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South China University of Technology

专业学位硕士学位论文

韧性理论视角下的广州船舶工业遗产更新策略研究——以广州文冲船厂为例

作　者　姓　名	聂萌
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指　导　教　师	导师组
所　在　学　院	建筑学院
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Research on the Renewal Strategy of Guangzhou Shipbuilding Industry Heritage from the Perspective of Resilience Theory——A Case Study of Wenchong Shipyard in Guangzhou

A Dissertation Submitted for the Degree of Master

Candidate：Nie Meng

Supervisor：SCUT-POLITO co-supervisors

South China University of Technology

Guangzhou, China

分类号：TU98 **学校代号：10561**

学　号：202121006704

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作者姓名：聂萌　　指导教师姓名、职称：导师组

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主席：　冯江　

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指导教师签名：　　日期：2023 年 09 月 06 日

作者联系电话：15920521951　　电子邮箱：1044006955@qq.com

联系地址（含邮编）：广州市天河区五山路 381 号建筑学院 510640

摘要

船舶工业遗产作为广州极具特色的工业遗产之一，见证了广州作为重要海洋贸易中心的地位，具有重要的历史意义。在城市更新的背景下，这些船舶工业遗产有的因保护不力而面临着拆除的命运，有的虽得到了更新,但并未考虑与周边环境的社会-生态关系，最终导致遗产的破坏和消失。因此，广州船舶工业遗产需要寻求一种更新方法，以一种可持续的方式发挥其在城市中的作用。

由于长期的工业建设，广州船舶工业遗产内部要素松散，连通性差，外部面临城市化和土地利用压力以及气候变化和海平面上升等环境威胁。而韧性理论将城市看作一个复杂的社会-生态系统，其理论的实施对象包括但不限于物理基础设施、社会经济结构、环境生态系统和治理机制等方面。韧性理论强调系统的适应力和恢复力，正是广州船舶工业遗产在更新过程中所需要的特质。本文从韧性理论的视角，提取出广州船舶工业遗产的五大韧性要素，并对其实施策略进一步延申，通过对物质和生态环境的改善来避免外部扰动，对社会框架和制度框架的调整来适应环境威胁，使其能有效预防、快速适应各类内外部不确定的风险和危机。

论文的主要创新点体现在：1、通过对相关文献和资料的整理，对广州 14 处船舶工业遗产的历史背景和更新保护现状进行了相对系统的梳理，为今后的船舶工业遗产研究提供基础；2、文章通过韧性理论的介入，尝试建立起广州船舶工业遗产韧性更新的实践框架，并提取出五大韧性要素，延申探讨具体实施策略。3、最后以广州典型船舶工业遗产——文冲船厂为实证案例，对韧性策略进行验证，并描绘出广州文冲船厂的再生蓝图。

关键词：广州船舶工业 ； 工业遗产 ； 韧性设计 ； 城市更新

Abstract

The shipbuilding industry heritage, as one of Guangzhou's highly distinctive industrial heritages, bears witness to Guangzhou's position as an important maritime trade center and has significant historical significance. In the context of urban renewal, some of these shipbuilding industry heritages face the fate of demolition due to inadequate protection, while others have been updated without considering the social ecological relationship with the surrounding environment, ultimately leading to the destruction and disappearance of the heritage. Therefore, Guangzhou's shipbuilding industry heritage needs to seek a renewal method to play its role in the city in a sustainable manner.

Due to long-term industrial construction, the internal elements of Guangzhou's shipbuilding industry heritage are loose, with poor connectivity, and external environmental threats such as urbanization and land use pressure, as well as climate change and sea level rise. The resilience theory regards cities as a complex socio-economic system, and its implementation targets include but are not limited to physical infrastructure, socio-economic structure, environmental ecosystems, and governance mechanisms. The resilience theory emphasizes the adaptability and resilience of the system, which is precisely the characteristic required for the renewal process of Guangzhou Shipbuilding Industry Heritage. This article extracts the five resilience elements of Guangzhou's shipbuilding industry heritage from the perspective of resilience theory, and further extends its implementation strategies. By improving the material and ecological environment to avoid external disturbances, and adjusting the social and institutional framework to adapt to environmental threats, it can effectively prevent and quickly adapt to various internal and external uncertain risks and crises.

The main innovation points of the paper are as follows: 1. Through the organization of relevant literature and materials, a relatively systematic review was conducted on the historical background and current status of renewal and protection of 14 shipbuilding industry heritage sites in Guangzhou, providing a foundation for future research on shipbuilding industry heritage; 2. The article attempts to establish a practical framework for the resilience renewal of Guangzhou's shipbuilding industry heritage through the intervention of resilience theory, extract five major resilience elements, and further explore specific implementation strategies. 3. Finally, taking Wenchong Shipyard, a typical heritage of Guangzhou's

shipbuilding industry, as an empirical case, the resilience strategy is validated and the regeneration blueprint of Guangzhou Wenchong Shipyard is depicted.

Keywords: Guangzhou Shipbuilding Industry ； Industrial Heritage ； Resilient Design ； Urban Renewal

Contents

Chapter1 Introduction

1.1 Background

1.1.1 Guangzhou Shipbuilding Industry Heritage urgently needs to be updated

Against the backdrop of tight urban development space, China has gradually entered the post industrial era with existing resources and available land as the carrier of development. Due to overcapacity in Guangzhou's old shipbuilding industry, it has gradually declined. Some poorly managed shipyards have been successively acquired, closed, and abandoned; Due to the needs of urban construction and self-development, some shipyards have carried out relocation from other places, leaving behind a large number of idle industrial waste areas, industrial buildings, and production equipment. Some of these legacy shipyard sites face the fate of demolition and idleness due to inadequate protection and weak control and resilience of their own social ecosystem (Fig. 1-1); Although some have been protected and utilized, their updating and protection work still faces problems such as a single transformation method, insufficient adaptability of functional space, lack of public participation, and incomplete implementation guarantee mechanisms (Fig. 1-2). In addition, due to its unique location and waterfront characteristics, climate change and sea level rise may lead to the destruction and disappearance of the shipbuilding industry heritage. Therefore, the heritage of Guangzhou's shipbuilding industry urgently needs to be updated.

The Guangzhou Shipbuilding Industry Heritage has witnessed important historical events and development changes in China's modern industrialization process, and has very rich historical and cultural value. Therefore, in the face of the dual threats of urban development and ecological environment changes, how to enable Guangzhou's shipbuilding industry heritage to continue to participate in urban vitality while maintaining its original characteristics, bring social and economic benefits to the city, and become a win-win demand for heritage and sustainable development of the city. In the future renovation of the shipbuilding industry heritage, it is crucial to comprehensively enhance the social ecological system of the shipbuilding industry heritage, so that it can effectively prevent and quickly adapt to various internal and external uncertain risks and crises. This is crucial for the current research work. On the basis of meeting the compound Functional requirement of urban waterfront and industrial zone, it provides dynamic possibility and adaptability for the protection of the

marine industrial heritage; Promote the organic restoration and growth of industrial heritage in waterfront areas while balancing the interests of multiple parties.

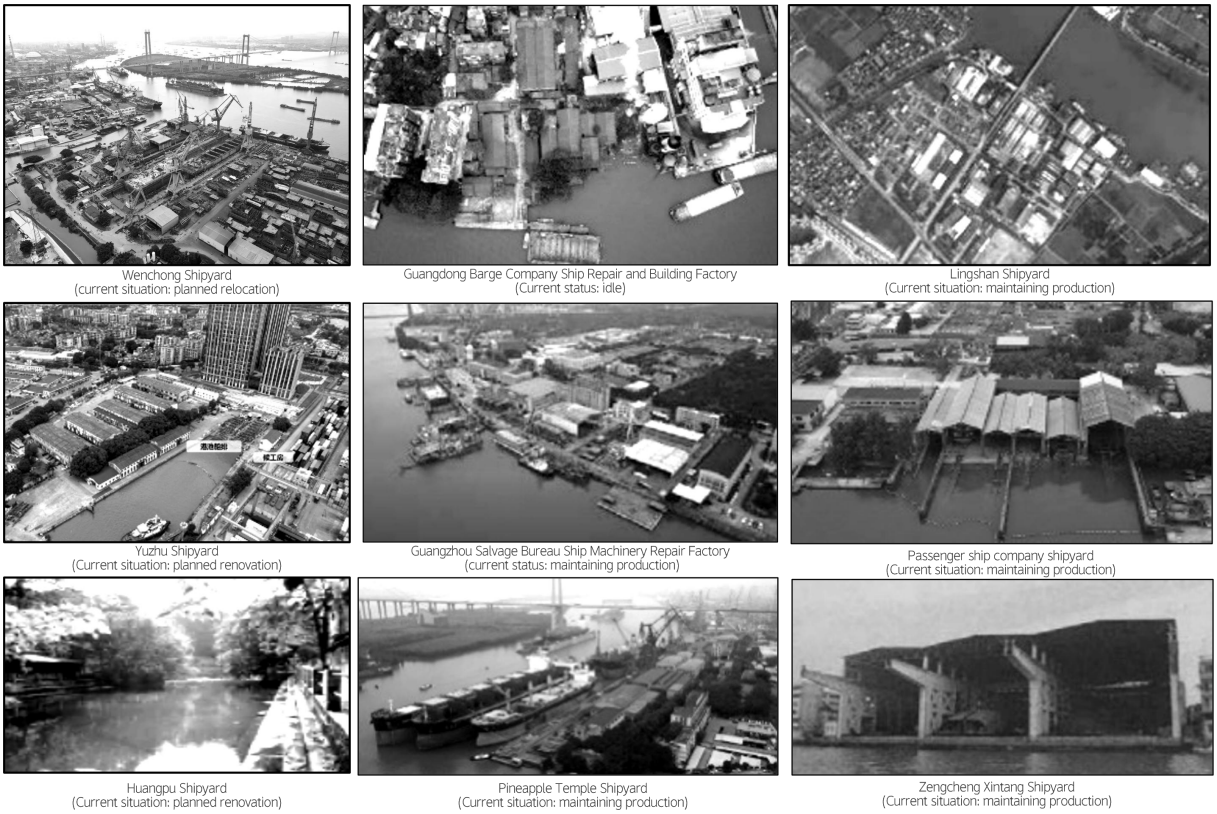


Fig. 1- 1 Guangzhou's Unrenewed Shipbuilding Industry Heritage
Source: Author's Self drawn

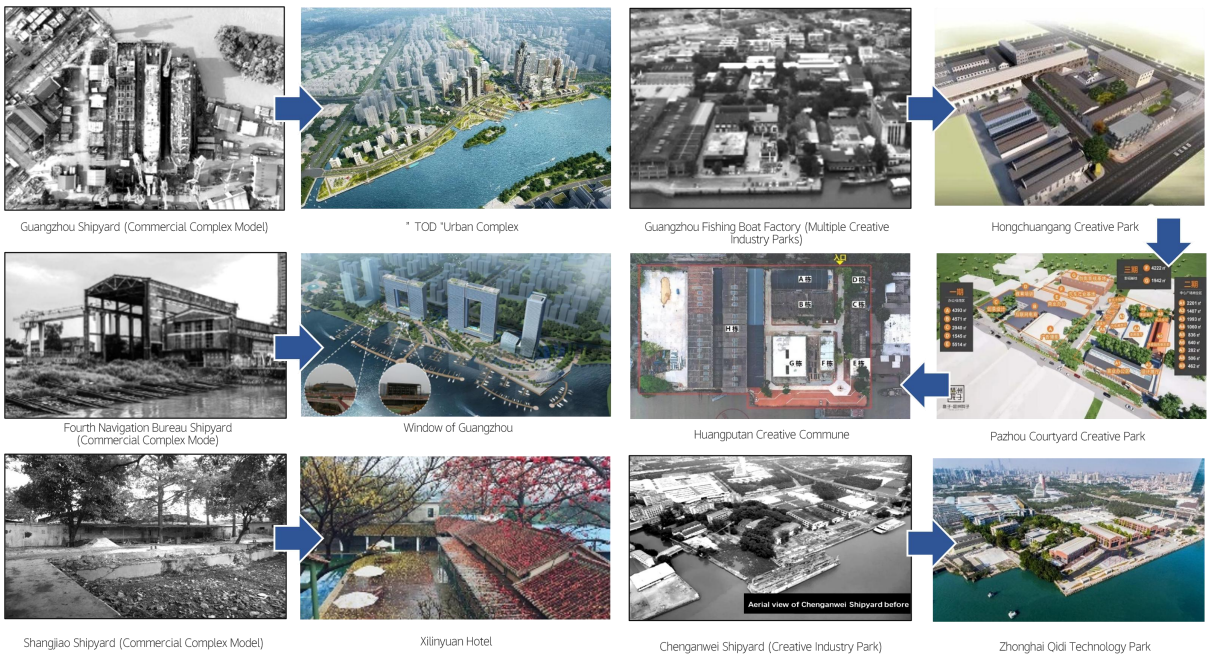


Fig. 1- 2 Updated Shipbuilding Industry Heritage in Guangzhou
Source: Author's Self drawn

1.1.2 Interpretation of Relevant Policies

China's industrial heritage protection started relatively late. In 2000, Dujiangyan was listed in the World Cultural Heritage list, which can be regarded as the beginning of industrial heritage protection in China. Since then, research on industrial heritage in China has been increasing, expanding its scope, but still primarily remains in the academic research stage. In 2006, the "Wuxi Proposal: Focus on Industrial Heritage Protection during the Period of High-Speed Economic Development" was published at the first seminar on industrial heritage protection and reuse in China. This was the first official document in China that proposed protection and attention to industrial heritage in an official capacity[1]. Subsequently, major cities have carried out a series of diverse practices and research on the protection and reuse of industrial heritage, aiming to improve land utilization efficiency and stimulate urban vitality. In December 2017, the Ministry of Industry and Information Technology of China published the first batch of the national-level "Industrial Heritage List (First Batch)." [2]

In 2020, the Department of Industry and Information Technology of Guangdong Province issued the "Management Measures for Industrial Heritage in Guangdong Province," which specifically defined industrial heritage in Guangdong Province [3].

In September 2021, the "Opinions on Strengthening Historical and Cultural Protection and Inheritance in Urban and Rural Construction," issued by the General Office of the CPC Central Committee and the General Office of the State Council, included industrial heritage in the system of historical and cultural protection and inheritance. The document explicitly defined the connotation of the urban and rural historical and cultural protection and inheritance system. It emphasized the importance of protecting and inheriting urban and rural complex and living heritage that holds value in different periods, including historical and cultural cities, towns, villages (traditional villages), blocks, immovable cultural relics, historical buildings, historical areas, as well as industrial heritage, agricultural cultural heritage, irrigation engineering heritage, intangible cultural heritage, and toponymic cultural heritage[4]. However, the specific protection of individual industrial heritage items has not been formally incorporated into the government's management system.

In 2022, the Guangzhou Municipal Government issued the "Guangzhou Industrial Heritage Management Measures," which clarified the research scope of Guangzhou's industrial heritage[5].

In March 2023, the Ministry of Industry and Information Technology of the People's Republic of China issued a policy document titled "Measures for the Management of National Industrial Heritage" to carry out the identification, protection and management, utilization and development, and supervision and management of national industrial heritage, And it is clarified that "National Industrial Heritage" refers to the industrial heritage formed during the long-term development of China's industry, which has high historical, technological, social, and artistic value and has been recognized by the Ministry of Industry and Information Technology. It also specifies the specific content of the core items of National Industrial Heritage[6].

This series of documents marks the official entry of the protection of China's industrial heritage into the government management system, no longer just staying at the academic research stage, greatly ensuring and promoting the recognition and protection of industrial heritage.

1.2 Research Objectives and Significance

1.2.1 Research Objectives

1) Elucidate the development overview, formation background, types, and characteristics of modern and contemporary shipbuilding industrial heritage in Guangzhou;
2) Sort out the origin and development of Resilience theory at home and abroad, clarify the principles and framework of resilience design;
3) Based on renovation case studies of different shipyards, summarize the main issues in their protection and reuse;
4) Explore the guiding significance of flexible design theory for the renovation of shipbuilding industrial heritage and possible research approaches and strategies;
5) Analyze the current situation and the government's future planning and positioning for Guangzhou Wenchong Shipyard, and investigate the strategies and plans for its flexible renovation.

1.2.2 Research Significance

Theoretical Research Significance

Based on the review of relevant materials, current research on shipbuilding industrial heritage in China is still in its early stages. Existing research mainly focuses on individual shipbuilding industrial heritage sites of significant value. Currently, there is only one systematic study of shipbuilding industrial heritage in Guangdong Province, which is Chen Li's master's thesis "Research on Shipbuilding Industrial Heritage in Guangdong Province." It mainly examines the current status and related strategies of shipbuilding industrial heritage in Guangdong Province, revealing the significant value of Guangdong's shipbuilding industrial heritage[7]. Other existing research primarily focuses on the historical development of shipbuilding industry, the general construction overview of certain shipyards, and the economic benefits brought about by the reform of shipyard industry, with limited information on urban renewal and transformation.

Practical Research Significance

Guangzhou's shipbuilding industry heritage is mainly distributed on both sides of the the Pearl River back channel, and plays an important role in the future development of the city; The structures and spatial forms of the buildings and structures within its factory area are diverse, retaining many production equipment and components with a sense of scale and iconic features. Moreover, the buildings are constructed at different historical stages, which can present the development context and characteristics of the shipbuilding industry. However, the renovation and renovation of Guangzhou's shipbuilding industry heritage has not yet received widespread attention, and there are still many problems in actual protection work. Many buildings and structures are considered obstacles and are vigorously demolished and rebuilt. Items that have already been protected in subsequent work have caused long-term and serious resource waste and repeated construction problems due to the implementation strategy not combining with actual life and production needs; In addition, due to its unique location and waterfront characteristics, climate change and sea level rise, urbanization and land use pressures, as well as issues such as system closure and ecological sensitivity caused by long-term industrial construction, all urgently need to be repaired. The theory of resilient design regards cities as a dynamic ecosystem, believing that urban design should have flexibility and adaptability, which can be adjusted and changed over time and environment. Therefore, exploring the resilience transformation model of the shipbuilding industry heritage

is of great significance for improving the city's resilience, achieving the renewal of Guangzhou's industrial structure, promoting economic development, and even urban renewal.

1.3 Research Object and Conceptual Definition

1.3.1 Research Object

The main focus of this study is on 14 shipbuilding industrial heritage sites located in the central urban area of Guangzhou (Tab. 1- 1). These sites include Guangzhou Shipyard, Shangjiao Shipyard, Fourth Navigation Engineering Bureau Shipyard, Guangzhou Fish Wheel Factory, and Cheng'anwei Shipyard, which have completed renovation and transformation. The planned sites for renovation include Huangpu Shipyard, Wenchong Shipyard, and Yuzhu Shipyard. The study also encompasses active production shipyards and idle shipyards, namely Boluotou Shipyard, Guangzhou Passenger Ship Company Shipyard, Guangzhou Barge and Shipbuilding Repair Factory, Guangzhou Dredging Salvage Shipping Company Shipyard, Guangdong Zengcheng Xintang Shipbuilding Co., Ltd., and Panyu Lingshan Shipyard.

Tab. 1- 1 Overview of 14 Shipbuilding Industrial Heritage Sites in Guangzhou
Source:Author's Self drawn

Transformation Status	Enterprise Name	Precursor	Establishment Date	Address	Economic Nature	Current Status
Completed Renovation	Guangzhou Shipyard	Guangnan Shipyard	1954-08	Guangzhou Fangcun Avenue South	State-owned	TOD Urban Complex
	Fourth Navigation Engineering Bureau Shipyard	/	1975	Guangzhou Lijiao	State-owned	Guangzhou Window
	Shangjiao Shipyard	/	1998	Guangzhou Panyu Dashizhen Shangjiao Township	Private Shareholding	Xilinyuan Hotel
	Guangzhou Fish Wheel Factory	/	1954-07	Guangzhou Xinzhou	State-owned	Huangpu Beach Creative Community Pazhou Yard Creative Park Hongchuan Port Creative Park
	Zhonghai Industrial Chenganwei Shipyard	/	1974-10	Guangzhou Lijiao	State-owned	Qidi Zhonghai Science and Technology Park

Continued Table 1-1

Planned Renovation	Guangzhou Huangpu Shipyard	Kebo Shipyard	1851-03	Huangpu Changzhou Island Changzhou Street	State-owned	Comprehensive Cultural Tourism Area
	Guangzhou Wenchong Shipyard	/	1955-06	Huangpu Hongshan Street Wenchuan Road	State-owned	Marine Economic Development Zone
	Yuzhu Shipyard	Guangzhou Port Machinery Repair Factory	1960	Huangpu District Zhujiang North Bank Yuzhu Street	State-owned	Yuzhu Waterfront Business District
Active Production	China Merchants Industry Boluotou Shipyard	/	1968-10	Huangpu Boluotou	State-owned	Active Production
	Panyu Lingshan Shipyard	/	1985	Guangzhou Nansha District	Collective	Active Production
	Guangzhou Passenger Ship Company Shipyard	/	1952	Haizhu District Nanzhou Road	State-owned	Active Production
	Guangdong Zengcheng Xintang Shipbuilding Co., Ltd.	/	1968	Zengcheng Xintang Town	Private Shareholding	Active Production
	Guangzhou Salvage Bureau Ship and Machinery Repair Factory	/	1979	Guangzhou Xiadu Road	Collective	Active Production
Idle	Guangdong Barge Shipping Company Shipbuilding and Repair Factory	/	1997	Nanji Middle Road, Haizhu District	Collective	Idle

1.3.2 Definition of Related Concepts

Resilience Design

Resilience design refers to the use of resilience design methods to increase the toughness threshold of the design object, while also enhancing the system's own balance ability. Its connotation refers to the ability of a system to resist or alleviate external shocks, and to maintain its original form and structure in the event of a crisis, and to operate normally.

For the renovation and renovation of waterfront industrial areas, resilience design has two meanings: the first meaning refers to resilience, which is suitable for solving the past of industrial areas and adapting to current living and production needs; The second meaning refers to flexibility, which refers to the dynamic adjustment ability in the face of crises, incorporating future uncertainty factors into the design system to ensure its sustainable renewal and growth[8]. The resilience design discussed in this article mainly refers to the second layer of meaning. Based on the perspective of resilience design theory, the design of ship industry heritage renewal and renovation mainly refers to the irreversible destruction of many industrial buildings in the original old industrial areas of the city due to the failure to consider the future sustainable development of the area in the process of reconstruction, expansion, and demolition. In response to such a phenomenon, we need resilience design to give the industrial heritage a certain degree of flexibility, that is, dynamic adjustment ability, considering uncertain factors in future use and development, and ensuring that the industrial heritage can continuously update and grow while balancing the interests of multiple parties in the future, meeting more possibilities [9].

Urban Renewal

Urban renewal is a mechanism for cities to continuously improve themselves, which has been associated with urban development since the establishment of cities. Cities are constantly undergoing spontaneous renewal, although prior to the industrial revolution, this renewal was a very slow process. Modern urban renewal, in its current sense, occurred during the urbanization process driven by the industrial revolution in Europe and America. The industrial revolution brought significant changes to the structure and function of cities. Blind urban expansion led to the decline of central urban areas, environmental degradation, traffic congestion, and widening wealth gaps, among other urban issues. The first seminar on urban renewal, held in the Netherlands in 1958, emphasized people's desire to improve their living

environment and quality of life. The reconstruction of residential areas after World War II marked the true beginning of urban renewal, as Western industrial cities formulated urban renewal policies to revitalize the economy, improve the environment, and restore vitality to the cities. In the late 20th century, urban renewal incorporated new theories, and the content and methods of renewal continuously evolved and became more rational. In general, early urban renewal practices were often targeted measures to address deteriorating urban problems, but new issues continued to emerge. With the progress of urbanization, various aspects of cities, such as their physical environment, industrial structure, cultural environment, and transportation systems, have undergone profound changes, making the problems we face more complex and diverse. At the same time, people's understanding of urban renewal has deepened, and the concept of urban renewal has constantly evolved with the times.

In the 1990s, based on theoretical research and practical experience in urban planning in both the East and the West, Academician Wu Liangpu proposed the theory of organic urban renewal, which provided theoretical support for the renovation of old cities in China based on long-term practice in Beijing's planning and construction. Wu Liangpu used the analogy of a living organism to describe the city, believing that the various parts of a city are organically connected, and urban renewal should respect the inherent logic of urban development, conform to the texture of the city, adopt appropriate scales and reasonable dimensions, properly handle the relationship between the past, present, and future in the process , and explore sustainable development strategies for urban renewal, ensuring relative consistency between the environment of the urban renovation area and the overall urban landscape.

According to the theory of organic urban renewal, urban renewal should follow principles such as wholeness, continuity, staged development, and economic viability. Firstly, a city is an organic whole, and its various parts are interdependent and interact with each other, allowing the city to function in an orderly manner, similar to a living organism. Secondly, the various elements of the city spontaneously improve the city's structure based on the city's texture and form. Thirdly, urban renewal is an ongoing progressive process that occurs over time, requiring a proper handling of the relationship between the past, present, and future. Similarly, the spatial reconstruction of old industrial factory areas should demonstrate a sense of duration, achieving an organic unity between the past, present, and future. In terms of the content of renewal, organic renewal includes not only the renewal of physical spatial environments but also organic renewal in multiple aspects such as the economy, culture, and

social ecology. Through continuous organic urban renewal, cities can maintain a good operational state.

Industrial Heritage

The term "industrial heritage" emerged as a result of the rise of industrial heritage protection based on the definition of industrial heritage in the "Charter of Turin." Industrial heritage refers to industrial cultural relics with historical, technological, social, architectural, or scientific value. It includes buildings and machinery, factories, production workshops and factory mines, processing and refining sites, warehouse facilities, production, conversion, and usage sites, transportation and infrastructure related to industry, as well as social activity sites associated with industry, such as residences, places of worship, or educational institutions[10].

Guangzhou Shipbuilding Industrial Heritage

Guangzhou shipbuilding industrial heritage generally refers to the shipyard sites built during the late Qing Dynasty and the period of the founding of the People's Republic of China. It includes both the material and non-material heritage related to shipbuilding. The material industrial heritage includes buildings, structures, industrial equipment, docks, etc., related to the shipbuilding industry. The non-material cultural heritage includes craft processes, textual and graphic materials, corporate culture, etc[7].Currently, there are six shipbuilding industrial heritage sites in Guangzhou that have legal protection status, including the Chenwei Battery, Guangnan Shipyard, and Shipways No. 1, No. 2, and No. 3 of Guangzhou Shipyard; the Kebo Shipyard, Lushun Shipyard, and the historical site of Changzhou Huangpu Military Academy of Huangpu Shipyard; the machinery workshop, ship launching slipway, and traverser of the Fourth Navigation Engineering Bureau Ship Repair Factory of the Ministry of Communications; workshops No. 13, 14, 15, and 16, and the launching slipway of Cheng'anwei Shipyard; docks No. 1 and No. 2 of Wenchong Shipyard; and the harbor pool ship ranks and waiting workshop of Yuzhu Shipyard. Among them, Guangzhou Shipyard, the Fourth Navigation Engineering Bureau Shipyard, and Cheng'anwei Shipyard have completed renovation and transformation, while Huangpu Shipyard, Yuzhu Shipyard, and Wenchong Shipyard are currently in the planning and renovation stage. In addition, there are eight other important shipbuilding industrial heritage sites in Guangzhou that have not yet obtained legal protection status, including Shangjiao Shipyard and Guangzhou Fishing Vessel Factory, which have completed renovation, as well as Zhonghai Industrial Boliu Temple Shipyard, Panyu Ling Mountain Shipyard, Guangzhou Ferry Company Shipyard, Guangdong

Zengcheng Xintang Shipyard, Guangdong Barge Company Ship Repair Factory, and Guangzhou Salvage Bureau Ship Machinery Repair Factory, which are still in operation or idle for production.

1.4 Research Methods and Framework

1.4.1 Research Methods

Literature Review

Review relevant literature and materials related to the renewal of industrial heritage, analyze in-depth, and summarize the elements and outcomes of the analysis. Supplement the information with online resources and relevant literature on industrial heritage.

Field Research

Conduct on-site field research on Guangzhou's shipbuilding industrial heritage. Obtain first-hand data through photography, observation, and surveys, and experience the heritage's current status firsthand to gain the most intuitive understanding. Summarize and extract the common characteristics of Guangzhou's shipbuilding industrial heritage through the compilation and organization of data. Conduct field research on successful urban renewal cases in China, collect relevant information through photography, observation, and surveys, and gain inspiration to explore renewal strategies for Guangzhou's shipbuilding industrial heritage.

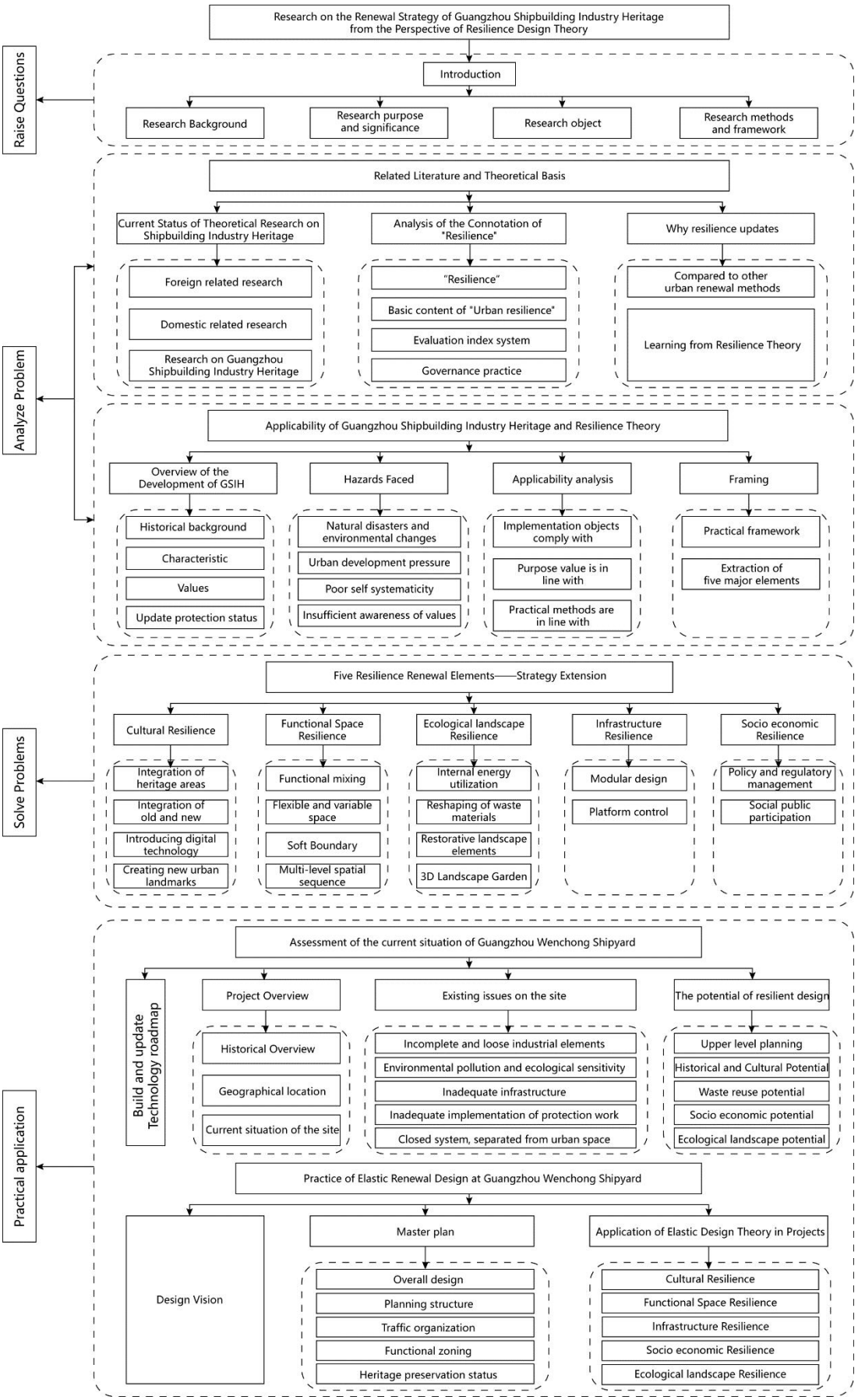
Analysis and Induction

After obtaining a large amount of relevant research material, induction is used to systematically organize and integrate different viewpoints and content for reference in further in-depth research. Analysis involves breaking down and refining objective things from surface to depth, allowing us to gain a deeper understanding of the subject and identify problems. It represents the process of exploration and discovery.

Case Study

Analyze practical cases of industrial heritage renewal to discuss the rationality of the proposed resilience performance in the renewal process. Based on the theory of resilience design, propose renewal strategies for heritage and elevate the theory to have practical significance.

1.4.2 Research Framework



Chapter2 Related Literature and Theoretical Basis

2.1 Theoretical Research Status of Shipbuilding Industrial Heritage

2.1.1 Foreign Research

There is relatively little theoretical research on the heritage of the shipbuilding industry abroad, and some articles elaborate on the protection and reuse of foreign shipbuilding industry heritage cases. Dong Yiping and Hou Binchao reviewed the revitalization process and development overview of the conservation movement in the Liverpool waterfront area, and introduced the process of several conservation and utilization of Albert Dock[11]. Li Yan introduced the historical background and update process of the Venetian Navy Shipyard, analyzed the problems in its update process, and provided suggestions for the update of China's waterfront land plots [12]. Yan Jun, Shen Ling, and Li Zhijun analyzed the historical evolution, development process of protection and utilization, and current status of renovation of Albert Shipyard[13]. Mikeli Bonino, Pierre Alain Croset, Chen Qian and others elaborated on the design and utilization of urban waterfront space in the process of transformation of Lisbon Ribeira Shipyard [14].

2.1.2 Domestic Research

Currently, research on shipbuilding industrial heritage in China is still in its early stages. Existing studies mainly focus on the historical development of individual shipbuilding industrial heritage sites, the general overview of certain shipyards' historical construction, and the economic benefits brought about by industrial reforms.

Thesis

Kongjian Yu transformed and utilized the Yuezhong Shipyard, and in his published papers, he described in detail the methods of landscape planning, design, transformation and reuse of the site of Zhongshan Qijiang Park (Yuezhong Shipyard) [15]. Cao Su, through the analysis and research on the historical overview and current situation of Dagu Dock of Beiyang Fleet in Tianjin, put forward the problems and suggestions of heritage protection and reuse [16]. Lu Shuang first analyzed the historical evolution of Fujian Shipbuilding Administration from a macro level, followed by a meso level analysis of the layout and technological process of Fujian Shipbuilding Administration, and finally analyzed the history and current situation of buildings and structures from a micro level[17]. Zhang Mingkai proposed that the project site

should be designed with the goal of constructing industrial cultural brownfield landscapes, and the project design strategy should be to sublimate shipyard culture[18]. From the perspective of landscape design and following the concept of sustainable development, Zhu Cong aims to create an industrial heritage park that integrates leisure and sightseeing, ecological demonstration, science education, and cultural experience[19]. Han Ping applied the "symbiotic thinking" to the renovation of the space of old shipyards and docks, and studied the strategies for the renovation of the space of old shipyards and docks [20]. Lin Lingfang studied the landscape pattern of the dock space and applied it to the landscape design of actual parks [21]. Sheng Yidan proposed that landscape regeneration and renewal are the most effective methods to revitalize industrial heritage sites, emphasizing the development of industrial heritage tourism models that can protect and continue the historical connotation of urban industry and have tourism and recreational functions[22].

