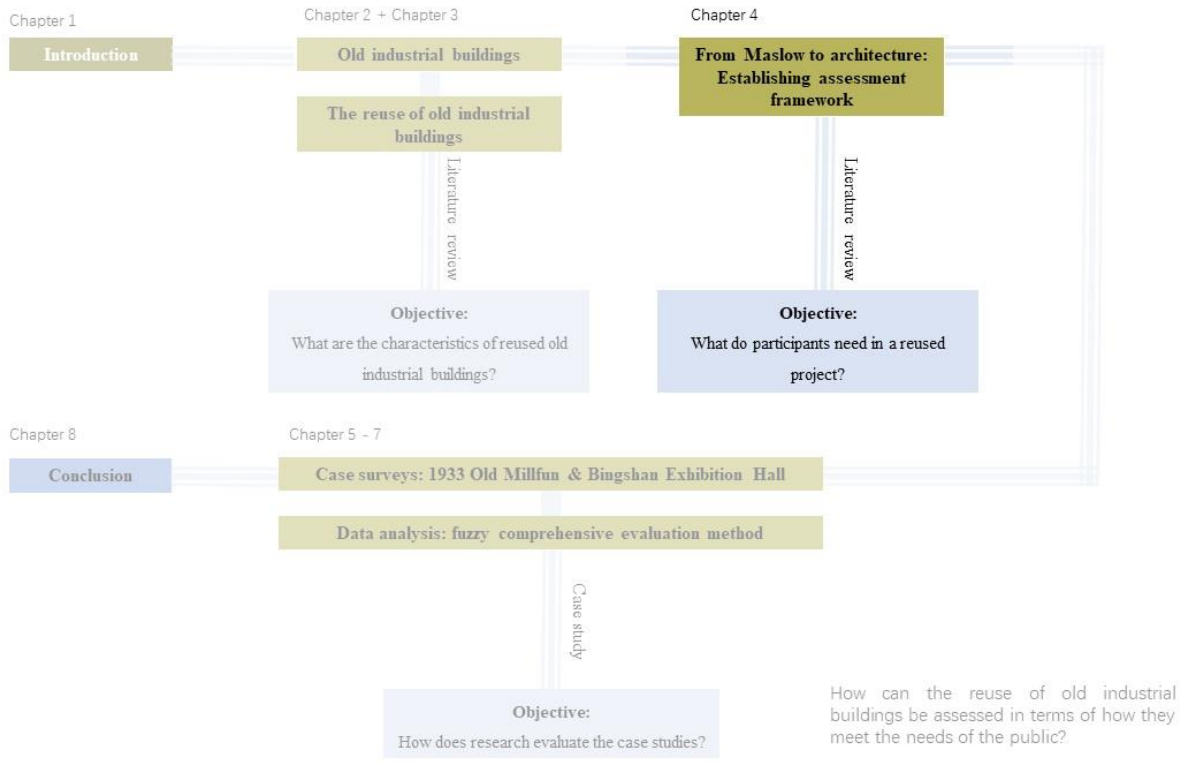


Figure 4.1-1 The structure role of Chapter 4 (by author, 2023).

4.2. A public space to be willingly visited

A successful public building should express its characteristics of publicness. Public spaces acquire their value from their ability to meet participants' needs and requirements (Carmona and Tiesdell, 2007; Alwah, et al., 2021). Determining public needs and expected experiences is of great importance in urban design (Francis, 2003; Carmona and Tiesdell, 2007). The satisfaction of public needs is central and critical in the failure or success of spaces (Bishop and Marshall, 2017), and is a critical way to measure the success of public spaces. (Do, et al., 2019). The so-called 'space' includes the aspects of physical space and psychological space. Among them, the physical space refers to the enclosed space defined by physical entities; the psychological space is the ideal spatial feeling triggered by visual elements such as the location, size, scale, form, colour, material, and texture of the physical space (Shepard, 1957). Psychological space is the perception of architectural space from the participant's personal mentality. When participants assess elements, which are perceived as consistent or similar to their self-perceptions in the space, this creates self-congruity or the sense of empathy and identity mentioned before. Because it is an individual feeling, this is different from person to person. Different people have different experiences and backgrounds, and their expectations and needs are different. However, when space is good enough, then people who have lower needs will rise their awareness and needs. A good public space can be considered, broadly speaking, as a space that meets or exceeds the expected needs of its participants.

When discussing whether participants are satisfied with a building, the premise is that people can come to the building with a purpose. This requires letting people get information about the building. Sources of relevant information can be news, advertisements, recommendations, etc. The active participants need a push force because of their freedom. The driving force behind this is in fact the said attraction. After the participants have been given information about the project, they will make their own judgments, such as, are they interested in the project? Is it worth visiting? Or what do they want to get from it? This type of self-judgement is based on a comparison of people's own needs and information about the project. In other words, the participants in the building will all have their own purpose, which is the 'needs' discussed in this chapter.

Once attracted to the project, participants will experience the building from their bodies and minds. Active participants' personal understandings will be compared to the expectations after they came. This forms the participants' first impression of the building. The participants are thus judged on the building, and this will also influence whether they will come back. The impressions of the first-time experience can be the driving force behind the next one to come.

Thus, the vitality of public realms should be sustainable (Heath, et al., 2011). Repeated visits by participants are an important factor in maintaining the long-term vitality of the project. An enjoyable experience can be a stimulus for participants to come back again and again. A long-term cycle from good attraction to a pleasant experience, which can promote people to go to the project repeatedly. In other words, the experience of the building will have a direct impact on the user's desire to come back, and of course, architects want to create a place that will keep the user coming back for more. For the participants, this could be a replay of memories of a pleasant experience, a desire to explore deeper, or even becomes part of their lives. Positive experiences can be shared with others, which will bring an excellent marketing and advertising effect.

4.3. Reviewing Maslow's Hierarchy of Needs

The Hierarchy of Needs is a theory developed by Abraham Maslow in his 1943 paper "A Theory of Human Motivation" published in the Psychological Review journal (Maslow, 1943). His theory can parallel with many other theories in the psychology of human development, and the stages of human growth. Maslow proposed that 5 layers core needs form the human behavioural motivation and describe the evolution of human needs. After 70 years, the theory has become a popular structure for sociological research, management training, higher education, and many other psychology programs (Shoib, et al., 2022; Sharma, et al., 2022; Saud and Mahajani, 2022).

These 5 levels of needs are organised into a pyramid that clearly describes the order and hierarchy of human needs. From the bottom of the hierarchy upwards, the needs are physiological, safety, social needs (love and belonging), esteem, and self-actualisation. The so-called basis of the composition is meant to illustrate that the lower-level needs in the pyramid have to be met before attention can be paid to the adjacent higher needs (Maslow, 1943). At the same time, Maslow (1943) noted that the order in which these needs are fulfilled does not always follow this standard progression. It should be pointed out that this does not detract from the fact that his theory has become a description of universal public needs. The human brain is a complex system and has parallel processes running at the same time. Thus, many different motivations from various levels of Maslow's hierarchy can occur at the same time. Maslow spoke clearly about these levels and their satisfaction in terms such as "relative", "general", and "primarily". For example, for some people, creative fulfilment maybe even more important than basic needs (Cherry, 2021).

4.4. An assessment framework from Maslow’s theory to architectural space

People in the city are seeking the fulfilment of their needs, so their requirements should be considered as an important section for urban regeneration. Since Maslow’s theory is based on the psychological perspective of human beings, it is necessary to build on the theory and apply it to the reuse of old industrial buildings. The theory will be developed in order to analyse the adaptive reuse projects. It will then be collated so that an assessment framework can be established for the contemporary reuse of old industrial buildings.

Maslow’s Hierarchy of Needs can be further grouped into three dimensions: basic needs, advanced needs, and challenging needs (Figure 4.4-1). The lower two tiers of the pyramid, basic physiological and safety needs, are considered to be the fundamental basis of life and therefore needs according to Maslow’s theory. After meeting these basic needs for survival, people should then be given higher ideological needs, or so-called advanced needs, which express a human being’s pursuit of spiritual civilisation. In modern times, the improvement of the human mind has not only enhanced spiritual civilisation, but also in turn demanded better services and guarantees for life. For example, advanced human thought has created medical care and food supplies. Finally, challenging needs will come from people’s need to grow beyond themselves, that is, the value of self-actualisation, which for the individual may include: “I learned”, “I discovered”, “I created”, etc. The highest level of need is therefore seen in this study as a challenge, self-challenge, and self-transcendence.

With the development of human civilisation for tens of thousands of years, contemporary architecture is not simply a shelter to give protection to people (Cambridge Dictionary, 2022). This research will focus on the human-centredness design, in order to provide a convenient and comfortable experiencing environment for participants, which may be easily neglected in contemporary architecture. Three dimensions (basic needs, advanced needs, and challenging needs) will contribute to the translation from psychology to architecture. Maslow's theory should be 'translated' somewhat in its application to the architecture field, rather than copied directly.

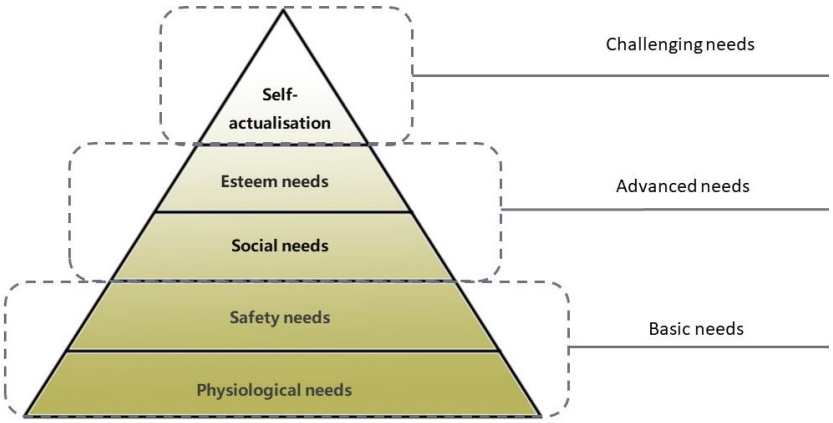


Figure 4.4-1 Maslow's pyramid of human needs with further categorization (adapted by author, 2022).

4.4.1. From physiological and safety needs to basic needs

Failure to meet either physiological needs or safety needs is a threat to life. These needs are similar to instincts and play a major role in motivating behaviour (Maslow, 1943). A comfortable building environment makes it possible for people to enter and escape the discomfort of the outside (bad weather, noisy streets, tired bodies, etc.), and makes people dependent on it. Further, this potentially dependent comfortable feeling can have a positive effect on their deeper experience and understanding of the building.

According to Maslow, some of these needs involve people's efforts to meet the body's need for homeostasis, that is, maintaining a body temperature of 37 °C. In addition to that, it is also a threat to life (physiology) on a higher level when safety needs cannot be met. At the same time, Maslow pointed out that the safety statement is not limited to life safety, but also health, emotional safety, and property safety (Maslow, 1943). Nowadays, a building is designed in accordance with the local building regulations and is constructed after a complex and lengthy process of approval at all levels of the government, as shown in Figure 4.4.1-1. Contemporary architecture has thus avoided some 'low-level mistakes'. Furthermore, due to the different functions of buildings and the different purposes for which they are used, not all needs have to be satisfied, such as sleep and sex.

From Maslow's hierarchy of needs in relation to the field of architecture, most contemporary public buildings do not endanger the lives of their participants as a result of strict building codes and regulations; however, enhanced comfort conditions also need to be considered.

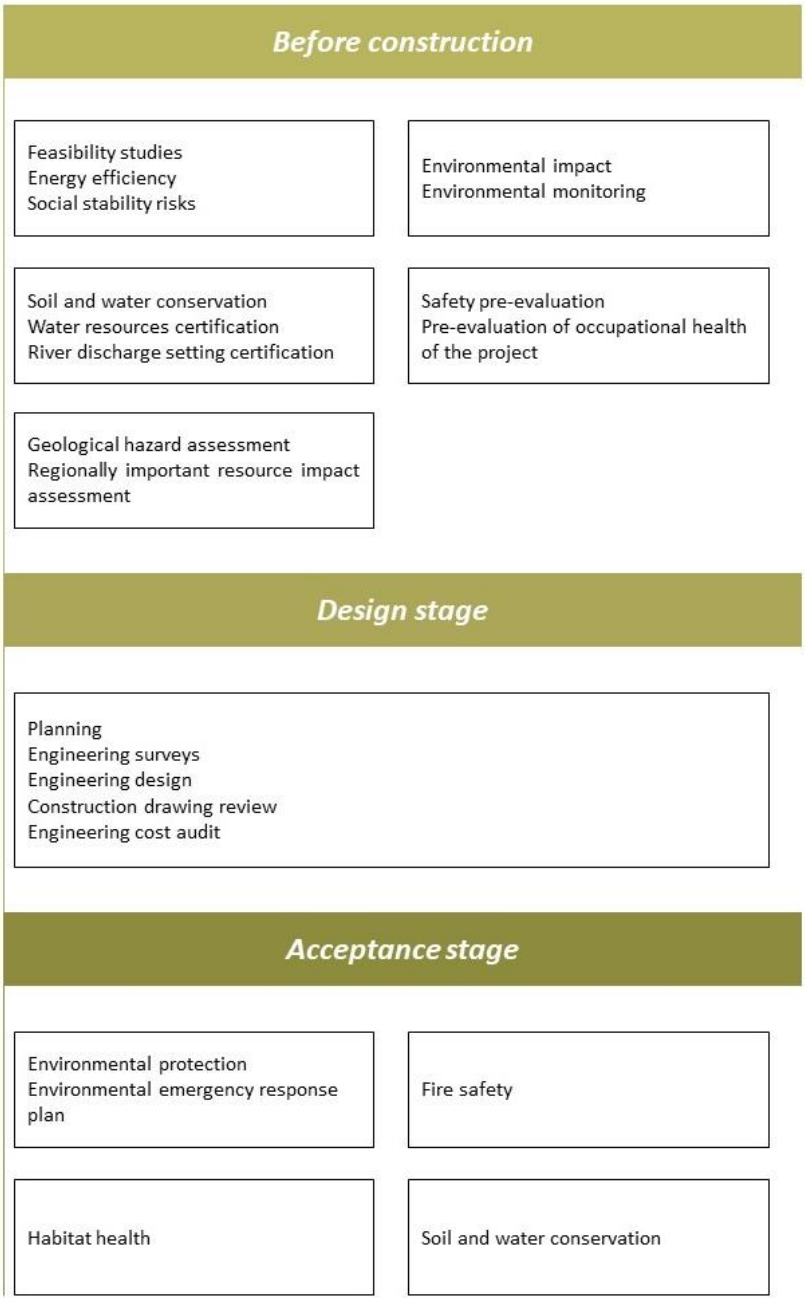


Figure 4.4.1-1 Basic element of construction project approval, with an example from China (by author, 2021).

4.4.1.1 Physiological needs

Physiological needs are considered as the base of the hierarchy. Maslow (1943) proposed that physiological needs are biological needs for human survival, such as air, food, drink, shelter, clothing, warmth, sex, sleep, etc. He considered physiological needs to be the most essential of human needs. If someone is lacking in more than one need, they are likely to try to meet these physiological needs first. For contemporary architecture, providing a building

environment that is comfortable for the human body in different regions and climates is an important indicator of the satisfaction of physiological needs. Of course, not all the needs can be met in public buildings; however, some basic physiological needs must be met, such as the air environment in the building (e.g., comfort in terms of temperature and humidity), the facilities in the building (e.g., provision of drinking, meals, or toilets).

Air environment

Air is one of the most important substances on which human beings depend for their survival. The measurement of the air environment in a building focuses mainly on the quality of the air environment, which refers to temperature, humidity, and ventilation. Overall, the aspect of the air environment can be seen as a comprehensive test of mechanical, electrical, and plumbing (MEP) performance of a building.

The indoor temperature of the building will be difficult to control due to the deep influence of the external environment and the design of the building, such as cold winter days or hot summer days, and wall materials or layout. Advanced building technology can significantly reduce the impact of the external environment on the internal air environment of buildings. Nevertheless, many buildings do not have access to such building technology due to a number of factors, especially in the case of reused industrial buildings, which are limited by the preservation of the original building elements and therefore present a challenge for designers. Both the temperature and humidity of the air can affect people's physiological comfort. Generally speaking, the comfort range for humidity is at the levels of 40–50% (McIntyre, 1978). For the temperature of the air environment, although studies have concluded that the comfortable indoor temperature for humans is around 20–24 °C (World Health Organisation, 1990; World Health Organisation, 2018), this indicator can be used as a reference only due to the different times of use and how much the participants wear. In addition, enough fresh air can make people have clear minds (Young, et al., 2018). To maintain fresh air in a building, good ventilation will play a significant role (Chao and Hu, 2004; Lohani and Acharya, 2016). A building equipped with heating, ventilation, and air conditioning (HVAC) systems can control indoor temperature, humidity, and ventilation and guarantee suitable comfort levels. The HVAC systems, to some degree, even can ignore the influence of the building's external air environment. As a result, the rooms with HVAC systems have a definite comfort advantage in measuring the aspect of air environment quality.

Facilities

In addition to the human need for air and warmth; food, drink, and metabolism are also important items in the maintenance of basic life, as mentioned in physiological needs. Participants may feel thirsty, hungry, or need to go to the toilet when they arrive at a public building, which is the basic metabolism of organisms. Without appropriate facilities, these physiological needs can have a negative impact on the experience of the building because of people's physiological discomfort. To make the experience of using the building better for participants, public buildings should provide opportunities for people to purchase and consume drinks and food through facilities like convenience stores in (or around) the building, cafes, and restaurants. A particular advantage of convenience stores is that they can also sell a wide range of products, including tissues, hand sanitisers, chargers, and other necessary items for visitors. This is not only an effective solution to the immediate needs of the participants, but can also bring in additional income to the project.

Toilets are another essential facility of public buildings. The accessibility of the toilets (clearly signposted, participant-friendly, etc.), and in sufficient numbers is an elemental measure of a successful public building (Bliss and Park, 2020). Most public buildings have a toilet located not far from the main entrance, which is participant-friendly. The experience of the toilets as part of the functional space of the building is also important. For example, a luxury hotel will invest heavily in upgrading its bathrooms with, for example, smart toilets (Figure 4.4.1.1-1). In addition, toilets in contemporary life also have a hand sanitisation and hygiene role. Significantly, the toilet environment and quality can also influence building participants' perceptions regarding a building's level of management, maintenance, and safety (Maxwell, 2000).



Figure 4.4.1.1-1 Smart Toilet at the Conrad Hotel Dalian (by author, 2021).

4.4.1.2 Safety needs

Once an individual's physiological needs are satisfied, the needs for security and safety become salient. It is also a threat to life when safety needs cannot be met. Maslow (1943) pointed out that in adults living in developed nations, safety needs are more apparent in emergencies (e.g. war and disasters), but this need can also explain why we tend to prefer the familiar or why we do things like purchasing insurance and contribute to a savings account. It can be seen that the content of the safety statement is not limited to life safety, but also health, emotional safety, and property safety are sought after while keeping life.

Maslow (1943) considered that safety needs can be summarised in two main aspects: threat and safeguard. If a safety accident occurs, it is already too late. When discussing safety issues, the focus should be on prevention. But nothing can be 100% guaranteed. Safety incidents are a safeguard system that can be divided into three stages: before, during, and after the occurrence. Before the incident happens, it is necessary to prevent, to the greatest extent possible, the potential threats. Once the danger has occurred, the corresponding person or function should be available to stop it in order to prevent the problem from worsening. In cases where neither of the first two can be prevented, the victim should be able to receive compensation after a safety problem has occurred. Eliminating threats and providing safeguards are therefore the assessment of the active (operation management of the building) and passive (constructions of the building) safety dimensions of the building.

Management

The management of safety usually refers to the management of the property and the operational aspects of the building after the building is completed. Safety management is a set of safety systems, including personnel, auxiliary equipment, and management methods. This is dominated by the human factor, which can be adjusted by the management of staff. The presence of security staff keeps order in the building and has a 'deterrent' effect, whilst also assisting people in emergency situations. At the same time, the security staff is employees in the building, they protect participants in the building and know the layout well. So that they can be at the victim's side and help in the shortest possible time in case of danger. Moreover, closed-circuit television (CCTV) systems can help to provide on-going monitoring (Welsh and Farrington, 2003). CCTV can not only reduce the number of hired staff but also provide important evidence of incidents through video recordings.

Furthermore, depending on the characteristics of different regions and social emergency events, the building management should have responses rapidly. For example, during the

Covid-19 epidemic, social distancing became a necessity and corresponding management measures to reduce the spread of the virus had to be implemented and enforced in public buildings. These included measures such as temperature measurement, maintaining safe distances, and supervision of formal mask-wearing.

Construction design

The transformation of the function of the building (from an industrial building to public use) means that the participants of the building change both in terms of the number and the diverse backgrounds of participants. Thus, it is important to discuss whether the old building design can still meet the requirements of the new use of safety needs, both in terms of time and function.

Although modern buildings are less likely to use flammable timber as a building material, fire safety still cannot be ignored. Adequate fire safety prevention (before fire danger occues) and escape (during the fire) need to be carefully considered in the design stage and the on-going management and operation of the building. The building contains not only the enclosing structure, but also the various electrical installations and gas energy, which provide important protection for human life; as a result, to some extent raising fire hazards (Fire and Rescue Department Ministry of Emergency Management, 2022). The fire safety and evacuation design in buildings should be effective in reducing damage (Lo, 1999; Rasbash, et al., 2004; Huseyin and Satyen, 2006; Nimlyat, et al., 2017). Fire safety focuses on extinguishing fires once they have occurred, and stops the spread of fire and smoke to reduce fire damage as much as possible. This will need buildings to be well-equipped with fire warning signs and smoke extraction devices together with a suitable spatial division to restrict fire spread. The building should also provide access to fire engines in order to further extinguish the fire quickly. The layout of a building space should also allow people to escape to a safe area as quickly as possible and to safely reach the open outdoor spaces within short distances. Especially for those participants above the 2F, the design of vertical escape routes could become a challenge. So, in different countries, there are corresponding regulations and standards, such as the *Code for Fire Protection Design of Buildings* in China and *National Fire Protection Association (NFPA)* in America.

Typically, old industrial buildings, whose main purpose is manufacturing, often give the impression of high spaces and balconies, basic and narrow stairs and corridors, and dangerous manufacturing facilities. Combined with rough treatment and negligent maintenance, this makes the components of old industrial buildings unfriendly to public visitors, especially the young, elderly, and those with disabilities. In the process of industrial

manufacturing, inevitably working in a dangerous space environment (like high places and small spaces), protective facilities such as handrails should be improved; floors may be uneven from heavy machines and need to be repaired; lifts and other facilities need to be maintained to ensure they function properly. Such building components should be repaired in order to ensure the safety of the participants. Much of the existing industrial building might therefore need significant upgrading; however, it is worth noting that there may be important industrial elements contained in some parts of the building that constitute important industrial heritage. A conflict arises from the fact that their transformation may destroy the heritage value. The common practice today is of two approaches: to make visitors take a detour, or to use it only as a display (Figure 4.4.1.2-1,2).



Figure 4.4.1.2-1 Making detour: Shanghai 1933 Old Millfun (by author, 2021). The steep and narrow staircase seems somewhat dangerous, while there is also a lift to allow people to reach the higher floors.



Figure 4.4.1.2-2 Only for display: Shougang No. 3 Blast-Furnace, Beijing (Available from: <https://ihmm.ustb.edu.cn/xw/a49bf9d0f39e4a658108e0e0a97627b5.htm>, 9 Aug 2020). Although there are platforms and stairs on the blast furnace, they are used only for display purposes in order to ensure the safety of visitors.

4.4.1.3 Summary of the items used to measure the provision for basic needs

In the study of basic needs, the physiological and safety needs at the bottom of Maslow's pyramid can be translated into the adaptive reuse of old industrial buildings as shown in Figure 4.4.1.3-1. The physiological needs will measure the air environmental quality of the building and the basic facilities to meet people's basic physiological needs; the safety aspects of the building will mainly concern the safety of the building components during the design of the transformation and the safety management of the building operation. These are the aspects of the building that make the participants feel safe and comfortable and allow them to better experience the building. At the same time, it is a good basis for the building to subsequently meet the higher needs of the participants.

The measurement of different types of cases will be adjusted somewhat. But the general principles can be summarised as follows:

- Measuring the ventilation, temperature, and humidity in the building, checking whether within a comfortable range?
- According to the location of the projects, examining whether HVAC is required to be equipped?
- Is the building equipped with the appropriate number of toilets and are they easy to find?
- Are the building's toilets clean, and does the water supply work?
- Is there a convenience store in or around the building and does it sell items for daily emergencies, such as drinks, snacks, fast food, tissue paper, chargers, etc.?
- Is there a security officer in the building?
- Is there a CCTV system in the building?
- Are the firefighting facilities (e.g., fire hydrants, sprinkler systems) in the building up to current codes and best practices?
- Does the fire escape design (e.g., escape stairs, escape distance) in the building meet the building code?
- Are the building's easily damaged elements regularly maintained?
- Are the floors, stairs, hand-railings balustrades, and other elements of the building safe for users?
- Are there suitable warnings or protective measures about safety hazards such as crashes, falls, graze, etc.?

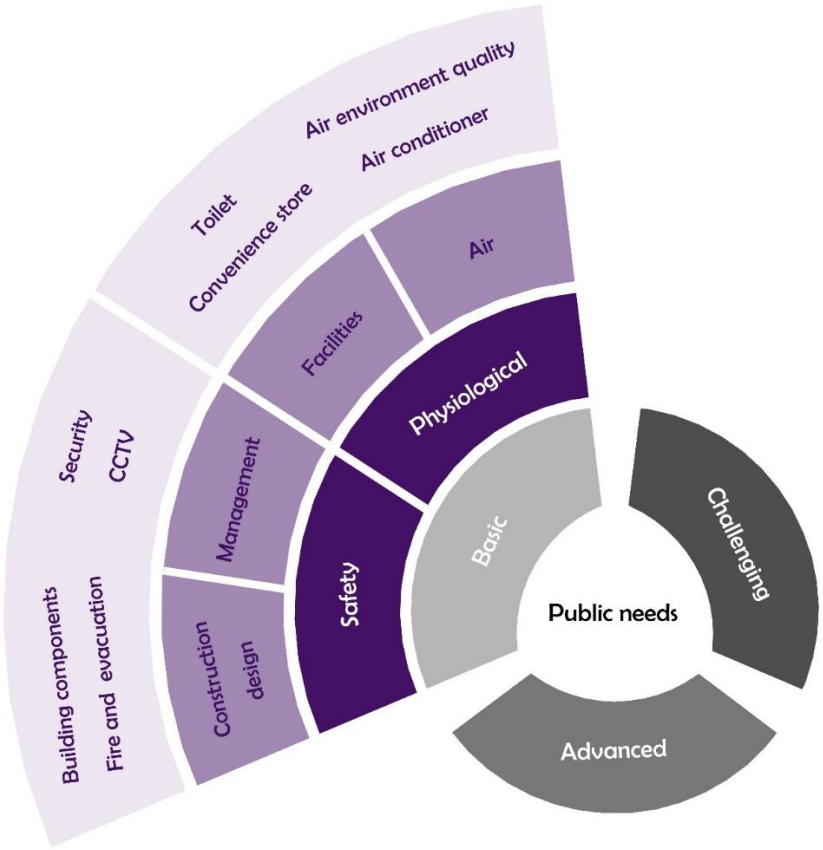


Figure 4.4.1.3-1 Basic needs of Measuring framework (by author, 2022).

4.4.2. From socialising and esteem needs to advanced needs

Spiritual pursuits have never been absent, for example, people have had beliefs for a long time. Maslow (1943) pointed out that once basic needs are fulfilled, the psychological dimension of the pursuit will emerge. In contemporary society, most people are no longer satisfied with just physical comforts and the pursuit of psychology has gradually taken on more importance. People in general live together in an organised way, making decisions about how to do things, and sharing the work that needs to be done, under this system a society is formed (Cambridge Dictionary, 2020). People's brains are linked in this social system. Since humans living in groups, it is essential to communicate with others in social groups. It is because of the need to communicate with others and get feedback from others that the need for social interaction and respect is particularly important. Such communication will effectively avoid psychological disorders such as ‘loneliness’ (Deckers, et al., 2017). The higher-level needs of Maslow’s theory are thus reflected in socialising needs and esteem needs (Maslow, 1943). It is clear that the needs at these two levels mainly require the participation of people. What

public buildings can do is to offer the participants the possibility of socialising and esteem in a way that satisfies these needs.

4.4.2.1 Socialising needs

The third level of human needs is interpersonal which involves feelings of belonging (Maslow, 1943). As an individual in a social group, socialising is an essential part of most human lives. Social behaviour in a place may occur with family, friends, or even strangers. Families come to the building to feel close; friends come to the building to experience friendship; even strangers come to the building to become friends. In addition to the socialisation within a common group, it also includes the passing of information to strangers, which can be extremely brief, such as a conversation with a salesperson when shopping. The building, therefore, becomes a platform to serve the need for social interaction. As a realm where social behaviour occurs, public buildings can therefore provide places that promote social interaction and can indirectly provide opportunities for participants to socialise through the organisation of activities.

Place

With safety needs met, people are encouraged to open their hearts and minds, to accept strangers, and to build communities. Social behaviour is based on establishing communication with others [30]. To promote the communication of different social groups, architecture should provide communication places and opportunities to serve the contemporary needs for social interaction; for example, providing open spaces around the entrances of public buildings. Indeed, well-designed landscapes or public realms around a building can be places for people to rest in sunny weather, or spend time with family and friends, or even meet new friends. Inside a building, there are also ancillary places such as lounges and cafes where people can stay and gather, thus also stimulating social interaction. In addition to these functional spots, unobtrusive corners and other ad-hoc spaces in a building may also be a good encouragement to socialize. Importantly, Gehl suggests “varied transitional forms”, where a lack of activity in a building’s functional transitions will make functional boundaries too clear and will reduce the chance of social interaction (Gehl, 2011). In some transitional corridors, seating can be provided to support social interaction; it can even be common to see people chatting together in designated smoking areas. All of these architectural spaces can provide a relaxing slow-paced atmosphere to encourage planned or spontaneous interaction among visitors.

Opportunity

It has often been reported that face-to-face connectedness or interaction can bring positive psychological outcomes (Lee and Robbins, 1995; Lee, et al., 2001; Cockshaw and Shoche, 2020). Despite virtual socialization being very advanced now, face-to-face socialization, such as the exchange of feelings and emotions, in the form of voice, facial expressions, and body language, can still bring positive benefits to people (Carmona, 2010; Xiong, et al., 2020). In the case of public buildings, it can be difficult to avoid interpersonal communication due to the social behaviour of the users and engagement with staff. Indeed, users' perceptions of a place can depend greatly upon their engagement experience with a building's staff (Sirgy, et al., 2000). The operational aspect of the building should therefore provide good social opportunities and various public events and activities for users. In relation to re-used old industrial buildings, this can take full advantage of the industrial culture and large industrial spaces to attract users to partake in activities. For the organizers, these activities can be organized to promote the project's publicity, thereby facilitating the users' social needs.

4.4.2.2 Esteem needs

Maslow (1943) stated that esteem in terms of the individual is mainly reflected in the respect from others and self-respect. Self-esteem is often expressed through a person's dignity, achievement, mastery, and independence; the desire for reputation or respect from others (e.g., status, prestige), that is, feeling that our achievements and contributions have been recognised by other people. The 'lower' version of esteem is the need for respect from others, and may include a need for status, recognition, fame, prestige, and attention. The 'higher' version of esteem is the need for self-respect, and can include a need for strength, competence, mastery, self-confidence, independence, and freedom. When people's esteem needs are met, they feel confident and see their contributions and achievements as valuable and important. However, when their esteem needs are not met, they may experience 'feelings of inferiority' (Bradley and Green, 2018).

As participants enter a public building, the network of interactions that is formed is not only between the participants but also between the participants and the architectural environment (Figure 4.4.2.2-1). The respect between the participants is easily understood. The respect of architecture for the participants is essentially a dialogue between the designer and the participants. In addition, the building (designer) wants to show familiarity with the participants as soon as possible in order to show maximum sincerity. Therefore, an emphasis upon humanistic design can allow the participant to feel cared for and thus respected by the designer; at the same time, the participant has a good experience of using the building and

feels admiration for the designer's work. Inclusiveness and legibility will reflect issues of respect between, and for, the participants in the internal environment of the building.



Figure 4.4.2.2-1 Participants' interactions in a building (by author, 2021). The interaction exists not only between people and people but also between people and the architectural environment.

Inclusiveness

All people, or in this case building users, should be treated equally. The publicness of a public space can also be reflected by the fact that it is inclusive of all groups of people. In practical terms, it is the demographic factors of the users that directly reflect the equality of the building (Clarkson and Coleman, 2015; Gawlak, et al., 2021). Indeed, the users in the building should include a range of ages, genders, different backgrounds, and different incomes (Carmona, 2021). Additionally, from the perspective of class and racism, public buildings should be the embodiment of inclusiveness in their treatment of these issues (Coon and Parker, 2021). It is also important that all potential building users are considered in the design process to ensure, for example, that the disabled, the elderly, those with young children in pushchairs, pregnant women, etc., are not discouraged by tangible or intangible barriers to their use of the building (Sirgy, et al., 2000). It is also important that any others with special needs are considered in the design and management of the building and not just as a result of legislation (Imrie and Hall, 2001; Carmona, 2021). For the reuse of old industrial buildings, the former building use may not require the relevant barrier-free designs, but the transformed public building definitely will. This might, for example, include lifts, ramps, and accessible toilets.

Legibility

People in unfamiliar surroundings can feel uneasy, as can users entering a building for the first time (Darken and Peterson, 2002). In public buildings, users want to become familiar with

their environment as soon as possible (Darken and Peterson, 2002; Guo and Zheng, 2022). This familiarity with the environment is primarily a sense of orientation to the layout of the building, otherwise, they will rapidly lose confidence in experiencing the building (Forrest, 2013). Therefore, legibility becomes an important point in measuring a successful public building (Moulay and Ujang, 2016; Carmona, 2021). However, it is worth noting that it is not necessary to know every detail of a building, otherwise, some people might lose interest in exploring, with some scholars highlighting the need and value of “surprise” and “mystery” in environments (Kaplan and Kaplan, 1989).

The legibility of a building’s layout is often linked to the images in the mind. Navigation within a building’s interior tends to be dependent on maps, information panels, and signage to inform the users (Ebster, 2011). Generally speaking, maps should be available at the entrance to a building, and signage should be easily visible, so that users can find them quickly and obtain the information they need. Furthermore, the content represented by the maps and signs should be comprehensive and include the locations of key places, such as lifts, stairs, toilets, exits, etc. The content also needs to be easy to read and understand by the wide spectrum of users and therefore be multilingual and include international symbols.

4.4.2.3 Summary of the items used to measure the provision for advanced needs

As individuals in a society, it is difficult to avoid communicating with others, and the need for advancement points to people's psychological dimension. Social behaviour is an indispensable part of human activity. In order to better enhance the social quality of a building for participants, old industrial transformation projects should provide suitable social places and facilitate social opportunities. Furthermore, the differences between individuals in society tend to create the psychological aspect of respecting and being respected. The inclusive design of a building will lessen this difference and at the same time, the legibility of the building will promote the formation of the self-esteem of the participants and improve the experience of the building by amplifying the advantages of the building’s respect for the participants (Figure 4.4.2.3-1).

The general principles can be summarised as follows:

- Are there areas within the project that offer relaxation (e.g., seats, coffee, tea bars, lounge areas)?
- Are there any behavioural activities evident, for example, exercise, chatting, picnics, etc.?
- Is there an information desk, patrolling staff, or volunteers?
- Is the attitude of the service staff welcoming?

- Are there regular or irregular online or offline themed events for the public?
- Is there an official online information social platform?
- Is there a good gender balance of users?
- Is it used by people of different ages and ethnic groups?
- Are there barrier-free designs, such as lifts and ramps, to make wheelchair access possible?
- Are there barrier-free toilets and a nursing room(s)?
- Does the project provide free assistive devices for special groups (e.g., wheelchairs, hearing aids, prams)?
- Is there a layout map in the building? Are the maps comprehensive, clear, and easy to understand?
- Is there any clear signage in the building (e.g., smoking, warning signs, exit signs, visit descriptions)?

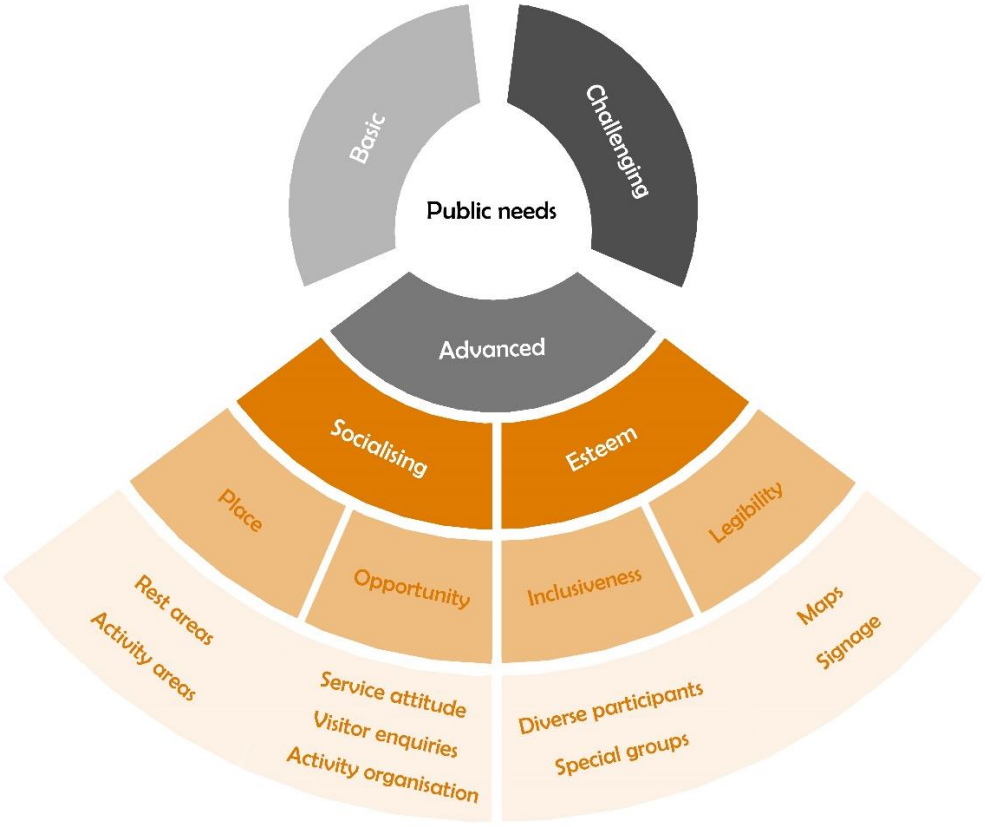


Figure 4.4.2.3-1 Advanced needs of Measuring framework (by author, 2022).

4.4.3. From self-actualisation needs to challenging needs

Self-actualisation is the highest level in Maslow's hierarchy, and refers to the realisation of a person's potential, self-fulfilment, seeking personal growth, and peak experiences. This hierarchy was divided in more detail in later years into cognitive needs, aesthetic needs, self-actualisation, and transcendence needs.

Basic and advanced needs are considered to be those that public buildings should meet for the users. All public buildings should, however, also provide for challenging needs in order to provide the best possible environment for their users. As the highest level in Maslow's theory, self-actualisation is considered to be a growth need (Masolow, 1943; Zhang and Dong, 2009), which can be considered as people realising their own potential by making a contribution to something (Ivtzan, et al., 2013; Hooley, 2015). The self-actualisation and self-transcendence of public users are the awareness of the value of the building's existence after using it, and even the discovery of its problems. Users who achieve this level can have a sense of pride in self-accomplishment, in being able to discover the potential value and meaning of the building. Obviously, achieving such needs for self-actualisation are challenging; indeed, Maslow himself estimated that only two percent of people would reach the state of self-actualisation (McLeod, 2007).

The users' understanding and interpretation of industrial culture and heritage is a significant challenge in the reuse of old industrial buildings. Indeed, industrial culture can be abstract, wide-ranging, and in some cases even invisible (Sadler and Thompson, 2001; Fredin and Jogmark, 2017). Industrial culture can make the reuse of old industrial buildings stand out from the other public realm. The fusion of historical elements with new functions after the transformation can inspire users and help them achieve self-actualisation needs; however, each individual is unique and their motivation for self-actualisation can be different (Kenrick, et al., 2010). For example, there are those who see the huge manufacturing equipment and thus fascinate by the human ingenuity of the past; or some of the participants are inspired to create art in the industrial space. The acceptability of the information delivered by the language of architecture to the public is a characteristic that can distinguish the reuse of old industrial buildings from other buildings. The industrial culture that promotes the interpretation and the enlightenment of the participants to culture will be the ingredients of the architecture that will help the participants to achieve self-actualisation. Participants are able to become more interested in architecture through the industrial culture in the buildings, through understanding the historical significance of the buildings and the significance of their transformation. This

study therefore considers that the transformation and communication of the industrial culture and heritage in the building can contribute to participants' challenging needs.

4.4.3.1 Needs of historical culture

Through the above analysis of self-actualisation needs in Maslow's theory, successful projects should enable participants to experience the meaning of industrial culture or draw inspiration from reused old industrial buildings. Elements in an old industrial building which are markings of life and manufacturing, left at a particular time, are the material industrial elements. As a tangible carrier of historical culture, material industrial elements should be preserved in the transformation process and ultimately displayed in the new building in the form of architectural language. At the same time, important historical culture and heritage should be interpreted and explained in order to be transmitted successfully to the public.

In short, the preservation of material industrial buildings is important, since they are the evidence of the historical industrial culture. With such 'evidence', the transmission and inheritance of industrial culture can be smoother and more efficient. So as it will provide possible satisfaction conditions for users' cultural needs.

Preservation

A precondition for being evidence is the existence and the ability for participants to find. The existence of material industrial elements is supposed to be meaningful. In other words, the designer responsible for the building's transformation has to choose and use them carefully, rather than carry out random demolition or preservation. It is therefore very important to evaluate and select the material industrial elements to be preserved. Most industrial buildings can be seen as a true reflection and important witnesses of the evolution of industrial history, helping to demonstrate important historical events and significant points in time (Liu, et al., 2018). Time has reduced the presence of industrial remains and raised the importance of the heritage value of industrial buildings. Indeed, some old industrial buildings are not only products of history but also creators of history, culture, and community. However, this is a complex task that needs to be evaluated by professionals from various fields, such as architecture, archaeology, history, economics, etc. (Feilden, 2007). Whoever it is, material industrial elements should be regarded as a 'living history' (Leary and Sholes, 2000), in order to guarantee their witness, scarcity and integrity.

- Witness:
  People need to be able to associate the cultural meaning of the historical period with the

material industrial elements that have been preserved. These important material elements are considered to be evidence of the legacy of history, and are thus metaphorically presented as a witness. Material industrial elements, therefore, can be seen as the true reflection and important witness of the development process of industrial history and the historical environment: the correlation with important historical events, turning points, or historical personage (Liu, et al., 2018). Most industrial buildings are the products of the historical societal environment, which could be a war, a technological revolution, a political struggle etc. At the same time, witnessing the historic development, old industrial buildings are not only limited to industrial development but also related to the development of various aspects of society, such as economic, political, and ecological (ibid).

- Scarcity:

  Scarcity will affect the value of the materialistic industrial element itself. Although Gottfried Wilhelm (von) Leibniz stated that "*no two leaves of any plants are identical in all the world*", universality and similarity still affect the value of the object. Most of the current old industrial buildings were built more than half a century ago, and time has reduced the number of industrial remains. The heritage value of some industrial buildings has consequently been enhanced, so that they attract much attention and protection. In addition, some old industrial buildings are not only products of history, but also creators of history. As scarce as those who made history, they may have been pioneers or milestones in the field of industrial manufacturing, or they may have been the first to use the new industrial architecture. Such a first created the uniqueness of the industrial culture, which also raises the value of material industrial elements.

- Integrity:

  Whether as an 'object of evidence' or as a heritage of rare historical value, of course, the more complete the elements left, the better. Although some of the broken elements may seem more historical feel, it has to be admitted that is self-congratulation in the absence of integral elements. The more complete the material industrial element, then the more historical and cultural information it will be enriched with. As in many historical museums, if many historical objects are only small parts, this will bring trouble to the description of the items. It may have to take a lot of money to restore them, or use the analysis diagram for the visitor's imagination. Even so, authenticity will still be challenged. Preserving the integrity of those industrial elements will therefore be a great contribution to future research.

Transmission

When material industrial elements are preserved, it is also a sign that the historical culture behind them has been recognised by experts. The next point to emphasise is whether people can read or understand the historical and cultural information from the material elements. Only then will the previous preservation of the elements be meaningful. Of course, this display is not simply placed there for the public to visit without any guidance or explanations. That would not only make the visitor feel bored, but it would also make it difficult to create an awareness of industrial culture within the public.

Human life has become habituated to the communication of speech and text, which is also considered the most direct form of expression. At the same time, it is not realistic for all reused old industrial buildings to use the way that a museum can describe or introduce each exhibit in detail with panels. In many cases, architects need to express industrial and cultural messages to the participants through architectural approaches. The material industrial element, which is the component of the building, needs to be discovered and experienced by the participants themselves actively. In terms of industrial cultural transmission, two aspects will be discussed, explicitly introduced and identified by participants.

- Explicitly introduced:
  Many important material industrial elements have been preserved in the transformation process. After in-depth research by experts, the industrial history culture represented by the elements was identified. As 'Industrial archaeology' mentioned, the important culture not only needs to be recorded in the archives (Falconer and Thornes, 1986; Wanser, 1998), but also this culture needs to be spread to the public (Leary and Sholes, 2000; Ercan, 2007). Like the exhibits in a museum, the elements are clearly described and introduced, and in this way, the meaning of education and knowledge transmission is emphasised. Some projects place important elements in a prominent position, using the most traditional way by placing introductory signage in the form of text. Nowadays, thanks to new media technologies, more vivid and convenient forms of presentation have appeared, such as internet display systems, video animations, and even hands-on model experiences. They are designed to be able to convey the historical and cultural information, which contained in the elements, more clearly to the participants.

- Identified by participants:
  Unlike giving explicit descriptions, some material industrial elements without instructional signage, such as towering chimneys, large spaces, thin steel staircases, and industrial equipment, will be experienced and interpretated by the participants actively. This is what is often known in architecture as the language of architecture. The language of

architecture is a symbolic system of shaped spaces that transmits a message to the participants, so that the publics can experience and interpret the architectural meaning (Remizova, 2015). Although it is not possible to give a clear introduction to the participant in terms of the architectural language, this does not affect the conveyance of the industrial culture theme. According to participants' own backgrounds, the meaning of the material industrial elements is interpreted under the context of the 'big idea'. The transmission or education of this knowledge will be open to the subject and will vary from person to person (Ghaderi and Srikant, 2014). This approach not only stimulates the participants' desire to explore, but also satisfies their need for self-actualisation. For example, the crane system or the steel columns and gantries allow visitors to mentally connect the building with a former industrial period. Furthermore, aesthetics as a feeling may be difficult to convey in the text (Miall, 2011; Fretwell, 2020). The preserved material industrial elements could contain industrial aesthetics as well. Industrial buildings have a specific aesthetic significance due to their distinction from normal civil buildings. There is a strong sense of form, sympathy, and colour in industrial buildings. The aesthetics of industrial culture are often subjective and vary from person to person (Omidfar, et al., 2015). However, the discovery of the aesthetic value of industrial aesthetics and how this might be perceived by users is key to the transformation of obsolete industrial buildings.

4.4.3.2 Needs of hybrid culture

The essence of the transformation of old industrial buildings is the 'selective preservation and strategic addition' of architectural elements (Zheng, 2022b). The material industrial elements can then be those that are definitively preserved. At the same time, in the process of functional transformation, the addition of new architectural elements and new functions that are used for serving the new activities will illustrate the 'strategic addition'. The process of reuse can be seen as a bridge between the past and the future. The integration of old industrial elements and new functions is not only the continuation and respect for the past, but also the cornerstone of the cultural development of the future. After preserving the old industrial elements, the designer should set up a matched relationship between old elements and new functions or new elements. It is undeniable that for those important heritage projects, old industrial elements may be considered to be emphasised as exhibits. However, for most projects, it is no longer a question of 'new is better than old' and 'old is better than new'. Their integration is a relationship of mutual support. In a building with both old and new, the integration between the two can result in a hybrid culture and this integration allows the two types of elements to amplify their respective strengths. This can present a new aesthetic and freshness to participants whilst also endowing the project with a unique character and identity

and the creation of a new culture that can meet the new needs of a new era. Therefore, cultural integration and innovation, based primarily on visuals, becomes the focus of the discussion in this section.

Visual integration

When the public enters the building, the most immediate impression is in the visual dimension. Vision is one of the most important dimensions in the evaluation of architecture and the environment (Heath, et al., 2011). ‘Beauty’ is usually due more to harmonious relationships among elements of composition than to the elements themselves; it is the ensemble that matters, both within the individual element and in terms of the element with its neighbours; therefore, visual beauty is primarily about relationships, which is integration (Frederick, 2007; Heath, et al., 2011; Koo, et al., 2020). Integration has a broad meaning, which can be emphasis, unity, obscurity, celebration, etc.; it refers to the relationships between different parts and how they fit together to form a connected whole (Smith, 1980). In general, visual integration mainly expresses a sense of wholeness. The overall architectural style should be unified, with the exception of certain important heritage elements and details that need to be emphasised. There will definitely be gaps in the architectural elements from different eras. However, this should not affect the participants' overall impression of the building, otherwise, the ‘big idea’ will become confused and may prevent the satisfaction of challenging needs.

The decoration of an architectural surface (interior or exterior) can provide visuals for people via the material, scale, proportion, and rhythm (Carmona, 2021). The wise use of elements can sharpen or soften differences between the various parts of the surface, as well as improve the connection between it and its surroundings. With an appropriate approach, the fusion between old and new architectural elements will provide a sense of visual depth and solidity, enriching architectural spaces and attracting people to explore architectural culture. In either case, the building should express a big idea, which may be a historical atmosphere or a modern artistic atmosphere. This can be likened to the restoration of a broken historical sculpture. As Figure 4.4.3.2-1 shows, the new additions will generally be in keeping with the style of the remaining parts, showing a complete old-style sculpture; it is also possible to paint the complete sculpture all in a new pattern; but a display that is half new and half old may be difficult for most people to understand. What has been said above only addresses the overall impression of the architectural space, which stresses that the participants perceive the general atmosphere or big idea. Of course, it does not mean that there cannot be differences between old and new elements. The emphasis here is only on the OVERALL impression of the space that the participants get visually in a very short period of time.

The emphasis above is on overall impressions, and therefore some details can be neglected. After the overall impression of the building has been established, the details within the architectural elements will continue to be explored by the participants, otherwise, the building will become boring. The elements used in the integration are expressed in different layers, which relate to people's visual distances and the time length for observation. The overall impression is often a visual perception from a far distance and for a short period of time. Details, on the other hand, require the participant to get closer and focus their attention on a smaller area of space. Such detail elements may be the texture of materials, patterns on windows, hidden elements, etc. Using the Tate Modern in London as an example (Figure 4.4.3.2-2), the first impression visitors get when entering the Turbine Hall is sided in white-painted medium density fibreboard (MDF), and the hall illuminated translucent and transparent spaces exude a contemporary atmosphere (Moore and Ryan, 2000). The designers also painted the I-columns black, creating a sense of contrast against the white background; at the same time, rivets on the I-columns enhanced the identity of the material industrial element. Looking up at the beams, two gantry cranes that are capable of being manoeuvred along the entire length of the hall, remain as functioning souvenirs in respect for the past reality. These material industrial elements in detail are not outstanding throughout the Turbine Hall and do not affect the overall contemporary decoration.

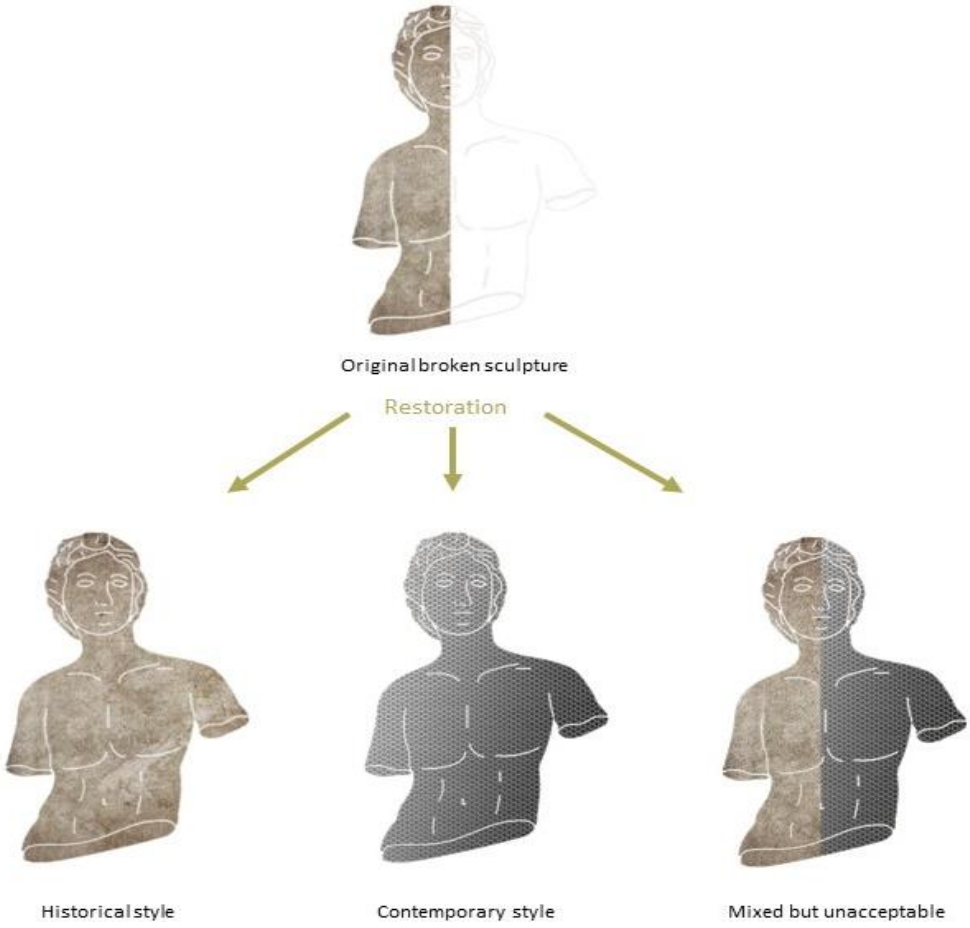


Figure 4.4.3.2-1 Examples of integrating old and new elements (by author, 2022).

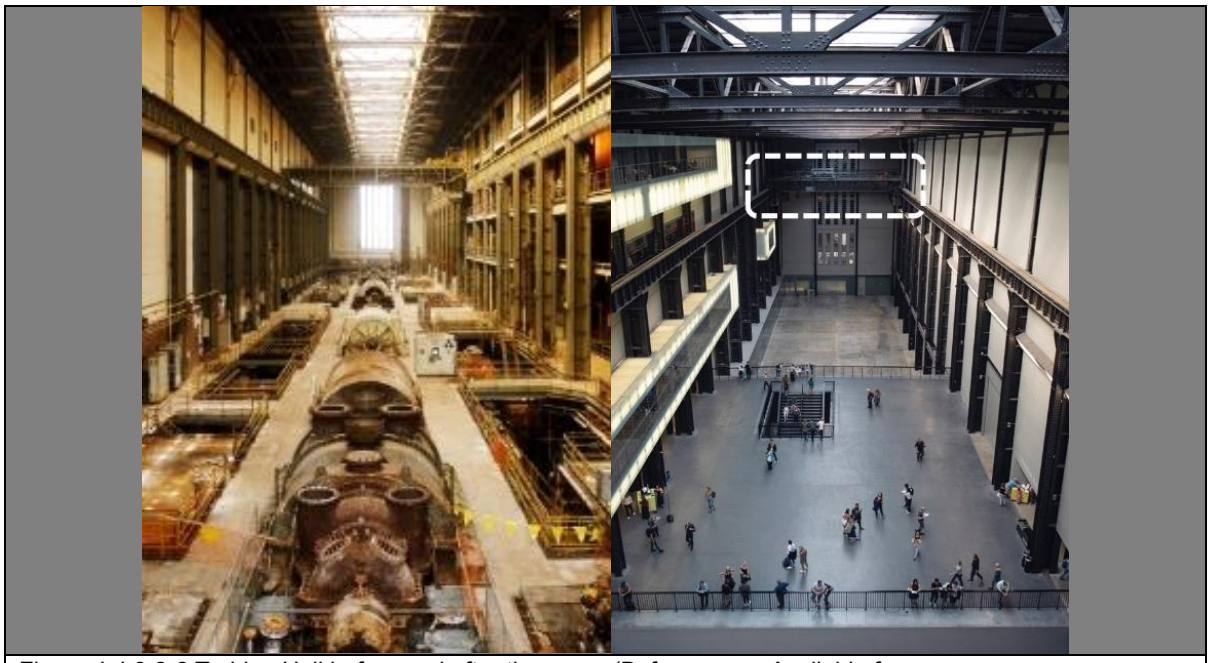


Figure 4.4.3.2-2 Turbine Hall before and after the reuse (Before reuse, Available from: <https://www.tate.org.uk/about-us/history-tate/history-tate-modern>, 4 Aug 2018; After reuse, by author, 2018).

Innovative culture

The essence of an innovative culture is hybrid culture, which is proposed in Section 3.3.3.3. In addition to visual integration, the innovative culture comes mainly from the new activities and psychological awareness of the participants in the transformed buildings. What used to happen in the industrial building was an industrial culture of manufacturing and working, whereas after the transformation people have new activities (visiting, playing, relaxing, etc.) in the building and therefore a new culture is formed.

The opposite party would think that new activities can then also take place in a completely new building. However, the historical legacy of the transformation project would become an added attraction of the project. For example, as shown in Figure 4.4.3.2-3, old industrial elements with new activities, the climbing garden in the Landscape Park Duisburg Nord reused from the place where coke and iron ores were stored. Places to practice rock climbing are easy to find, such as in university gyms, but this kind of climbing experience in an industrial legacy is rare and innovative. This rare and innovative culture will enhance the regional identity, which distinguishes one area, domain, or social collective from others (Paasi, 2002; Carmona, et al., 2010); at the same time, the attractiveness of the project is then increased, thus contributing to the vitality of the project and the presentation of new cultural activities (Sani and Mahasti, 2012; Agaliotou. 2015). The challenge for the architects will thus be about how to make use of these historical industrial gifts in order to express the project as special and innovative. It's like the appearance of the LOFT apartments, once popular in some countries, which are generally built from former industrial buildings (Shaw, 2006; Lin, 2013), and are characterised by high ceilings and oversized, often floor-to-ceiling windows (Urban Edge, 2018). Today, such creative architectural cultures are even copied by new buildings.

Overall, the appeal of the transformed buildings is to make the most of the historical industrial culture, relying on the historical gift to attract more people to go to the buildings, and to spread the culture (both new and old). The hybrid culture is unique to a reused project. It can promote the rise of some new industries with the old industrial background. It is also a powerful way of advertisement. As a result, more people will get to know the old industrial culture of the project and, at the same time, more people will participate in the innovation of the hybrid culture. Furthermore, the old culture is spread through the attraction of new functions, with public participation making it possible to promote a sustainable culture of creation. These are the positive concept of win-win and inheritance.



Figure 4.4.3.2-3 The climbing garden in the Landscape Park Duisburg Nord (Available from: <http://www.landscape.cn/landscape/11171.html>, 13 Aug 2021).

4.4.3.3 Summary of the items used to measure the provision for challenging needs

Challenging needs are a need for a cultural dimension, translated from self-actualisation at the top of Maslow's pyramidal hierarchy of needs. This research has divided the culture of reused industrial buildings into two categories: old historical culture, and innovative hybrid culture. Material industrial elements are the evidence of historical culture and heritage in the architecture, and their preservation and the expression of historical information should be an important part of the reuse of historical buildings. Indeed, their transformation should not avoid the integration of new architectural elements, and the adaptive treatment of the old and new elements will not only enhance the attractiveness of the project with history, but can also help to create a new regional culture (Figure 4.4.3.3-1). The concept of culture is broad, and its meaning is constantly evolving and expanding, and only a small part of it can be specified at present. Thus, challenging needs are more of a vision of the future of humanities research. While the challenging needs may not satisfy many of the participants, the participants' activities in the buildings have in fact become part of the culture. Participants are just not aware or have not yet achieved what they consider to be self-actualisation. Architects, therefore, have a responsibility to use architecture to help the public achieve their self-actualisation. As such, in the process of transformation, the architectural culture, both old and new, needs to be perceived and accepted by the participants as much as possible. The old industrial elements in the building can be easily distinguished. However the interpretation of those industrial cultures will be examined for clarity and certainty. For the particular reason of the Challenging Needs, a questionnaire is needed to collect data on the subjective wishes of the users.

Issues to be examined:

- Are there any preserved material industrial elements, and are these easy to find?
- Do the material industrial elements have historical value?
- Is there information about the important industrial elements, or an official website with relevant descriptions, are these easy to find?
- Can users associate with the industrial scene of the past from these material industrial elements?
- Does the building use its industrial background and heritage to attract visitors?
- Is there an element of contemporary-meets-historical?
- Is the project advertised in an attractive way?
- Will the project achieve local recognition in a short time?

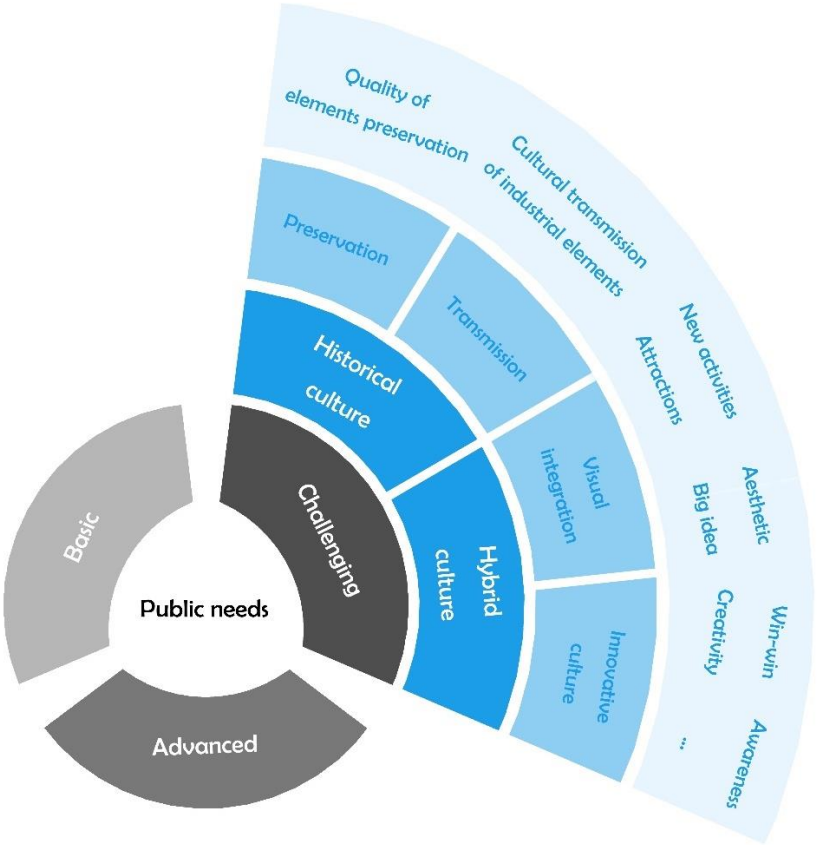


Figure 4.4.3.3-1 Challenging needs of Measuring framework (by author, 2021).

4.5. Summary: assessment framework output

The study focuses on measuring the quality of a project to transform an old industry into an urban public space at the level of the needs of public, and therefore developed an assessment framework. In terms of the reusing result, what is presented to the public is first of all an urban public space, and as such it should meet the basic functional demands of a public space. In particular, the most basic requirements for the use of the building must not be overlooked in the pursuit of the characteristics. For example, as a residential building, it is important to ensure that the basic needs of the home are met, including privacy and security, appropriate temperatures, low noise levels, etc. As an urban public space, it should meet, first and foremost, the basic and advanced needs of the public. The industrial culture in the reuse of old industrial buildings is then an added value to this public space. The assessment framework specifically identifies industrial culture as a key measure in some of the advanced needs (esteem) and challenging needs. Because the industrial culture will distinguish the transformation project from the other public space. The reason for listing this as a challenging needs is that it is not expected that every user will be able to appreciate the implication. However, it is undeniable that the presence of an industrial culture or new functions (e.g. commercial, entertainment, etc.) will be the attraction of the project, which will greatly increase the desire of the users to come. Therefore, this assessment framework is a complete system of public needs evaluation.

The hierarchy of needs is a psychological idea but also a '... valuable assessment tool ....' (Poston, 2009). The analysis of Maslow's hierarchy of human needs and its application to the adaptive reuse of old industrial buildings have helped to develop an assessment framework (Figure 4.5-1). As an innovation section, the establishment of such a framework can be used for evaluating the reuse of old industrial buildings into public buildings. In this way, the success of the project will be judged by evaluating whether or not it meets the needs of the public participants. The three dimensions in cases evaluation can be understood as follows: the basic needs are evaluated at the level of the building infrastructure, advanced needs are about humanistic care, and challenging needs are about the distinctiveness and attractiveness created through their own characteristics. Following the process of establishing the evaluation framework in section 4.4, the project-specific evaluation items can be further specified. The evaluation items in Table 4.5-1 will be applied specifically to the actual project. It is, however, necessary to highlight that these issues are not absolute and that they should be applied flexibly in different projects, especially in different counties, and can be expanded or reduced accordingly, because of the national conditions. Indeed, the framework the research established is mainly specific to the Chinese context. Future studies should detail the

assessment framework according to specific practical projects, while conducting a questionnaire survey and statistical analysis to discover the relationship between each factor and the overall assessment system.

The measuring framework is a breakdown of a comprehensive problem into smaller problems; it is more like a process of 'simplifying a complex problem' and examining the full range of such comprehensive problems under the influence of multiple factors. In this research the comprehensive problem is *What do participants (users) need in a reused project?* The subitems could be found in Table 4.5-1. The measuring framework for the study was developed from the professional perspective of architecture and with the aim of serving the public. Some of these measurement items need to be evaluated by professional scholars, and some of them need to receive subjective personal feedback from participants. Next, the research will discuss the extent to which the project meets the needs of the public by collecting data on two case studies under the framework.

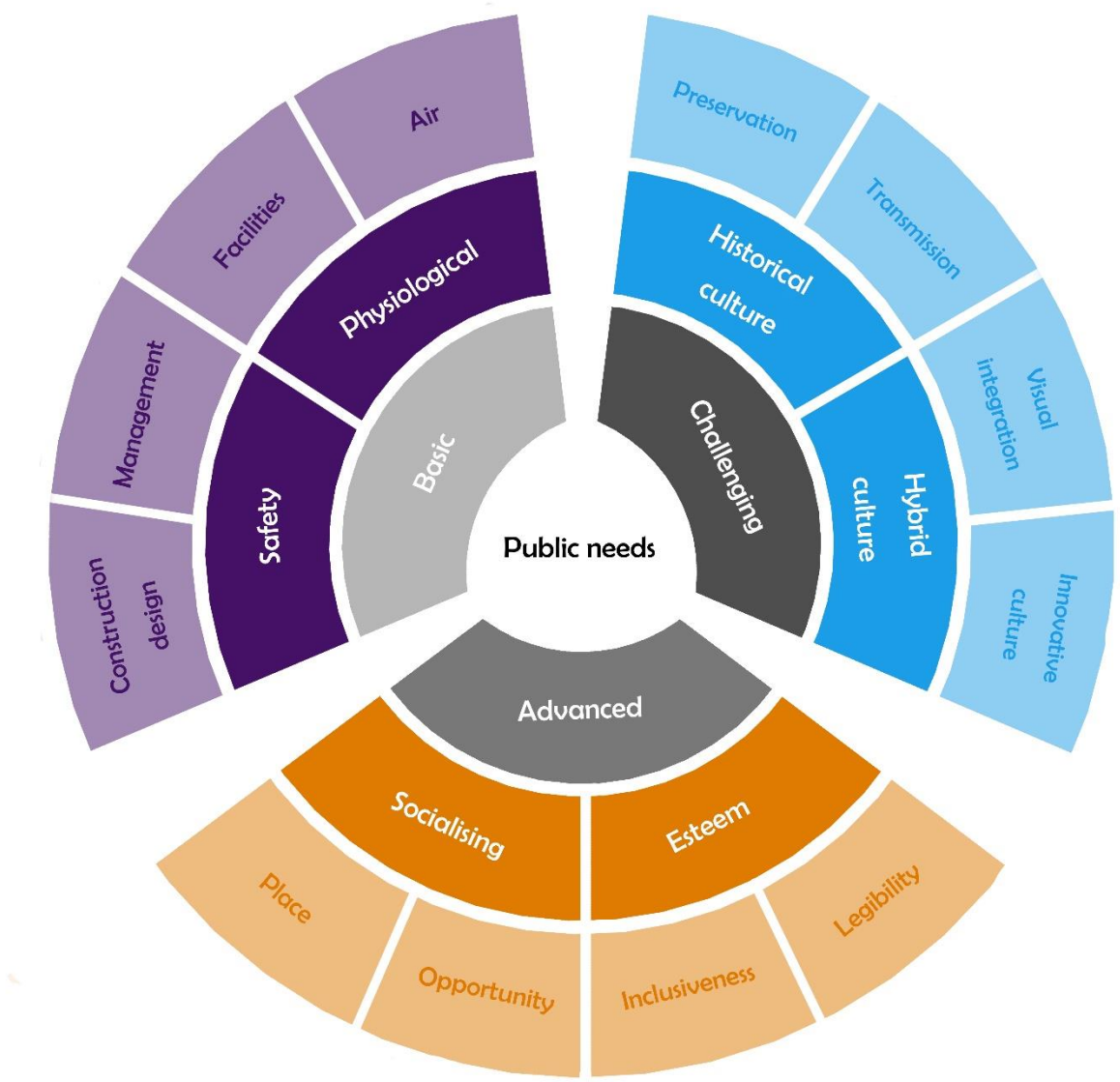


Figure 4.5-1. Full assessment framework of basic, advanced, and challenging needs (by author, 2022).

Basic needs
Air environment quality
Toilet
Convenience store
Security
Fire and escape
Building components

Advanced needs

	Rest areas
	Visitor enquiries
	Activity organisation
	Diverse participants
	Facilities for special groups
	Map and signage

Challenging needs	
	Preservation of industrial elements
	Transmission of historical culture
	Integration of ‘old and new’
	Attractiveness

Table 4.5-1 The measuring framework (by author, 2022).

Chapter 5

Case survey 1

5.1. Introduction

The case surveys have been selected in the context of the Chinese national context with 1933 Old Millfun in Shanghai. This chapter and the following chapter will measure whether the cases of reuse as public buildings meet the needs of the public. Specific data collection will be carried out in accordance with the assessment framework established in Chapter 4, that is, the presentation of survey results on the cases under each item. Overall, the data collection for the cases guided by the assessment framework is the focus of this chapter, which prepares the foundation for the data analysis in later chapters; and this combined with Chapter 6 and 7 to complete the objective, *How does research evaluate the case studies?*

It should be noted here that as the floors labelled in China differs from the UK, the case descriptions will be standardised with those in the project, i.e., the ground floor is the 1F.

5.2. The design of the investigation

The data for the case surveys came primarily from an examination of the spaces and facilities, and a survey of participant behaviours. The research to investigate will be based on the measuring framework established in Chapter 4. For the professionalisation and validity of the data, different research methods are needed to collect data for different items. In the process of data collection, the measuring items will be checked by field measurements, computer modelling, questionnaires, and observational methods.

5.2.1. Field measurements

Field measurements are a very direct and realistic way of obtaining the building's data. To some extent, this approach is somewhat similar to the 'final acceptance' of the project. From the design drawings to the completion of construction, there are a variety of factors that impact on the process. Some changes from the design drawings may then no longer meet the requirements of the regulations. In short, the validity of the field measurement data will be stronger than the data from the drawings. Some of the items in the measuring framework need to be tested for human comfort and safety. Especially for those projects with secondary renovations or secondary decoration, the modification may make the building non-compliant with the regulations (Geng, 2007; Yu, 2014; Wang, et al., 2019; Lv, 2021). For example, some stair steps may have had a decoration, with the addition of beautiful material, which may have changed the size of the step. During the survey, the research took a laser rangefinder, anemometer, and room digital thermometer (Figure 5.2.1-1). These will measure the built environment, the dimensions of the building elements, and also provide a realistic basis for computer modelling and simulation.



Figure 5.2.1-1 Measuring instruments: laser rangefinder, anemometer, and room digital thermometer (by author, 2021).

5.2.2. Computer modelling

Humans are small in relation to the scale of buildings. When people experience the building, they can be limited in certain ways, especially in visual terms. People can't see the building from any one angle, such as a bird's eye view or a cutaway view. Computer modelling can be used to 'zoom in' the building and 'play with it in the hands' of the architect. The most basic function of computer modelling, which is done digitally, is architectural data statistics (CRC Construction Innovation, 2007; Azhar, et al., 2008). After some measurements in the field have been taken, the complete building data can be deduced automatically via computer modelling, such as the area of spaces or certain longer distances. Furthermore, thanks to the development of computer modelling techniques, environmental simulation software allows the data to be estimated based on a computer model (Roberts and Marsh, 2001). Although the research has the measuring instruments and can obtain real data, such as wind and temperature environments, it is not realistic to stay in the project all year round during the PhD phase. Therefore, to get the full range of data, computer simulations of the environment are an important supporting approach.

5.2.3. Questionnaires

The questionnaire is a quick and efficient way of obtaining large amounts of data from a huge sample of people, especially the collection of subjective feedback from participants. The setting of the corresponding questions can reflect the attitudes, preferences, opinions, and

intentions of different groups of visitors. The questionnaire questions (Appendix 1) were divided into two main sections: personal subjective experience and demographic information. The questionnaires can ensure that randomly selected participants complete within 2 minutes to avoid negative emotions caused by too many questions and presented in the form of an electronic questionnaire (Electronic questionnaire creation and statistical APP, available online: https://www.wjx.cn/). To avoid missing details and limiting the scope for respondents to supply answers that reflect their true feelings on a topic, there is an open-ended question. Due to the Covid-19 epidemic, the research period in Shanghai 1933 Old Millfun was September to December 2021; the Dalian Bingshan Industrial Culture Exhibition Hall was January to March and July to August 2022. During the research period, both projects experienced the longest holiday in China: The Spring Festival and The National Holiday. For each project, more than 110 questionnaires were collected during the field surveys, of which 100 were selected as valid for analysis.

5.2.4. Observation methods

Sometimes feedback from participants in the questionnaires are inaccurate and thwarted by their misguided understanding. Interviewees outright lie about their perceptions of sensitive topics to present a better view of themselves (Hall, 2018). In addition, there are a number of professional issues in architectural design that the public participants may not be able to give their opinion on, such as fire and evacuation safety, project operational issues, etc. In this situation, observational research can supplement the data gaps in the questionnaire by directly observing and recording the participants' ongoing behaviours in the building. Researchers can capture data on what participants do rather than what they say they do, which can gather more reliable insights. Sometimes, standing by and listening to the conversation between visitors about the museum and its exhibits may get more real and valuable information than interviewing them directly. At the same time, the research will use architectural expertise to observe and find specialist building facilities. This could be combined with a field measurement to judge some measuring items.

5.3. Case 1: 1933 Old Millfun, Shanghai

5.3.1. Background

5.3.1.1 Regional characteristics (Shanghai, China)

Shanghai, China's largest city (Xing and Sheng, 2008), is the centre of China's economy, technology, industry, and exhibitions (Dai, 2020; Liu, et al., 2021). It has the largest industrial base in China (Zhou and Yin, 2014; Li, 2015).

The breakthrough in the development of modern industry (which is explained as a manufacturing industry using machines and mechanical power in China from the 1840s (Zhu, 1985)) in Shanghai came during the period of the Shanghai International Settlement (Li, 2015). The settlement of Western countries who were the first to complete the industrial revolution led to the establishment of a large number of industrial buildings in Shanghai with a strong Western or a combination of Eastern and Western styles. Modern industry in Shanghai grew rapidly from the late 19th century to the early 20th century, making Shanghai become the industrial heart of China (Zhang and Liu, 2007). In 1949, when the People's Republic of China (PRC) was established, Shanghai accounted for 50% of the country's total number of both factories and production value; and warehouses in the centre area of Shanghai reached 2.04 million m² (Li, 2015).

In the 1990s, influenced by China's policy: "*suppress the second industry and develop the third industry in the urban area*" (Wu and Li, 2020), industrial factories began to move out of the city centre area (Zhou and Yin, 2014). The area of industrial land in Shanghai was reduced by half from 1998 to 2010 (Li, 2015). According to the 'Shanghai Master Plan (2017~2035)', the total area of industrial land in Shanghai is to be reduced by 43%-62% in the 20 years to 2035, and the released industrial area will be at least more than 360 km² (Shanghai Municipal People's Government, 2018). As a result, due to the closure, relocation, and amalgamation, Shanghai in the 21st century has been left with a large number of abandoned old industrial buildings.

Shanghai is the birthplace of the conservation and reuse of old industrial buildings in China (Li, 2015). Documentation shows that in 1989 the Yangshupu Power Plant and Shanghai Customs Post Office were awarded the Shanghai Outstanding Historic Building, which is considered to be the beginning of reusing old industrial buildings. At the beginning of the 21st century, the reuse of old industries in Shanghai was at its peak. Due to the large size of the city, the large population, and the fast pace of Shanghai, the mixed-function buildings have

been recognised. Influenced by the 798 Project in Beijing in 2003, a number of reused old industrial projects as Creative Industry Clusters (mixed-use) appeared in Shanghai. 2010's Shanghai World Expo once again brought Shanghai's old industrial reuse to a peak, with 500,000 m² and over 70 factory buildings being transformed (Liu and Zhou, 2008; Yao, 2011). Shanghai took 12 years from 1998 to compress industrial land by 327 km² (Xiong and Luo, 2000). According to the Shanghai Municipal Administration of Culture and Tourism (2022), by the end of 2021, Shanghai has more than 290 industrial heritage sites, 149 city-level cultural and creative parks, 65 industry museums, more than 300 popular science and education bases and 19 national industrial tourism demonstration sites. After nearly 20 years of exploring the reuse of old industrial buildings and combining with the international city status, Shanghai has become a leader in the reuse of old industrial buildings in China. Its success cases have been studied by numerous scholars.

5.3.1.2 Animal Welfare: Shanghai Municipal Council Slaughterhouse (The original name of 1933 Old Millfun)

In the 1840s, Shanghai opened to the world and became a passport-free port, attracting jobseekers, and even political refugees from many countries. Subsequently, the foreign population increased nearly twofold in three years, from 36,500 in 1930 to 70,000 in 1933 (Wang and Pendlebury, 2016). Faced with the pressure of huge population demand, the Shanghai government built two slaughterhouses in 1892 and 1893; however, due to the backward technology with inefficient meat production, they were still unable to meet the market demand (Hong, 2008). As a result, a new large slaughterhouse was born.

Shanghai Municipal Council (SMC) was the governing body of the International Settlement in Shanghai and was mainly administrated by British expatriates. Designed by British architects, Balfours, at the Public Work Department of SMC, the Shanghai Municipal Council Slaughterhouse deployed the humanitarian and hygienic principles on animal slaughtering laid down by the Model Abattoir Society in England (Richardson, 1893; Ayling, 1908; Pendlebury, et al., 2017). The design began in 1930 (Figure 5.3.1.2-1,2), construction began in 1931, tons of concrete were imported from Britain, and was completed in November 1933. The building covers an area of more than 8,000 m² and the main building is a three-storey reinforced concrete structure with a comprehensive slaughter line (Figure 5.3.1.2-3). The layout looks like ring-shaped functional rooms around a central core. The two structures formed independent spaces, with a series of bridges connecting and weaving together. The Shanghai Municipal Council Slaughterhouse could slaughter 300 cows, 100 calves, 300 pigs and 500 sheep per day, making it the 'No.1 slaughterhouse in the Far East' (Hong, 2008). At that time

there were only three slaughterhouses of this scale in the world, one in the UK, one in the USA, and one in Shanghai. It is interesting to note that all three slaughterhouses were built by the same architect (ibid).

In Ruth Harrison's (1964) book, *Animal Machines*, is considered a real milestone in animal welfare (Fraser, 2008). Nevertheless, animal welfare was already invisibly carried out in Shanghai Municipal Council Slaughterhouse. According to Hong's (2008) description in *The Past Life of the 24 Turret in the Far East - from 'Shanghai Municipal Council Slaughterhouse' to 'Shanghai 1933 Old Millfun'*, the slaughter process at that time as follows:

- The animals are transported here to enjoy more than 24 hours of rest to relax their nervousness. This will not only improve Animal Welfare but also the quality of the meat.
- The following day, the animals enter the ground floor of the building and are driven upstairs along the cattle path (detailed in Section 5.3.2.13).
- When the animals enter the 2F and 3F, they enter an area with smooth floor tiles. The animals then slide uncontrollably into the slaughter hall (Figure 5.3.1.2-4).
- The animals are then electrocuted by a specialist and hung on a conveyor belt (Figure 5.3.1.2-4) to be killed by the butcher.

The slaughterhouse passed from the British to Japanese occupying forces in 1937 and then the new Chinese authorities in 1946, retaining its original function until the late 1950s (Zhao, 2007). Subsequently, it was occupied by meat processing companies, food manufacturers and research institutes and later a pharmaceutical company (Pendlebury, et al., 2017). This gradual conversion of the slaughterhouse: from animal slaughtering to meat processing and then medicine making – altered the internal layout of the building, and the original machinery and fixtures and fittings were mostly removed. The slaughterhouse became completely vacant in 2002 when the last tenant moved out (Figure 5.3.1.2-5) (ibid). As a summary, the historical evolution route of the Shanghai Municipal Council Slaughterhouse can be shown as follows (collected by author 2022):

- 1931: Shanghai Municipal Council at the site, building 'Shanghai Municipal Council Slaughterhouse' (上海工部局宰畜厂).
- 1933: Shanghai Municipal Council Slaughterhouse completed.
- 1937: After the Japanese army entered China, they occupied the Shanghai Municipal Council Slaughterhouse as the 'Municipal First Slaughterhouse' (市立第一宰畜厂).
- 1945: After the victory of the war against Japan, the slaughterhouse was taken over by the Shanghai government.
- After 1958: The slaughterhouse has been renamed and functionally transformed several times;

including Shanghai Frozen Meat Processing Factory, Dongfeng Meat Processing Factory, Shanghai Changsheng Food Factory, Shanghai Meat Food Factory, Shanghai Food Research Institute, Shanghai Food Comprehensive Machinery Factory, Shanghai Great Wall Biochemical Pharmaceutical Factory.

- 2002：The pharmaceutical factory was relocated, and the building is in an abandoned state.
- 2005：The building was awarded 'Shanghai Outstanding Historic Building'.

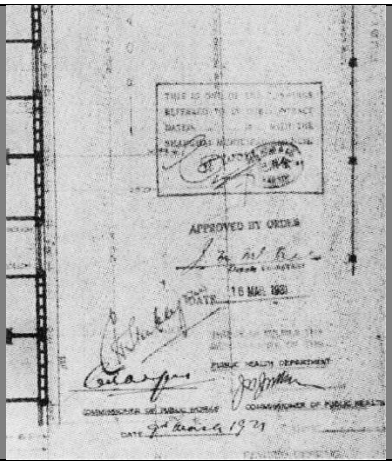


Figure 5.3.1.2-1 The slaughterhouse construction approval letter with Buarfus's signature (Hong, 2008).

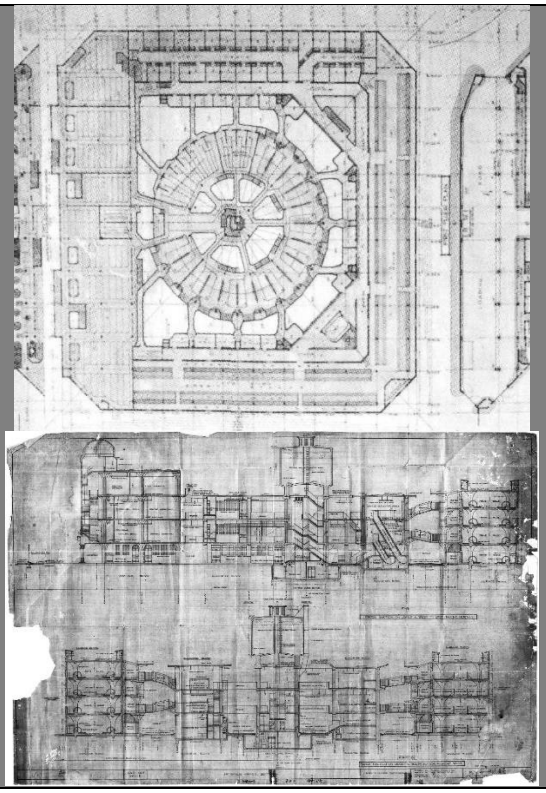




Figure 5.3.1.2-2 The original design drawings and photo. Layout (Hong, 2008); Sections and photo (Wang and Pendlebury, 2016). Now in the Shanghai Urban Construction Archive.

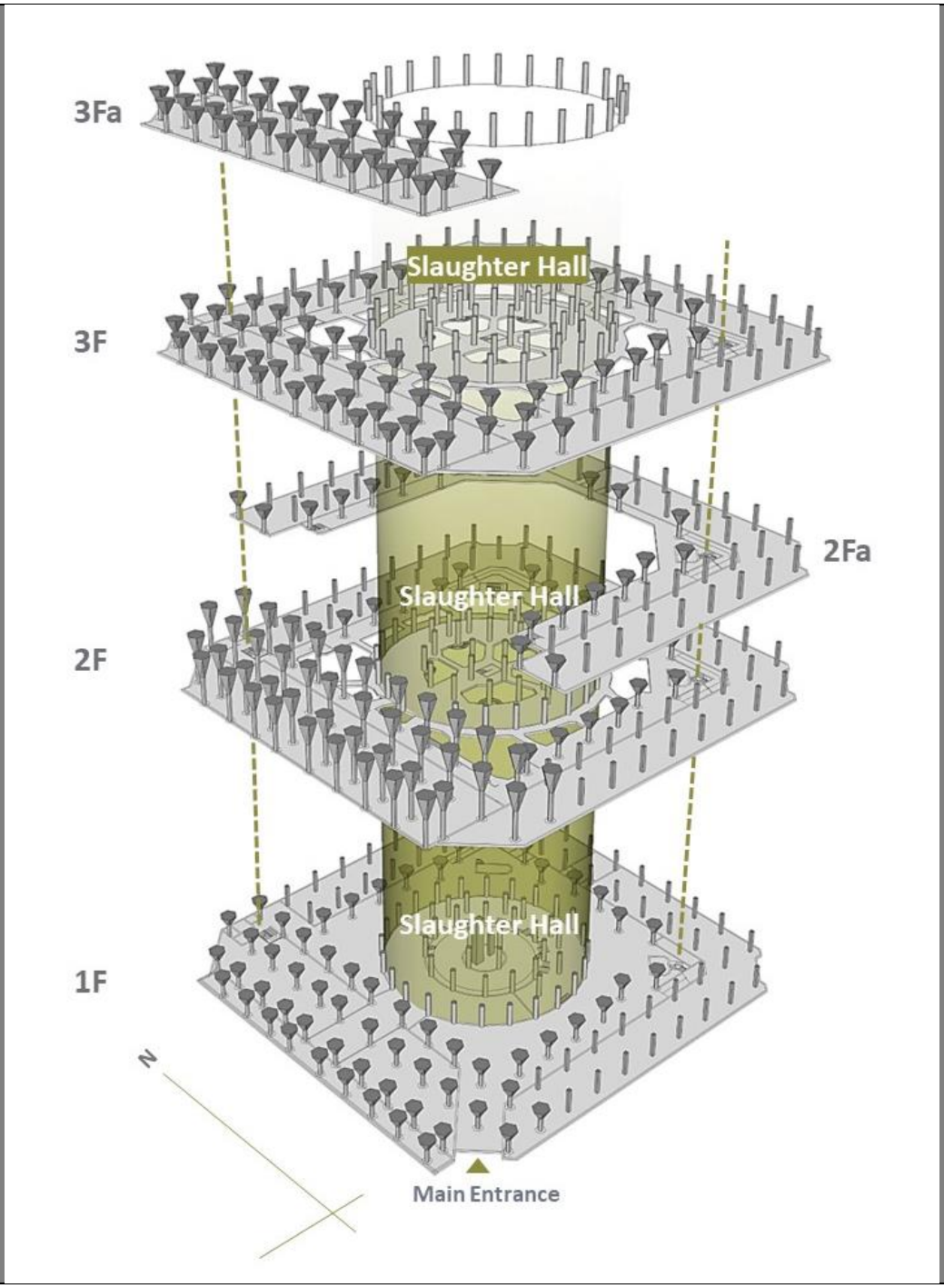


Figure 5.3.1.2-3 The original spatial configuration of Shanghai Municipal Council Slaughterhouse (by author 2022).

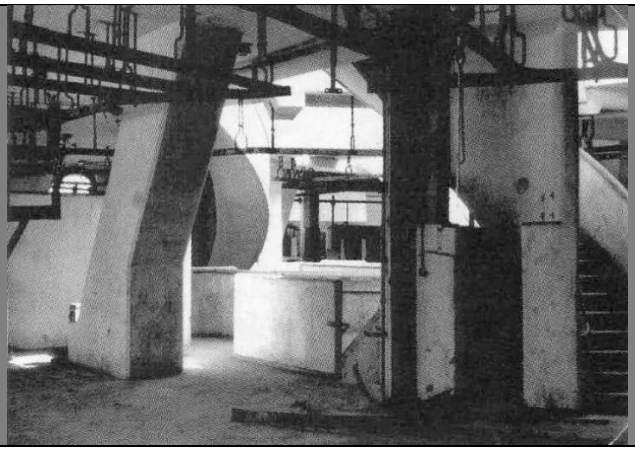


Figure 5.3.1.2-4 Inside the slaughter hall (Hong, 2008).



Figure 5.3.1.2-5 The building was a pharmaceutical company before 2002 (Pendlebury, et al., 2017).

5.3.1.3 The new life of 1933 Old Millfun: strategic ‘forgetting’ and selective ‘remembrance’

Located in the bustling Hongkou District in modern Shanghai city, 1933 Old Millfun has good traffic accessibility (Figure 5.3.1.3-1). Close to two tube lines, the site is connected to main urban roads and is 1km from the Shanghai luxury cruise terminal and the Hyatt on the Bund. Due to the special basilica-style layout (an oblong building surrounded by a colonnade with a raised central nave), the building was soon back in the spotlight (Figure 5.3.1.3-2). In August 2006, the government-owned Shanghai Creative Industry Centre (SCIC) officially started to reuse the building (Pendlebury, et al., 2017).

In this reusing project, the distinctive space and full historical value of this slaughterhouse were conserved, and new mixed-use gave this old mill a new life. The 30,000 m² building brings together a range of culture, fashion, creativity and classics, housing exhibitions, exchanges, launch events, and transactions. Nowadays, 1933 Old Millfun is a creative

industry cluster that incorporates 5 industries: retail; restaurants; clubs; office units; and exhibition.

Once the project had started, the interior was gradually cleared of decoration and machinery (Zheng, 2013). The reusing chief project architect, Mr Chongxin Zhao has attempted to closely integrate his creation with the key principles of modern conservation, emphasising the retention of original structures and materials, and the restoration of original designs (Zhao, 2007; Zhao, 2008). Zhao stresses making a clear distinction between the old fabric and the new and that the added new elements should ‘speak of their own time’ and should be reversible where possible. Finally, the building is presented to the public in concrete form (Figure 5.3.1.3-3,4). The sense of history and heaviness brought by the concrete elements inside corresponds to the façade, in a way that does not give the impression that the building is unfinished, but rather enhanced the sculptural qualities of the architectural elements with curved shapes or streamlined designs. In the 1930s, the slaughtering process did not rely on advanced equipment, but on architectural spaces. The architectural spaces created for manufacturing have been left completely intact (the new layout is shown in Appendix 2). As a result, a distinctive view of the building is presented.

In a country where death is taboo, saving the old slaughterhouse is an especially awkward task. The transformation of 1933 Old Millfun was exceptional in that it allowed people to forget that they had been killed and to accept him. Even the reborn 1933 Old Millfun has been used for weddings and conferences, a fact that proves its success. The preserved structures balanced the dark memory and historical authenticity. This approach not only avoids directly showing the bloody manufacturing process, but it also preserves the important industrial elements to encourage people who wish to discover the real story. The designer uses texts on the introduction panels to explain the manufacturing process behind the architectural elements (details in Section 5.3.2.14). Compared to old slaughtering pictures or an exhibition of massacre machinery, the indirect expression in 1933 Old Millfun can be accepted by the public. In other words, it is thanks to the space of the building being specifically designed for the manufacturing process. 80 years later, these scenes of killing are sealed in the architectural elements; the stories they transmit are not straightforward and require one's imagination and a certain amount of background knowledge to gain insight into the manufacturing process. Thus, participants do not feel uncomfortable in terms of visual dimensions. The complex interlocking spaces combined with the pure concrete skin are presented with a historically steeped, light and shade variegated, and industrial heritage aesthetic. The strategic ‘forgetting’ and selective ‘remembrance’ of 1933 Old Millfun is the transformation of ‘killing and death into art’.

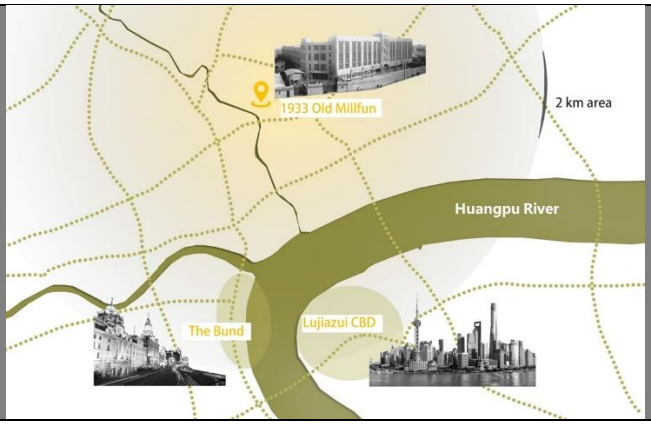


Figure 5.3.1.3-1 Location of 1933 Old Millfun in Shanghai city (by author 2022).

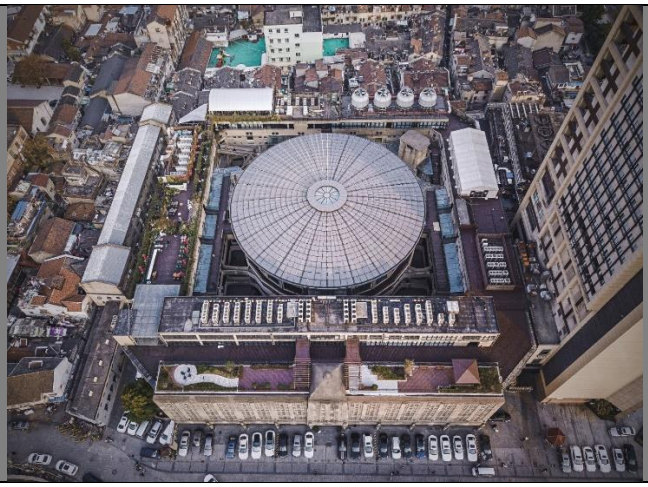


Figure 5.3.1.3-2 1933 Old Millfun with basilica-style layout (Available from: <https://en.wikipedia.org/wiki/1933_Old_Millfun#/media/>, 4 Aug 2018)



Figure 5.3.1.3-3 Restored facade of 1933 Old Millfun (by author 2021).



Figure 5.3.1.3-4 Inside the 1933 Old Millfun (by author 2021).

5.3.2. Study under measuring framework

At the end of Chapter 4, an assessment framework for evaluating the reuse of old industrial buildings based on Maslow's theory has been established. This section will examine 1933 Old Millfun on an item-by-item study within the measuring framework (Table 4.5-1) by using the various investigation methods mentioned before. At the same time, the flaws of the case in the item will be illustrated at the end of each item analysis, in order to provide data to support the comprehensive fuzzy evaluation in the next chapter.

5.3.2.1 Air environment quality

Since the building's layout is divided into two independent structures (with a series of bridges connecting and weaving together): the central core and the enclosed square space, there is a large part of open-air space in the 1933 Old Millfun (Figure 5.3.2.1-1,2). The external environment will have a significant impact on the air environment of the building, which also distinguishes it from a normal enclosed single building.

In the 1930s, the building was not equipped with active ventilation and air conditioning systems. The bad smell caused by the storage and slaughter of animals relies heavily on the natural ventilation of the building, which is the main reason for the large open-air spaces; at the same time, the hollowed-out walls of the façade allow airflow directly into the building's interior as well. The building has now been reused and the inner side of the facade has been installed with a glass curtain wall to create an enclosed space (Figure 5.3.2.1-3). Further, Shanghai is a subtropical monsoon climate, as shown in Chat 5.3.2.1-1, the average temperature in summer can reach 32 °C (90 °F), with a maximum temperature of over 40 °C, and extremely

uncomfortable humidity; in winter the average temperature is around 0 °C (35 °F). It is clear from this that the equipment of HVAC systems is necessary.

As shown in Figure 5.3.2.1-1, depending on the HVAC equipped, the spaces within the building will be measured and discussed in three categories, which are:

- Long-term lease space (offices, retails, conference venues, etc.):
  After the 1933 Old Millfun transformation, most indoor area of the building was divided into various smaller spaces for offices, workshops, retail, restaurants, entertainment, etc. As most public buildings, these long-term leased spaces are equipped with individual HVAC systems by the tenants. Depending on the size of the space, the HVAC system can take various forms, such as Variable Refrigerant Volume (VRV) central air conditioners and Split AC single-unit air conditioners (Figure 5.3.2.1-4). These HVACs are undoubtedly the best guarantee of a comfortable indoor air environment.

- Flexible public space (the space that can be used flexibly):
  Most of the space in the central ‘Slaughter Hall’ is not rented out, but is returned to visitors whenever possible. Most of the time, the artistical concrete space is presented to the public in its entirety, and sometimes it is also rented out temporarily for film and television shoots. No HVAC systems can be found in the space. However, due to the small proportion of windows in this part of the space and the fact that the concrete walls of the building are more than 300mm thick, the temperature inside is well controlled. The research selected several days in different seasons and measured the indoor and outdoor temperatures as shown in Chat 5.3.2.1-2. Combined with what the public was wearing at the time of the season, the temperature in the space felt relatively comfortable.

- The open-air space (location of a series of bridges):
  The air environment in this space can be considered almost the same as outside, and it is not realistic to try to control it through the HVAC system. However, for the participants, this outdoor space has to be visited, because of the wonderful visual presentation. Creating a good ventilation environment through the building's spatial structure will then provide a comfortable experience for the participants, such as, whether the ventilation is good in summer, or whether the wind is shielded from the building in winter. The research built a computer model of the building and used ‘Ecotect’ application to simulate the wind speed inside the building throughout the year. In order to ensure the reliability of the computer simulation, some data was also sampled during the site survey via using an anemometer. After comparison, the results were generally consistent. The computer simulation result (Appendix 3) shows that the building shields the wind from the outside, and the inner wind speed is relatively low and stable.

Summary of flaws：

The equipped HVAC systems are an advantage to the retail in the building. However, as HVAC systems were installed by the tenants themselves, the outdoor units of the HVAC at the central ‘Slaughter Hall’ were placed on the footpath (Figure 5.3.2.1-5). This not only reduces the width of the pedestrian walkway, but also greatly affects passers-by when the HVAC is in operation.

During the site survey, the central ‘Slaughter Hall’ was temporarily used for filmmaking and was being prepared and decorated (Figure 5.3.2.1-6). The smell of spray paint from the decoration was noticeable in the space. As the space was not equipped with an active ventilation system, the smell did not disappear even after the decoration was completed. In short, although this type of situation occurs less frequently in the project, it can still indicate that there are problems with its ventilation, and could lead to an uncomfortable experience for the participants during the decorating period.

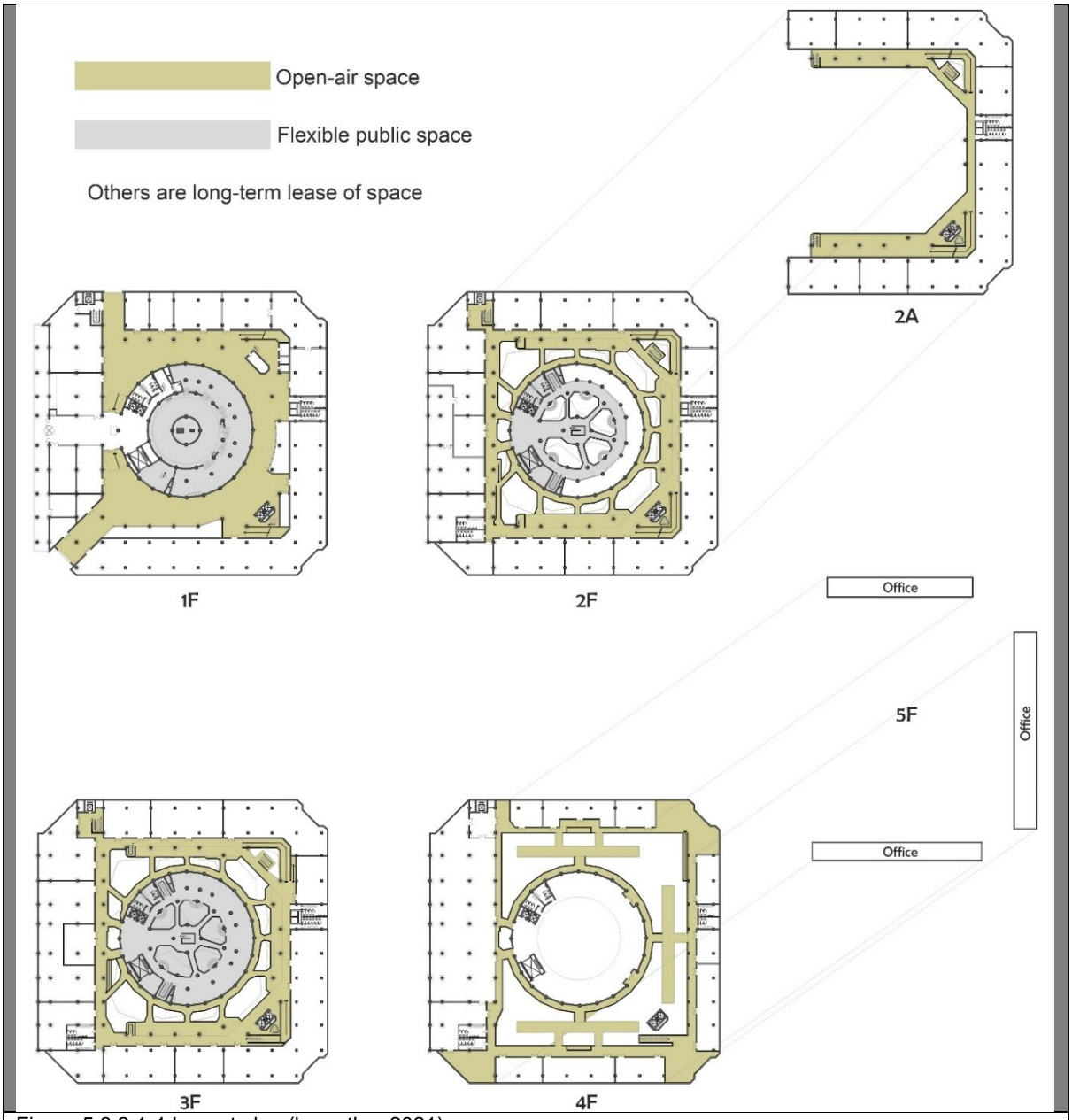


Figure 5.3.2.1-1 Layout plan (by author 2021).



Figure 5.3.2.1-2 The open-air space (by author 2021).



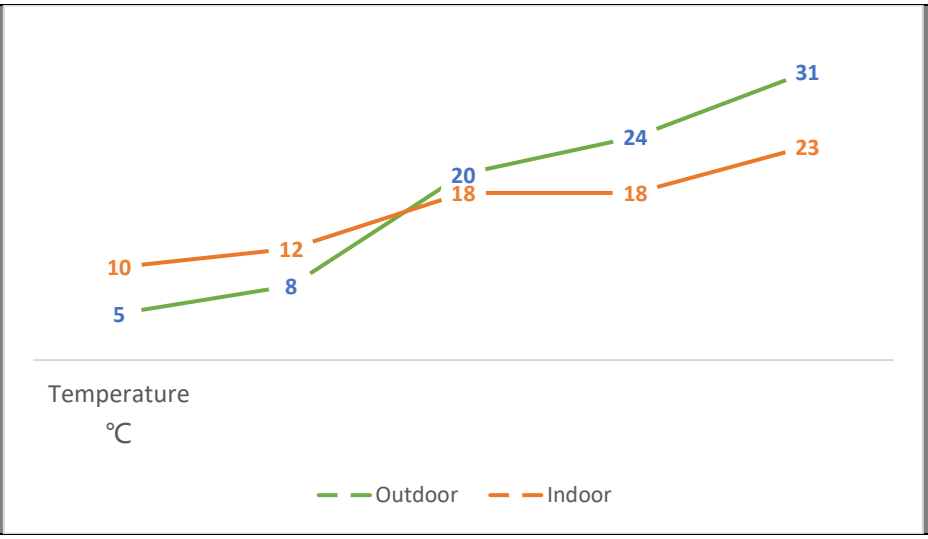
Figure 5.3.2.1-3 Hollowed-out walls with a glass curtain wall (by author 2021).



Chat 5.3.2.1-1 Shanghai temperature and humidity data (Available from: <https://zh.weatherspark.com/y/137446/%E4%B8%AD%E5%9B%BD%E3%80%81%E4%B8%8A%E6%B5%B7%E5%B8%82%E7%9A%84%E5%85%A8%E5%B9%B4%E5%B9%B3%E5%9D%87%E5%A4%A9%E6%B0%94>, 1 Aug 2022).



Figure 5.3.2.1-4 Various types of HVAC in 1933 Old Millfun (by author 2021).



Chat 5.3.2.1-2 Comparison of indoor and outdoor temperatures (by author, 2021).

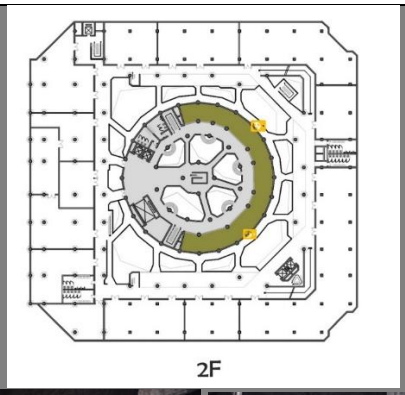




Figure 5.3.2.1-5 Outdoor units of the HVAC at the central ‘Slaughter Hall’ (by author 2021).



Figure 5.3.2.1-6 Decorated for filmmaking (by author 2021).

5.3.2.2 Toilets

Because having ready access to clean and safe public toilets is not only a vital part of personal and public health, but is also key to fostering liveability in cities. As a separate building with various small enterprise offices, 1933 Old Millfun should have permanent and functional toilets. Not only that, 1933 Old Millfun as an urban public realm, its toilets will provide a good service to the urban population as well. According to China's ‘*Standard for Design of Urban Public*

Toilets (CJJ 14-2016)' (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2016), good toilets in public buildings should be measured by the following principles:

- Good accessibility:
  The toilets are well located in the building, and easy to be found. There are at least two toilets on each floor of the building, and they are located in the same position on each floor (Appendix 2). The toilets on the 1F are signed at the entrance hall and are a short walk away (Figure 5.3.2.2-1). Not only the toilet's positions are marked in the building's guide map (Figure 5.3.2.2-2), but also the toilet's signage is clearly visible in the corridors (Figure 5.3.2.2-3). Further, according to '*Standard for design of office buildings (JGJ/T 67-2019)*' (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2019), the toilets services should be within 50m. For the project with sides within 80m, it meets the regulations.

- Adequate number and reasonable proportion of toilets:
  For 1933 Old Millfun, since it is a mixed-use of office and commercial model, the number of toilets needs to be discussed separately. The 1F and 2F of the project are dominated by commercial retails, with a long-term lease area of approximately 5400 ㎡; the two conference halls on 4F have a total capacity of 700 people (1933 Shanghai, 2022). According to the '*Standard for Design of Urban Public Toilets (CJJ 14-2016)*': the 1F and 2F need to be equipped with 5 toilets (including urinals) for males and 10 toilets for females, and actually the area is equipped with 30 toilets for male and 23 toilets for female, which are well beyond the standard; the 4F needs 2 toilets and 4 urinals for male and 10 toilets for female, but actually there are 5 toilets and 5 urinals for male and 8 toilets for females that serve conference halls.

  Besides, the office being a non-public area, the research statistics could not be carried out in depth. According to '*Standard for design of office buildings (JGJ/T 67-2019)*', the number of toilets required for the office is related to the number of people working in the office. Therefore, it is hard to obtain data to compare with the regulation. For these reasons, the research has to judge whether the number of toilets is enough on the office floors by observing the crowdedness of the individual toilets. The result is that not only is there not any overcrowding, but it is mostly unused.

- Safe and hygienic environment:
  As shown in Figure 5.3.2.2-4: each toilet is reasonably bright, either with natural light or active lighting; there is no bad smell in the toilet and the floor is clean and without water stains. There are professional cleaning staff who carry out regular cleaning of the project. Although in the Chinese situation, it is not common for public toilets to be provided with toilet tissue, it is

commendable that the project's toilets are equipped with toilet tissue (Figure 5.3.2.2-5).

Summary of flaws：

In terms of demand for toilets in 1933 Old Millfun, the problem arises mainly in the number of toilets for females provided in 4F, just 2 toilets below regulation requirements. That means when the two conference halls are operating at full capacity, the toilets will likely not be able to provide adequate service.



Figure 5.3.2.2-1 Toilet signage in the entrance hall (by author 2021).

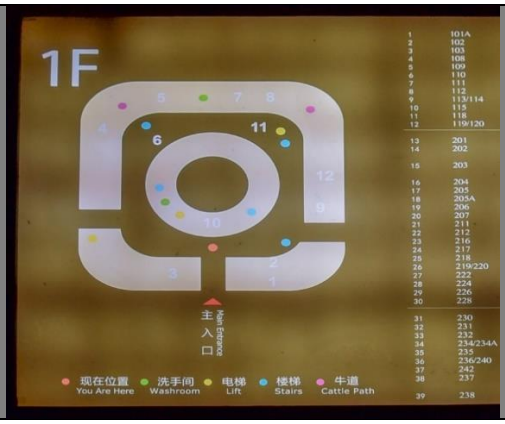


Figure 5.3.2.2-2 The guide map (by author 2021).



Figure 5.3.2.2-3 Toilet signage (by author 2021).

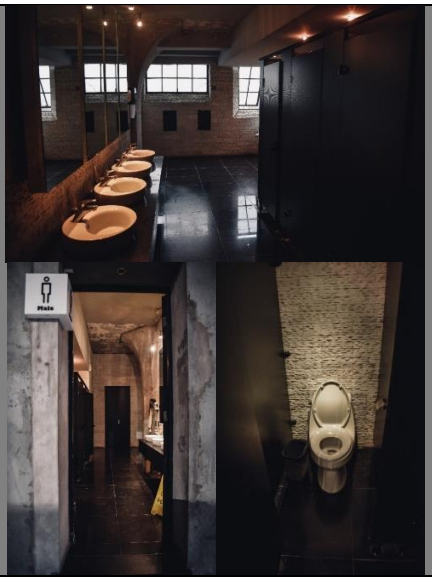


Figure 5.3.2.2-4 A sampling of the toilets (by author 2021).



Figure 5.3.2.2-5 The toilet tissue (by author 2021).

5.3.2.3 Convenience store

1933 Old Millfun has a Starbucks on the 1F (Figure 5.3.2.3-1). It does not need too much introduction, like other chains around the world, and offers drinks and cakes, at a uniform price (more details are shown in 5.3.2.7). In this section, the research will focus on the convenience store, called 'Quik' (Figure 5.3.2.3-2). It is a chain brand in China with shops located in 22 provinces and municipalities. The research will measure this convenience store mainly in the aspects of location, range of products, and prices.

- Location:
  The Quik is located on the 1F in the southwest corner of the building (Figure 5.3.2.3-1). It is located on the side of the building facade near the pedestrian flow.

- Range of products:
  Quik's products are mainly fast-moving consumer goods, including drinks, snacks, daily necessities, etc. In terms of the products sold, there is enough to provide the services that participants need in public spaces. Also, in this store of only 30 ㎡, Quik offers tables for dine-in meals. This convenience store not only serves the visitors of 1933 Old Millfun, but also serves as a supply station for the office staff within the project.

- Prices:
  The research investigated the prices of products within the Quik. He mainly selected drinking water and bread, the most common items in the market at the time, and compared their prices with the same items in other two popular convenience store chains in Shanghai, Lawson and FamilyMart. According to the current exchange rate, the price of the same water was 15p in Quik, 20p in Lawson and FamilyMart; and the bread was 48p in Quik, 55p in Lawson, and 60p in FamilyMart. This shows that the products in 1933 Old Millfun's convenience store are very well priced.

Summary of flaws：

As shown in Figure 5.3.2.3-1, as the convenience store is located on the facade side of the building, if participants inside the building want to go to the convenience store, they need to go out of the building. Of course, there is a rain shelter at the 1F so that people will not be affected by bad weather. However, due to the global impact of the epidemic (Covid-19), there are checking processes at the entrance to prevent the spread of the epidemic (details to follow in 5.3.2.4), which can cause some inconvenience to staff and visitors when passing through

the entrance frequently. Additionally, the convenience store has a limited space combining the variety of products sold. The sense of crowdedness and confusion leads to a subjectively poorer environment inside the store than in Lawson and FamilyMart (Figure 5.3.2.3-3).

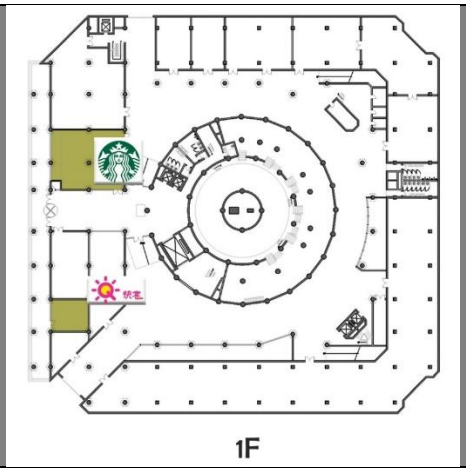


Figure 5.3.2.3-1 The location of the convenience store and the café (by author 2021).