Journal

Sun Yanzheng analyzed the current research status of China's shipbuilding industry heritage and elaborated on its value components, proposing display strategies for the value of shipbuilding industry heritage [23]. Ji Hong and Wang Qiong made a more comprehensive interpretation of the outstanding universal value of Fujian Mawei Ship Administration and Dagu Dock of Beiyang Fleet, the important military industrial heritage of the late Qing Dynasty that has been preserved so far in China, and provided a basis for the application for World Heritage of China's modern industrial heritage [24]. Ji Hong, Xu Subin and Aoki Xinfu discussed the site selection, historical evolution and military construction of Dagu Dock in the late Qing Dynasty by combining historical documents and historical maps and archives, using multiple disciplines such as history, sociology, Military science and archaeology, and tried to evaluate the industrial heritage value of Dagu Dock from the evaluation criteria of world cultural heritage [25]. Xiao Xiangdong, Chen Xing and Zhang Deshun reconstructed and updated the original site of the Yangtze River Shipyard through modern landscape design techniques, extending the City Garden, preserving the memory of the shipbuilding industry, and integrating diverse community leisure experience activities [26]. Wang Jue and Qin Lingling studied the renovation of the old factory building of Nanjing Xinhua Shipyard, exploring reasonable strategies for the renovation of old industrial factories in terms of structural preservation, internal space and functional layout of the building, facade skin materials, and external environment [27]. Liu Lingwen, Li Xiaohai, and Shen Lijun start from the perspective of commonality and individuality between industrial heritage and waste

shipyards. Starting from industrial heritage, they conduct on-site research on typical cases in three major cities: Beijing, Shanghai, and Guangzhou, and analyze them, thus forming a complete pre planning thinking method for the transformation and development of waste shipyards[28]. Wang Jun, Wang Gang and Li Baihao proposed to solve the problem of shipyard decline by re analyzing the broken landscape structure and elements, and integrate it into the functional system of Yantai Chaoyang Street Historical and Cultural Block, to shape a port cultural landscape tourist area with regional characteristics, to meet the needs of tourism and economic development [29].

Monograph

There is currently no dedicated book that comprehensively reviews the shipbuilding industrial heritage. Existing books mainly focus on the research of China's shipbuilding industry, such as *China Shipbuilding Industry Yearbook*, series on Chinese shipbuilding history, *Modern Shipbuilding History in China*, as well as provincial chronicles.

The *China Shipbuilding Industry Yearbook* is an annual compilation of data and analysis on the development, industrial structure, technological level, market conditions, and enterprise situations of China's shipbuilding industry. The series on Chinese shipbuilding history, compiled by the China Institute of Navigation, is a collection of documents that covers ancient, modern, and contemporary Chinese shipbuilding history, as well as the shipbuilding development history of different regions[30]. *Modern Shipbuilding History in China* by Wang Zhiyi is a monograph that specifically focuses on the development history of China's modern shipbuilding industry, including the rise and fall of the shipbuilding industry from the late Qing Dynasty to 1949. In addition, provincial chronicles also provide specialized introductions to the development of the shipbuilding industry in different regions[31].

2.1.3 Research on Guangzhou's Shipbuilding Industrial Heritage

Regarding the research on Guangdong's shipbuilding industrial heritage, papers and journal studies mainly focus on the renovation and transformation of individual shipbuilding industrial heritage sites. They primarily provide historical development overviews, current conditions of the sites, and strategies for their renovation. Currently, there is only one systematic study on Guangdong's shipbuilding industrial heritage, which is Chen Li's master's thesis titled "Research on Guangdong's Shipbuilding Industrial Heritage." It analyzes and categorizes the current status and related strategies of shipbuilding industrial heritage in

Guangdong Province, highlighting the significant value of Guangdong's shipbuilding industrial heritage.

In terms of book literature, there are "Guangdong Shipbuilding History," "Guangdong Provincial Chronicles - Shipbuilding Industry Volume," "Guangzhou City Chronicles - Shipbuilding Industry Volume," "Guangdong Provincial Chronicles - Military Industry Volume," as well as factory histories published by some shipyards, which outline the construction history of the shipyards over the years.

Thesis

Jia Chao proposed four protection gradients for the relationship between Guangzhou's industrial heritage and the city: cultural preservation, preservation and utilization, renovation and transformation, and general heritage preservation[32]. Chen Li conducted a comprehensive review and quantitative analysis of Guangdong's shipbuilding industrial heritage, while exploring the protection and reuse of the heritage from the perspectives of institutions, planning, and heritage. This study provides valuable insights for the protection and reuse of Guangdong's shipbuilding industrial heritage[7].

Journal

Peng Changxin's article "The Westernization Movement Construction and Spatial Production in Guangdong Huangpu at the End of the Qing Dynasty" briefly describes the industrial architecture of shipyards and studies the Westernization movement activities in Guangdong Huangpu at the end of the Qing Dynasty[33]. Peng Changxin, Li Tong, and Chen Li reviewed the historical evolution, current status, and value of Huangpu Shipyard[34]. Guo Ying, based on the transformation project of Guangzhou Cheng'anwei Shipyard, addressed the issues of industrial heritage continuity and development, proposing four design principles of "preservation, governance, integration, and revitalization," which were applied in the planning, architectural renovation, and spatial design of the park[35]. Luo Fei, Guo Ying, Chen Yongyi, and Wei Zhao analyzed and categorized the current status of Cheng'anwei Shipyard's original industrial base and buildings, proposing transformation, renovation, and activation strategies from the perspectives of "retention, integration, contrast, and revitalization" for project development and industrial layout[36].

Monograph

Guangdong Shipbuilding History is a volume in the series of Chinese water transportation history. It covers ancient, modern, and contemporary periods, providing a detailed account of the development of Guangdong's shipbuilding transportation in different eras[37]. *Guangdong Provincial Chronicles - Shipbuilding Industry Volume,* compiled by the Guangdong Provincial Local Chronicles Compilation Committee, is an important work that records the history of shipbuilding industry in Guangdong Province. It describes the development of the shipbuilding industry in Guangdong Province in various periods[39]. *Guangzhou City Chronicles - Shipbuilding Industry Volume*, compiled by the Guangzhou City Local Chronicles Compilation Committee, provides a detailed account of the development of the shipbuilding industry in Guangzhou City in different periods, including shipbuilding, ship repair, and shipping, and introduces the overview of shipbuilding enterprises in Guangzhou City from 1991 to 2000[40].

Some shipyards have specially published factory histories to sort out the construction situation of the shipyard over the years. These detailed records of the factory history are of great significance for studying the historical development of the shipyard.

2.2 Analysis of the Connotation of "Resilience"

2.2.1 Resilience

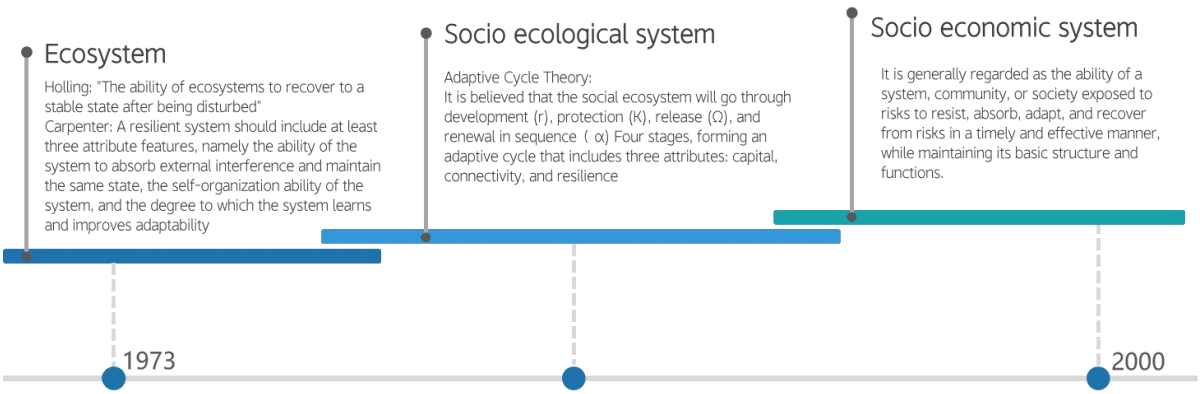


Fig. 2- 1 The Development of Resilience Theory
Source: Author's Self drawn

The term "resilience" originates from the Latin word "resilio" (re= back, salio= to leap), which means the action of bouncing back. According to Webster's Dictionary, it refers to the ability of an object to return to its size and shape after being deformed by pressure[41]. After the 1970s, the concept of resilience gradually extended to the ability of systems to recover and

return to their initial state after experiencing disturbances, also known as the capacity for restoration (Fig. 2-1).

Holling was the first to introduce the concept of resilience into the study of ecosystems, defining it as "the ability of an ecosystem to return to a stable state after being perturbed.[42]" Carpenter pointed out that a resilient system should possess at least three characteristic attributes: the ability to absorb external disturbances while maintaining the same state, the capacity for self-organization, and the degree of learning and improving adaptive capacity[43]. After the concept of resilience was proposed, it gradually expanded from the field of ecology to the study of social-ecological systems. The adaptive cycle theory was put forward to explain the operating mechanisms of social-ecological systems. This theory suggests that social-ecological systems go through four phases in an adaptive cycle: exploitation (r), conservation (K), release (Ω), and reorganization (α), forming an adaptive cycle[46]. It incorporates three attributes: capital, connectedness, and resilience (Fig. 2-2). In the exploitation phase, the relationships among system elements are relatively loose. In the conservation phase, the connectivity of system elements improves, and various resources begin to accumulate. When external conditions change, especially when significant events and crises create strong disturbances, the connectivity of the system is disrupted, and control gradually decreases, becoming the main characteristic of the release phase. The reorganization phase involves creating new connectivity and rebuilding the system. In this adaptive cycle, resilience constantly changes as the system operates. This theory can be applied to urban systems or specific social systems, and identifying the stages of the adaptive cycle is crucial.

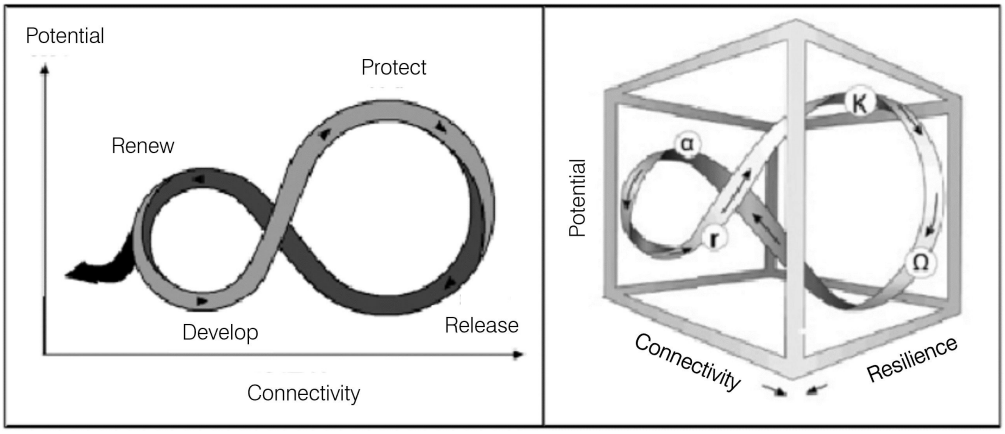


Fig. 2-2 Adaptive Cycle and Three-Dimensional Illustration with Increased Resilience
Source：Gunderson L H, Holling C S. Understanding the Complexity of Economic, Ecological and Social Systems[J]. Ecosystems, 2001(6): 390-405.

Since 2000, the concept of resilience has been extended from social ecosystem research to social economic system, and has been widely used, such as Sustainable city resilience research, economic resilience research, disaster resilience research, urban safety resilience research, etc. Resilience in the socio-economic system is generally considered as the ability of a system, community, or society exposed to risks to resist, absorb, adapt, and recover from risks in a timely and effective manner, while maintaining its basic structure and functions[47].

2.2.2 Connotation and definition of "Urban Resilience"

It is impossible for human beings to build a city without disasters at all, but to build a Urban resilience that can adapt to disasters and coexist with disasters. The future direction of urban development is to develop appropriate adaptation strategies, reduce urban vulnerability, and increase public awareness of risks, in order to establish low risk and high resilience cities.

In recent years, with the acceleration of the process of Global city, urban development policies are increasingly concerned by the society at home and abroad. Strengthening the management of urban planning and construction, building a Urban resilience, and improving the city's ability to cope with various risks have become the focus of research at home and abroad. In 2002, the Local Governments for Sustainability (ICLEI) put forward the concept of "urban resilience" at the UN Global Summit on Sustainable Development for the first time, and the "Urban resilience" has attracted academic attention worldwide. At present, the definition of "Urban resilience" in academic circles at home and abroad is not uniform, which mainly reflects the following four orientations:

Ability oriented.

For example, the United Nations defines "urban resilience" as the ability of a system, community, or society at risk to resist, absorb, accommodate, and recover from disasters in a timely and effective manner, including by protecting and restoring its basic structure and functions. This highlights the capacity building of cities in response to disasters.

Subject oriented.

For example, in 2006, Professor Campanella of the Department of Urban and Regional Planning of Cornell University in the United States concluded that whether a city has resilience is determined by the people in the city and the community forces composed of people after studying the disaster caused by Hurricane Katrina in New Orleans. This means

that the size of urban resilience is closely related to the urban community composed of the main body of the city - the citizens.

System oriented.

For example, some scholars believe that "Urban resilience" is a city that can absorb the impact and pressure of future uncertainties on its socio-economic and technological system and infrastructure, and maintain its own basic functional structure system and characteristics, which reflects the systematic characteristics of Urban resilience. When dealing with the risk disturbance, the software and hardware of each system in the city have sufficient adaptability, shock resistance, learning ability and resilience. The infrastructure such as hospitals, schools, commercial transportation and various organizations in the city can maintain their own functions to the maximum extent and meet the basic needs of urban residents to ensure the orderly operation of urban society in crisis.

Spacetime orientation.

Some domestic scholars have also proposed that Urban resilience should highlight the resilience of urban physical and social space, and resilient urban social space can show the stability of society and space before, during and after the event when subjected to sudden internal and external shocks or "slow destruction". On the premise of preserving the structure of "city" and the function of "city", it will develop to a higher balanced state.

Although there are differences in the above definitions, they also have commonalities: firstly, they emphasize that toughness has the ability to absorb external shocks and disturbances, and can maintain a certain degree of elasticity. Secondly, they all focus on the ability of the system to restore its original state or reach a new state through learning and reorganizing after external interference. Thirdly, they all focus on resilience, which has the ability to reduce disaster risks and losses, as well as the ability to quickly restore normal conditions. Fourthly, both emphasize the ability and speed of resilience to respond to disaster impacts from both software (technology and knowledge) and hardware (equipment and institutions) levels.

2.2.3 Evaluation index system of Urban resilience

Basic principles for selecting resilience indicators

Urban resilience refers to a city that can quickly reorganize and restore life and production even after experiencing the impact of disasters. It has the characteristics of reflection, adaptability, robustness, redundancy, flexibility and inclusiveness. Western scholars develop different evaluation indicators based on different research purposes, and when selecting resilience indicators, they need to follow several basic principles:

(1) Comply with the principle of resilience. When selecting factors that affect urban resilience, it is necessary to determine the type of disaster, therefore, the selection of indicators should comply with the basic definition of resilience.

(2) Be able to compare principles. All toughness factors should be selected as standardized measurement tools that can be converted into comparative forms, such as percentages, averages, or density functions, and further analysis of the correlation between factors should be conducted. If there is a high degree of correlation between factors, selective elimination should be considered while paying attention to internal reliability.

(3) The principle of representativeness. The selection of indicators can reflect the cultural background, geographical characteristics and Areal feature of the city. The selection of indicators cannot be uniform, but should reflect differences on the basis of commonness.

(4) Feasibility principle. Researchers need to consider the completeness of survey data and the convenience of obtaining it, in order to avoid administrative segregation causing difficulties and significant errors in data collection. Data that is difficult to collect or indicators that cannot be obtained through reasonable assumptions should be deleted.

Overall Urban resilience Assessment Indicators

Carter initially created a relatively complete toughness evaluation index in his 2008 toughness research[48]; In 2010, Carter et al. proposed more reasonable evaluation indicators based on previous studies. Due to the different ecosystems in different regions, the impact of different ecosystems on resilience cannot be compared horizontally. He excluded most of the ecological parts mentioned in resilience literature (Fig. 2-3). Therefore, the overall

assessment indicators of Urban resilience mainly include climate disasters, economy, community organization policies and infrastructure[49]:

(1) Climate disaster resilience assessment indicators

This indicator aims to quickly assess and compare the resilience of Urban climate, mainly using the scores given by local experts and scholars to different factors to assess the performance of resilience at all levels of the city. The indicators involved in physical economic organization, social and natural levels are subjective, which are quite different from other objective resilience indicators. This indicator is more suitable for the comparison of resilience between cities.

(2) Economic resilience evaluation indicators

The assessment of economic resilience focuses on economic diversity, as a single industry can lead to urban dependency, leading to post disaster industrial decline and having a direct impact on urban resilience. At the same time, this assessment focuses on economic stability and economic capacity, with the former focusing on employment, debt, inflation, and external debt, while the latter focuses on wealth creativity, household assets, household capacity, financial capacity, real estate, and labor force.

(3) Community Resilience Assessment Indicators

Carter believes that community resilience is an effective mechanism for reducing disaster losses, and currently faces many challenges in the use of indicators, measurement standards, and methods. Community resilience includes the ability to resist and restructure, with strong resilient communities having better resilience and restructuring adaptability, and vice versa. The resilience directly affects the effectiveness of actions taken by cities in the face of disasters, and the restructuring ability represents the ability of cities to recover and grow after disasters.

(4) Organizational resilience evaluation indicators

Organizational resilience assessment focuses on the degree of adaptation of public and private organizations to disasters. It is a unique indicator system for urban resilience, reflecting the external resilience of the city to disasters. The objective environment of a city is often difficult to compensate for, but the subjective environment can significantly improve the city's ability to withstand disasters. The assessment of organizational resilience also focuses on the

resilience and organizational capacity. The resilience mainly includes the number of plan members, volunteers, response budget, insurance mechanism and other factors. The organizational capacity includes the number of donations, unit exchanges and technology.

(5) Infrastructure evaluation indicators

This evaluation model mostly focuses on measuring hardware indicators, mainly focusing on the redundancy of basic buildings and whether key facilities can continue to function after disasters.

In general, due to the obvious differences in the development stages, natural environment, social environment, social culture and economic conditions of each city, it is necessary to formulate a Urban resilience development plan according to local conditions. In the western cities with fragile ecology in China, we should focus on building urban ecological and environmental resilience mainly by improving disaster resilience. In cities with a predominantly outward oriented economy along the eastern coast, the main focus is on improving economic resilience, with a focus on the development of a diversified economy.

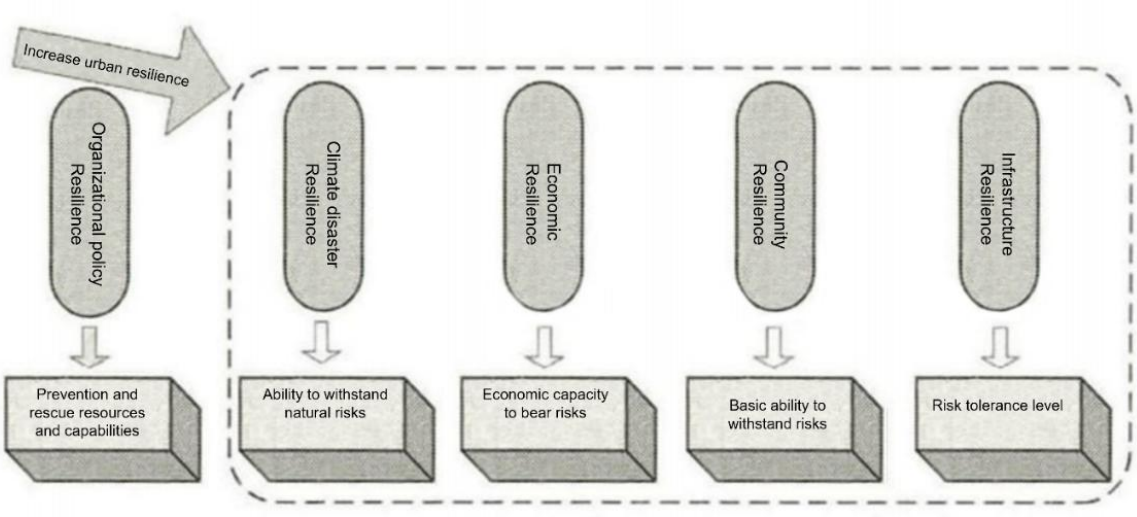


Fig. 2- 3 Concept map of Urban resilience evaluation index system

Source：Zhou Limin. Urban resilience: Risk Governance and Index Construction -- Also on International Cases [J]. Journal of Beijing Institute of Administration, 2016 (02): 13-20. DOI: 10.16365/j.cnki.11-4054/d.2016.02.003

2.3 Governance practice of Urban resilience

Some cities around the world have carried out resilience strategy practice. Due to the differences in politics, culture and economy of each city, the government also has some differences in promoting the Urban resilience plan, which includes the promotion of the national resilience strategy from top to bottom, the promotion of all sectors of society from

bottom to top, and the joint promotion of the two to achieve the goal of sustainable urban development (Tab. 2- 1).

Tab. 2- 1 Global Representative Urban resilience Plan
Source:Author's Self drawn

City	Plan name	Dealing with risks	Release time	Resilience plan content
New York, USA	A stronger and more resilient New York	Flood and Storm surge	2013.06	● Social resilience: poverty alleviation to strengthen social equity ● Climate resilience: combining hardening engineering with green ecology ● Organizational resilience: Climate Protection Standards, Climate Risk Information, Resilience Assessment Guidelines, etc
Rotterdam, Netherlands	Rotterdam Climate Protection Program	Floods, sea level rise	2008.12	● Environmental resilience: green increment, roof greening, and installation of solar panels, etc ● Infrastructure Resilience: Urban Planning Based on Water ● Social resilience: residential renewal plans and provision of affordable housing
London, UK	Managing Risk and Enhancing Resilience	Hot summer, dense fog, floods, and storms	2011.10	● Construct the "Climate of London Climate Change Public Private Partnership Mechanism" and issue the UK Climate Impact Plan ● Develop a resilience plan and establish the Ministry of Climate Change and Energy ● Manage flood risks, increase parks and greenery

2.3.1 Practice of Urban resilience in New York

In order to address the imminent disaster risks brought about by climate change, and to repair the devastating impact of Hurricane Sandy, New York has formulated a comprehensive resilience plan, which takes the "Urban resilience" as the core concept, improves the city's ability to cope with risks as the main goal, increases the city's competitiveness as the core, strengthens infrastructure and post disaster reconstruction as the breakthrough, and increases capital investment as the guarantee, mainly including the impact analysis of Hurricane Sandy Climate status and change analysis, urban infrastructure, community reconstruction and resilience planning of living environment, funding and implementation, etc[50].

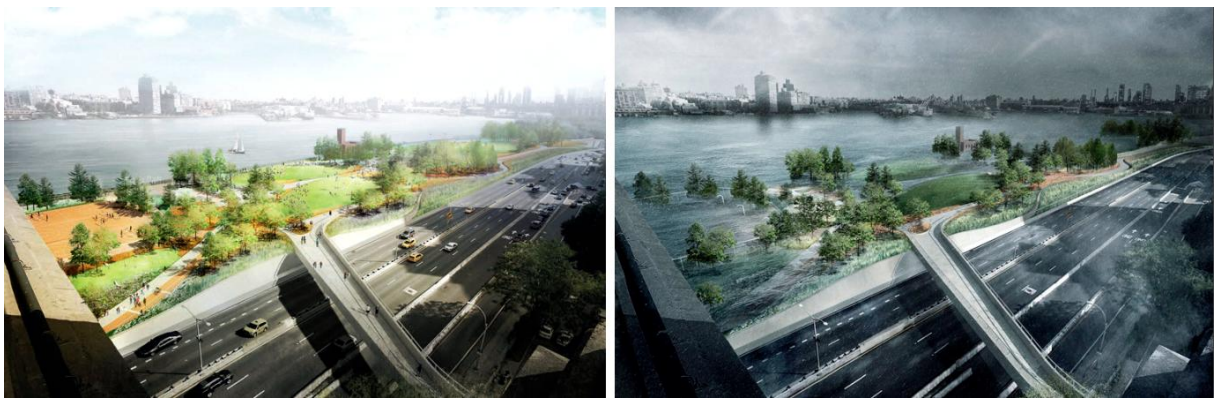


Fig. 2- 4 Schematic diagram of sea level rise before and after
Source：Bjarke Ingels，2017

Firstly, at the level of organizational resilience, building a strong and resilient New York through policy formulation and action plans.

The Urban resilience construction and climate adaptation project in New York has been proposed in the "Greener and Better New York" in 2007. In 2013, the Urban resilience plan "Stronger and More Resilient New York" to deal with climate change was formulated, and a list of 10-year Urban resilience construction projects was proposed. In 2014, New York released the report "One City Rebuilds Together", aiming to strengthen and expand the construction of Urban resilience. The report proposes to set up a Urban resilience construction office to promote the updating of the version of urban resilient construction. At the same time, the office should assume the function of executing key project implementation and evaluation, including accelerating loss compensation review and initiating construction projects. In 2015, New York released an updated and more comprehensive climate resilience construction plan called "New York: A Strong and Suitable City" to serve the continued implementation of the climate change response route.

Secondly, in terms of climate disaster resilience, the construction of resilient disaster prevention infrastructure should be achieved through landscape integration.

In order to cope with the impact of global climate change, especially the extreme climate such as typhoon and rainstorm with rising sea level on New York, New York has made great efforts to improve coastal flood control facilities, while emphasizing the combination of hardening projects and green ecological infrastructure construction, especially focusing on the resilience of urban infrastructure projects. Based on the construction and changes of the New York waterfront in history, this paper proposes flood control strategies for elastic waterfront parks in the context of climate change through research on their scheme design, operation and maintenance modes. Explore how to stimulate more comprehensive social benefits through flood control infrastructure by creating diverse urban coastal spaces. With the change of concept and the innovation of planning and design, on the basis of the construction of traditional urban flood control engineering facilities, the level of urban comprehensive resilience can be further improved by reducing the exposure level of the Built environment and correspondingly improving the flood adaptability.

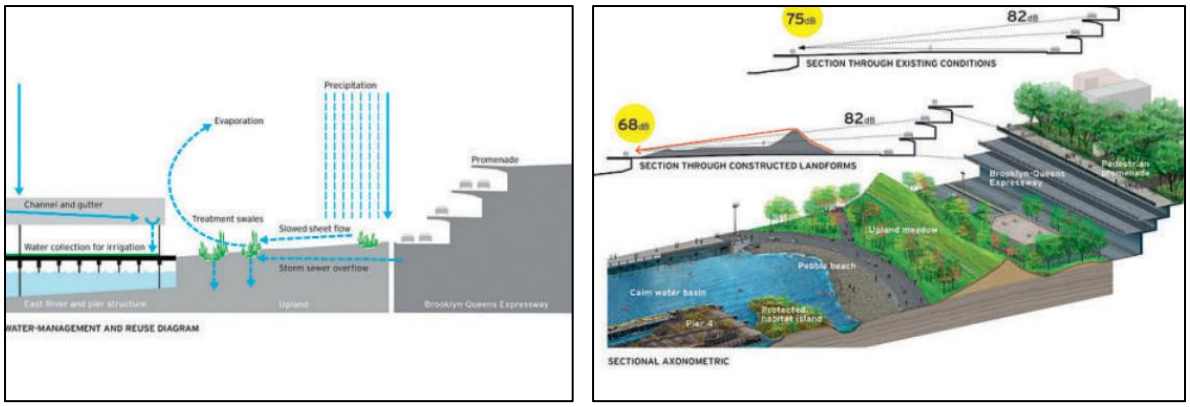


Fig. 2- 5 Resilient design of water bank section
Source：http://www.zhulong.com

Thirdly, in terms of social resilience, the government is vigorously supporting poverty alleviation to strengthen social equity.

The population of New York is approximately 8.5 million, with 45% being in or near poverty. In response to this situation, in February 2015, the Mayor of New York hoped to help 800000 impoverished people lift themselves out of poverty within a decade. At the same time, New York also plans to build a large number of affordable housing and expand the benefits of free preschool education, making it a more equal and resilient city.

Fig. 2- 6 U-shaped protection system for the waterfront area of Manhattan's main island
Source: Bjarke Ingels，2017

2.3.2 Practice of other Urban resilience

In addition to New York, other cities such as London, the United Kingdom, Chicago, Rotterdam, the Netherlands, Quito, Ecuador, and Durban, South Africa have also formulated Urban resilience plans, which have their own characteristics, wide coverage, and many fields.

In order to cope with sea level rise, Rotterdam, the Netherlands, has formulated the Urban resilience Plan. Its goal is to have sufficient resilience in the face of climate change by 2025, so as to build the world's safest port city. The key areas of this plan are flood management, accessibility of ships and passengers, adaptive buildings, urban water system and urban life quality. In terms of environmental resilience, Rotterdam focuses on green increment, shifting from emphasizing green area to volume and capacity, from planting grass to planting trees, mobilizing citizens to participate in roof greening and encouraging the installation of solar panels. It also vigorously develops projects that can reduce energy consumption to improve the urban ecological environment. At the level of infrastructure resilience, urban planning is carried out based on the principle of "living by water", while transforming small ports and docks into leisure, shipping, and multi-functional waterfront areas. In terms of social resilience, the government also strives to ensure the smooth integration of different classes in the dock space when re planning the dock. In order to ensure social equity, the government has launched a residential renewal plan, which stipulates that a certain proportion of social security housing must be equipped when constructing large-scale residential projects, so that all residents can share the benefits of urban development.

In order to closely integrate Urban resilience with the national resilience strategy, the UK has set up the "Ministry of Climate Change and Energy". At the same time, it has set up full-time civil servants to be responsible for formulating the Urban resilience plan. In 2001, Climate of London built a "public-private partnership mechanism for climate change in London" with the participation of governments, enterprises and the media. In 2002, London introduced the UK Climate Impact Plan, which mainly promotes the development of sexual policies and research plans for climate change. In response to the impact of flood risks, London has developed plans to increase parks and greenery. Meanwhile, London plans to upgrade and renovate 1 million households' water and energy facilities by 2015.

2.4 Why Applying Resilience Theory to Shipbuilding Industry Heritage

With the continuous development of cities, the incremental space of cities is gradually decreasing, and urban renewal is becoming the main growth point of China's urbanization process. At the same time, with the development of society and the adjustment of industrial structure, the old shipbuilding industry has excess capacity and is gradually declining, leaving behind a large number of shipbuilding industry factories in the waterfront areas of the urban center. In order to protect the value of the shipbuilding industrial heritage and continue to create social benefits for the people, we should protect this special waterfront industrial heritage while making it participate in the urban vitality function, promote the transformation of the urban waterfront industrial shoreline to the urban vitality shoreline, and become a win-win demand for heritage and sustainable development of the city.

2.4.1 Comparison with other urban renewal methods

Since the 20th century, with the reflection of the world's urban development and urban renewal as the background, in addition to the "Urban resilience", urban renewal theories such as urban catalyst theory, organic collage theory, and tactical urbanism have also emerged in the field of urban renewal.

“Urban Catalysts ”is a concept proposed by American scholars Wayne Atton and Don Logan in their book" American Urban Architecture - Catalysts for Urban Design "in 1989. Urban catalysts refer to various urban activities that can have a positive impact on subsequent urban development and construction. 'Contact media' may be a hotel, a shopping area, or a transportation center; It may also be a museum, theater, or designed open space; Or it can be a small-scale, special entity, such as a column or a fountain. Urban catalyst is not only a conventional Mog completed project, but also an important factor that can continuously stimulate and guide subsequent urban construction, aiming to promote gradual urban renewal[51].

The concept of "organic collage" was proposed by Colin Rowe, who believes that cities are a product of historical forces, and anyone's understanding or influence of cities is one-sided and localized. The overall structure of a city is formed through the patchwork of local collages. In this way, we can reconnect the history of urban isolation and showcase the future while

respecting the past. The collage city theory believes that there will always be conflicts between new and old, modern and traditional, local and world, private and public in a city. Urban planning and construction should explore the convergence points and methods of planning and construction from the context. Those seemingly incompatible things can be collaged together in urban structure[52].

Tactical urbanism "was proposed by Lydon and Garcia as a method of using short-term, low-cost, and scalable interventions and policies to establish and activate communities. Tactical urbanism is used by a range of actors including governments, businesses, non-profit organizations, civic groups, and individuals. It leverages the creative potential unleashed by open and iterative development processes, effective resource utilization, and social interactions[53]. The advantage of tactical urbanism lies in the perfect combination of short-term and long-term. During the implementation of the project, people can obtain on-site experiences that cannot be provided by written plans. City officials can quickly evaluate and adjust the plan based on usage data and user feedback, thereby providing a strong basis for the permanent implementation of the project.

Compared with the above-mentioned urban renewal methods, the "Urban resilience" theory has the advantages of gradual renewal of "urban catalyst", multi-dimensional combination of "collage city" theory, and short-term and long-term coordinated renewal of "tactical urbanism". In addition, the "Urban resilience" also has the advantage of comprehensively improving the function or structural resilience of the urban system by "giving consideration to both soft and hard, and combining hard and soft", which not only makes overall planning for the upper level, but also facilitates the implementation of the lower level. On the other hand, due to the diversity of the size, structure and geographical characteristics of cities, standardized ideas and unified plans are difficult to adapt to the development needs of different cities, Therefore, it is necessary to develop a differentiated resilience construction planning system based on the actual situation of the city. Therefore, it is particularly suitable for urban renewal of shipbuilding industry heritage.

Due to its typical waterfront characteristics and long-term industrial construction, the shipbuilding industry heritage faces dual threats of ecological and social environment changes due to the separation of system space and urban space. Therefore, when carrying out urban renewal practices, it is necessary to start from a multidimensional perspective,

comprehensively carry out political, economic, social, ecological, cultural, and other aspects from the aspects of urban hardware facilities and systems, technical organizations, mentality, and culture The comprehensive system optimization and improvement of governance and other "multidimensional integration" ensure that the city has the strongest urban construction facilities, the most reasonable and efficient resource allocation system, the most complete organizational system, and the most united social cohesion, effectively preventing and quickly adapting to various internal and external uncertain risks and crises, and promoting the sustainable construction of shipbuilding industry heritage in various risks.

2.4.2 Learn from Urban resilience theory

Since Urban resilience have the main advantages of other urban renewal methods, as well as unique advantages of their own, they should actively learn from the advantages of Urban resilience in urban renewal, so as to respond to a series of problems of urban renewal status.

Learn the ideal city vision of people-oriented, safe, green, fair, inclusive, and sustainable development.

In essence, a Urban resilience is to effectively deal with the unknown risks of "instability, uncertainty and unpredictability" by improving the determined "resilience", and build an all-round and systematic urban security defense line.

Learn to guard against natural and man-made 'uncertainty' risks.

These "uncertainties" mainly include: first, extreme weather brought about by traditional climate change, including urban extremely heavy rainstorm, typhoon, freezing, flood, drought, sea level rise, etc. Secondly, the outbreak of major epidemic diseases. In addition to SARS, avian influenza, Ebola virus and novel coronavirus, cities may also face various epidemics caused by virus overflow in the polar permafrost layer and gene mutation caused by climate warming. Third, Liquidity risk. For example, high-speed planes, high-speed railways, subways, vehicles on expressways, water, gas, electricity and coal transported through urban Pipeline transport and other urban lifeline projects, all have the possibility and pressure of major unpredictable disasters. Fourthly, the risks caused by technological changes. Interconnection, networking, and intelligence have accumulated a large amount of data, making cities more susceptible to technological security risks such as network attacks, data security, and privacy breaches. Fifth, the risks of energy and economic crises. Due to the interference of various uncertain risk factors, the urban economy may face short-term or

medium - and long-term crises. At the same time, the city faces problems related to energy supply and demand. Therefore, strengthening the crisis response capacity of the urban economic industry chain, innovation chain, and value chain, improving economic resilience, and achieving rapid economic recovery after disasters are also the key points of building a Urban resilience.

Learn the basic framework of a flexible system that combines software and hardware, and integrates multiple dimensions.

The construction of a Urban resilience aims at comprehensively improving the city's "resilience, adaptability, resilience and learning ability" to cope with diversified "uncertainty" risks or disaster shocks, focusing on urban hardware facilities and systems, technical organizations, mentality, culture and other software, and comprehensively carrying out the "multi-dimensional" comprehensive system optimization and improvement of politics, economy, society, ecology, culture, and governance, Ensure that the city has the strongest urban construction facilities, the most reasonable and efficient resource allocation system, the most complete organizational system, and the most united social cohesion, effectively preventing and quickly adapting to various internal and external uncertain risks and crises, and promoting the city to continuously become strong and prosperous amidst various risks. Among them, "hard toughness" mainly refers to the resistance and adaptability to disaster risks of urban transportation facilities, pipeline energy lifeline facilities, urban buildings, ecological maintenance facilities, digital New Infrastructure, etc. "Soft resilience" mainly refers to the resilience of the urban industrial chain value chain, government emergency response capabilities, urban human capital, community management, urban spiritual culture, etc., which is conducive to the institutional advantages and cultural environment of disaster response

Learn the full cycle governance approach before, during, and after the event.

For a single crisis disaster, focus on the entire process of urban disaster prevention, response during disasters, and post disaster recovery. Once a disaster occurs, the city enters a period of resistance and adaptation to the disaster. Urban resilience allows the city to eliminate the impact of the disaster in the shortest possible time and restore the normal functions of urban infrastructure, economy, society, and other aspects as soon as possible.

Learn the implementation methods of government, enterprises, and the public's multi-party co construction and governance.

As a huge and complex system covering all elements, processes, and time periods, cities are highly interconnected and influenced by various related subsystems. The construction of a Urban resilience is a comprehensive systematic project integrating political decision-making, government management technology application, market participation, social mobilization, and institutional innovation, which requires the collaborative participation and close cooperation of the government, enterprises, communities, and the public.

2.5 Case Studies of Shipbuilding Industrial Heritage Reuse

2.5.1 Camp Mare Port City Renewal

Camp Mare Port City Renewal Project is located on the southern coastline of Jeju Island, South Korea, with a total area of about 1300000 square meters, and will be completed in 2023. This project integrates the traditional craftsmanship, culinary culture, and shipbuilding traditions of the city, and through the introduction of new technologies, research facilities, cultural activities, tourist attractions, etc., the original shipyard site is transformed into a new urban center that integrates craftsmanship, tourism, research and development, and life, revitalizing the coastal life in this area.

Fig. 2- 7 Camp Mare Old Shipyard Area Urban Renewal Plan
Source: https://www.henn.com/en

From the perspective of resilience theory, the strategy of Camp Mare Port City Renewal Project is mainly reflected in the material and social aspects:

(1) Resource integration, guided by ecological planning.

The Camp Mare site is adjacent to water to the north and the picturesque Mireuk Mountain to the south. The design team envisioned two linear coastal expansion zones, covering the former shipyard area, connecting the mountainous landscape in the south with the coastal area through two parks, extending the bay.

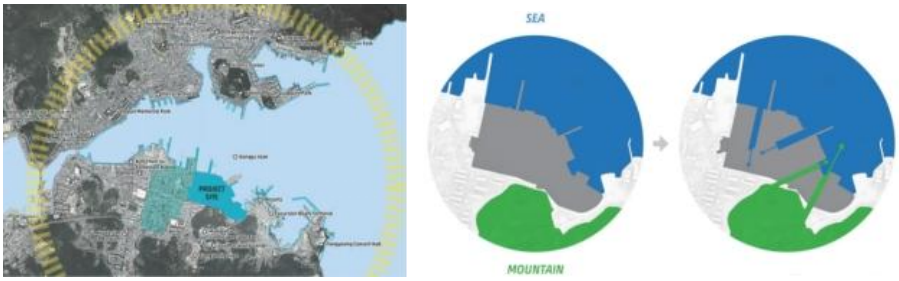


Fig. 2- 8 Schematic diagram of the surrounding area and seaside expansion zone
Source: https://www.henn.com/en

(2) Mixed functions and diversified urban functions.

The entire project is divided into 5 different areas, each with its own unique characteristics, composed of different facilities and buildings, which connect the entire bustling public seaside area. The project can increase the resilience and adaptability of the city by transforming the originally single port function into diversified urban functions.

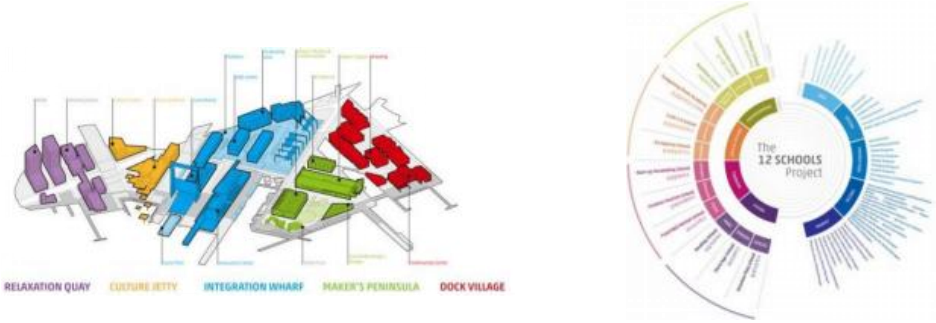


Fig. 2- 9 Plan five major regions and "12 schools" project (Source: https://www.henn.com/en)

(3) Emphasize communication and cooperation with local residents.

The plan includes the "12 Schools" project, which will become symbols of promoting innovation. Each region contains multiple schools, and each school's education will focus on the various stages of the industrial cycle: research and development, design, production, testing, marketing, and sales. Camp Mare will eventually become a colorful and dynamic new area of Tongyeong, which will lay the foundation for the regeneration and future development of the city. This reflects the concept of community participation and democratic governance advocated by the Urban resilience theory.

2.5.2 Renovation of the Central Waterfront in Seattle, United States

The central area of Seattle is adjacent to Puget Sound. Its waterfront reconstruction project is about 2.0km long. The reconstruction scope is Alaska Street and the waterfront space along the Quayside of Puget Sound to the west. The reconstruction design project includes the overall design strategy and the reconstruction design of main public spaces[54] (Fig. 2- 10).

The project was launched in 2009, when the renovation principles were initially determined and three participating organizations were formed: a review committee consisting of 45 community representatives, all participants in the waterfront community, the waterfront district office of the city government, and the city council.

Through a series of project discussions and extensive public participation, a three stage renovation plan was formed in 2011. The first stage is to establish a renovation design concept, including vision concept, dredging of waterfront paths, basic goals, integration of breakwaters and public spaces; The second stage is to determine the maintenance of the breakwater and tunnel engineering, determine the design plan, participate in the public, and improve the design plan; The third stage is the implementation of construction.

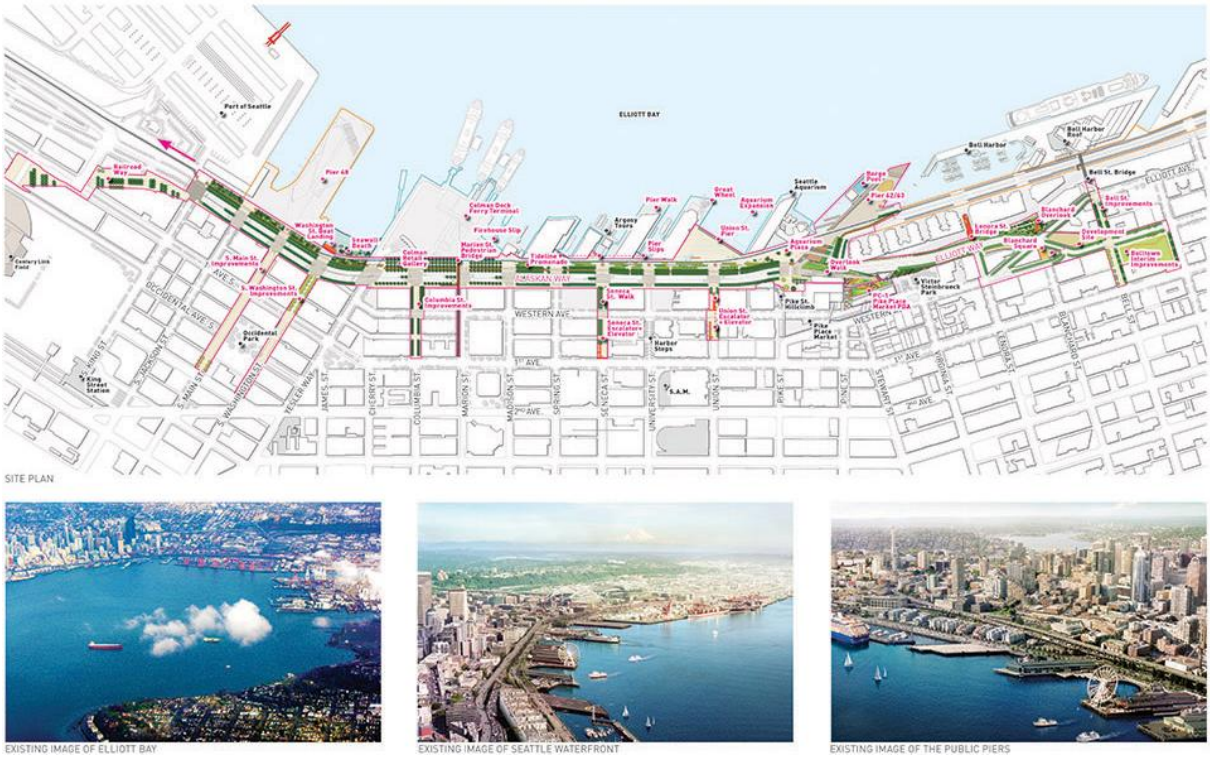


Fig. 2- 10 Seattle Waterfront Planning Master Plan
Source: https://www.gooood.cn/waterfront-seattle.htm

From the perspective of Resilience theory, the renewal strategy of the Seattle Central Waterfront is mainly reflected in both material and social aspects:

The fusion of history and modernity

The history of the Seattle waterfront is the development history of industry, shipping, and transportation. The urban grid that continues the traditional north-south direction and maintains the original residential pattern extends northward along the coastline.

Prioritize waterfront and sustainable innovative design

The project has developed sustainable strategies to continuously optimize the urban system from multiple aspects such as ecological, environmental, economic, and social aspects. And because this waterfront area is located between two major Ecotope - the coast and the Intertidal zone, the design strengthens this Ecotone, and enhances the connection between the two major Ecotope (Fig. 2- 11).

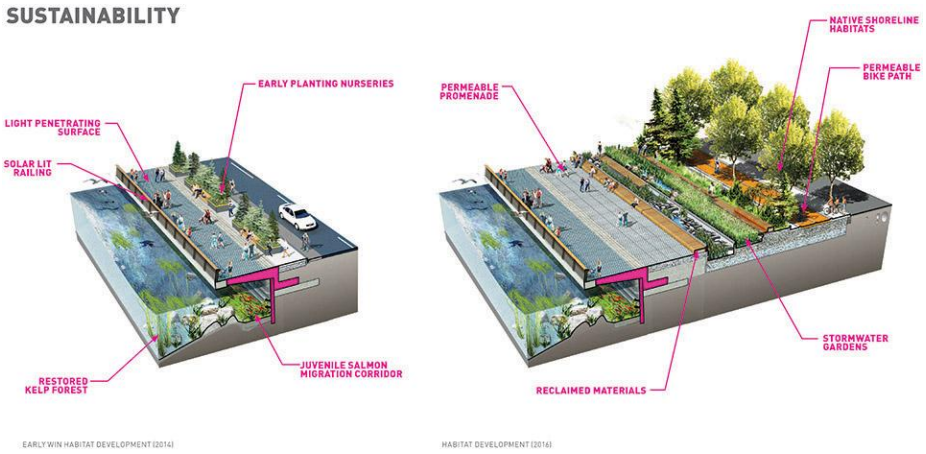


Fig. 2- 11 Sustainable Design of Ecotone
Source: https://www.gooood.cn/waterfront-seattle.htm

Improve accessibility and mobility

The center of the new waterfront area is the City Avenue and pedestrian walkways. As the backbone of the region, city roads and sidewalks play a role in promoting connections between existing shopping, catering, shipping, and cultural activities. The plan analyzes each mode of transportation and designs a satisfactory and safe public domain by balancing the needs of all parties. The optimization of east-west transportation and the improvement of waterfront accessibility will extend the vision of the central waterfront area of Seattle to the heart of the city. The design of core engineering and subsequent elements ensures that the planning of the waterfront area can still proceed in an orderly manner after many years.

Multi party collaboration

The Seattle waterfront combines three elements of urban size, community size, and waterfront area size to comprehensively consider the planning and design of the central waterfront area, and prioritizes urban design. The landscape architect led a team of engineers, ecologists, designers and art consultants, graphic and signage designers, architects, and transportation consultants to carry out a panoramic design of the waterfront area with investors. In addition, a non-profit organization called "Friends of Seattle Waterfront", supported by grassroots support and responsible for project expansion, education, publicity, and fundraising, has been established to promote the management of the waterfront.

Public participation

Seattle and the general public participated in every detail of project analysis and planning through typical democratic procedures, including even selecting design teams. In order to let the masses of the community participate in decision-making, the design team held large public meetings, issued briefings, developed cooperation, and held round tables attended by more than 50 organizations. The focus of the outreach team is on how to attract new tourists, how to expand the project to a wider community, and how to collaborate with community organizations and leaders. In addition, a special logo has been designed for the project and a website called waterfrontseattle.org has been established to facilitate public access to relevant information and better participate in planning (Fig. 2- 12).

Fig. 2- 12 Public Participation and Website Construction
Source: https://www.gooood.cn/waterfront-seattle.htm

2.5.3 Case Summary

From the analysis of the cases of ship industry heritage and urban waterfront renewal, it can be seen that the resilience theory is applied to the renewal and reuse of ship industry heritage, and the specific methods are mainly reflected in the following two levels:

① At the physical level

Resilience theory mainly focuses on the continuation of historical and cultural heritage, the creation of composite functional spaces, and the restoration of ecosystems. By integrating resources in the heritage area, connecting various key elements within the site, continuing the historical context while establishing a sound urban system; Secondly, the mixing of diversified functions, optimization of transportation, and improvement of waterfront accessibility can better connect the waterfront and urban hinterland, making the renovated shipbuilding industry heritage area serve the public and urban development. In addition, the reuse of the inherent ecological resources and material resources of the shipbuilding industry heritage can reduce the construction cost while avoiding the production of Construction waste. Therefore, by reshaping the material environment of the heritage, the shipbuilding industry heritage can provide sufficient space and venue to meet the different needs of society, ensuring the variability and adaptability of the system; The reshaping of the ecological environment can enhance the system's self-healing ability and enhance its resilience to stress.

② At the social level

Resilience theory mainly focuses on the formulation of policies and regulations, public participation, modular design, and platform control. The protection of the shipbuilding industry heritage emphasizes the integration of various forces and perceptions in society, in order to coordinate complex interest relationships and maintain stable social development. By establishing diversified social networks, improving institutional guarantees, establishing open innovation platforms, and encouraging diversified thinking, we aim to strengthen the protection role of the government, relevant institutions, or citizens for the heritage of the shipbuilding industry. By establishing a social and institutional framework, the shipbuilding industry heritage can mobilize different resources and support when facing different challenges, better respond to future challenges and changes, and maintain system stability and sustainable development.

2.6 Chapter Summary

This chapter first analyzes the research status of the shipbuilding industry heritage at home and abroad, and summarizes the basic content and advantages of the resilience theory. By comparing with other urban renewal methods, it is concluded that the "Urban resilience" theory has the advantages of "giving consideration to both hard and soft, combining hard and hard", and "adjusting measures to local conditions"; Secondly, through the practice of Urban resilience governance and the practice of updating the shipbuilding industry heritage, it is concluded that the current resilience theory is mainly to adapt the system to environmental threats by adjusting the social and institutional framework, to adapt to external disturbances by improving the physical environment and ecological environment, so as to comprehensively improve the flexibility and adaptability of the system, so that it can effectively prevent and quickly adapt to various internal and external uncertain risks and crises, Provide strategic research ideas for the following text.

Chapter3 Applicability between Guangzhou Shipbuilding Industry Heritage and Resilience Theory

3.1 Development Overview

3.1.1 Development Overview and Background of Heritage Formation

Guangzhou, located in southern China, is situated at the lower reaches of the Pearl River and adjacent to the South China Sea. With a history of more than 2,200 years, it is the birthplace and prosperous center of Lingnan culture. Since the Spring and Autumn Period and the Warring States Period, Guangzhou has been an important metropolis. After the unification of China by the Qin Dynasty and the establishment of feudal dynasties, Guangzhou has served as an administrative center and a political, military, economic, cultural, and educational hub in South China. It is also the birthplace of modern Chinese revolution and an important cradle of modern civilization[39]. The development and formation of the shipbuilding industry and heritage in Guangzhou can be divided into three stages: late Qing Dynasty (1840-1911), the Republican era (1911-1949), and the period after the founding of the People's Republic of China (1949-present).

Late Qing Dynasty (1840-1911)

The late Qing Dynasty marked the beginning of China's modern shipbuilding industry and the transition from traditional handicrafts to modern industries. In December 1838, Lin Zexu was appointed to Guangdong to ban opium and control the Guangdong Navy. Shortly after, he became the Governor-General of Guangdong and Guangxi. Recognizing the advanced artillery and shipbuilding technologies of the West, Lin Zexu proposed the concept of "learning from the enemy to overcome the enemy" and initiated the translation of foreign books and publications to seek ways to defend against and compete with Western powers. Influenced by Lin Zexu, many patriotic officials and scholars in Guangzhou raised funds to build Western-style warships. However, after the Opium Wars, the Qing court repeatedly emphasized the avoidance of employing foreign artisans or purchasing foreign goods, causing the budding modern shipbuilding industry in Guangzhou to stagnate. It was only after the Second Opium War that the Qing court acknowledged the effectiveness of Western "strong ships and powerful cannons." Local officials, represented by Zeng Guofan, Li Hongzhang, and Zuo Zongtang, initiated the "Self-Strengthening Movement" and established institutions such as Guangdong Armament Machinery Bureau, Guangdong Arsenal Bureau, Huangpu

Torpedo Bureau, and Huangpu Shipyard in Guangzhou to build and repair steamships and warships. However, due to foreign control, private shipbuilding industry in Guangzhou failed to develop. It was not until 1882 when foreign shipyard companies relocated to Hong Kong that private ship repair yards emerged in Guangzhou.

The shipbuilding industry in late Qing Guangzhou can be categorized into government-run military shipbuilding, private shipyards and ship machinery factories, and foreign-owned ship repair yards.

(1) Government-run military shipbuilding

The military shipbuilding industry in Guangzhou was gradually established during the Self-Strengthening Movement. Prior to the Opium Wars, Guangzhou's shipbuilding industry was still in the handicraft stage. After the Self-Strengthening Movement, under the advocacy of Lin Zexu, many intellectuals and patriotic individuals raised funds to imitate Western warships, leading to a wave of imitating Western warships and experimental steamships in Guangzhou. However, they did not receive strong support from the Qing court. It was not until 1842, as the Opium Wars were coming to an end, that the Qing court ordered the construction of warships. Afterward, there were some improvements in shipbuilding technology in Guangzhou. From 1866 to 1868, the governors-general of Guangdong and Guangxi, Rui Lin and Jiang Yili, purchased seven small and large gunboats from England and France. Due to the need for repairs and additional construction of steamships, the Guangdong Armament Machinery Bureau was established in Guangzhou in 1873. Subsequently, other bureaus were established, including the Arsenal Bureau, Torpedo Bureau, and Huangpu Shipyard, specializing in the repair and construction of military vessels (Tab. 3- 1).

Tab. 3- 1 Overview of Guangzhou's Military Shipbuilding Industry in the Late Qing Dynasty
Source: Compiled by the author based on *Guangdong Provincial Annals - Shipbuilding Industry Annals*

Factory/Bureau Name	Year Established	Location	Founder	Overview	Notes
Guangdong Armament Machinery Bureau	1873	Juxianfang, Guangzhou	Rui Lin, Zhang Zhaodong	Purchased Kebei, Lushun, and Yuren shipyards, affiliated factories, buildings, and machinery equipment	Manufactured military products and also engaged in ship construction. Merged into Arsenal Bureau in 1884, renamed Guangdong Manufacturing Bureau, and no longer involved in ship construction.

Continued Table 3-1

Guangdong Arsenal Bureau	1875	Zengpu, Guangzhou	Zhang Zhaodong	Affiliated with a shipyard, imported steam engines	The affiliated shipyard repaired military vessels. Merged with Armament Machinery Bureau in 1884, renamed Guangdong Manufacturing Bureau, and no longer involved in ship construction.
Huangpu Shipyard	1885	Huangpu, Guangzhou	Zhang Zhidong	Self-built, no employment of foreign technicians	Specialized in the construction of military vessels. Disbanded in 1893, resumed operation in 1901.
Huangpu Torpedo Bureau	1883	Huangpu, Guangzhou	Zhang Shusheng	Studied abroad	Constructed torpedoes, merged with Torpedo Bureau, responsible for ship repair at Huangpu Shipyard.
Huangpu Torpedo Bureau	1884	Huangpu, Guangzhou	Zhang Zhidong	Studied abroad and returned to China	Constructed torpedoes and torpedo boats, merged with Torpedo Bureau.

(2) Private Shipyards and Marine Machinery Plants

During the late Qing Dynasty, private shipbuilding industry faced limited development due to foreign control. After the Opium War, Guangzhou and other coastal areas continued to build wooden sailing ships that operated in Southeast Asia and Japan. In the 7th year of Emperor Guangxu's reign (1881), with the development of river transportation, human-powered ferry boats emerged. In the early 16th year of Emperor Daoguang's reign (1836), a British-made wooden steamship arrived at Huangpu, marking the gradual increase in the number of steamship repairs. Starting from the 25th year of Emperor Daoguang's reign (1845), after the establishment of foreign-owned shipyards in Huangpu, the original wooden sailing ship construction industry in Huangpu gradually declined.

In the 12th year of Emperor Tongzhi's reign (1873), after the relocation of foreign-owned shipyards to Hong Kong from Huangpu, privately-owned shipbuilding industry in Guangzhou began to slowly develop. In the early 1870s, shipyards such as Zhu Linji, Lin Shunhe, and Lin Shunchang appeared on the north bank of the Pearl River in Guangzhou (now in the Datou Sha and Er Tou Sha areas). On the opposite bank, there were shipyards in Henanwei such as Wanli, Lizhen, Quanli, and Xingli. These shipyards were mainly engaged in the construction of wooden sailing ships, barges, ferries, as well as wine boats and pleasure boats, which were non-motorized wooden vessels.

During the early years of Emperor Guangxu's reign, there were frequently seen privately-owned "huo chuan zi" (small steamships) on the Pearl River. With the increasing

demand for these steamships capable of towing cargo ships and transporting passengers, the steamship repair industry gradually developed. Notable large-scale establishments in this field included the renowned Chen Liantai Machinery Factory and Junhe'an Machinery Factory. Starting from the 24th year of Emperor Guangxu's reign (1898), several specialized shipbuilding factories emerged in Guangzhou, such as Lichang Machinery Factory, Hengchangtai Machinery Factory, and Yixin, Yihe Xiang, which were mostly developed from old ironwork factories engaged in ship repair business. These machinery factories were mostly concentrated along the rivers in Guangdong province (Tab. 3- 2).

Tab. 3- 2 Larger-Scale Private Shipyards in Guangzhou during the Late Qing Dynasty
Source: Compiled by the author based on *Guangdong Provincial Annals - Shipbuilding Industry Annals*

Gategory	**Shipyard Name**	**Establishment Year**	**Location**	**Founder**	**Overview**	**Remarks**
Main Shipyards	Chen Liantai Machinery Factory	1839	Guangzhou, Doulan Street	Chen Danpu	Studied marine engineering at the Fujian Shipbuilding School, started replicating steam engines and small steamships	Originally a small workshop for repairing machinery, renamed as Chen Liantai Machinery Factory in the eighth year of Emperor Guangxu's reign, later wrongfully seized and sealed
		Junhe'an Machinery Factory	1886	Guangzhou, near the Thirteen Hongs	Chen Taochuan	Studied under Wen Zishao, the director of Guangdong Machinery Bureau
Other Shipyards	Hengchangtai	1880	Guangzhou	Distributed along the rivers in Guangzhou	/	/
	Lichang Machinery Factory	1899	Guangzhou		/	/
	Yixin, Yihe Xiang, Yixing Xiang, Sixing, Guangyuan, etc.	1898	Guangzhou		Boiler Factory	/

(3) Foreign-Owned Shipbuilding and Repair Yards

On July 1, 1843, the Sino-British trade was restored in Guangzhou, leading to a significant increase in the number of merchant ships coming to China due to the massive influx of opium and goods. By 1845, there were already 302 foreign merchant ships anchored at Huangpu, and the shipyard business in Huangpu became busy as well. In the same year, the first iron-hulled steamship named "Lady Mary Wood" from the British Steam Navigation Company arrived in Huangpu for repairs. John Cockerill, a Scottish man responsible for supervising the repair, saw the profitability of ship repairs and leased a mud dock in Huangpu. He hired local workers and established Cockerill Dock, setting a precedent for foreign capital to operate factories in China. Other British and American businessmen followed suit and established nine shipyards and dock companies in Huangpu, Guangzhou.

The period from the second year to the ninth year of the Tongzhi reign (1863 to 1870) was the peak period for shipbuilding and repair industry in Huangpu. In the ninth year of Tongzhi , the dock companies in Huangpu were successively merged by the Hong Kong and Whampoa Dock Company. In the 1870s, most foreign ocean-going vessels were over 300 feet long with a draft exceeding 25 feet. However, at that time, Huangpu Shipyard had only two docks exceeding 300 feet, and the water depth inside the docks was less than 25 feet, clearly unable to meet the needs of ship repairs. At this time, the ship repair industry in Kowloon, Hong Kong, had already emerged, and the foreign-owned shipbuilding enterprises in Huangpu shifted their focus to Hong Kong. In the second year of Emperor Guangxu's reign , the docks and factories in Huangpu were purchased by the Guangdong government (Tab. 3- 3).

Tab. 3- 3 Overview of Foreign-Owned Shipbuilding and Repair Yards in Late Qing Period Guangzhou
Source: Compiled by the author based on *Guangdong Provincial Annals - Shipbuilding Industry Annals*

Year of establishment	Shipyard Name	Location	Founder & Nationality	Dock			
				Types	Length	Width	Depth
1845	Couper Dock J.C.Couper & Co	Huangpu	John Couper (British)	Stone Dock Stone Dock Wood Dock Mud Dock Mud Dock	300 550 220 180 150	 70 48 35	17 17 13 13.5 10
1847	Dancs' Island Dock Company	Huangpu	(American)	/	/	/	/

Continued Table 3-3

1850	Thos hunt & Co	HuangpuHong Kong	Thomas Hunt (American)	/	230 160 145	46 46 40	14.5 14.5 11
1850	Ryder's Dock	Huangpu	(American)	Wood Dock	/	/	/
1853	Union Dock Company	HuangpuHong Kong	(British)	Stone Lime Dock Stone Lime Dock Stone Dock Stone Dock	240 185 163 190	45 36.5 36.5 36.5	/
1863	Hall & Co, Looksun Dock	HuangpuHong Kong	Cardew CouperKent (British)	Stone Dock	330	70	23.5
1863	Cow & Co.	Huangpu	(British)	Stone Wood Dock Stone Wood Dock	255 175	40 34.5	/
1863	Hong Kong and Whanpoa Dock Co.	HuangpuHong Kong	(British)	Stone Dock Stone Dock Stone Dock Stone Mud Dock Stone Mud Dock	550 350 260 165 125	80 75 55 55 55	/
1867	Ferguson & Co.	Huangpu	(British)	Wood Mud Dock	240	50	/

The Republic of China era (1911-1949)

After the Xinhai Revolution in the third year of the Xuantong era (1911), which overthrew the feudal rule of the Qing Dynasty, the early years of the Republic of China until the end of World War I saw temporary development in the shipbuilding industry in Guangzhou. This was due to Sun Yat-sen's proposal of industrialization to save the country, and the Western powers were preoccupied with the war and temporarily relaxed their economic aggression against China. However, during the outbreak of the Second Sino-Japanese War, Guangzhou fell under Japanese occupation, and many privately-owned enterprises were either occupied by the Japanese or destroyed by the war. A number of shipyards relocated to the upper reaches of the Pearl River, and the shipbuilding industry in Guangzhou faced a difficult period of development. After the victory of the war against Japan, the Kuomintang government took

over the Japanese and puppet naval vessels, and private shipyards resumed operation. New shipyards were also established, such as Yuguo Shipyard, Huannan Shipyard, New China Machinery Factory, and Tongsheng Machinery Factory. However, during this period, the Kuomintang initiated the Chinese Civil War, which resulted in continuous military failures and severe political and economic crises. By the eve of the founding of the People's Republic of China, many shipyards had closed down and gone bankrupt, while the remaining ones were struggling to survive.

The shipbuilding enterprises in the Republican Era mainly consisted of state-owned shipyards, private shipyards, and ship machinery factories.

(1) State-owned Shipbuilding Shipyards

In the early years of the Republic of China, the Huangpu Shipyard was renamed as the Huangpu Shipyard Bureau. In the fifth year of the Republic of China (1916), it was taken over by the Guangdong Provincial Bureau of Industry and renamed as the Huangpu Shipyard. After the victory of the war against Japan, the New First Army stationed in the Huangpu Shipyard and established the Huangpu Naval Shipbuilding Plant. In the thirteenth year of the Republic of China, the Guangdong Military Government acquired the Guangnan Shipyard and renamed it as the Guangnan Naval Shipbuilding Plant. The plant focused on repairing naval vessels and also constructed some small warships. In the nineteenth year of the Republic of China (1930), the plant was taken over by the Navy Ministry of the Nationalist Government in Nanjing and renamed as the National Revolutionary Army Guangnan Shipbuilding Plant. In the twentieth year of the Republic of China (1931), the plant was placed under the command of Chen Jitang's First Army Fleet and renamed as the First Army Guangnan Shipbuilding Plant. In the twenty-first year of the Republic of China (1932), the Huangpu Torpedo Bureau was disbanded. In the twenty-third year of the Republic of China (1934), Chen Jitang established a torpedo fleet to strengthen the naval power and established a torpedo base at the former site of the Huangpu Torpedo Bureau. In addition, there were various large and small shipyards either occupied or established by the invading Japanese forces in Guangzhou, such as the Fangcun Dachongkou Coordination and Machinery Plant

occupied by the Japanese in the twenty-seventh year of the Republic of China (1938); the Takenaka Shipyard and Taitaku Shipyard established by the Japanese in Henanzhou; the Eighth Field Ship Repair Shop established in the Huangpu Shipyard in the twenty-eighth year of the Republic of China (1939); and the Guanghe Xing Machinery Plant occupied by the Japanese in the thirtieth year of the Republic of China (1941) (Tab. 3- 4).

Tab. 3- 4 List of Officially Managed Shipbuilding Yards in Guangzhou during the Republican Era
Source: Compiled by the author based on *Guangdong Provincial Annals - Shipbuilding Industry Annals*

Affiliation	Factory Name	Year of Establishment	Address	Business	Description
Guangdong Military Government	Huangpu Shipyard Bureau Huangpu Shipyard Huangpu Naval Shipyard	1885 1916 1945	Guangzhou, Huangpu Changzhou	Shipbuilding and repair	Occupied by the Japanese during the Guangzhou occupation period
	Guangnan Shipyard Guangnan Naval Shipyard National Revolutionary Army Guangnan Shipyard First Army Guangnan Shipyard	1914 1924 1930 1931	Guangzhou, Dahuangjiao	Shipbuilding and repair	Occupied by the Japanese during the Guangzhou occupation period Long-term disrepair and abandonment
	First Army Fleet Torpedo Base	1883 1934	Guangzhou, Huangpu Changzhou	Repair and maintenance of water, torpedoes, and torpedo boats	/
Japanese Puppet Shipyard	Coordination and Machinery Factory	1938	Guangzhou, Fangcun	Shipbuilding and repair	Occupied
	Takeda Shipyard, Taiko Shipyard	1938	Henanzhou	Repair of small ships	Newly established
	Eighth Field Ship Repair Workshop	1939	Guangzhou, Huangpu	Shipbuilding and repair	Established within the Huangpu Shipyard
	Guanghexing Machinery Factory (converted to Fishery Repair Shipyard)	1941	Guangzhou	Shipbuilding and repair	Occupied

(2) Private Shipyards and Marine Machinery Factories

In the early years of the Republic of China, a large number of national capitalists emerged under the ideology of Sun Yat-sen's industrialization for the salvation of the country. They attempted to strengthen the country's economic power in order to achieve the goal of saving the nation. During this time, the private shipbuilding and marine machinery industries experienced rapid development, mostly consisting of small shipyards and machinery repair factories. From the Xinhai Revolution to the eve of the Sino-Japanese War, numerous private factories were established in Guangzhou, engaging in the construction of steam-powered ships (commonly known as "fire ships") and internal combustion engine-powered ships (commonly known as "electric ships").

From the first year to the 27th year of the Republic of China (1912-1938), Guangzhou established a total of 56 shipyards and 146 marine machinery factories. During the period of the Anti-Japanese War, Guangzhou fell under Japanese occupation, and the shipbuilding industry suffered severe destruction at the hands of the Japanese invaders. Some shipyards and workshops were relocated to inland areas, while others were forced to close down.

After the victory of the Anti-Japanese War, the shipbuilding industry in Guangzhou began to recover. Among the reopened shipyards, there were 16 old ones and 24 new ones, totaling 40. As for marine machinery factories, there were 41 in total. Among these newly established shipyards, in addition to the New China Machinery Factory, there were several large-scale ones, including Xiadu Shipyard (later renamed Huadu Shipyard), Yuguo Shipyard, and Tongsheng Machinery Factory.

From the first year to the 38th year of the Republic of China (1912-1949), a total of 100 shipyards and 128 marine machinery factories were established in Guangzhou (Tab. 3- 5).

Tab. 3- 5 Private Shipyards and Marine Machinery Factories in Guangzhou during the Republic of China Period
Source: Compiled by the author based on *Guangdong Provincial Annals - Shipbuilding Industry Annals*

Category	Factory Name	Year of Establishment	Address	Founder(s)	Business	Description
Main Private Shipyards	Guangnan Shipyard	1914	Guangzhou, Dahuangjiao	Tan Yuxiu, Tan Litin	Ship repair	The largest shipyard in modern Guangdong owned by private individuals. Later acquired by the Guangdong Military Government.
	Xiadu Shipyard	1945	Guangzhou	Wu Deshao, Wu Dejiao	Shipbuilding	Later renamed Huadu Shipyard.
	Yuguo Shipyard	1945	Guangzhou	Wu Deshao, Wu Dejiao	Shipbuilding	-
		New China Machinery Factory	1946	Guangzhou, Nanhuazhong Road	Guan Chensheng, Zhang Bingzhou, and others	Shipbuilding
Other Private Shipyards	Liang Yueli, Cheng Xing, Sihe, Yongdexiang, Yongtaixing, Yongtaian, Yongtailin, Licheng, Jingbo, He Yongji, Xie Anxiang, Xinxingxiang, Xie Xing, Xingfa, Haixing, Xingdeli, Zhihe, Taixinglong (Zhoutouzui), Tai'anlong (Gongzheng Street), Shunyi, Anxing, Hongfa, Shenghe, Weipu, Jiuxing, Hehexiang, Lizhen, Guangxinglong, Shuji, Yicheng, Zhencheng, Changtai, Guangfaxiang, Heli, Hehelong, Zhu Linji, Wanli, Lin Shun'an, Lin Shunhe, Lin Xingchang, Quanli (Henanwei), Mingli, Xingli, Guang'an (Shichongkou), Guanghecheng, Yuanli, Xieji, Dachanglong Shuji, Fuxing, Xinji, Lichenglong, Taixinglong (Haizhu Bridgehead), Taianlong Heji, Shunchenglong, Xinlihe, Runfaxiang, Zhaotai, Shengxinglong, Guang'an Manji, Yongxinglong, He Jinji, Chen Taoji, Zhonghua, Xiehelong, Guangfaxiang, Yongji, Hexiangxing, Gong'anlong, Siheheji, Guangdexing, Fushun, Youfa, Guangtai, Mo Chengxing, Xie'anlong, Xianghe, Xinxiangtai, Changfeng, Guangzhou, Guangchengfa, Pacific, Dean Tai, Liangshunlong, Sihezaiji, Helilong, Xianghe, Li Bingji, Xie Xiangxiang, Yongxingxiang, Dongchengxing, Heyi, Mingji, Dexinglong, Dean					
Main Marine Machinery Factories	Tongsheng Machinery Factory	1945	Guangzhou	Liang Bohong	Machinery production	Also involved in the construction of iron-hulled ships.
		Coordination and Machinery Factory	1912	Guangzhou, Fangcun	He Weiwen and five others	Machinery production
Other Marine Machinery Factories	Junhe'an, Lichang, Hengchangtai, Yixin, Yihe Xiang, Jiu Xing, Guangyuan, Guangtong'an, Bozhou, Yijian, Guanghexing, Hongyi, Dexiang, Yihe Xiang, Xie Runji, Shunfaxiang, Tongxing, Yuanfa, Dean Xiang, Linjingji, Chenshenji, Renyouji, Chenpei Ji, Xiedangji, Guangyongxin, Risheng, Chengxing, Dahua, Jufa, Xie'anlong, Yuhua, Nanxing, Juyuan, Yuxingxiang, Junxingxiang, Shunanxiang, Xiangji (Boiler Factory), Shaofa, Xiechengchang, Guangtongfa, Junanlong, Shunl Xiang, Youxiangxiang, Yonghexiang, Anxing, Hexing, Shengchanghe, Yongxing, Delongxing, Tongde, Shengchang, Chenghe, Yingji, Xinxinglong, Guangxinglong, Dengjihao, Xie Xinglong, Hongyi Hao, Yuji Hao, Yuesheng, Nanqiang, Heji, Gonghexiang, Yilong, Xiehe Xiang, Liang Yiji, Lingji, Xiangji (Machinery Factory), Yuanli, Shengjilong, Ronghe, Linhaiji, Li Linji, Huqiuji, Yongyulong, Yimin Hao, Wen Guichang, Lianhe Hao, Tongde Hao, Yiji, Huiji, Xiangxing, Lianghuaji, Li Huiji, Shengjixiang, Chengfahao, Yongchanghe, Heng'an Hao, Zhang Xiangji, Changxing, Henan Hao, Tongjihe, Zhenxing, Shengl Xing, Hezuo, Dongxing, Si Xiangxiang, Linxinji, Dean Hao, Hongyuan, Yihe, Hongxing, Hongchang, Shengji Hao, Zhihexiang, Dexing Hao, Quanyuan Hao, Hongxing Hao, Ruiyuan Hao, Yu Yongji, Lianfa Hao, Qin Chang, Chenliuji, Hehe Xiang, Chenniuji, Jianguo, Yonghe Xiang, Baiji, Suyingji, Nanfa					

The new Chinese Time (1949 to Present)

After the establishment of the People's Republic of China, the development of the shipbuilding industry in Guangdong Province was regarded as an urgent need to defend the shipbuilding frontier, promote shipping and fishing industries. The central leadership, relevant ministries and committees, as well as local governments at all levels, attached great importance to and supported the construction of a number of large and medium-sized shipyards. Small-scale shipyards were also established throughout the coastal and riverside areas. Supporting shipbuilding factories, ship research institutes, and design institutes were established. A large number of ships were built for transportation, fishing, and other sectors. Various types of combat ships and auxiliary vessels were constructed for the People's Liberation Army Navy, and a significant number of ships were provided for foreign aid and foreign trade. This laid the foundation for one of the six major shipbuilding bases in China, with Guangzhou as the main center.