Figure 5.3.2.3-2 The Quik (by author 2021).



Figure 5.3.2.3-3 The better environment of Lawson (by author 2021).

5.3.2.4 Security

Due to the function of the 1933 Old Millfun, there are no valuables to be taken. However, a public space needs a reasonable level of orderly management. The security staff in the project have uniforms with the identity of security written on their clothes (Figure 5.3.2.4-1). Security staff are in the car park in front of the building to guide the parking of vehicles throughout the day (Figure 5.3.2.4-2). The entrance to the building has a security room, and security staff patrol around the entrance hall (Figure 5.3.2.4-3). In addition, the same as other public buildings in China, a huge number of security cameras are placed throughout the building. Security cameras are installed by two main parties: 1933 Old Millfun project operators and room leaseholders. As a result, there is a wide variety of security cameras (Figure 5.3.2.4-4). In terms of the emergency response, the recent Covid-19 epidemic has swept the world, the project's security management has set up special staff assisted by security staff to measure the temperature at the entrance (Figure 5.3.2.4-5), and carry out movement surveys to ensure, as far as possible, people entering the building do not carry the virus through the Big Data Statistics APP.

Summary of flaws：

Except for the entrance hall and entering the interior of the building, no security staff was found patrolling. Although the building is a mixture of office and retail and the area is not very large, the fact that it is a well-known tourist attraction with a large floating population makes it necessary to patrol the site (Chen, 2002).



Figure 5.3.2.4-1 Uniformed security with Chinese ‘Security’ on the back (by author 2021).

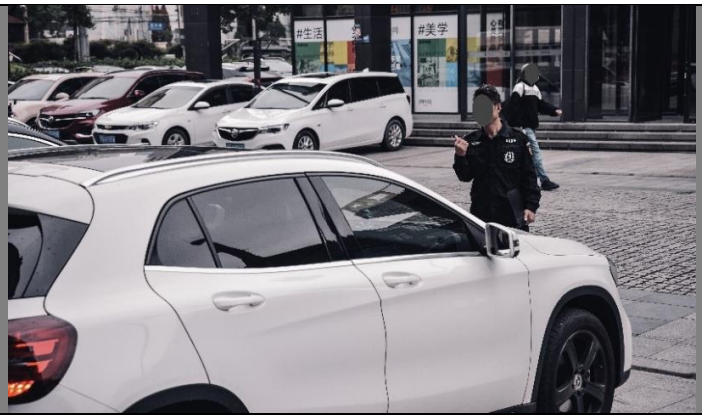


Figure 5.3.2.4-2 Security is guiding to park the car (by author 2021).



Figure 5.3.2.4-3 Security staff and the security room at the entrance (by author 2021).

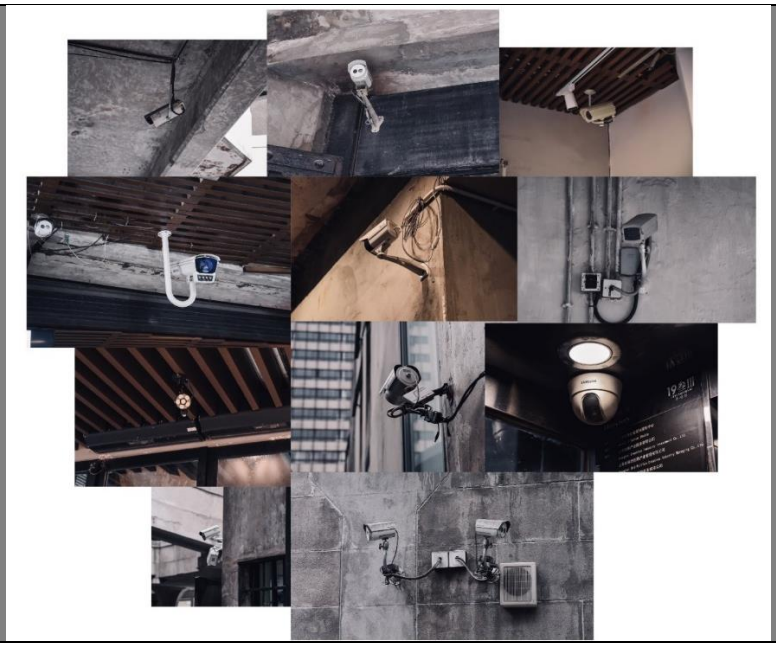


Figure 5.3.2.4-4 Security cameras (by author 2021).



Figure 5.3.2.4-5 Staff for virus prevention (by author 2021).

5.3.2.5 Fire and escape

Thankfully, the building of 1933 Old Millfun is concrete and cement structures with little use of flammable timber. Even so, after the survey, there is no hesitation about fire prevention in the project. Also, although the building consists of a large amount of open-air space, it is a non-smoking building. At the same time, huge numbers of fire hydrants are placed throughout the building in preparation for emergencies (Figure 5.3.2.5-1,2). Furthermore, smoke detectors are on the ceilings of the building (Figure 5.3.2.5-3); and in the central space, the 'Slaughter Hall' has sprinkler pipes on the ceiling of each floor (Figure 5.3.2.5-4), which not only can increase the efficiency of firefighting, but also provide more time for the evacuation of people inside the building (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2018).

A large amount of open-air space provides an inherent advantage for fire safety in 1933 Old Millfun. People on higher floors can escape directly to the open-air space to survive from the fire, without the need to go downstairs. The central 'Slaughter Hall', at the same time, was enhanced with a fire escape design during the transformation design process as well. According to the *'Code for Fire Protection Design of Buildings (GB50016-2014)'*, the internal escape staircase was required to allow people to reach the 1F safely during the fire accident. The reused project, therefore, has two new steel escape staircases in the central hall (it needs two staircases for a single floor area of more than 200 ㎡ according to the code) (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2018). The newly added evacuation staircases are located on the north and south sides of the central hall (Figure 5.3.2.5-5). The south evacuation staircase provides direct access to the outdoor space on the 1F (Figure 5.3.2.5-6); from the north staircase, evacuation is via a corridor of toilets and lifts before reaching the outside (Figure 5.3.2.5-7).

Summary of flaws：

The fire and escape flaws at 1933 Old Millfun are focused on newly added evacuation staircases in the central hall space. Firstly, as shown in Figure 5.3.2.5-8, there is an issue of the size of the new evacuation stairs. The height of the stairway steps should not be higher than 170mm, but the measured height of the stairway steps is 180mm. This could lead to a certain degree of a safety hazard for people with limited mobility, such as the elderly or children. Secondly, as the 1F of the north staircase does not have direct access to the outside, the *'Code for Fire Protection Design of Buildings (GB50016-2014)'* requires that this staircase should be accessible from the outside within 15m; otherwise, all the doors on the 1F would have to be fire doors, which is not possible in this project. As Figure 5.3.2.5-7 shows, the distance from the stairs to the doorway is 18m measured in the field. In other words, in a fire, people escaping from the upper floors may be injured because they cannot reach a safe space at the 1F.

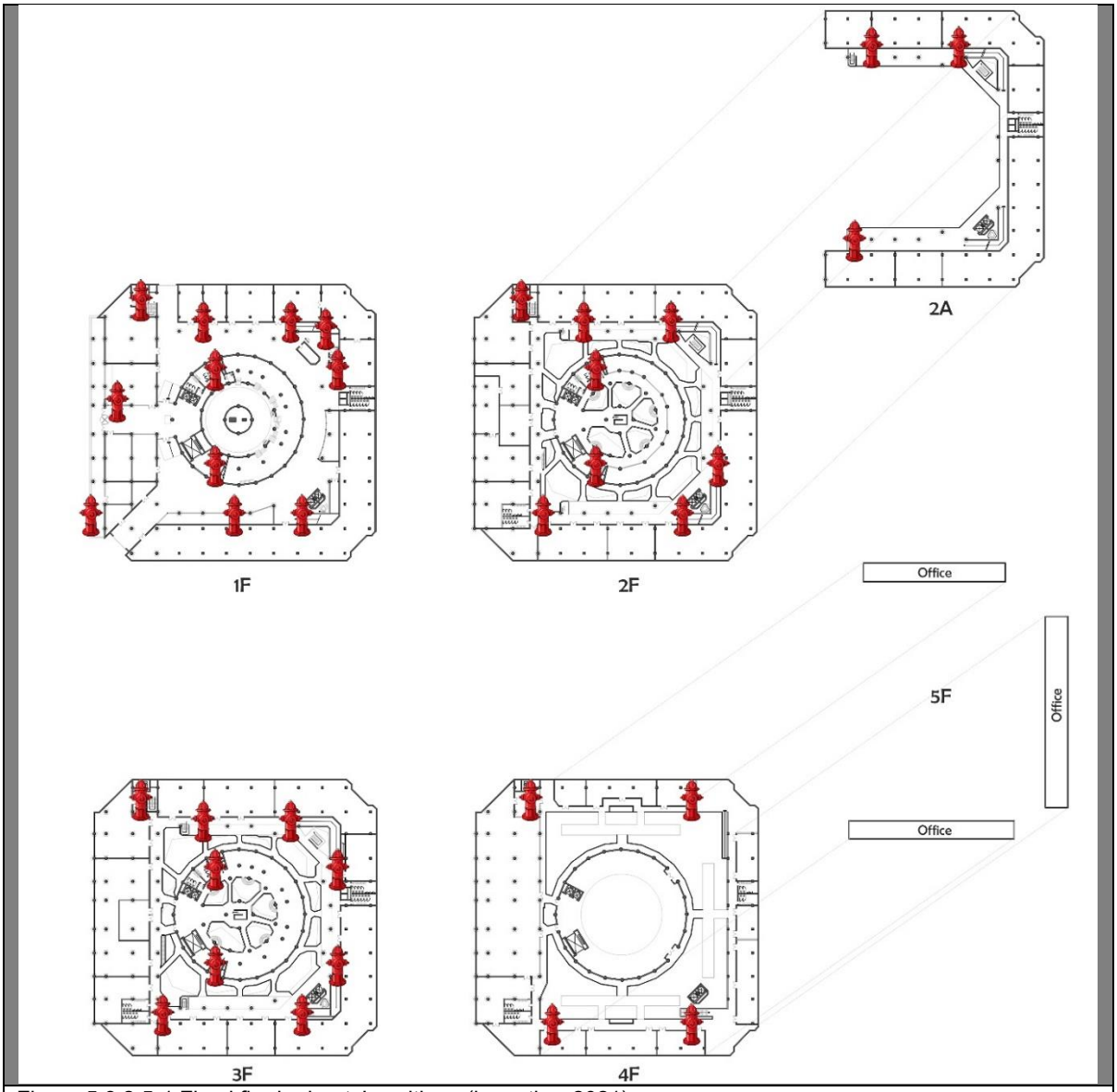


Figure 5.3.2.5-1 Fixed fire hydrants' positions (by author 2021).

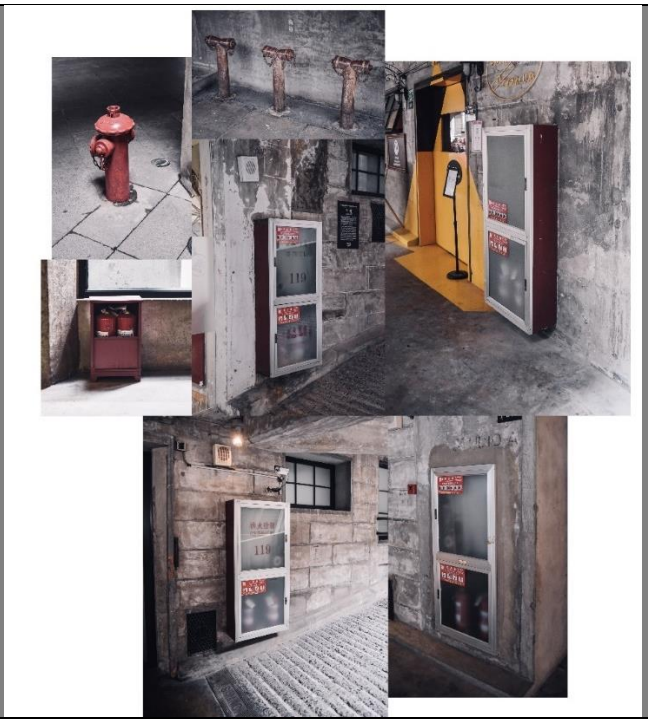


Figure 5.3.2.5-2 Various fire hydrants (by author 2021).



Figure 5.3.2.4-3 Smoke detectors (by author 2021).



Figure 5.3.2.5-4 Sprinkler pipes (by author 2021).

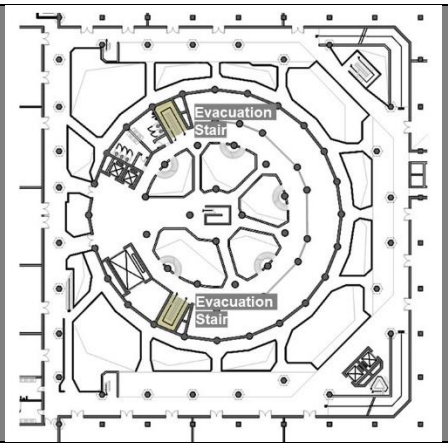


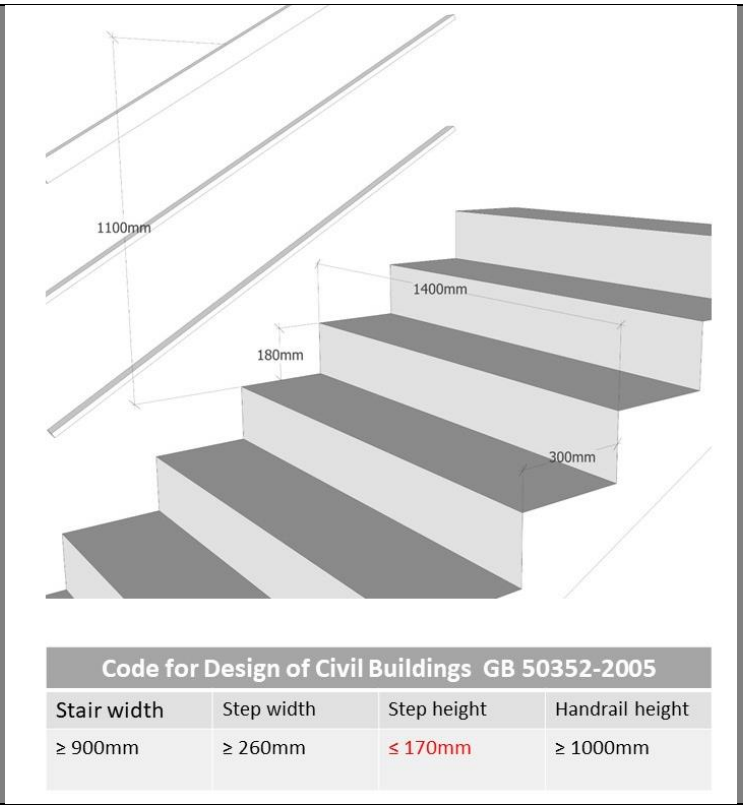
Figure 5.3.2.5-5 Evacuation staircases (by author 2021).



Figure 5.3.2.5-6 Open-air space of the south evacuation staircase (by author 2021).



Figure 5.3.2.5-7 The escape route of the north stair (by author 2021).



Code for Design of Civil Buildings GB 50352-2005			
Stair width	Step width	Step height	Handrail height
≥ 900mm	≥ 260mm	≤ 170mm	≥ 1000mm

Figure 5.3.2.5-8 Stair size (by author 2021).

5.3.2.6 Building components

1933 Old Millfun has a complex plan form with a large number of staircases, connecting bridges, and balconies at high levels (Figure 5.3.2.6-1). This is a safe challenge not only for the vertical traffic, but also for the protective components. The building was originally designed for slaughter production, not for public use, and it is understandable that there is some discomfort for the public. However, now the building is used as a public space, the safety threats to the building components should be avoided. Challengingly, these narrow and steep stairs are important parts of this historical heritage, and they should be preserved. Fortunately, 1933 Old Millfun has the cattle paths that were originally designed to transport cattle. As shown in Figure 5.3.2.6-2, the cattle paths are wide and non-slip, as large ramps can replace the steep stairs (more details can be found in 5.3.2.13). In addition, the building was transformed by adding five passenger lifts and one cargo lift (Figure 5.3.2.6-3). These provide convenience and detours for people in need. Therefore, in terms of the building components of 1933, the main measurements of the project will be carried out in 4 aspects: balustrades; stairs or ramps; lifts; and hazards of other components.

- Balustrades:

Unlike the traditional metal or wooden balustrades, the balustrades in the 1933 Old Millfun's staircase and bridge are ‘concrete fences’ (Figure 5.3.2.6-1). The height of these concrete fences has been measured at between 1.2m and 1.4m, which is in accordance with and better than the regulation, *‘Code for Design of Civil Buildings (GB50352-2005)’*, 1.05m as defined.

- Stairs:
  Most of the heritage stairs in the building can only be passed by one person and are no wider than 0.7m (Figure 5.3.2.6-4). The step data for these original stairs have been measured: the width of the steps is 250mm and the height of the steps is between 200mm and 240mm. The stair floors have a non-slip treatment, and on some stairs, there are hazard warning signages (Figure 5.3.2.6-5). Although it seems that these stairs are somewhat dangerous, they are not used for evacuation or main vertical traffic. There are no problems with the newly added fire stairs, as detailed in 5.3.2.5.

- Lifts:
  All 6 lifts in the building were newly installed after the transformation (Figure 5.3.2.6-6). And detailed reports of maintenance, disinfection, and reparation can be found in the lifts (Figure 5.3.2.6-7,8,9).

- Hazards of other components:
  Other safety hazards in the building are mainly found on the ground, where small steps appear in many places and some of them can be higher than 50mm.

Summary of flaws：

As the manufacturing functional layout of the building is the separation of human and cattle traffic, the staircases in order to save space are not satisfactory, after the above data description can be seen: the steps’ width is small and the height is big. Furthermore, excessive small steps on the building floors, which were not treated in a targeted manner after the transformation, also brought a safety threat to participants.



Figure 5.3.2.6-1 Interior space of 1933 Old Millfun (by author 2021).



Figure 5.3.2.6-2 One of the cattle paths (by author 2021).

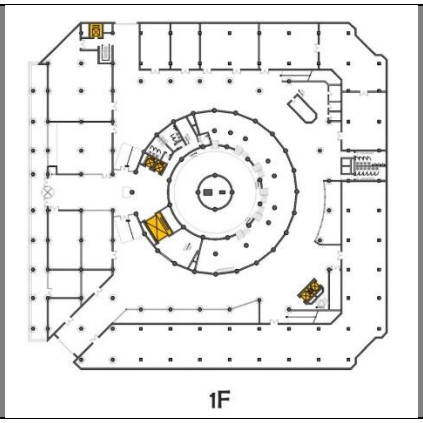


Figure 5.3.2.6-3 New lifts (by author 2021).



Figure 5.3.2.6-4 Stairs in 1933 Old Millfun (by author 2021).



Figure 5.3.2.6-5 Hazard warning signages at the stairs (by author 2021).



Figure 5.3.2.6-6 Lifts (by author 2021).



Figure 5.3.2.6-7 Disinfection records (by author 2021).

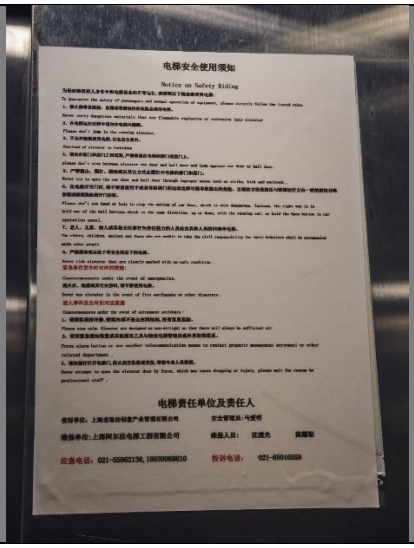


Figure 5.3.2.6-8 Notice on safety riding (by author 2021).



Figure 5.3.2.6-9 Maintenance report (by author 2021).

5.3.2.7 Rest areas

The areas where participants can have rest in 1933 Old Millfun can be described as very rich. Firstly, in terms of area distribution, there are large rest areas on each floor of the building, it

can be shown in Figure 5.3.2.7-1. Many areas are covered with wooden flooring and equipped with power outlets; some with lounge tables and chairs, and some are empty and used as flexible spaces (Figure 5.3.2.7-2,3). In addition, there is a wide variety of places for rest and activities, such as the cafe (Starbucks), the tea bar, and consumption areas (Figure 5.3.2.7-4).

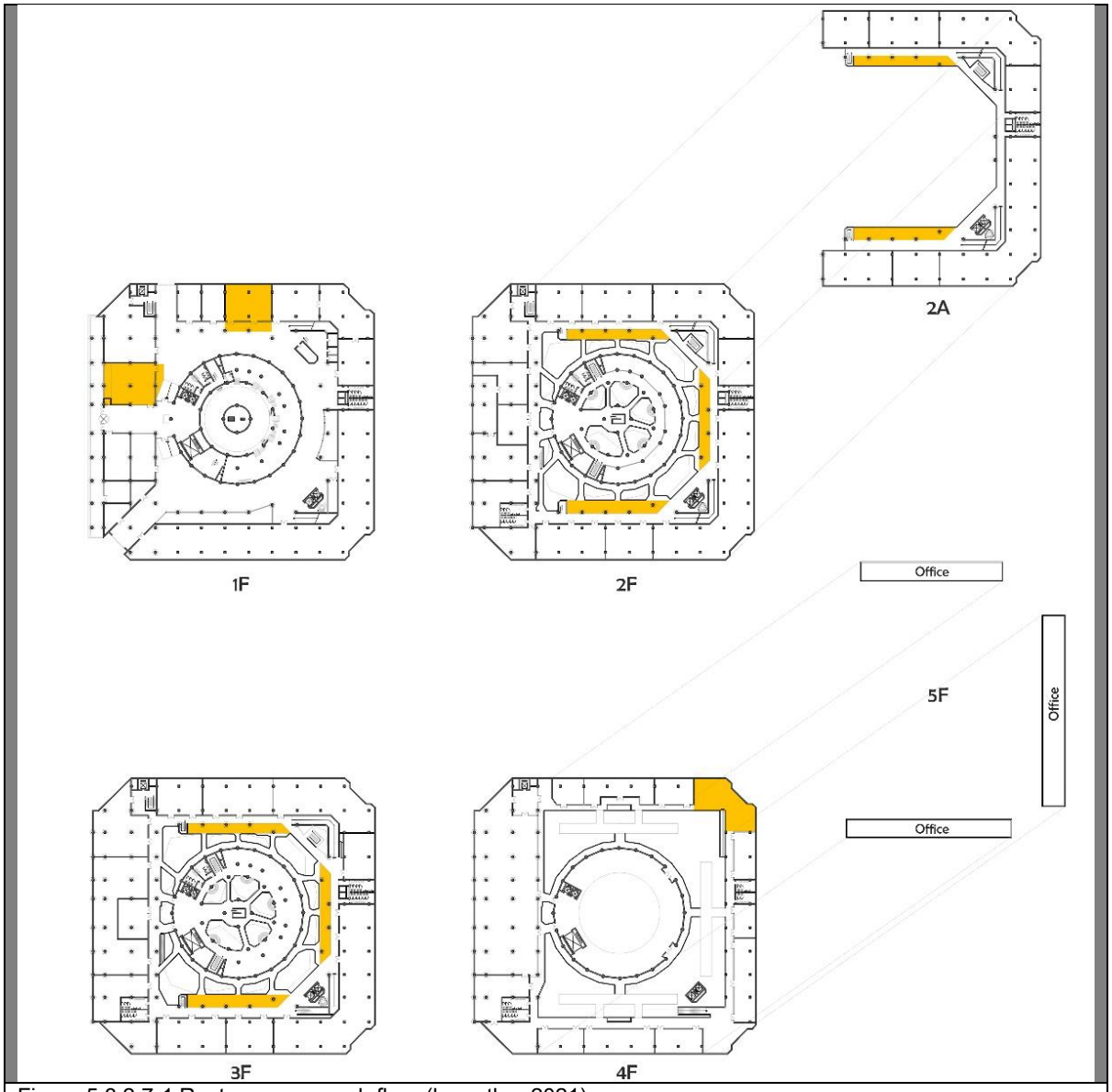


Figure 5.3.2.7-1 Rest areas on each floor (by author 2021).



Figure 5.3.2.7-2 Rest areas (by author 2021).



Figure 5.3.2.7-3 Highlighted power outlets at the rest area (by author 2021).



Figure 5.3.2.7-4 Various rest areas (by author 2021).

5.3.2.8 Visitor enquires

In a public building, especially for first-time visitors, being able to quickly find and ask for a staff member is a convenient, efficient, and heart-warming social experience. In 1933 Old Millfun, two groups of people can be seen as being very familiar with the project: the dedicated receptionists and the potential support. Both of them work on the project all year round and

with their familiarity with the project, they can help most of the participants with simple questions, such as finding the required places, the opening hours of some of the stores, and even the context around the project.

- Dedicated receptionists:
  In many large public buildings such as shopping malls and museums, there will be dedicated staff or volunteers who may be around reception or information desks and may be often wearing clothes with 'Help'. In 1933 Old Millfun, there is no dedicated staff as described above, as the space and visitor flow rate are not very large. As mentioned in 5.3.2.4, outside the entrance, there are friendly security guards to help to park cars and staff sitting at the entrance where participants can ask questions (Figure 5.3.2.4-2,3).

- Potential support:
  Potential support comes from tenants who are not employees of the project, but who work in 1933 Old Millfun, mainly as shop assistants. As there are no patrols in the project, this potential support is a good ‘replacement’. At the same time, there are many offices in the project, which are leased by companies and enterprises. Although the staff in the office are familiar with the building, they are not in a condition to potentially provide support due to the private nature of the office area.

Summary of flaws：

As mentioned above, there is no patrolling staff in the building, so if participants want to seek help during the tour they have to rely on other potential support. However, given the current leasing situation at 1933 Old Millfun, the stores open to the public are concentrated on 1F and 2F, with the others being mainly offices. In other words, participants on 3F and 4F will have nowhere to enquire.

5.3.2.9 Activity organisation

In addition to the retail and office functions, the rental of the 1933 Old Millfun as an activity venue is also a major income for the project (Pendlebury, et al., 2017). In the heart of the bustling city of Shanghai, a building with such a distinctive spatial form and rich in history and culture is a good choice for cultural and artistic events. The Sky Theatre (the middle circle hall) and the Basilica Suite (the west hall) on the top floor of the building are therefore well known as a venue for weddings and conferences in Shanghai. As shown in Figure 5.3.2.9-1, 1933 Old Millfun can host a wide range of activities, including brand events, exhibitions, banquets, weddings, conferences, training, team building, baby feasts, and parties (1933 Shanghai, 2022). Besides, there is a Micro Theatre on the 2F of the building (Figure 5.3.2.9-2). The stage

is closely arranged beside the audience, which shortens the distance between actors and the audience, creating an outstanding effect of performance and watching experience; the theatre can accommodate 120 people and can be set up into a three-side structure based on the performance need; a variety of drama performances are held from time to time on a wide range of themes including literature, family, children, youth, comedy, history and more (1933 Shanghai, 2022).

As the urban public space,1933 Old Millfun brings unplanned social activities to the community. During the site survey, it can be seen people doing morning exercises in the open space of the project (Figure 5.3.2.9-3). However, this kind of exercise is only done in China by elderly people in the early morning. In any case, the project provides a place for these elderly residents, and with its shelter from the wind and rain, as well as the provision of toilets, it is a good place for activities in the heart of a busy city. Furthermore, the café, tea shop, and convenience store on the 1F not only serve the 1933 Old Millfun, but also provide a good space for the neighbourhood to relax and socialise. The Starbucks Café, in particular, attracts many customers through its popularity.

Summary of flaws：

Although the project provides a space for activities for the surrounding public, it is too limited. As shown in Figure 5.3.2.9-3, people have to exercise very early in the morning and even occupy the parking space. But in such a city centre, it would also be unrealistic for the project to provide a large event space for the public.



Figure 5.3.2.9-1 Organised activities (1933 Shanghai, 2022).



Figure 5.3.2.9-2 The Micro Theatre (by author 2021).



Figure 5.3.2.9-3 People doing morning exercise (by author 2021).

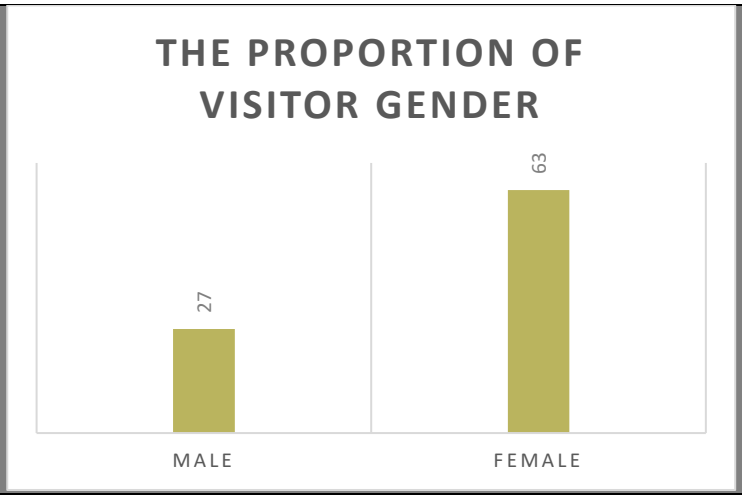
5.3.2.10 Diverse participants

Apart from the people who work in 1933 Old Millfun, the main participants are the visitors. These visitors are the active participants of the study and are also the ones measured in this item. The diversity of visitors is mainly reflected in the inclusiveness of the project. For such a mixed-use public building for history, culture, retail, entertainment, and exhibition, it is theoretically able to attract a wide range of people from diverse groups. The diversity of the project in terms of visitors is mainly reflected by the visitor structure, such as different genders, ages, and regions. Due to concerns that sensitive or private issues related to occupational background may cause discomfort for some interviewees, a rough judgment will be made based on the age division of the interviewees and the Chinese national context: those over 60 years old are predominantly retired.

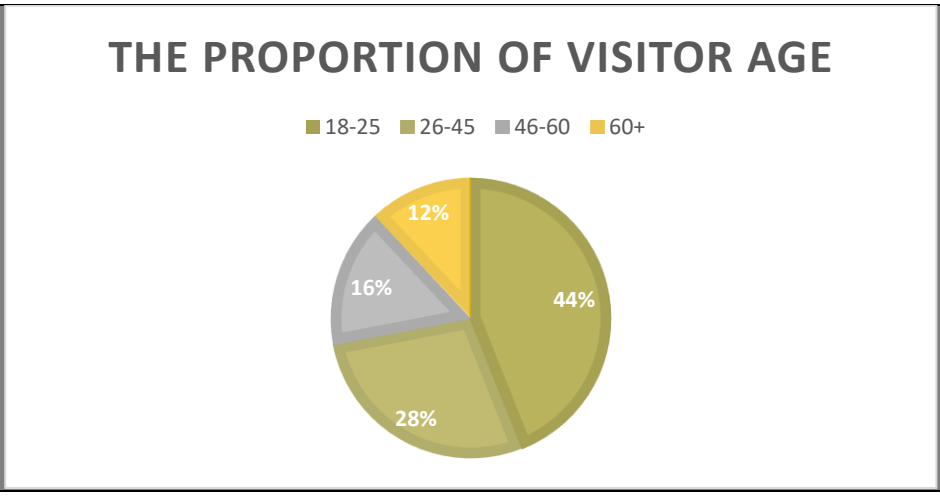
The research was undertaken through the 'Demographic Data Collection' of the questionnaire to collect data on this information. Of the 100 interviewees, the number of male and female visitors was 27 and 63 respectively, with women more than half the number of men (Chat 5.3.2.10-1). The interviewees were divided into four age groups and the results are shown in Chart 5.3.2.10-2. Chat 5.3.2.10-3 shows a proportion of local and non-local people in Shanghai, which also included 4 foreign visitors.

Summary of flaws：

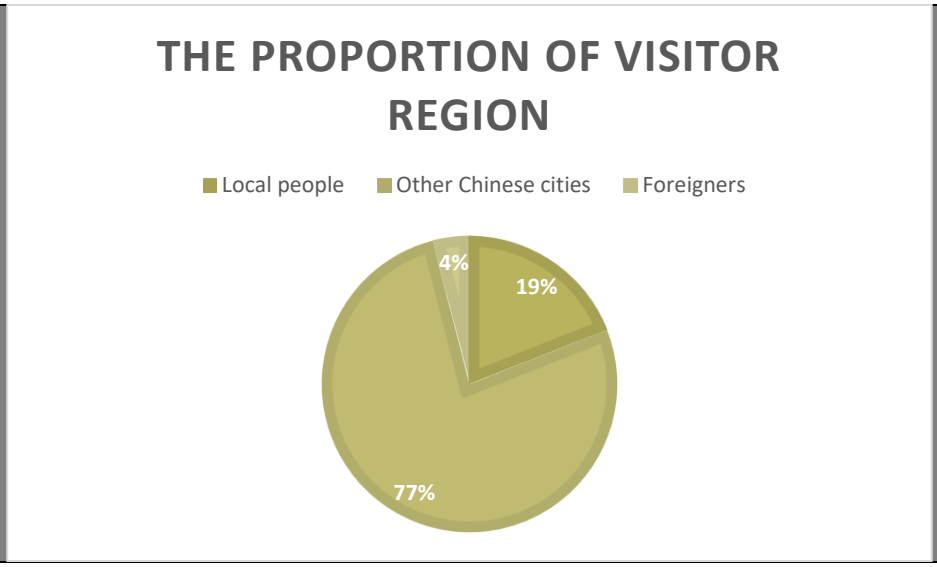
The data shows that the visitors are not balanced in terms of gender and age group. 1933 Old Millfun can be more attractive to women, and more popular with young people. The data shows that the majority of visitors are tourists from other parts of the country, and it appears that the project has developed into a tourist site. However, due to the characteristics of Shanghai city: nearly half of the total resident population in Shanghai is from other provinces (The State Council Information Office of the People's Republic of China, 2021), this is one of the reasons that affects the high proportion of out-of-Shanghai visitor figures in the project.



Chat 5.3.2.10-1 The proportion of visitor gender (by author 2021).



Chat 5.3.2.10-2 The proportion of visitor ages (by author 2021).



Chat 5.3.2.10-3 The proportion of visitor region (by author 2021).

5.3.2.11 Facilities for special groups

In a human-centred design system, some of the content of this section will co-exist with Section 5.3.2.6 Building Components. After all, their fundamental purpose is to ensure that the participants in the building can reach their destination safely and smoothly. As stated in Section 5.3.2.6, some industrial buildings, especially the 1933 Old Millfun, have complex interiors that are not friendly to special groups of people, such as wheelchair-bound, pregnant, and people with children. The accessible design will therefore play an important role in the reuse of this project. The stairs in the project will be avoided by special groups. However, the Cow Paths could be a good option because they are spacious and non-slip. In addition to these, according to '*Codes for Accessibility Design (GB 50763-2012)*' (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2012), the classification of accessibility in the 1933 Old Millfun for the support for special groups will be measured in four aspects: accessible toilets, ground transport, accessible lifts, and information reading.

- Accessible toilets:
  In some countries, like China, accessible toilets are also called unisex toilets which serve mainly people with limited mobility or in wheelchairs, people who need to be accompanied to the toilet, or people who need to use the nursing room (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2016). The project has an accessible toilet near the entrance and close to the common toilets on the 1F (Figure 5.3.2.11-1,2). Figure 5.3.2.11-1 shows that there are no steps at the entrance to allow wheelchair access.

- Ground transport:
  As mentioned in Section 5.3.2.6, there are many small steps on the ground on each floor. This is undoubtedly unfriendly to participants in wheelchairs and the elderly. Fortunately, the raised steps and thresholds at each floor of the main traffic flow are covered with steel boards to form ramps (Figure 5.3.2.11-3).

- Accessible lifts:
  From observation, it is clear that the passenger lifts have not been designed for accessibility. After the measuring, the size of passenger lifts is 1.3m wide and 1.5m deep. It is compliant with the '*Codes for Accessibility Design (GB 50763-2012)*' for larger than 1.1m * 1.4m. It can contain a normal wheelchair, but the wheelchair cannot be turned around in the lift. And the lift keys are between 1.2m and 1.6m high (Figure 5.3.2.11-4).

- Information reading:
  As a historical site, 1933 Old Millfun is now rated as a Chinese industrial heritage building and

has a lot of historical and cultural information (Zhao, 2007; Zhao, 2008; Wang and Pendlebury, 2016; Pendlebury, et al., 2017). Some explanatory signs for important historical and cultural information in the project are bilingual, in Chinese and in English.

Summary of flaws：

The additional steel plate at the steps of the ground transport improves the wheelchair's accessibility to a certain extent. However, this is not perfect, as the ramp (1:4) does not comply with the '*Codes for Accessibility Design (GB 50763-2012)*', which has a slope lower than 1:12. Besides, the height of the lift keys is not friendly to people in wheelchairs and is higher than the standard 1.1m (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2012). Furthermore, although the project does not have a lot of textual signs, some of them are still not bilingual, even including the Shooting Notice and Danger Warning (Figure 5.3.2.11-5). Also, the project does not make special provisions for people with reading difficulties, which is a general problem in many public buildings. There are no assistive devices such as audio guides at reception, and all instructional panels do not contain braille for the blind.

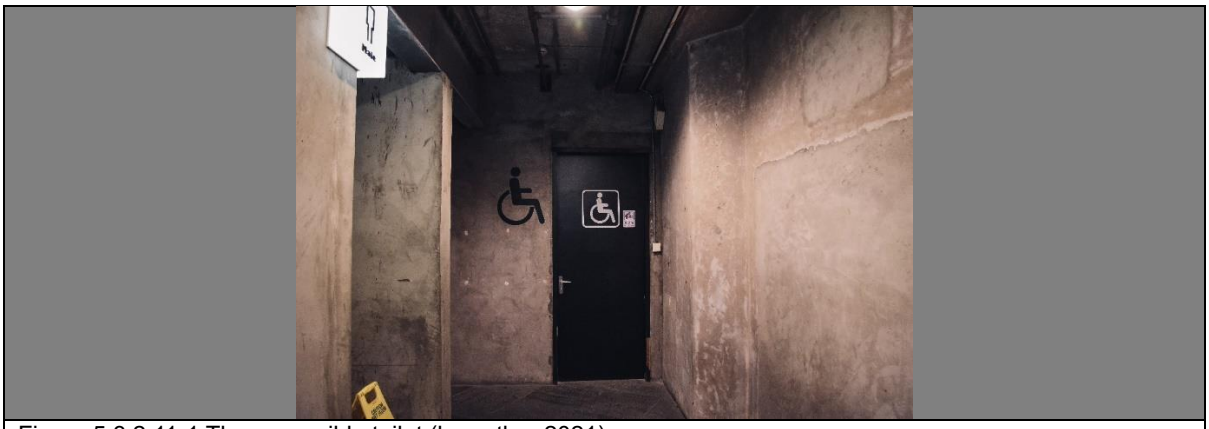


Figure 5.3.2.11-1 The accessible toilet (by author 2021).

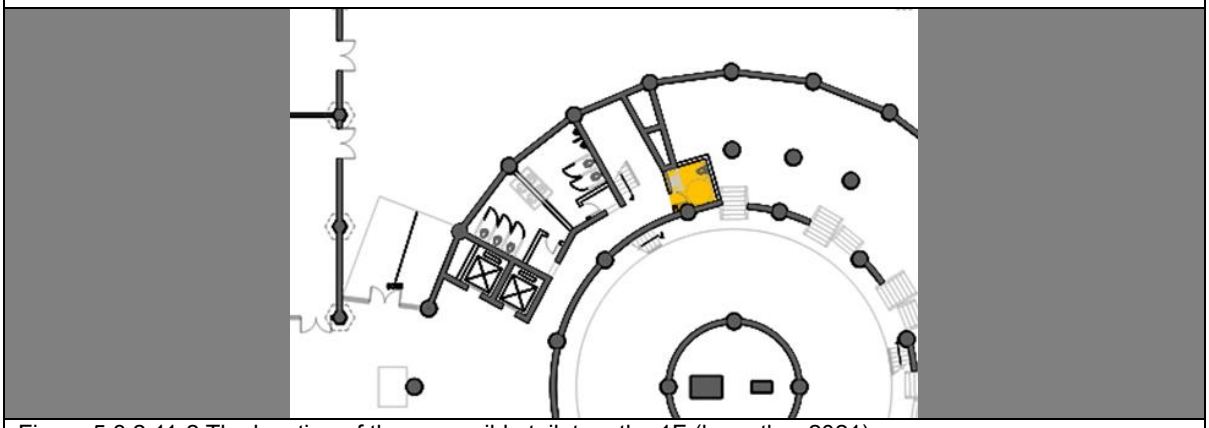


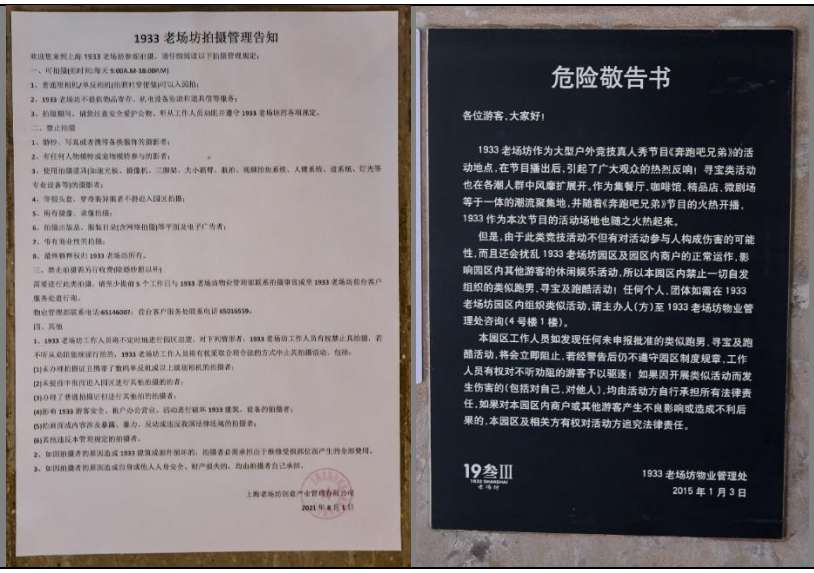
Figure 5.3.2.11-2 The location of the accessible toilet on the 1F (by author 2021).



Figure 5.3.2.11-3 Steel plates to form ramps (by author 2021).



Figure 5.3.2.11-4 Keys in the lift (by author 2021).



1933 老场坊拍摄管理告知

危险敬告书

各位游客，大家好！

1933 老场坊作为大型户外竞技真人秀节目《奔跑吧兄弟》的活动地点，在节目播出后，引起了广大观众的热烈反响！寻宝类活动也在各潮人群中风靡扩展开。作为集餐厅、咖啡馆、精品店、微剧场等于一体的潮流聚集地，并随着《奔跑吧兄弟》节目的火热开播，1933 作为本次节目的活动场地也随之火热起来。

但是，由于此类竞技活动不但有对活动参与人构成伤害的可能性，而且还会扰乱 1933 老场坊园区及园区内商户的正常运作，影响园区内其他游客的休闲娱乐活动，所以本园区内禁止一切自发组织的类似跑男、寻宝及跑酷活动！任何个人、团体如需在 1933 老场坊园区内组织类似活动，请主办人(方)至 1933 老场坊物业管理处咨询(4 号楼 1 楼)。

本园区工作人员如发现任何未申报批准的类似跑男、寻宝及跑酷活动，将会立即阻止，若经警告后仍不遵守园区制度规章，工作人员有权对不听劝阻的游客予以驱逐！如果因开展类似活动而发生伤害的(包括对自己、对他人)，均由活动方自行承担所有法律责任，如果对本园区内商户或其他游客产生不良影响或造成不利后果的，本园区及相关方有权对活动方追究法律责任。

1933 老场坊物业管理处

2015 年 1 月 3 日

Figure 5.3.2.11-5 Shooting Notice and Danger Warning in Chinese (by author 2021).

5.3.2.12 Map and signage

The layout of the 1933 Old Millfun is complex and for visitors who are not familiar with the project, a clear guiding map would be efficient and welcoming (Simon, 2010). There are map panels at the entrance and at the lift lobbies on each floor. As shown in Figure 5.3.2.12-1, the map shows: you are here, toilets, lifts, evacuation stairs, and cattle paths; and lists the names of companies and retail stores with their numbers, which also can be found in lifts (Figure 5.3.2.12-2).

The signage is numerous in the project and can be found everywhere. Depending on what they represent, they can be broadly divided into three categories:

- Exit signage:
  The aim is to guide participants directly and quickly to safety areas or to find escape exits, especially in case of emergencies such as fires. In 1933 Old Millfun there are signages on the stairs, on the ground, and on the walls (Figure 5.3.2.12-3).

- Safety signage:
  Like what is stated in Section 5.3.2.6, some building components may cause potential threats and injuries to participants, such as steps, fences, etc. Therefore, safety signage is provided in these areas to remind participants to be careful with them.

- Functional signage:
  The signage of the various functional rooms in the building allows participants to see at a certain distance and to be able to find the way to their destination quickly, such as the location of lifts, toilets, shops, etc. (Figure 5.3.2.12-4).

Summary of flaws：

In the questionnaire data collection, 37 people explicitly mentioned getting lost in the building and having to ask someone for help in the open-ended question in the questionnaire: ‘other unsatisfactory aspects of the project’. The reason for this can be explained by the fact that the layout map, drawn in an overly simple and abstract way, is difficult to clearly reflect the complex internal spaces of the project, causing participants to get lost. At the same time, because of the large amount of outdoor space, many signages are hidden by complex light and shadow, some of which have been dirty and blurred, making it difficult to serve as a reminder (Figure 5.3.2.12-5). Furthermore, for the safety signage, in the whole building, because there are so many small steps on the floor ground, it is estimated that 20% of them have signs to remind the visitors (Figure 5.3.2.6-6).



Figure 5.3.2.12-1 Map panels (by author 2021).



Figure 5.3.2.12-2 Enterprises list in the lift (by author 2021).



Figure 5.3.2.12-3 Escape signage (by author 2021).



Figure 5.3.2.12-4 Functional signage (by author 2021).



Figure 5.3.2.12-5 Broken signage (by author 2021).



Figure 5.3.2.6-6 Small steps on the floor ground (by author 2021).

5.3.2.13 Preservation of historical industrial elements

In comparison to other reuse projects, the reuse concept of 1933 Old Millfun used the approach of ‘subtraction’ (Zhao, 2007). Previously added elements, whether partitions or surface layers, were stripped out. The concrete lattice-work of the Art-Deco façade was restored, and later red paint was removed throughout the building to reveal the bare aggregate concrete structure as it was first completed in early 1930 (Figure 5.3.1.3-3). Similarly, the original white paint and tiles were ripped off the columns and walls of the storage room and slaughter hall, showing the concrete structure; and all the rough surfaces were plastered with cement (Figure 5.3.1.3-4). In short, the reuse of 1933 Old Millfun is a 'restoration' of the original 1930s design; people could describe this reused project as a 'seal' and a 'preservation', as if it were a 1933's historical object displayed in the great museum of the city of Shanghai. The excellent preservation of the layout can reflect the industrial processes that once existed.

Many material industrial elements of the project have interesting historical stories and historical manufacturing functions stored behind them. According to the historical sources: *The Past Life of the 24 Turret in the Far East - from ‘Shanghai Municipal Council Slaughterhouse’ to ‘Shanghai 1933 Old Millfun’,* some of the material industrial elements represent the wisdom of human civilisation.

- Columns:
  The columns, which are the main supporting structure in the building, are distinctive in that they are not of the same thickness at the top and bottom. As the representative of a beamless floor structure, over 300 ‘Flowering columns’ are preserved in this building. As the name implies, on the top of these columns is like a flower. Figure 5.3.2.13-1,2 show the columns that can support the gravity which comes from the broad area; these can replace the role of beams and thus save roof space (Zhao, 2007).

- Cattle paths:
  The hulking ‘net’ of intertwining ramps, staircases, and bridges in the building plays a role in guiding the workers and cattle to their stations. The most remarkable part is the wide cattle paths (Figure 5.3.2.13-3), they are stairs for the cattle, designed for the cattle drive: the rough, anti-slip surface was to prevent cattle from getting injuries (Figure 5.3.2.13-4).

- Bridges:
  In addition to passages for transporting animals like the cattle path, there are many intertwined narrow bridges. To distinguish different types and sizes of animals, the bridges are given diverse sizes; at the same time, their widths are narrow enough to avoid animals from turning

around and the side walls are high enough to prevent animals from striding over (Figure 5.3.2.13-5). Such special types of bridges will easily arouse curiosity, stimulating people to discover the industrial culture behind the elements.

- Stairs:

  The complex stairs were the workers' channel. These stairs wrap closely around the functional areas (Figure 5.3.2.13-6). Such a separation of pedestrians and animals expressed the best international slaughtering technology at that time (Shi, 2012).



Figure 5.3.2.13-1 Flowering columns (by author 2021).

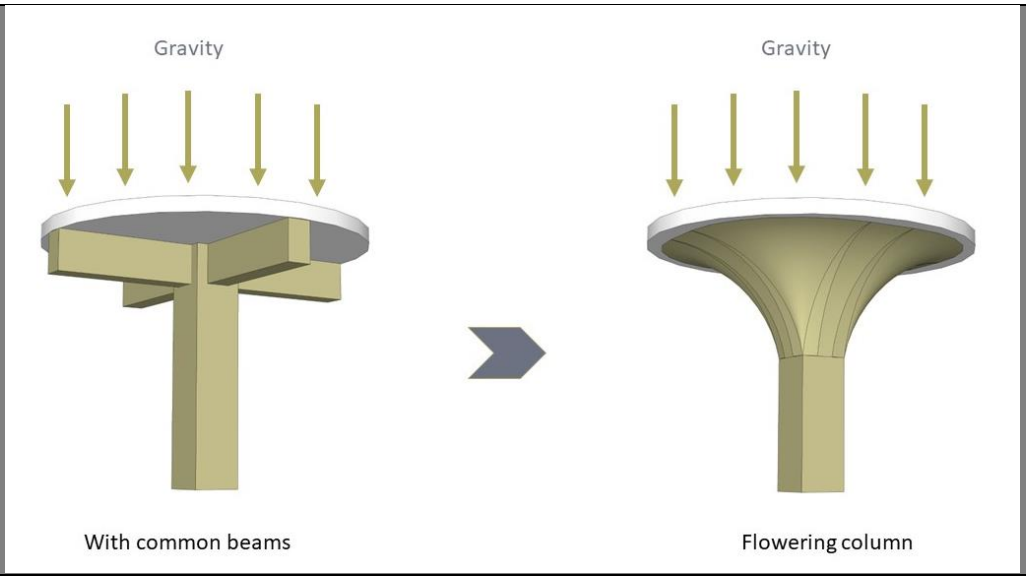


Figure 5.3.2.13-2 Principle of the flowering column (by author 2021). The floor should be supported by columns and beams. The flowering column can replace the ordinary beams, and can also be seen as a combination of columns and beams.

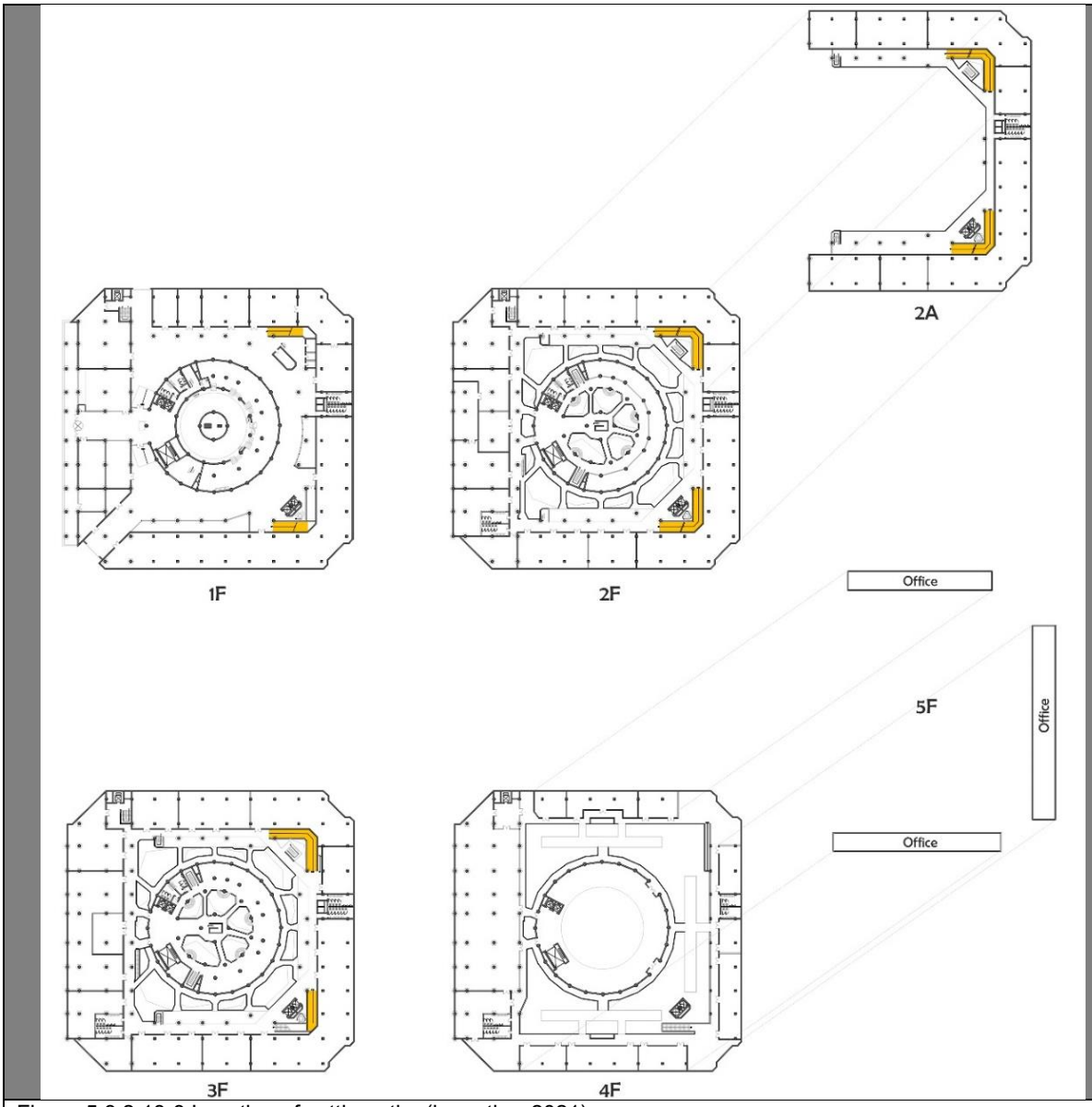


Figure 5.3.2.13-3 Location of cattle paths (by author 2021).



Figure 5.3.2.13-4 The anti-slip surface of the cattle path (by author 2021).



Figure 5.3.2.13-5 The bridges for transporting animals (by author 2021).

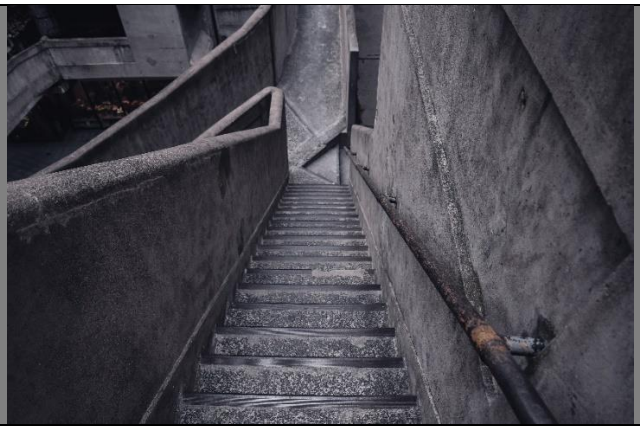


Figure 5.3.2.13-6 The stairs (by author 2021).

5.3.2.14 Transmission of historical culture

In the 1933 Old Millfun, some material industrial elements are accompanied by an explanation introduction panel. They are uniformly in the same size and typographic format. The dark base colour of the introduction panels is harmoniously attached to the structural skin of the concrete. The research's fieldwork found a total of 3 instruction panels about the important historical industrial elements throughout the building, namely: Cattle path (Figure 5.3.2.14-1), Air bridges (Figure 5.3.2.14-2), and Flowering columns (Figure 5.3.2.14-3).

Summary of flaws：

Although the 1933 Old Millfun preserves the material industrial elements well and exhibits them well to visitors, the explanation, education, and transmission of the historical and cultural information are a failure. According to the feedback in the questionnaire, only 8.4% of the

participants gained the knowledge of history and culture that they wanted to get from the project. The main problem was summarised by the research as the fact that in the building of this size, there are only 3 historical introduction panels, the analysis is as follows:

- Cattle path:
  As shown in Figure 5.3.2.13-3, throughout the building, the cattle paths can be thought of in two groups, each of them running from 1F to 3F. However, the introduction panel on this industrial element are only available on the north side of the cattle path on 1F. In other words, if participants chose the cattle path on the south side, they would miss the instruction panel; or participants would not see the introduction after passing through the cattle path after reaching other floors (except for 1F) via the stairs or lifts.

- Air bridges:
  The layouts shown in the appendix show that there are 34 air bridges with the same function. Sadly, only one of the bridges on the 2F has an introduction panel and is quite easy to miss.

- Flowering columns:
  The research has to describe it as ‘extremely sad’ that there is only one instruction panel attached to one of the more than 300 umbrella columns in the whole building.

- Others:
  As a visitor, the source of information about the history and culture of the building, apart from the project site, is the official website of the 1933 Old Millfun. However, the latest official website does not contain any information about the history of the building (1933 Shanghai, 2022). Therefore, when the public comes to a building with such a sense of history and novelty, it is natural to ask: “what was this strange part used for?” The project was unable to satisfy the participants for cultural information. Because, apart from these 3 introduction panels, the other material industrial elements are not described or introduced as such. There will be some confusion for the participants, and it will be difficult to find answers to questions. For example, why is the functional layout of the building in a separate enclosed form and what do these two parts do? (Although this question has been clarified by the research in this chapter in Section 5.3.1.2 that have explained academic sources, it is still a source of confusion for the public); some rooms with special functions have names from the slaughterhouse period, but some of these do without any explanation of what they were used for, such as the Confinement room (Figure 5.3.2.14-4), which even cannot find the answer through the academic publications.



Figure 5.3.2.14-1 Introduction panel for cattle path (by author 2021).



Figure 5.3.2.14-2 Introduction panel for air bridges (by author 2021).

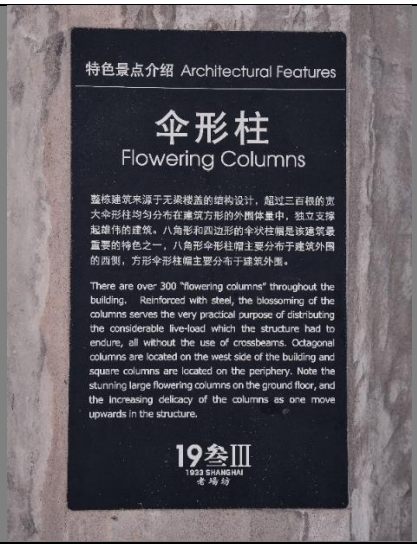


Figure 5.3.2.14-3 Introduction panel for flowering columns (by author 2021).



Figure 5.3.2.14-4 confinement rooms (by author 2021). From the nameplate, it looks like it was used to close the cattle. The research has combined some information on slaughter and explained it this way: some cattle are so stressed or crazed before they die that they need to be confined to a room to calm down. The calmer cattle are then slaughtered with better meat quality than the stressed cattle.

5.3.2.15 Integration of ‘old and new’

It could be argued that the 1933 Old Millfun’s achievement of integrating the old with the new comes largely from its powerful visuals. Visually, as described in Section 5.3.2.13, there is a strong 'restoration' of the project, with a concept of 'repairing the old as the old'. In the process of project transformation, new architectural interventions were restricted to black steel frames and clear glass panels. The main new addition is the multifunctional room on the top of the slaughter hall. As a whole, these new elements seem to integrate well with the concrete and avoid making huge visual contrasts (Figure 5.3.2.15-1). After all, the project is still designed to highlight a sense of history. In terms of visual integration, the building provides various sight angles for visitors to enjoy such a space and the changing of light and shadow. Zhao (2007) states that the value of the 1933 Old Millfun is embedded in the visual aesthetics of its complex concrete structures. A person who wears a colourful dress will produce a strong contrast with the concrete background. Hence, through different sight angles combined with contrasting backgrounds, this public space can create infinite visual works (Figure 5.3.2.15-2). At this point, the integration is no longer about inclusion, but about the ability to better highlight the modern elements, such as the woman in red that is to be highlighted.

In addition, the industrial culture is carried through to a certain extent in terms of function. There are examples of shops that incorporate the theme of the slaughterhouse, such as Japanese restaurants that offer beef as a signature dish (Figure 5.3.2.15-3). The 1930s were a special period in Shanghai's history when 'prosperity', 'colonialism', 'multiculturalism' and 'trade' were considered synonymous with the city. Some of the shops are based on a 1930s

Shanghai theme and sell products and layouts that allow people to experience the architecture in a way that is immersive, such as an ‘Old Class Fit’ shop selling vintage 1930s products (Figure 5.3.2.15-4).

Summary of flaws：

The historical and cultural aspects of this heritage building are present, but the percentage is low. Apart from a few culture-related shops, there is no other cultural integration. Unfortunately, however, the questionnaire shows that only 6% of people are interested in the historical shops in the project.

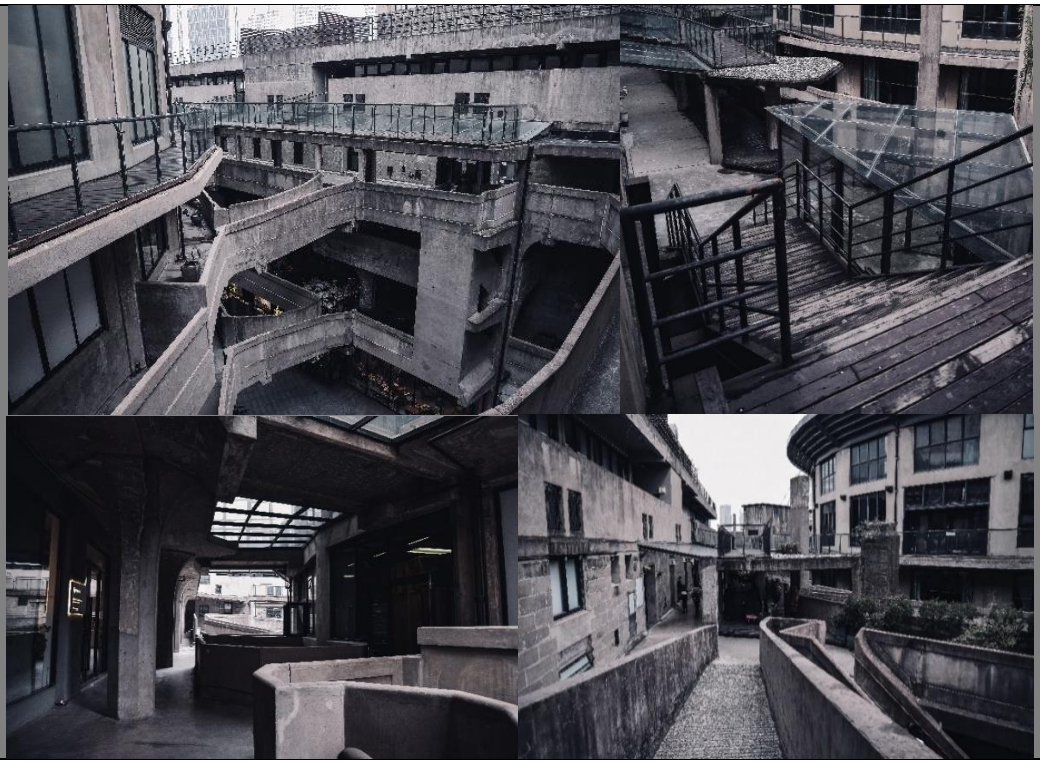


Figure 5.3.2.15-1 New elements with glazing and black steel (by author 2021).



Figure 5. 3.2.15-2 Photography works (Available from: <www.poco.cn/works/>, 4 Aug 2018)



Figure 5.3.2.15-3 The restaurant's signature dish of beef (by author 2021).



Figure 5.3.2.15-4 The vintage shop (by author 2021).

5.3.2.16 Attractiveness

This item, attractiveness, is more like a summary of the above, as each of the outstanding points above could be part of the attraction of the project. As mentioned in terms of integration (Section 5.3.2.15), the historical sense of the curious spatial form is visually impressive. The advantage of the visual experience becoming the main attraction of 1933 Old Millfun is therefore particularly significant. The visual impression of the project is successful. In the questionnaire, 14 visitors from outside the city, who were just passing by 1933 Old Millfun, were all shocked by the visual effect of the place. The visual success of the project has brought opportunities for awareness, recognition, and commercial income.

Besides retail businesses and office rentals, the main income is from the Basilica Suite and Sky Theatre on the top floor of the building (Figure 5.3.2.16-1). As mentioned in Section

5.3.2.9, these two large spaces can host a variety of events. This is thanks to its unique spatial features. The Basilica Suite is a rectangular space, supported internally by a number of Flowering columns. The designer tried to make full use of the space created by these specially shaped columns. Arranged in a row, Flowering columns emphasise the sense of depth in the space and help the sight-line focus on the central axis (Figure 5.3.2.16-2). The Sky Theatre is the location of the water tank on top of the original building. During the transformation, the designers laid out a glass floor for it (Figure 5.3.2.16-3). This huge circular space, combined with the reflective effect of the glass floor has attracted numerous commercial collaborations for the project (Figure 5.3.2.16-4). In practice, new product launches, weddings, and conferences conducted here have benefited from this nave style and visual guiding space.

This unique historical building has given rise to a wide range of sources of visual creativity. This has made the 1933 Old Millfun become a popular place for advertisements, movies, and TV shoots (Figure 5.3.2.16-5,6). In fact, these works are a great way to advertise the 1933 Old Millfun and attract more visitors to the project. According to the results of the questionnaire, 100% of the visitors come to appreciate the industrial view of the project and take photos, many of them specifically to create photographic art (Figure 5.3.2.16-7).

Summary of flaws：

The success of 1933 Old Millfun in creating visual effects is obvious to all. However, participants come here mainly with the purpose of staying at the level of the 'lens'. The tangible and intangible historical industrial culture that the building itself contains is not fully presented and does not become the attraction of the project. This is the reason, to some extent, why the participants are mainly young. Overall, the project is still too single-minded in its attractions and there should be more space to develop.

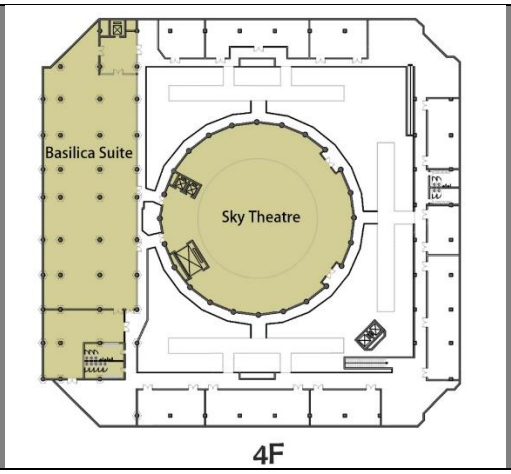


Figure 5.3.2.16-1 Basilica Suite and Sky Theatre (by author 2021).

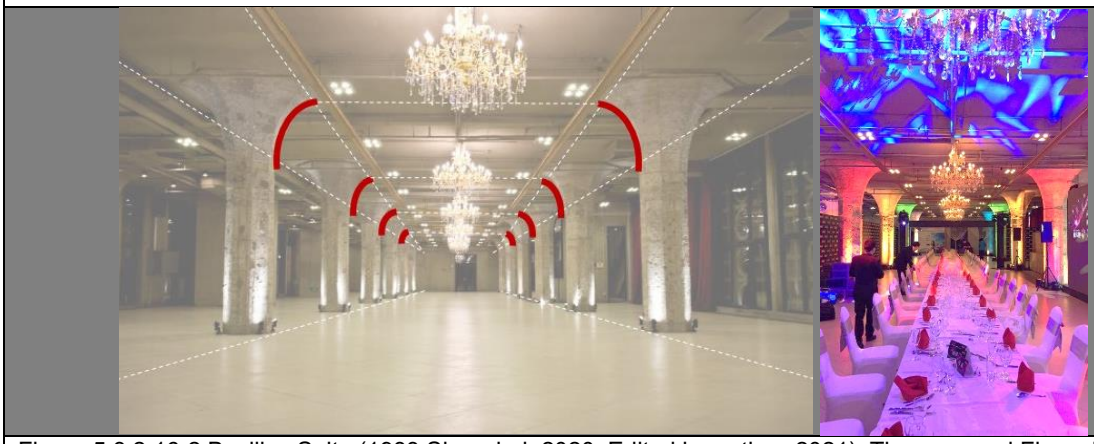


Figure 5.3.2.16-2 Basilica Suite (1933 Shanghai, 2020, Edited by author, 2021). The arranged Flowering columns can enhance the perspective sense of the space, which will help people focus sight lines along the columns in a complex environment. Pendlebury, Wang and Law (2018) note that there are more than 150 requests for the building's use as a wedding venue every year.



Figure 5.3.2.16-3 Glass floor of the Sky Theatre (by author 2021).



Figure 5.3.2.16-4 Spatial effects of light reflection (1933 Shanghai, 2022).



Figure 5.3.2.16-5 Chinese reality TV in the Sky Theatre (Available from: <https://weibo.com/1933shanghai>, 18 Aug 2022).



Figure 5.3.2.16-6 Chinese movie: Tiny Times (Available from: <https://www.zhihu.com/question/25270489>, 18 Aug 2022).



Figure 5.3.2.16-7 Professional photography group (by author 2021).

Chapter 6

Case survey 2

6.1. introduction

This chapter is a case survey of another case, Bingshan Industrial Culture Exhibition Hall in Dalian, the methodology of which is generally similar to that of the previous chapter 1933 Old Millfun. It is hoped that this will demonstrate the wide range of applications of this assessment framework.

6.2. Case 2: Bingshan Industrial Culture Exhibition Hall, Dalian

6.2.1. Background

6.2.1.1 Regional characteristics (Dalian, China)

Dalian city is located in the southernmost part of North-east China, surrounded on three sides by the sea, and separated from Japan, South Korea, and North Korea by the Yellow Sea (Figure 6.2.1.1-1). China's four most important industrial bases are located in: Beijing-Tianjin-Hebei, Yangtze River Delta, Pearl River Delta, and Liaoning; and Dalian is the heart of Liaoning.

Although the city of Dalian is only one-third the size of Shanghai, the degree of industrial development placed it in the leading position in China (Liu, 2008). Dalian's modern industrial development is rather unique, this modern city was built based on a village with Russian and Japanese investment (Li, 2015). Dalian's industrial history did not go through the transition from handicraft to machine industry. Dalian went straight into the era of the machine industry. The industry developed from heavy industry, and the weight of heavy industry has been maintained at over 60% (Chen, et al., 2008). A number of heavy industry enterprises such as locomotives, shipbuilding, iron and steel, and chemicals were built in Dalian during the Russian and Japanese governments' time (ibid). Today Dalian has a full range of industrial categories, and the total industrial output value is the top in the North-east region of China (Liu, 2008). The complete industry mainly involves petrochemical, shipbuilding, electronics, machinery, metallurgy, food, and pharmaceutical industries. Among them, petrochemicals, shipbuilding, locomotives, bearings, and refrigeration equipment are the top level in the same industry in China (Li, 2015).

However, it is well known that some traditional heavy industry has become limited in the development of today's society due to environmental damage and the rise of technology. Dalian is the most important transportation hub in the North-east due to its important geographical location and important air and seaports. At the same time, combined with the beautiful coastal scenery (Figure 6.2.1.1-2), the 21st-century city plan has positioned Dalian for development as an international city of scenic tourism. It aims to build an international city of cultural and modern industrial (tourism service industry) development. According to the '*Dalian City Master Plan (2001-2020) (revised in 2017)*' (Bureau of Natural Resources, Dalian, China, 2017), Dalian would be transformed from heavy industry to the development of tourism and the digital age. Such transformation has been the driving force behind the relocation of a large number of Dalian's industrial enterprises to the suburbs. The vacated sites will be used

mainly for the construction of cultural and tourism industries. The data shows that Dalian's efforts in this regard are getting rewarded. *"Between 2016 and 2020, the total added value of the city's cultural and related industries will be RMB 110.74 billion (about GBP 13.5 billion), accounting for approximately 4.1% of the city's total GDP; during the period, total tourism revenue of RMB 551.19 billion (about GBP 67.3 billion) will be achieved, with an average annual growth rate of 13.21%"* (Dalian Municipal Bureau of Culture and Tourism, 2021).

As a result of the relocation of industrial factories, the old industrial buildings left in the city have become an important resource for urban transformation and regeneration. Dalian is a late starter in the revitalisation of old industries, but it has been able to learn from the successful experiences of pioneering cities such as Beijing and Shanghai, and has achieved some success in the conservation and reuse of old industries (Li, 2015). 10 of Dalian's industrial heritage sites are listed in the first and second batches of the 200 projects in the national list (*Protection List of China's Industrial Heritage (the first batch), 2018; Protection List of China's Industrial Heritage (the second batch), 2019*). In addition, the city's reuse of old industries is developing rapidly and smoothly as the city defines its own direction for industrial tourism. The current model of industrial tourism in Dalian includes museums, parks, comprehensive creative industries (mixed-use), and combined shopping tourism.



Figure 6.2.1.1-1 The map of Dalian (Available from: <https://worldmapwithcountries.net/2020/04/22/map-of-china/>, 9 Sep 2021, Edited by author 2021).



Figure 6.2.1.1-2 Dalian's seaside scenery (by author 2020).

6.2.1.2 A site-specific enterprise: Dalian Bingshan Refrigeration Factory

Dalian is considered to be the most open city in north-east China, mainly due to its excellent geographical location and port resources (Liu, 2008; Li and Zhou, 2011). At the end of the 20th century, Dalian was not in a position to develop resource-based industries as other cities in the north-east, because of the lack of large mineral and energy resources in the city; at the same time, the lack of freshwater resources in Dalian was a major challenge as well, limiting the development of water-consuming industries (Li, 2015). As a result, Dalian made use of its excellent geographical location by sea to develop a range of port industries. Dalian has proved to be on the correct path for development in this direction. Nowadays Dalian already stands at the top of China in terms of cold-chain transport and storage at the port. According to the '*China cold-chain logistics development report (2020)*', China is a major importer of bananas, with an annual import of 2 million tonnes, the consumption of bananas is growing year on year; more than a third of imported bananas in China enter at Dalian's Dayaowan Port. Besides, the data shows in the '*China cold-chain logistics development report (2019)*', that cold storage in Dalian port is the largest in China, more than 1.5 times the capacity of second place Qingdao city. Such success has been accompanied by the rise of Dalian's cold-chain equipment manufacturing, the top Chinese company in this industry: Dalian Bingshan Refrigeration Factory.

Based on the description of the panels in the Bingshan Industrial Culture Exhibition Hall, the development process of the Bingshan Group is summarised below. On August 5, 1930, Xinmin Iron Factory was founded (Figure 6.2.1.2-1). In the beginning, the factory was mainly repairing foreign-brand compressors and making refrigeration auxiliary equipment. In 1954, the factory changed its name to Dalian Refrigeration Factory, and specialised in the manufacture of refrigeration equipment. In the same year, the factory began to study casting technology, which is the basis for compressor components. In November 1965, China's first 8AS17 refrigeration compressor was successfully produced, and the 'Bingshan' (Pinyin of Iceberg) brand was born at the same time. In the 1980s, the casting sand of the factory was still made of sodium silicate sand. The casting process has poor forming and many defects, such as needing to blow dry and causing dust. After continuous research and experimentation, the researchers in the factory succeeded in transforming from sodium silicate sand to resin sand, which solved the above problems and was a revolution in casting technology. In 1987, in order to expand the casting production capacity, the factory introduced a resin sand casting production line from Germany. After having a strong foundation of parts casting, the factory would consider upgrading the design and assembling about the whole equipment. At the time, Dalian Bingshan Refrigeration Factory could not be called a world leader in the field of refrigeration compressors; the technology of Germany and Japan was more advanced and mature. In the end, the factory chose to enter the world lead with Sanyo of Japan, and stabilised its position as the first in China in the same field. In 1993, the factory became a joint stock company, the Dalian Bingshan Group.

Nowadays, the refrigeration equipment manufactured by the Dalian Bingshan Group is widely used in the cold chain storage and transportation of Dalian Port. Dalian Bingshan Group and Dalian Port collaborate with each other and promote each other, all pressed to the top level in China. In 2017, with the modernisation and transformation of the industry, the business of the Dalian Bingshan Group has been expanding. For better development, the Group decided to relocate the factory to the Economic and Technological Development Zone in Dalian, which is in the suburbs of the city.



Figure 6.2.1.2-1 The 1970s factory (Available from: <https://www.sohu.com/a/520996308_175523>, 17 Sep 2021, Edited by author 2021).

6.2.1.3 The new life of Bingshan Wisdom Park: hot in the cold

The site of the old factory is in situ, which is in an excellent location in Dalian. The transport situation is very convenient, with over 20 bus routes to reach the site. The project is located 4.4 km from Dalian International Airport, 6.3 km from the railway station, and 3 km from the commercial centre (Figure 6.2.1.3-1). Within a 500m radius, there are residential areas, schools, hospitals, shopping malls, and other urban facilities. After the group has relocated and following negotiations within the group, the old factory will be redeveloped into a new income-producing project by transforming the business model.

The old factory site, which was left behind after the relocation of the Bingshan Group, covers a total area of approximately 180,000 m², with more than 40 large and small buildings remaining within the site (Xie, 2020). These buildings are of various types, including offices, mills, storage warehouses, etc. In addition, the buildings within the site have evolved over the last 90 years, and the equipment and mills have been constantly renewed and improved in order to be at the leading edge of the same field; for this reason, the existing buildings on the site are from different periods, ranging from old buildings from the 1950s to contemporary buildings that have been added or renovated at a later stage (Figure 6.2.1.3-2).

Mr Wei Xu, the legal representative of Dalian Bingshan Wisdom Park Co., Ltd, suggests that "*the reuse of the site should not be left for emotional purposes only, but also to explore how it can be used*". For such a huge park area, the reuse of the site should be multi-functional and mixed-use. The design team referred to the design of 798 in Beijing, which is one of the most famous and successful mixed-reused projects in China. However, Dalian's project does not

copy Beijing 798, because unlike other famous industrial parks in China where the government is highly participatory, the project is purely built by the enterprises themselves with Bingshan Group and Zhejiang South Design Institute. The reuse project opened in 2021 and was named Bingshan Wisdom Park. The whole area has been developed into a mixed creative industry zone in the city with exhibitions, hotels, retail, restaurants, sports, entertainment, offices, library (Bingshan Wisdom Park 1930, 2020). A 24/7 operational lifestyle centre is formed to ensure the vitality of the project. In short, Bingshan Wisdom Park can never leave the theme of 'ice cold', but is now a 'hot' spot for consumers and entertainment in Dalian.

After the transformation and re-opening of the park, the buildings are mostly covered the surface in a modern style or are shown with huge painted advertisements or lighting boxes (Figure 6.2.1.3-3). In the southeast corner of the park, there is a red brick mill with a strong sense of history (Figure 6.2.1.3-4). It is a foundry mill, which is the oldest of the 46 buildings here and built-in 1959 in the style of a Russian industrial building. Casting is considered the first and most important stage in the manufacture of refrigeration compressors (Zhu and Hong, 2019). The Bingshan Group has a leading position in China in the manufacture of refrigeration equipment, and the equipment and documents archived in the foundry are considered to be the most integrative and comprehensive. This 'historic' building therefore naturally became a pavilion for the culture of the refrigeration industry, called Bingshan Industrial Culture Exhibition Hall; and it is also the first place in China to showcase and educate about the refrigeration industry.

The whole exhibition hall is not large, covering an area of 1,500 m² (layout is shown in Appendix 4). From the outside, the whole building still appears to have the vicissitudes of 1959; only a contemporary structure has been added at the entrance as an emphasising. The new structure of the entrance is a sculpture of a polar bear (Figure 6.2.1.3-5). And the exhibition hall also uses the 'polar bear' as a brand image to reflect the big idea of the refrigeration industry; at the same time, the cartoon polar bear is also used as a theme throughout the exhibition. Entering the building through the polar bear entrance, the industrial atmosphere is brought to the peak by the large display of manufacturing equipment (Figure 6.2.1.3-6). The building is divided into four large functional areas (Figure 6.2.1.3-7,8): manufacturing equipment exhibition area, popularisation of science and experiences, lecture room, and brand theme store and café. Due to the small size of the project, the circulation is linear and single, which has the advantage that it is possible to follow the narrative of the exhibition throughout the whole exhibition without taking too long (Figure 6.2.1.3-9). The tour ends with the exit of a contemporary structure, an outdoor staircase (Figure 6.2.1.3-10), which calls back

to the contemporary entrance. If people have 'a passion for the cold culture', Bingshan Industrial Culture Exhibition Hall is the excellent place.



Figure 6.2.1.3-1 Location of Bingshan Wisdom Park (by author, 2022)



Figure 6.2.1.3-2 Buildings of different periods in the park (by author 2023).

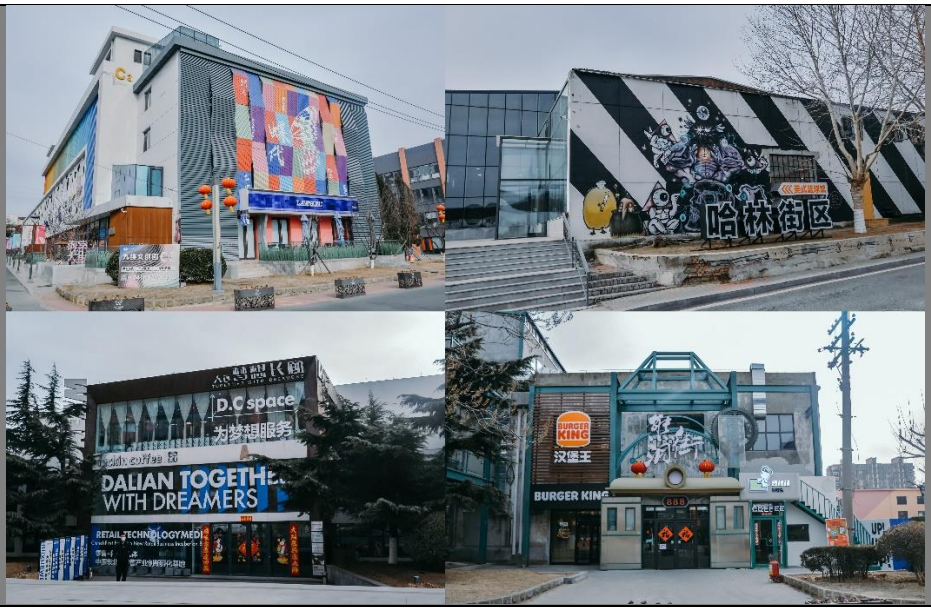


Figure 6.2.1.3-3 Façade decoration of the buildings (by author 2022).



Figure 6.2.1.3-4 Red brick building (by author 2022)



Figure 6.2.1.3-5 Polar bear entrance (by author 2022)



Figure 6.2.1.3-6 Inside the exhibition hall (by author 2022)

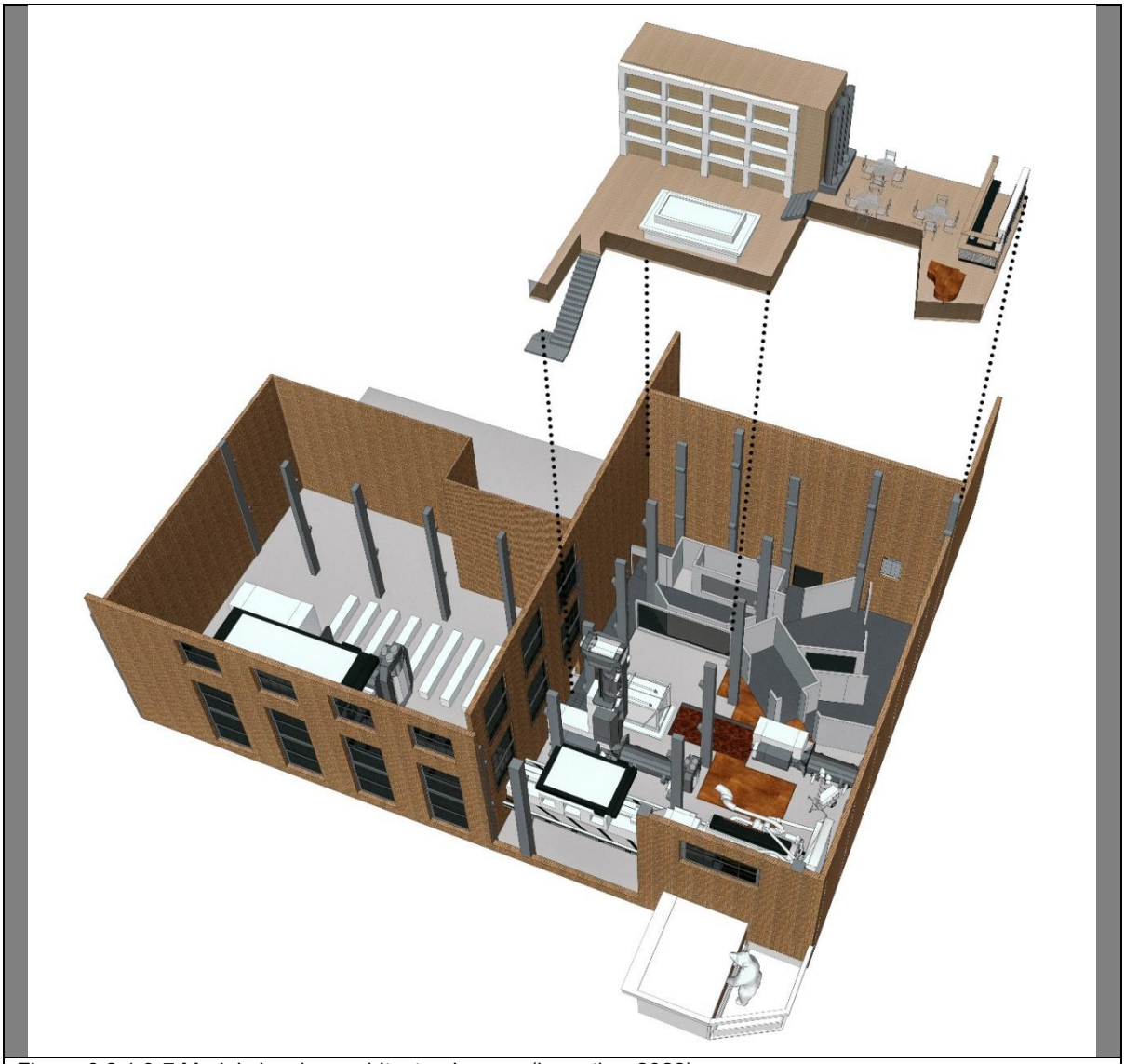


Figure 6.2.1.3-7 Model showing architectural space (by author 2022)

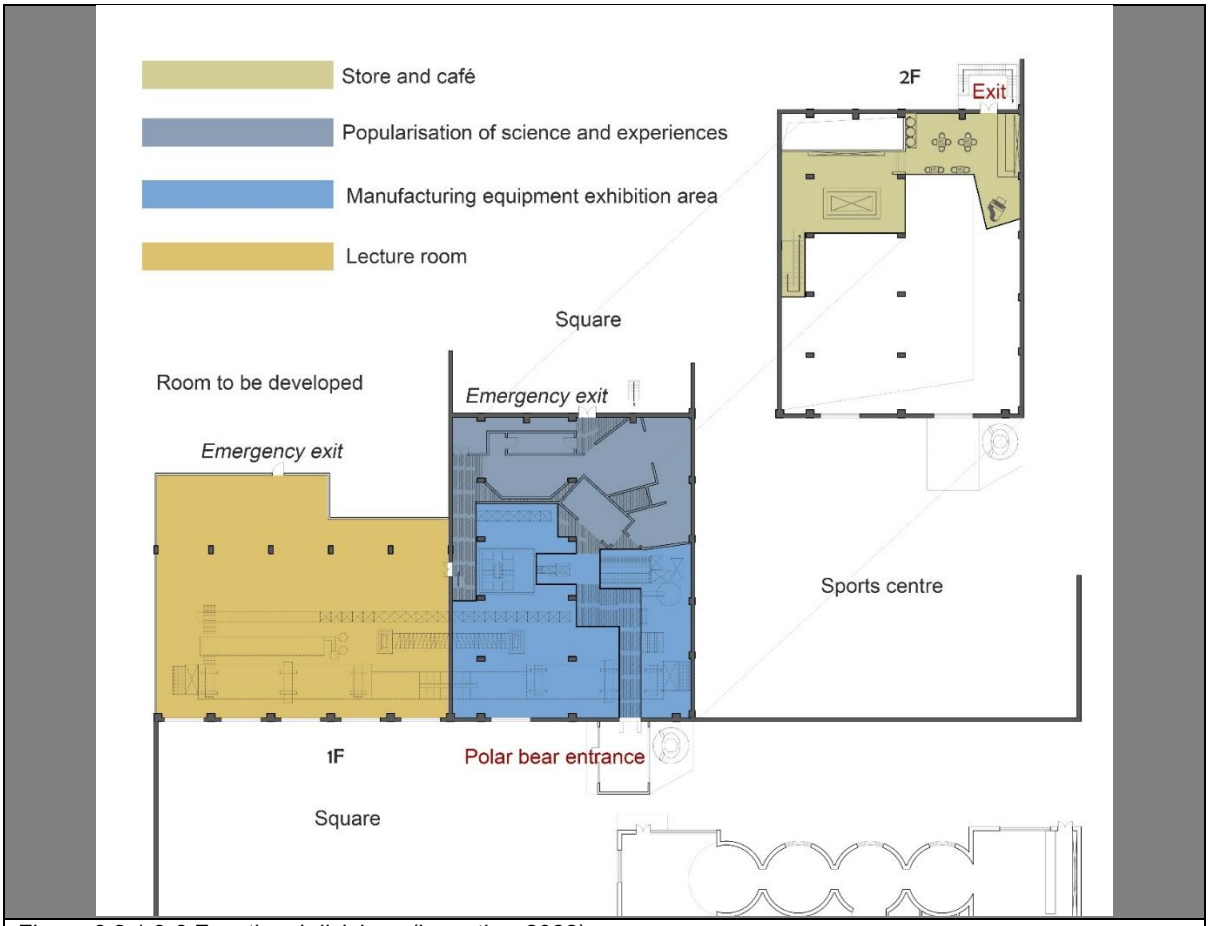


Figure 6.2.1.3-8 Functional divisions (by author 2022)

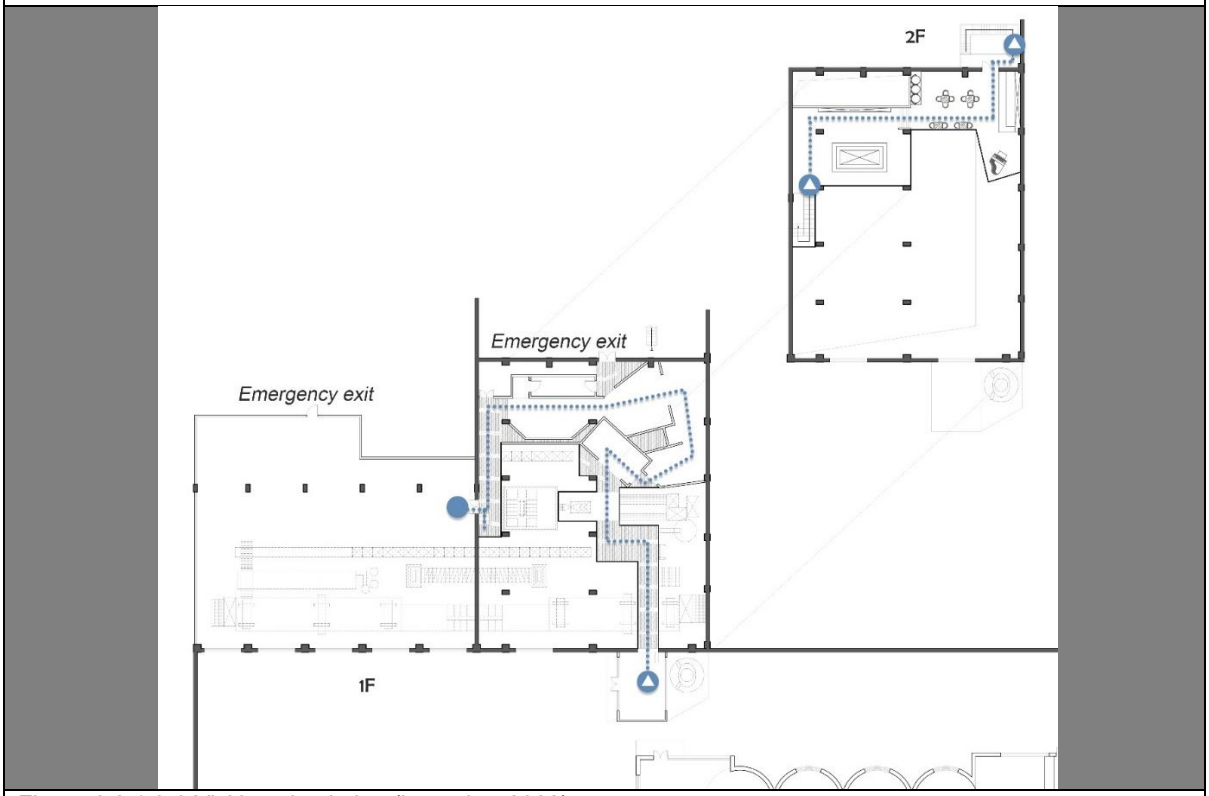


Figure 6.2.1.3-9 Visiting circulation (by author 2022)

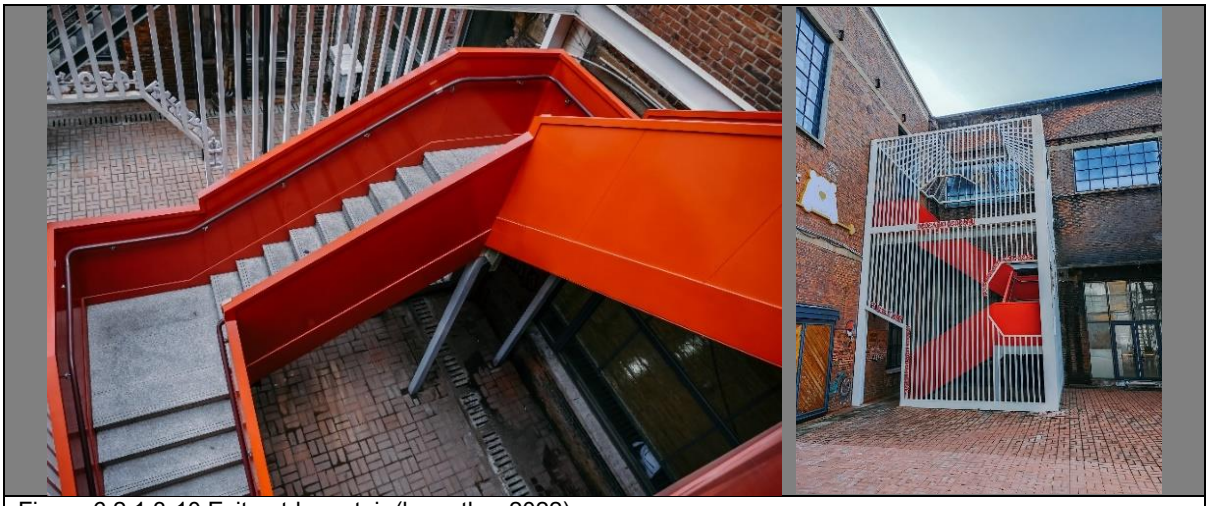


Figure 6.2.1.3-10 Exit outdoor stair (by author 2022)

6.2.2. Study under measuring framework

Sincerely, Bingshan Industrial Culture Exhibition Hall has not yet been fully tested by the participants as a new old industrial reused project for 2021. Whether it will meet the needs of the participants or be popular with the public is not yet known. Because of this, the assessment framework established by the research becomes more meaningful and the measurement of the project will be demonstrated subsequently.

6.2.2.1 Air environment quality

Dalian has four distinct seasons, with highs of 32 °C in summer and lows of -18 °C in winter (Zhao and Yang, 2008; Wu, et al., 2019; Wang, et al., 2019). Unlike the 1933 Old Millfun, the exhibition hall is a direct reuse of a traditional single-floor mill and does not have a lot of complex indoor and outdoor spaces; rather, it is a fully enclosed indoor space (Figure 6.2.1.3-7). This does not mean, however, that this does not need to be considered. A 60-year-old building that is protected from heat and cold is also a great challenge to provide a comfortable air environment for people to experience.

Although the interior of the building is simple, the space where the lecture room is located belongs to another mill and they share a partition wall (Figure 6.2.2.1-1). In terms of the style of the decoration and the equipment, the designer did not unify the two parts of the space during the transformation. Thus, in the following, it will discuss the lecture room and the main exhibition space separately:

- Lecture room:

As shown in Figure 6.2.2.1-2, it is easy to see that the mill has not been overly transformed, but simply cleaned up and used directly. The south side has huge windows which provide a good basis for light and natural ventilation in the lecture room (McCreey and Hill, 2005; de Rubeis, et al., 2018; Mehta, 2020). Besides, it has been measured that no buildings shelter within 60 metres from the south side of the building, except for a short 3-storey building 60 metres away. The lecture room does not have any additional active air conditioning systems. However, in summer the natural air circulation through the windows can be opened to reduce the sense of hotness of the participants inside, while in winter the sunlight can have a good effect on raising the temperature of the interior space.

- Main exhibition space:

  The main exhibition space includes 3 functions: store and café, popularisation of science and experiences, and manufacturing equipment exhibition area. Unlike the lecture room, A does not have large southern windows, and the pedestrian flow of visitors weaves through the exhibition machines. This has little impact on the exhibition space and the café store, which will control the natural light (McGlinchey, 1993; Beltrán, 2003). This area is equipped with a fresh air and cooling system, which is effective from the research's subjective experience. At least in a space full of large production machinery, there is no smell of machinery oil or rusted metal; nor does the smell of meals and coffee being made in the 2F café in the space, preventing them from having a 'feeling of crossing over'. In addition, the space does not have the variety of cooling and fresh air systems installed by the tenants themselves, as in 1933 Old Millfun in all kinds of ways. Here the system has been designed and installed uniformly, and is extremely well integrated visually with the decoration, even if it is difficult to find (Figure 6.2.2.1-3).

  It is worth noting that due to Dalian's location in the north-east of China and the colder winters, the city has an urban central heating system during the winter months (Chen, et al., 2014; Liu, et al., 2020). There are several boiler stations distributed throughout the city to heat the large quantities of water that are piped to each building; at the same time, the return flow of cooling water is heated again. Because of this facility, the air conditioning in the exhibition hall does not require a heating function. The floor heating system controller, which is laying the heat pipes inside the floor, can be found in the corner of the exhibition hall (Figure 6.2.2.1-4) and ensures that the room is kept warm in winter.

Summary of flaws：

It is mainly in the lecture room that, despite the large windows, it is still not possible to control the temperature in summer and winter when the temperature is too high or too low; and to some extent, the large window openings would cause energy loss as well.

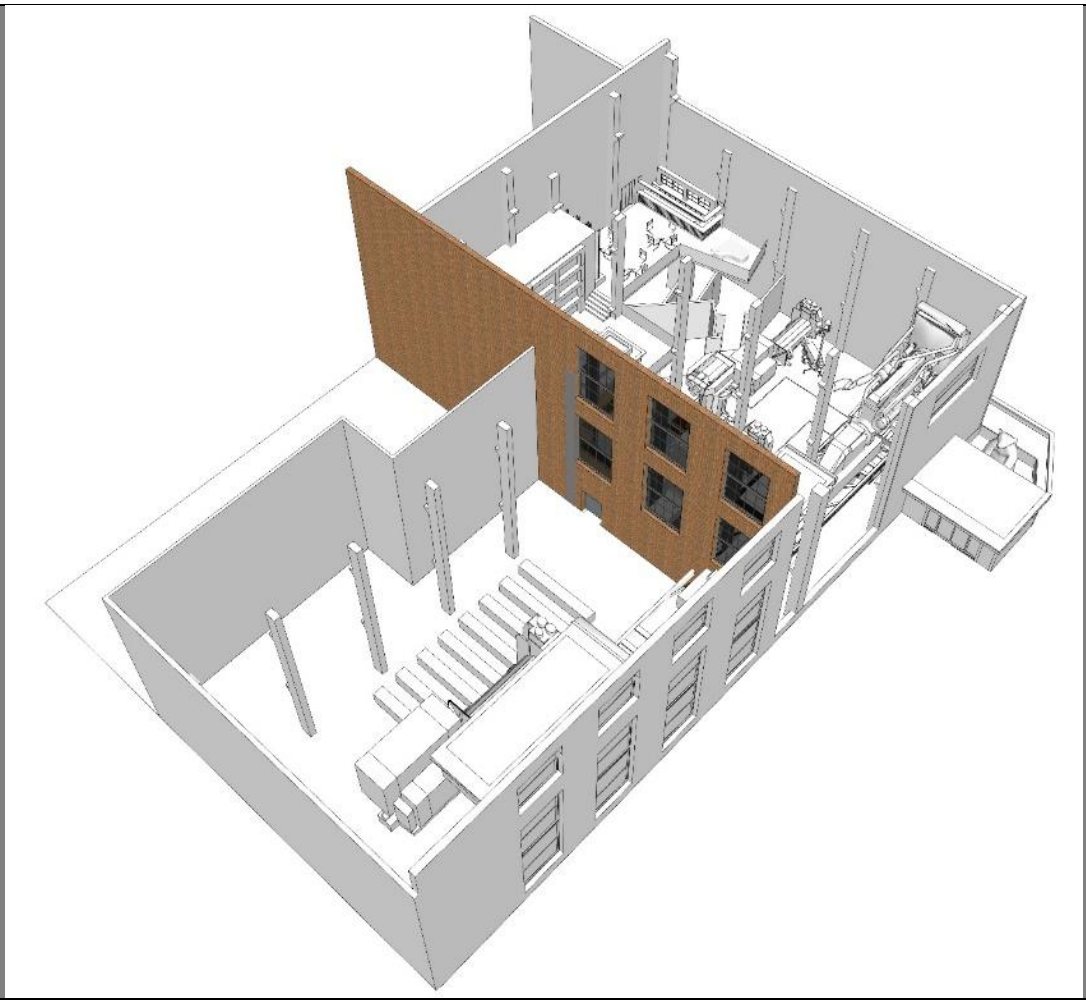


Figure 6.2.2.1-1 The shared partition wall (by author 2022)

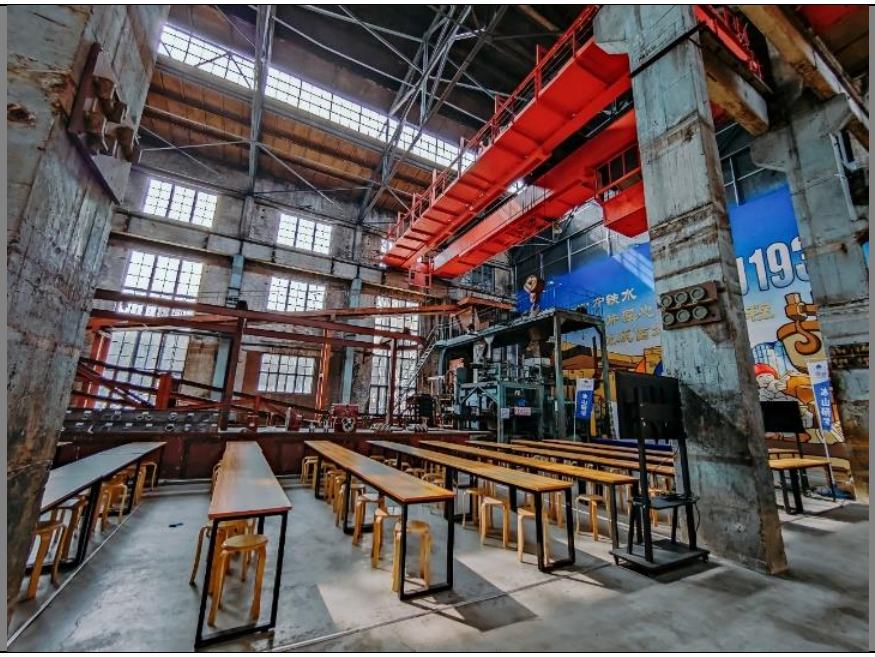


Figure 6.2.2.1-2 The lecture room (by author 2022)

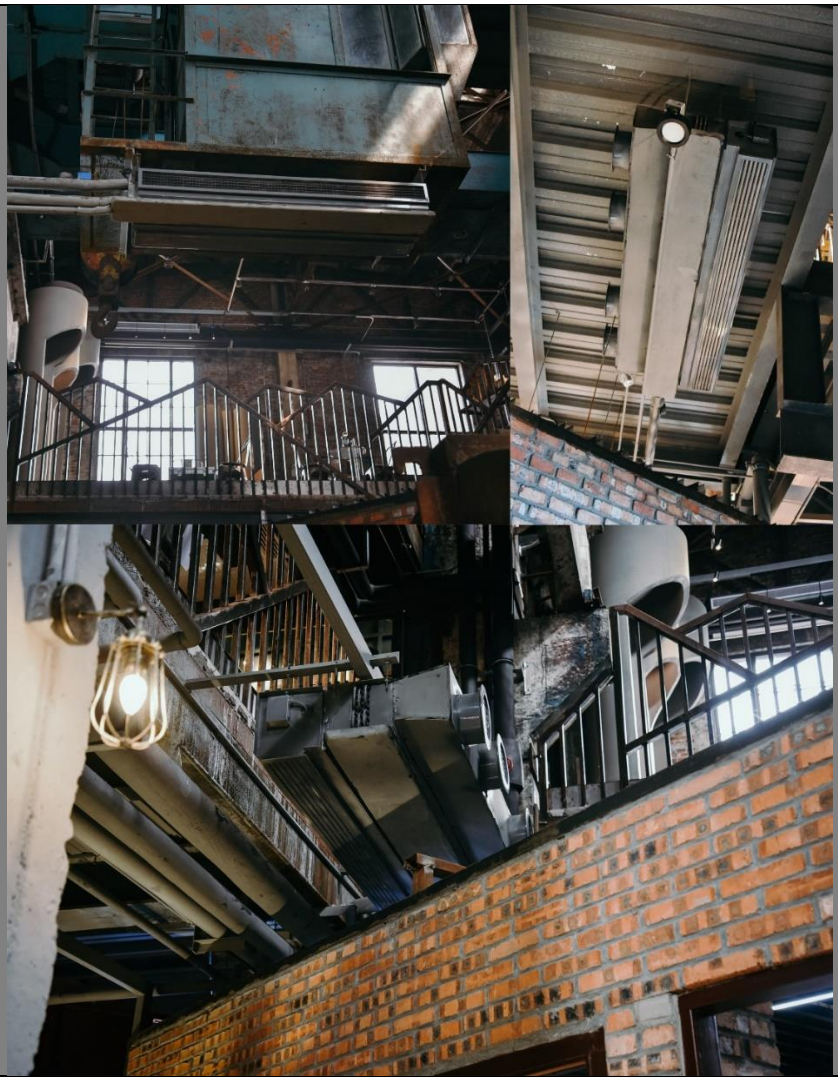


Figure 6.2.2.1-3 Cooling and fresh air systems (by author 2022)



Figure 6.2.2.1-4 The floor heating system controller (by author 2022)

6.2.2.2 Toilet

In terms of the toilets, Bingshan Industrial Culture Exhibition Hall does not give much thought to this issue. The building is not equipped with a toilet. But it cannot be said that visitors are unable to go to the toilet as a public toilet is located 30 metres from the exit of the exhibition hall, serving the whole park, together with the other public toilets.

Summary of flaws：

For a separate public building of 1700 m², it is a sad thing that it is not equipped with a toilet. Not only are there no toilets provided in the building, but there is no signage inside the building to guide participants to the public toilet outside the building. Assume that a visitor needs to use the toilet during his visit. He/she first has to go up the stairs to the store and café on the 2F, as this is the only exit for visitors. From there, he exits the exhibition hall, goes outside and then goes down to the ground via a stair. Finally, it is a 30m walk in the open air to reach the public toilet (Figure 6.2.2.2-1). It is worth noting that this public toilet is in good environmental condition: the large number of toilets (Figure 6.2.2.2-2), and the staffed cleaning (Figure 6.2.2.2-3) ensure a good experience.



Figure 6.2.2.2-1 The public toilet (by author 2022)

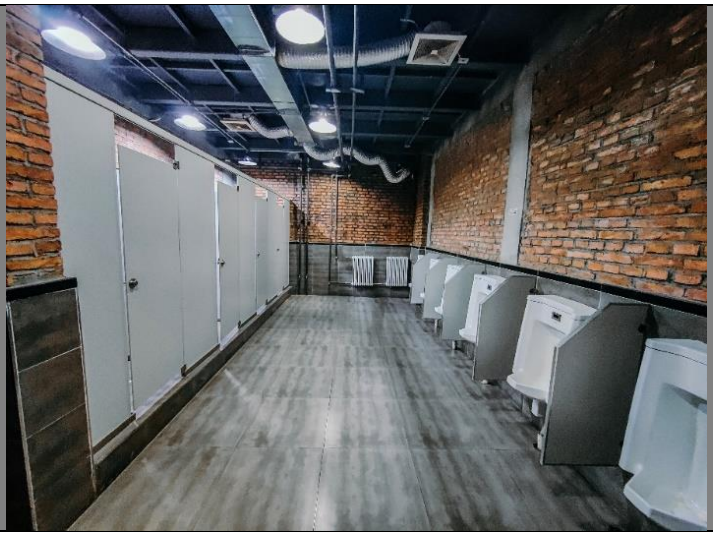


Figure 6.2.2.2-2 Inside the men's toilet (by author 2022)



Figure 6.2.2.2-3 The cleaner duty sheet (by author 2022)

6.2.2.3 Convenience store

In the measurement of this item, the store and café function in the Bingshan Industrial Culture Exhibition Hall cannot be fully equated with that of a convenience store. However, for a building whose main exhibition function is less than 800 m², the café function is able to provide visitors with some basic food and drinks. On the 2F of the exhibition hall, at the end of the visitor circulation line, there is the souvenir store and café. As shown in Figure 6.2.1.3-8 and 6.2.2.3-1, the 2F is connected to the exhibition area space, or rather this 2F is more like an interlayer. It is operated and managed by the same company, Dalian Bingshan Wisdom Park Co., Ltd. The research will measure this item mainly in the aspects of location, range of products, environment, and prices.

- Location:

The exit is right next to the cafe's bar and visitors have to go through the store and cafe to leave the building. In addition, it is possible to access the café on the 2F directly via the outdoor staircase at the exit, without going through the tour route. However, this may require some familiarity with the project, as there is no relevant signage.

- Range of products:
  The souvenir store tends to sell more creative products related to the theme of the exhibition (details in Section 6.2.2.15). Although the range of products is not as varied as the convenience store, it is fortunate that together with a café, it is able to provide visitors with basic food and drinks, such as chilled soft drinks, tea, coffee, cakes, etc.

- Environment:
  As shown in Figure 6.2.2.3-2, the environment of the store and the cafe is ideal, and the overall style is characteristically industrial. The cabinets, the bar, and the seats are arranged in an orderly manner. The products look polished in the bright light, and they will adapt their placement according to their updates (Figure 6.2.2.3-3).

- Prices:
  Apart from the inconvenient comparison of the prices of the cultural and creative products, the food is reasonably priced. The research investigated that a cupcake costs £2.50, a price slightly higher than the Dalian bakery store chains, which is around £2.20. But it is worth pointing out that the added value of the creative ideas here is likely to be more.

Summary of flaws：

Although the location of the store and café is very visitor-friendly, it is not very accessible for those outside the project as there is no signage and participants have to use the outdoor stairs. This can weaken the advertising power of creative products. Furthermore, the food served in the cafe is mainly western-style cakes. Some Chinese people, especially those over 60 years old, are not willing to go for western food like coffee and cakes, therefore, this Western-style food may bring challenge to these group of people.