The development of the shipbuilding industry in Guangzhou after the establishment of the People's Republic of China can be divided into three stages: the recovery stage (1949-1952), the development stage (1953-1978), the reform and opening-up stage (1978-1999), and the stage of protection and utilization (1999 to present).

(1) Recovery Stage: October 1949 to 1952

From October 1949 to 1952, it was the recovery stage of the shipbuilding industry in Guangzhou. The military administration committees in various regions of Guangdong gradually took over the repair shipyards of the former Kuomintang Navy and the shipyards of bureaucratic capital, designating them as repair workshops under the jurisdiction of the river defense forces and ship maintenance sites under the transportation and shipping departments. Most of the small private shipyards in the region were simple in terms of facilities and outdated, resembling artisanal workshops. Guangzhou had a total of 46 ship repair yards, 24 marine machinery factories, 19 boiler factories, and 5 factories for paint, wood molds, and other products, employing more than 1,000 workers. After the establishment of local people's governments, these private shipyards were placed under the management of provincial or local industrial, transportation, and fisheries departments (bureaus). The repair shipyards and sites of the navy were initially under the direct jurisdiction of the Jiangfang Command of the Guangdong Military Region and later under the leadership of the Naval Shipbuilding Department of the South Central Military Region. Some small repair workshops (sites) were

directly managed by naval bases (water police zones, patrol zones) and received leadership from the military region's shipbuilding department.

During this period, the workers who took over the former naval shipyards under the mobilization of the People's Liberation Army repaired machinery and facilities, resumed production, and mobilized some private shipyards to repair ships, making contributions to supporting the liberation of Hainan Island and coastal islands by the People's Liberation Army. There was also an urgent need to restore shipping and fishing production in various regions. Under the leadership of people's governments at all levels, shipyards gradually regained vitality. The main shipyards during this stage included the Navy Huangpu Shipyard and the Inland River Shipyard of the Provincial Department of Transportation.

(2) Development Stage: 1953-1978

From 1953 to 1978, the shipbuilding industry in Guangzhou gradually developed according to the principles of "simultaneous construction and repair, with repair as the main focus" and "joint development of military and civilian, with the military leading the civilian sector."

During the first Five-Year Plan period (1953-1957), the shipbuilding industry in Guangdong Province followed the spirit of central-local division of shipbuilding tasks and assigned the construction of medium-sized ships required for the Pearl River system to shipyards under the Ministry of Transportation. During this period, as China was undergoing socialist transformation of capitalist industry and commerce, many small private shipyards were merged and transformed to become local state-owned shipyards, collectively owned shipyards, or joint ventures. The shipbuilding industry system in Guangzhou began to take shape.

From 1957 to 1966, China was in the period of comprehensive socialist construction, and the shipbuilding industry in Guangzhou entered a stage of comprehensive development. During this period, the National Planning Commission proposed that the shipbuilding industry, with its characteristic combination of military and civilian and repair and construction, needed to be planned comprehensively and divided reasonably, with a unified system throughout the country instead of separate efforts. The establishment of a Shipbuilding Industry Ministry to coordinate shipbuilding activities nationwide was suggested. In the late 1950s, the construction of shipbuilding supporting networks began, and large, medium, and small shipbuilding and repair yards were expanded. In the early 1960s, the shipbuilding industry

implemented the policy of "self-reliance and striving for self-improvement" and gradually embarked on the path of developing modern military and civilian ships through domestic efforts and independent research and development. In 1975, Guangdong Province established five shipbuilding networks for warships, marine vessels, inland river vessels, fishing boats, and engineering vessels, and formulated supporting plans and ship standardization work. With the continuous improvement of the shipbuilding system, the increase in shipbuilding output, the trend toward larger ships, the improvement of technological standards, and the gradual improvement of the quality of the workforce, the shipbuilding industry in Guangzhou experienced rapid development.

(3) Reform and Opening-Up Stage (1978-1999)

In December 1978, the Third Plenum of the 11th Central Committee of the Communist Party of China proposed shifting the focus of work to socialist construction and put forward the guidelines of "adjustment, reform, rectification, and improvement." Based on this, significant adjustments were made to the construction of the shipbuilding industry, shifting from the previous policies of "military-civilian integration with the military as the main focus" and "simultaneous repair and construction with repair as the main focus" to the policies of "military-civilian integration with priority given to military products" and "integration of repair and construction with priority given to construction," focusing primarily on the development of civilian products. In terms of production and operation, the main guiding principles were "domestic focus, active export, shipbuilding as the main business, and diversified operations."

With the deepening of economic system reform, there were new changes in the management of the shipbuilding industry. After 1987, most of the provincial enterprises were gradually transferred to the management of the local transportation systems, increasing the autonomy of the enterprises. However, the principles of voluntariness, equality, and mutual benefit were still adhered to, and joint operation and overall coordination were implemented to adapt to the needs of a market economy and competition.

Stage of Protection and Utilization (1999 to Present)

With social development and the adjustment of industrial structure, the old shipbuilding industry in Guangzhou faced overcapacity and gradually declined. Poorly managed shipyards were gradually acquired, closed, or abandoned. Some shipyards were relocated to

accommodate urban development and their own needs, moving away from the city center. However, some significant shipbuilding industrial buildings and industrial equipment were preserved as witnesses to the history of shipbuilding industry development in Guangzhou. In 1999, Kebai Shipyard was selected as the fifth batch of cultural heritage conservation buildings in Guangzhou, marking the beginning of the heritageization of Guangdong's shipbuilding industry and the formal initiation of the protection work for Guangdong's shipbuilding industry heritage. Subsequently, some shipbuilding industry heritage sites with high heritage value were gradually included in the heritage protection list.

3.1.2 Site Selection and Layout Characteristics

Distribution Characteristics

In terms of temporal distribution, Guangzhou's shipbuilding industry has typical heritage representative cases from the modern era. From traditional shipbuilding to foreign-funded shipyards after the industrial revolution, state-owned military shipbuilding industries, private shipyards, and shipbuilding machinery factories, to the diverse development of the shipbuilding industry during the period of the People's Republic of China, Guangzhou's shipbuilding industry has progressed with the times. During the late Qing Dynasty and the Republican era, there were relatively few remaining shipbuilding industry heritage sites in Guangdong, with the Huangpu Shipyard being the representative. However, during the period of the People's Republic of China, there are more shipbuilding industry heritages in Guangzhou, with a concentrated temporal characteristic, mainly represented by Guangzhou Shipyard, Wenchong Shipyard, and others. These shipbuilding industry heritages from different periods witness the development process of Guangzhou's shipbuilding industry in various stages.

In terms of spatial distribution, Guangzhou's shipbuilding industry heritage is mainly concentrated in the central urban area. The central urban area of Guangzhou has a superior geographical location and a dense river network, making it a concentration area for the city's shipbuilding industry heritage. Most of the shipbuilding industry heritages in this area are distributed along the Pearl River Industrial Heritage Corridor and the Railway Industrial Heritage Corridor (Fig. 3-1). Representative examples include Guangzhou Shipyard, Shangjiao Shipyard, the Fourth Navigation Engineering Bureau Shipyard, Guangzhou Fishing Boat Factory, Cheng'anwei Shipyard, Huangpu Shipyard, Wenchong Shipyard, Yuzhu

Shipyard, Boluotan Shipyard, Guangzhou Passenger Shipping Company Shipyard, Guangzhou Barge and Shipbuilding Repair Factory, and Guangzhou Dredging and Salvage Shipping Company Shipyard. Some heritage sites are scattered outside the central urban area, including Guangdong Zengcheng Xintang Shipbuilding Co., Ltd. and Panyu Lingshan Shipyard.

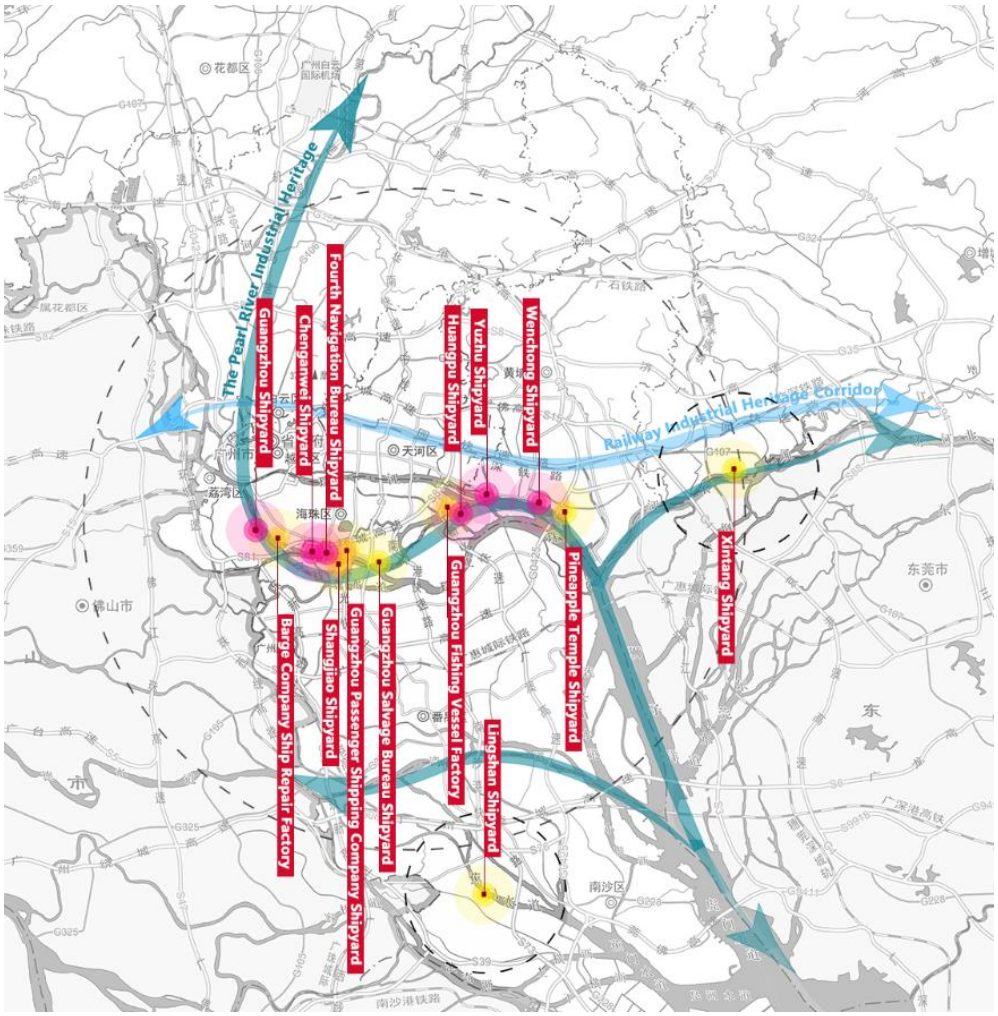


Fig. 3- 1 Spatial Distribution Map of Guangzhou's Shipbuilding Industry Heritage
Source: Author's Self drawn

Site Selection Characteristics

In terms of the distribution of shipyards, the site selection of Guangzhou's shipbuilding industry heritage is concentrated near the estuary of the Pearl River's rear channel. Due to the underdeveloped land transportation and air transportation in the last century, international trade relied heavily on shipbuilding shipping, which was cost-effective and enabled long-distance transportation. The water depth, width, and flow velocity of the rear channel of the Pearl River in Guangzhou would affect the docking, maneuvering, and turning of ships, especially large vessels with greater draft. Therefore, most shipyards are located on both sides of the rear channel.

Planning and Layout Characteristics

From a timeline perspective, the construction of Guangzhou's shipbuilding industry heritage mainly occurred after the 1950s, during the third and fourth generation of shipyards. The shipbuilding mode can be summarized as organizing production based on regions, stages, and types, essentially establishing a flexible assembly line production method. Within the factory area, based on the production flow, it can be integrated into four major production facilities: steel stockyard, hull processing, hull welding, and dry dock (slipway). They influence the rationality of the shipyard's process flow, logistics, and various other aspects. The overall layout of the shipyard is mainly influenced by the combination of these four major production facilities and can be divided into four categories: Type I, T-shaped, L-shaped, and U-shaped.

Looking at the existing layout of Guangzhou's shipbuilding industry heritage, the waterfront area of the factory site exhibits a compact layout centered around the ship production and manufacturing zone. The land along the waterfront is mostly used to accommodate production spaces closely related to the shipbuilding process. The dry docks and slipways, as the core of the shipyard's process organization, are generally arranged perpendicular or at a certain angle to the waterfront. Pre-assembly areas and auxiliary workshops are set up around the dry docks and slipways. Residential and office buildings are usually located in the rear of the factory area or in separate areas outside the factory site. For example, in Wenchong Shipyard in Guangzhou, the production and living areas are separate. The factory area is located on the north side of the Pearl River, with the slipways and Dock 1 and Dock 2 concentrated on the west side of the factory area, and Dock 3 located on the east side. Other factory spaces are arranged around the dry docks and slipways. The living area is situated on the north side of the factory area and includes dormitories, clubs, schools, and other amenities.

Core Physical Features

Guangzhou's shipbuilding industry heritage generally refers to the shipyard sites constructed during the late Qing Dynasty to the establishment of the People's Republic of China. It includes both tangible and intangible heritage related to shipbuilding. In terms of the composition of shipbuilding industry heritage, the tangible cultural heritage of the shipbuilding industry includes buildings, structures, industrial equipment, dry docks, and other tangible industrial heritage. The intangible cultural heritage includes craft processes, textual and graphic materials, corporate culture, and so on (Fig. 3-2).

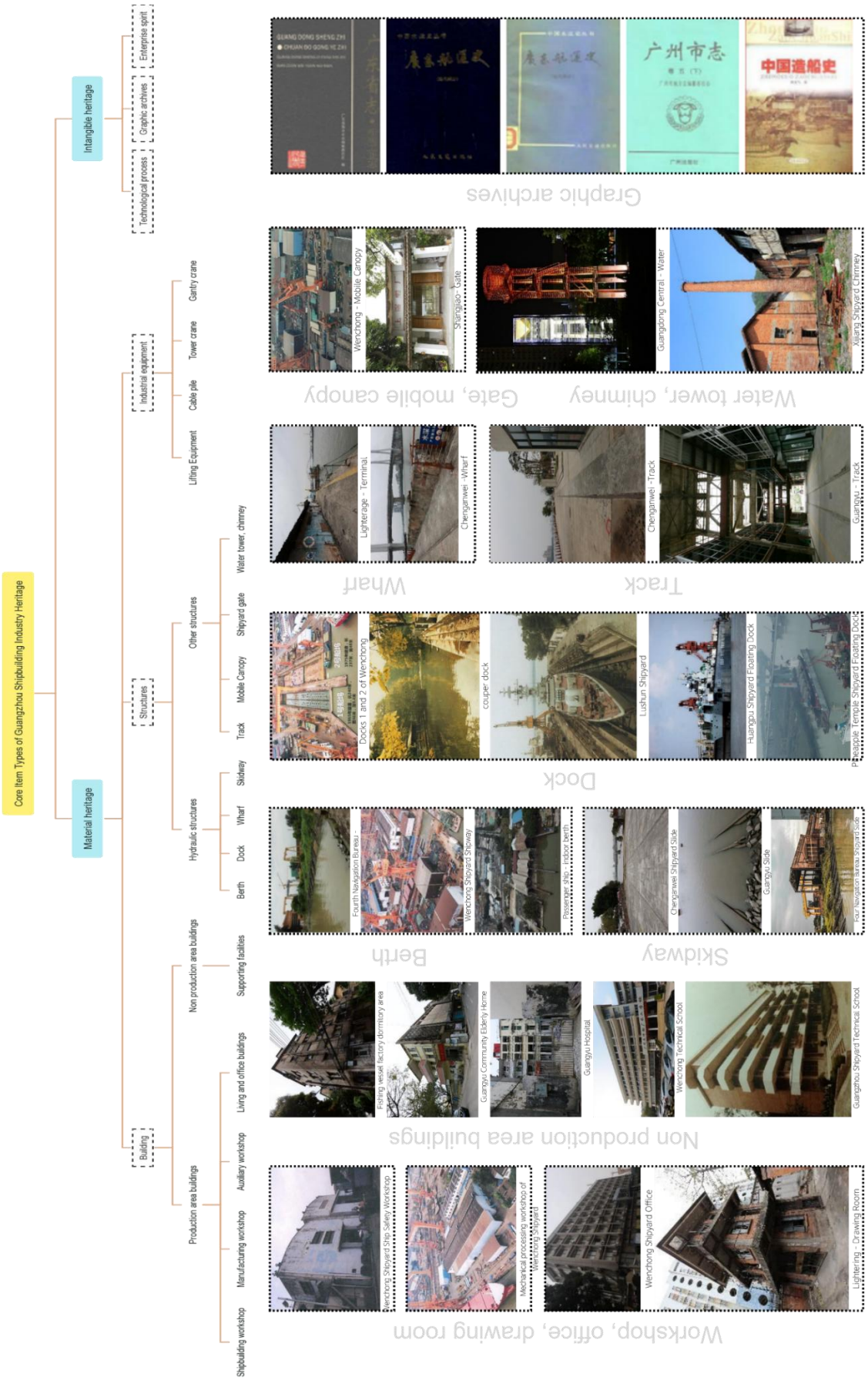


Fig. 3- 2 Characteristics of Core Items of Guangzhou Shipbuilding Industry Heritage
Source: Author's Self drawn

（1）Features of Tangible Remains

① Buildings

Building heritage represents the physical remains of Guangzhou's shipbuilding industry heritage and plays an important role in understanding the construction of shipyard sites in Guangdong and the production processes of the shipbuilding industry. Based on the functional use of buildings, building heritage can be divided into production area remains and non-production area remains.

The production area remains include workshops for shipbuilding, machinery manufacturing, auxiliary processes, and office buildings. These buildings constitute the core of the shipbuilding industry and represent the prominent industrial heritage within the shipbuilding industry heritage system.

The non-production area remains include residential areas, educational facilities, clubs, hotels, and various public service facilities that serve the daily lives of shipyard workers. These facilities are generally located away from the production areas and are situated in the rear of the factory site, far from the riverbanks. For example, the value of preserving residential buildings in the factory area, such as the living quarters in Wenchong Shipyard in Guangzhou, is relatively lower. In the process of industrial heritage preservation, these buildings are often neglected, and many residential buildings in shipyards have been demolished for urban development projects.

② Structures

The structures in shipyards can be mainly divided into two categories: hydraulic structures and other structures. Hydraulic structures are the most prominent ones in Guangzhou's shipbuilding industry heritage, such as slipways, docks, ramps, and piers. Other structures include rails, movable canopies, shipyard gates, water towers, and chimneys.

Slipways: These are the tracks that connect the shipyard and the water. Slipways usually consist of two rails, with the transverse slipway running parallel to the water's edge and the longitudinal slipway perpendicular to it. The longitudinal slipway is commonly used in shipyards.

Shipyard: It is a dedicated area for ship construction and is usually connected directly to the slipway or through a track transfer area. The two common types of shipyards are open-air shipyards and covered shipyards. Open-air shipyards operate in an open environment and are susceptible to weather conditions, but they are suitable for using various large lifting equipment. Covered shipyards can be divided into two types: those with peripheral protective structures and those without. They are not affected by weather conditions and typically have crane installation positions reserved at the top of the building columns.

Dock: It is a hydraulic structure used for building or repairing ships. Common types of docks include dry docks and floating docks. Dry docks consist of a dock entrance, gates, dock chambers, and a drainage system. They are the most widely used type of docks and are generally arranged perpendicular to the riverbank or at a certain angle to it. Floating docks are shipyards that can float on the water surface, providing greater flexibility.

Wharf： Generally, there are production and auxiliary docks in shipyards, which can be classified according to the characteristics of shipbuilding processes, such as berthing, outfitting, testing, and material docks. The classification of docks is sometimes difficult to strictly define, and smaller factories often consider merging them. In specific designs, flexibility should be exercised based on the scale of the factory, production requirements, and geographical conditions.

Track: Used for the movement of ships, equipment, etc., typically installed on docks, docks, shipyards, and workshops where ship and equipment movement is required.

Mobile Canopy: A temporary structure installed on a specific track that can create an indoor-like environment. It can only be moved along the track.

Shipyard Gate: Usually bearing the name of the shipyard, located at the main entrance of the shipyard.

Water Tower: A structure used for pressurizing and storing water for production and daily use in the factory.

Chimney: Installed to minimize the impact of gas emissions on the surrounding environment.

From a structural perspective, the structures of buildings and facilities can be mainly categorized into three types: brick and timber hybrid structures, reinforced concrete structures, and steel structures. Brick and timber hybrid structures typically feature brick exterior walls and timber frames. However, due to their vulnerability and difficulties in preservation, the number of existing brick and timber hybrid shipbuilding heritage sites is relatively small, primarily found in older shipyards. Reinforced concrete structures are widely used in shipbuilding facilities in Guangdong. Steel structures, known for their fast construction speed and low costs, were extensively employed in shipyards at the end of the last century. Large-scale production workshops in shipyards such as Guangzhou Shipyard and Guangzhou Wenchong Shipyard utilized steel structure technology.

In terms of spatial characteristics, the configurations of structures can be classified into single-span, double-span, and multi-span types. Single-span structures are commonly used for workshops with smaller spatial requirements, which are frequently seen in Guangdong shipyards. Double-span structures are often used for pipe fitting workshops, foundries, and other workshops with larger spatial demands. Multi-span structures are more commonly found in shipyards' slipways.

③ Industrial Equipment

Industrial equipment in shipyards includes lifting equipment, gantry cranes, cable winches, and more, playing a crucial role in the shipbuilding process.

(2) Non-material Heritage Characteristics

①Craftsmanship and Processes

The organization and processes involved in shipbuilding are representative of shipbuilding craftsmanship, including shipbuilding technical regulations and company management organization. The shipbuilding heritage in Guangzhou falls within the third and fourth generations of shipyards, characterized by flexible production processes. Since the 1950s, shipbuilding in the industry can be summarized as organized production based on regions, stages, and types. This approach involves dividing tasks and combining them according to spatial areas, stages, and types. During this time, shipbuilding was influenced by specialized and large-scale vessels, leading to the development of a series-based product structure. Major European shipbuilding companies renovated their existing shipyards to adapt to this new

production organization model, which emphasized process management and resembled assembly-line production. As a result, the shipyards integrated four major production facilities: steel stockyards, hull fabrication, hull welding, and dry docks (ship platforms). These facilities influenced the rationality of the shipyard's processes, logistics, and overall layout.

② Graphic and Documentary Archives

Graphic and documentary materials include local historical records of shipyard construction in Guangzhou, as well as publications related to ships. They consist of design drawings of shipyard buildings and ship equipment, which document the growth and changes of the shipbuilding industry in Guangdong through books, charts, and other formats.

③ Corporate Culture

Corporate culture represents the collective memory of shipyard workers and includes slogans, mottos, and oral traditions of enterprise stories. In addition, non-material cultural heritage includes oral records of the shipyard's history and specialized exhibitions.

3.1.3 Values

The shipbuilding heritage in Guangzhou is an important part of China's shipbuilding industry, with a profound historical background and rich cultural significance. Its historical value, technological value, artistic value, and social value are all significant and should not be overlooked.

Historical Value

(1) Witness to China's Modern Industrialization

As one of the important birthplaces of modern shipbuilding in China, the shipbuilding heritage in Guangzhou witnessed significant historical events and development changes during China's modern industrialization process. From the late Qing Dynasty to the present, the shipbuilding industry in Guangzhou has undergone a long transformation from manual craftsmanship to mechanized production, gradually forming a complete shipbuilding system and industrial production model. After nearly a century of development, Guangzhou's shipbuilding industry has become one of the important bases of China's shipbuilding industry. The heritage of its shipyard buildings, equipment, technology, and management is precious

historical artifacts that reflect the historical process and technological level of China's modern shipbuilding industry.

(2) Remarkable Contribution to China's Modern Industrial Development

The historical value of Guangzhou's shipbuilding industry is also reflected in its contribution to China's modern industrial development. In the early 20th century, Guangzhou shipyards were among the largest shipbuilding facilities in China and made significant contributions to China's modern navy and commercial shipping. The shipbuilding industry in Guangzhou not only provided a large number of employment opportunities for China but also stimulated economic development in the surrounding areas.

(3) Unique Style and Characteristics

Guangzhou's shipbuilding technology has a long-standing tradition and has maintained its unique style and characteristics for centuries. The craftsmanship of shipbuilding in Guangzhou is exquisite and is regarded as a precious gem of "Oriental Shipbuilding Art." The wooden ships produced in Guangzhou are particularly renowned as the finest examples of "Oriental Wooden Ships."

Technological Value

During the development of China's modern shipbuilding industry, Guangzhou's shipbuilding industry introduced advanced technologies and equipment, such as steam engines, steel materials, and railways, which were highly advanced for the Chinese shipbuilding industry at that time. Furthermore, Guangzhou's shipbuilding industry continuously innovated and developed based on these technologies and equipment, driving the continuous progress of China's shipbuilding industry. Therefore, the heritage of Guangzhou's shipbuilding industry holds significant technological value for studying the history of modern Chinese technology, particularly shipbuilding technology. The technological value of Guangzhou's shipbuilding heritage is mainly reflected in the following aspects:

(1) Ship Design and Manufacturing Technology

The heritage of Guangzhou's shipbuilding industry is one of the origins of modern shipbuilding technology in China, and its shipbuilding technology and design concepts still hold important reference significance for the modern shipbuilding industry. Guangzhou's shipyards have manufactured various types of ships, including commercial vessels, military

warships, and offshore exploration ships. These ships have unique characteristics and advantages in their design and manufacturing, providing important insights and inspiration for the development of the modern shipbuilding industry.

(2) Marine Machinery and Equipment Technology

Guangzhou's shipyards have developed and produced various marine machinery and equipment, including marine diesel engines, ship generators, and ship compressors. These equipment represented the highest level of China's shipbuilding industry at that time, and their technology and manufacturing processes still have important reference value for the research and manufacturing of modern marine machinery and equipment.

(3) Ship Maintenance and Preservation Technology

Guangzhou's shipyards had a well-established system for ship maintenance and preservation, and their technology and experience hold important reference significance for modern ship maintenance and preservation. The shipyards accumulated a wealth of experience and technology in ship maintenance and preservation, providing important guidance for standardization, normalization, and intelligentization in modern ship maintenance and preservation processes.

Artistic Value

The architecture, equipment, and artifacts of Guangzhou's shipbuilding industry incorporated the artistic styles and craftsmanship of that time, making them valuable artistic heritage. These artistic values not only reflect the social background and cultural atmosphere of that time but also showcase the historical and cultural heritage of Guangzhou's shipbuilding industry, carrying significant historical and cultural significance.

(1) Architectural Artistic Value

The buildings in the heritage of Guangzhou's shipbuilding industry, such as shipyards, docks, and dry docks, are not only important industrial sites of that era but also representative works of architectural art. These buildings integrate technology and aesthetics of the time, possessing unique styles and characteristics that reflect the level of architectural art and industrial development at that time.

(2) Sculpture and Painting Artistic Value

Within the heritage of Guangzhou's shipbuilding industry, many sculptures and paintings were created around the themes of shipbuilding and the ocean. These artworks not only have decorative and commemorative significance but also reflect the social background and cultural atmosphere of that time, possessing high artistic value.

Social Value

As an important component of China's modern industrialization process, Guangzhou's shipbuilding industry made significant contributions to local and national economic development.Therefore, the heritage of Guangzhou's shipbuilding industry holds significant social value in promoting various aspects of local and national development, including the economy, society, and culture.

(1) Economic Value

As one of China's important economic centers, Guangzhou's shipbuilding industry was once an important supplier in the domestic and international markets. The protection and utilization of this heritage can not only generate tourism revenue for Guangzhou but also become an important driving force for local economic development.

(2) Educational Value

These heritages can provide opportunities for learning and understanding historical and cultural knowledge and serve as important venues for educational activities. Through the protection and utilization of these heritages, they can provide rich and diverse educational resources for students and promote the development of the education sector.

3.1.4 Protection status and practice

Current Status of Renewal and Preservation

In recent years, the government has increased its efforts in the preservation of related heritage and has formulated a series of protection policies and measures. Significant progress has been made in the preservation of Guangzhou's shipbuilding industrial heritage. However, some shipbuilding industrial heritage sites have not received sufficient attention. Based on research findings, the current status of preservation for Guangzhou's shipbuilding industrial heritage can be categorized into the following four types:

(1) Cultural Heritage Buildings

Some shipbuilding industrial sites with significant historical value have been designated as municipal-level cultural heritage sites. For example, the Chawei Battery of Guangzhou Shipyard was selected as the fourth batch of cultural heritage buildings in Guangzhou, the Kebo Dry Dock of Huangpu Shipyard was selected as the fifth batch, and the historical site of Changzhou Huangpu Military Academy was selected as the sixth batch (Tab. 3-6).

(2) Historic Buildings

These are buildings that have been determined and announced by the municipal or county government to possess certain preservation value, reflecting historical features and local characteristics, but have not been designated as cultural heritage sites or registered as immovable cultural relics. For instance, the former site of the Ship Repair Factory of the Fourth Navigation Engineering Bureau of the Ministry of Communications was selected as the second batch of historic buildings in Guangzhou, the Lushun Dry Dock of Huangpu Shipyard was selected as the third batch, and the workshops numbered 13, 14, 15, and 16, the slipway, and the No. 1 Dry Dock of Wen Chong Shipyard, as well as the harbor basin and waiting workshop of the Fish Pearl Shipyard, were selected as the seventh batch (Tab. 3-6).

(3) Other Forms of Protection

Other forms of protection mainly refer to inclusion in the List of Chinese Industrial Heritage Protection, identification as clues to traditional architectural styles, and recommendation for protection as industrial heritage buildings. For example, the Kebo Dry Dock of Huangpu Shipyard was included in the first batch of Chinese Industrial Heritage Protection list, and Guangnan Dry Dock was included in the second batch. The Dry Dock, No. 1 Shipyard, No. 2 Shipyard, and No. 3 Shipyard of Guangzhou Shipyard were included in the second batch of protected traditional architectural styles in Liwan District (Tab. 3-6).

Tab. 3- 6 Guangzhou Shipbuilding Industrial Heritage with Legal Protection Status
Source: Compiled by the author based on " Chen Li， Research on Guangdong Shipbuilding Industry Heritage"

Shipyard Name	Designation Content	Announcement Date	Protection Level	Current Status	Image
Guangzhou Shipyard	Che Wai Battery	1993.08	Fourth Batch Cultural Relic Protection in Guangzhou	TOD Urban Complex (Commercial Complex Model)	
	Guangnan Dock	2019.04	Listed in China Industrial Heritage Protection (Second Batch)		
	Dock; Slipways 1, 2, 3	2020.06	Second Batch Traditional Architectural Style in Liwan District		
Huangpu Shipyard	Ke Bai Dock	1999.07	Fifth Batch Cultural Relic Protection in Guangzhou	Planned Transformation (Integrated Cultural Tourism Zone)	
		2018.01	Listed in China Industrial Heritage Protection (First Batch)		
	Lu Shun Dock	2016.06	Third Batch Historical Buildings in Guangzhou		
	Changzhou Huangpu Military Academy Sites	2002.07	Sixth Batch Cultural Relic Protection in Guangzhou		
Fourth Navigation Bureau Shipyard	Engine Workshop; Shipbuilding Slipway; Translational Car	2014.09	Second Batch Historical Buildings in Guangzhou	Guangzhou Window (Commercial Complex Model)	
Former Site of Cheng'anwei Shipyard	Workshops 13, 14, 15, 16; Slipway	2021.09	Seventh Batch Historical Buildings in Guangzhou	Guangzhou Qidi Zhonghai Technology Park (Creative Industry Park Model)	
Wenchong Shipyard	Dock 1, Dock 2	2021.09	Seventh Batch Historical Buildings in Guangzhou	Continued Production and Manufacturing (Planned Transformation)	
Former Site of Yuzhu Shipyard	Harbor Pool, Workshop for Workers	2021.09	Seventh Batch Historical Buildings in Guangzhou	Planned Transformation (Yuzhu Port Business District)	

(4) Unprotected Status

Among the surveyed shipyards, currently only a small portion of shipbuilding industrial heritage has obtained legal protection status, while the majority of shipbuilding industrial heritage remains unprotected. Shipyards such as Guangzhou Yulun Shipyard, Zhonghai Industrial Boluotemple Shipyard, Panyu Lingshan Shipyard, Guangzhou Passenger Ship Company Shipyard, Guangdong Zengcheng Xintang Shipyard, Guangdong Barge Transport Company Shipbuilding Factory, and Guangzhou Salvage Bureau Ship and Equipment Manufacturing Factory do not possess legal protection status (Tab. 3- 7).

In terms of the number and content of designations, only a few structures of six shipyards in Guangzhou have legal protection status. These shipbuilding industrial heritage sites with legal protection status have been designated and delimited based on individual buildings or structures. Currently, there have been no cases where the entire shipyard complex is designated for protection. This lack of comprehensive designation has led to inadequate protection of the integrity of shipbuilding industrial heritage. Many unprotected shipbuilding industrial heritage sites within the shipyard complexes have been forcibly demolished, resulting in the destruction of the overall appearance of the complexes.