Figure 6.2.2.3-1 View from the café (by author 2022)

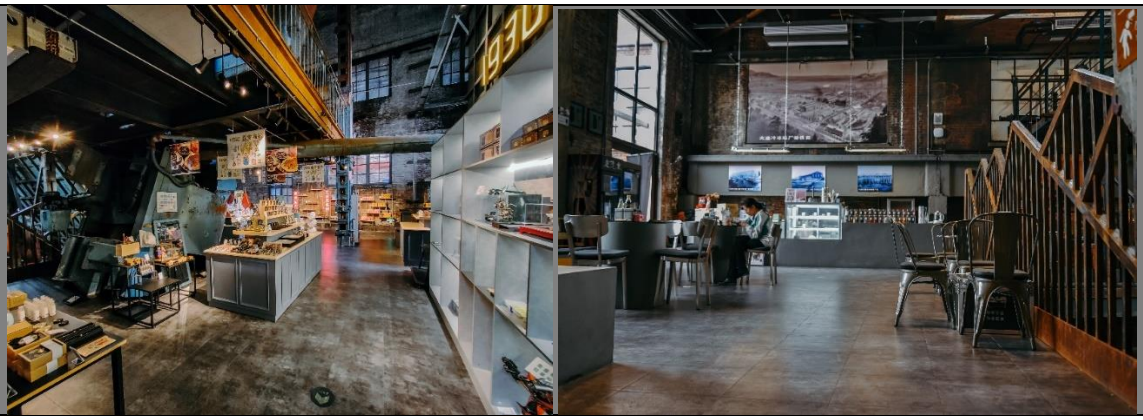


Figure 6.2.2.3-2 The store and café (by author 2022)

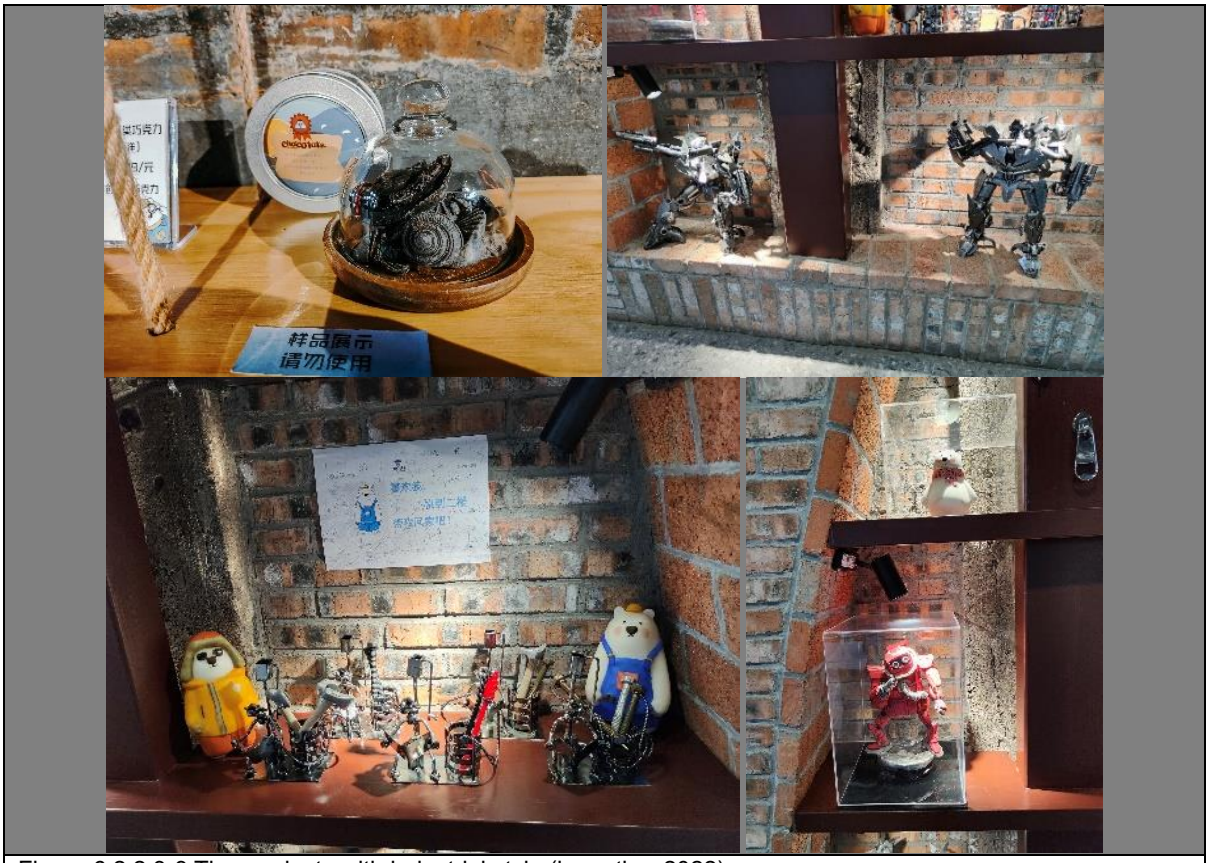


Figure 6.2.2.3-3 The products with industrial style (by author 2022).

6.2.2.4 Security

Unlike the 1933 Old Millfun, the operation and management of Iceberg are to a large degree unified and even rely on the Bingshan Wisdom Park, such as the toilet. And security staffing is one of these. The park is staffed by security guards with uniforms and auxiliary equipment (e.g., radios, police batons, patrol cars) to improve security and efficiency. They patrol the park and guide the traffic (Figure 6.2.2.4-1).

In addition, as a contemporary reused building, it has rich modern technology. The well-placed and well-equipped CCTVs are the basis for the security of the modern Chinese building. Like the HVAC system, the CCTV equipment is extremely well hidden in the decorative space as well. They are painted in a rusty colour, which harmonises not only with the colour of the old brick walls, but also with the old metal facilities (Figure 6.2.2.4-2). As the building does not have a large visitor area, there is no internal security staff, but the project controls the number of visitors and reduces the risk of dangerous accidents to a certain extent. The project uses online booking and QR code scanning to control visitors' access to the exhibition hall. The number of people in the building at any one time can be controlled by two scanning gates at

the entrance and the end of the tour on the 2F (Figure 6.2.2.4-3). This limit on the number of visitors can be modified by the staff on the management system. After research, the current set-up is that the maximum number of people allowed is 50 during peak periods on holidays and 30 on weekdays.

Summary of flaws：

Although there are patrolling security officers in the park, they do not go inside the exhibition hall. Security inside the exhibition halls still relies on technological equipment. When danger occurs, the time it takes for security staff to reach the site is undoubtedly delayed. Furthermore, the project's control of safety emergencies is not good. In the context of China's resistance to the pandemic, the project does not have temperature measurement or mobility surveys like other public buildings. In some ways, this is a lack of safety awareness on the part of the project.

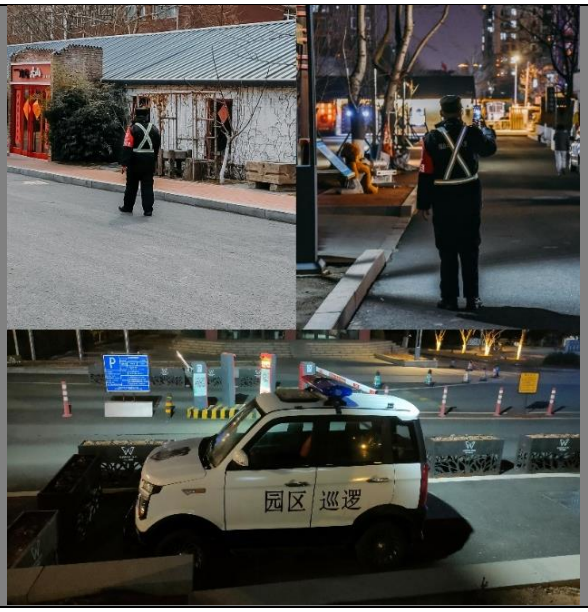


Figure 6.2.2.4-1 Security staff on patrol and the patrol car (by author 2022).

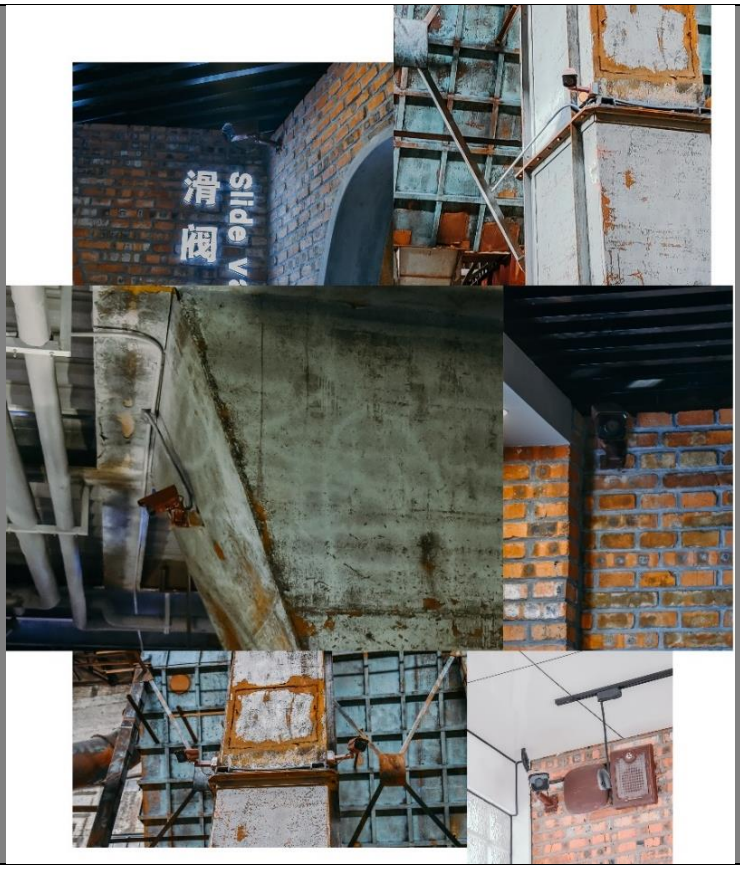


Figure 6.2.2.4-2 CCTV equipment (by author 2022)

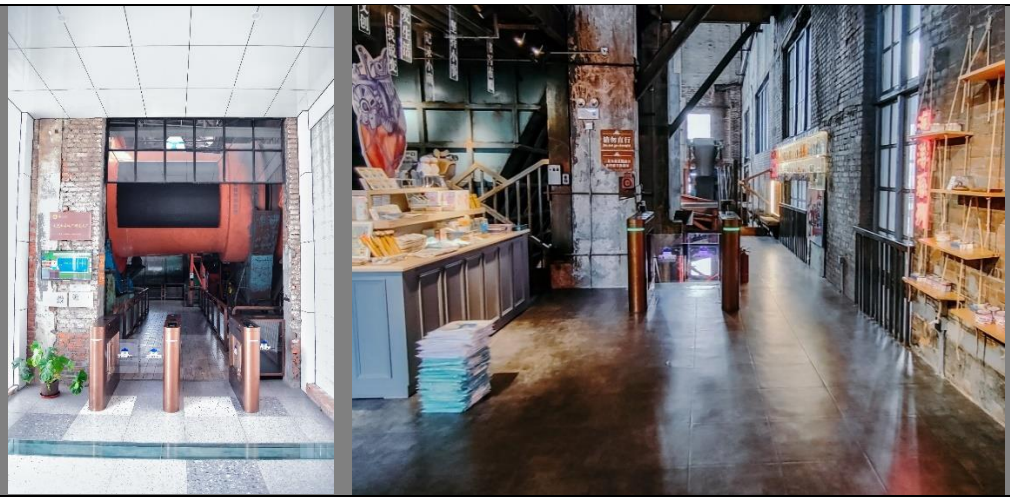


Figure 6.2.2.4-3 The gate at the entrance and 2F (by author 2022)

6.2.2.5 Fire and escape

It is easy to see that the building is made up of brick and steel structures, which combined with the large metal facilities displayed inside, radically reduces the combustibility. The building is very well equipped with fire hydrants and fire extinguishers, which can be found

everywhere in the exhibition area and on the 2F (Figure 6.2.2.5-1). The categories are a combination of fixed hydrants and fire extinguishers (Figure 6.2.2.5-2). In such a relatively small space, the fixed hydrants can ensure the water supply, at the same time, the small extinguishers increase the flexibility of extinguishing the fire.

In terms of evacuation, the 1F of the building has 3 exits, one at the entrance, one on the north side of the lecture room, and one on the north side of the exhibition area (Figure 6.2.2.5-3); the 2F has a directly accessible outdoor exit with an outdoor evacuation staircase and an indoor evacuation staircase to the 1F (Figure 6.2.2.5-4). The data for the outdoor and indoor evacuation staircases are shown in Figure 6.2.2.5-5 and 6. The results showed that they all met the standard for evacuation stairs. In the event of a fire, although the building is divided into two parts by a thick wall as illustrated in Figure 6.2.2.1-1, the internal space of the Bingshan Exhibition Hall will be considered as a whole fire compartment due to the fact that the two parts of the space are separated by a glazing door, not a fire door (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2018). Thus, according to *Code for Fire Protection Design of Buildings (GB50016-2014)*, the area served by the escape exit is 30m in the big indoor space (ibid). As shown in Figure 6.2.2.5-7, the circles with a radius of 30m would cover the whole building, and therefore the building meets the regulations.

Summary of flaws：

The use of wood panels and seating in the lecture room might create a certain fire risk. It is easy to see from Figure 6.2.2.5-1 that the lecture room is not smaller than the exhibition space, but the fire hydrant and extinguishers are much less equipped. Due to the many uncertainties of (such as function, decoration, number of people, etc.) in spaces and the influence of fire-fighting equipment (such as the amount of water supply, equipment type, water pressure, etc.), it is difficult to find the relevant regulations. But, to some extent, the difference in the number of fire-fighting devices from a subjective point of view makes people worry. Furthermore, the interior evacuation staircase, when reaching the 1F, can be seen to make the same mistake as 1933 Old Millfun, neither being able to escape out of the building within 15m (as shown in Figure 6.2.2.5-8, the evacuation distance is more than 25m). According to *Code for Fire Protection Design of Buildings (GB50016-2014)*, if the 15m condition is not met, it is possible to replace the glazing door of the lecture room with a fire door.

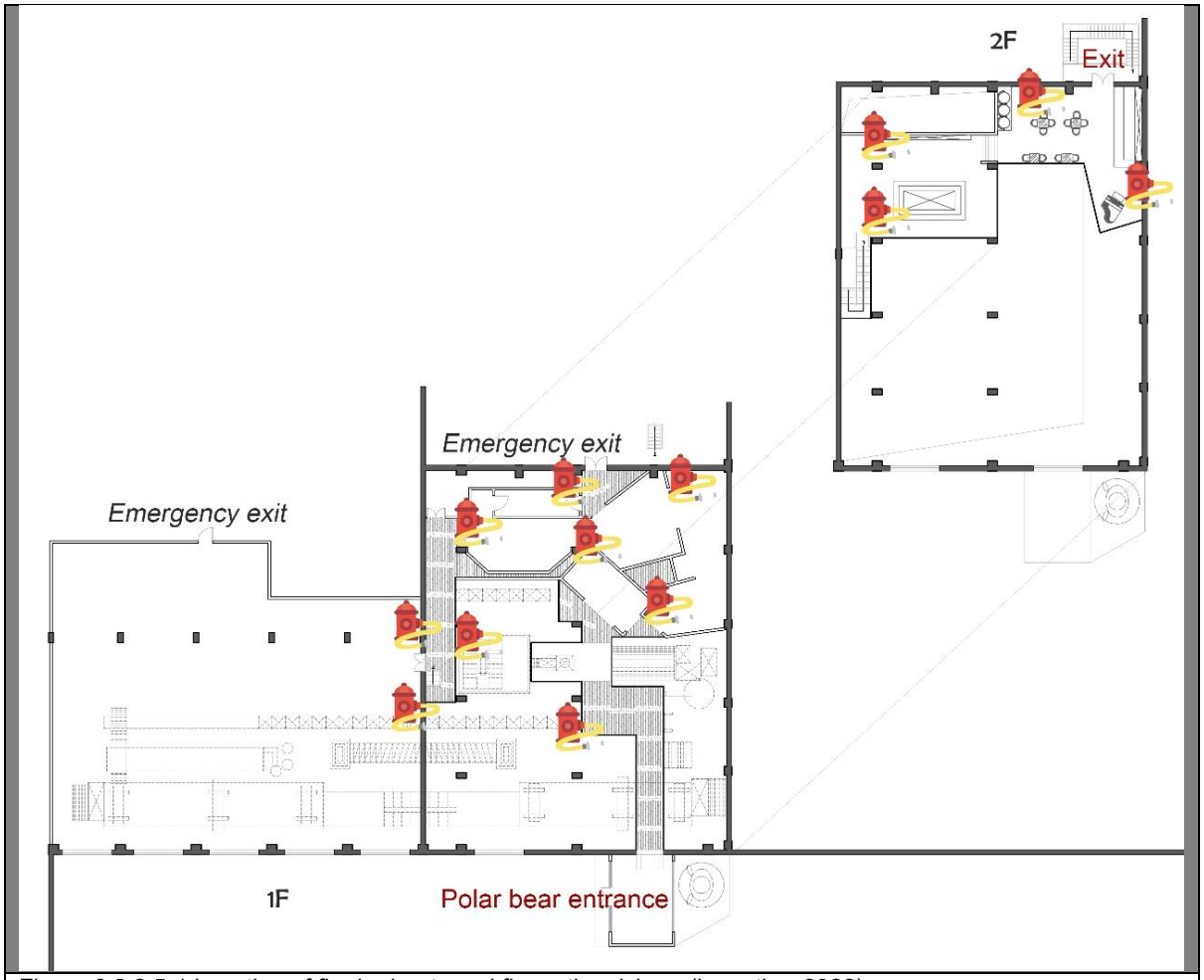


Figure 6.2.2.5-1 Location of fire hydrants and fire extinguishers (by author 2022).

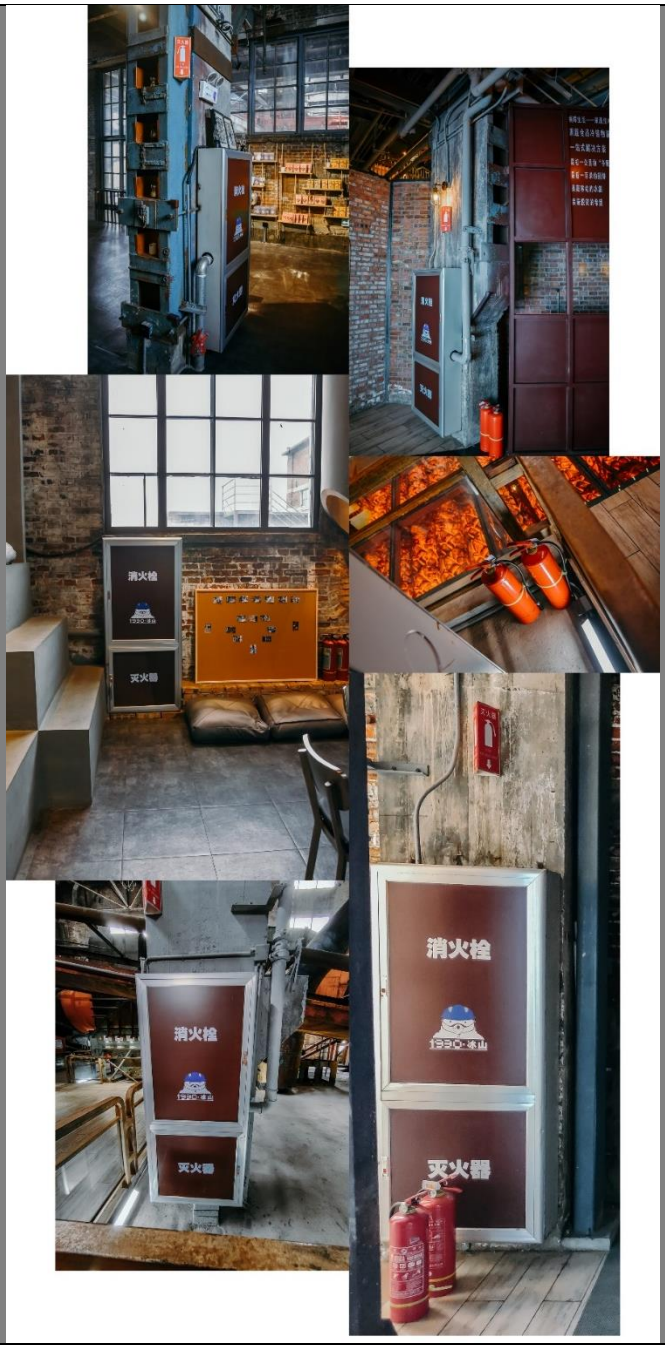


Figure 6.2.2.5-2 Different types of fire-fighting equipment (by author 2022).

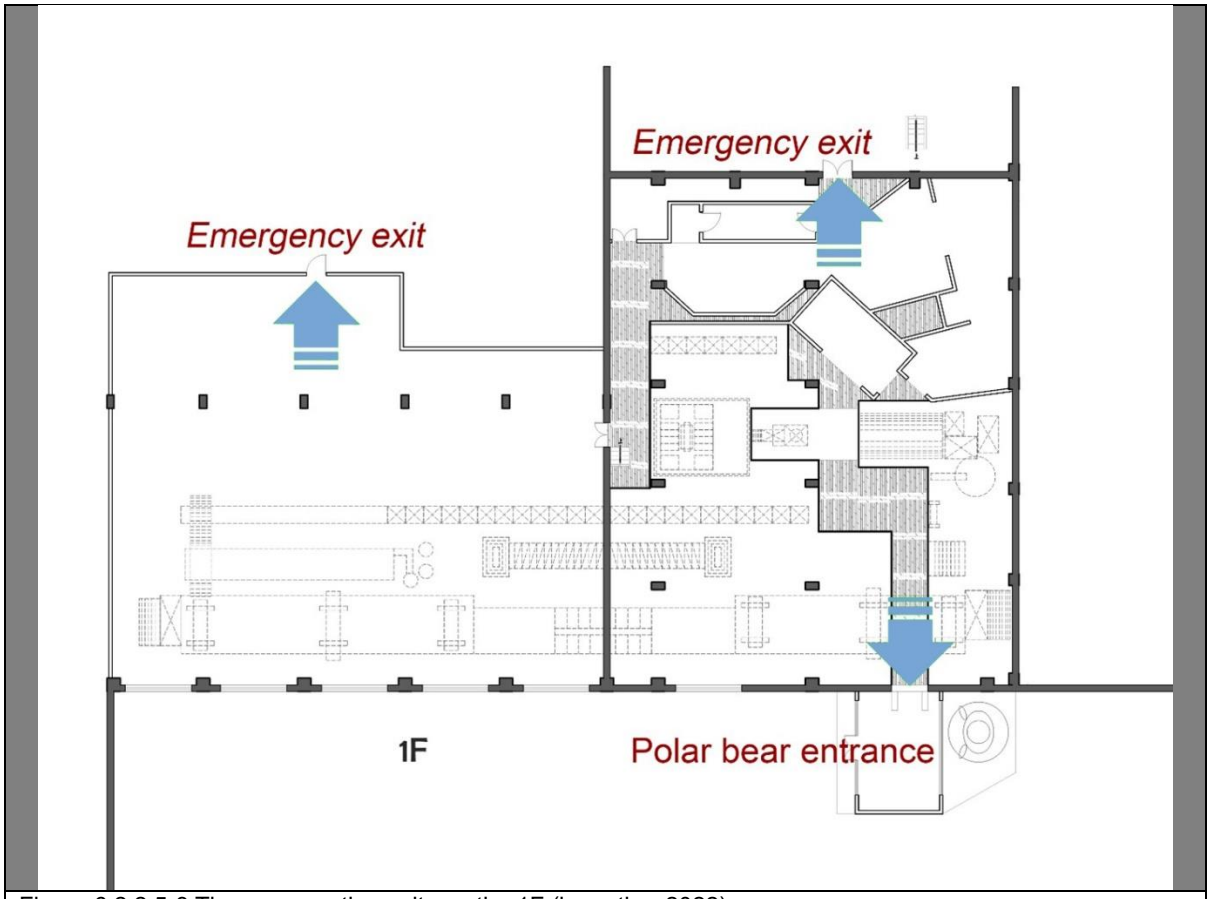


Figure 6.2.2.5-3 Three evacuation exits on the 1F (by author 2022).

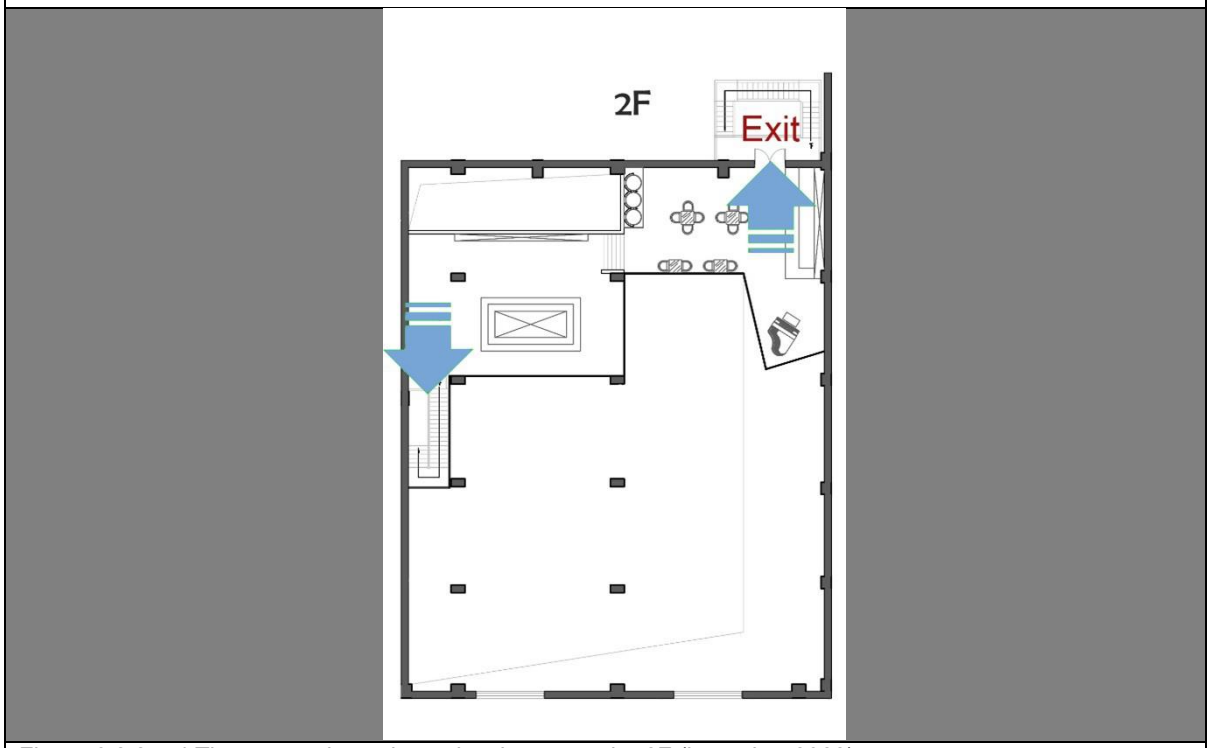
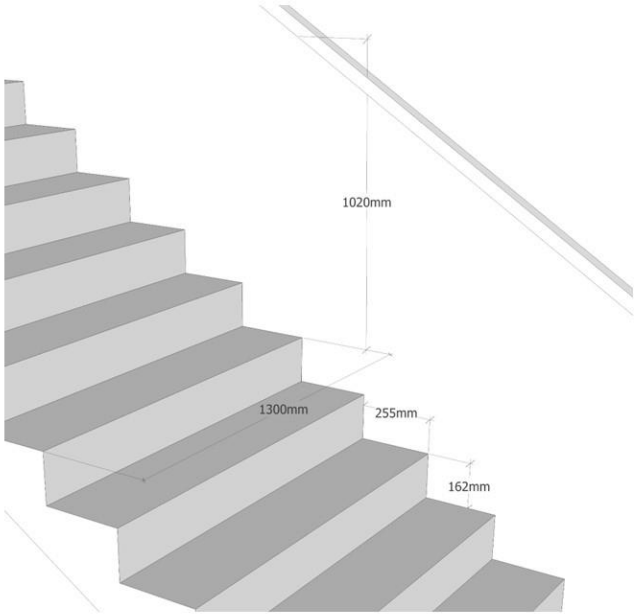
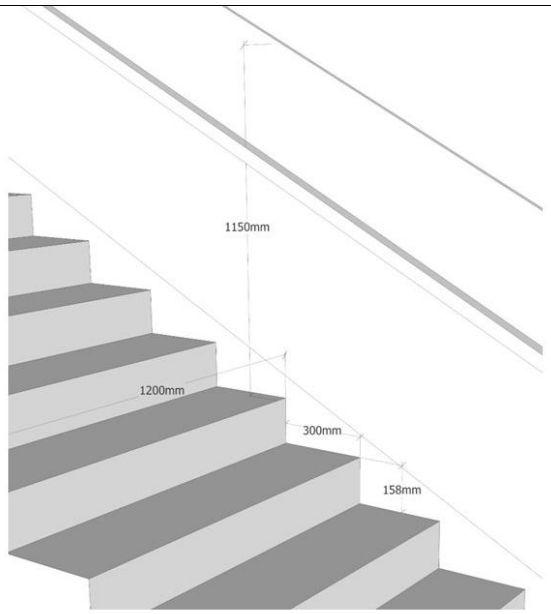


Figure 6.2.2.5-4 The evacuation exits and staircase on the 2F (by author 2022).



Code for Design of Civil Buildings GB 50352-2005 (Evacuation stairs)			
Stair width	Step width	Step height	Handrail height
≥ 1200mm	≥ 250mm	≤ 180mm	≥ 1000mm

Figure 6.2.2.5-5 The indoor stair size (by author 2022).



Code for Design of Civil Buildings GB 50352-2005 (Evacuation stairs)			
Stair width	Step width	Step height	Handrail height
≥ 1200mm	≥ 250mm	≤ 180mm	≥ 1000mm

Figure 6.2.2.5-6 The outdoor stair size (by author 2022)

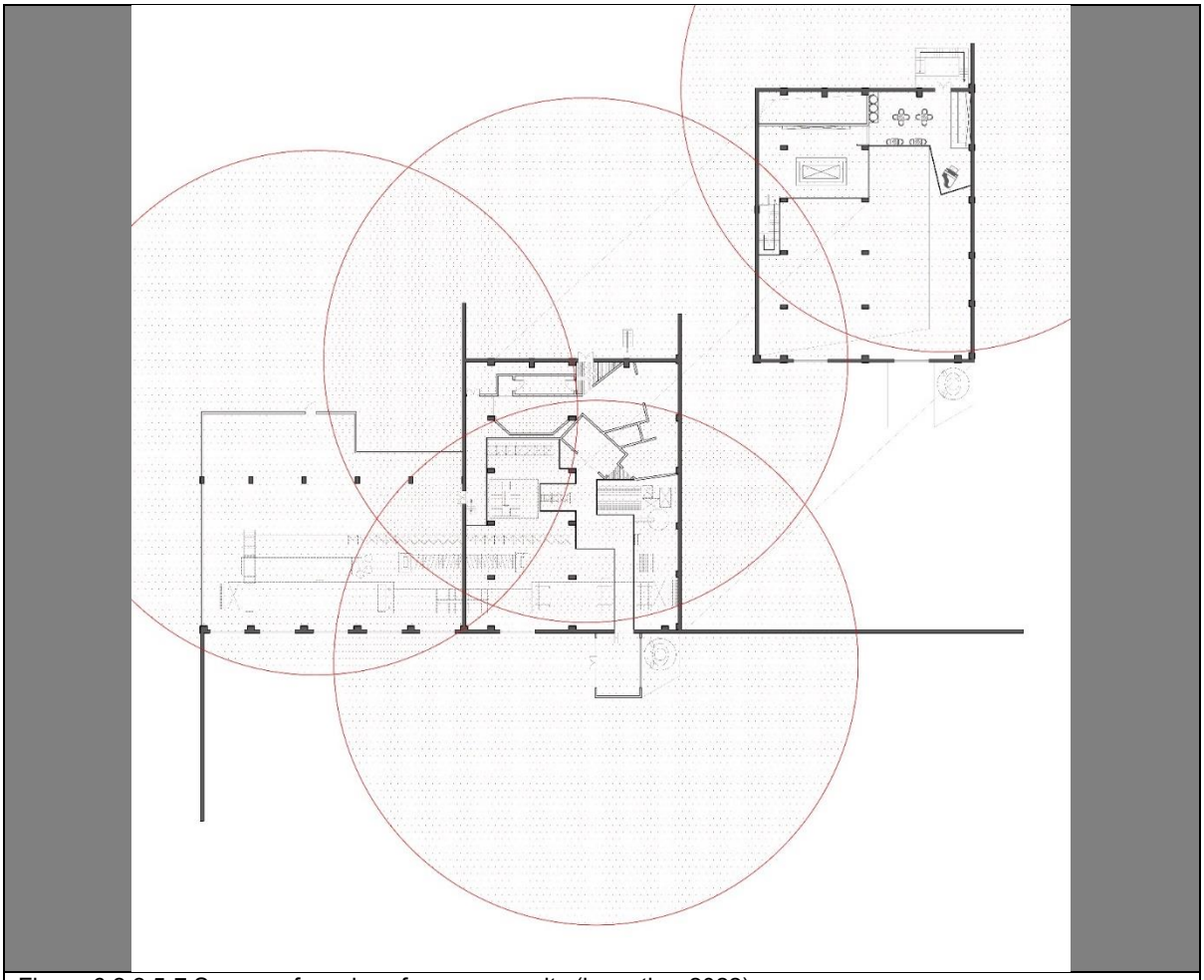


Figure 6.2.2.5-7 Scopes of services for escape exits (by author 2022).

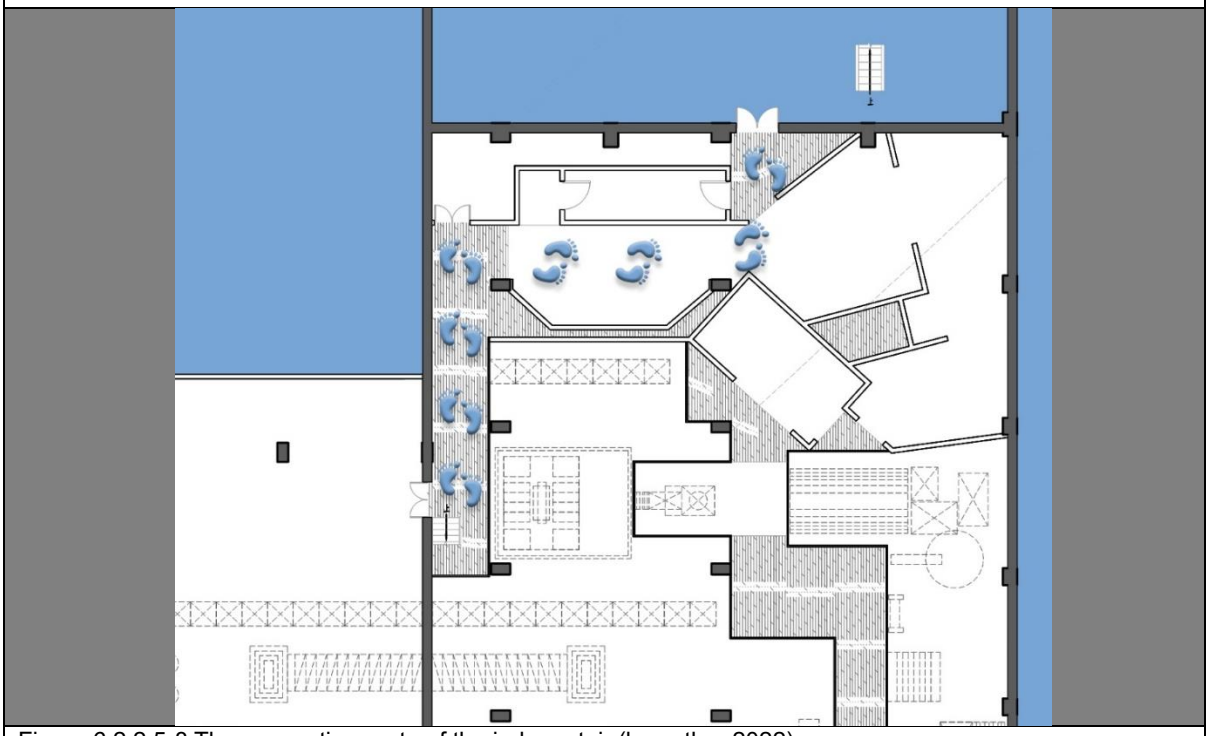


Figure 6.2.2.5-8 The evacuation route of the indoor stair (by author 2022).

6.2.2.6 Building components

During the transformation, the ground has been treated and there are no steps that could pose a hazard. At the same time, the ground surface has been resurfaced and made of non-slip material. Due to the use of the mill, there are some hazards of components; further, the stairs and balustrades will be the focus of the measurement as well.

- Hazards of components:
  Some of the original columns of the building have to support loads (beams, floor, or large equipment) at a low level, and therefore there are protrusions on the columns, which can cause visitors to hit their heads. In order to avoid as much danger as possible, the project's approach is to set up warning signs to remind participants (Figure 6.2.2.6-1). A similar issue can be found at the outdoor stair. The sharp edges of the stair balustrades are wrapped with soft material, which way it reduces the risk of injury from crashes (Figure 6.2.2.6-2).

- Stairs:
  The building has two stairs, which are used as evacuation staircases as well as for the daily use of visitors. Therefore, the size of the stairs should not only meet the evacuation requirements but also the comfort requirements, the measurements of which are shown in Figure 6.2.2.6-3 and 4. Both indoors and outdoors, the stair surfaces have been made non-slip. Indoor staircases are designed to increase friction by means of protrusions on the surface, and with humorous language to remind users to be careful with the steps (Figure 6.2.2.6-5); the outdoor stair is designed with two grooves on the step surface to increase the friction.

- Balustrades:
  The balustrades on the 2F are not as horizontal as they traditionally are, but rather undulating (detailed in Section 6.2.2.15). After measuring, the lowest height of the balustrade is 1.3m, which meets the requirement of 1.05m (Ministry of Housing and Urban-rural Development of the People’s Republic of China, 2019).

Summary of flaws：

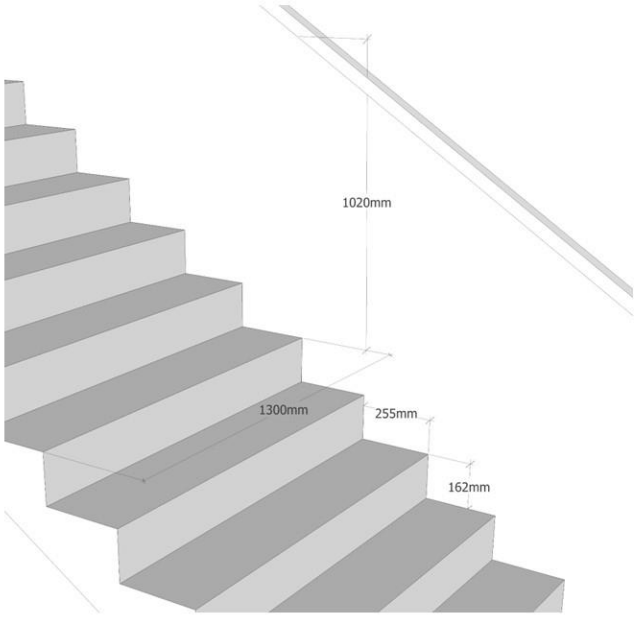
As shown in Figure 6.2.2.6-3, although the indoor stair meets the need for evacuation, it is not comfortable as the main traffic staircase in the exhibition hall. Furthermore, in terms of the hazard of components, there is nothing wrong with having warning signage at hazards, but the risk of injury to users can be fundamentally reduced if soft materials are wrapped around the hazards.



Figure 6.2.2.6-1 The Reminder sign on the column (by author 2022).

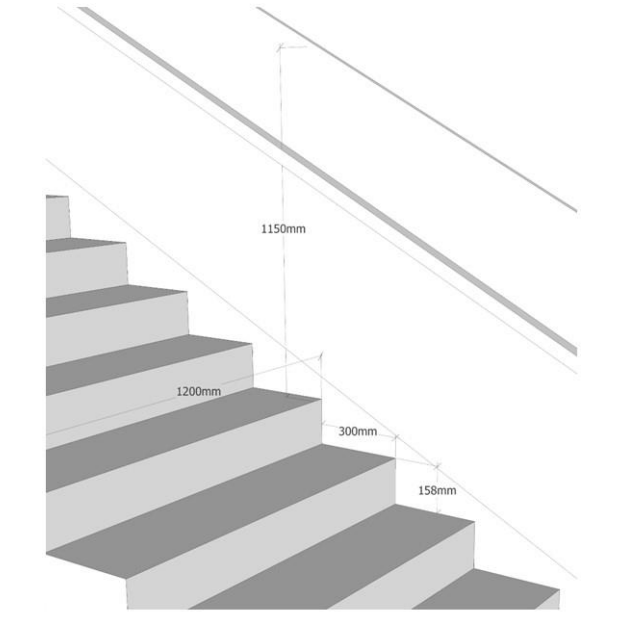


Figure 6.2.2.6-2 Treatment of the sharp edge of balustrade (by author 2022).



Code for Design of Civil Buildings GB 50352-2005 (Stairs in exhibition buildings)			
Stair width	Step width	Step height	Handrail height
≥ 1200mm	≥ 280mm	≤ 160mm	≥ 1000mm

Figure 6.2.2.6-3 The indoor stair size (by author 2022)



Code for Design of Civil Buildings GB 50352-2005 (Stairs in exhibition buildings)			
Stair width	Step width	Step height	Handrail height
≥ 1200mm	≥ 280mm	≤ 160mm	≥ 1000mm

Figure 6.2.2.6-4 The outdoor stair size (by author 2022)

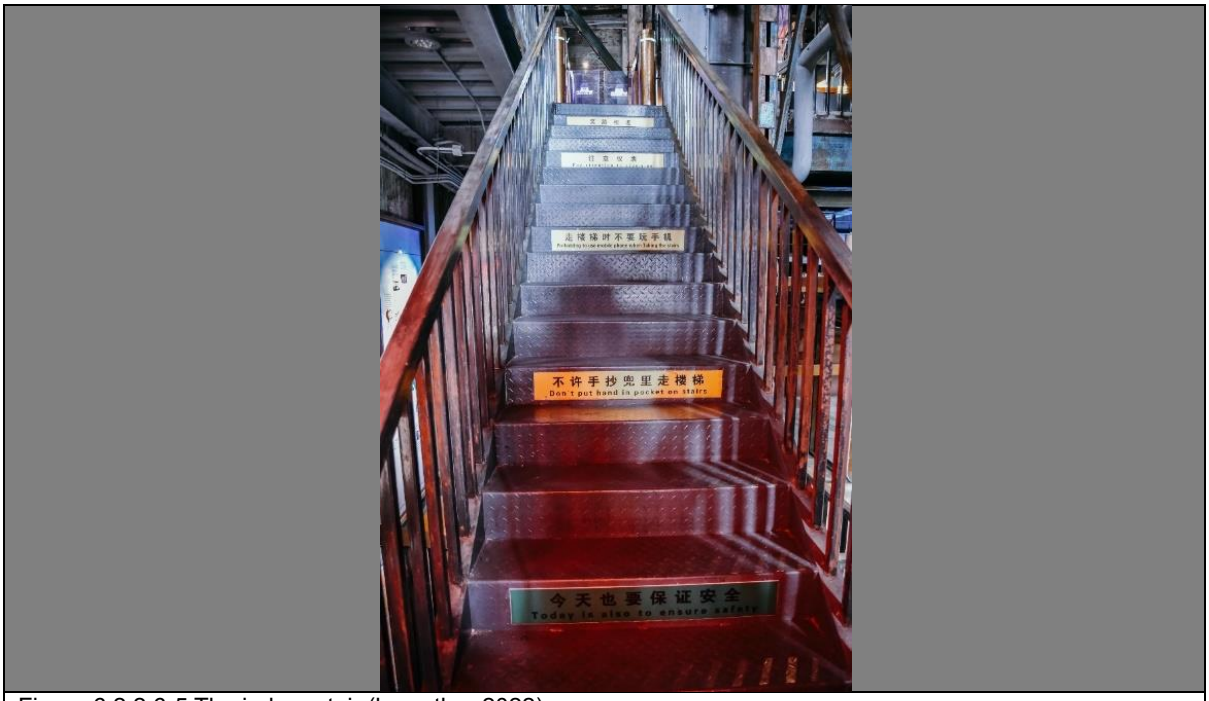


Figure 6.2.2.6-5 The indoor stair (by author 2022)

6.2.2.7 Rest areas

Despite the small size of the project, it does not neglect to provide areas for visitors to rest. Obviously, the café on the 2F is the perfect place to take a break, where you can not only sit and relax with a drink and a simple cake meal, but also go to the souvenir store to pick up and enjoy the creative items at a slow pace. In addition, 'social smoker' is also present in the project (Schane et al., 2009). The smoking area is located on the terrace outside the café exit and provides a place and opportunity for smokers to socialise (Figure 6.2.2.7-1). Coming outside, on the south side of the building (outside the lecture room), there is a square of 2500 m^2 (Figure 6.2.2.7-2). In the shade of the square, there are seats made from tree trunks that provide a resting place (Figure 6.2.2.7-3). The research found that the design of this resting place was not random, and that it was the excellent place to enjoy such industrial buildings of the 1950s (Figure 6.2.2.7-4).

The project also offers a potential resting place which is the lecture room. It is still open when there are no lectures. The desks and seats inside will undoubtedly provide visitors with a place to rest (Figure 6.2.2.7-5). The spacious and bright space also offers the possibility of other activities, with tables and chairs that can be moved around to turn the area into an indoor event space. The spatial flexibility of the lecture room is therefore also illustrated.

Summary of flaws：

The resting area is on the 2F; and the potential resting area (lecture room) on the 1F could be made more comfortable, such as the soft chairs and vending Machines, since the visiting circulation is not allowed to return from the 2F café to the lecture room 1F.

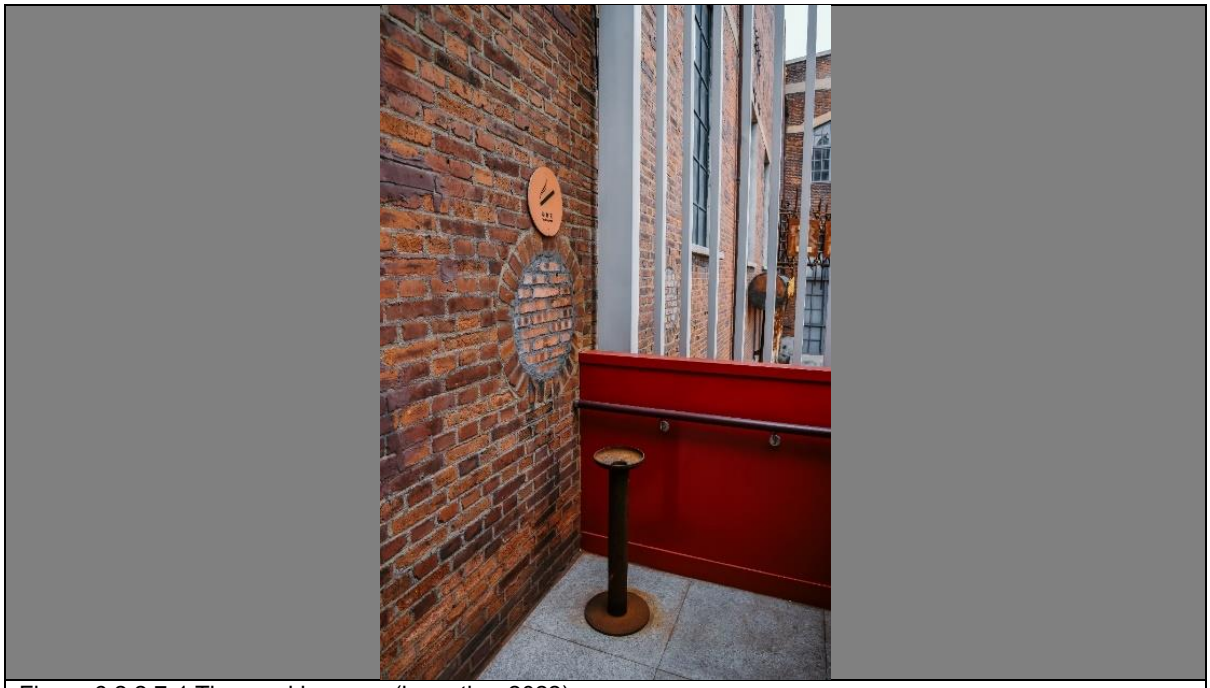


Figure 6.2.2.7-1 The smoking area (by author 2022).

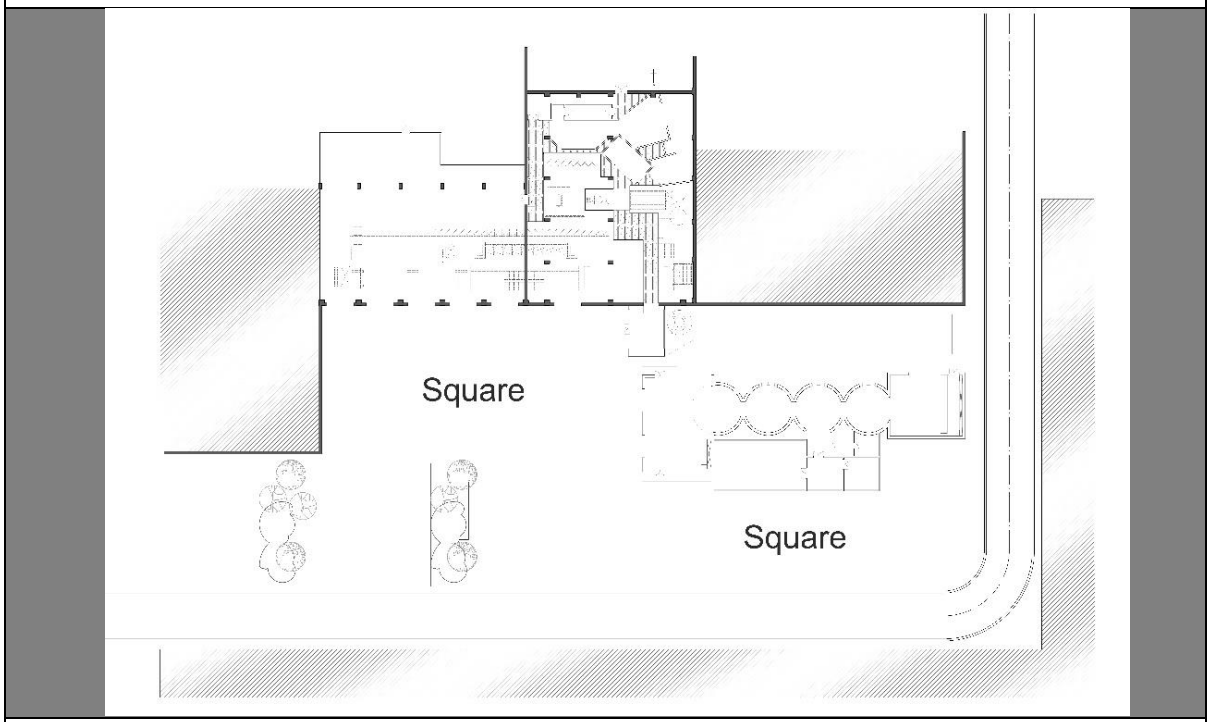


Figure 6.2.2.7-2 The square (by author 2022).



Figure 6.2.2.7-3 The trunk seat (by author 2022).



Figure 6.2.2.7-4 Architectural views (by author 2022).



Figure 6.2.2.7-5 Lecture room (by author 2022).

6.2.2.8 Visitor enquires

The only staff member in the building is a young woman whose job is to sell souvenirs and serve food and drink in the café. In the research's survey, she graduated from Dalian Polytechnic University and her discipline was design. Such an educational background makes

it possible for her to have a positive effect on the sale and explanations of cultural and creative souvenirs. In addition, she can talk to visitors in English, which helps to make the exhibition hall more caring and inclusive for international visitors.

Summary of flaws：

Due to the simplicity and small size of the building, combined with the modern technology entrance and exit gate system, there is no staff in the 1F. It is only on opening days or event days that staff stay in the buildings to introduce the cultural knowledge. This is certainly an inconvenience for first-time visitors who have a need to ask questions. Especially, combined with the fact that, as mentioned in Section 6.2.2.2, there are no toilets, and visitors have to walk a long way to reach the public toilet. It is therefore imaginable that it is not friendly to many visitors.

6.2.2.9 Activity organisation

The project has been developed as an industrial education and learning experience base for primary school students in Dalian. The project organises visits for primary school students to learn and experience industrial heritage (Figure 6.2.2.9-1). In addition to the exhibition space, the lecture room is a theoretical learning area for the students, with desks, chairs, and multimedia equipment arranged. It serves as a base for the popularisation of industrial technology and the enlightenment of future technological innovation. Xu said that in less than six months since the project opened, 35 study activities have been held. At the end of 2022, the project launched an industrial study of the city for people of all backgrounds and ages (Figure 6.2.2.9-2). Besides, as a contemporary project, the smart city concept has been applied to the project. Since its completion, the project has developed social networking platforms such as Tik Tok, Xiaohongshu, and WeChat (the most popular social platforms in China). People can interact with each other using social networks (Bingshan Wisdom Park's official public platform), and they can also get information and knowledge about relevant industrial exhibitions on the internet.

The potential activity takes place in the south square. Especially during the summer months, it is an ideal place for the residents to have activities: there is spontaneous exercise (square dancing, fitness, skateboarding, etc.); also, the restaurants across the street will allow people to have outdoor dining. The square outside the Bingshan Industrial Culture Exhibition Hall is bustling with activity at this time (Figure 6.2.2.9-3).

Summary of flaws：

The downside is that the square is too silent in winter, and could do with something to make it bustle.



Figure 6.2.2.9-1 Primary school children taking part in activities (available from: <https://mp.weixin.qq.com/s/qf_0xBB7j7XJ4Haax2Ef5w>, 22 August 2022).



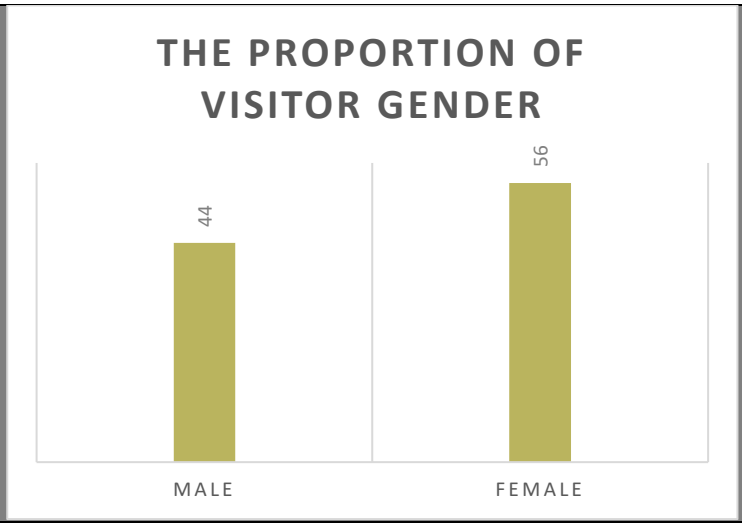
Figure 6.2.2.9-2 Activities for public (Available from: <https://mp.weixin.qq.com/s/CG2LCDIeTVwUMyd5W77CwA>, 22 November 2022).



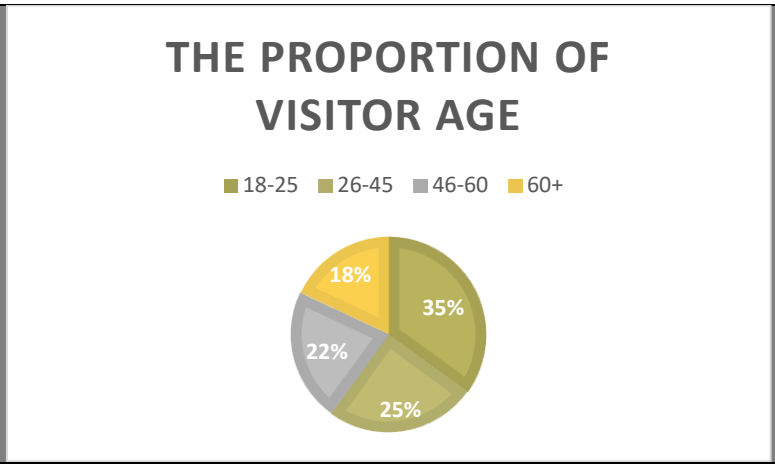
Figure 6.2.2.9-3 The busy square in summer (by author 2022).

6.2.2.10 Diverse participants

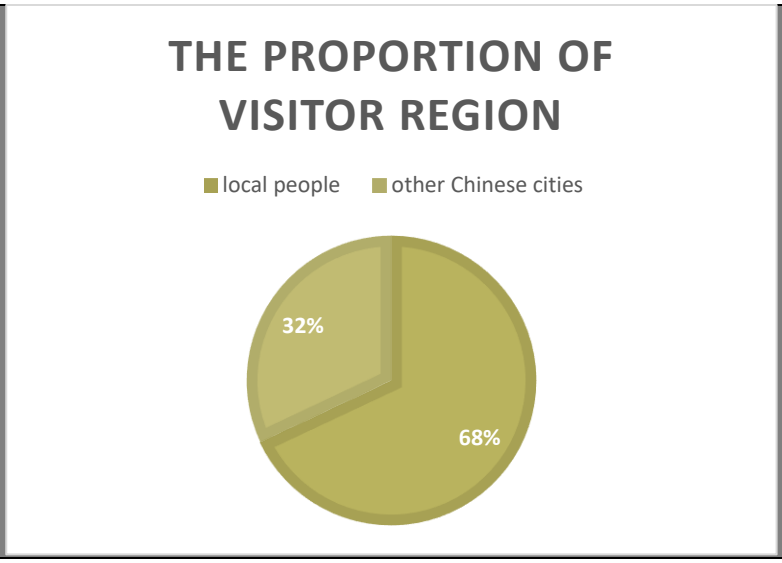
Since the ‘Demographic Data Collection’ of the questionnaire to collect data, of the 100 interviewees, the number of male and female visitors was 44 and 56 respectively, with the number of men and women tending to be equal (Chat 6.2.2.10-1). The interviewees were divided into four age groups and the results are shown in Chart 6.2.2.10-2. Chat 6.2.2.10-3 shows a proportion of local and non-local people in Dalian. During the research's investigation, no foreigners were visiting the site. However, on the open day at the end of 2022, it could be seen through the official website that there were international visitors to the project (Figure 6.2.2.9-2).



Chat 6.2.2.10-1 The proportion of visitor gender (by author 2022).



Chat 6.2.2.10-2 The proportion of visitor ages (by author 2022).



Chat 6.2.2.10-3 The proportion of visitor region (by author 2022).

6.2.2.11 Facilities for special groups

In section 6.2.2.11 in accordance with the '*Codes for Accessibility Design (GB 50763-2012)*' (Ministry of Housing and Urban-rural Development of the People's Republic of China, 2012), the following four aspects: ground transport, accessible toilets, accessible lifts, and information reading, are applicable to the evaluation of the Bingshan project.

- Ground transport:
  The ground surface of all the interior spaces has been redecorated, the ground is flat with no height differences and there are no bumps in the transition between the different floor materials (Figure 6.2.2.11-1). It is very friendly to wheelchair users.

- Information reading:
  The textual content of the project, such as instructions, is well bilingual, in Chinese and English.

Summary of flaws：

- Toilet:
  As described in Section 6.2.2.2, the toilet is not considered in the project, and therefore, an accessible toilet is even impossible to appear in the building. Although there is an accessible toilet in the public toilet, it is outside the building and will not be considered.