Tab. 3- 7 The following table presents the shipyards that have not yet obtained legal protection status
Source: Author's Self drawn

Shipyard Name	Founding Year	Address	Current Status	Image
Shangjiao Shipyard	1998	Shangjiao Township, Dashizhen, Panyu, Guangzhou	Xilin Yuan Hotel	
Guangzhou Yulun Shipyard	1954-07	Xinzhou, Guangzhou	Huangpu Beach Creative Community, Pazhou Yard Creative Park, Hongchuan Port Creative Park	
Zhonghai Industrial Boluotemple Shipyard	1968-10	Boluotemple, Huangpu	Continued Production and Manufacturing	

Continued Table 3-7

Panyu Lingshan Shipyard	**1985**	**Nansha District, Guangzhou**	**Continued Production and Manufacturing**	
Guangzhou Passenger Ship Company Shipyard	1952	Nanzhou Road, Haizhu District, Guangzhou	Continued Production and Manufacturing	
Guangdong Zengcheng Xintang Shipbuilding Co., Ltd.	1968	Zengcheng Xintang Town, Guangdong	Continued Production and Manufacturing	
Guangdong Barge Transport Company Shipbuilding Factory	1997	Nanji Zhongyue Dajie, Haizhu District, Guangzhou	Idle	
Guangzhou Salvage Bureau Ship and Equipment Manufacturing Factory	1979	Xiadu Road, Guangzhou	Continued Production and Manufacturing	

Reuse Practices of Guangzhou Shipbuilding Industrial Heritage

Currently, there are relatively few practical cases of updating and protecting Guangzhou's shipbuilding industrial heritage. Only five shipbuilding industrial heritage sites have been successfully transformed, while the remaining three are still in the planning and transformation stage. Six sites are either maintaining production and manufacturing or have ceased operations (Tab. 3-8). Based on the functional reuse of shipyards, three development models can be identified: commercial complex model, creative industry park model, and urban public space model. These models often coexist, with one model predominating. The updating and transformation of Guangzhou's shipbuilding industrial heritage is primarily led by the commercial complex model and the creative industry park model. According to the survey, the Shangjiao Shipyard, Guangzhou Shipyard, and the Fourth Navigational Engineering Bureau Shipyard of Guangdong Province have completed the transformation into commercial complex developments. The Guangzhou Yulun Shipyard and Cheng'anwei Shipyard have completed the transformation into creative industry parks. The Huangpu Shipyard, Wenchong Shipyard, and Yuzhu Shipyard are in the planning and transformation stage. The Lingshan Shipyard, Boluotemple Shipyard, Guangzhou Passenger Ship Company Shipyard, and Guangzhou Salvage Bureau Ship and Equipment Manufacturing Factory

continue to maintain production and manufacturing. The Guangdong Barge Transport Company Shipbuilding Factory has ceased operations and is currently idle.

Tab. 3- 8 Practice of Reuse of Guangzhou Shipbuilding Industry Heritage
Source: Author's Self drawn

Model	Company Name	Predecessor	Establishment Year	Address	Economic Nature	Remarks
Commercial Complex	Guangzhou Shipyard	Guangnan Dock	1954-08	South Fangcun Avenue, Guangzhou	State-owned	Partially preserved (Completed urban design, demolition work completed)
	Shipyard of the Fourth Navigational Engineering Bureau	/	1975	Li Jiao, Guangzhou	State-owned	Partially preserved (Office + Commercial)
	Shangjiao Shipyard	/	1998	Shangjiao Township, Panyu District, Guangzhou	Private (Stock)	Basic preservation (Hotel)
Creative Industry Park	Guangzhou Yulun Shipyard	/	1954-07	Xinzhou, Guangzhou	State-owned	Basic preservation (Completed transformation, Office + Commercial)
	Cheng'anwei Shipyard	/	1974-10	Li Jiao, Guangzhou	State-owned	Basic preservation (Office + Commercial)
Planned Transformation	Huangpu Shipyard	Ke Bai Dock	1851-03	Changzhou Street, Changzhou Island, Huangpu	State-owned	Fully preserved
	Wenchong Shipyard	/	1955-06	Wenchuan Road, Huangpu	State-owned	Fully preserved
	Yuzhu Shipyard	Guangzhou Port Machinery Repair Factory	1960	Yuzhu Street, North Bank of Pearl River, Huangpu District	State-owned	Partially preserved
Other	Boluotemple Shipyard	/	1968-10	Boluotemple, Huangpu	State-owned	Fully preserved
	Panyu Lingshan Shipyard	/	1985	Nansha District, Guangzhou	Collective	Fully preserved
	Passenger Ship Company Shipyard	/	1952	Nanzhou Road, Haizhu District	State-owned	Fully preserved
	Zengcheng Xintang Shipyard	/	1968	Xintang Town, Zengcheng, Guangdong	Private	Basic preservation
	Guangdong Barge Transport Company Shipbuilding Factory	/	1997	Nangji Middle Road, Haizhu District	Collective	/
	Guangzhou Salvage Bureau Ship and Equipment Manufacturing Factory	/	1979	Xiadu Road, Guangzhou	Collective	Fully preserved

(1) Commercial Complex Model

The commercial complex model refers to the transformation and renovation of shipbuilding industrial heritage into a comprehensive building with multiple functions such as commerce, culture, and entertainment. Specific elements of this model include but are not limited to: 1) transforming old industrial buildings into commercial centers, shopping malls, hotels, and other commercial complexes; 2) adding cultural, entertainment, educational, and other functions to the existing buildings; 3) converting the original waterfront areas such as docks and shipyards into yacht clubs, water sports centers, and more; 4) utilizing existing factories, workshops, and spaces for exhibitions, performances, and other cultural activities; 5) combining heritage buildings with modern architecture to create hybrid structures while preserving the historical and cultural heritage value. Examples of shipbuilding industrial heritage in Guangzhou that have undergone transformation into commercial complexes include Guangzhou Shipyard, Shipyard of the Fourth Navigational Engineering Bureau, and Shangjiao Shipyard.

① Guangzhou Shipyard

Guangzhou Shipyard, established in the 1950s, is the only shipyard located in South China among the eight major shipyards in China. Its origins can be traced back to the late Qing Dynasty. From the establishment of Guangdong's largest modern civilian shipbuilding and repair yard, Guangnan Dock, by Tan Litin in 1914, to the formation of the state-owned Guangzhou Shipyard in 1958, and subsequent four expansions in the 1980s, the glorious century-old shipbuilding industry legacy continues in the Guangzhou Shipyard area. Prior to the liberation, there were no formal military shipbuilding factories in the Guangdong region. Since the 1950s, a large number of warships have been produced, repaired, maintained, and modernized here, consolidating and enhancing the combat capabilities of the South Sea fleet and making significant contributions to the defense of the South China Sea. In order to implement the "Two Retreats and Three Advances" strategy of Guangzhou and meet the requirements of overall urban land planning, Guangzhou Shipyard initiated plans to relocate its Liwan facility to the Zhongship Longxue facility in Nansha District. In 2018, the Liwan facility of Guangzhou Shipyard concluded its shipbuilding history (Fig. 3- 3).

Fig. 3-3 Aerial View of Guangzhou Shipyard Before Renovation
Source：https://sparkarchitects.com/

In 2017, the controlled detailed plan for the Guangzhou Shipyard site was announced. The construction of the Guangzhou Shipyard site focuses on commercial, residential public services, green spaces, and other main functions. The central green axis of the site should be connected to the green axis of the Guanggang New Town. At the same time, the protection range of the city-level cultural preservation unit, Che Wai Battery, within the factory area is designated. Four recommended traditional architectural clues, including the dock, Shipyard No. 1, Shipyard No. 2, and Shipyard No. 3, are preserved. The Guangzhou Shipyard has completed the relocation work. Except for the Che Wai Battery, the dock, Shipyard No. 1, Shipyard No. 2, Shipyard No. 3, and some industrial equipment such as gantry cranes, most of the other remaining structures in the factory area have been demolished.

Fig. 3-4 Conceptual Plan and Master Plan of Guangzhou Shipyard
Source：https://sparkarchitects.com/

In 2018, SPARK Architects completed the urban design of the Guangzhou Shipyard site through an international competition (Fig. 3-4). The planned total construction area is 1,254,000 square meters, including 677,000 square meters for commercial offices, 525,000 square meters for residential (including supporting facilities), 52,000 square meters for public service facilities, and 49,300 square meters for underground commercial spaces. The original

Guangzhou Shipyard factory area will be transformed into a technology activity cluster in the Liwan District, combining commercial, residential, and waterfront landscape development. The planning and design are based on the shipbuilding culture of Guangzhou Shipyard, which has a history of over a hundred years. The design revolves around a central square and transforms the preserved dock, shipyard, cranes (including tower cranes and gantry cranes), and other heritage elements into the Shipyard Park, a historical landmark. The sunken space of the dock is repurposed for museum exhibitions, while the shipyard incorporates artistic, cultural, and recreational functions. The cranes, including the tower cranes and gantry cranes, are illuminated and treated as landscape decorations. In the future, the Guangzhou Shipyard will become a landmark in the Pearl River waterfront complex and an important venue for showcasing shipbuilding culture to the public (Fig. 3- 5).

Fig. 3- 5 Aerial Rendering of Guangzhou Shipyard International
Source：https://sparkarchitects.com/

The renovation and transformation strategy can be summarized as follows:

1) Memory - "Only by discovering the memory of the site can old objects continuously acquire new identities, images, and meanings. They can maintain vitality and relevance in a constantly changing generation and not be easily forgotten by time."
2) Integration - a) Integration with the surrounding urban fabric: Creating a TOD (Transit-Oriented Development) hub, establishing a 1-hour Bay Area metropolitan circle and a 30-minute Guangzhou-Foshan central living circle. b) Internal integration of the

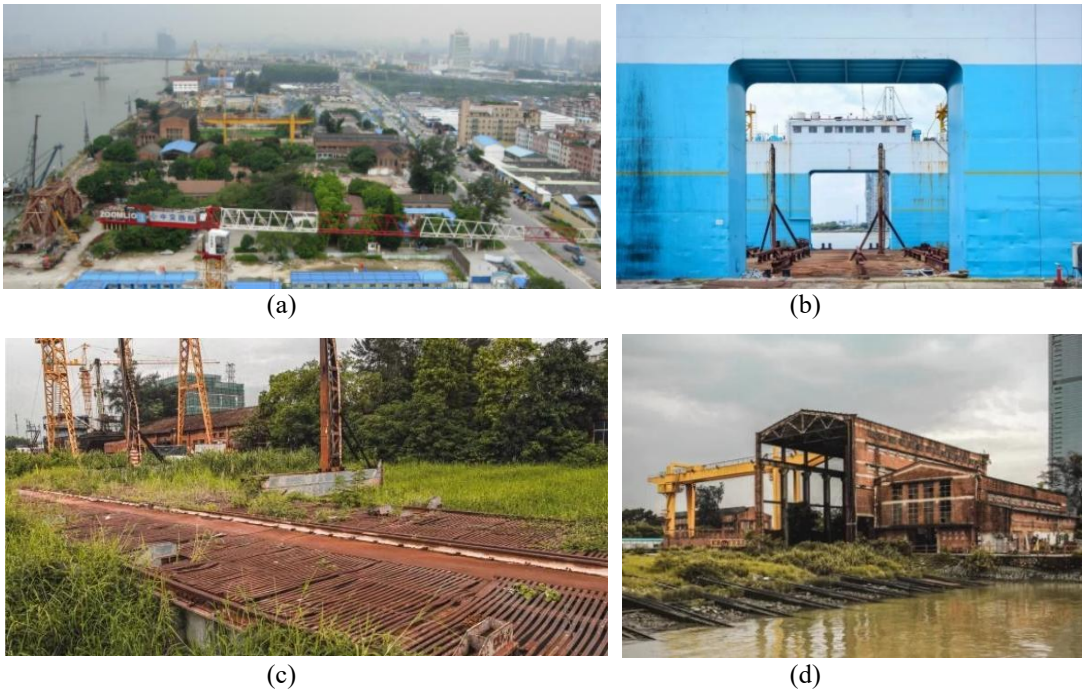
site: Multiple levels and directions of pedestrian flow, interaction and connection between various blocks and industrial heritage sites.

3) Creating Urban Destinations - Mixed-use: Expanding the scope of the all-weather urban destination to a wider audience, enhancing public awareness and participation in the site.

4) Future Concepts: Work, Residence, Technology - a) Connecting material and non-material resources, becoming an important element of the waterfront heritage cultural corridor. b) "Future Valley": Close proximity to subway and urban transportation, creating an urban living room that combines ecology, commerce, performance, and entertainment.

② The 4th Shipbuilding Bureau Shipyard of the Ministry of Transport

The shipbuilding and repair factory of the 4th Shipbuilding Bureau of the Ministry of Transport was established in Li Jiao, Haizhu District, Guangzhou in 1963, adjacent to the Pearl River back channel (Fig. 3- 6). Due to the implementation of Guangzhou's "retreat two, advance three" strategy and the development plan of Guangzhou's new urban central axis, on August 3, 2009, China Communications Construction Group and the Guangzhou Municipal Government signed the "CCTC Southern Headquarters Base Project Cooperation Agreement" to develop and utilize the original factory area.



(a) (b)

(c) (d)

Fig. 3- 6 Before the renovation of the shipyard of the Fourth Navigation Bureau
Source: https://mp.weixin.qq.com/s/bHH5ESqWEjR-wPC86vpj3Q

After the renovation and transformation, the 4th Shipbuilding Bureau Shipyard of the Ministry of Transport is transformed into the "Window of Guangzhou," which is the Southern Headquarters Base of China Communications Construction Group. It is an urban complex that integrates headquarters offices, business hotels, conference centers, high-end yacht marinas, exhibition and display centers, and a riverfront theme park. The transformation of the factory area involves preserving the core shipbuilding features such as the engine workshop, ship launch slipway, and transverse carriage, while demolishing other buildings within the factory to create space for the development of a large-scale complex. During the transformation of the preserved industrial heritage, the engine workshop, which has been included in the historical buildings of Guangzhou, will serve as the project's marketing center in the early stages of development and later be converted into an art exhibition and product display center. The project incorporates the design concept of waves and sails, reflecting the shipbuilding and yacht culture. It includes a one-kilometer riverbank and waterfront ecological gardens, and the original dock area is transformed into a yacht marina (Fig. 3- 7).

Fig. 3- 7 Guangzhou Window Art Center
Source: https://www.atkinsglobal.com/

The renovation and transformation strategy can be summarized as follows:

1) Transformation of old industrial buildings - preserving the exterior appearance, retaining the original structure, and flexibly utilizing the interior space.
2) Functional transformation - serving as a carrier for cultural and creative industries or other emerging industries.
3) Construction of supporting facilities - enhancing the comprehensive functions and attractiveness of the factory area.
4) Sustainable development strategy - promoting the coordinated development of the economy, society, and environment.

③ Shangjiao Shipyard

Since its establishment in the 1980s, Shangjiao Shipyard has undergone several transformations. Located in Shangjiao Village, it is the oldest dragon boat manufacturing base in Guangzhou. Shangjiao Shipyard originally started with the production of dragon boats. However, with the decreasing demand for dragon boats in the 1980s, the shipyard shifted its focus to ship repair services. Due to the rapid development of transportation infrastructure such as highways, the ship repair business declined continuously, and the shipyard was eventually shut down and left idle in 2012 (Fig. 3-8). In 2014, the shipyard officially began its transformation and was revitalized as the Xilin Yuan Hotel in 2016. The Shangjiao Shipyard site adopts a U-shaped layout with the dock at its core. When the ship (70m long x 26m wide) is filled with water, ships can enter and exit the water surface. After draining the water, ships can be constructed on the dry bottom. Nearly 1,000 mechanical ships and ferry boats stay and undergo repairs here.

(a)

(b)

Fig. 3- 8 Shangjiao Shipyard Before Renovation
Source: https://www.jiemian.com/article/2272406.html

After the renovation and transformation, Shangjiao Shipyard became the "Xilin Yuan" Hotel, a small commercial complex that integrates hotel, restaurant, and office spaces. The renovation of Shangjiao Shipyard began in 2014 and lasted for three years. The transformation aimed to preserve the original spatial layout and the industrial charm of the shipbuilding industry. The dock was transformed into a landscape pool and swimming pool. The original industrial equipment such as generators and hoisting machines were showcased on the north and south sides of the dock. The workshop adjacent to the Pearl River on the north side of the dock was transformed into river-view rooms, with a rooftop observation platform. The tool storage room and office on the south side of the dock were converted into a restaurant and hotel office spaces. The west side of the dock was transformed into a leisure area. The riverside pier was converted into an observation platform, and three docking piers were established. The transformed Shangjiao Shipyard, now known as the "Xilin Yuan Hotel," has re-emerged in the public eye and serves as a venue for outdoor weddings, bar performances, artistic activities, and more (Fig. 3- 9).

Fig. 3- 9 Xilin Yuan Hotel Rendering
Source: https://www.jiemian.com/article/2272406.html

The renovation and transformation strategy can be summarized as follows:

1) Preserve the original spatial layout and shipbuilding industrial charm.
2) Moderate architectural renovation - retain old building elements and refurbish the bu1ilding facades.
3) Functional transformation - convert the shipyard space into a commercial and hotel complex.

The commercial complex model is a comprehensive architectural model that integrates various functions such as business, culture, and entertainment. Its role lies in the transformation and revitalization of shipbuilding industrial heritage, enhancing its utilization value, and meeting diverse needs. Furthermore, the commercial complex model can improve the commercial atmosphere and economic level of the surrounding area, promoting urban development and transformation. However, due to its high commercialization level, to achieve higher profitability, only industrial heritage with legal protection status or relatively complete preservation is generally retained, often overlooking the cultural value and historical significance of historical buildings during renovation and transformation, resulting in the loss of their original historical charm and cultural significance. Therefore, when using the commercial complex model for the renovation and transformation of shipbuilding industrial heritage, it is necessary to consider issues such as the authenticity and integrity of historical building preservation, functional diversity, and the impact on the surrounding environment to ensure that the renovated buildings have both commercial value and maintain their historical charm and cultural significance.

(2) Creative Industry Park Model

The creative industry park model shares some similarities with the commercial complex model. It involves transforming the factory area into an industrial park that integrates leisure, business, and office functions. This model places more emphasis on the overall protection of the factory area and can showcase the historical value and cultural heritage of shipbuilding industrial heritage through various activities and exhibitions, thereby increasing public awareness and appreciation of shipbuilding industrial heritage. Examples of the creative industry park model for the renovation and transformation of Guangzhou's shipbuilding industrial heritage include Guangzhou Yulun Factory and Cheng'anwei Shipyard.

① Guangzhou Yulun Factory

Guangzhou Yulun Shipyard was originally the ship repair yard of Nanhai Fisheries Company, established in 1952. In 1958, Nanhai Fisheries Company relocated to Hainan Island, and the original site came under the ownership of the Guangdong Provincial Department of Fisheries, renamed as the Guangdong Provincial Department of Fisheries Yulun Ship Repair Yard. In 1980, it was renamed Guangzhou Yulun Factory and became part of the China Fisheries Administration. In 1984, under the leadership of the China Fisheries Joint Corporation, it became one of the three largest ship repair yards in China and the largest ship repair base in South China. It underwent renovation and transformation in 2019 (Fig. 3- 10).

Fig. 3- 10 Guangzhou Yulun Factory Before Renovation
Source: https://mapcarta.com/N8193673681

The renovation and transformation of Guangzhou Yulun Factory is a typical case of multiple creative industry park models. It has been transformed into three different parks: Huangpu Beach Creative Community, Pazhou Yard Creative Park, and Hongchuan Port Creative Park (Fig. 3- 11). Huangpu Beach Creative Community serves as an office and design innovation platform.Pazhou Yard Creative Park is a culturally creative ecosystem with a complete industry chain. It integrates functions such as the Greater Bay Area's double innovation incubation base, an internet celebrity photography culture base, and a supercar club.Hongchuan Port Creative Park is a creative park that integrates technology, education, cultural and creative industries, and commercial leisure cultural products.These three parks represent different types of creative industry parks, providing diverse platforms and services for creative businesses and fostering a vibrant ecosystem for cultural and creative industries in Guangzhou.

Fig. 3- 11 Guangzhou Yulun Factory After Renovation
Source: WeChat official account

The renovation and transformation strategy can be summarized as follows:

1) Principle - "Less demolition, more renovation, and utilization of existing elements."
2) Planning - Respecting the memory of the site, preserving the original spatial layout and road system of the factory area.
3) Functional transformation - Introducing emerging industries to revitalize the building spaces.
4) Individual Buildings - Preserving the original architectural features as much as possible, only reorganizing the interior spaces and conducting simple renovations based on the needs.
5) Landscaping - Preserving the existing old trees within the factory area to create a comfortable and natural environment.

② Cheng'anwei Shipyard

Cheng'anwei Shipyard was initially established in 1974 as Cheng'anwei Navigation and Repair Station, under the Guangzhou Shipbuilding Bureau. In 1985, it was renamed Cheng'anwei Shipyard and came under the administration of the Guangzhou Shipping (Group) Co., Ltd., affiliated with the Ministry of Transport. In 2014, it ceased production and was relocated as part of the "retreat two, advance three" strategy in Guangzhou (Fig. 3- 12).

Fig. 3- 12 Before and After Renovation Comparison
Source: https://mp.weixin.qq.com/s/rAqD1VMbxPupYt0Wjb_idA

In 2017, the former site of Cheng'anwei Shipyard was transformed into Guangzhou Qidi Zhonghai Science and Technology Park. It is a mixed-use park that combines scientific research offices, entrepreneurial incubation, marine exhibitions, leisure activities, and supporting dining and accommodation facilities. In 2020, the park was included in the Guangzhou Science and Technology Enterprise Incubator Park. In 2021, workshops 13, 14, 15, and 16, as well as the slipway, were listed as the seventh batch of historical buildings in

Guangzhou. During the renovation and transformation, the park mainly focuses on themes such as marine technology and shipbuilding culture. Following the principle of preserving the original industrial factory's architectural style, the park has effectively retained its original spatial layout (Fig. 3- 13).

Fig. 3- 13 Before and After Renovation Comparison and Overall Plan
Source: https://mp.weixin.qq.com/s/rAqD1VMbxPupYt0Wjb_idA

The renovation and transformation strategy can be summarized as follows:

1) Preservation of Historical Style - Coordinating the relationship between old and new, revitalizing and utilizing the site while maximizing social and economic benefits.
2) Contrast - Strong contrast between commercial spaces and heritage spaces, harmonious coexistence of old and new, highlighting progress over time.
3) Revitalization - Mutual transformation between the old factory area and the science and technology park, integrating new design concepts in later maintenance and use.
4) Categorized Management of Buildings - Restoration of original structures, integration of old and new elements, and new construction.

The creative industry park model can maximize the economic and cultural value of industrial heritage, promote regional economic development, and facilitate industrial upgrading and transformation. However, this model requires heritage sites to possess high economic and functional value, well-preserved buildings, favorable locations, and adequate policy and legal support to ensure sustainable development and long-term operation. In conclusion, the creative industry park model is a promising approach for the renovation and transformation of shipbuilding industrial heritage, offering broad prospects for development and significant

social value. However, it is necessary to overcome difficulties and challenges in practice to ensure successful implementation and long-term growth.

(3) Urban Public Space Model

Transforming shipyards into urban public spaces is a reuse model that effectively showcases shipbuilding culture. Under the urban public space model, the shipyard's conversion typically involves transforming it into a riverside park and square. The urban public space model was one of the earliest adopted reuse models for shipbuilding industrial heritage in Guangdong. For example, as early as 2001, the Yuezhong Shipyard was transformed into the Zhongshan Qijiang Park. However, there are currently no dominant cases in Guangzhou that are solely based on the urban public space model. Instead, many transformations combine the commercial complex model and the creative industry park model.

The urban public space transformation model can effectively utilize existing architectural resources, reduce waste, preserve historical and cultural heritage, and enhance urban cultural heritage. Additionally, it can enrich the types and functions of urban public spaces and improve residents' quality of life. However, due to limitations of the original buildings, the transformed public spaces may have some deficiencies in layout and functionality. Therefore, when adopting this model as the main approach, attention should be given to the improvement of layout and functionality.

By analyzing the five completed renovation projects of shipbuilding industrial heritage in Guangzhou, the following renovation and transformation strategies can be summarized:

① Cultural Preservation and Inheritance Strategy

This strategy focuses on preserving the historical and cultural value of shipbuilding industrial heritage and promoting its inheritance. For example, organizing heritage exhibitions and cultural activities to showcase the history and technology of shipbuilding, increasing public awareness and attention. Additionally, establishing craft stores and cultural creative industries to promote the inheritance and development of local handicrafts and traditional skills.

② Innovative Activation Strategy

Through innovation and the introduction of new technologies, shipbuilding industrial heritage is given new functions and vitality. For example, transforming shipbuilding heritage into

creative office spaces or recreational venues to attract young entrepreneurs and tourists, promoting the development of entrepreneurship and cultural creative industries.

③ Landscape Planning and Architectural Design Strategy

Integrating shipbuilding industrial heritage into the urban landscape through comprehensive planning and design. For example, improving the surrounding environment, adding green spaces and public areas, creating an attractive urban leisure zone. Simultaneously, designing the facades, colors, and forms of buildings to combine with the characteristics of shipbuilding industry, highlighting its historical and cultural value.

④ Community Participation and Sharing Strategy

Encouraging community residents and local businesses to participate in the protection and utilization of shipbuilding industrial heritage, promoting sharing. For example, organizing community activities and involving local residents in the protection and transformation process, increasing their sense of participation and belonging. Additionally, promoting cooperation with local businesses to jointly develop shipbuilding industrial heritage, achieving resource sharing and mutual benefits.

3.2 Risks Faced by Guangzhou Shipbuilding Industry Heritage

3.2.1 Natural disasters and environmental changes

Guangzhou is located along the coast of the South China Sea and is one of the areas where typhoons frequently make landfall. The strong wind and rainstorm brought by typhoon may cause serious damage to the shipbuilding industry facilities, such as collapse, flooding, etc. In addition, strong winds may also cause damage to port facilities, affecting the docking and maintenance work of ships.

Secondly, rising sea levels are another potential threat. With global warming, glacier melting and ocean expansion have led to a gradual rise in sea levels. Guangzhou is located in the the Pearl River Delta, with a low altitude. Therefore, the rise of sea level may lead to Saltwater intrusion, threatening the facilities and equipment of the shipbuilding industry heritage. In addition, sea level rise may also increase the height of Storm surge and increase the impact of floods and storms on industrial areas.

Climate change may also lead to more frequent and intense extreme weather events, such as rainstorm, flood and drought. These extreme weather events may cause damage and impact on the shipbuilding industry heritage in Guangzhou. Rainstorm and flood may cause damage to facilities and equipment in the industrial area, and increase the risk of ship construction and repair. On the other hand, drought may lead to water shortages, affecting the normal operation and supply chain of the shipbuilding industry.

Marine pollution is also an important environmental change issue. The shipbuilding industry involves a large amount of chemical substances and fuel usage, which may lead to river and marine pollution. This pollution poses a threat to the local ecosystem and marine biodiversity, and has a negative impact on Guangzhou's shipbuilding industry heritage.

3.2.2 Urban development pressure

Conflict between urban planning and land use. The protection and renewal of the shipbuilding industry heritage need to be coordinated with the needs of urban planning and land use. However, in the process of urban development, the reuse and development of land may conflict with the goals of heritage protection. This may lead to the risk of demolition or renovation of the shipbuilding industry heritage. For example, land originally used for the shipbuilding industry may be used for more profitable commercial, residential, or other development projects, leading to the risk of demolition, transformation, or relocation of the area where the shipbuilding industry heritage is located.

3.2.3 Separation of the connection between heritage and urban space

Shipbuilding industrial plants usually have independent industrial systems to ensure the efficiency of industrial production, but this also cuts off the possibility of establishing connections with urban space. The scale of shipbuilding industry factories is usually large and covers a vast area. Due to the needs of industrial facilities, the site is often filled with large mechanical equipment, ports, docks, and storage facilities. These factors limit the versatility and flexibility of the venue, making it difficult to seamlessly connect with other parts of the city.

3.2.4 Insufficient functional and spatial adaptability

Single function. The original design of the shipbuilding industry heritage is often designed to meet the needs of ship manufacturing and maintenance. However, over time, these industrial

heritage sites may not be able to adapt to the diverse urban needs. The factory buildings originally used for shipbuilding may not be suitable for modern office spaces or cultural activity venues. The limitation of a single function will result in limited utilization value of these heritage properties.

Space layout limitations. The spatial layout of shipbuilding industry heritage is usually designed for the shipbuilding and maintenance processes, and there may be layout limitations. This may include space division, channel design, and equipment installation. With the changes in urban demand, these limitations will make it difficult to flexibly adjust and transform the functional space of the shipbuilding industry heritage, unable to adapt to diverse usage needs.

Aging of building structures. Buildings in the shipbuilding industry heritage typically have a long history, and after years of use and natural wear and tear, the building structure may experience aging and damage, limiting the load-bearing capacity and availability of these buildings, leading to insufficient functional space resilience.

3.2.5 Insufficient recognition of historical value and insufficient utilization

The heritage of the shipbuilding industry has rich historical value and cultural significance, and they are witnesses to the development of the shipbuilding industry in the past. However, with the passage of time and changes in urban development, people's attention and protection of these historical memories may weaken, leading to the forgetting and loss of heritage, mainly reflected in the following three aspects:

Lack of promotion of historical value. The historical value of Guangzhou's shipbuilding industry heritage may not have been fully promoted and disseminated, leading to insufficient public awareness of its importance.

Lack of diversity in heritage utilization. The utilization of Guangzhou's shipbuilding industry heritage is relatively single and lacks diversity. If limited to tourism or the utilization of a single industry, its potential economic and cultural value may not be fully realized.

Lack of professional management and planning. The management and planning of shipbuilding industry heritage lacks professionalism, resulting in insufficient utilization; The

lack of effective management institutions and planning strategies hinders the effective protection and rational utilization of heritage.

3.2.6 Lack of social public participation

The protection and renewal of Guangzhou's shipbuilding industry heritage require the active participation and support of the public. However, due to insufficient awareness of the heritage and a lack of relevant participation channels, public participation is low. We should strengthen communication and interaction with the public, encourage them to participate in the process of heritage protection and renewal, and enhance the public's awareness of independent participation and sense of responsibility. In addition, there is a lack of support from relevant policies in time protection work, a lack of sound implementation guarantee mechanisms and stable management institutions, and a lack of financial support in the restoration, maintenance, research, and promotion stages of heritage, resulting in the inability of heritage to be protected in a timely manner and being damaged.

3.3 Applicability Analysis of Resilience Theory

3.3.1 Implementation objects comply with

As an urban area with historical, cultural, economic, and social value, and located on the waterfront, the renovation design of Guangzhou Shipbuilding Industry Heritage needs to protect its uniqueness and continue its historical context. In the current social and ecological environment, Guangzhou's shipbuilding industry heritage is facing various impacts and changes such as natural disasters, urban development, and economic transformation. After the industrial system withdraws from the factory area, the controllability and resilience of its social ecological system become quite weak in the face of external uncertain factors, lacking flexibility and applicability.

The resilience theory is applied to the field of urban planning and design, treating cities as a complex social ecological system. Its implementation targets include but are not limited to physical infrastructure, socio-economic structure, environmental ecosystems, and governance mechanisms. The resilience theory emphasizes the adaptability and resilience of the system, which is precisely the characteristic required for the Guangzhou Shipbuilding Industry

Heritage. Therefore, from the perspective of the implementation object, the resilience theory is applicable to the protection of Guangzhou's shipbuilding industry heritage.

3.3.2 Purpose Value Compliance

The renewal and protection of Guangzhou's shipbuilding industry heritage aims to inherit historical and cultural heritage, promote urban development and regeneration, achieve sustainable development, and enhance residents' well-being and social connections through community participation and social identity.

The resilience theory is applied in the field of urban planning and design, with the aim of addressing the challenges of climate change, natural disasters, and other physical and social environments to protect the safety and well-being of cities and their residents. At the level of responding to environmental change, Urban resilience improve their adaptability, reduce disaster risks, and rapidly recover and rebuild by adopting sustainable development strategies and emergency preparedness measures; At the level of economic and sustainable development, achieving economic prosperity by encouraging entrepreneurship and innovation, providing a good business environment and infrastructure, and supporting the development of local industries and enterprises; At the level of urban planning and infrastructure, encourage diversified land use, including Mixed-use development, sustainable transportation and green infrastructure, to improve the efficiency and sustainability of cities; At the level of community participation and governance, Urban resilience improve the city's coping capacity and decision-making efficiency by establishing flexible community networks and strengthening the urban governance system.

Therefore, the purpose of protecting the heritage of Guangzhou's shipbuilding industry is in line with the value of resilience theory, both for protecting and enhancing the sustainability and resilience of the system.

3.3.3 Compliance with practical methods

When updating the design of Guangzhou Shipbuilding Industry Heritage, it is necessary to carry out full process control. Firstly, it is necessary to conduct comprehensive research and evaluation to understand the historical, cultural, and architectural characteristics of the shipbuilding industry heritage, as well as its current status and potential value. Secondly, based on the research results, detailed planning and design plans are formulated, and historical

buildings and facilities are protected and restored to ensure that their original historical characteristics and style are preserved. According to the planning and design plan, carry out functional renovation of the shipbuilding industry heritage to ensure that the new functions are coordinated with the original buildings and historical background. In addition, the renovation of the shipbuilding industry heritage should also focus on community participation, encouraging residents to participate in the decision-making process and project promotion, to ensure that the renovation project meets the needs and interests of the local community. After completing the renovation, it is necessary to carry out publicity and promotion to attract tourists and the public to come and experience. In summary, the renovation and renovation of Guangzhou's shipbuilding industry heritage requires comprehensive consideration of factors such as protection, functional transformation, innovative utilization, and community participation. In the practical process, it is necessary to comprehensively apply professional knowledge and technology from multiple fields to ensure that the renewal project can achieve the goals of protecting historical and cultural heritage, promoting economic development, and enhancing the city's image.

The resilience theory also provides a series of practical methods and strategies to enhance the resilience of the system. In the initial evaluation and analysis stage, cities need to assess and analyze current and potential risks, challenges, and vulnerabilities. This includes assessing the risks of physical factors and analyzing the vulnerability of urban infrastructure, socio-economic conditions, and other aspects. Through these assessments and analyses, cities can understand the problems and challenges they face and provide a basis for formulating resilience plans. In the goal setting stage, cities need to clarify the goals and vision of resilience planning. The setting of goals should be specific, measurable, and actionable, such as reducing disaster losses, increasing community participation, and improving infrastructure resilience. Cities can develop resilience goals that are suitable for their own situation based on the evaluation results and the participation of stakeholders. In the strategy development stage, cities need to develop corresponding resilience strategies and action plans. Resilience strategies should be comprehensive, coordinated, and cover various aspects, including buildings and infrastructure, community participation, emergency response, etc. Cities can promote resilient development by formulating policies, regulations, rules and regulations, and other means. During the implementation and monitoring phase, cities begin to implement the developed resilience plans and strategies. This includes investing resources, improving infrastructure, conducting training and education, etc. At the same time, cities also need to

establish monitoring and evaluation mechanisms to track the implementation effectiveness of resilience planning, and make adjustments and improvements as needed. Urban resilience planning is a continuous process. The city needs to constantly improve and perfect its planning and strategies to adapt to the changing environment and needs.

Therefore, in the renovation of Guangzhou's shipbuilding industry heritage, the practical methods of resilience theory can be borrowed, including establishing emergency response mechanisms, developing risk management strategies, strengthening community participation, and enhancing educational awareness. These methods help improve the adaptability and resilience of Guangzhou's shipbuilding industry heritage, ensuring its sustainable existence and development in the face of shocks and changes.

In summary, the resilience theory is applicable to the protection of Guangzhou's shipbuilding industry heritage from three aspects: compliance with the implementation object, compliance with the purpose value, and compliance with the practical methods. The implementation of resilience theory can improve the adaptability and resilience of Guangzhou's shipbuilding industry heritage, protect its historical and cultural value, and promote sustainable development of the city. However, the specific implementation process still requires in-depth research and exploration based on the characteristics and specific situation of Guangzhou's shipbuilding industry heritage, in order to ensure the accuracy of the theory and the effectiveness of implementation.

3.4 Practical framework and element extraction

3.4.1 Practical Framework

The practical framework for applying resilience theory to the renewal design of Guangzhou shipbuilding industry heritage can include the following steps (Fig. 3- 14):

（1）Identify and evaluate the value of heritage.

Firstly, conduct a comprehensive survey and evaluation of the Guangzhou Shipbuilding Industry Heritage, including its historical, cultural, and economic values, as well as the internal and external environmental risks and challenges it faces. By understanding the

characteristics and potential of the shipbuilding industry heritage, it provides a basis for resilience planning.

（2）Set planning goals.

According to upper planning, the needs of the surrounding environment, the characteristics of the heritage itself and the requirements of sustainable development, the future planning direction of the heritage area is defined to ensure the rationality and Realizability of the goal setting; The setting of goals at the same time needs to be specific, measurable, and actionable.

（3）Extracting Resilience Planning Elements

The planning goal of Urban resilience is that the system can cope with uncertainty and change, so as to improve the adaptability and resilience of the city. Due to the vastly different scale, structure, and geographical characteristics of a district or city, standardized thinking and unified solutions are difficult to meet different development needs. Therefore, it is necessary to develop a differentiated resilience construction planning system based on actual situations. Based on the analysis of the current situation of Guangzhou's shipbuilding industry heritage and the summary of the renewal dilemma, and according to the basic principles of the selection of planning indicators for a Urban resilience, the resilience planning elements adapted to local conditions are extracted and summarized, so as to develop resilience planning strategies, which is very important for breaking the current dilemma and carrying out resilience renewal one by one.

（4）Develop resilience update strategies

Based on the evaluation of heritage and the extraction of resilience elements, develop a set of resilience renewal strategies and plans. Resilience strategies should be comprehensive, coordinated, and cover all aspects of the system. The resilience renewal strategy requires the core goal of comprehensively enhancing the resilience, adaptability, resilience, and learning ability of heritage areas to cope with diversified "uncertain" risks or disaster impacts. Through the design method of "combining software and hardware, multi-dimensional integration", the focus is on comprehensively carrying out political, economic, social, ecological, cultural The comprehensive system optimization and improvement of governance and other "multidimensional integration" ensure that the shipbuilding industry heritage can effectively prevent and quickly adapt to various internal and external uncertain risks and crises in the

future development with the strongest building facilities, the most flexible functional space, the most reasonable and efficient resource allocation system, the most complete organizational system, and the most united social cohesion.

(5) Implementation phase

In the implementation phase of the resilience renewal plan, attention should be paid to protecting the original appearance and historical value of the heritage, engineering feasibility, building safety, cultural protection and sustainability. Protecting heritage includes respecting the original structure and materials, and preserving the original elements as much as possible. Conduct a detailed technical assessment and feasibility study to ensure the feasibility of the update work and avoid irreversible damage to the heritage. Comply with building safety standards and specifications, including requirements for fire prevention, structural strength, and seismic resistance. Pay attention to protecting the cultural heritage value of the shipbuilding industry. Consider sustainability factors in the update process, including energy efficiency, water resource management, and waste disposal.

(6) Monitoring stage

During the monitoring phase, attention should be paid to structural monitoring, environmental monitoring, usage monitoring, maintenance and upkeep, as well as public participation. Conduct regular structural monitoring, including deformation, cracks, corrosion, etc. of buildings, as well as safety assessments of related foundations and infrastructure. Monitor changes in the surrounding environment, such as soil quality, water quality, air quality, and their impact on buildings and cultural relics. Monitor the usage of buildings, including personnel flow and load conditions, and promptly identify issues that may affect structural safety and cultural relic protection. Regularly carry out maintenance and upkeep work to ensure the long-term protection and sustainable development of buildings and cultural relics. Encourage the public to participate in the monitoring process, provide feedback and suggestions, and strengthen the common sense of responsibility and Cultural identity of the shipbuilding industry heritage.

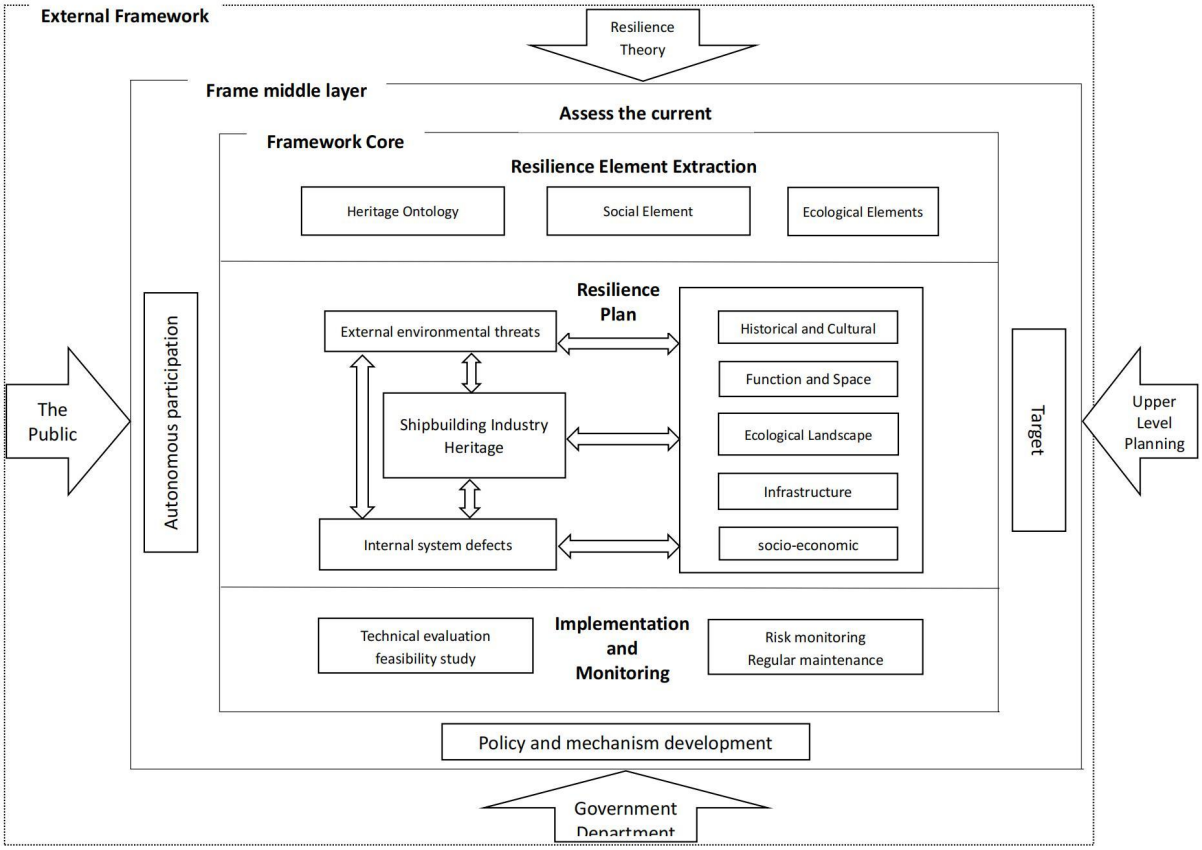


Fig. 3- 14 Practical Framework for Resilience Renewal of Shipbuilding Industry Heritage
Source: Author's Self drawn

3.4.2 Extraction of Resilience Elements

Based on the previous review of the basic content of the application of resilience theory in urban and planning fields, it is summarized that the current application of resilience theory in urban planning and design mainly starts from two aspects. At the "hard resilience" level, it mainly improves the material and ecological environment to avoid external disturbances; At the level of 'soft resilience', it is mainly through adjusting social and institutional frameworks to adapt to environmental threats (Fig. 3- 15).

Based on the practical steps of resilience theory, an analysis of the current situation and environmental risks of Guangzhou's shipbuilding industry heritage is conducted. Based on the basic principles of extracting resilience indicators, five elements of resilience renewal design for Guangzhou's shipbuilding industry heritage are summarized and proposed, namely historical culture, functional space, ecological landscape, infrastructure, and socio-economic elements. These elements are interrelated and together form the resilience system of the shipbuilding industry heritage (Fig. 3- 16). Among them, “Historical and Cultural Resilience” refers to the inheritance and continuation of historical and cultural heritage through the re

integration of system resources and the comparison of new and old elements; “Functional and Spatial Resilience” refers to mixing the functions of various blocks of a system and creating predictive and adaptive spaces to enhance the adaptability of the heritage; “Ecological Landscape Resilience” refers to the full utilization of energy stored within a heritage site and the incorporation of restorative landscape elements to enhance the system's self-healing ability; “Infrastructure Resilience” refers to the modular organization and platform control of a system to achieve stable and sustainable operation; “Socio Economic Resilience” refers to the establishment of policies and regulations to improve the systematic work framework for heritage protection, while enhancing social attention and optimizing the quality of life.

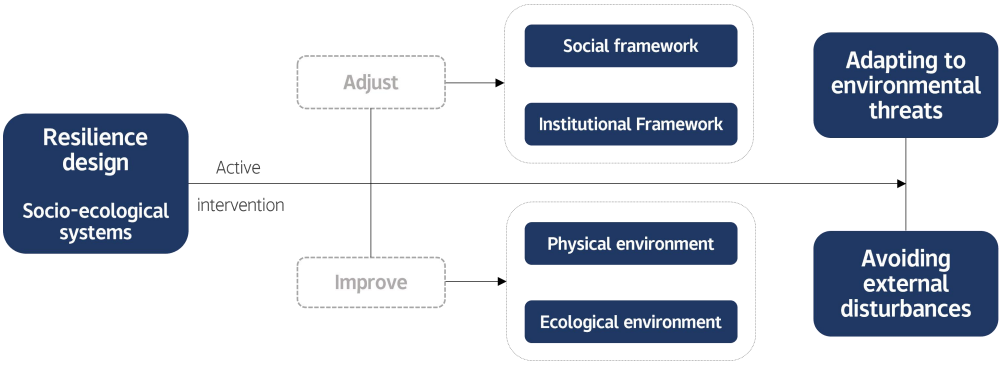


Fig. 3- 15 Mechanism of the Application of Resilience theory to Guangzhou Shipbuilding Industry Heritage
Source: Author's Self drawn

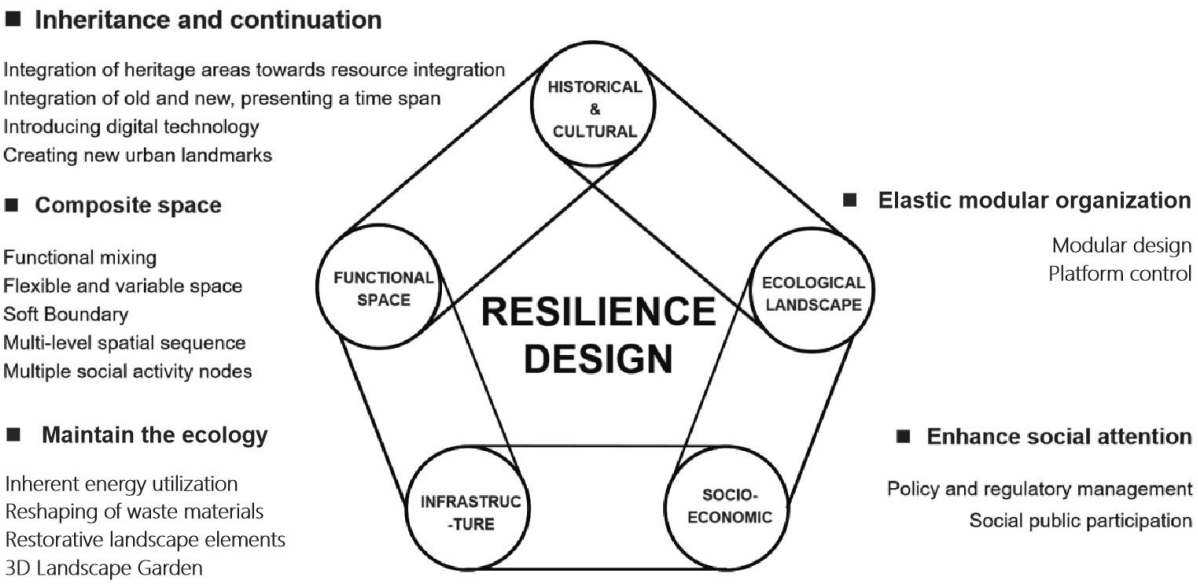


Fig. 3- 16 Five Key Elements of Resilience Design for Updating Guangzhou's Shipbuilding Industrial Heritage
Source: Author's Self drawn

3.5 Chapter Summary

This chapter sorts out the historical background, distribution characteristics, core item characteristics, and current status of renewal and protection of Guangzhou's shipbuilding industry heritage, summarizes its value and the current difficulties faced by the heritage. It clarifies that Guangzhou's shipbuilding industry heritage is currently facing dual threats such as weakened internal system control and external social and ecological environment changes. Then, from the implementation object, purpose value Comprehensively explore the applicability of resilience theory in the application of Guangzhou Shipbuilding Industry Heritage from three aspects of practical methods; Based on the previous analysis, a practical framework for applying resilience theory to the renewal of shipbuilding industry heritage is constructed. Based on the principles of resilience element extraction and combined with the current situation of Guangzhou shipbuilding industry heritage, five major elements are extracted: historical culture, functional space, ecological landscape, infrastructure, and socio-economic. This lays the foundation for further exploration of specific implementation strategies in the following text.

Chapter4 Strategies for Resilience Renewal of Guangzhou Shipbuilding Industry Heritage

4.1Cultural Resilience: Inheritance and continuation

4.1.1 Resource integration

Relying on Guangzhou's urban waterfront spaces, abandoned railways, urban greenways, and industrial heritage corridors, scattered shipbuilding industrial heritage sites are connected and integrated. By combining the shaping of urban public spaces, the protection and utilization of shipbuilding industrial heritage are integrated into urban life. Guangzhou's overall industrial heritage protection framework is based on the Pearl River Industrial Heritage Corridor and the Railway Industrial Heritage Corridor. A historical and cultural route with the theme of "Rediscovering Industrial Relics" has been planned (Fig. 4- 1), spanning a total length of 11 kilometers, linking 15 concentrated areas of industrial heritage sites such as Riqing Warehouse, Taikoo Warehouse, Zhadian Warehouse, Asia Dragon Warehouse, Guangzhou Steel Park, Guangzhou Shipyard, Guangzhou Paper Mill, First Cotton Mill, and First Rubber Factory. Following the linear path, the work of enhancing the quality of the areas along the route is carried out. By creating waterfront parks and open public spaces with distinctive industrial heritage characteristics, regional development is promoted, urban industrial memories are showcased, and the dispersed urban structure is re-integrated.

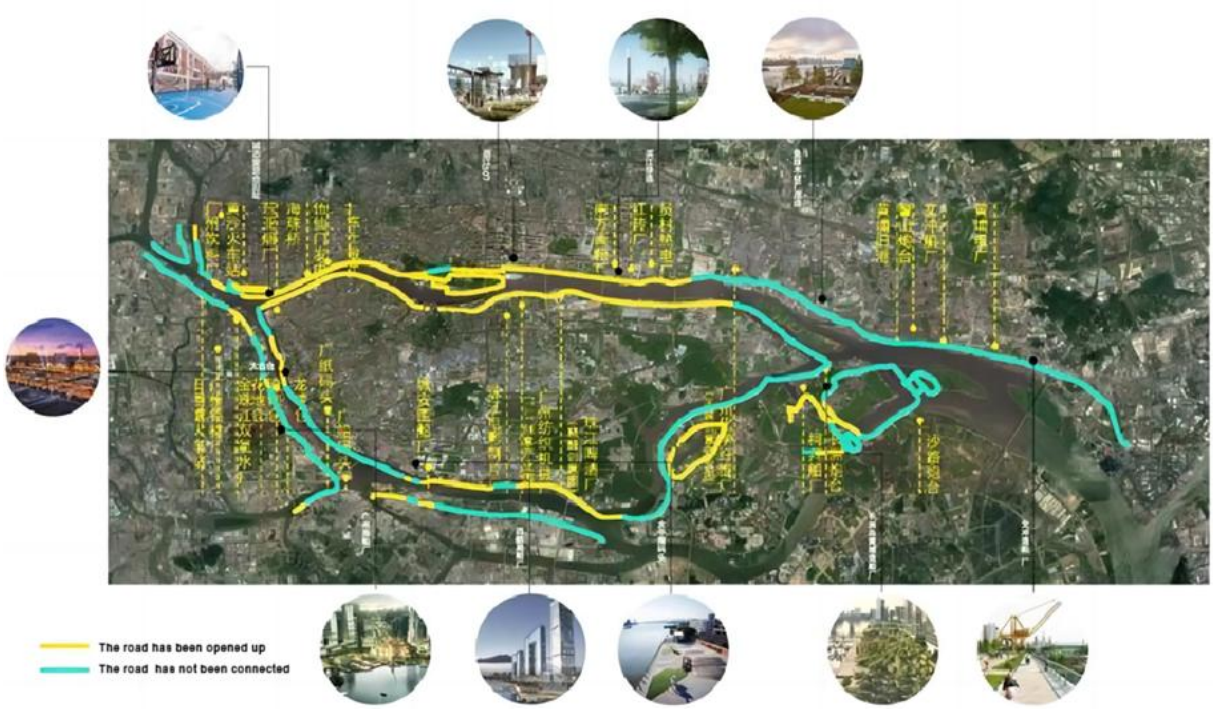


Fig. 4- 1 Planning Concept Map of Guangzhou's "Rediscovering Industrial Relics" Route
Source: https://mp.weixin.qq.com/s/yu0gqg1fp57FukjZ8vyjDg

Since 12 out of the 14 shipbuilding industrial heritage sites in Guangzhou are located along the Pearl River Industrial Heritage Corridor, and the remaining 2 sites are situated along the Railway Industrial Heritage Corridor (Fig. 4-2), the updating and preservation of shipbuilding industrial heritage should be based on the overall framework for the protection of industrial heritage in Guangzhou. The shipbuilding industrial heritage sites along the "Rediscovering Industrial Relics" route within the Pearl River Industrial Heritage Corridor should be interconnected, forming a shipbuilding industrial heritage route (Fig. 4-3). This will help better connect shipbuilding industrial cultural spaces and historical context, and promote public awareness of shipbuilding industrial culture.

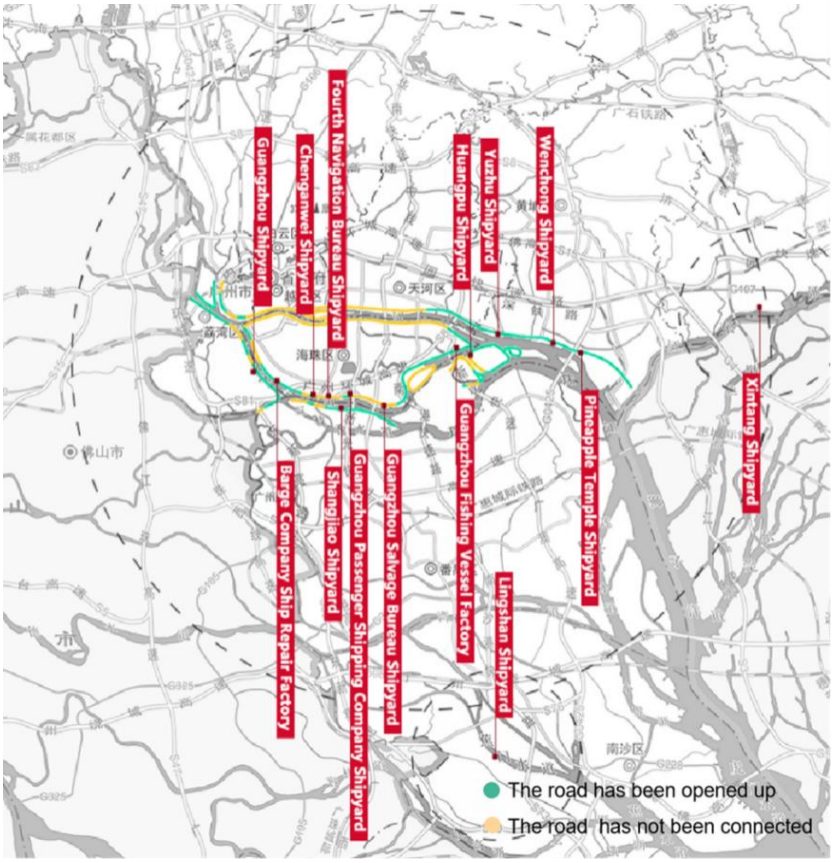


Fig. 4-2 Relationship Diagram between Guangzhou's Shipbuilding Industrial Heritage and "Rediscovering Industrial Relics" Route (Source: Author's Self drawn)

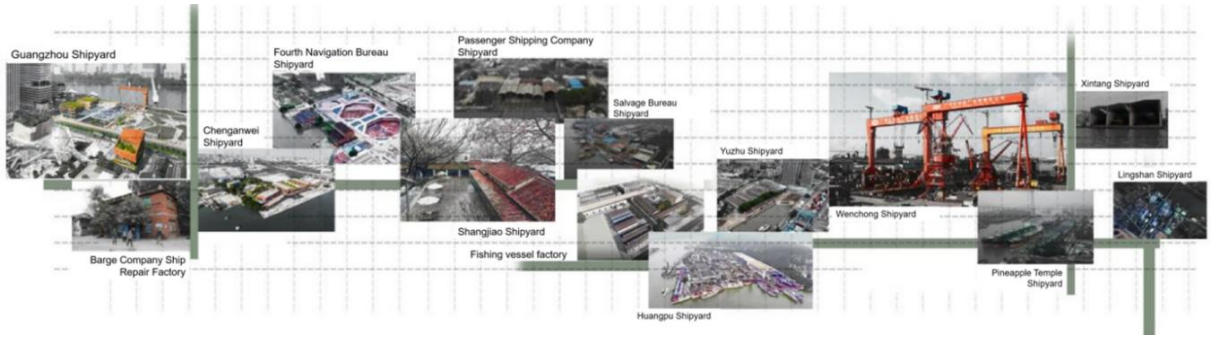


Fig. 4-3 Secondary Interconnection of Guangzhou's "Rediscovering Industrial Relics" Route - Shipbuilding Industrial Heritage Cultural and Tourism Route (Source: Author's Self drawn)

4.1.2 Integration of the Old and the New, Showcasing Time Span

With the continuous progress of technology and advancements in craftsmanship, the shipbuilding industry has undergone multiple technological innovations and industrial transformations. Therefore, in the preservation of shipbuilding industrial heritage, integrating old and new elements together and creating a contrast between history and modernity can better showcase the time span and present the shipbuilding industrial culture to the public.

Preservation of the scale and iconic components of shipbuilding industrial buildings

In the design of the renovation and transformation of shipbuilding industrial heritage, preserving the unique scale and iconic architectural components of the shipyards can evoke a sense of awe at the original size of the old buildings and create a strong industrial atmosphere. It also adds many details to the transformed spaces, creating a subtle and interesting walking experience.

Exposing the building structure

Exposing the structure of old buildings showcases a different industrial and historical aesthetic. Industrial factory buildings appear as "living organisms with bones," with exposed brick walls, pre-stressed beams, rusty steel frames, and the dust that settles on them without restraint. They may not be pristine, but they possess a unique beauty that comes with the passage of time. From both vertical and horizontal perspectives, they offer entirely different visual experiences.

Clearly distinguishing between new and old building materials

Differences in materials can better reflect the contrast between history and modernity, showcasing modern structures, materials, and technological advancements while effectively conveying the shipbuilding industrial culture to the public.

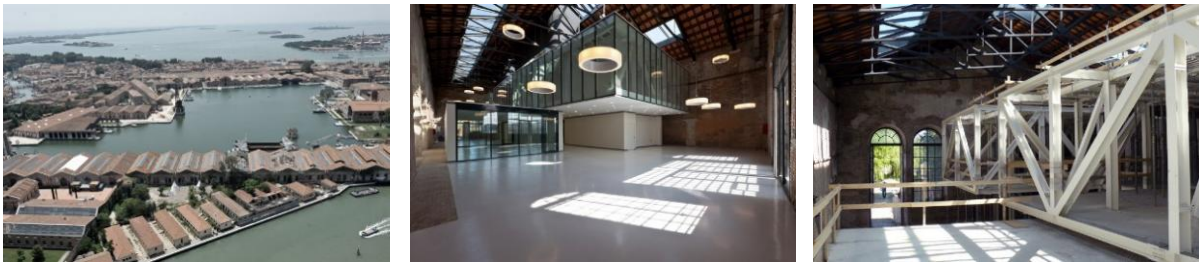


Fig. 4- 4 Visualization of the Renovated Venetian Arsenal in Italy
Source: https://www.gooood.cn/tesa-105-conversion-by-estudio-n.htm

In the renovation and transformation design of the Venetian Arsenal in Italy, the designers believed that the existing 16th-century warehouse buildings were "historic" containers that needed to incorporate "contemporary" content while maintaining their respective styles and engaging in dialogue. The exterior of the buildings is completely exposed, while modern new elements are inserted internally (Fig. 4- 4).

Fig. 4- 5 Shanghai Shipyard 1862 Fashion Art Center
Source: https://www.gooood.cn/farrells-complete-first-phase-of-shanghai-shipyard.htm

In the design of Shanghai Shipyard 1862 Fashion Art Center, a design approach of "hanging brick walls" is employed, where stainless steel cables connect brick unit modules composed of several types of molds on the periphery of the original building facade. This design technique, which combines old building materials with new construction techniques, to some extent mitigates the cultural destruction caused by architectural renovation (Fig. 4- 5).

4.1.3 Introducing Digital Technology to Popularize Industrial Culture

Digital technology plays an irreplaceable role in the preservation of shipyard industrial heritage. By integrating shipyard industrial heritage with modern technology, more sustainable and environmentally friendly solutions can be created. Through digital technology, the physical form and historical value of shipyard industrial heritage can be digitally recorded, leading to better preservation and management, and promoting the inheritance and popularization of industrial culture.The application of digital technology in the protection of shipyard industrial heritage can involve the use of 3D scanning, virtual reality, artificial intelligence, cloud computing, and other technologies in the process of updating and preserving shipyard industrial heritage. In the future, we should continue to explore the application of digital technology in the protection of shipyard industrial heritage, and constantly innovate and improve related techniques and methods.

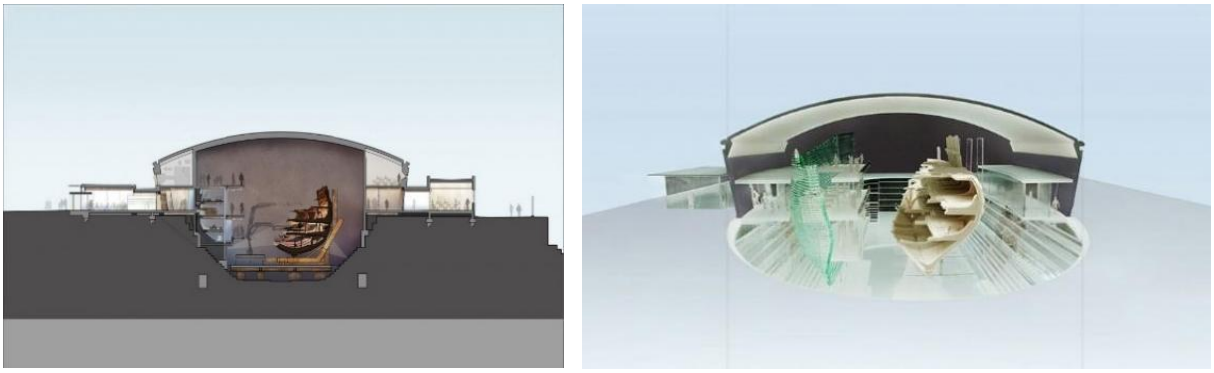


Fig. 4- 6 Exhibition space at the Mary Rose Museum in the United Kingdom
Source: https://www.gooood.cn/mary-rose-museum-by-wilkinson-eyre-perkins-will.htm

In the Mary Rose Museum, the core of the interior design is to freeze time on January 19, 1545, showcasing the final moments of the Mary Rose before it sank. To supplement the missing parts of the ship's hull, designers created a virtual hull, equipped with cannons, cannonballs, supplies, storage chests, and ropes, based on the original layout of the ship's interior. The museum is divided into three levels, allowing visitors to walk on the preserved starboard side, moving between the real and virtual ship, as if they have truly boarded the Mary Rose and experienced every material and component inside the ship (Fig. 4- 6).

4.1.4 Creating Urban Landmarks

Due to the early establishment of the Guangzhou shipyard and its typically waterfront location, as the city expanded, the shipyards that were once on the outskirts found themselves occupying prime locations in the city. These shipyards had to relocate from the city center to accommodate urban development, leaving behind old factory areas that are now situated in important urban districts. Therefore, shipyard heritage has become an important element in creating new urban landmarks. The challenge lies in how to transform shipyard heritage into modern, fashionable, and artistic urban landmarks, by recognizing their value and significance, integrating them with urban renewal and development, and incorporating modern technologies and artistic elements. Furthermore, in the design process, it is important to strike a balance between history and modernity, and to harmoniously blend the heritage with the surrounding environment. Given the unique nature of ship production, the remaining hydraulic equipment best reflects the characteristics of the shipbuilding industry. There are often distinctive structures and production facilities on the site, such as water towers and dry docks, as well as large-scale shipbuilding facilities like cranes and gantries, which can be utilized to create urban landmarks with a sense of time and cultural significance.

Fig. 4- 7 Camp Mare Port City Regeneration Project in South Korea
Source: https://www.gooood.cn/urban-regeneration-of-camp-mare-by-henn.htm

In the Camp Mare Port City Regeneration Project in South Korea, the former shipyard has been transformed into a brand new urban square. The southern mountain landscape is connected to the waterfront area through two parks, and the existing large-scale shipbuilding equipment within the site is utilized as a landscape element. This creates a distinctive urban landmark and evokes strong industrial memories within the site (Fig. 4- 7).

4.2 Functional and Spatial Resilience: Composite Spaces, Enhancing Adaptability

Urban development involves various uncertainties and possibilities. The singularity of existing functions lacks the ability to withstand unknown impacts. Therefore, the concept of resilience calls for the development of urban functions towards greater complexity to adapt to various scenarios and different needs.

4.2.1 Functional Mixing, Improved Facilities

In order for shipyard heritage to better adapt to the needs of urban development, functions can be regulated according to different development phases of the city, including the conversion of functions in shipyard heritage and the supplementation of missing functions. From a functional resilience perspective, space can be utilized for mixed-use purposes, enabling self-upgrades and compensating for functional deficiencies in the area. By meeting the requirements of urban development, the shipyard heritage can enhance its adaptability to change. For example, transforming shipyard heritage into museums, cultural centers, creative industry parks, and more not only preserves historical and cultural heritage but also injects new vitality and economic value into the city. Furthermore, with improved supporting facilities, these heritage sites can better serve the public and contribute to urban development.

Additionally, when external circumstances change, resource sharing and mutual assistance can be achieved by adjusting the relationships between different functions, thus better safeguarding the well-being of the public.

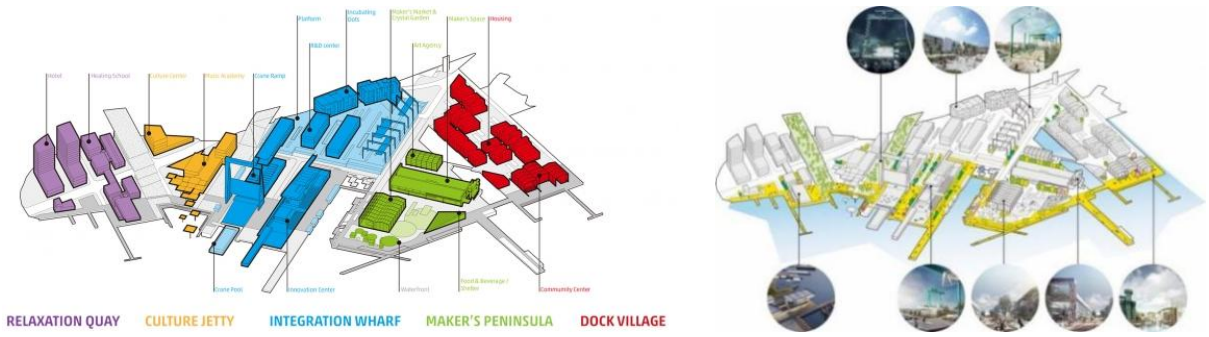


Fig. 4- 8 Functional Plan of the Camp Mare Port Urban Regeneration Project
Source: https://www.gooood.cn/urban-regeneration-of-camp-mare-by-henn.htm

In the Camp Mare Port Urban Regeneration Project in South Korea, the design incorporates the city's traditional craftsmanship, culinary culture, and shipbuilding heritage. By introducing new technologies, research facilities, cultural activities, tourist attractions, etc., the project aims to revitalize the coastal lifestyle in this area. The plan also includes the "12 Schools" project, where these schools will serve as symbols of innovation, creating a new industrial ecosystem for the entire city and region. Each region will have multiple schools, and each school's education will focus on various stages of the industrial cycle: research and development, design, production, testing, marketing, and sales. Camp Mare will ultimately become a vibrant and dynamic new district in the city, laying the foundation for urban regeneration and future development (Fig. 4- 8).

4.2.2 Flexible and Adaptive Spatial Layout

In the design of industrial heritage regeneration and transformation, the functional and usage patterns of historical heritage buildings have changed, requiring them to be re-planned and reconFig.d. Through flexible and adaptive design, buildings can accommodate different uses and needs, extending their lifespan. Furthermore, through well-designed spatial layout, the internal space and resources of the buildings can be maximized. This not only reduces operating costs but also minimizes environmental impact and improves sustainability.

Fig. 4- 9 Shanghai Submarine Museum with Flexible Spatial Layout
Source: https://www.gooood.cn/shanghai-submarine-museum-pes-architects.htm

The Shanghai Submarine Museum, while fully preserving the historical and cultural heritage of the site, creates a waterfront landscape in conjunction with the surrounding scenery of the Huangpu River, establishing a landmark for the site's historical and cultural landscape. Its flexible spatial layout is primarily manifested in the undulating terrain at the bottom of the dock, which can change the landscape and functionality of the entire area according to the water level, extending the activity space of the Bund. Additionally, its flexible exhibition spaces allow for the isolation of certain docks, which can become part of exhibitions or event plans based on the season (Fig. 4- 9).

4.2.3 Soft Boundaries: Anticipating Change and Adaptive Spaces

Soft boundaries refer to open spaces within the city that can adapt to changes and needs. These spaces are usually multifunctional and can be used for various activities and purposes, such as parks, plazas, and bicycle lanes. The design of soft boundaries helps cities better adapt to future changes and needs while enhancing sustainability and resilience.

In the design of industrial heritage revitalization and renovation, rigid boundaries between different functional areas can restrict the flow of people and resources. Hard boundaries often require significant resources and energy for construction and maintenance. In contrast, soft boundaries can break these limitations, allowing for self-recovery of the factory area through natural ecosystems, reducing resource waste and environmental pollution, and making the interior of the factory area more flexible and efficient. Moreover, as the factory area develops in the future, the demands and proportions between different functional areas will change, and soft boundaries can adapt to these changes, ensuring balance and stability within the city. Integrating the industrial heritage with the surrounding environment through soft boundaries

breaks the sense of isolation brought by rigid boundaries and increases its utilitarian value. This approach not only increases public awareness and understanding of industrial heritage but also enhances its historical and cultural value. For example, transforming docks into cultural and creative industrial parks or converting piers into tourist attractions can increase the economic and social value of industrial heritage.

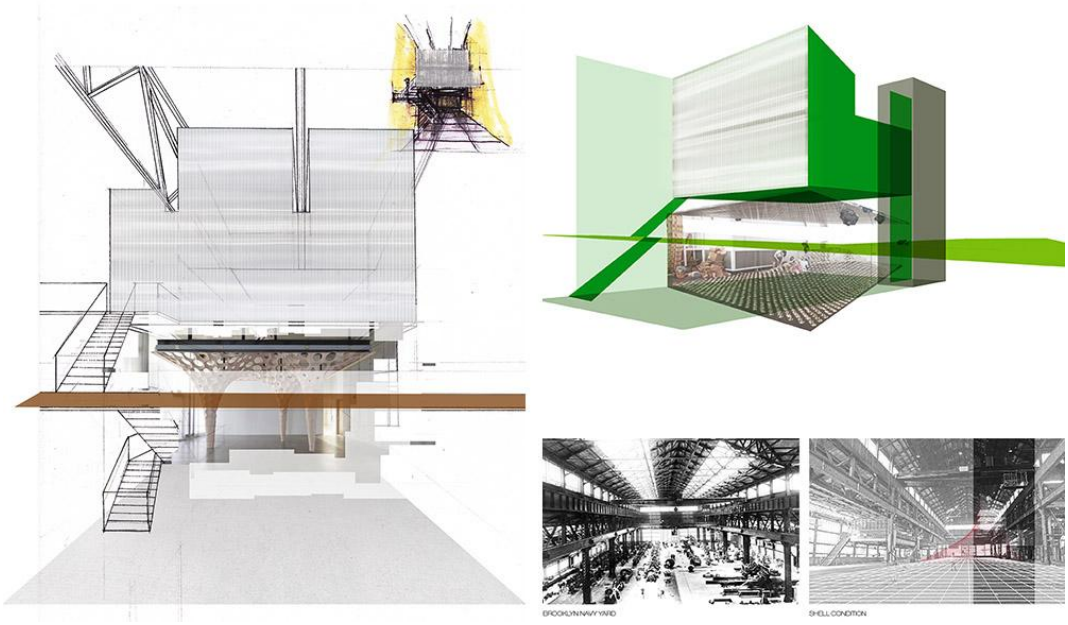


Fig. 4- 10 Lucent Cube Glowing Box: Interior and Exterior Space Treatment
Source: https://www.gooood.cn/lucent-cube-by-yun-wan.htm

The Lucent Cube Glowing Box project in the United States cleverly utilizes the open space of the renovated 128 Factory and repurposes the roof space of the old shipyard for One Lab, a biopharmaceutical research center. In the design process, the primary consideration was how the new building could adapt to future changes in functional requirements. The approach taken by the designers was to consolidate all fixed-function spaces into one entity and suspend this "box" above the flowing spatial elements. The illuminated "box" from One Lab shines upon the first and second floors, creating shared spaces for exhibitions, open classrooms, and other flexible uses. By making use of the suspended structure and the open space below, the rooftop of the old shipyard will also be utilized for plant and biological research (Fig. 4- 10).