- Accessible lifts:
  Although the building is provided with a 2F, it is sad that only two staircases (indoor and outdoor) are connected to the 1F and are not equipped with any lift. As the regular exits are located on the 2F and the gate at the entrance is single identification, it can even be said that none of these special groups of people can leave the building. In general, the building will reject people who are unable to use the stairs.

- Information reading:
  The project does not make special provisions for people with reading difficulties, which is a general problem in many public buildings. There are no assistive devices such as audio guides at reception, and all instructional panels do not contain braille for the blind.

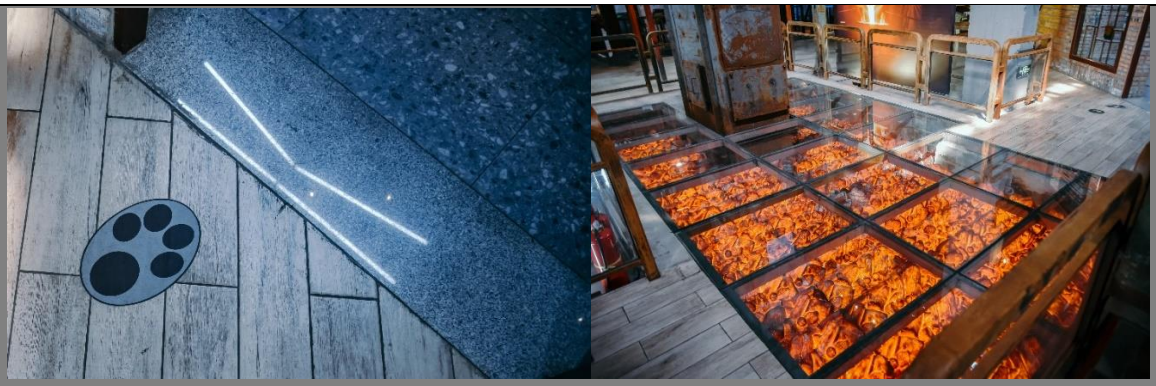


Figure 6.2.2.11-1 Flat joints between different materials on the floor (by author 2022).

6.2.2.12 Map and signage

In comparison with the 1933 Old Millfun, the Bingshan Industrial Culture Exhibition Hall has a small floor area and a simple form of space with a single circulation line for visitors. It can be said that visitors do not easily lose themselves in the building. Even so, the building has a building map at the entrance (Figure 6.2.2.12-1). The map is very detailed, with the location, the various functions of the exhibition, the staircases, and the evacuation exits. The map is drawn in a sketch-style 3D view, but the map is not very legible. Fortunately, the space is in a simple form and only 5 of the 100 participants stopped to look at the map for a while, the rest did not care. Moreover, no one mentioned they were lost in the building.

In terms of signage in the project, the research will describe them in the following 3 aspects:

- Exit signage:
  In addition to the exit points marked on the map, there is signage on the ground, on the walls, and on the top of the emergency exit doors (Figure 6.2.2.12-2).

- Safety signage:
  For dangerous building components, mainly those mentioned in Section 5.4.2.6, such as protrusions on columns and steps of stairs, there are relevant tips and signage.

- Functional signage:
  Mainly in the section about the popularisation of science and experiences, the industrial exhibition areas have been further classified and refined with walls, and each area has a clear theme and description (Figure 6.2.2.12-3).

Summary of flaws：

In terms of functional signage, the lecture room is not reflected on the map and there is no signage at the lecture room's entrance. But the function is obvious when one sees the desks and chairs.

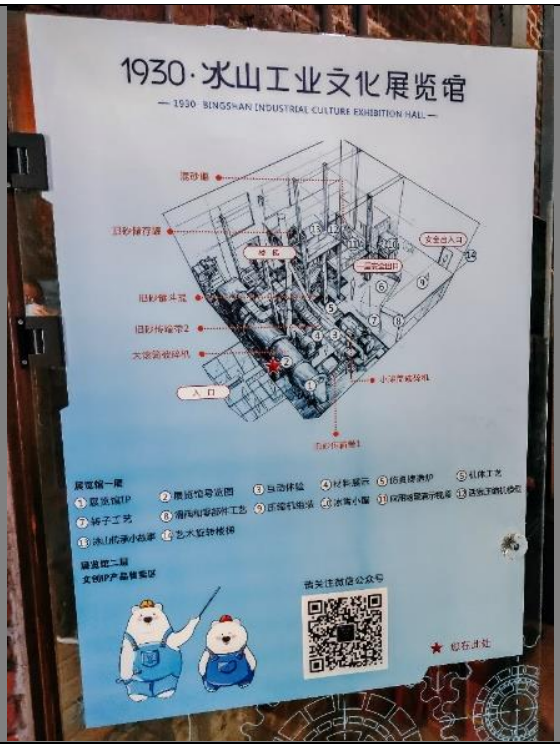


Figure 6.2.2.12-1 The map (by author 2022).



Figure 6.2.2.12-2 Exit signage (by author 2022).



Figure 6.2.2.12-3 Exhibition theme signage (by author 2022).

6.2.2.13 Preservation of historical industrial elements

To some extent, Bingshan Industrial Culture Exhibition Hall's approach to architectural reuse is similar to that of 1933 Old Millfun in the way that it expresses the big idea of a historical and industrial feel. Unlike the 1933 Old Millfun, which preserves the structure of the building but has no facilities inside; Bingshan exhibition hall not only has the building preserved, but also has large facilities inside. The impression one gets when entering the building is that it is just a normal day off from work in a factory in the 1950s and that manufacturing will restart when the holiday is over.

- The building:
  The facade of the building is very recognisable, with old bricks and window ribs that perfectly reflect the 1950s architecture and the vicissitudes of almost 70 years of history. Only contemporary elements have been added at the entrances and exits, this has little impact on the whole project. The walls, columns and roof of the building preserve all the elements of the original building, with the exception of the ground, which has been redecorated.

- Exhibits:
  As the function of the industrial museum, there is no doubt that the facilities and mechanical components here have become the excellent preservation of the material industrial element. The first thing that faces visitors when they enter the exhibition area is the huge casting machine, which fills almost a large part of the room. The rusted metal and peeling paint on the machine tell visitors that this is a manufacturing facility with historical significance. It is the

‘DISA 3030’, imported from Denmark in 1992 (Figure 6.2.1.3-6). There are only two vertical production lines left in the world, this is one of them, and the other one is in Los Angeles, USA. Then there are the various components that are kept in display cabinets (Figure 6.2.2.13-1). They are illuminated by bright spotlights, like superstars on the stage.



Figure 6.2.2.13-1 Exhibits in the cabinets (by author 2022).

6.2.2.14 Transmission of historical culture

As a museum function, these exhibits are, of course, explained in detail and clearly. As an object of measurement, research should hold projects to a higher standard. In a theoretical study of museums, Wang and Lei (2016) pointed out that the most basic experience of visitors in a museum is eyes-on, for example, visitors get information and knowledge about the exhibits through reading and observation. The traditional way of displaying the exhibits is to place description panels next to the exhibits with relevant information clearly written in text for visitors to read. The project has been further upgraded and optimised from the traditional way of displaying the exhibits. Multimedia technology has been applied to the exhibits, with not only textual descriptions but also screens showing animations of industrial culture and knowledge. The animations, with the cartoon polar bear as the main protagonist, express the information in a vivid and easy-to-understand way (Figure 6.2.2.14-1). In addition, in the era of smart cities, the exhibits are equipped with QR codes that can be scanned with WeChat to obtain relevant information, pictures, sounds, and animations, which can be chosen according to the public’s needs (Figure 6.2.2.14-2).

In addition, Wang and Lei (2016) proposed an innovative way of displaying the exhibit that goes beyond the eyes-on, namely ‘Hands-on’, where the project is widely used. Hands-on expresses a form of exhibition that allows participants to experience it with their bodies. In the

project, for example, the helical-lobe compressor display area allows visitors to personally turn the machine to be able to experience the principle of its rotation (Figure 6.2.2.14-3); the ice and snow room, which can show the creation of snowflakes by compressor technology in a room temperature (25 °C) environment (Figure 6.2.2.14-4).

Summary of flaws：

For a project with a museum function, it is logical to focus on the display of exhibits and the transmission of cultural knowledge. However, the mill building is also an important historical building, yet the transmission item has neglected it. A certain amount of description and introduction should be added to introduce such a 1950s historical building.



Figure 6.2.2.14-1 Screens showing animations (by author 2022).

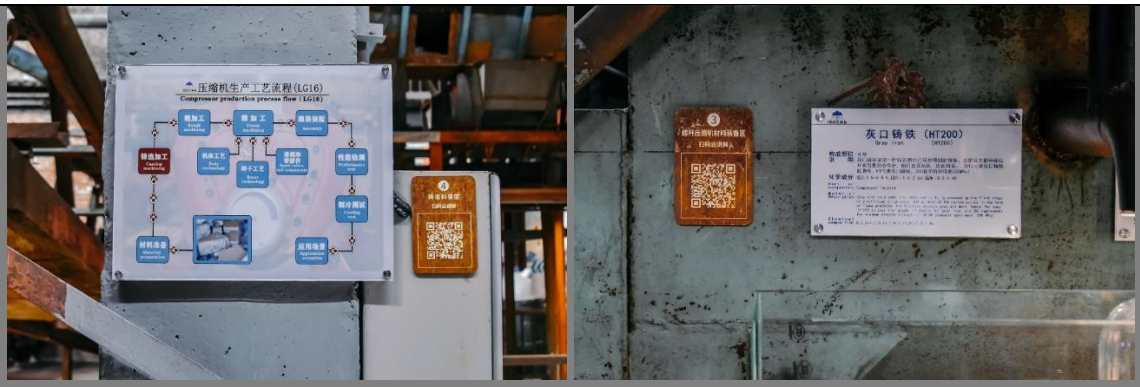


Figure 6.2.2.14-2 QR code (by author 2022).



Figure 6.2.2.14-3 Hands-on experience (by author 2022).



Figure 6.2.2.14-4 Ice and snow room (available from: <https://mp.weixin.qq.com/s/qf_0xBB7j7XJ4Haax2Ef5w>, 22 August 2022).

6.2.2.15 Integration of ‘old and new’

The building was transformed from a traditional manufacturing mill, there is an industrial feel to both the exterior and the interior. The building, therefore, expresses a big idea of the historical industrial style. Visually, this is not only due to the well-preserved architecture and large facilities, but also to the fact that the new supplementary elements added in the transformation integrate well with the overall architectural style. For example, the lecture room, although cut off from the exhibition area by a wall, it still has a strong industrial feel to its visual style. This is thanks to the high space and the preservation of the manufacturing facilities (Figure 6.2.2.15-1). Unlike the traditional lecture room approach, the project is not a dark

multimedia room, it responds to the exhibition space and industrial style, making them more integrated. There is also equipment that hides itself well by its placement or colour, without breaking the whole industrial-style environment, such as air conditioning, CCTV, antique bronze instructional signage, etc. There are also ways of making new architectural elements old or 'industrial', such as the balustrades in the café 2F, which look like an undulating balustrade but actually simulates the feeling of an iceberg (Figure 6.2.2.15-2); and the seats in the café, which simulates the element of the tanks or cylinders (Figure 6.2.2.15-3). All of this highlights the celebration of the old industry in the reuse.

In addition to these visual fusions, historical industrial culture blossoms in the store and café on the 2F as well. In the 2F, the products sold are mostly related to the Bingshan industrial theme. A variety of items in the style of gears and industrial components, and some derivatives of the polar bear mascot become the main popular souvenirs here (Figure 6.2.2.15-4). The cold drinks sold in the café are a 50-year-old beverage brand in China, which symbolises the deep collaboration between cold drinks and refrigeration equipment (Figure 6.2.2.15-5). The most interesting things are the cakes and desserts, which are made in the shape of various industrial components or tools (Figure 6.2.2.15-6). During the survey, there were even some visitors who bought the cakes and did not want to eat them. This shows, in another way, that the creative idea of the cake was successful.

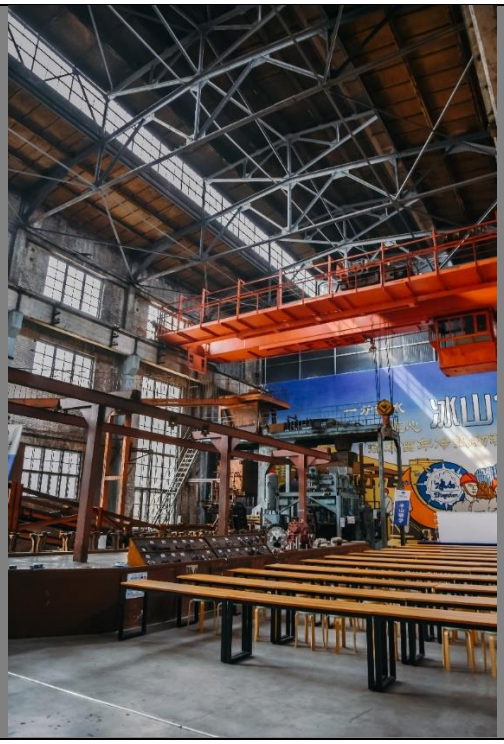


Figure 6.2.2.15-1 The facility and the crane in the lecture room (by author 2022).



Figure 6.2.2.15-2 The iceberg form balustrade (by author 2022).



Figure 6.2.2.15-3 The seating area (by author 2022).



Figure 6.2.2.15-4 Cultural and creative products (by author 2022).



Figure 6.2.2.15-5 The drinks (by author 2022).



Figure 6.2.2.14-6 Creative desserts (by author 2022).

6.2.2.16 Attractiveness

Due to the limitations of the building's function, Bingshan Industrial Culture Exhibition Hall does not take advantage of the visual impact of the novelty of the architectural space in the way that the 1933 Old Millfun does. However, the advantage of the project is that it does not 'stand-alone'. Its attractiveness and competitiveness can rely on Bingshan Wisdom Park. The park will be developed into one of the city's future lifestyle centres. For the moment, the park has a large base of visitors with its good location and parking environment, and it has been able to sustain the vitality of functions such as entertainment and food street, the gymnasium, the library, etc. A large number of visitors to the park becomes the customer base for the exhibition hall. All of these visitors who are interested in industrial culture will be potential participants in the project. In addition, the project will be able to be well-advertised as an industrial science base for the city.

During the tracking study, 96% of the visitors would stay on the 2F (store and cafe). Unexpectedly, it was found that a large number of visitors did not visit the museum, but went directly to the store and cafe via the outdoor staircase. As there is no signage outside to direct people to this area, the research believes that most of them should have been here before.

Summary of flaws：

Perhaps it is too niche, perhaps the project is in the development stage. The exhibition itself was not very attractive, with 25% of the questionnaire respondents being interested in the project and only 18% of people coming specifically for the purpose. Although it is clear that

these polar bear cartoons and the hands-on experience can enhance the appeal of an exhibition hall, it is still a challenging subject that requires in-depth research.

6.3. Summary

Chapter 5 and 6 bring the theoretical research (Chapter 4) into the analysis of the case studies. The research has set up relevant research methods for the two cases' practical situations, and combined them with a theoretical measuring framework. With the help of survey methods, the case survey was researched to obtain a large amount of valid measurement data, which was presented in 16 items of description. The data for both cases were obtained within the same framework, allowing a clear view of the strengths and weaknesses of the same item and the differences in the focus of each case. Within the data obtained, the research has separated the strengths and weaknesses of the measurement results for each item. The aim is to be better able to assign numerical values to individual items in the next chapter of the analysis, to transform and innovate the study from qualitative to quantitative, in order to evaluate the case studies.

Chapter 7

Data analysis:

Fuzzy comprehensive evaluation method

7.1. Introduction

The case surveys in the previous chapter were based on two projects in China and a large amount of research data was obtained. There are good and bad assessments of each case in terms of the different items of the satisfaction of the public's needs. Although the study has analysed the strengths and weaknesses in terms of the multiple influencing factors of the case, a comprehensive judgement of the case studies is still necessary. This chapter will therefore combine a mathematical statistical method: fuzzy comprehensive evaluation method, integrating the judgments of several sub-items from the previous chapter and resulting in an all-round comprehensive evaluation of the case. This is an innovative exercise in interdisciplinarity, combining the humanities with the fuzzy comprehensive evaluation method of mathematics in the hope of transforming a qualitative problem into a quantitative one. The final part of this chapter will compare the strengths and weaknesses of the two cases within the Chinese context and provide a series of preliminary guidelines that can inspire future related design projects. Combined with Chapter 5 and 6, Chapter 7 will demonstrate the evaluation process, and complete the objective, *How does research evaluate the case studies?* (Figure 7.1-1).

The basic principle of the fuzzy comprehensive evaluation method is to break down an evaluation problem into multiple sub-items; after that, to score each sub-item; and finally, to calculate the result of the original evaluation problem based on the combined weight of each sub-item. The evaluation process can ignore some factors and errors that have a small impact on the overall comprehensive evaluation. This is necessary for the study of the humanities science. The fuzzy comprehensive evaluation method provides an evaluation of completed adaptive reuse projects and identifies challenges for further development, but can also inform and provide guidance for architects in the design and assessment of future projects.

The application of this mathematical approach to architecture was at an experimental stage during the researcher's doctoral studies. After establishing the assessment framework at the end of the research, the study demonstrates the feasibility of its application by interrogating the cases. In 2022, the researcher published the application of fuzzy set in the following journals, which are indexed within Scopus, SCIE, Inspec, etc.:

Zheng, X.; Heath, T.; Guo, S. (2022) From Maslow to Architectural Spaces: The Assessment of Reusing Old Industrial Buildings. *Buildings*, 12, 2033.

Guo, S., Zheng, X., & Heath, T. (2022). Research on the Design of Community Museums Based on the Fuzzy Comprehensive Evaluation Method. *Sustainability*, 14(17), 10802.

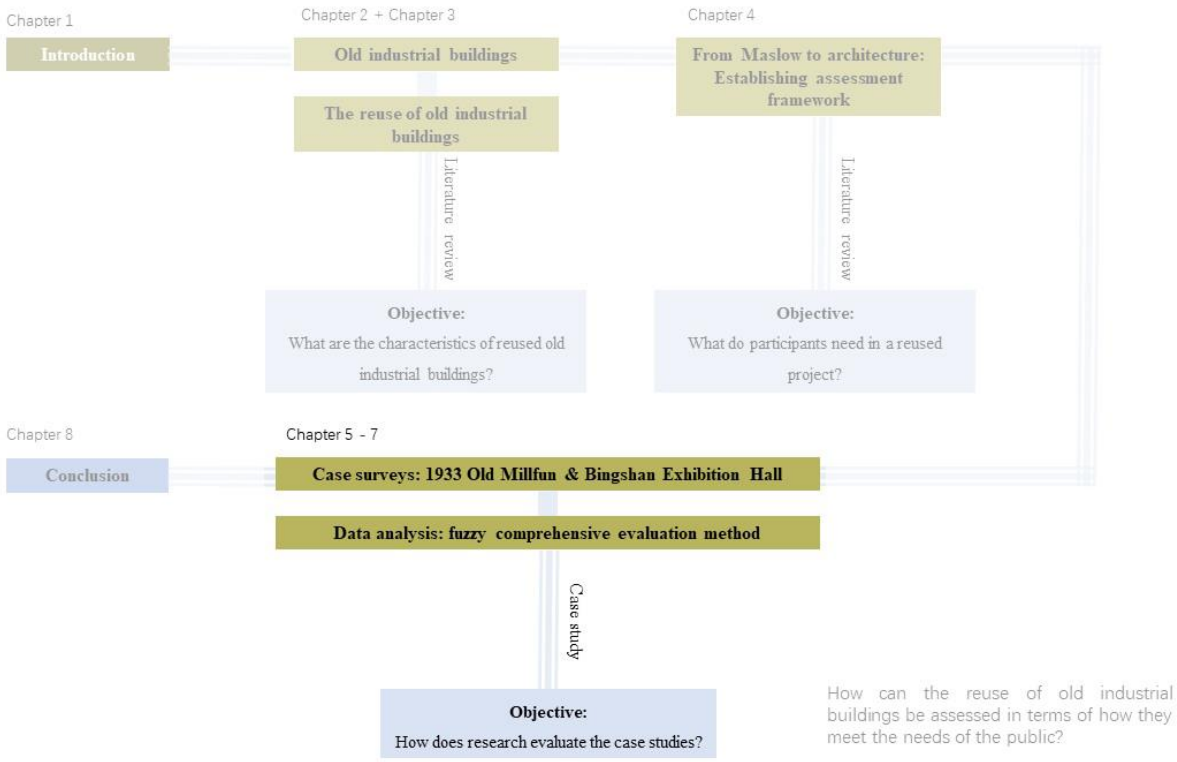


Figure 6.1-1 The structure role of Chapter 5-7 (by author, 2023).

7.2. Fuzzy comprehensive evaluation method

7.2.1. Background

The fuzzy comprehensive evaluation method is based on fuzzy mathematics (fuzzy set), which was mentioned by the American mathematician Lotfi A. Zadeh in 1965 (Zadeh, 1965). The basic principle of the fuzzy comprehensive evaluation method is to measure the value consistently and without contradiction from the evaluation scale given by the evaluation subject according to the specific situation, to obtain the evaluation results acceptable to most people, and provide the necessary information for correct decision-making; this comprehensive evaluation method integrates the evaluation of objects subject to multiple factors and transforms a qualitative assessment into a quantitative one (Feng and Xu, 1999).

In mathematics, fuzzy sets are sets whose elements have degrees of membership. The meaning here can be interpreted to be that, the results calculated by the fuzzy comprehensive evaluation method reflect the issue of the degree of membership of the objectives on different levels. The fuzziness in the fuzzy comprehensive evaluation method means that this approach is able to fuzzy out some values that are less influential and get a comprehensive result. In the field of architecture or urban planning, often the evaluation of a place that is good or bad is influenced by multiple factors. This method allows the evaluation of these multiple factors to be integrated to give a comprehensive evaluation.

Architectural design and urban planning are not only subjective and technically applied by the designers, but also about the need for users' participation and feedback. Evaluating a public building from the public's perspective is an important way to truly reflect the success of a project. Because public preferences vary, evaluating a public building should take into account multiple influence factors; the conclusion from the integration of these influences becomes the meaning of this method application.

In layman's terms, the core of the fuzzy comprehensive evaluation method is to break down the influencing factors of a target issue, score these broken-down items, and then calculate them through a fuzzy set calculation to obtain a final decision. The application of this research is to obtain an evaluation of two cases to measure the degree to which they meet the needs of the public. Of course, it may be questioned: *why the participants were not asked directly whether the project met their needs? Such issue does not seem to require such complex mathematical calculations.* The importance of the fuzzy comprehensive evaluation method is to break down the professional comprehensive issue into multiple and simpler items. Since the public is not expert, it is difficult for the public to give professional and in-depth opinions

during the evaluation process. The measuring framework derived from the research in Chapter 4 thus serves as a tool for breaking down the evaluation items. Specific data collection for the cases was then carried out in accordance with the measuring framework, while the interview questions for the public could be specified, simplified, or easy to understand. The data from these subitems is then scientifically organised and statistically analysed by the fuzzy comprehensive evaluation method, to achieve the comprehensive quality of reusing projects.

The fuzzy comprehensive evaluation method has been used in the field of humanities and social sciences for years, such as the evaluation of historical heritage, the comfort of space, and so on (Su, et al., 2008; Bo, et al., 2020; Guo, et al., 2022). However, the challenges remain, mainly regarding the scoring of some influence factors. For example, some content may be good, but how this 'goodness' is determined through quantitative means is the challenge; or simply put, how good can be considered good? The solution to this challenge in this research is to further breakdown each of the influence factors and compare them to the whole project based on the flaws (Section 7.3.2) that arise to arrive at a final evaluation. For example, if a project has two staircases and one of them is not in accordance with the regulations, then it will be judged as 50% bad. It has to be admitted that there is subjectivity in the evaluation of certain influence factors, which may not be accurate and fair. However, as the final result of the fuzzy comprehensive evaluation method is a combination of many factors, those subjective evaluation factors that are subject to error will have a minimal impact on the final result, which is why this study favours fuzzy mathematics.

7.2.2. Mathematical principles

A fuzzy mathematics comprehensive evaluation model is a comprehensive evaluation of something under multiple influence factors. The multiple factors can be summarised into two finite discourse domains: $\boldsymbol{U} = \{\boldsymbol{U_1}, \boldsymbol{U_2}, \cdots, \boldsymbol{U_m}\}$ and $\boldsymbol{V} = \{\boldsymbol{V_1}, \boldsymbol{V_2}, \cdots, \boldsymbol{V_n}\}$, where $\boldsymbol{U}$ represents the factor set which has $\boldsymbol{m}$ factors, and $\boldsymbol{V}$ is the evaluation set which has $\boldsymbol{n}$ evaluation levels.

The evaluation results for different factors will tend to converge to different levels in $\boldsymbol{n}$. The comprehensive evaluation can be seen as a fuzzy subset $\boldsymbol{B} = \{\boldsymbol{b_1}, \boldsymbol{b_2}, \cdots, \boldsymbol{b_n}\}$ of $\boldsymbol{V}$, and the $\boldsymbol{B}$ depends on the weight distribution of multiple factors, which can be regarded as the fuzzy vector $\boldsymbol{A} = \{\boldsymbol{a_1}, \boldsymbol{a_2}, \cdots, \boldsymbol{a_m}\}$ (the sum is equal to 1) of $\boldsymbol{U}$. The fuzzy relation $\boldsymbol{R}$ is regarded as a “fuzzy converter”, its relationship with $\boldsymbol{A}$ and $\boldsymbol{B}$ is shown in Figure 7.2.2-1. Finally, $\boldsymbol{B}$ will be a fuzzy calculation result, which reflects the affiliation of the evaluation levels $\boldsymbol{V}$.



Figure 7.2.2-1 Fuzzy converter (by author, 2022).

7.2.3. Calculation formulas

The fuzzy comprehensive evaluation method is a method to evaluate things collectively in multi-factor and multi-level situations. Because of the complexity, fuzziness, subjectivity, and difficulty in quantifying and defining the quality of reused projects, the fuzzy comprehensive evaluation method can be calculated, which will make the evaluation results tend to be a summary judgment. In other words, the fuzzy comprehensive evaluation method is more like a big data statistic, which combines various influencing factors to assess. According to the evaluation of reused industrial buildings quality which has three dimensions (basic needs, advanced needs, and challenging needs) and each dimension has several sub-items (Basic needs: 6 sub-items; advanced needs: 6 sub-items; challenging needs: 4 sub-items), the fuzzy comprehensive evaluation process can be divided into the following 6 steps:

1) Establish the factor set of the evaluation object

The quality of the cases needs to be measured in each of the three dimensions (basic needs, advanced needs, and challenging needs, which are indicated $\boldsymbol{U_1}, \boldsymbol{U_2}, \text{and } \boldsymbol{U_3}$). The factor set $\boldsymbol{U}$ is established as follows:

$$U_1 = \{u_{11}, \cdots, u_{16}\};$$

$$U_2 = \{u_{21}, \cdots, u_{26}\};$$

$$U_3 = \{u_{31}, \cdots, u_{34}\}.$$

2) Establish a weight set

Because the situation of each level and each influence factor in the evaluation target are different, the degree impacting the comprehensive result is different. Although all of these sub-items in the measuring framework are very important, there are always some differences between them. The percentage of importance attributed to each of these sub-items can be called the weight. And the weight set $\boldsymbol{A}$ is established, which can reflect, namely:

$$A_1 = \{a_{11}, \cdots, a_{16}\};$$

$$A_2 = \{a_{21}, \cdots, a_{26}\};$$

$$A_3 = \{a_{31}, \cdots, a_{34}\}.$$

3) Establish a judgment set

The research has divided the evaluation level of the project into 5 levels, which are: excellent, very good, good, satisfactory, and unsatisfactory. These 5 levels will be used to evaluate each sub-item and ultimately the comprehensive evaluation of the project to determine which of the 5 levels the project meets the needs of the public. The evaluation set $\boldsymbol{V}$ can be expressed as:

$$V = \{\text{excellent, very good, good, satisfactory, unsatisfactory}\}$$

4) Determine the membership degree of the evaluated factor

The membership degree of each factor to the judgement levels reflects a certain correlation between $\boldsymbol{U, V}$, that is, the membership degree of each factor to the judgement levels, thus establishing the membership degree matrix $\boldsymbol{R_1, R_2, R_3}$, and transforming it into dimension one. In short, the influencing factors (sub-items) are calculated in a matrix for the purpose of integration.

$$R_1 = Matrix\ (U_1 \times V);$$

$$R_2 = Matrix\ (U_2 \times V);$$

$$R_3 = Matrix\ (U_3 \times V)$$

5) Fuzzy comprehensive evaluation calculation

After determining the weight set and membership matrix, fuzzy transformation can be used for a comprehensive evaluation and the corresponding evaluation set $\boldsymbol{B_i}(\boldsymbol{i = 1, 2, 3})$ is obtained as the final comprehensive evaluation result, as follows:

$$B_1 = A_1 * R_1;$$

$$B_2 = A_2 * R_2$$

$$B_3 = A_3 * R_3$$

In the formula: $\boldsymbol{B_i}$ is the evaluation set of evaluation indexes for reusing old industrial buildings for a public purpose; '*' is the operator.

6) Determine the evaluation results

Using the 'Maximum membership method', that is, taking the evaluation set factor corresponding to the maximum evaluation index $\boldsymbol{\max_{1} B_{1j}(j = 1, \cdots, 6)}$ **;…;** $\boldsymbol{\max_{3} B_{3j}(j = 1, 2, 3, 4)}$ as the evaluation result of the project's quality in each dimension, and finally, the evaluation result of the reused old industrial project can be achieved.

7.2.4. Construction of evaluation model of reused industrial buildings

In Chapter 4, a measuring framework was developed based on Maslow's Hierarchy Theory. In the case surveys, the data is collected from the 16 sub-items in the three dimensions (basic needs, advanced needs, and challenging needs) under the measuring framework. These sub-items are the factors in the comprehensive evaluation. Table 7.2.4-1 shows the factor set for the quality of reused old industrial buildings and subitems covered under each dimension.

Index bed of basic needs U_1	
Physiological needs	Air environment quality u_{11}
	Toilet u_{12}
	Convenience store u_{13}
Safety needs	Security u_{14}
	Fire and escape u_{15}
	Building components u_{16}

Index bed of advanced needs U_2	
Socialising needs	Rest areas u_{21}
	Visitor enquiries u_{22}
	Activity organisation u_{23}
Esteem needs	Diverse participants u_{24}
	Facilities for special groups u_{25}
	Map and signage u_{26}

Index bed of challenging needs U_3	
Cultural needs	Preservation of historical industrial elements u_{31}
	Transmission of historical culture u_{32}

	Integration of ‘old and new’ u_{33}
	Attractiveness u_{34}

Table 7.2.4-1 Evaluation factor system of reused old industrial buildings (by author, 2022).

7.3. Empirical analysis of the cases

7.3.1. Establishing a fuzzy matrix framework of the multiple factors

Based on the calculation formula ($\boldsymbol{R} = \boldsymbol{Matrix}\ (\boldsymbol{U} \times \boldsymbol{V})$), the matrix framework for $\boldsymbol{U}$ and $\boldsymbol{V}$ will first be established. $\boldsymbol{U}$ has been shown in Table 7.2.4-1, the next step is to combine the evaluation items with the judgement levels set (excellent, very good, good, satisfactory, and unsatisfactory), thus forming the evaluation matrix framework in Table 7.3.1-1.

Basic needs R_1	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Air environment quality u_{11}	-	-	-	-	-
Toilet u_{12}	-	-	-	-	-
Convenience store u_{13}	-	-	-	-	-
Security u_{14}	-	-	-	-	-
Fire and escape u_{15}	-	-	-	-	-
Building components u_{16}	-	-	-	-	-

Advanced needs R_2	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Rest areas u_{21}	-	-	-	-	-
Visitor enquiries u_{22}	-	-	-	-	-
Activity organisation u_{23}	-	-	-	-	-
Diverse participants u_{24}	-	-	-	-	-
Facilities for special groups u_{25}	-	-	-	-	-
Map and signage u_{26}	-	-	-	-	-

Challenging needs R_3	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Preservation of industrial elements u_{31}	-	-	-	-	-
Transmission of historical culture u_{32}	-	-	-	-	-
Integration of 'old and new' u_{33}	-	-	-	-	-
Attractiveness u_{34}	-	-	-	-	-

Table 7.3.1-1 The matrix framework (by author, 2022).

7.3.2. Conversion from qualitative to quantitative

After the matrix framework has been established, the next step is to score each of the measuring items. How to give the corresponding score, which is a conversion from qualitative to quantitative, is a major challenge for the field of humanities and social sciences.

The study will score each item based on the results of the case survey in Chapter 5. Each item will be judged by the research on 5 levels (excellent, very good, good, satisfactory, and unsatisfactory). The main basis for the scoring will be the 'Summary of flaws' in the description of each item in Chapter 5 and 6; scoring will be based on the seriousness of the 'flaws'. For maximum scientific assurance, each of the 5 levels can be determined as follows:

- Excellent:
  The issue has no flaws and even provides some better surprises under the national context.
- Very good:
  Very minor flaws exist, do not occur frequently, and basically do not affect the normal participating experience.
- Good:
  There are some problems in this aspect that participants need to be careful of and avoid., or people have to detour their way around.
- Satisfactory:
  Problems exist that make participants have to suffer. Although it is a bad experience for people, most people can accept it through effort or patience. Or perhaps there was no solution in the conditions at the time.
- Unsatisfactory:
  The issue was not considered by the designer and became a barrier to the participant's experience of the building.

The judgement is done by dividing the 100 points into the appropriate levels. At the same time, when there are multiple influences on the item, the research will divide the 100 points and assign them to the 5 levels respectively. The following sections will describe how to do this in the cases.

7.4. Statistics and calculations for 1933 Old Millfun

7.4.1. Scoring 1933 Old Millfun

The description of 1933 Old Millfun in each item has been in detail in the case surveys in Section 5.3.2. Then, it will be to score these descriptions and distribute the 100 points to the matrix in each item.

7.4.1.1 Air environment quality

As described in Section 5.3.2.1, most indoor spaces of the project are equipped with HVAC systems, which are able to control the indoor air environment well to respond to the seasonal changes in Shanghai. The total area of the air-conditioned public indoor space is 14,121 m², which is excellent. In addition, there is 262 m² of indoor space with HVAC, but the problem is that the outdoor unit is placed in the passageway; luckily, the narrow passageway is not a necessary route for visiting the building, so this section can be seen as the balance of strengths and weaknesses and is judged as good. On the 2F and 3F of the central hall, which has an unpleasant smell and is not equipped with an HVAC system, this section has an area of 1,816 m² and is judged to be unsatisfactory.

The 100 points were divided according to the area proportion of these spaces, resulting in: 87.2 excellent; 1.6 good; and 11.2 unsatisfactory.

7.4.1.2 Toilet

As described in Section 5.3.2.2, the scores for the toilet will be considered in 3 parts. Firstly, the toilets are easily accessible, and this aspect is excellent (1/3 of the total). Secondly, in terms of the number of toilets, the number of toilet facilities in 4F would not be sufficient if both the Sky Theatre and the Basilica Suite were operating at full capacity; however, this is not often the case; so, the 4F is rated as good (1/3*1/4) and the other as excellent (1/3*3/4). Finally, in terms of environmental hygiene, the interior is cleaned regularly to keep it tidy and, surprisingly, tissue paper is provided, so this 1/3 is excellent.

The 100 points were divided resulting in: 33.3 excellent; 8.3 good, 25 excellent; and 33.4 excellent.

7.4.1.3 Convenience store

As described in Section 5.3.2.3, the scores for the convenience store in 1933 Old Millfun will be considered in 4 aspects. Firstly, the entrance to the Quik shop is outside the building, which causes some inconvenience to the participants served inside; of course, it has to be admitted that being on the outside of the building also provides better service to people passing by; therefore, the location aspect is satisfactory (1/4 of the total). Secondly, the store is excellent (1/4) in terms of the variety of products available. Thirdly, the wide range of products crowded into a small space, combined with the low lighting, highlights the poor experience of the interior environment, as satisfactory (1/4). Fourthly, the prices were excellent (1/4) as the best value among the competing stores.

The 100 points were divided resulting in: 25 satisfactory; 25 excellent; 25 satisfactory; and 25 excellent.

7.4.1.4 Security

As described in Section 5.3.2.4, there are 2 main aspects: security staff and security facilities, which make up a greater proportion. In addition, the response for special situations is one of the elements to be considered for the security of the project. In terms of security personnel, the project does not have a lot of security staff; although there is a person directing parking, there is no patrol within the site, so this is judged to be good (2/5). As for facilities, which have always been a strength of Chinese public spaces, the large amount of monitoring equipment ensures safety, and is excellent (2/5). For other safety practices, 1933 Old Millfun, has maintained its usual review process, excellent (1/5), due to the special times of recent years.

The 100 points were divided resulting in: 40 good; 40 excellent; and 20 excellent.

7.4.1.5 Fire and escape

As described in Section 5.3.2.5, it is necessary to think in terms of both fire protection and escape. The type and distribution of fire-fighting facilities in the building are excellent, with the exception that they are not well integrated into the building, for example, some are fixed directly to the walls and seem to stand out. The fire protection is therefore very good (1/2 of the total). A large amount of outdoor space in the building makes participants very easy to escape to the safe areas, so the designer only needs to focus on the addition of two evacuation staircases in the central hall. However, even with the new staircases, they still have potential problems: one stair has over-height steps and is judged to be satisfactory (1/2*1/2); another

stair is not only too high, but also has an unsatisfactory (1/2*1/2) escape distance from the 1F to the safety area.

The 100 points were divided resulting in: 50 very good; 25 satisfactory; and 25 unsatisfactory.

7.4.1.6 Building components

As described in Section 5.3.2.6, the scores for the building components will be considered in 4 parts. Firstly, with regard to the balustrade, the height of them is measured to be greater than the regulations; however, as they are stone walls, they create a slight blocking of views, and this is judged to be very good (1/4 of the total). The second is the stairs in the building, although the stairs are somewhat steep and narrow, people can get around the building by other routes, such as lifts; at the same time, such stairs are the heritage of the project, which cannot be transformed, and are therefore very good (1/4). Thirdly, the lifts in the project are regularly maintained and safety reminders are given as excellent (1/4). Fourthly, due to the original function of the building, there are still many small steps on the floor ground and are therefore considered as satisfactory (1/4).

The 100 points were divided resulting in: 25 very good; 25 very good; 25 excellent; and 25 satisfactory.

7.4.1.7 Rest areas

As described in Section 5.3.2.7, the rest areas can be analysed mainly in terms of size and form. The size of the rest areas is large in relation to the whole building; and they are very widely distributed throughout the building, on every floor, with a distinctive character, so it is excellent (1/2 of the total). There is also a variety of forms, ranging from flexible spaces to seating and restaurant, meeting a wide range of needs, making it as excellent (1/2).

The 100 points were divided resulting in: 50 excellent; and 50 excellent.

7.4.1.8 Visitor enquires

As described in Section 5.3.2.8, dedicated receptionists and potential support are a good way of assessing the needs of the participants for enquires. The staff is concentrated in the entrance hall, and they include both managers and security staff. There are no patrols within the project and therefore it is difficult to seek help from staff within the building; however, thankfully, the traffic and space are not very large, thus, this can be accessed as satisfactory (1/2 of the total). The staff of the shops are potential support in the building. There are not

many shops in the project, but these are mainly on the 1F and 2F, so the only potential support are on the 1F and 2F of the whole 4 floors, which is rated as very good (1/2*1/2); however, on the 3F and 4F, there is no one to ask, which is rated as unsatisfactory (1/2*1/2).

The 100 points were divided resulting in: 50 satisfactory; 25 very good, and 25 unsatisfactory.

7.4.1.9 Activity organisation

As described in Section 5.3.2.9, the activities organised and arranged by the 1933 Old Millfun company are very diverse, involving a wide range of people and making good use of the 1933 Old Millfun's site; the only weakness is that these activities require the financial support, so this is judged to be very good (7/10 of the total). Furthermore, as an important public building in the city, it is a good (3/10) in terms of providing activities for the citizens in the early hours of the morning due to the limited space available.

The 100 points were divided resulting in: 70 very good; and 30 good.

7.4.1.10 Diverse participants

As described in Section 5.3.2.10, the diversity of the participants is reflected in the questionnaire in 3 aspects. Firstly, the gender distribution of the participants clearly shows that there are more women than men, which is good (1/3 of the total). Then, the age information shows that the participants are mainly young people, with a very small number of older people, so it is satisfactory (1/3). Finally, in terms of people's place of birth, due to the large proportion coming from other cities in Shanghai, it gives the project an inherent advantage in this aspect of the evaluation, which is excellent (1/3).

The 100 points were divided resulting in: 33.3 good; 33.3 satisfactory; and 33.4 excellent.

7.4.1.11 Facilities for special groups

As described in Section 5.3.2.11, the scores for the special groups' facilities will be considered in 4 parts. Firstly, there are accessible toilets for special groups, which are provided at the entrance, but there is only one small accessible toilet for the whole building, which is not ideal and is therefore very good (1/4 of the total). Secondly, in terms of ground transport, as mentioned in Section 5.3.2.6, there are many small steps on the floor; of course, the treatment of these steps is a challenge in the heritage building in order to preserve the historical characteristics, so this is assessed as satisfactory (1/4). Thirdly, the size of the lifts and the height of the keys show that the designers have neglected special groups, but in the Chinese

situation, special groups such as wheelchair users are usually accompanied by an accompanying person, so this can be judged as good (1/4). Fourthly, there are few introduction signs, and some are not bilingual; similar to most small public places, it is difficult to take into consideration the care of people with dyslexia, such as braille or hearing devices, due to financial problems, which is satisfactory (1/4).

The 100 points were divided resulting in: 25 very good; 25 satisfactory; 25 good; and 25 satisfactory.

7.4.1.12 Map and signage

As described in Section 5.3.2.12, the map of the 1933 Old Millfun is reflective of the layout of the building as a whole and is weighted more heavily. This is also evidenced by the central position of the entrance; however, the content of the map is too abstract and too simple to be confusing for those unfamiliar with the project, hence it is satisfactory (2/5 of the total). Furthermore, the design of the signage is divided into 3 aspects. Firstly, the exit signage, which has signs on the floors and walls for escape directions, also uses national iconography and includes English; only some of the signs have some dust on the surface, which may have an impact in case of emergency if people cannot see clearly, and is very good (1/5). The safety signage is then mainly concerned with warning of the safety hazards of the building components, but the maintenance of these safety hazards is satisfactory (1/5), because of the ignored settings and blurred displays. Finally, the signage of the room functions is eye-catching, illuminated and has its own personality; the weakness is that, due to the complexity of the building space, the participants cannot see very far and some of the function rooms can only be displayed when they walk in; overall this project is judged as good (1/5).

The 100 points were divided resulting in: 40 satisfactory; 20 very good; 20 satisfactory; and 20 good.

7.4.1.13 Preservation of historical industrial elements

As described in Section 5.3.2.13, the 1933 Old Millfun should be excellent for the preservation of industrial elements, and it is difficult to find another industrial building in China that has been transformed with such a high degree of restoration. This project is not aimed as a museum, but the historical details it preserves are surprising. It is even an exaggeration to say that the 2023's 1933 Old Millfun, with the addition of equipment, would be able to continue his slaughter manufacturing.

The 100 points were resulting in: 100 excellent.

7.4.1.14 Transmission of historical culture

As described in Section 5.3.2.14, the scores for the transmission of historical culture will be considered in 4 parts. There are 3 main material industrial elements within the project. Firstly, there are 2 Cattle Paths that run through the whole building, one of which, although illustrated in the introduction panel, is only on the 1F; after all, it is not an obligatory route through the project and is not easy to be found by the participants, so it is satisfactory (1/4*1/2 of the total); the other one is not specified at all, and is unsatisfactory (1/4*1/2). Then, of the 34 Air Bridges, only one has an introduction panel, which could only be judged as unsatisfactory (1/4). Finally, sadly, of the 300 Flowering Columns, only one is provided with an introduction panel; like the Air Bridge, this column is neither special nor an obligatory route for visitors, so the chances of finding it are very slim, being unsatisfactory (1/4). Except for these 3 specific material industrial elements, the other preserved historical elements are not described in a way that would confuse the participants, as unsatisfactory (1/4).

The 100 points were divided resulting in: 12.5 satisfactory, 12.5 unsatisfactory; 25 unsatisfactory; 25 unsatisfactory; and 25 unsatisfactory.

7.4.1.15 Integration of ‘old and new’

As described in Section 5.3.2.15, scoring can be done from visual and functional aspects. In terms of visual integration, the project has chosen to focus on the 'old' as the dominant design concept, highlighting the industrial atmosphere that has been retained; although some of the later lines and pipes have had an impact on the building, the overall effect is very good (1/2 of the total). In terms of functional integration, some of the shop themes relate to the 1930s slaughterhouse, but the actual result from the questionnaires is not so ideal, so as good (1/2).

The 100 points were divided resulting in: 50 very good; and 50 good.

7.4.1.16 Attractiveness

As described in Section 5.3.2.16, the scoring of the attractiveness will be divided into the building itself, the advertising effect, and the commercial potential. Of course, the building itself should have a higher weighting, as it is the basis of this study. The architecture of 1933 Old Millfun itself is unique, and the key is the visual success of the project; however, in a way, the building is only a visual success, a little singular; after all, it is an important heritage building, and therefore judged to be very good (1/2 of the total). The advertising effect is also due to the unique visual effect of the project. 1933 Old Millfun on camera is undoubtedly the best

advertisement, with variety shows and films as shooting locations, and their promotion of the project is extensive and well received by the public, as excellent (1/4). The various commercial events and weddings organised by the project prove that the commercial operation of the project has a certain attraction to the public, which is very good (1/4).

The 100 points were divided according to the area proportion of these spaces, resulting in: 50 very good; 25 excellent; and 25 very good.

7.4.2. Establishing a fuzzy matrix of factor evaluation about 1933 Old Millfun

With the above scoring, the score for each level (excellent, very good, good, satisfactory, unsatisfactory) in each item after the evaluation can also be considered as the membership level. According to the analysis in Section 7.4.1, the results can be filled into the matrix of the table; for the fuzzy matrix $\boldsymbol{R_1, R_2, R_3}$ dimensions, evaluation scoring is established, shown in Table 7.4.2-1 for details.

Basic needs R_1	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Air environment quality u_{11}	87.2	0	1.6	0	11.2
Toilet u_{12}	91.7	0	8.3	0	0
Convenience store u_{13}	50	0	0	50	0
Security u_{14}	60	0	40	0	0
Fire and escape u_{15}	0	50	0	25	25
Building components u_{16}	25	50	0	25	0

Advanced needs R_2	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Rest areas u_{21}	100	0	0	0	0
Visitor enquiries u_{22}	0	25	0	50	25
Activity organisation u_{23}	0	70	30	0	0
Diverse participants u_{24}	33.4	0	33.3	33.3	0
Facilities for special groups u_{25}	0	25	0	50	25
Map and signage u_{26}	0	20	20	60	0

Challenging needs R_3	Excelent	Very good	Good	Satis-factory	Unsatis-factory
Preservation of industrial elements u_{31}	100	0	0	0	0
Transmission of historical culture u_{32}	0	0	0	12.5	87.5
Integration of ‘old and new’ u_{33}	0	50	50	0	0

	Attractiveness u_{34}	25	75	0	0	0

Table 7.4.2-1 The scored matrix framework (by author, 2022).

The establishment of the fuzzy matrix $\boldsymbol{R_1, R_2, R_3}$ for factor evaluation can be calculated in the matrix process, as follows:

$$R_1 = \begin{bmatrix} 87.2 & 0 & 1.6 & 0 & 11.2 \\ 91.7 & 0 & 8.3 & 0 & 0 \\ 50 & 0 & 0 & 50 & 0 \\ 60 & 0 & 40 & 0 & 0 \\ 0 & 50 & 0 & 25 & 25 \\ 25 & 50 & 0 & 25 & 0 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 100 & 0 & 0 & 0 & 0 \\ 0 & 25 & 0 & 50 & 25 \\ 0 & 70 & 30 & 0 & 0 \\ 33.4 & 0 & 33.3 & 33.3 & 0 \\ 0 & 25 & 0 & 50 & 25 \\ 0 & 20 & 20 & 60 & 0 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 100 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 12.5 & 87.5 \\ 0 & 50 & 50 & 0 & 0 \\ 25 & 75 & 0 & 0 & 0 \end{bmatrix}$$

7.4.3. Giving weight to the items

Weight is the percentage of importance of each of these 16 sub-items in the project's overall (comprehensive) evaluation. Since each item comes from a translation of Maslow's theory in Chapter 4, it is undeniable that they are all important in the assessment process. However, these important factors (items) will have differences according to the different projects. It will be the focus of this section to determine how mathematically reflect the proportion of importance of each item. The method chosen by the research is the ‘Expert assessment method’. A number of experts in the relevant field were asked to score each item, and eventually, the weightings for each item could be obtained statistically.

7.4.3.1 Selection of the experts

Operating since 2006, it is a well-known project in China and most architectural professionals are familiar with 1933 Old Millfun and have even studied it in depth. Therefore, the experts will not be limited to the Shanghai area, and the specific backgrounds of the 10 experts are shown in Table 7.4.3.1-1 (some information cannot be disclosed to protect privacy).

		General Organisation	Biography/Position

1	Mr. Wang	Architectural design institute	Senior Engineer
2	Mr. Yang	Architectural design institute	Head of the institute Professoriate senior engineer Class 1 Registered Architect (PRC) Master's degree supervisor
3	Mr. Du	Architectural design institute	Deputy director of the institute Senior Engineer Class 1 Registered Architect (PRC)
4	Mr. Zheng	City Municipal Bureau of Planning and Nature Resources	The head of a department Registered Property Manager (PRC)
5	Dr. Xing	University	Ph.D Senior Engineer
6	Mrs. Zhang	Architectural design institute	Deputy director of the institute Senior Engineer
7	Dr. Zhu	University	Ph.D Associate professor Class 1 Registered Architect (PRC) Senior Engineer Master's degree supervisor
8	Pro. Liu	University	Ph.D Professor Ph.D supervisor
9	Pro. Zheng	University	Ph.D Professor Class 1 Registered Architect (PRC) Ph.D supervisor
10	Ms. Xu	Freelancers	Registered Property Manager (PRC)

Table 7.4.3.1-1 The 10 experts' general backgrounds (by author, 2022).

7.4.3.2 Experts scoring results

The research asked 10 experts to score the importance of the 16 items in relation to the 1933 Old Millfun. The 16 items were scored on a whole number from 1 to 10, with higher scores representing greater importance. The subjective opinions of the experts were collected, and the results were as follows (Table 7.4.3.2-1):

	Air quality u_{11}	Toilet u_{12}	Store u_{13}	Security u_{14}	Fire u_{15}	Components u_{16}
1	9	9	7	8	8	7

2	8	9	5	9	10	10
3	9	10	7	5	10	10
4	9	10	8	8	10	10
5	9	5	4	7	9	7
6	9	8	7	10	10	10
7	7	7	10	9	10	10
8	8	10	4	6	10	10
9	7	10	6	9	10	6
10	9	10	4	9	10	10

	Rest areas u_{21}	Enquires u_{22}	Organisation u_{23}	Diverse u_{24}	Special groups u_{25}	Map & signage u_{26}
1	5	4	5	10	5	8
2	7	3	7	9	4	10
3	8	4	8	9	5	8
4	5	4	6	5	8	10
5	6	6	9	7	4	8
6	5	4	4	9	3	9
7	6	3	4	7	4	10
8	4	3	5	3	8	5
9	7	7	5	8	9	7
10	5	6	6	8	4	7

	Rest areas u_{31}	Enquires u_{32}	Organisation u_{33}	Diverse u_{34}
1	7	7	6	8
2	7	7	7	10
3	9	9	10	9
4	8	10	10	10
5	10	10	10	9
6	9	9	10	10
7	6	6	7	7
8	8	8	7	5
9	8	8	10	8
10	8	9	8	10

Table 7.4.3.2-1 Scoring by 10 experts (by author, 2022).

7.4.3.3 Results statistics

The research considered that the final scores of the 10 experts for the importance of the 16 items could be weighted by using the percentage within the section, the result shows as follows (Table 7.4.3.3-1).

	Air quality u_{11}	Toilet u_{12}	Store u_{13}	Security u_{14}	Fire u_{15}	Components u_{16}
1	9	9	7	8	8	7
2	8	9	5	9	10	10
3	9	10	7	5	10	10
4	9	10	8	8	10	10
5	9	5	4	7	9	7
6	9	8	7	10	10	10
7	7	7	10	9	10	10
8	8	10	4	6	10	10
9	7	10	6	9	10	6
10	9	10	4	9	10	10
∑	84	88	62	80	97	90
Weight	**16.77%**	**17.56%**	**12.38%**	**15.97%**	**19.36%**	**17.96%**

	Rest areas u_{21}	Enquires u_{22}	Organisation u_{23}	Diverse u_{24}	Special groups u_{25}	Map & signage u_{26}
1	5	4	5	10	5	8
2	7	3	7	9	4	10
3	8	4	8	9	5	8
4	5	4	6	5	8	10
5	6	6	9	7	4	8
6	5	4	4	9	3	9
7	6	3	4	7	4	10
8	4	3	5	3	8	5
9	7	7	5	8	9	7
10	5	6	6	8	4	7
∑	5	4	5	10	5	8
Weight	**15.59%**	**11.83%**	**15.86%**	**20.16%**	**14.52%**	**22.04%**

	Rest areas u_{31}	Enquires u_{32}	Organisation u_{33}	Diverse u_{34}

1	7	7	6	8
2	7	7	7	10
3	9	9	10	9
4	8	10	10	10
5	10	10	10	9
6	9	9	10	10
7	6	6	7	7
8	8	8	7	5
9	8	8	10	8
10	8	9	8	10
∑	80	83	85	86
Weight	**23.95%**	**24.85%**	**25.45%**	**25.75%**

Table 7.4.3.3-1 The highlighted weight result of each item (by author, 2022).

7.4.4. The evaluation calculation

According to the statistics above, the final assessment frame can be established as the following Table 7.4.4-1:

Weight	Basic needs R_1	Excellent	Very good	Good	Satis-factory	Unsatis-factory
16.77%	Air environment quality u_{11}	87.2	0	1.6	0	11.2
17.56%	Toilet u_{12}	91.7	0	8.3	0	0
12.38%	Convenience store u_{13}	50	0	0	50	0
15.97%	Security u_{14}	60	0	40	0	0
19.36%	Fire and escape u_{15}	0	50	0	25	25
17.96%	Building components u_{16}	25	50	0	25	0

Weight	Advanced needs R_2	Excellent	Very good	Good	Satis-factory	Unsatis-factory
15.59%	Rest areas u_{21}	100	0	0	0	0
11.83%	Visitor enquiries u_{22}	0	25	0	50	25
15.86%	Activity organisation u_{23}	0	70	30	0	0
20.16%	Diverse participants u_{24}	33.4	0	33.3	33.3	0
14.52%	Facilities for special groups u_{25}	0	25	0	50	25
22.04%	Map and signage u_{26}	0	20	20	60	0

Weight	Challenging needs R_3	Excellent	Very good	Good	Satis-factory	Unsatis-factory

23.95%	Preservation of industrial elements u_{31}	100	0	0	0	0
24.85%	Transmission of historical culture u_{32}	0	0	0	12.5	87.5
25.45%	Integration of 'old and new' u_{33}	0	50	50	0	0
25.75%	Attractiveness u_{34}	25	75	0	0	0

Table 7.4.4-1 The scored matrix framework (by author, 2022).

According to the formula of the fuzzy comprehensive evaluation method in Section 7.2.3 and combined with the data derived from Table 7.4.4-1, the matrix and weights will be multiplied and will result in a fuzzy comprehensive evaluation result for each dimension: $\boldsymbol{B_1, B_2, B_3}$.

$$B_1 = A_1 * R_1$$

$$= \begin{bmatrix} 16.77\% \\ 17.56\% \\ 12.38\% \\ 15.97\% \\ 19.36\% \\ 17.96\% \end{bmatrix} * \begin{bmatrix} 87.2 & 0 & 1.6 & 0 & 11.2 \\ 91.7 & 0 & 8.3 & 0 & 0 \\ 50 & 0 & 0 & 50 & 0 \\ 60 & 0 & 40 & 0 & 0 \\ 0 & 50 & 0 & 25 & 25 \\ 25 & 50 & 0 & 25 & 0 \end{bmatrix}$$

$$= (50.988 \quad 18.660 \quad 8.114 \quad 15.520 \quad 6.718)$$

In the same way, the fuzzy comprehensive evaluation results of $\boldsymbol{B_2, B_3}$ are:

$$B_2 = A_2 * R_2 = (22.323 \quad 22.098 \quad 19.509 \quad 33.112 \quad 2.958)$$

$$B_3 = A_3 * R_3 = (30.388 \quad 32.038 \quad 12.725 \quad 3.106 \quad 21.744)$$

In the formula: '*' is the operator for multiplication.

7.5. Statistics and calculations for Bingshan Industrial Culture Exhibition Hall

7.5.1. Scoring Bingshan Industrial Culture Exhibition Hall

According to the description of the Bingshan Industrial Culture Exhibition Hall in Section 6.2.2, the 100 points will be distributed as follows.

7.5.1.1 Air environment quality

As described in Section 6.2.2.1, Bingshan Industrial Culture Exhibition Hall is divided into two parts of space for discussion because of the air conditioning systems. The total floor area of the project is 1,654 m²; of these, the lecture room, which is not equipped with an air conditioning system, has a floor area of 676 m²; others are equipped with air conditioning systems. Although the lecture room has good ventilation and natural light, it is still not possible to guarantee a year-round indoor temperature environment in Dalian, a city with cold winters and hot summers. Overall, the air environment quality in the lecture room is rated as good and the rest is excellent.