4.2.4 Multilevel Spatial Sequences: Connecting the Urban Core

Multilevel spatial sequences in urban design refer to the organic connection of spaces with different heights and functions to create a spatial sequence relationship. By designing multilevel spatial sequences, waterfront areas can be effectively connected to the urban core,

forming a complete urban spatial system. This approach can alleviate urban traffic pressure and promote urban development and prosperity.

In the context of renovating and transforming shipyard industrial heritage, multilevel spatial sequences can enhance sustainability and resilience by integrating the shipyard heritage into urban planning. Specifically, these buildings and facilities can be utilized as part of functional areas such as urban parks, cultural centers, and creative industry parks. This approach preserves the historical and cultural value of these buildings and facilities while also providing more public spaces and cultural venues for the city, fostering urban development and prosperity.

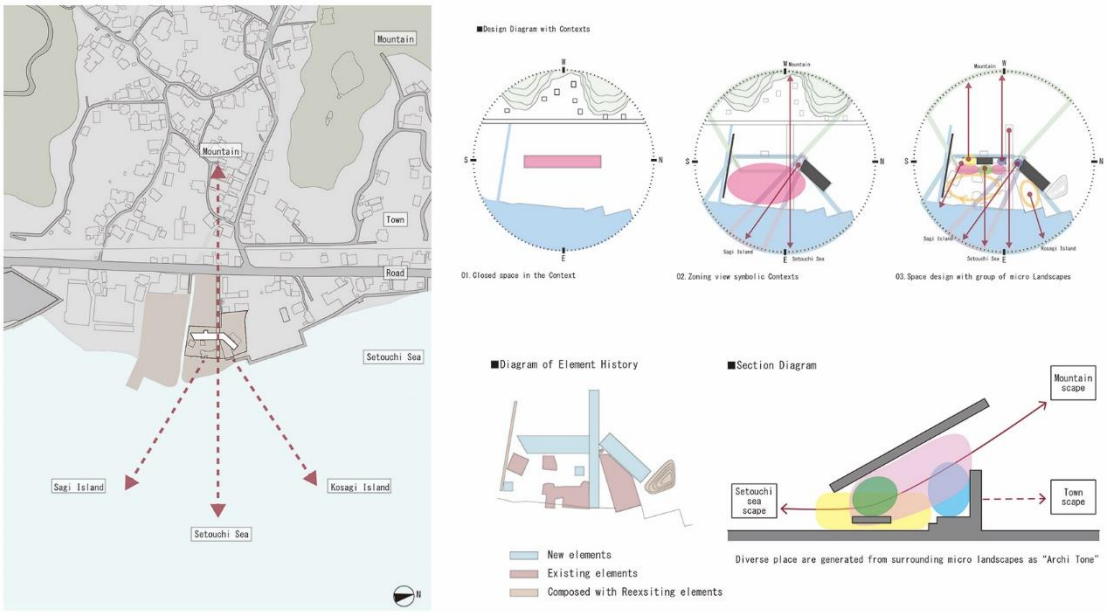


Fig. 4- 11 Planning proposal for the SETOUCHI JOZOJO Distillery Restaurant project
Source: https://www.gooood.cn/setouchi-jozojo-sugawaradaisuke-architects.htm

The SETOUCHI JOZOJO Distillery Restaurant project in Japan is located on the site of a former shipyard dock. The design objective is to create a versatile space that offers various choices, connecting the iconic architecture with the surrounding environmental context. The architectural and landscape design uses entrance axes, door frames, and elongated roofs to connect with the sea and mountain views (Fig. 4- 11).

4.2.5 Waterfront Multi-functional Social Activity Nodes

As urbanization continues to accelerate, residents in cities have an increasing demand for quality of life and social activities. Therefore, in the renovation and transformation of shipbuilding industrial heritage, it is necessary to consider how to establish diverse social

activity nodes in waterfront areas. In this process, it is important to preserve the historical value and cultural significance of the heritage buildings while incorporating modern design concepts and technologies to create waterfront nodes that are contemporary and functional.

The key focus of waterfront area activity space design is the establishment of pedestrian, recreational, and leisure systems. In the renovation and transformation of public waterfront spaces in shipbuilding industrial heritage, the existing structures and industrial equipment on the site can be utilized to reshape landscape nodes. Given the unique nature of shipbuilding production, the remaining hydraulic structures can best represent the shipbuilding industry's character. Water towers, docks, and other structures, as well as large shipbuilding production facilities such as cranes and hoists, can be utilized to create iconic landscape landmarks with distinctive shipbuilding cultural features, thereby extending the industrial heritage. Smaller facilities such as generators and railway tracks, with their small size and high flexibility, can be treated as artistic elements in the landscape to reshape the urban scenery and prolong the memory of shipbuilding history. Based on the needs of the surrounding area and the city, different activity nodes can gradually spread along the coast, gradually repairing the fragmented relationship between the urban core and the waterfront area.

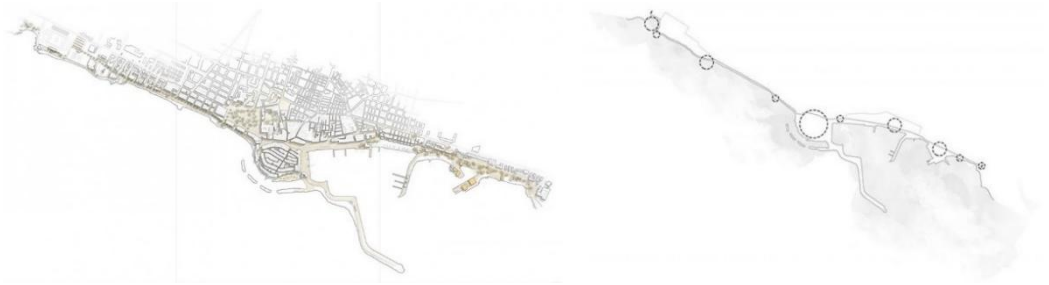


Fig. 4- 12 Molfetta Waterfront Space Transformation Project Node System
Source: https://www.gooood.cn/terre-e-mare-molfetta-by-elements-arch-lab.htm

In the Molfetta Waterfront Space Transformation Project, all the schemes for urban space transformation aim to preserve or restore the intimacy between the city and the water, returning the urban space to the residents. The designers have laid out different activity nodes along the coastline based on the surrounding area and the city's needs. By creating upper-level platforms that are level with the city interface and lower-level platforms connected to the sea level, the project meets the residents' various needs for activities such as sunbathing, picnicking, and fishing. The existing dock on the site has been transformed into a waterfront public activity space, and various service facilities along the waterfront provide convenience for people to enjoy the entire waterfront activity space. Bar-shaped benches replace railings

and serve as distinctive landscape elements that unify the style of the entire waterfront space, providing a resting space and activating the use of the surrounding area (Fig. 4- 12).

4.3 Ecological landscape resilience: enhancing self repair ability

Ecological resilience emphasizes the ability to adapt to the natural environment, including various development approaches that align with the natural environment. It aims to create a regulated and organized "living landscape" in cities, ensuring the coordination between urban functions and environmental ecology. In terms of the renovation and preservation of industrial heritage, it is necessary to integrate the natural environment with the Functional and Spatial of industrial heritage from the perspective of spatial resilience, emphasizing the harmonization between the preservation of industrial heritage and the ecological environment to enhance the adaptability of industrial heritage to the ecological environment.

4.3.1 Utilizing Inherent Energy Resources

Due to the unique waterfront characteristics of shipbuilding industrial heritage sites, they harbor rich biodiversity within their premises. In the design of renovation projects, the abundant biological and material resources on the site can be integrated to tap into and reuse the inherent energy resources within the site.

Given that waterfront areas are generally low-lying and prone to flooding, it is crucial to address and utilize this characteristic. In order to minimize earthwork volume and make the most of site resources, principles of sponge cities, including infiltration, retention, storage, purification, utilization, and discharge, can be applied. Artificial lakes can be excavated within the site to store water, forming a water circulation system. Simultaneously, the excavated soil can be used for local site backfilling, creating coastal dissipation zones or active areas that become part of the landscape.

Additionally, ecological techniques such as constructing an ecological grass ditch network, setting up rain gardens, retention basins, artificial wetlands, and filter drains can be employed to mitigate the impact of heavy rain, improve the quality of surface runoff, and provide ecological habitats for animals. The establishment of an ecological grass ditch network allows for the effective reuse of abandoned building materials within the site.

An ecological grass ditch network refers to a system that collects, purifies, and treats rainwater and wastewater through the planting of herbaceous plants and the establishment of waterways. It achieves multiple effects such as environmental protection, energy conservation, and beautification. In the renovation of shipbuilding industrial heritage, a series of ecological grass ditch networks can be constructed by effectively reusing the abundant concrete and asphalt waste materials within the shipyard and the site's existing material conditions. This enhances the site's permeability, gradually slows down the flow of rainwater into the river, and filters the water for irrigation of shrub hedgerows.

The ecological grass ditch network in the renovation of shipbuilding industrial heritage serves the following purposes:

①Water Environment Purification:

Shipbuilding industrial heritage areas are often affected by industrial pollution, resulting in poor water quality. The ecological grass ditch network can collect, purify, and treat rainwater and wastewater, improving the water environment quality. The herbaceous plants in the grass ditches can absorb nutrients from the wastewater, reducing the occurrence of water eutrophication.

②Enhanced Flood Control and Drainage Capacity:

Shipbuilding industrial heritage areas are usually located in low-lying areas susceptible to flooding. By establishing waterways and storing rainwater, the drainage capacity within the area can be enhanced. Moreover, the herbaceous plants in the grass ditches can improve soil water retention capacity, reducing the damage caused by flooding.

③Environmental Beautification:

Shipbuilding industrial heritage areas are often located on the outskirts of cities or in industrial zones with relatively poor environments. The ecological grass ditch network can beautify the surroundings and enhance the area's figure by planting herbaceous plants and establishing waterways. Additionally, the herbaceous plants in the grass ditches can absorb particulate matter and harmful gases, improving air quality.

④Energy Conservation and Consumption Reduction:

Shipbuilding industrial heritage areas often have a surplus of untapped rainwater and wastewater resources. By establishing an ecological grass ditch network, these resources can be collected, purified, and treated, achieving energy conservation and consumption reduction. Moreover, the herbaceous plants in the grass ditches can lower the ambient temperature, reducing the frequency of air conditioning and other equipment usage.

Fig. 4- 13 Construction of Ecological Grass Ditch Network in Headquarters Campus Project
Source: https://www.gooood.cn/urbn-headquarters-by-dirt.htm

In the Headquarters Campus Landscape Remodeling Project in Philadelphia, the effective construction of a series of ecological grass ditch networks and the reuse of a significant amount of concrete and asphalt waste materials within the former shipyard site successfully avoided the generation of nearly 1,000 cubic yards (approximately 765 cubic meters) of waste. Additionally, the permeability of the project site increased approximately 8 times compared to its original state (Fig. 4- 13).

4.3.2 Industrial Traces and Recycling of Waste Materials

During the initial stages of the remodeling project, relevant material selection strategies with a focus on "material recycling" are formulated. For example, existing or demolished decorative asphalt, old concrete, recycled bricks, rusted metals, coarse ground paving materials, and abundant dismantled leftover materials from the project site are chosen to restore the industrial landscape area.

Traditional demolition projects typically involve simple dismantling and hauling, and many reusable building materials are considered waste and cannot be recycled. However, in future remodeling projects, comprehensive waste recycling strategies should be developed early on to significantly reduce the need for new construction materials. Moreover, the full utilization of existing site materials will create a sense of familiarity for former shipyard employees in the new corporate park landscape space. They will be able to reminisce about the past while appreciating the presence of a contemporary landscape ambiance.

Fig. 4- 14 Waste Utilization Methods in the Headquarters Campus Landscape Remodeling Project
Source: https://www.gooood.cn/urbn-headquarters-by-dirt.htm

In the Headquarters Campus Landscape Remodeling project in Philadelphia, unlike the typical demolition projects that involve simple removal and hauling, a comprehensive waste utilization strategy was developed. Materials that are typically considered as waste were fully recycled and reused in this project. Many full-sized solid demolition debris posed challenges to conventional construction practices, but they also became crucial elements in the development strategy of waste utilization, demonstrating the project's strong commitment to cost efficiency (Fig. 4- 14).

4.3.3 Placement of Restorative Landscape Elements

Restorative landscape elements refer to the creation of landscape elements with ecological functions and aesthetic value through the restoration and reconstruction of the original urban ecosystem during the process of urbanization. In the design of shipbuilding industrial heritage renewal and transformation, the placement of restorative landscape elements can be achieved through the following measures:

①Placement of diverse plant landscapes: By planting trees, flowers, and other plants, a green environment can be created, improving urban air quality, purifying the environment, and alleviating the urban heat island effect. Plant landscapes can also provide recreational spaces for urban residents and enhance the beauty of the urban landscape.

② Placement of water features: By constructing artificial lakes, water systems, and other water features, better connectivity can be established between the urban core and waterfront areas, achieving landscape permeation. Water features can also provide recreational spaces for urban residents and enhance the beauty of the urban landscape.

③ Placement of ecological corridors: By establishing ecological corridors, the internal industrial heritage areas and the urban ecosystem can be connected, promoting ecological connectivity, biodiversity conservation, and urban greening.

The placement of restorative urban landscapes can better achieve sustainable development within the region and enhance the adaptability of the ecological environment to external changes. By integrating different natural landscapes on the site, an immersive living landscape can be formed, providing ecosystem services, scientific research, and aesthetic enlightenment.

4.3.4 Three-Dimensional Landscape Gardens

Three-dimensional landscape gardens are comprehensive landscape forms that combine garden landscapes, architectural landscapes, and sculpture art. They can not only add greenery and enhance the figure of industrial heritage sites but also provide beautiful recreational spaces for citizens. Constructing three-dimensional landscape gardens requires considering the terrain and topography of the site and making clever use of height differences. By incorporating platforms, steps, and stairs of different heights, a well-structured and diverse landscape effect can be created. Additionally, water features can be arranged based on the variations in terrain, adding to the visual appeal and artistic qualities of the garden. Architectural landscapes are also indispensable elements in constructing three-dimensional landscape gardens. Buildings can infuse cultural atmosphere and artistic elements into the garden while providing shaded areas for rest. In the design of architectural renovations, integration with the garden landscape should be achieved to form an organic whole.

In addition to terrain and topography and architectural landscapes, plants are also essential elements in constructing three-dimensional landscape gardens. By selecting plants of different species, colors, and heights and arranging them harmoniously, the garden can become more lively and interesting. Consideration should also be given to the changes in different seasons to maintain a green garden throughout the year. Comfort for visitors should also be taken into account. Rest areas, fountains, musical fountains, and other facilities can be incorporated into the garden to provide a beautiful and comfortable environment. Additionally, the design of visitor flow lines should be rational to avoid congestion and confusion.

4.4 Infrastructure Resilience: Modular Organization for Sustainable Operation

Infrastructure resilience in the context of urban design encompasses both speed and durability. As the foundation of a city's normal functioning, infrastructure not only ensures the essential support for people's production and daily life but also constitutes a necessary condition for an resilience city. This resilience emphasizes the independent existence of various facilities while maintaining interconnectedness. This approach highlights the resilience system's resistance, adaptability, and recovery capabilities in the face of various hazards. To leverage this resilience, shipbuilding heritage can be organized in a modular and flexible manner, employing platform-based resilient management measures to protect and renovate the heritage and enhance infrastructure to achieve sustainable operation.

4.4.1 Modular Design

During the process of renovating shipbuilding heritage, modular organization can be employed to enhance flexibility in spatial arrangement, facilitating easier protection and maintenance. Several considerations should be taken into account for modular design:

Analyzing shipbuilding heritage characteristics

Before implementing modular design, an analysis of the shipbuilding heritage should be conducted to understand its characteristics and structure. By breaking it down, the main components and functional modules can be identified, providing a foundation for subsequent design.

Determining modular design schemes

Based on the heritage's characteristics and analysis results, modular design schemes should be determined. These schemes should encompass module divisions, interface design, and module functions. During the design process, the heritage's historical value and cultural significance should be considered, preserving its original structure and characteristics as much as possible.

Establishing modular design standards

To ensure the quality and feasibility of modular design, corresponding standards and specifications need to be established. These standards should cover module dimensions, interface specifications, material requirements, and other aspects. When setting standards, the

heritage's protection needs and requirements for sustainable development should be taken into account.

Implementing modular design

During the implementation of modular design, operations should follow the design schemes and standards. First, module manufacturing and assembly should be carried out, followed by testing and debugging. During the testing process, the interfaces between modules should be checked for compliance with specifications to ensure proper module functionality.

Monitoring and maintenance

After implementing modular design, monitoring and maintenance work should be conducted. Regular inspections should be performed to identify any damage or aging of the modules and promptly replace or repair them. Additionally, modules should be maintained and protected against corrosion to ensure their long-term preservation.

Fig. 4- 15 Modular Structure of Shanghai Submarine Museum
Source: https://www.gooood.cn/shanghai-submarine-museum-pes-architects.htm

In the Shanghai Submarine Museum project, the building adopts a modular structure primarily based on prefabricated components, allowing for quick construction. This also enables the disassembly and reassembly of the structure in other locations once its lifespan ends. As the museum project expands, the volume of the Phase 2 building will increase to 3,000 square meters to accommodate the growing demand for exhibition space (Fig. 4- 15).

4.4.2 Platform Management

Platform management is crucial in the preservation of shipbuilding heritage. Through platform management, shipbuilding heritage can be better protected, managed, and

maintained. The following are specific measures for achieving platform management in the preservation of shipbuilding heritage:

Establish a comprehensive platform management system:

This system should include basic information about the platform, platform managers, maintenance personnel, and usage regulations. By establishing such a system, shipbuilding heritage can be better managed and maintained.

Categorize and manage platforms:

Classify platforms based on their characteristics and purposes, and implement different management approaches for different categories of platforms. For platforms with significant historical value, enhanced protection and management measures are necessary, while simpler management measures can be applied to general platforms.

Strengthen inspection and supervision of platforms:

Conduct regular inspections and supervision of platforms to promptly identify and address any issues. Additionally, strengthen supervision of platform users to ensure compliance with regulations and prevent damage to the platforms and surrounding environment.

Enhance publicity and education:

Increase awareness and knowledge of shipbuilding heritage through publicity and education initiatives. Educate the public on proper usage and conservation of these heritage sites. Furthermore, raise public awareness and appreciation for the preservation of shipbuilding heritage through publicity and education efforts.

Provide technical support:

Utilize technological means, such as installing surveillance devices and establishing information systems, to support platform management. These technological measures can improve platform management and enhance efficiency.

By implementing measures such as establishing a comprehensive platform management system, categorizing and managing platforms, conducting inspections and supervision, strengthening publicity and education, and providing technical support, shipbuilding heritage can be better protected, managed, and maintained.

4.5 Socio economic resilience: enhancing social awareness and optimizing quality of life

The concept of resilience is manifested at the social level through a flexible and innovative management system. In addition to taking a leading role, the management department should integrate the efforts and knowledge of experts, scholars, organizations, businesses, and the urban public to coordinate complex interests and maintain social stability and development. In terms of social resilience, the emphasis on the preservation of shipbuilding heritage lies in the role of the government, relevant organizations, and citizens in protecting industrial heritage, including the government's formulation of appropriate policies and regulations, and the spontaneous protection and revitalization efforts of the public. By employing flexible measures in management, combined with government decisions and public participation, the social resilience of shipbuilding heritage can be enhanced.

4.5.1 Policy and Regulatory Management

In future shipbuilding heritage renovation and design projects, there should be a focus on government management requirements, improving the systematic framework for the protection and utilization of industrial heritage, and transitioning from planning and design to institutional design. This involves establishing a protection system that encompasses protection planning, institutional development, and implementation management, and providing recommendations and implementation strategies to link statutory planning, inclusion in the protection registry, and policy promotion.

Establishing a Heritage Inventory System

A heritage inventory refers to a comprehensive survey and registration of specific cultural heritage in a particular area or of a specific type. This allows for a better understanding and protection of cultural heritage. Establishing a heritage inventory system requires collaboration among the government, experts, and scholars. The government should increase investment in the protection of shipbuilding heritage, providing funding and policy support. Experts and scholars should participate in the inventory work, providing technical and academic support. Additionally, active involvement from various sectors of society is essential to promote the inventory work.

In the field of shipbuilding, due to its unique historical background and technical characteristics, the protection of shipbuilding heritage is particularly important. However, in practice, many valuable shipbuilding heritage sites remain neglected, and they are at risk of destruction or disappearance due to the lack of a comprehensive heritage inventory system. Therefore, establishing a shipbuilding heritage inventory system is of great significance and can be approached from the following aspects:

①Develop an inventory plan: The inventory plan should include the scope, objects, content, and methods of the inventory. When developing the inventory plan, the unique characteristics of shipbuilding heritage should be considered, and the expertise of professionals should be fully utilized to ensure the scientific and practical nature of the inventory plan.

②Conduct the inventory: The inventory should be conducted using scientific, systematic, and comprehensive survey methods to ensure a thorough and accurate assessment and registration of each shipbuilding heritage site.

③ Establish a heritage archive: After completing the inventory work, the inventory data should be promptly organized and archived, and a corresponding heritage archive should be established. The heritage archive should include basic information, historical evolution, technical features, and other relevant details to better document and pass down these valuable cultural heritage assets.

Enhancing Implementation Assurance Mechanisms

Improving relevant laws and regulations contributes to the protection of shipbuilding heritage. Although China has already enacted laws and regulations for the protection of industrial heritage, there are still some issues that need to be addressed during their implementation. Specific research on shipbuilding heritage can be conducted, and special plans for the protection and utilization of shipbuilding heritage can be developed to ensure their preservation. Additionally, efforts should be made to strengthen publicity and education. The protection of shipbuilding heritage requires the active participation and support of the entire society. Therefore, various channels should be utilized to strengthen publicity and education on the protection of shipbuilding heritage, raising public awareness and understanding of cultural heritage conservation. Establishing and improving implementation assurance

mechanisms also necessitates the establishment of sound management systems. In the process of shipbuilding heritage protection, a scientific management mechanism should be established, including the identification, assessment, classification, registration, protection, and utilization of heritage sites. Furthermore, efforts should be made to enhance the training and recruitment of professionals in heritage conservation to improve the professional level of heritage protection.

Establishing a City-District Collaboration Mechanism

The city-district collaboration mechanism refers to a mechanism where urban management departments and regional management departments coordinate and cooperate to advance urban construction and management. In terms of shipbuilding heritage preservation, the city-district collaboration mechanism can effectively integrate various resources to achieve comprehensive protection of industrial heritage. Since shipbuilding heritage often spans multiple administrative regions, without coordination and cooperation between different regions, it is difficult to achieve comprehensive protection. Urban management departments and regional management departments possess different resources and advantages, and through coordination and cooperation, resource sharing can be realized, resulting in improved protection outcomes. Through the city-district collaboration mechanism, information sharing and rapid response can be achieved, enhancing the efficiency of shipbuilding heritage protection. The establishment of a city-district collaboration mechanism can be approached through the following methods:

① Establish a dedicated joint working group: Urban management departments and regional management departments should jointly establish a dedicated joint working group responsible for coordinating, managing, and promoting the protection of industrial heritage.

② Develop unified planning and standards: Establish unified planning and standards that clarify the goals and measures for the protection of industrial heritage, facilitating coordinated efforts from all parties.

③ Enhance information sharing and communication: Establish an information-sharing platform to facilitate timely communication of information, data, and experiences, thereby improving the efficiency and quality of protection.

④ Strengthen publicity and education: Increase public awareness and understanding of industrial heritage protection through publicity and education initiatives, fostering a favorable social atmosphere.

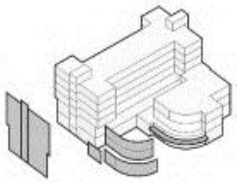
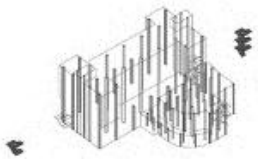
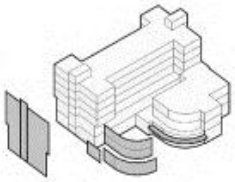
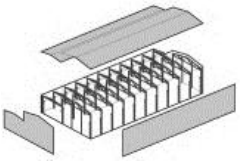
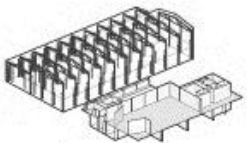
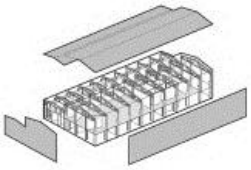
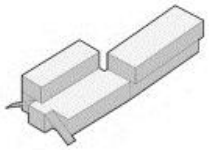
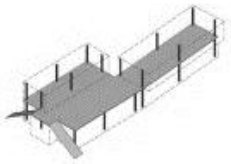
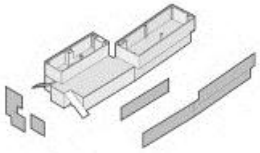
Establishing a city-district collaboration mechanism is one of the important means of protecting shipbuilding heritage. In the process of establishing such a mechanism, all parties need to collaborate, enhance information sharing and communication, establish unified planning and standards, and strengthen publicity and education measures to achieve comprehensive protection of industrial heritage.

Categorizing Building Management: Restoration, Integration of Old and New, and New Construction

In shipbuilding heritage preservation, different protection methods and utilization models can be employed based on the characteristics and current conditions of the heritage sites. For instance, for historically significant shipbuilding heritage sites that are well-preserved, a conservation-focused approach can be adopted, aiming to retain the historical and cultural value while ensuring functional use. For heritage sites that are in disrepair or no longer usable, reconstruction or renovation can be considered to transform them into new industries or cultural facilities.

In the Guangzhou City Construction and Security Shipyard Renovation Project, the designer analyzed and classified the existing industrial base and buildings, dividing them into three categories for management[36] (Tab. 4- 1):

Tab. 4- 1 Classification of Building Renovation at Chenganwei Shipyard
Source: Luo Fei, Guo Ying, Chen Yongyi, et al. Protection and Revitalization of Lingnan Stock Shipbuilding Industry Heritage - Renovation Practice of Guangzhou Chenganwei Shipyard [J]. Architectural Techniques, 2022-28 (09): 105-107. DOI: 10.19953/j.at. 2022.09.017

Transformation type	Transformation timing		
Original repair category	 Step 1: Remove aged and unsafe building components, clean peeling plastered exterior walls, and aged interior decorations	 Step 2: Structural reinforcement, adding evacuation stairs and other firefighting facilities according to firefighting needs	 Step 3: Repair the exterior facade of the building and renovate the urban decoration
New and old fusion class	 Step 1: Dismantle aging building components that do not meet safety requirements, and retain the main structural components	 Step 2: Structural reinforcement, supplementary construction of structural columns, slabs, and walls, and addition of evacuation stairs and other firefighting facilities according to firefighting needs	 Step 3: Repair the exterior facade of the building and renovate the urban decoration
New class	 Step 1: Demolish the original building	 Step 2: Use a light steel structure to rebuild the original site's original contour	 Step 3: Construction of exterior facade and interior decoration of the building

① Restoration Category: This category includes buildings with a specific historical significance and preserved exterior value. While ensuring functional use, minimal modifications are made to the building's appearance. For example, Building 7A# in the factory area, originally a ship data workshop, has been transformed into a badminton venue. Elements such as the stepped roof panels, exposed structural columns, crane beams, and diagonal bracing were retained, and the interior walls were restored to showcase the texture of red bricks, fully embodying the industrial heritage.

② Integration of Old and New Category: This category involves buildings that no longer have preserved exterior value, where an integration of old and new elements is employed to transform the appearance into a "vintage industrial building" with a sense of history and industrial characteristics. Alternatively, a contrast between old and new elements can be achieved. For example, Buildings 13# and 14# in the factory area, originally engine workshops, have been renovated into exhibition centers and office spaces for growing enterprises. Both buildings preserved the original exposed structural framework, crane beams,

diagonal bracing, ship racks, and tracks, while incorporating new elements such as an indoor steel spiral staircase, replacement of doors and windows, exterior and interior decorative materials, and the addition of skylights. The integration of old and new elements highlights the industrial heritage. Buildings 8# to 12#, which were originally forging workshops, wood warehouses, central warehouses, and compressed air stations, have been transformed into dining facilities. Due to the small scale and low exterior value of the original buildings, the renovation employed an "addition" approach, incorporating elements such as steel, glass, metal louvers, and glass canopies into the facade to create a contrast between solid and void, resulting in a rhythmic effect.

③ New Construction Category: This category involves new buildings that harmonize with the surrounding environment in terms of architectural style and texture.

Fig. 4- 16 Practice of the Guangzhou Cheng'anwei Shipyard Renovation Project
Source: goood Design

4.5.2 Public Participation

The protection of shipbuilding industrial heritage is an important task in cultural heritage preservation, and the involvement of the public plays a vital role in advancing this cause. To promote public participation, first, it is necessary to strengthen public awareness and recognition of the importance of protecting shipbuilding industrial heritage through enhanced publicity and education. Secondly, establishing a volunteer team can attract more members of the public to engage in the preservation of shipbuilding industrial heritage. These volunteers can contribute to the cause through activities such as patrols, conservation work, and cultural events. Additionally, organizing special lectures and exhibitions can deepen public understanding and knowledge of shipbuilding industrial heritage. Establishing interactive platforms where the public can access relevant information, participate in discussions, and provide suggestions can enhance their sense of participation and fulfillment. By implementing these measures, public participation in the preservation of shipbuilding industrial heritage can be effectively promoted, fostering the inheritance and development of cultural heritage.

4.6 Chapter Summary

Based on the previous extraction of the five resilience renewal elements of Guangzhou's shipbuilding industry heritage, this chapter further explores the specific implementation strategies of each element in the renewal process. In terms of historical and cultural resilience, regional integration, strengthening the collision between history and modernity, introducing digital technology, and creating new landmarks can better inherit and continue the shipbuilding industry culture. In terms of functionality and spatial resilience, functions are developing towards a more complex direction, with flexible and varied spatial layout and soft boundary creation, which can maximize the utilization of internal space and resources in buildings. At the ecological landscape level, the self restoration ability of heritage can be greatly enhanced by exploring and utilizing inherent energy reserves, and incorporating restorative landscape elements. In terms of infrastructure, the sustainable operation of the system is maintained through methods such as modular organization and platform control. At the socio-economic level, it is necessary to integrate resources from all sectors of society, coordinate multiple rights and interests, strengthen public participation, etc., in order to promote the protection of the shipbuilding industry heritage. A series of strategies have been proposed to lay the foundation for the application of the following in the updated design practice of Guangzhou Wenchong Shipyard.

Chapter5 Renovation Design Practice of Guangzhou Wenchong Shipyard

5.1Technology roadmap of Wenchong Shipyard's Resilience Renewal

Based on the previous summary of the theoretical research framework of resilient design and the development process and characteristics of Guangzhou's shipbuilding industry heritage, the Technology roadmap of the resilient renewal design of Wenchong Shipyard is constructed (Fig. 5- 1). The current situation of the shipyard is analyzed through active intervention, site element composition, and combination of resilient elements. By summarizing the current characteristics of various industrial elements within the site, it is found that there are five major problems that need to be adjusted appropriately based on resilience theory to guide the protection and renewal of industrial heritage towards growth and development.

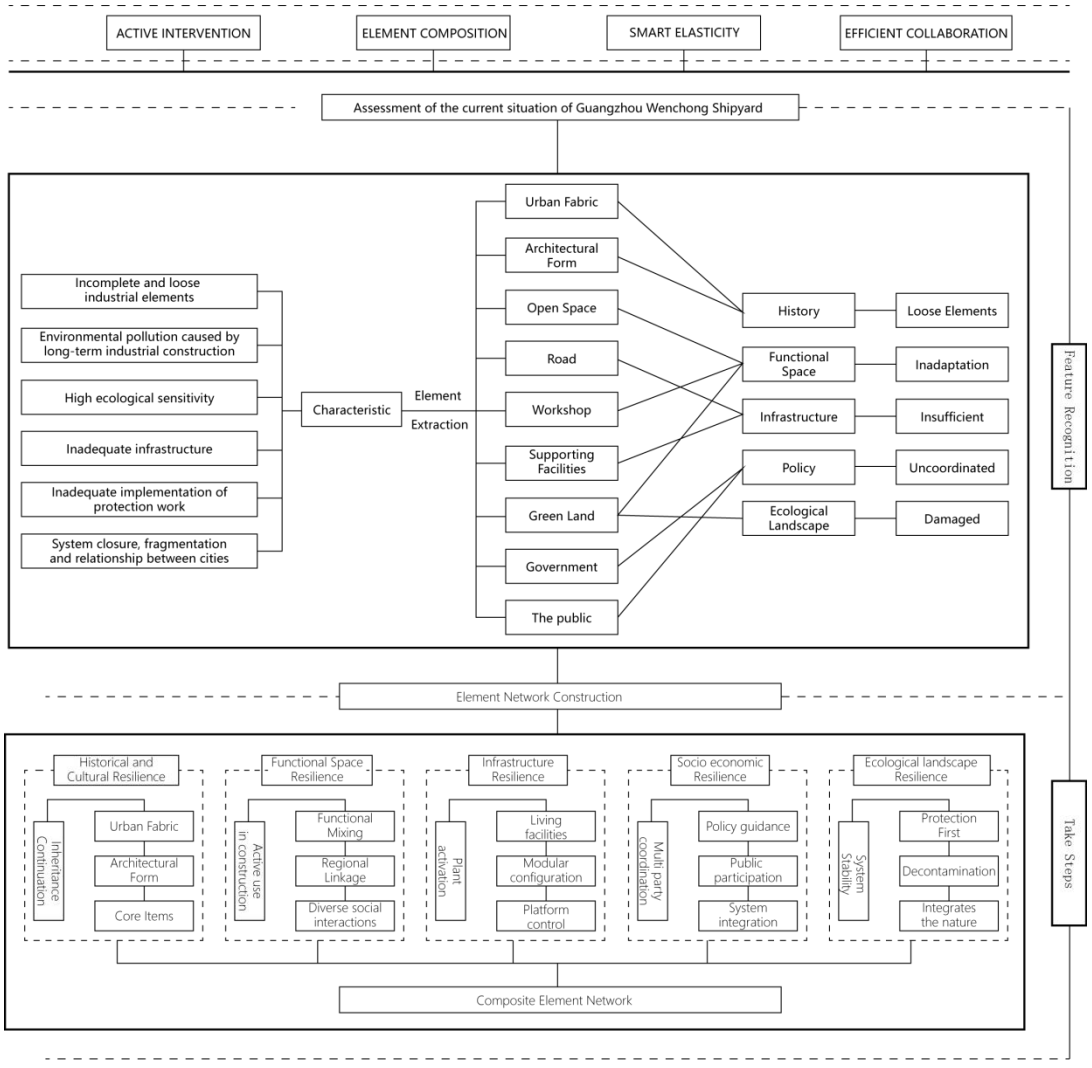


Fig. 5- 1 Technology roadmap of Resilience Renewal Design of Guangzhou Wenchong Shipyard
Source: Author's Self drawn

5.2 Overview and Background Research of Wenchong Shipyard

5.2.1 Historical Overview

Wenchong Shipyard in Guangzhou was established in 1955 and is affiliated with China State Shipbuilding Corporation. Its predecessor was the Guangzhou Ship Repair Yard, a joint venture between the government and private enterprises. Wenchong Shipyard is a ship repair and construction enterprise that was formed by the combination of 61 private small-scale factories through joint ventures, mergers, reorganizations, and transformations. The growth history of Wenchong Shipyard can be roughly divided into three stages: the initial establishment period, the middle growth period, and the reform and opening-up period.