The 100 points were divided according to the area proportion of these spaces, resulting in: 40.8 good; and 59.2 excellent.

7.5.1.2 Toilet

As described in Section 6.2.2.2, toilets are not considered at all in the project. The accessibility of the public toilet relied upon is not convenient. Therefore, the scores for the convenience store in Bingshan Industrial Culture Exhibition Hall will be very unpromising.

The 100 points were divided resulting in: 100 unsatisfactory.

7.5.1.3 Convenience store

As described in Section 6.2.2.3, the scores for the convenience store in Bingshan Industrial Culture Exhibition Hall will be considered in 4 parts. Firstly, the 2F, where the store and cafe are located, is easily visible from the 800m² exhibition area and, as the only exit from the project, is undoubtedly in an excellent position within the project. There is a little disappointment that it is not very friendly to visitors from outside the project. Therefore, the location aspect is very good (1/4 of the total). Secondly, focusing on souvenirs and creative cakes, the store and café are not as well accepted by the public as the items sold in traditional Chinese convenience stores, hence the rate as satisfactory (1/4). Thirdly, mixed with the café,

it gives the store the excellent (1/4) environment. Fourthly, the price is considered reasonable, and after all, there are creative shapes, so it is very good (1/4).

The 100 points were divided resulting in: 25 very good; 25 satisfactory; 25 excellent; and 25 very good.

7.5.1.4 Security

As described in Section 6.2.2.4, security staff and security facilities are still the focus of the measurement. Further, the response for special situations can also reflect the level of project management. In terms of security personnel, the park is patrolled by security staff, but there is no security staff in the project, so this is judged to be satisfactory (2/5 of the total). For facilities, as a contemporary building, the project makes use of a great deal of technology. In addition to CCTV, smart gates also help to record and manage visitors inside the building. So it is excellent (2/5). In terms of the handling of the safety situation, the project was judged to be unsatisfactory (1/5), given the strict control of the pandemic in the Chinese context and the lack of corresponding measures.

The 100 points were divided resulting in: 40 satisfactory; 40 excellent; and 20 unsatisfactory.

7.5.1.5 Fire and escape

As described in Section 6.2.2.5, protection against fire and the escape of people from a building in a fire are still the focus of this item. The fire hydrants and fire extinguishers are well-equipped in the main exhibition hall, but there is relatively less firefighting equipment in the lecture room. Although this does not constitute a safety threat, the large difference with the main exhibition area may affect the safety psychology of the participants. The firefighting equipment in the lecture room is very good (1/2*40.8% of the total) according to the area proportions; others are excellent (1/2*59.2%). The building's interior staircase escape presents the same problems as 1933 Old Millfun, it has an unsatisfactory (1/2*1/2) escape distance from the ground floor to the safety area; others are excellent (1/2*1/2).

The 100 points were divided resulting in: 20.4 very good, 29.6 excellent; 25 unsatisfactory, and 25 excellent.

7.5.1.6 Building components

As described in Section 6.2.2.6, the scores for the building components will be considered in 3 parts. Firstly, with regard to hazards of components, the hazards are signposted accordingly,

it would just be better if the risks were fundamentally reduced, such as wrapping with soft. So this can be rated as very good (1/3 of the total). The second is the stairs in the building, their sizes meet the requirements for escape, but as the only vertical traffic in the building, the size of the indoor stair is not comfortable and is therefore satisfactory (1/3*1/2), the other one is excellent (1/3*1/2). Thirdly, the balustrades meet safety height requirements, which is excellent (1/4).

The 100 points were divided resulting in: 33.3 very good; 16.7 satisfactory, 16.7 excellent; and 33.3 excellent.

7.5.1.7 Rest areas

As described in Section 6.2.2.7, the rest areas in Bingshan Industrial Culture Exhibition Hall can be analysed mainly in terms of social places and potential social places provided by the project. All that can be provided within the project is the store and café on the 2F. It is not excellent as it is too single and the location is on the 2F, so it is very good (1/2 of the total). In addition, the project provides several potential resting places, such as the lecture room, where the comfort level could be improved, making it very good (1/2).

The 100 points were divided resulting in: 50 very good; and 50 very good.

7.5.1.8 Visitor enquires

As described in Section 6.2.2.8, the only staff is the waitress in the 2F store and café. Therefore, according to the proportion of the area the staff serves, this item is judged as excellent (12.1% of the total); the other area is unsatisfactory (87.9%).

The 100 points were divided resulting in: 12.1 excellent; and 87.9 unsatisfactory.

7.5.1.9 Activity organisation

As described in Section 6.2.2.9, the activities organised and arranged by Bingshan Wisdom Park Co., Ltd are currently an activity for the popularisation of science, which is a little bit single. In other words, the project can develop more activities around the theme. Of course, the project is small, and it has been a pleasant surprise to be able to organise the event. Thus, this is judged to be very good (7/10 of the total). Furthermore, the square on the south side is a great place for people to do a wide range of activities; the only weakness is in winter, when would be more vibrant. It is rated as very good (3/10).

The 100 points were divided resulting in: 70 very good; and 30 very good.

7.5.1.10 Diverse participants

As described in Section 6.2.2.10, from the questionnaire the diverse participants will be measured from the aspects of gender, age, and location. Firstly, the number of male and female visitors is generally the same, so it is excellent (1/3 of the total). Then, the age information shows that the distribution of ages is reasonable covering all the age groups, which is excellent (1/3). Finally, for a small city like Dalian, it is optimistic that the project will attract a third of the people from other cities, which is excellent (1/3).

The 100 points were divided resulting in: 33.3 excellent; 33.3 excellent; and 33.4 excellent.

7.5.1.11 Facilities for special groups

As described in Section 6.2.2.11, the scores for the special groups' facilities will be considered in 4 parts. Firstly, the fully new paved ground surface is friendly to visitors with limited mobility, which is excellent (1/4 of the total). Secondly, in terms of text reading, the project uses bilingualism. However, there is still no design support for people with reading difficulties. Thus, it is satisfactory (1/4). Then, it is very unfortunate that the project does not take into account toilets and lifts at all, so both of these are unsatisfactory (1/4 + 1/4).

The 100 points were divided resulting in: 25 excellent; 25 satisfactory; 25 unsatisfactory; and 25 unsatisfactory.

7.5.1.12 Map and signage

As described in Section 6.2.2.12, There is a map in the Bingshan Industrial Culture Exhibition Hall, but due to the small size of the project, the map is not as important as the 1933 Old Millfun. The map is richly drawn, but the legibility is somewhat affected by the need to express the art of hand-drawing, hence it is good (1/4 of the total). In addition, the other signage design is divided into 3 aspects. Firstly, the exit signage can be found on the floors, walls, and exit doors, which are excellent (1/4) placed and clearly expressed. Secondly, safety signage is everywhere and there are places where humorous language (such as stairs which describe in Section 6.2.2.6) is used to interact with users, which is a great surprise and rated excellent (1/4). Finally, all of them have functional signage, except for the lecture room. However, this does not affect the identification of the lecture room, which is very good (1/4).

The 100 points were divided resulting in: 25 very good; 25 excellent; 25 excellent; and 25 very good.

7.5.1.13 Preservation of historical industrial elements

As described in Section 6.2.2.13, as a museum function for the reuse of old industries, the preservation of the industrial elements in terms of exhibits is deservedly excellent (1/2 of the total). At the same time, it is surprising that the building has been well preserved and is excellently (1/2) preserved in its original form in the 1950s.

The 100 points were resulting in: 50 excellent; and 50 excellent.

7.5.1.14 Transmission of historical culture

Naturally, the exhibits in the project are well introduced in the exhibition hall. A higher expectation should be used to measure whether it is able to meet contemporary modern exhibition technology. As described in Section 6.2.2.14, in the exhibition, the introduction information interconnecting with personal mobile phones and multimedia seems conforming to this time. However, strictly speaking, this is not innovative and does not yet surprise the participants. The transmission of the exhibits could be very good (3/4 of the total). Besides, since the project has chosen to preserve this 1950s mill, it should be treated as if it were an exhibit. The historical story behind it should be transmitted to the public as culture. By contrast, it should also be taken into account that the building is not as distinctive as the 1933 Old Millfun, so perhaps a short presentation will be sufficient. At the same time, this building will stand less weight than the inside exhibits in this item, as the satisfactory (1/4).

The 100 points were divided resulting in: 75 very good; and 25 satisfactory.

7.5.1.15 Integration of ‘old and new’

As described in Section 6.2.2.15, scoring can be done from visual and cultural aspects. In terms of visual integration, the project is dominated by an expression of the old industrial style, with almost all of the newly added elements well integrated or hidden. The design of this part of the project can be considered excellent (1/2 of the total), as can be seen from the painted contemporary technological equipment and the iceberg-shaped balustrades, which were designed with great care for the transformation. Furthermore, the products in the store and cafe are a excellent (1/2) reflection of the cultural integration and at the same time the most attractive part of the project.

The 100 points were divided resulting in: 50 excellent; and 50 excellent.

7.5.1.16 Attractiveness

As described in Section 6.2.2.16, the scoring of the attractiveness will be divided into the building function itself, the advertising effect, and the commercial potential. In terms of the main function of the project itself, it has been open for a short time, the area is small, and the content of the exhibition is not very popular with the public, so not many visitors were able to come deliberately. Therefore, it is rated as good (1/2 of the total). Then, the project relies on the publicity of the whole park and has a good base of potential participants; further, it has made an effort to discourage students from research and study and to make an effort for future development; as very good (1/4). Finally, as mentioned in Section 6.5.1.15, the cultural and creative products are currently a huge attraction for the project, which is positive (1/4) for bringing more visitors. However, the main function and role of the building are to exhibit industrial culture, not the sale of souvenirs. The most important function of the project does not stand out; this is completely contrary to the original design of the project and is not a worthy cause for celebration; so is satisfactory (1/4).

The 100 points were divided according to the area proportion of these spaces, resulting in: 50 good; 25 very good; and 25 satisfactory.

7.5.2. Establishing a fuzzy matrix of factor evaluation about Bingshan Industrial Culture Exhibition Hall

Similar to the method of 1933 Old Millfun in Section 7.4.2, according to the analysis in Section 7.5.1, the results can be organised, and the fuzzy matrix $\boldsymbol{R_1, R_2, R_3}$ can be established as follows:

$$R_1 = \begin{bmatrix} 59.2 & 0 & 40.8 & 0 & 0 \\ 0 & 0 & 0 & 0 & 100 \\ 25 & 50 & 0 & 25 & 0 \\ 40 & 0 & 0 & 40 & 20 \\ 54.6 & 20.4 & 0 & 0 & 25 \\ 50 & 33.3 & 0 & 16.7 & 0 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0 & 100 & 0 & 0 & 0 \\ 12.1 & 0 & 0 & 0 & 87.9 \\ 0 & 100 & 0 & 0 & 0 \\ 100 & 0 & 0 & 0 & 0 \\ 25 & 0 & 0 & 25 & 50 \\ 50 & 50 & 0 & 0 & 0 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 100 & 0 & 0 & 0 & 0 \\ 0 & 75 & 0 & 25 & 0 \\ 100 & 0 & 0 & 0 & 0 \\ 0 & 25 & 50 & 25 & 0 \end{bmatrix}$$

7.5.3. Giving weight to the items

Similarly, the weighting of the projects was scored by 10 experts from the relevant disciplines in Dalian, and the statistics are shown below (Table 7.5.3-1,2):

		General Organisation	Biography/Position
1	Mr. Guo	Architectural design institute	Senior Engineer Project Creator
2	Dr. Zheng	Architectural design institute	Ph.D Head of the institute Master's degree supervisor
3	Ms. Du	Architectural design institute	Senior Engineer Master's degree supervisor
4	Ms. Lu	Architectural design institute	The head of a department Class 1 Registered Architect (PRC)
5	Dr. Guo	University	Ph.D Assistant professor Senior Engineer Ph.D supervisor
6	Mrs. Feng	Architectural design institute	Deputy director of the institute Senior Engineer Class 1 Registered Architect (PRC)
7	Mr. Wu	Architectural design institute	Senior Engineer Class 1 Registered Architect (PRC) Master's degree supervisor
8	Dr. Zhen	University	Ph.D Assistant professor Senior Engineer Ph.D supervisor
9	Mr. Yu	University	Class 1 Registered Architect (PRC) Lecturer
10	Mrs. Liu	Architectural design institute	Senior Engineer

Table 7.5.3-1 The 10 experts' general backgrounds (by author, 2022).

	Air quality u_{11}	Toilet u_{12}	Store u_{13}	Security u_{14}	Fire u_{15}	Components u_{16}
1	9	10	8	5	10	10
2	8	10	9	7	10	10
3	9	9	8	4	9	8
4	9	10	8	7	10	10
5	8	9	7	8	10	9
6	8	8	8	4	10	10
7	6	3	4	7	7	6
8	5	10	10	5	10	10
9	7	8	9	5	10	8
10	7	8	10	5	4	10

	Rest areas u_{21}	Enquires u_{22}	Organisation u_{23}	Diverse u_{24}	Special groups u_{25}	Map & signage u_{26}
1	9	9	5	9	10	4
2	8	8	8	8	8	3
3	9	6	5	5	10	2
4	8	8	8	10	8	4
5	10	10	7	7	10	5
6	9	9	4	6	10	4
7	5	5	4	6	4	4
8	10	7	8	4	3	6
9	8	5	6	6	10	5
10	8	8	6	10	10	3

	Rest areas u_{31}	Enquires u_{32}	Organisation u_{33}	Diverse u_{34}
1	10	10	10	8
2	9	10	9	9
3	7	10	10	10
4	10	10	5	10
5	8	10	10	10
6	10	10	10	9
7	10	10	10	8
8	10	10	4	7

9	10	10	10	10
10	10	10	6	10

Table 7.5.3-2 Scoring by 10 experts (by author, 2022).

The weighting percentage of 10 experts could be done through the percentage statistics after summation, as shown in Table 7.5.3-3.

	Air quality u_{11}	Toilet u_{12}	Store u_{13}	Security u_{14}	Fire u_{15}	Components u_{16}
Weight	**15.83%**	**17.71%**	**16.88%**	**11.88%**	**18.75%**	**18.95%**

	Rest areas u_{21}	Enquires u_{22}	Organisation u_{23}	Diverse u_{24}	Special groups u_{25}	Map & signage u_{26}
Weight	**20.29%**	**18.12%**	**14.73%**	**17.15%**	**20.05%**	**9.66%**

	Rest areas u_{31}	Enquires u_{32}	Organisation u_{33}	Diverse u_{34}
Weight	**25.47%**	**27.11%**	**22.76%**	**24.66%**

Table 7.5.3-3 The weight of each item (by author, 2022).

7.5.4. The evaluation calculation

The final assessment framework can be established in Table 7.5.4-1.

Weight	Basic needs R_1	Excellent	Very good	Good	Satis-factory	Unsatis-factory
15.83%	Air environment quality u_{11}	59.2	0	40.8	0	0
17.71%	Toilet u_{12}	0	0	0	0	100
16.88%	Convenience store u_{13}	25	50	0	25	00
11.88%	Security u_{14}	40	0	0	40	20
18.75%	Fire and escape u_{15}	54.6	20.4	0	0	25
18.95%	Building components u_{16}	50	33.3	0	16.7	0

Weight	Advanced needs R_2	Excellent	Very good	Good	Satis-factory	Unsatis-factory
20.29%	Rest areas u_{21}	0	100	0	0	0
18.12%	Visitor enquiries u_{22}	12.1	0	0	0	87.9
14.73%	Activity organisation u_{23}	0	100	0	0	0
17.15%	Diverse participants u_{24}	100	0	0	0	0
20.05%	Facilities for special groups u_{25}	25	0	0	25	50
9.66%	Map and signage u_{26}	50	50	0	0	0

Weight	Challenging needs R_3	Excellent	Very good	Good	Satis-factory	Unsatis-factory
25.47%	Preservation of industrial elements u_{31}	100	0	0	0	0
27.11%	Transmission of historical culture u_{32}	0	75	0	25	0
22.76%	Integration of 'old and new' u_{33}	100	0	0	0	0
24.66%	Attractiveness u_{34}	0	25	50	25	0

Table 7.5.4-1 The scored matrix framework (by author, 2022).

Using the formula of the fuzzy comprehensive evaluation method, the result for each dimension, $\boldsymbol{B_1, B_2, B_3}$ are:

$$B_1 = A_1 * R_1 = (38.056 \quad 18.575 \quad 6.457 \quad 12.137 \quad 24.774)$$

$$B_2 = A_2 * R_2 = (29.185 \quad 39.850 \quad 0 \quad 5.013 \quad 25.952)$$

$$B_3 = A_3 * R_3 = (48.230 \quad 26.498 \quad 12.330 \quad 12.943 \quad 0)$$

7.6. Results discussion

After the calculation of the fuzzy comprehensive evaluation method, the final comprehensive evaluation results have been decided. The following part will start with the analysis of the final comprehensive evaluation results and will also call back the statistical process. Each case is first discussed individually, and then compared with the aim of identifying the strengths and weaknesses of the project.

7.6.1. Summary of respective results

These results reflect the membership to the 5 evaluation judgment levels (excellent, very good, good, satisfactory, unsatisfactory). In the field of mathematics, the result analysis of the fuzzy comprehensive evaluation method is often judged by the principle of maximum membership. To put it another way, in social science research in architecture, the data on the results can be seen as the 'degree of agreement' at each level (excellent, very good, good, satisfactory, unsatisfactory), with the higher numbers indicating that the result is more agreeable. So, the principle of maximum membership can be explained that whichever judgement level the public agrees with the most, then that such judgement level is the result of that dimension. In this research, the analysis of the results will be carried out in terms of each case's satisfaction with the public's needs on three dimensions.

7.6.1.1 1933 Old Millfun

In order to illustrate the results, the data for scoring and calculating the results are shown again in Table 7.6.1.1-1, and the results of maximum membership are highlighted in red.

Basic needs	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Air environment quality	87.2	0	1.6	0	11.2
Toilet	91.7	0	8.3	0	0
Convenience store	50	0	0	50	0
Security	60	0	40	0	0
Fire and escape	0	50	0	25	25
Building components	25	50	0	25	0
Result	50.988	18.660	8.114	15.520	6.718

Advanced needs	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Rest areas	100	0	0	0	0

	Visitor enquiries	0	25	0	50	25
	Activity organisation	0	70	30	0	0
	Diverse participants	33.4	0	33.3	33.3	0
	Facilities for special groups	0	25	0	50	25
	Map and signage	0	20	20	60	0
Result		22.323	22.098	19.509	33.112	2.958

Challenging needs		Excellent	Very good	Good	Satis-factory	Unsatis-factory
	Preservation of industrial elements	100	0	0	0	0
	Transmission of historical culture	0	0	0	12.5	87.5
	Integration of 'old and new'	0	50	50	0	0
	Attractiveness	25	75	0	0	0
Result		30.388	32.038	12.725	3.106	21.744

Table 7.6.1.1-1 Results of 1933 Old Millfun (by author, 2022).

The scores of excellent (50.988) in the assessment of basic needs are very high. This indicates that most areas in the 1933 Old Millfun meet the needs of the public well. The well-equipped infrastructure and the architectural design in strict accordance with safety regulations are a good foundation for meeting basic needs. The results of the fuzzy comprehensive evaluation calculations show that the excellent level has the significantly highest membership. The problems of the project in terms of basic needs are mainly due to the specific and complex spatial form of the building, which makes the building a landmark but creates a large amount of work and difficulties in its adaptive reuse.

In terms of advanced needs, the performance of the case varies widely across the different items. After the fuzzy comprehensive evaluation calculation, the highest membership is at satisfactory level (33.112). Although both excellent (22.323) and very good (22.098) have high scores, there are still weakness with the advanced needs of the project. This polarisation seems highlighted, but the result of the fuzzy comprehensive evaluation calculation shows that the project still has a significant problem with the dimension of the advanced need. The project should be welcoming and respectful to the public; in other words, it needs to be more considerate of the public, such as providing visitor enquiries, clear maps, and more care about special groups.

Concerning the challenging needs, the project has its own unique historical atmosphere and is successful in terms of feedback data (very good: 32.038). However, as an industrial heritage, its important historical context needs to be further explored and cultural knowledge needs to

be further transmitted to the public. Although the project has provided a successful visual environment for the public, industrial culture is not limited to this, with the historical, scientific, and social values contained in industrial history being important as well. Therefore, how to help the public understand, interpret, and be inspired by the knowledge contained therein is an issue that needs to be considered by the project in the future.

7.6.1.2 Bingshan Industrial Culture Exhibition Hall

The results of Bingshan Industrial Culture Exhibition Hall are shown below in Table 7.6.1.2-1.

Basic needs	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Air environment quality	59.2	0	40.8	0	0
Toilet	0	0	0	0	100
Convenience store	25	50	0	25	
Security	40	0	0	40	20
Fire and escape	54.6	20.4	0	0	25
Building components	50	33.3	0	16.7	0
Result	38.056	18.575	6.457	12.137	24.774

Advanced needs	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Rest areas	0	100	0	0	0
Visitor enquiries	12.1	0	0	0	87.9
Activity organisation	0	100	0	0	0
Diverse participants	100	0	0	0	0
Facilities for special groups	25	0	0	25	50
Map and signage	50	50	0	0	0
Result	29.185	39.850	0	5.013	25.952

Challenging needs	Excellent	Very good	Good	Satis-factory	Unsatis-factory
Preservation of industrial elements	100	0	0	0	0
Transmission of historical culture	0	75	0	25	0
Integration of ‘old and new’	100	0	0	0	0
Attractiveness	0	25	50	25	0
Result	48.230	26.498	12.330	12.943	0

Table 7.6.1.2-1 Results of Bingshan Industrial Culture Exhibition Hall (by author, 2022).

According to the results of the fuzzy comprehensive evaluation, the highest score for basic needs is excellent (38.056) in Bingshan Industrial Culture Exhibition Hall. It is not surprising that a contemporary building with small spaces meets the basic needs of the public well. The 'hidden' air conditioning and CCTV system can enhance the quality of the experience of the building space with an impressive old industrial style. However, for a contemporary building, it is surprising that there are no toilets. This is why the project scored higher on the unsatisfactory level (24.774). Although this did not affect the final result (the principle of maximum membership), the significant problem with the project was pointed out and needs to be improved.

It is positive that the scoring data is mainly concentrated on excellent and very good, with very good (39.850) being the maximum membership. A smaller space allows participants to be familiar with the environment more quickly, which is its own strength; but at the same time, the simpler space and functions are an inherent weakness in terms of the variety of activities. It is not easy for a small building to provide the public with very good rest areas. Overall, the project met the advanced needs of the public well, but it would have been better if staff had been available to support the exhibition area on the 1F.

The richness of the architectural design is more easily demonstrated in the small space. In addition to the preservation of the building and the exhibits, the adaptation of the project has resulted in an excellent integration into the industrial style. As a result, the project received a excellent (48.230) rating on the dimension of the challenging need. At the same time, it can be seen that the project, which is in its infancy, still needs to be more outstanding in the region again to attract more participants.

7.6.2. Comparative discussion

The final evaluation results for both projects can be reflected in three dimensions. In Figure 7.6.2-1, the focus and evaluation results of the cases in the different dimensions are shown. And a comparison of the analysis of the two projects will be discussed subsequently.

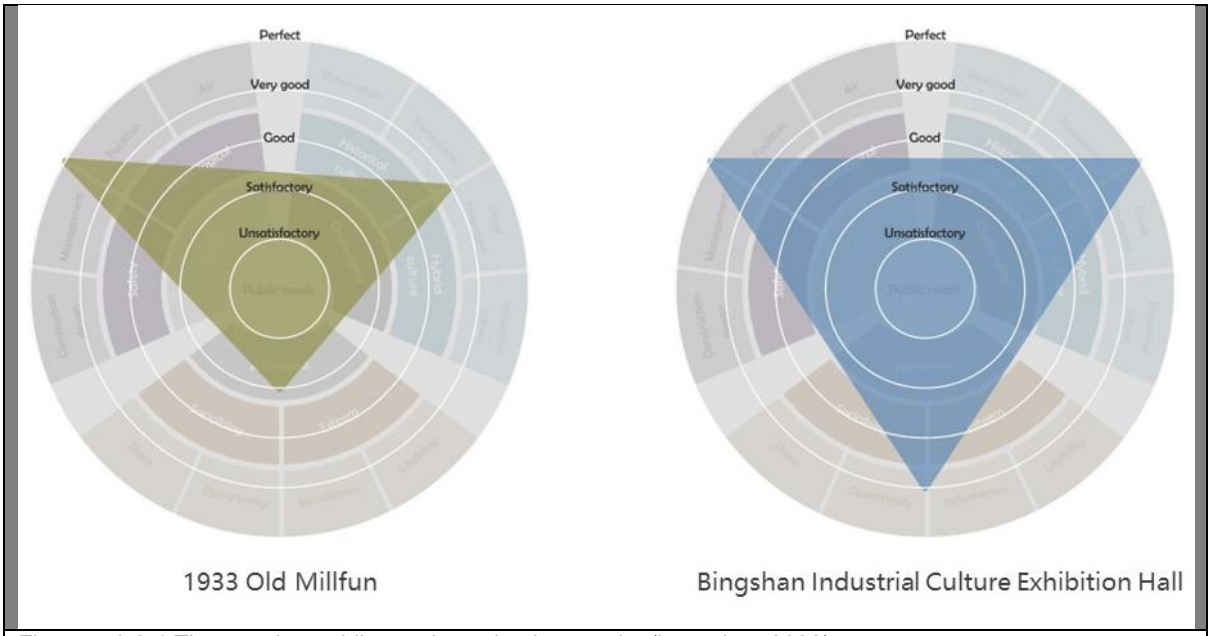


Figure 7.6.2-1 The meeting public needs evaluation results (by author, 2022).

The results of the fuzzy comprehensive evaluation method in terms of basic needs are 1933 Old Millfun 50.988 excellent and 38.056 excellent. Although both are at the excellent level, Bingshan is below 1933 Old Millfun. The biggest problem is in the Bingshan's toilets, where is in large part by unsatisfactory.

- Air environment quality:
  As the most effective way to guarantee the air environment comfort inside the building, both cases are equipped with air conditioning after the transformation. Since Bingshan Industrial Culture Exhibition Hall (Bingshan for short) is operated by Bingshan Wisdom Park Co., Ltd, the uniform installation of air conditioning was integrated into the transformation design and kept the industrial style. In contrast, the 1933 Old Millfun's space is divided and leased by individuals, with the air-conditioning system installed by the tenants themselves, which results in non-uniformity, various types, and even impacts on the traffic of the participants.

- Toilet:
  This is a complete contrast; the 1933 Old Millfun is very well equipped with toilets; Bingshan is surprisingly not equipped. Although it tries to use the outdoor public toilets, there is a lack of accessibility, which makes it a bad experience for the participants.

- Convenience store:
  Due to the different functional positioning of the projects, there are different groups of customers served by the stores. The convenience store at 1933 Old Millfun is needed not only

to serve visitors, but also to support the daily life of the office staff inside. The Bingshan, on the other hand, mainly impresses visitors and increases the attractiveness of the project.

- Security:
  Both projects are very well equipped with CCTV systems. For the security staff, there is staff at the entrance of the 1933 Old Millfun. There is no staff in Bingshan project, the security relies on the 180,000 m² park. There are no patrols on either project, and in the event of danger, the arrival time of the security staff may be lengthy, especially the Bingshan project.

- Fire and escape:
  In general, the fire safety of both buildings has been carried out in accordance with the regulations, especially the fire extinguishers which are widely distributed throughout the buildings. Both multi-storey buildings, however, have problems with the vertical evacuation design, such as the height of stair steps and escape distances on the 1F.

- Building components:
  1933 Old Millfun was transformed on the basis of a complex spatial environment, most building components can still guarantee comfort and safety; although many of the stairs are rather dangerous, there are lifts available for people to use within the project. In contrast, the size of the new stair added to the interior of the Bingshan building does not meet the comfort needs of the users.

The results of the fuzzy comprehensive evaluation method in terms of advanced needs are 1933 Old Millfun 33.112 satisfactory and 39.850 very good. The smaller size and more homogeneous functional form of the Bingshan will result in better detail and human care services compared to the 1933 Old Millfun.

- Rest areas:
  Both are great in this aspect; they offer variety and large resting places for participants.

- Visitor enquiries:
  There are no staff in both two buildings. It is not a big problem for a small building like Bingshan, but it is easy to lose one's way in the complex space of 1933 Old Millfun.

- Activities organisation:
  1933 Old Millfun takes advantage of its mixed-use (theatres, Basilica Suite, etc.) to host a variety of commercial activities; due to the limitations of the site, it does not provide good space for free activities. Bingshan hosts activities with an educational focus; also, the square has inadvertently become a satisfactory venue for public activities.

- Diverse participants:
  As important sites of industrial culture in their respective cities, both projects attract various kinds of visitors. Only 1933 Old Millfun attracts more young female participants due to its outstanding visual presentation (a great place for photos).

- Facilities for special groups:
  With the complex space of 1933 Old Millfun, it took a lot of work to make sure that the building was accessible to special groups. However, Bingshan has no toilets or lifts, so it is basically closed off to special people.

- Map and signage:
  The signage within both projects is relatively clear. However, for the maps, although both projects have them, it has to be said that neither of them is good at giving clear directional indications to the participants.

The results of the fuzzy comprehensive evaluation method in terms of challenging needs are 1933 Old Millfun 32.038 very good and 40.230 excellent. 1933 Old Millfun gets a high score of very good, due to its stunning architectural space and visual impact, and it is very close to the excellent score. Bingshan, as an export site for industrial culture, naturally has an advantage over 1933 Old Millfun, in terms of an emphasis on culture-like challenging needs.

- Preservation of historical industrial elements:
  Both are restored to the historical industrial style as far as possible, preserving and reflecting the historical appearance of a historic building.

- Transmission of historical culture:
  1933 Old Millfun has a marvellous architectural appearance, but the interpretation and transmission of these important historical elements are insufficient, and this will disappoint those visitors who want to seek industrial culture. Bingshan as a museum function, should be the focus of attracting participants in this aspect of culture transmission as a basic.

- Integration of ‘old and new’:
  The neglect of some details during the transformation of 1933 Old Millfun (such as the exposed equipment appears different from the architectural style) has to a certain extent affected the experience of the building; at the same time, apart from the visual, the cultural integration is not well reflected, making the reuse of the building more 'stay at the level of the body without the soul'. Bingshan has integrated the present elements well into the historic industrial buildings, not only in terms of the built environment; the cultural and creative

products are also one of the key attractions.

- Attractiveness:
  Each project will have its strengths that will become its attractions. 1933 Old Millfun is more about amazing visual spaces; Bingshan is about science education, and cultural and creative products.

Although the scoring of the two cases was compared, it cannot simply be said that a high score is more successful; that is because, there are too many factors affecting the process of comparison, such as different human environments, different functional profiles, different floor areas, different financial investments, etc. Therefore, a uniform standard may be difficult to apply to different projects. After all, the standards of evaluation may not be the same for different projects, for example, Bingshan Industrial Culture Exhibition Hall is a museum function and opened in 2021, the research should use higher standards to measure the transmissions of historical industrial elements. However, through their comparison, a positive perspective can be better drawn, which can gain experience for the future design about the reuse of industrial buildings. Furthermore, the fuzzy comprehensive evaluation method is to simplify and break down the comprehensive problem into multiple factors of influence, and analyses the strengths and weaknesses in order to provide a better foundation for further analysis, such as SWOT (Helms and Nixon, 2010).

Chapter 8

Conclusions

8.1. Summary of the research chapters

In today's mature development of architecture, there has been a focus on the exploration of quality enhancement of the architectural experience. This research assesses how the reuse of old industrial buildings can meet public needs. The whole study progresses step by step and completes the answer to this research question through three objectives:

- ***What are the characteristics of reused old industrial buildings?***
- ***What do participants (users) need in a reused project?***
- ***How does research evaluate the case studies?***

The application of this evaluation framework can then not only be used to evaluate completed adaptive reuse projects, but can also inform and provide guidance for architects in the design and assessment of future projects.

Chapter 2 identifies the broad scope of the industry, including production, services, and management. The exploration reviews the development of the industry from the 'First Industrial Revolution' to the present day, from which it is possible to see that industry and industrial buildings have distinctive historical features. Focusing on the Chinese context, they are grouped into the time of learning, implantation, Soviet Union, and self-innovation. In addition, the aspects of industrial building obsolescence - technology, economic and industrial restructuring, and political or event driven - are summarised as causes of the formation of old industrial buildings. Chapter 3 begins by explaining that the reuse of old industrial buildings is complex and that it is challenging to preserve an old building in the context of today's urban development. However, thanks to human efforts, the preservation and reuse of old industrial buildings have been achieved, and several charters and organisations have been drafted and established to provide guidance and a basis for the field of building reuse. At the same time, the historical, economic, and social value inherent in old industrial buildings makes their reuse more meaningful. The study proposes material industrial elements in order to highlight culture as a specific value of old industrial buildings, and to locate these specific cultural hosts more accurately in the complex of old industrial buildings. These results, a combination of Chapter 2 and 3, addressed the objective about ***What are the characteristics of reused old industrial buildings?***

Chapter 4 finds the answer to ***What do participants (users) need in a reused project?*** This research has involved the translation of Maslow's Hierarchy of Needs (psychological systems) to the evaluation of architecture; in particular, it has established an assessment framework that aims to analyse the success of the reuse of old industrial buildings as public buildings.

The needs of the public in buildings have been divided into three dimensions (basic needs, advanced needs, and challenging needs), which correspond to Maslow's hierarchy of needs (basic needs: physiological needs and safety needs; advanced needs: socialising needs and esteem needs; challenging needs: needs of historical culture and needs of the hybrid culture). This is based on the needs of the people, and comparing, selecting and converting to the configuration of the reused old industrial buildings, in order to examine the satisfaction of the buildings. Therefore, a number of sub-items in the assessment framework are used as critical factors in the evaluation of these buildings.

Chapter 5 and 6 are the beginning of the case study, which focuses on data collection. The plan for the site survey was based on the previous assessment framework and used field measurements, computer modelling, questionnaires, and observational methods to investigate the situation of the 16 sub-items. In this chapter, the performance of the 1933 Old Millfun and Bingshan Industrial Culture Exhibition Hall in the sub-items is reported in detail with graphics and text, and this report is used as the basis for the next data analysis. In Chapter 7, the data obtained in the previous chapter were statistically analysed by the fuzzy comprehensive evaluation method, and the examined results were achieved in three dimensions. Firstly, the description of the operating principle of the fuzzy comprehensive evaluation method shows that this mathematical and statistical method is suitable for this kind of research about multiple influence factor evaluation. A score of 100 points was assigned to each sub-item based on its strengths and weaknesses, resulting in a rating of excellent, very good, good, satisfactory, or unsatisfactory. Although the results show that both projects have high ratings, the analysis from the fuzzy calculations shows that they still have their own shortcomings and areas for future improvement. The objective: ***How does research evaluate the case studies?****,* was achieved through the assessment framework of chapter 4, and the case survey and fuzzy comprehensive evaluation method of chapters 5-7.

8.2. Key research findings

The case study in the above chapters evaluated the projects and identified the strengths and weaknesses of each case. However, this is not the ultimate aim of this research. The scholar's research should be able to promote the future development of the field. The case study will therefore be a cornerstone that will ultimately provide design guidance and reference for future projects. Importantly, this obtained finding so far will also serve for future developments, this will need to be developed and detailed in the future continuously.

At last, the assessment of reused old industrial buildings has come to some results with the above chapters. The key research finding is the establishment of the assessment framework (Figure 8.2-1). It focuses on the evaluation of the reused old industrial buildings for public use, dividing people's needs into three dimensions and extending this circle outwards to specify what is measured. It can be said that this is creative research finding and is therefore considered to be a PhD-level study. The assessment framework was able to measure whether a reused industrial project was able to meet the needs of public participants. At the same time, the specific application methods and processes are demonstrated from the case study process, and the innovative mathematical method of fuzzy comprehensive evaluation method is used to obtain the final assessment results of the project.

The assessment process shows that the basic needs of contemporary buildings are of high quality, which may be attributed to strict architectural scrutiny and the development of modern technology. The advanced needs are mainly a reflection of the care and concern of architecture for the psychological aspects of the participants, which is what architecture, and the humanities and social sciences are currently trying to study and explore; and projects may for some reason neglect this aspect of design, resulting in a worse experience for the participants. The challenging needs could be seen as the driving force behind making the project unique and attractive; this dimension makes a reused building to keep the industrial identity and culture. More importantly, the issues of the project that have been exposed in this research assessment can provide a good chance to clear room for enhancement, and to improve the public’s experience quality in the future.

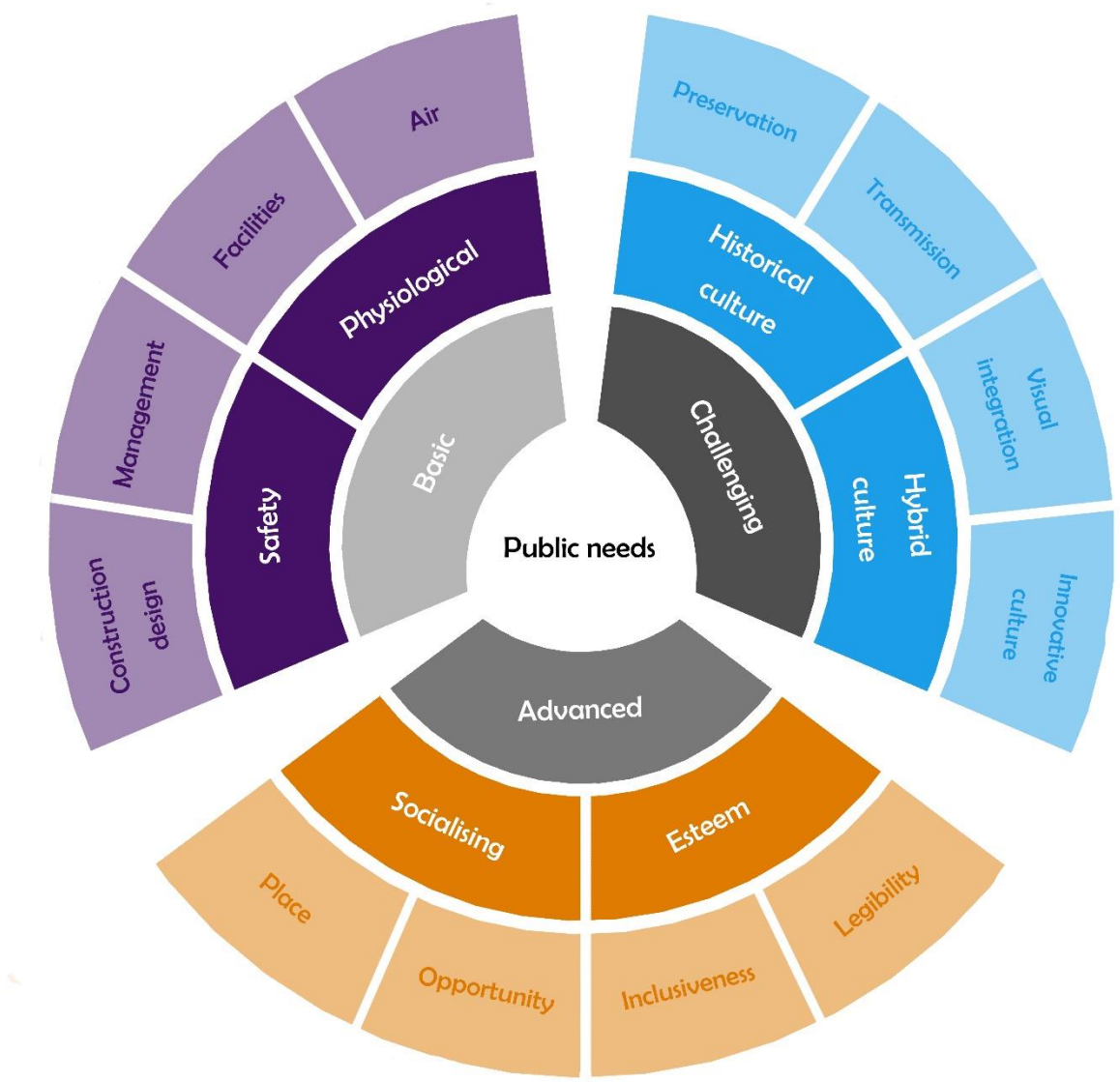


Figure 8.2-1. The assessment framework (by author, 2022).

8.2.1. Basic needs

A building should be adapted to the geographical environment in which it is located, in order to guarantee the comfort of the indoor air environment in extreme weather. It has to be agreed that many of the solutions to this problem are a challenge for low energy consumption and environmental protection. However, the green building and low carbon building theories we have proposed are still in the experimental and exploratory stages and are not yet ready to be popularised. Thus, for the moment, the HVAC system could be the most effective method. In addition, the building needs to consider some supplies to meet the physiological needs of the

participants. As living individuals, human beings cannot live without one of the characteristics of life: metabolism. The project therefore should help participants with feeding and excretion. For example, the project should provide convenient and clean toilets; emergency items should be provided inside or around the building, this can take the form of a convenience store, a vending machine, etc.

Modern security technology is necessary and helpful to assist and enhance the security of the building. As a public building, it should be equipped with a CCTV system, and the surveillance should cover the whole public area. Some easily damaged equipment and components such as fire-fighting equipment, lifts, fire doors, etc., require regular maintenance and ensure that they are working properly. Additionally, the building's fire protection and evacuation, as an important safety requirement for the building design, should be strictly enforced in accordance with the relevant regulations (e.g., Code for Fire Protection Design of Buildings (*GB50016-2014)*). Among them, some particular attention should be paid to the stairs and 15m escape distance at ground floor staircases. Depending on the site situation of people moving around the building, there can be patrolling security officers or plainclothes police to keep participants safe.

In the following Table 8.2.1-1, the main items (questions) that need to be taken into account in the design of the reuse are listed. It is, however, necessary to highlight that these items are not absolute and that they should be applied flexibly in different projects; they can be expanded or reduced accordingly; this also applies to the next advanced needs and challenging needs.

Basic needs	
Physiological	Are the ventilation, temperature, and humidity in the building within a comfortable range?
	Is there an HVAC system in the building?
	Is the building equipped with the appropriate number of toilets and are they easy to find?
	Are the building's toilet clean, and does the water supply work?
	Is there a convenience store in or around the building and does it sell items for daily emergencies, such as drinks, snacks, fast food, tissue paper, chargers, etc.?
Safety	Is there a security officer in the building?
	Is there a CCTV system in the building?
	Are the firefighting facilities (e.g., fire hydrants, sprinkler systems) in the building up to current codes and best practices?
	Does the fire escape design (e.g., escape stairs, escape distance) in the building meet the building code?

	Are the building's easily damaged elements regularly maintained?
	Are the floors, stairs, hand-railings balustrades, and other elements of the building safe for users?
	Are there suitable warnings or protective measures about safety hazards such as crashes, falls, graze, etc.?

Table 8.2.1-1 Questions to consider on the aspect of basic needs (these are not absolute, and should be applied flexibly in different projects, could be expanded or reduced accordingly) (by author, 2022).

8.2.2. Advanced needs

Depending on the scale of the project, seating, cafés, restaurants, etc. could be provided for the participants; besides, the outdoor lawn or garden can also be a resting or relaxation area. For some projects with complex spaces or large areas, there will be a need for 'insiders' (i.e., the staff who is familiar with the project, such as security staff, cleaners, shop assistants, etc.) to be scattered throughout the building, who can be easily found and can provide friendly support to the participants. The operator of the project should organise a variety of activities for the public, which can be based on the functional themes, either online or offline; it will also encourage the project to organise urban production and live events, such as weddings, conferences, etc.; in short, the aim is to organise people's social life through a variety of activities.

The project should show adequate care for the participants, especially at a psychological level, with good services that make people feel well cared for and respected. The main function of the project is to be adapted to the various groups in society, which will reflect inclusiveness to the public. This will be reflected in the treatment of special groups, such as people with reduced mobility, dyslexia, and parents with little babies. Thus, it is necessary for the project to provide appropriate support facilities, such as an accessible toilet, accessible lifts, assisted readers, and these facilities need to be equipped in accordance with the relevant accessibility regulations. It is important to have a clear and easy-to-understand map at the entrance, clear functional signage in the building space and important safety escape signs, as well as warning signs for areas of the building that may cause harm to the participants and appropriate protective measures are also necessary.

In Table 8.2.2-1, the measurement items will be shown in relation to the advanced needs. Humans have a strong ability to adapt to their environment (Wilcock, 1993), not so much in terms of physiology, but in terms of perception. Just as, for example, sometimes the social behaviour does not always take place in a café or on the lawn; sometimes a few people

standing in a corner and chatting together can be very convivial as well. But a project that offers a comfortable social space makes for a better experience.

Advanced needs	
Socialising	Are there areas within the project that offer relaxation (e.g., seats, coffee, tea bars, lounge areas)?
	Are there any behavioural activities evident, for example, exercise, chatting, picnics, etc.?
	Is there an information desk, patrolling staff, or volunteers?
	Is the attitude of the service staff welcoming?
	Are there regular or irregular online or offline themed events for the public?
	Is there an official online information social platform?
Esteem	Is there a good gender balance of users?
	Is it used by people of different ages and ethnic groups?
	Are there barrier-free designs, such as lifts and ramps, to make wheelchair access possible?
	Are there barrier-free toilets and a nursing room(s)?
	Does the project provide free assistive devices for special groups (e.g., wheelchairs, hearing aids, prams)?
	Is there a layout map in the building? Are the maps comprehensive, clear, and easy to understand?
	Is there any clear signage in the building (e.g., smoking, warning signs, exit signs, visit descriptions)?

Table 8.2.2-1 Questions to consider on the aspect of advanced needs (these are not absolute, and should be applied flexibly in different projects, could be expanded or reduced accordingly) (by author, 2022).

8.2.3. Challenging needs

For some old industrial buildings with important historical value, the process of reuse will be dominated by the preservation of these important industrial elements. The preservation of elements not only provides the building with an identity, but also allows the public to recall its history. The façade or materials that reflect the old industry image, the specific spatial or structural forms that served the historical industrial manufacturing, the aesthetic elements that reflect the specific historical period, the old equipment that has historical significance or artistic value, and even the old elements that were used to create historical style buildings or spaces, all these will be the target elements to be preserved. At the same time, some elements containing values, such as historical, cultural, social, economic, aesthetic, technological, etc., should be explained by the relevant experts. The cultural meaning of the valuable elements

should be transmitted to the participants, either simply by textual explanations, by multimedia displays, or by more advanced displays as museum functions.

The new elements added during the reuse process should take into account the integration of the historical elements that have been preserved; it can be either hidden or highlight the historical elements (restoration as it was in the past), or the creative combination of old and new (new elements to create a historical style, such as iceberg-shaped balustrades and creative cakes). Ultimately all the project's outstanding strengths will become the attraction of a project. Public participants are the foundation of the project's survival. The project should not only be advertised in a way that makes the public desire to come to the project; it also needs to make less disappointing for the participants, and better provide the public with a sense of identity, safety, surprise, freshness, and many other positive feelings of place.

In the following Table 8.2.3-1, the main measurement items are listed. Culture is often found in people's unconsciousness. Culture's concept is extremely broad and its meaning is constantly evolving and expanding, and only a small part of it can be specified at present. Thus, the challenging needs is more of a vision of the future of humanities research. While the challenging needs may not seem to satisfy many of the participants, in fact, the participants' activities in buildings have become part of the culture. Participants are just not aware or have not yet achieved what they consider to be self-actualisation. As architects, it is their responsibility to use architecture to help the public achieve their self-actualisation. Therefore, in the process of transformation, the architectural culture, both old and new, needs to be perceived and accepted by the participants as much as possible.

Challenging needs	
Cultural needs	Are there any preserved material industrial elements, and are these easy to find?
	Do the material industrial elements have historical value?
	Is there information about the important industrial elements, or an official website with relevant descriptions, are these easy to find?
	Can users associate with the industrial scene of the past from these material industrial elements?
	Does the building use its industrial background and heritage to attract visitors?
	Is there an element of contemporary-meets-historical?
	Is the project advertised in an attractive way?
	Will the project achieve local recognition in a short time?

Table 8.2.3-1 Questions to consider on the aspect of challenging needs (these are not absolute, and should be applied flexibly in different projects, could be expanded or reduced accordingly) (by author, 2022).

8.3. Contribution to knowledge

As an important resource for urban regeneration, old industrial buildings are an important representative of the optimisation of existing abandoned buildings and can be adapted to most countries. The reuse of old industrial buildings has its own specificities and can represent the reuse of many other types of buildings. For example, office buildings are similar to many civil buildings, and older buildings will relate to the reuse of historical or heritage buildings. This research will have an important impact on the reuse of buildings.

8.3.1. Implications for academic research

8.3.1.1 Interdisciplinary, from psychology to architectural space

The emphasis throughout the thesis has been on buildings as a service to people. The direction of architectural development is to a large extent determined by the public users. The researcher's discipline is architecture, but the study is not limited to the field of architecture. The life of public users will involve a wide range of scientific fields. In other words, the scientific issues involved in people's use of buildings are not limited to the field of architecture either. This study examines whether architecture can satisfy people's needs from the perspective of their psychological needs. It is an interdisciplinary experiment and an innovation that will influence the future of public architecture. It also shows that the field of architecture has reached a new level of development, which is not only focused on physical comfort but also on the psychological comfort of the users. All new technologies will ultimately be reflected in how they are used, and it is how people experience them that is the key measure of these new technologies. Not all innovations are positive; for example, the once well-known case of the Farnsworth House ended up in court because it went against the needs of its user. Overall, this thesis integrates psychology and architecture, emphasising that the future of architecture is dependent on the joint work of a wide range of fields.

8.3.1.2 Clear assessment content and process

The study creatively lists evaluation items that are easy to understand, specific, and clear. As in Maslow's Hierarchy of Needs, it is clear what each need should contain, such as breathing, temperature, sleep, water, food, etc., in the physiological needs. These clear evaluations can be easily applied to the design by the designer, rather than being understood only by the academic. In addition, the study is not just a framework, but also a demonstration process of the assessment process. Guided by the assessment framework, it allows one to easily find the objects to be measured corresponding to the real-world cases in order to obtain the

relevant data. Thereafter, the use of an efficient mathematical statistical method, the fuzzy comprehensive evaluation method, enables the evaluation process to be transformed from qualitative to quantitative and the calculation model to become simpler and more scientific. Overall, an important impact of the research is its universality. If designers understand the content of this evaluation, then the design will be made more satisfying to the needs of the public. It is even assumed that by making the public aware of this assessment system, not only will more people be able to achieve their self-fulfilment needs and undertake the transmission of culture, but it will also demonstrate the phenomenon of public participation in architectural design.

8.3.2. Implications for future design

This study is an evaluation of a completed (reused) project, but this does not mean that its significance stays in the 'past'. The purpose of evaluating completed projects is to identify strengths and weaknesses, but also to learn from them and improve what is mentioned in the assessment in future designs. Academic research will ultimately be applied to reality, serving the public in the everyday life, and as a guide for the design of future projects. The key research findings summarised above can be seen as issues to be taken into account in the future design of the project. By addressing these issues well, the project will be able to provide a better experience for the public. At the same time, as the project is revitalised, it can also have a positive radiating effect on the community in which it is located. For example, the public square of the project becomes an event venue for the surrounding population and the retail attracts city residents to come and enjoy activities and consumption.

In addition, this research gives hope for the future of those ordinary old industrial buildings. In simple terms, the study concludes that a building that meets the needs of people can be considered a good building. Many of those buildings that are rated as heritage are forced to be preserved or reused due to government pressure. The pressure of rapid urban regeneration, especially in China, has led to the demolition of too many old industrial buildings before their historical and cultural value has been explored. Therefore, the proposal of such a transformation programme to meet the needs of the public has the potential to preserve some historical buildings to a certain extent.

The reuse of old buildings is an adjustment of the gap between the physical and functional life of a building throughout its life cycle. The functional life of an old building is over, and the reuse gives it a new functional life based on its physical life, so that it can start a new life cycle. According to the study, the reused building will better meet the needs of the public, which

means that the new functional life will last longer, slowing down the project's elimination to maintain a longer life cycle.

8.4. Research limitations

The whole PhD research is an innovative approach to the assessment of reused old industrial buildings through the study of Maslow's psychological theory, combined with the design theory of architectural space. Although this research can have an impact on the development of architecture, it must be acknowledged that there are limitations to this doctoral study, which may be influenced by time, economic conditions, independent research factors (non-team), unexpected situations (epidemics), etc.

As an assessment method, it should be able to be widely used by a category of architectural issues. It is therefore necessary to use a certain number of cases to demonstrate the usefulness and universality of this assessment method. At present, the research has only selected two cases from China, the 1933 Old Millfun and Bingshan Industrial Culture Exhibition Hall. Although their individual characteristics are representative of some of the problems in the current situation, more case studies should have a positive effect on the improvement of the assessment method. However, the three-year period of PhD research is not sufficient for the researcher to conduct detailed research on multiple cases. In the future, the researcher would like to be able to build a team to help collect data on multiple cases.

Furthermore, in the individual case study, some data collection may be inadequate. In detail, this means that the data collected in the case study can only reflect the situation at the time of the survey and not for the whole year or for a long period. Of course, it is not realistic for a research to visit a case every day for a whole year. More importantly, due to the impact of the epidemic, public buildings in China have been closed for a long time in the last three years. This created a major obstacle for the research to investigate the case at different times (such as different seasons and different holidays). Now that there is a change in China's attitude towards the issue of the epidemic, the research is confident that the data can be improved and perfected in the future.

The research is a breakthrough in the interdisciplinary field, combining not only psychology but also mathematical ideas. This breakthrough is in fact an experiment, as there is little research and practice of this kind to acknowledge the positive effects of this research on the future development of architecture. As this is an experimental step, the current assessment framework may not be excellent and there is a greater need for future scholars to improve and develop this theory. At the same time, some of the standards for measuring items in the assessment framework are based on the context of China. As different countries have different standards and habits, the research hopes that the assessment framework will be developed

by scholars in more countries in the future so that it can be applied to more countries around the world.

8.5. Potential for further research

The innovation of the research is that it opens up a new path for future research on the subject: the assessment of buildings to meet the needs of the public participants. The current study may still be in the experimental stage, but its theoretical ideas will provide an important foundation for future research; in this way, many further innovative studies could be carried out around the framework.

The first is about the universality of the assessment methods. As mentioned in Section 7.4, although the thesis was conducted in the context of China, the assessment method should be able to be applied to other countries' environments in the future. Therefore, in the future, there is a need to try to apply this idea to projects in different countries as a way to adapt the assessment method and make it more widely applicable. This mainly relates to the standards for measuring items. For example, in the measurement item of fire safety, the regulations vary from country to country, so it is important to score according to the local standards.

Secondly, this method of assessing statistical calculations is not limited to the fuzzy comprehensive evaluation method. The fundamental approach in this research is to take a complex issue and divide it into a number of simple influences; these multiple influence factors are studied one by one, and the statistics are then integrated by the fuzzy set to solve the initial complex issue. In addition to the fuzzy comprehensive evaluation method, there are other statistical or evaluation methods that can also integrate data from multiple influencing factors. In this research, the fuzzy comprehensive evaluation method has provided a reference point for future similar multi-factor-influenced building assessment methods, such as principal component analysis (PCA), analytic hierarchy process (AHP), and data envelopment analysis (DEA). Besides, based on these statistical methods, future research can be combined with the computer field. For example, a computer could be loaded with a statistical algorithm program, so that statistical results could be obtained quickly by simply inputting the data researched in the project; even, in the future, AI technology will be able to autonomously evaluate the goodness of a built case, or develop guidelines for a new case, after allowing the computer to 'learn' from a large number of cases.

Then, there is a vision for the future of the research field of the reuse of old industrial buildings. ‘Cultural circulation’ is mentioned in Section 3.3.3.3 of the thesis. In future research, it is hoped that the current reused cases, which have fallen into decline, can be re-used. This will further explore the people’s needs for 're-reused buildings' in the decades to come.

Finally, this assessment framework does not need to be limited to the adaptive reuse of old industrial buildings as public buildings, and in the future, it can be evolved to evaluate many other types of buildings. With a basis for assessing how buildings meet people's needs, future research could involve the evaluation of the reuse of other types of old buildings or area planning, such as historical buildings, old villages, etc.

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Appendix 1

Questionnaire for

Shanghai 1933 Old Millfun and Dalian Bingshan Industrial Culture Exhibition Hall

The purpose of this survey is to evaluate the experience of visitors attending Shanghai 1933 Old Millfun or Dalian Bingshan Industrial Culture Exhibition Hall. Thank you for taking the time to fill in this questionnaire; it should only take 2 minutes. Your answers will be treated with complete confidentiality and entirely anonymous. If you have any questions about this questionnaire, please contact the researcher of this application: Xuesen Zheng. Email: xuesen.zheng@nottingham.ac.uk.

1. Does it match your expectations after the visit? [Choose Yes or No]*

	Have expectation before visiting		Are expectations met after the visit	
A wonderful industrial visual experience	Yes	No	Yes	No
Interesting stories of industrial history	Yes	No	Yes	No
Favourite stores (retails, restaurants, etc.)	Yes	No	Yes	No
Just passing by	Yes	No	Your achievements: _____	

2. Does it feel like anything is unsatisfactory

☐ No, everything is good.

☐ _____ make me feel unsatisfactory.

Demographic Data Collection:

1. Your age range: [Single Choice]*

☐ 18-35 ☐ 36-45 ☐ 46-59 ☐ Above 60 ☐ Prefer not to say

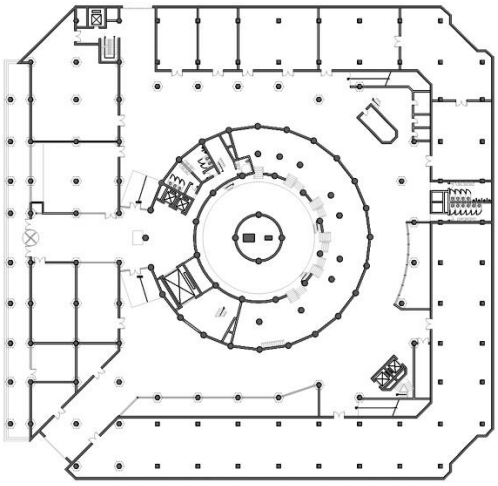
2. Your gender: [Single Choice]*

☐ Male ☐ Female ☐ Prefer not to say

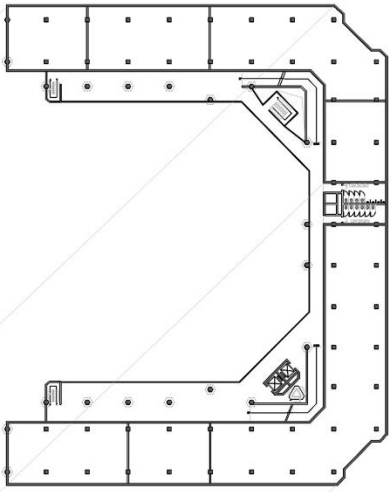
3. Your birthplace: [Single Choice]*

☐ Local ☐ Out of this city ☐ Prefer not to say

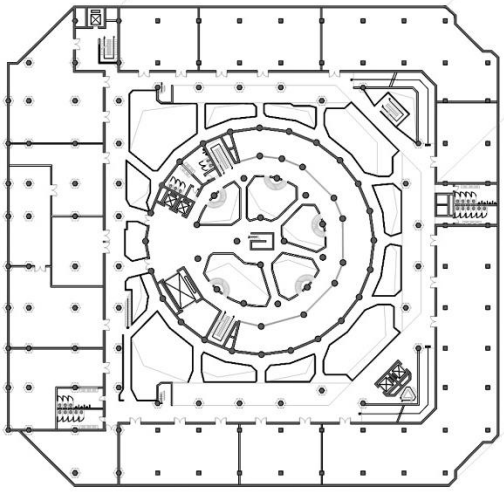
Appendix 2 （Layout of 1933 Old Millfun）



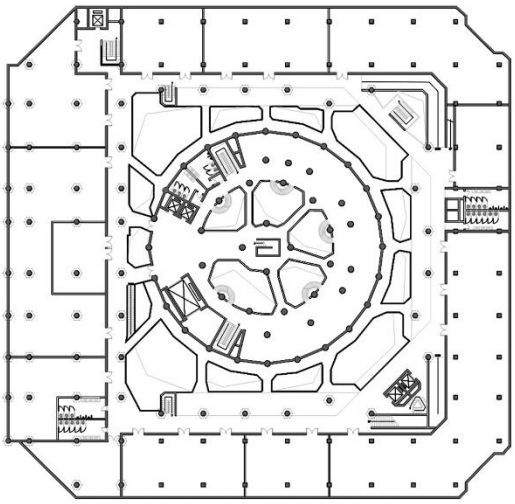
1F



2A



2F



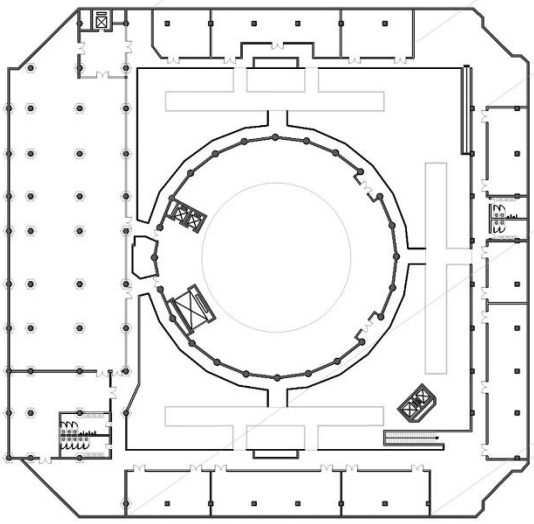
3F

Office

5F

Office

Office



4F

Appendix 3

Wind Speed Simulation Report

Hot summer days outside: if it is windy outside, you can start to feel the coolness on the first floor. Due to the complexity of the building space, the lower floors have more shaded areas in the outdoor space and can be sheltered from sunlight.

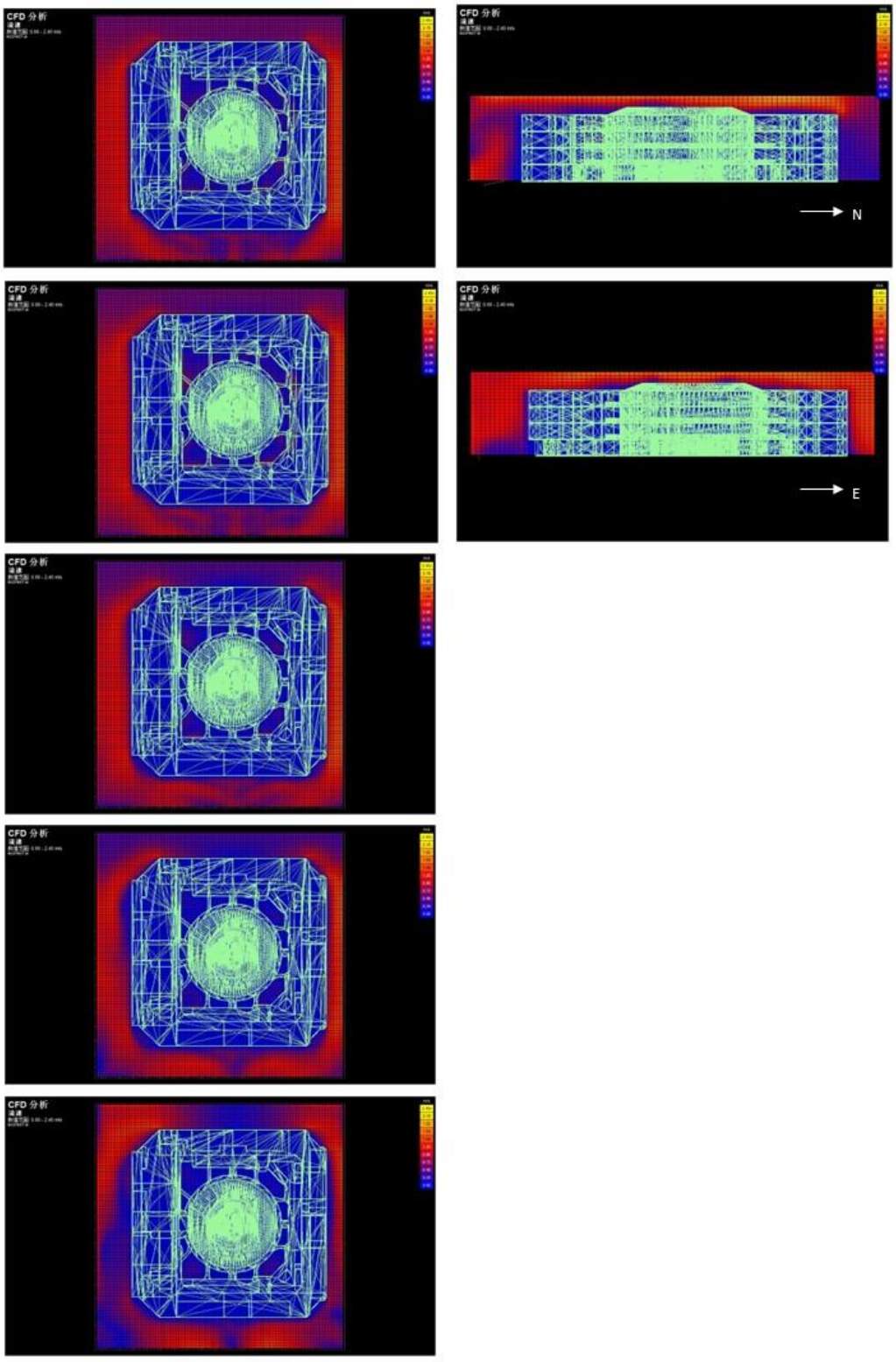
Winter when it is cold outside: 4F is windy, and below 3F it can be sheltered from the wind.

Summary:

The wind is low on the 1,2,3F all year round, except on the top floor, where the 4F accessible terrace is more influenced by the outside wind. The building shelters the wind at the outside, and the inner environment is relatively low and stable in terms of wind speed.

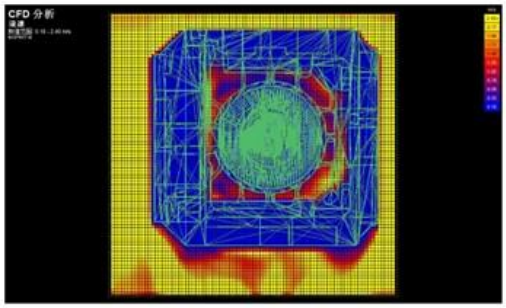
Winter

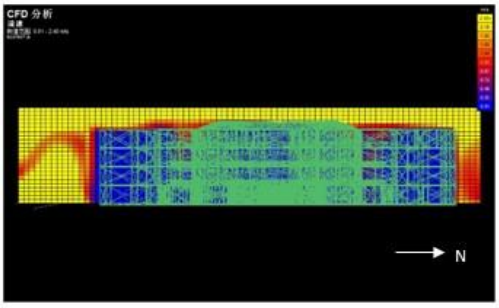
Wind direction:
Minimum north

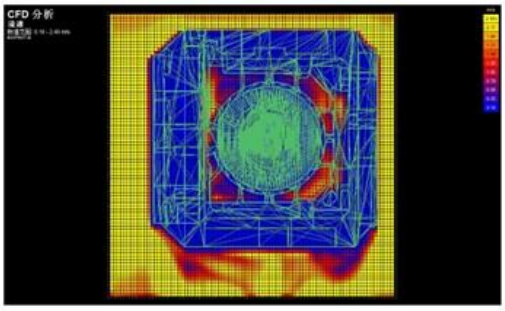


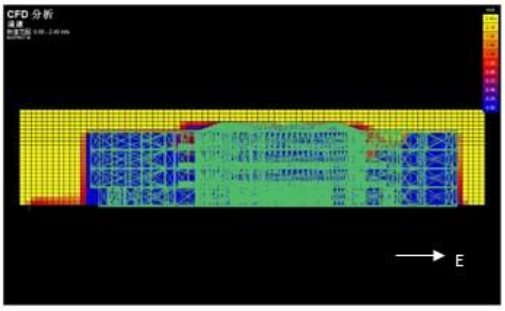
Winter

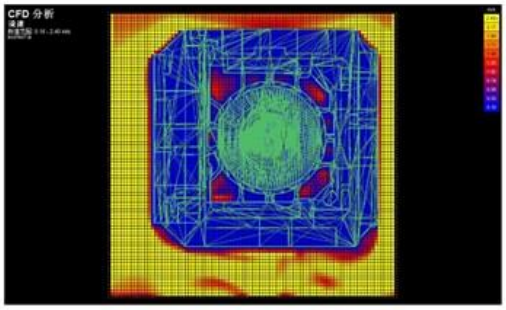
Wind direction:
Maximum north

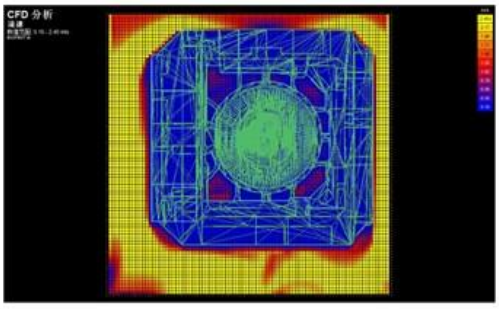


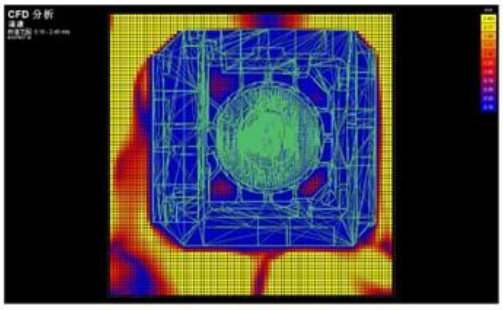






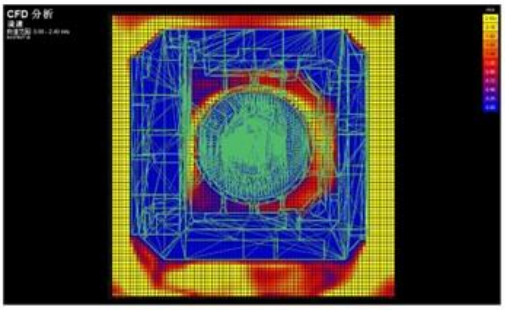


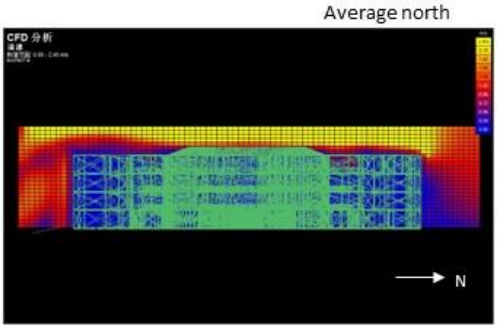


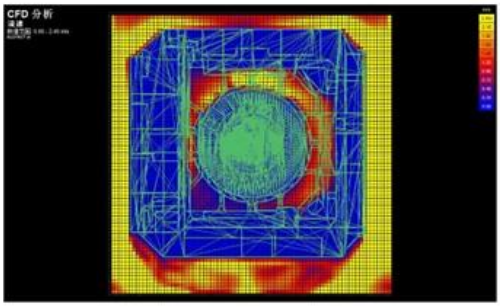


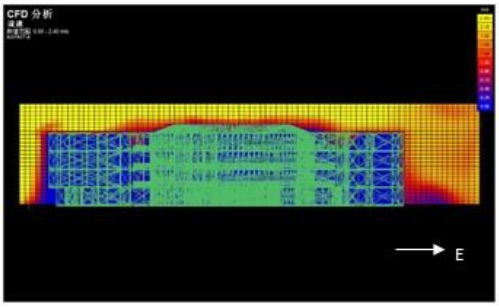
Winter

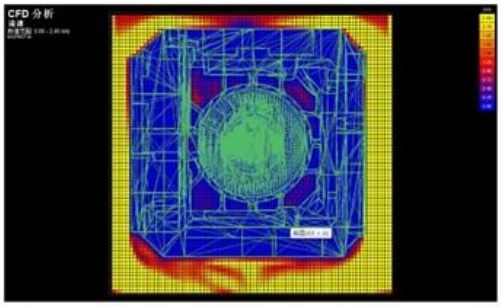
Wind direction:
Average north

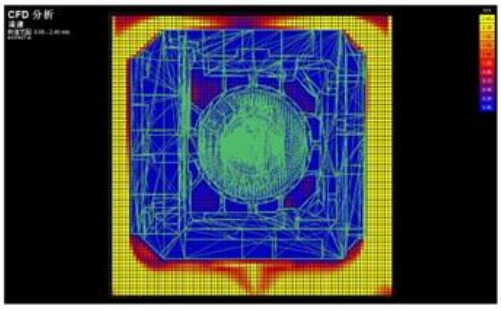


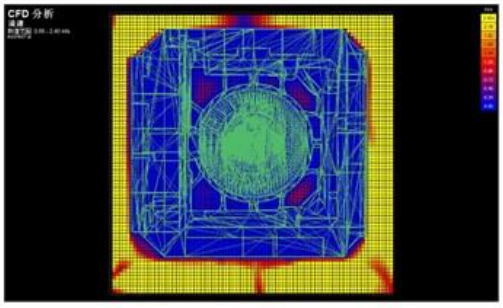






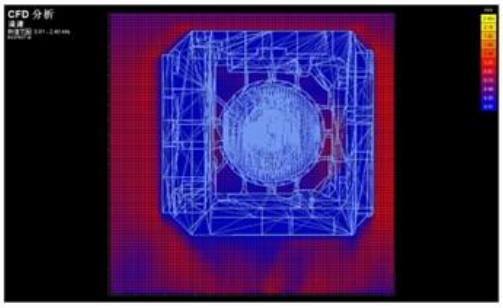


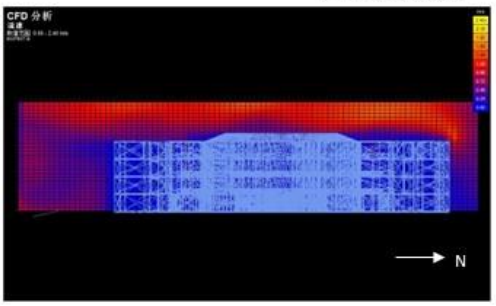


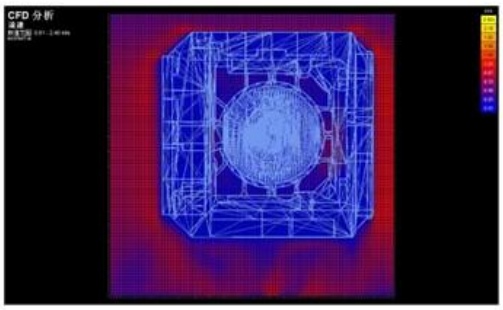


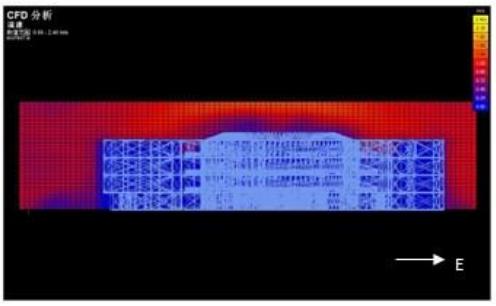
Autumn

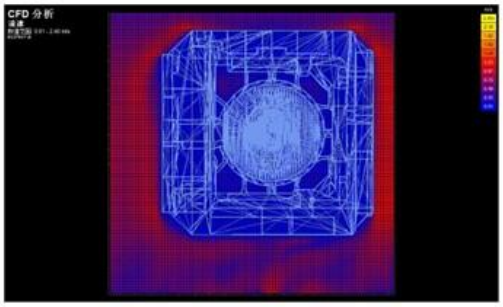
Wind direction:
Minimum north

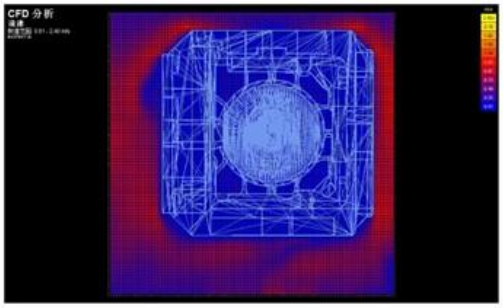


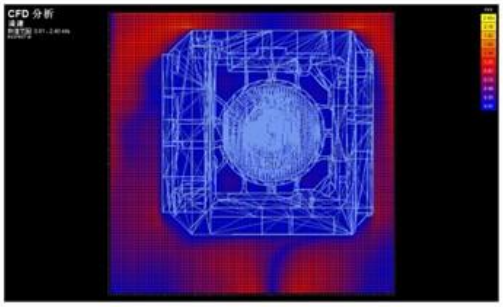






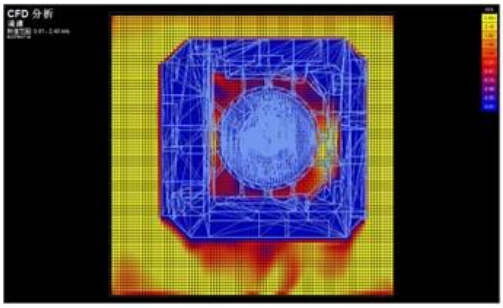


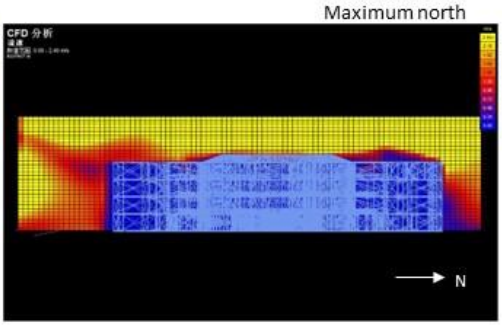


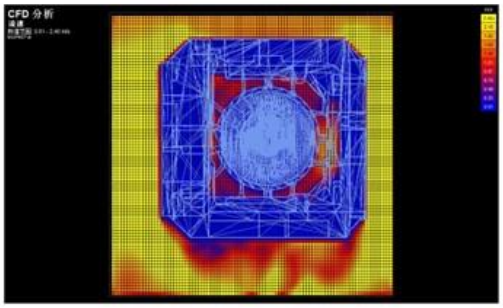


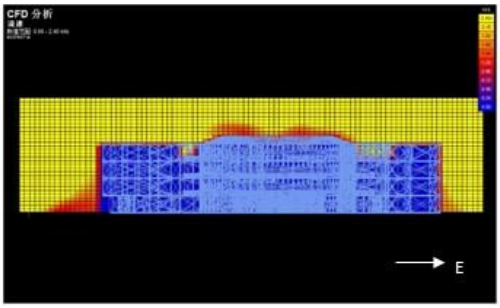
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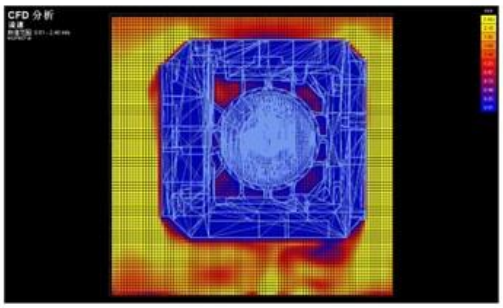
Wind direction:
Maximum north

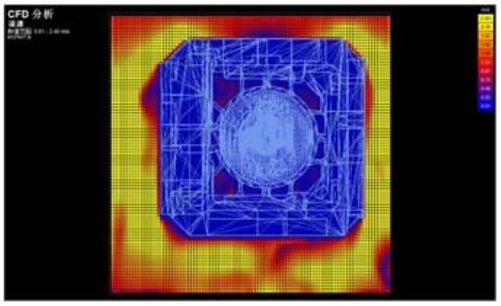


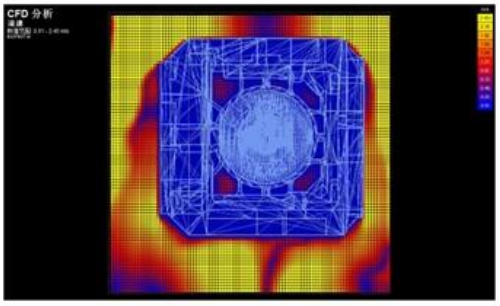






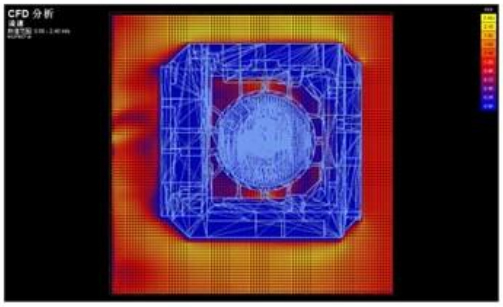


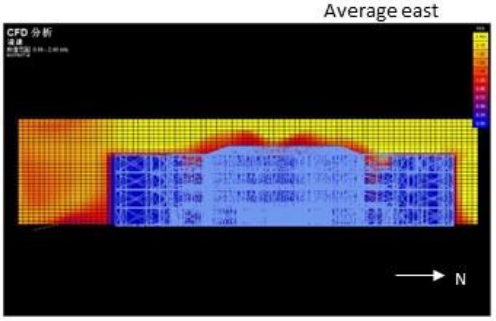


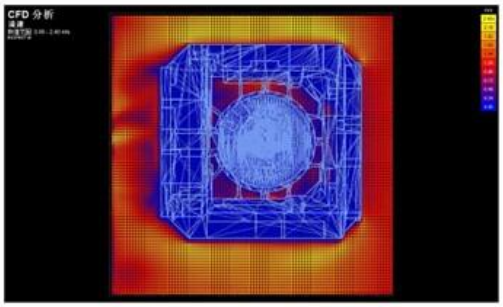


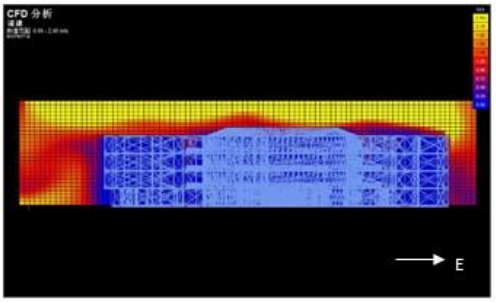
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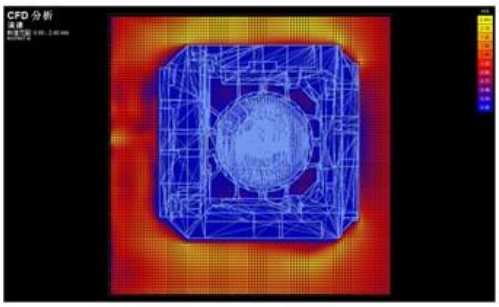
Wind direction:
Average east

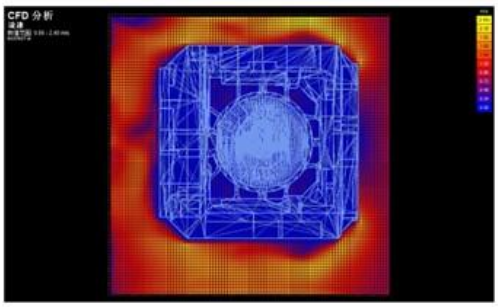


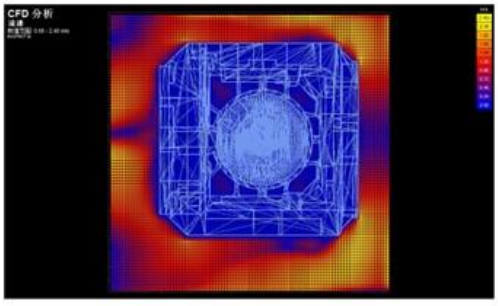






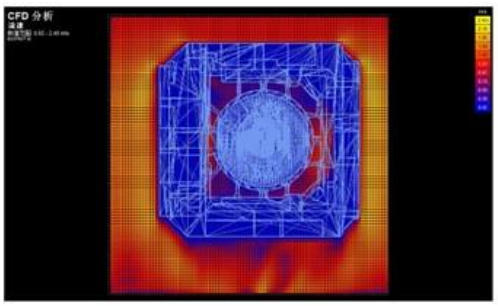


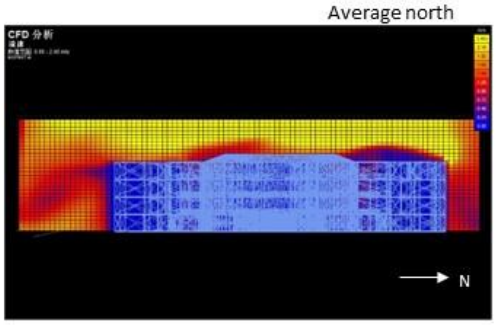


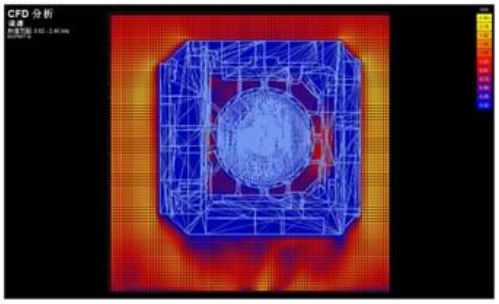


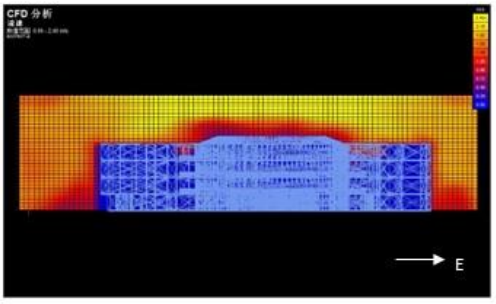
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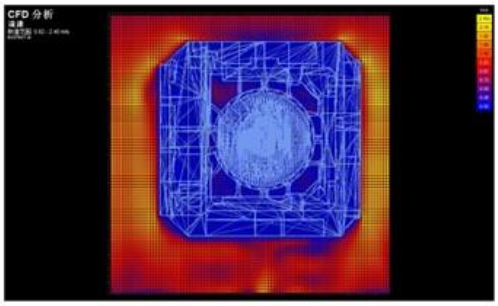
Wind direction:
Average north

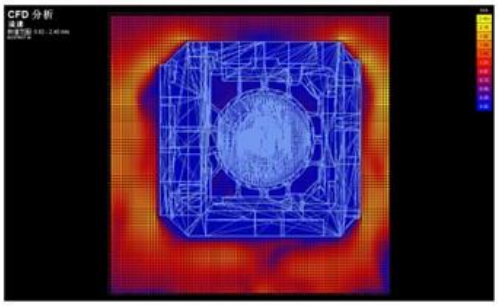


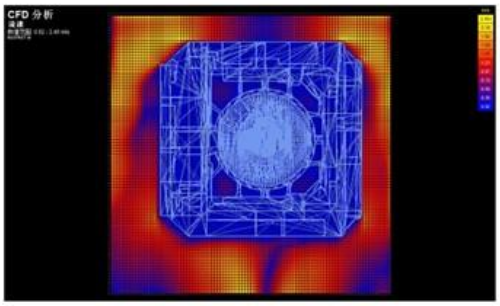






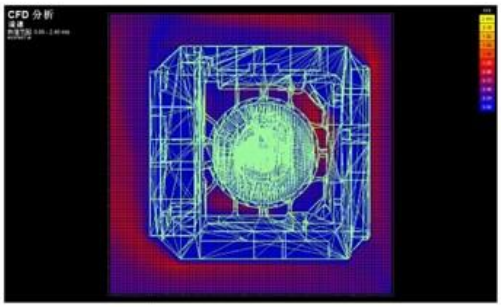


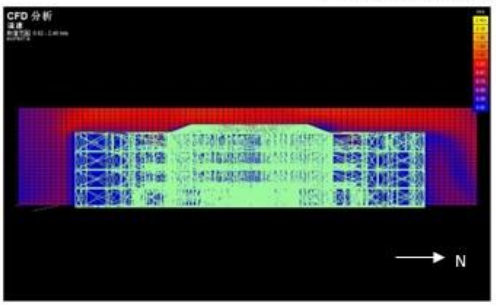


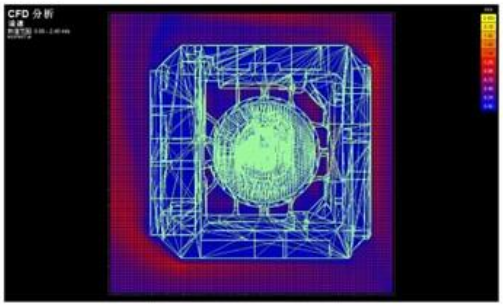


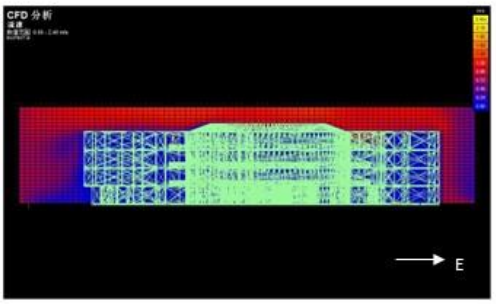
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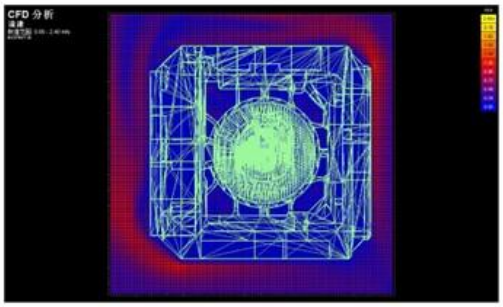
Wind direction:
Minimum southeast

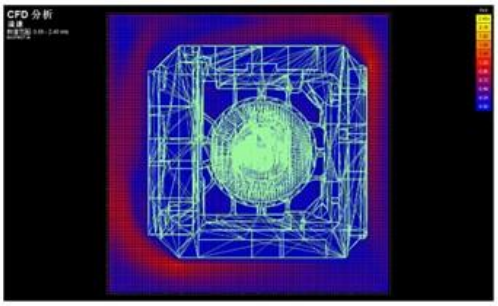


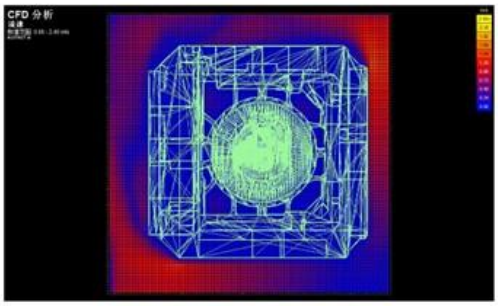






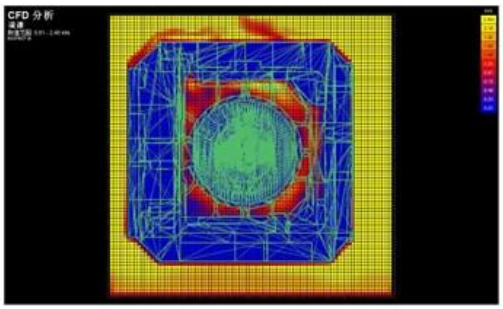


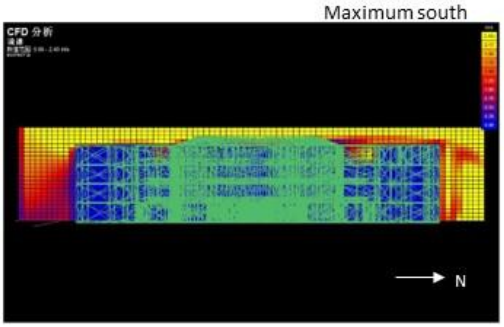


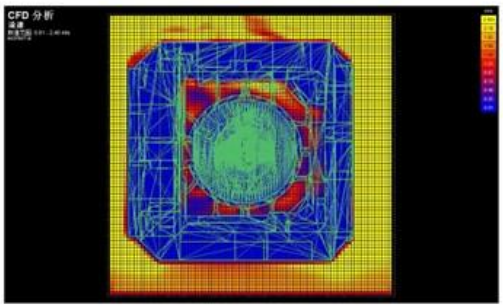


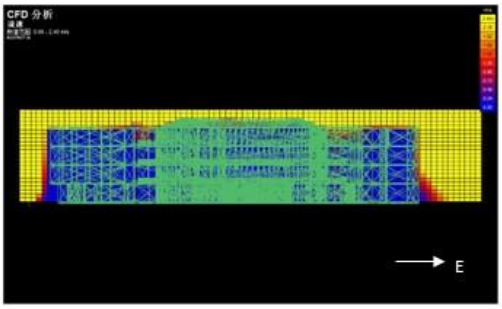
Summer

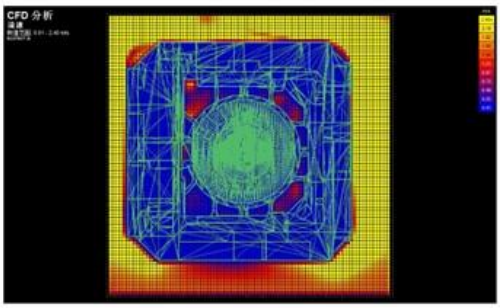
Wind direction:
Maximum south

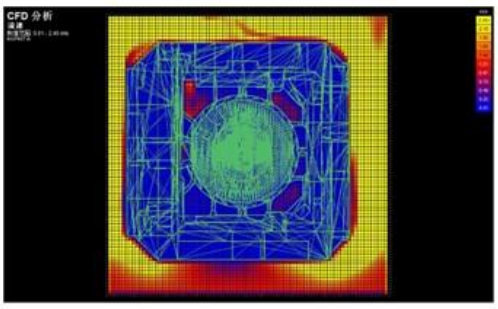


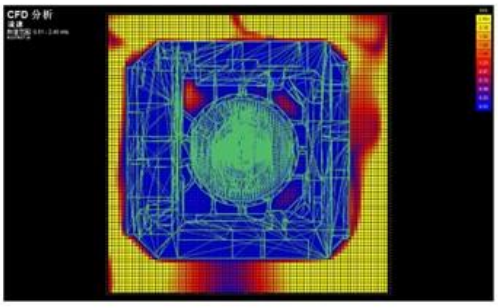






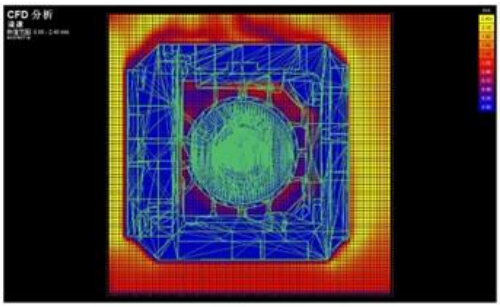


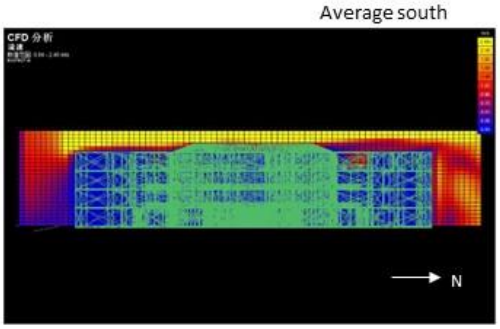


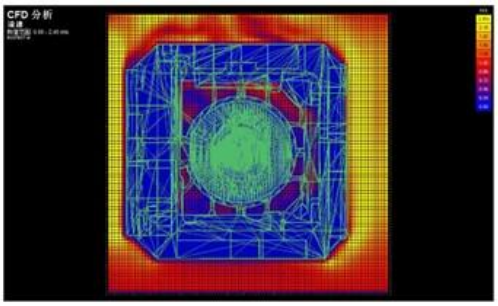


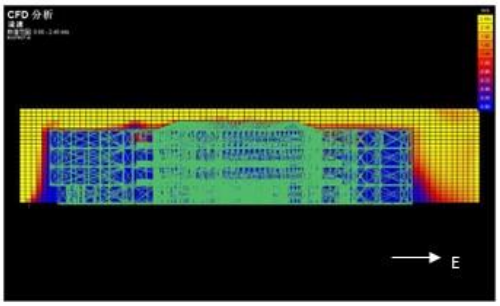
Summer

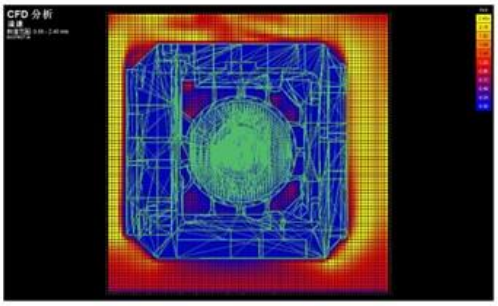
Wind direction:
Average south

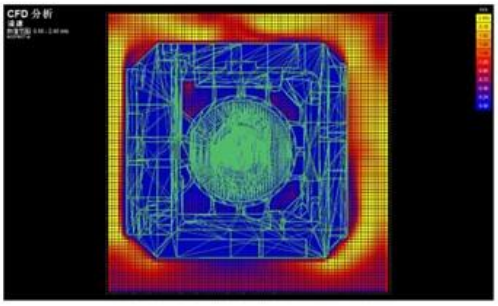


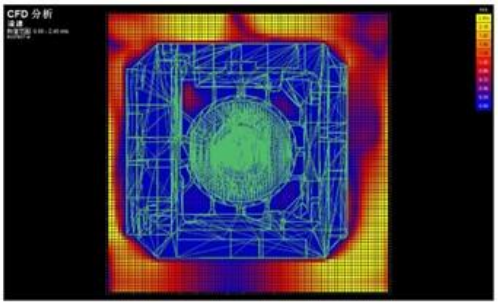






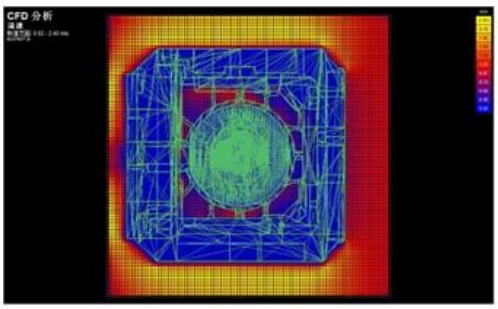


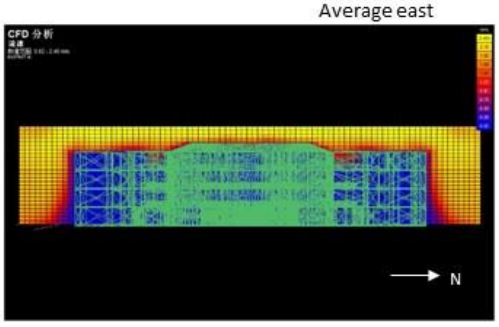


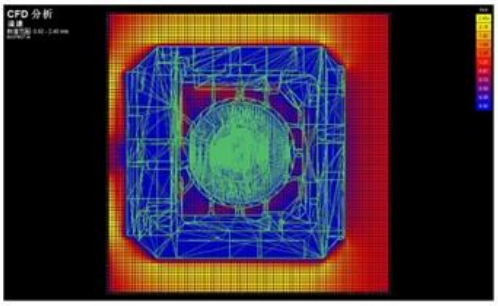


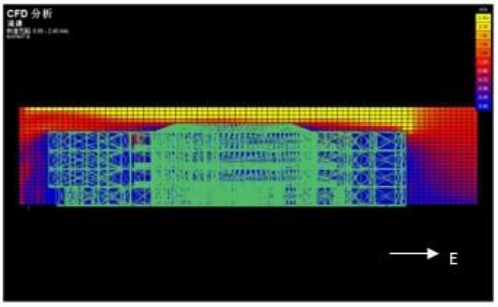
Summer

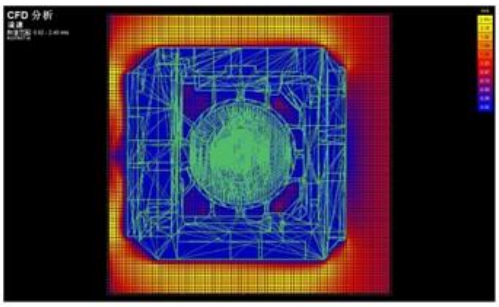
Wind direction:
Average east

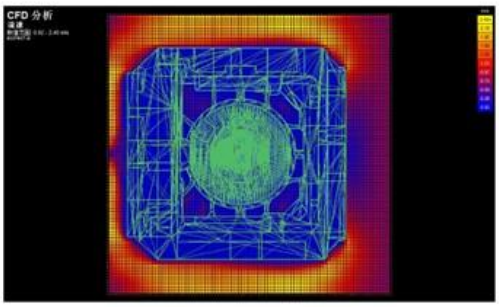


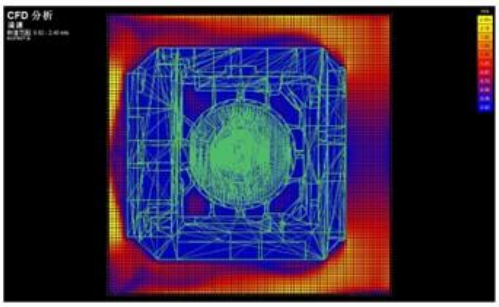






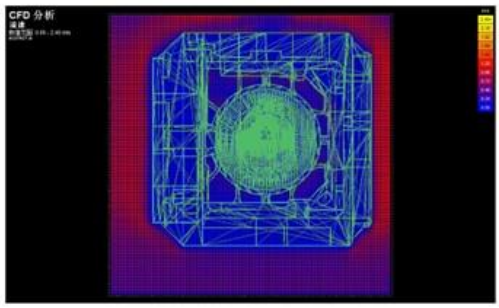


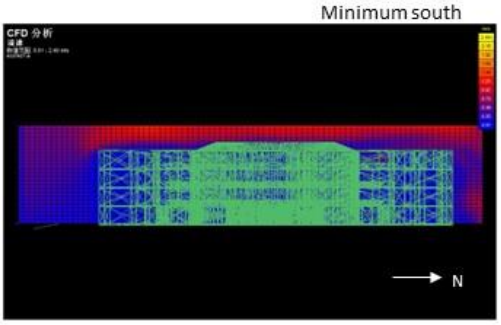


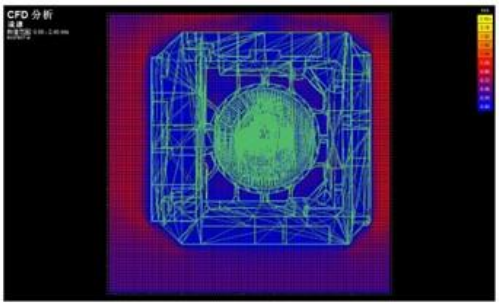


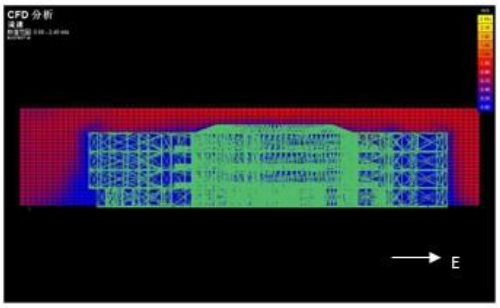
Spring

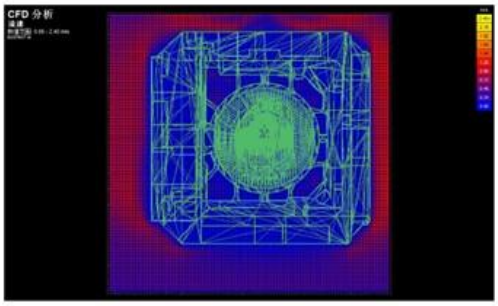
Wind direction:
Minimum south

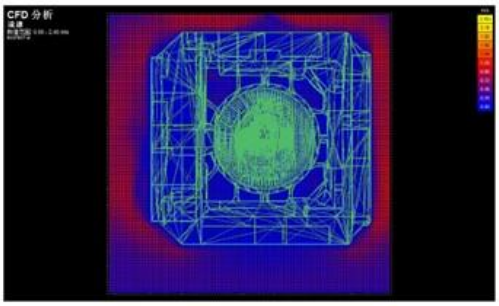


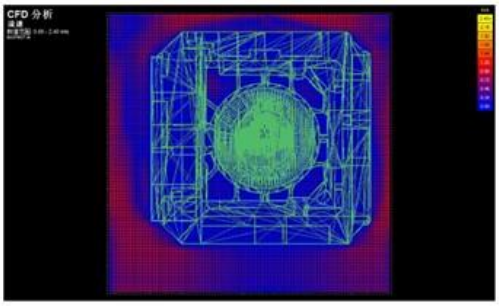






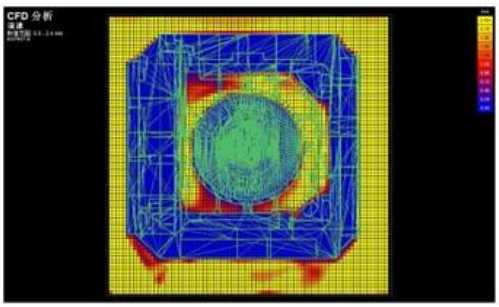


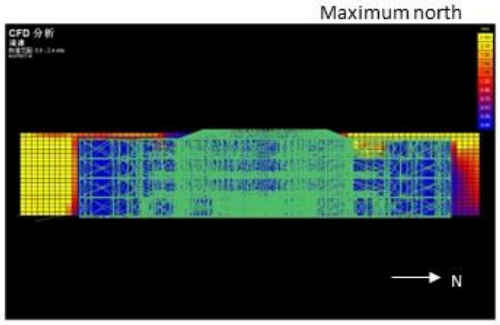


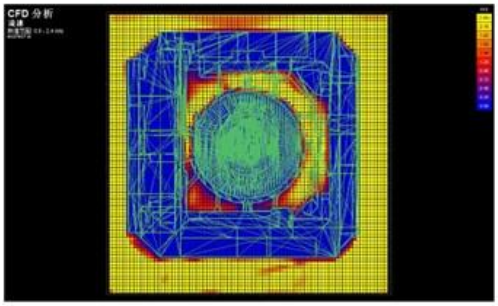


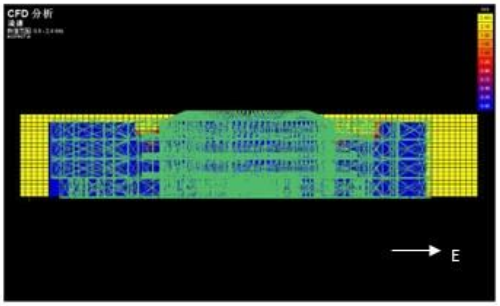
Spring

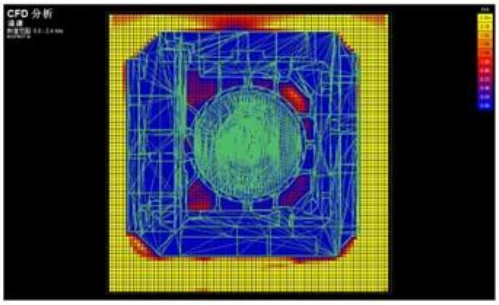
Wind direction:
Maximum north

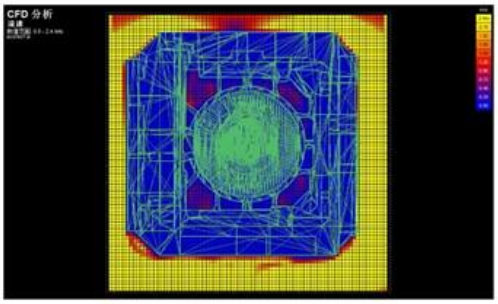


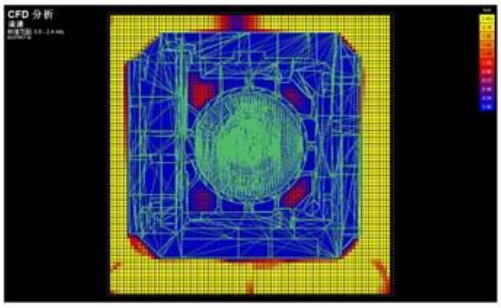






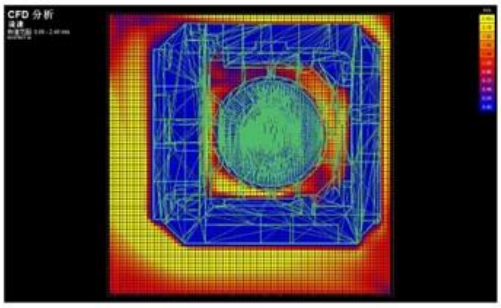


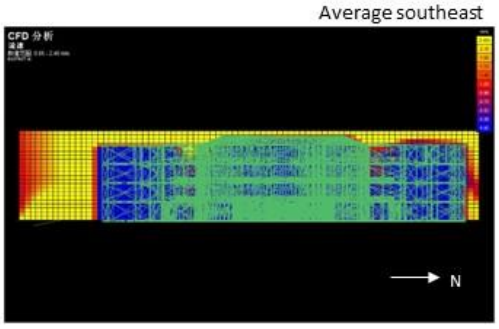


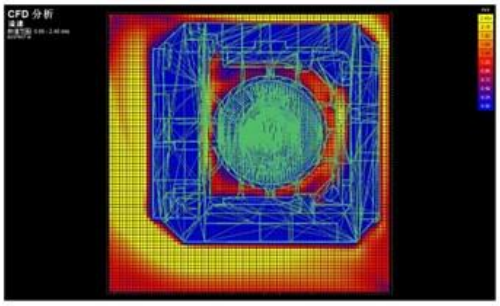


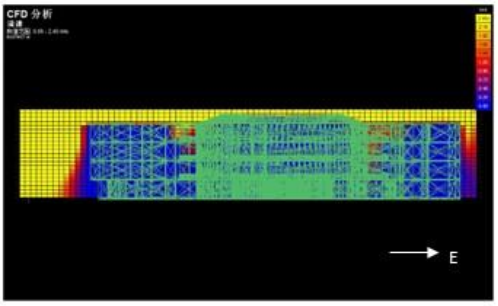
Spring

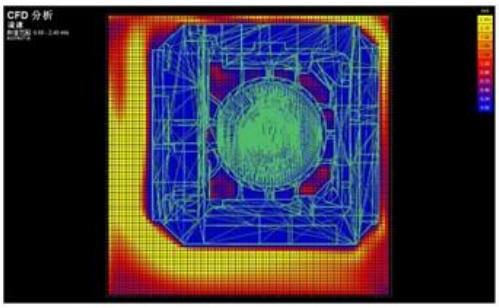
Wind direction:
Average southeast

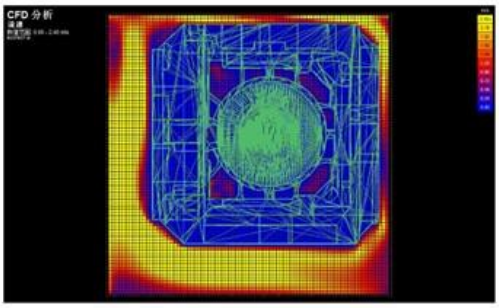


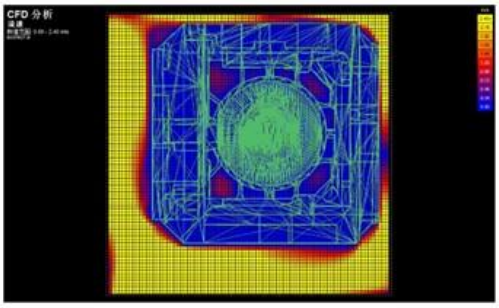






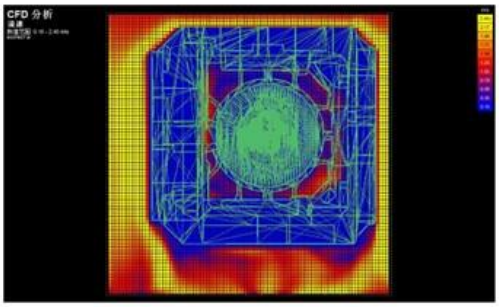


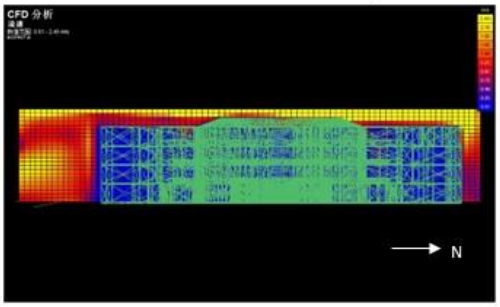


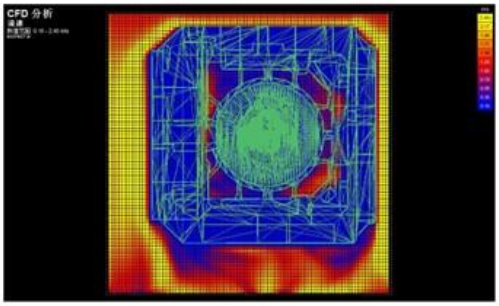


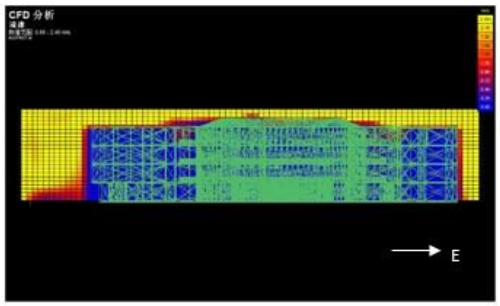
Spring

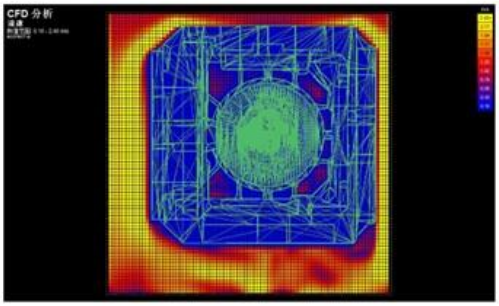
Wind direction:
Average north

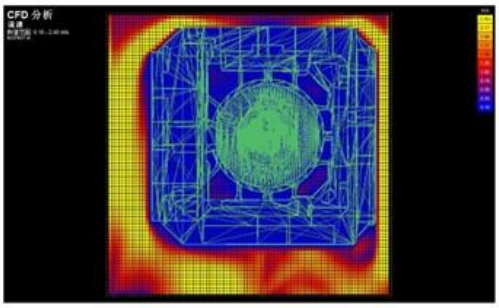


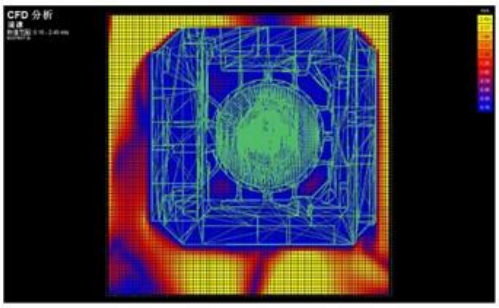












Appendix 4 （Layout of Bingshan Industrial

Culture Exhibition Hall）