Initial Establishment Period (1955-1962)

In 1952, the Guangdong Provincial Department of Transportation took over the enemy-owned enterprise, Zhonghua Shipyard, and established the Ship Repair Yard of the Provincial Department of Transportation, which was later transferred to the newly established Guangzhou Shipbuilding and Repairing Yard of the Ministry of Transportation in 1954. In January 1955, it was reorganized into the Ship Maintenance Yard of the Pearl River Shipping Administration.

During the "First Five-Year Plan" period, under the leadership of the Guangzhou South District Party Committee, the Guangzhou Ship Repair Yard was officially established on June 1, 1955, based on the Ship Maintenance Yard, with voluntary applications from the capital, asset inventory, and joint venture regulations. It was approved by the Pearl River Shipping Administration of the Ministry of Transportation, registered with the Guangzhou Administration for Industry and Commerce, and placed under the jurisdiction of the Pearl River Shipping Bureau, with six sections, one office, and several workshops and sections. The yard was located at No. 74 South Huadong Road in Guangzhou, while the workshops and yards were scattered in the Henan and Pearl River areas of Guangzhou.

With the approval of the higher authorities, in September 1956, another 54 private small enterprises, including Jingbo Shipyard, South China Shipyard, Guang'an Shipyard, and Xie Xing Shipyard, which were taken over by the Guangzhou Industrial Bureau Machinery Professional Company, were merged with the Shipping Administration Bureau. Thus, the company, Guangzhou Ship Repair Yard, expanded through three batches of mergers,

combining a total of 61 enterprises, including 38 shipyards, 12 machinery factories, 3 boiler factories, 2 foundries, 2 paint factories, as well as 1 welding factory, 1 ironworking factory, 1 model factory, and 1 automobile repair factory. At that time, the yard had 38 machines, 16 dry docks with a maximum load of 100 tons and a minimum of 40 tons, and 5 docks with a maximum load of 1,000 tons and a minimum of 120 tons. It was capable of producing ships powered by steam engines and internal combustion engines within 600 tons, building wooden barges below 300 tons, and boilers below 9.3 meters, making it the cradle of inland waterway shipping in the Pearl River water system.

In September 1958, the factory was officially renamed "Guangdong Provincial Transportation Bureau Guangzhou Shipbuilding and Repairing Yard." Its enterprise nature changed from "joint venture" to "state-owned enterprise," with ship repair as the main focus and the construction of some inland and coastal tugboats and barges. In October 1958, the Guangdong Provincial People's Committee approved the factory's relocation to the Wenchong area of Huangpu, Guangzhou (the current location of the factory) and entrusted the 9th Design Institute of the First Machinery Industry Ministry to conduct overall planning and design.

Construction of the New Plant (1959-1962)

On March 25, 1959, the Guangdong Provincial Planning Commission approved the relocation of the factory, which was carried out in stages. In the short term (two to three years), ship repair should be the main focus, and the dry dock could be expanded to a scale of 15,000 tons. Corresponding ship repair workshops should be built to meet the repair needs of existing inland and coastal passenger and cargo ships, large-tonnage ocean vessels, dredgers, work boats, and some foreign ships. The factory also formulated design tasks based on the principle of "repair as the main focus."

In September 1959, the Guangdong Provincial Transportation Bureau initiated the construction of the new plant in the Wenchong area, located 1.5 kilometers east of Huangpu Port on the north bank of the Pearl River's main channel. The investment was completed that year, with a total investment of 2.73 million yuan, a construction area of 22,558 square meters, an 800-meter-long road network within the factory area, a newly built machinery workshop covering 2,380 square meters, and temporary workshops for woodworking, riveting, etc., covering approximately 6,380 square meters. Additionally, 6 dormitory buildings covering 10,489 square meters were constructed, along with temporary sheds.

In November 1959, to strengthen the centralized construction of the factory, the Guangdong Provincial Transportation Bureau merged its subsidiary Zhanjiang Port Machinery Factory and renamed it the Guangdong Provincial Transportation Bureau Huangpu Shipbuilding and Repairing Yard. The number of employees was 2,402, and the fixed assets amounted to 2.15 million yuan. The establishment of the Wenchong shipyard in Huangpu laid the foundation for it to become the largest ship repair base in South China.

From the late 1950s to the early 1960s, during the process of constructing the new plant, Wenchong Shipyard overcame three years of economic difficulties. It adhered to the policy of "simultaneous construction and production," promoted the entrepreneurial spirit of hard work and self-reliance, and earnestly implemented the national "adjustment, consolidation, enrichment, and improvement" policy. It focused on ship repair whileconcurrently engaging in ship construction. Efforts were made to shorten the ship repair cycle and carry out labor competitions centered around "five stability and five guarantee" and "six excellence," which focused on technological innovation, productivity improvement, and cost savings. The shipyard continuously improved labor productivity, successfully completed ship construction tasks, and achieved remarkable results. For example, it successfully produced the first 150-ton cement ship in South China and built the "Hailin" yacht for Vietnam. It also refurbished the "Xin Hainan" dredger and the "Minben" vessel as temporary docks, successfully repaired the 10,000-ton "Nanhai 141" and "Nanhai 146" vessels, and refitted the 10,000-ton ocean liner "Guanghua." It successfully completed the political task of transporting overseas Chinese from Indonesia back to China. By the end of 1962, the construction of the new plant had temporarily come to a close.

Reform and Opening-Up Period (1979-Present)

After the Third Plenary Session of the Eleventh Central Committee of the Communist Party of China, Wenchong Shipyard in Guangzhou embarked on a path of reform and opening up, entering a new stage of development. During this period, the shipyard adhered to the principles of ship-focused operations, diversified business, domestic market orientation, and global reach. It made efforts to explore new business opportunities, transform its business mechanisms, and undertook extensive work in enterprise management, production and operation, basic construction, technological innovation, and organizational personnel, achieving significant progress. Ship repair, shipbuilding, and non-ship production capabilities have continued to grow, and major advances have been made in various aspects of its work.

Currently, after more than 60 years of development, Wenchong Shipyard has become a modern enterprise under the China State Shipbuilding Corporation, with shipbuilding, port machinery, and large steel structures as its main businesses. It is a major production base for dredging vessels and feeder container ships in China (Fig. 5-2).

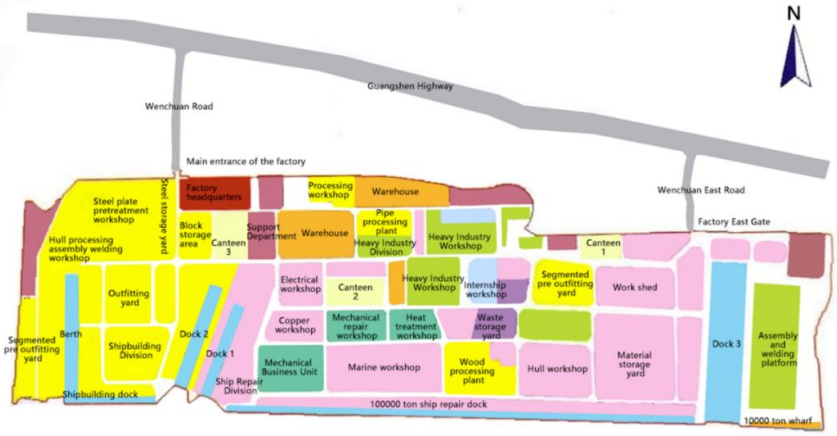


Fig. 5-2 Illustrative Plan of Wenchong Shipyard in the 2000s
Source: Chen Li Research on Guangdong Shipbuilding Industry Heritage [D]. South China University of Technology, 2021. DOI: 10.27151/d.cnki.ghnlu.2021.001614

5.2.2 Location Overview

The Wenchong Shipyard project site is located at No. 1 Wenchuan Road, Hongshan Street, Huangpu District, Guangzhou. It is bordered by Wenchong Creek to the west, Gangqian Road to the north, Guangyu Wharf to the east, and the Pearl River to the south. The land area is approximately 70 hectares. The current urban road network is incomplete, with limited external transportation capacity mainly relying on Wenchuan Road for external connections. The internal road network has low density and many dead-end roads, resulting in poor accessibility. The project site is approximately 500 meters away from Shuanggang Metro Station, providing convenient public transportation options (Fig. 5-3).

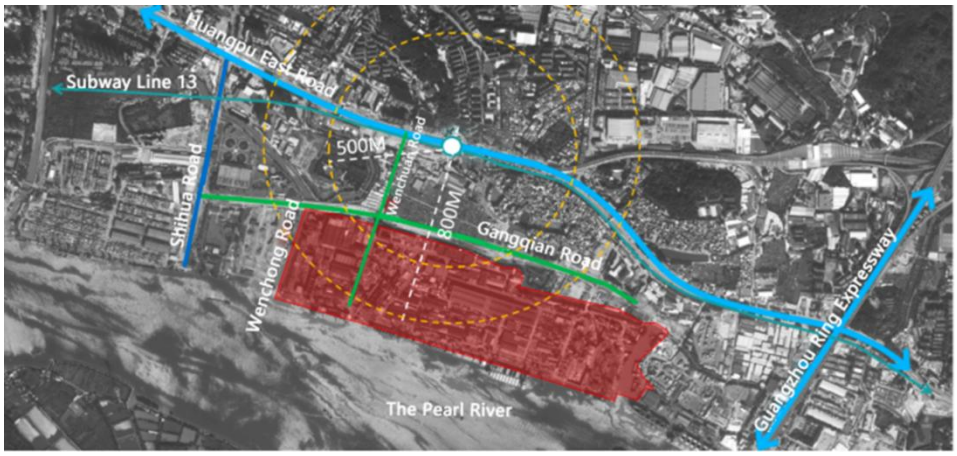


Fig. 5-3 Location Map of Guangzhou Wenchong Shipyard
Source: Guangzhou Urban Planning Survey and Design Institute

5.2.3 Current situation of the site

Due to continuous manufacturing activities over the past 60 years, the industrial structures and buildings within Wenchong Shipyard are relatively well-preserved, with adequate infrastructure. In the "Notice of the Guangzhou Municipal People's Government on the Announcement of the List of Historical and Cultural Buildings in Guangzhou" published on the official website of the Guangzhou Municipal Government on July 14, 2022, Shipyard No. 1 and Shipyard No. 2 of Wenchong Shipyard were designated as the seventh batch of historical buildings in Guangzhou, with the main structural elements of the dry docks being recognized for their core value. In addition, the No. 3 dry dock on the east side, the slipway on the west side, the old warehouse, and the distribution warehouse are also relatively well-preserved. Relevant authorities have conducted assessments of the industrial structures and buildings within the shipyard and have plans for their graded protection as important industrial heritage. In the future, this approximately 70-hectare site will undergo urban renewal design, and the remaining dry docks, gantry cranes, workshops, and other industrial heritage assets require protection and utilization (Fig. 5-4).

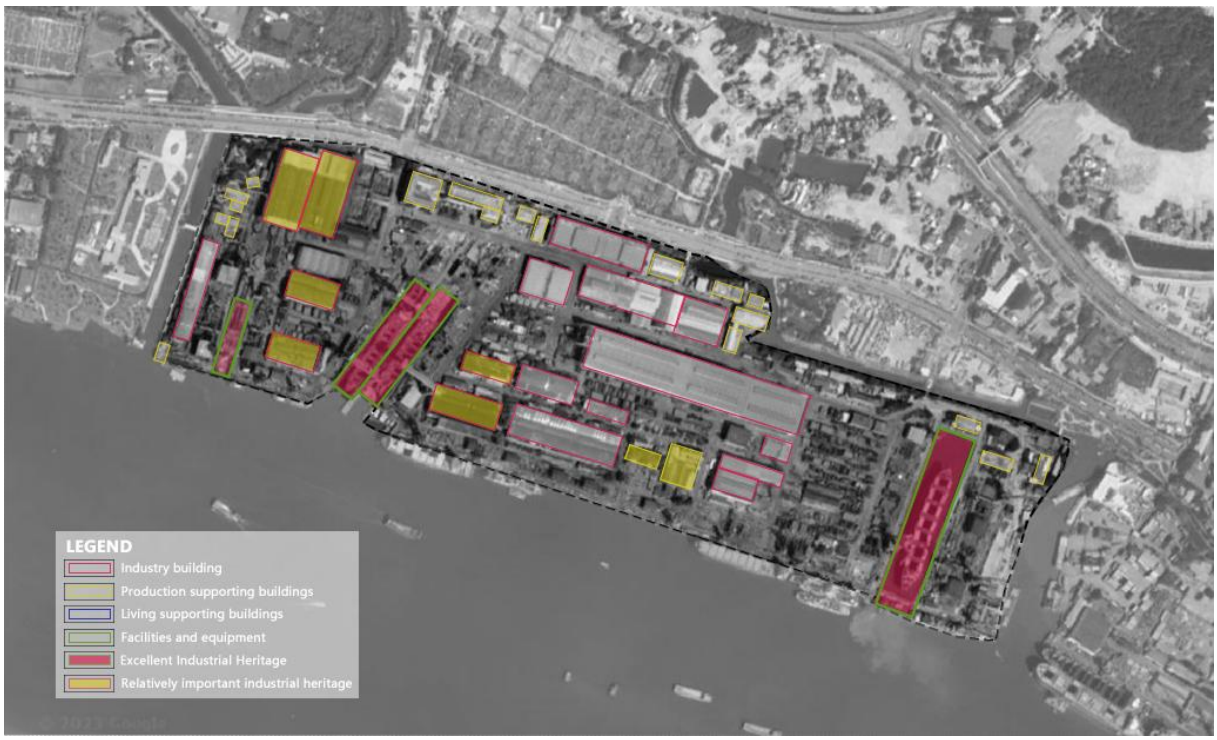


Fig. 5-4 Current Status of Wenchong Shipyard Buildings
Source: Adapted by the author based on 172Chen Li Research on Guangdong Shipbuilding Industry Heritage [D]. South China University of Technology, 2021. DOI: 10.27151/d.cnki.ghnlu.2021.001614

Currently, Wenchong Shipyard has been identified for relocation and renovation. However, the entire shipyard is not completely ceasing operations and relocating; instead, it is a phased process with production and relocation happening simultaneously. The first phase of

relocation began in 2019, with the cessation of production on the designated relocation site and the transfer of related assets. By the end of September 2022, CSSC Huangpu Wenchong Shipbuilding Company Limited completed the relocation project of two S20058K12 200-ton gantry cranes, and the relocation process is still ongoing.

Urban Fabric

The urban fabric is the spatial characteristic formed by the integration and long-term interaction of natural systems that reflect the urban ecology and natural environmental conditions, and artificial systems that embody urban history, tradition, economy, culture, and science and technology. It is a whole constructed by the city, natural environment, and human beings. Wenchong Shipyard is located in the riverside area of Guangzhou, with a unique location and abundant historical and cultural resources. Its proximity to the Pearl River creates a unique riverside landscape, and it is also adjacent to the old city area, connected to the surrounding historical buildings and cultural attractions. From a macro perspective, it can be observed that the urban fabric outside the Wenchong Shipyard area exhibits stronger clustering characteristics, with enclosed or arranged buildings of similar size and relatively small differences. However, within the Wenchong Shipyard area, due to the mixture of old industrial buildings, residential buildings, and office buildings with different functions, the spatial fabric is more chaotic, with buildings arranged in a disorderly manner and significant differences in scale between different types of buildings (Fig. 5- 5).

(a)Urban Texture from a Macro Perspective (b) Urban Fabric within the Factory Area

Fig. 5- 5 Urban Texture
Source: Author's Self drawn

Current Traffic Organization

From a regional transportation perspective, Wenchong Shipyard is located in the south, adjacent to the Pearl River, while the main traffic routes are situated on the north side of the

site, including the presence of a subway line. Regional transportation is relatively developed, and there are convenient connections between the area and the outside world. However, there is a lack of secondary road networks within the area, and the phenomenon of dead-end and cul-de-sac roads exists.

In terms of internal traffic organization within the factory area, similar to other large-scale factories, Wenchong Shipyard has its own independent road system, connected to urban main roads through two entrances and exits. The factory area is divided into different blocks using a grid-like road network. The enclosed road system within the factory area can create a strong sense of belonging, but it also limits the possibility of communication with the outside world (Fig. 5- 6).

Fig. 5- 6 Analysis of Current Traffic Network
Source: Author's Self drawn

Spatial Form Status

① Architectural Form

The existing buildings in Wenchong Shipyard mostly adopt reinforced concrete structures, brick-and-wood structures, and steel structures, with varying quality. There are many production equipment within the factory area, reflecting the typical architectural characteristics of Guangzhou's shipbuilding industry. The buildings are predominantly single-story with large-scale spaces, and the spatial forms are relatively uniform. Buildings with distinctive features and potential for spatial transformation are preserved, while other

buildings such as dormitories and office buildings, which do not have significant industrial characteristics, can be demolished (Fig. 5- 7).

Fig. 5- 7 Photo of Wenchong Shipyard Buildings and Supporting Structures
Source: Aerial Photography

② Open Spaces

Compared to the city, Wenchong Shipyard is in a closed state, and there are no open spaces within the urban context. Therefore, in spatial reconstruction, it is necessary to break the existing boundaries and establish connections between the factory and the surrounding areas through public spaces.

In terms of the factory area, the spatial layout of Wenchong Shipyard is relatively simple. The main external spaces within the factory are the existing material storage yards and production equipment areas, which are primarily designed for industrial production. These spaces have a lower level of humanization and fewer spatial hierarchies, which are not conducive to the development of public activities (Fig. 5- 8).

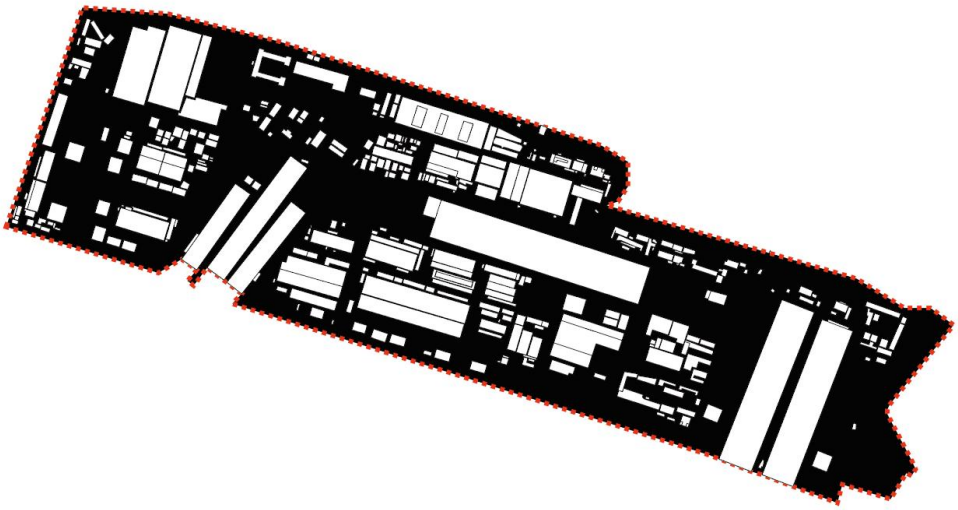


Fig. 5- 8 External Spaces of the Factory Area
Source: Author's Self drawn

Status of Built Structures

As of now, only the 1st and 2nd docks in Wenchong Shipyard have obtained legal protection status in the 7th batch of historical building surveys conducted by the Guangzhou Municipal Government. However, there are still many well-preserved built structures in the factory area that possess the characteristics of shipbuilding industry.

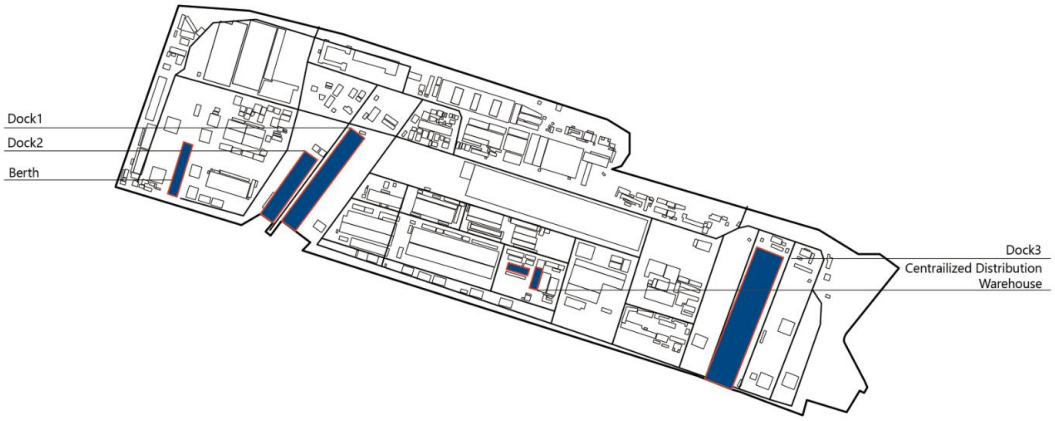
According to the "Huangpu Lingang 15 kilometer Industrial Heritage Park Plan" (under preparation) organized by the Development Zone Development and Research Center, 6 excellent industrial heritages, 7 relatively important industrial heritages, and other existing buildings have been evaluated as general industrial heritages (Fig. 5-9).

(1) Six excellent industrial heritage，including: Dock 1、Dock 2、Dock 3、Shipyard、Old warehouse, and Distribution warehouse.

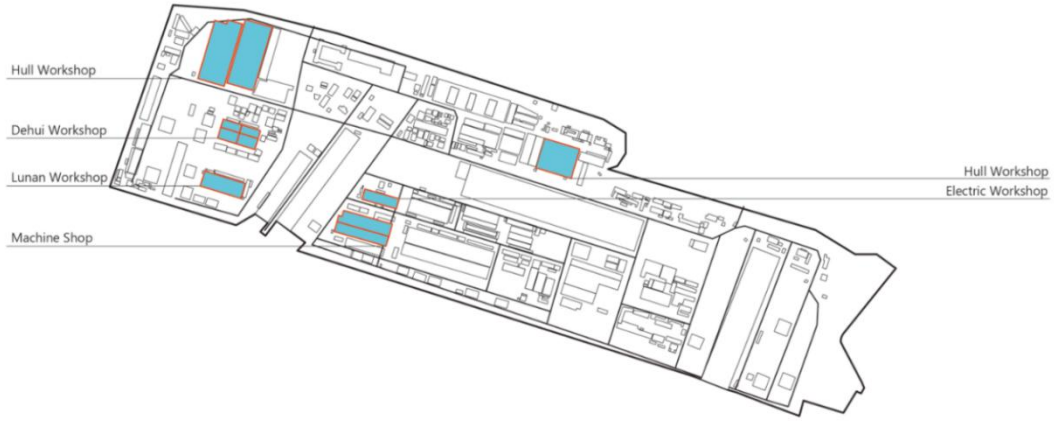
(2) Seven comparatively important industrial heritage, including: Body Shop 1、Body Shop 2、Dehui Workshop、Lun'an Workshop、Forging Workshop、Mechanical Processing Workshop, and Electrical Workshop.

(3) The remaining existing buildings are classified as general industrial heritage.

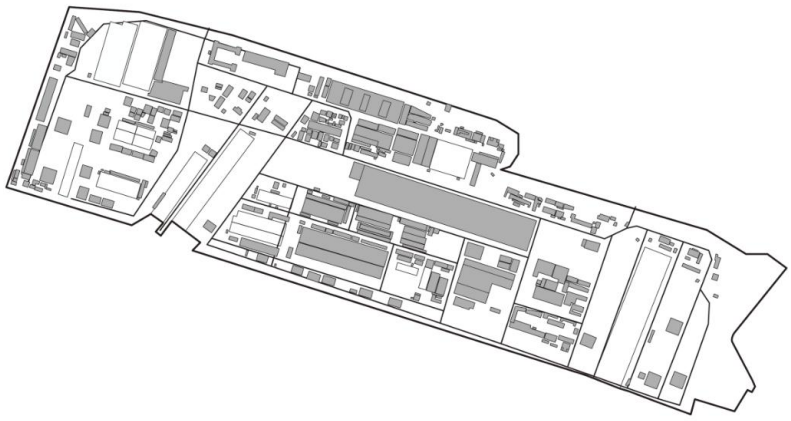
These assessment results have been reviewed and approved by expert consultation and evaluation meetings, and will be further refined as a reference for future preservation. It can be seen that there is a considerable number of core elements with preservation value within the site. By leveraging these well-preserved buildings and structures, the vitality of the urban waterfront area can be greatly enhanced (Fig. 5-10).



（a）Excellent Shipbuilding Industrial Heritage



（b）Comparatively Important Shipbuilding Industrial Heritage

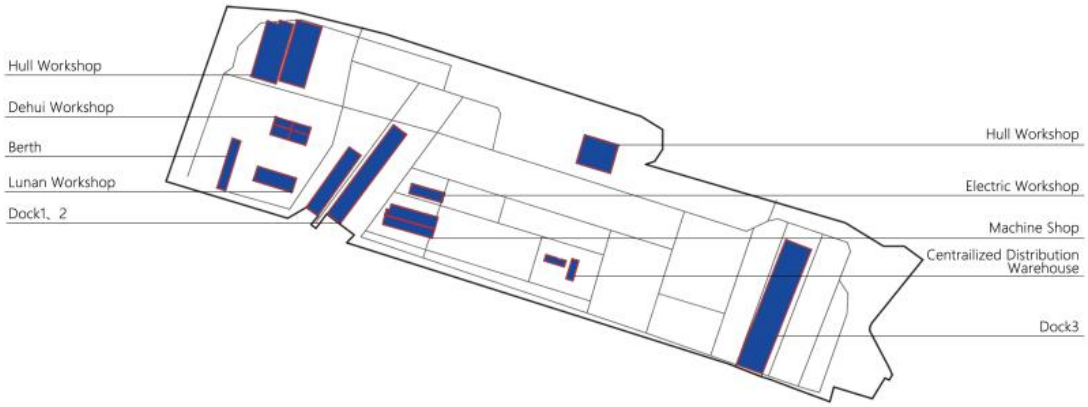


（c）General Shipbuilding Industrial Heritage

Fig. 5- 9 Current status of building evaluation
Source: Author's Self drawn


Welding and assembly of the main section and outfitting of the final stage on land using gantry cranes and coastal gantry pendant lighting equipment
1975
Dock 2
Welding and assembly of the main section and outfitting of the final stage on land using gantry cranes and coastal gantry pendant lighting equipment
1965
Dock 1
Hull space is used for hull assembly operations, welding and making segments of different hulls and parts
1970
Hull Workshop 1, Hull Workshop 2
The workshop is used for small production operations, and pre outfitting of equipment and components is carried out according to the hull sections
1970
Dehui Workshop
The workshop is used for small production operations, and pre outfitting of equipment and components is carried out according to the hull sections
1970
Lunan Workshop
Used for welding sections of different hulls and parts
1980
Hull workshop
Used for material storage
1960
Old warehouse
Used for material storage
1960
Centralized distribution warehouse
Mainly used for processing mechanical equipment, components, etc
1970
Mechanical processing workshop
Mainly used for electrician work, including installation, operation, inspection, etc. of electrical equipment
1970
Electrical workshop
One of the main places for ship repair and construction
1965
building slip
Welding and assembly of the main section and outfitting of the final stage on land using equipment such as gantry cranes and coastal gantry cranes
1995
Dock 3
Used for welding sections of different hulls and parts
1980
Hull workshop

(a)



(b)

Fig. 5- 10 Overview of Industrial Heritage in Wenchong Shipyard
Source: Guangzhou Urban Planning and Survey Design Research Institute

Building Height and Factory Profile Analysis

The building heights within the Wenchong Shipyard are consistent with the surrounding buildings, and the predominant arrangement is parallel. The main workshop within the factory has a height of approximately 30m, while medium-sized buildings have a height of around 15m, and small-sized buildings have a height of approximately 9m. There is not much variation in building heights within the area, and the overall profile in the vertical direction is relatively gentle, without any prominent high points (Fig. 5- 11).

Fig. 5- 11 Building Volume Relationship of Wenchong Shipyard
Source: Author's Self drawn

The building profile is an important indicator of the spatial form within the area and a significant representation of its image. The continuity and undulation of the building profile directly impact the perception of the spatial quality by the residents. From the analysis of the skyline, we can observe that the heights of the façade buildings are similar, resulting in an overall flat profile line (Fig. 5- 12).

Fig. 5- 12 Urban Skyline of the Wenchong Shipyard Area
Source: Author's Self drawn

Ecological Landscape Status

The Wenchong Shipyard area has good natural landscape resources. From a regional perspective, the southern side of the site is adjacent to the Pearl River secondary channel, while the northern side is characterized by large urban green spaces. The eastern and western sides are occupied by urban parks and tributaries of the Pearl River. However, the quality of greening in these areas needs improvement. From an internal perspective of the shipyard, due to long-term industrial construction, there is a lack of green space within the site. Only linear greening is arranged along the banks of the Pearl River tributaries, and there are only a few scattered green areas in other parts of the site. As a result, a complete ecological landscape system has not been formed, and the connection with the urban ecosystem is relatively fragmented (Fig. 5- 13).

Fig. 5- 13 Surrounding Ecological Environment of Wenchong Shipyard (Source: Captured by drones)

5.2.4 Existing Site Issues

Based on the analysis of the current situation of Guangzhou Wenchong Shipyard's site in the previous text, Wenchong Shipyard is in the initial development stage, and the relationship between various resource elements within the site is relatively loose (Fig. 5- 14). The pressure resistance and self repair ability of the social ecological system are poor. Based on the analysis of the current state of the Wenchong Shipyard site, the following main issues can be summarized:

1) Chaotic spatial organization and significant differences in building volumes, lacking a clear arrangement order.
2) Closed regional transportation, with a lack of secondary road networks outside the factory area and a closed internal road network that hinders external communication possibilities.
3) Monotonous spatial form, lacking permeability between internal and external spaces and variations in volume, resulting in an overall uninteresting spatial environment.
4) Uneven building quality, with only a few buildings displaying typical characteristics of shipbuilding industrial architecture, while others lack distinct industrial features.
5) Ecological sensitivity, with severe environmental pollution within the site and a lack of complete ecological systems.
6) Single function, with the existing functions primarily focused on industrial construction and a limited number of supporting facilities, lacking emerging industries.

Therefore, when applying the Resilience theory to guide the industrial heritage renovation of Wenchong Shipyard, a series of measures need to be taken to address the existing issues both inside and outside the factory area. The proposed plan, based on the strategic framework of Resilience theory applied to shipbuilding industrial heritage outlined in Chapter 4, will involve urban design practice for Wenchong Shipyard.

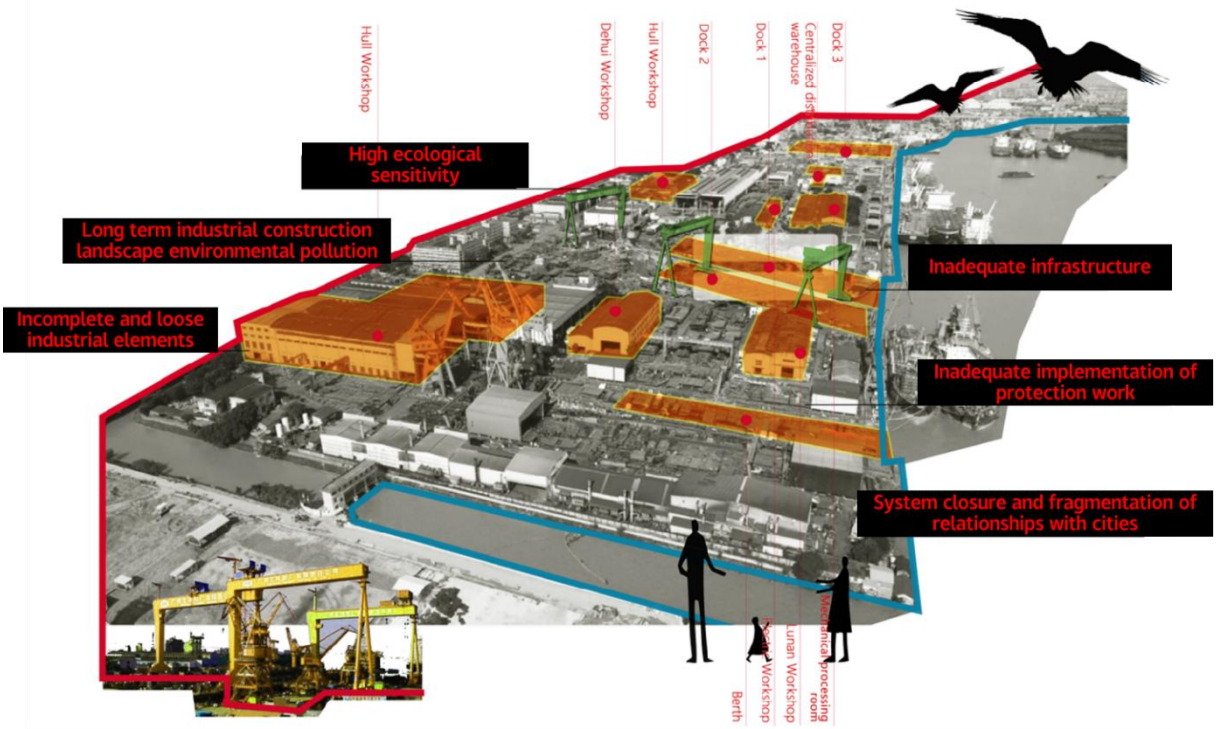


Fig. 5- 14 Current Status and Existing Issues of Wenchong Shipyard
Source: Author's Self drawn

5.3 The Potential of Resilience Design for Wenchong Shipyard

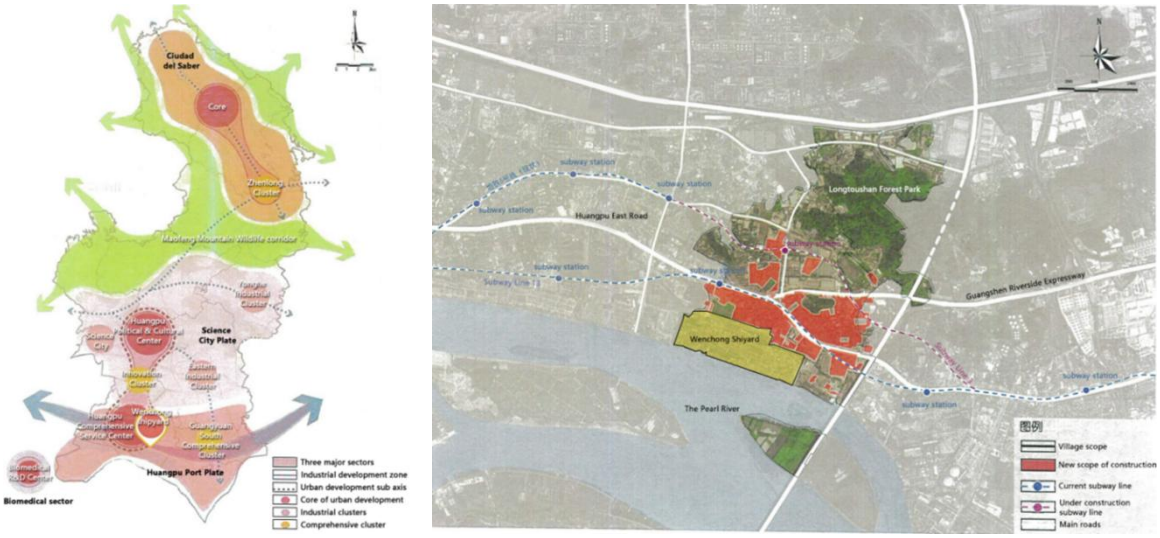
Wenchong Shipyard is located at the southern end of Huangpu District in Guangzhou, at the eastern end of the Pearl River channel. It is situated within the Huangpu Port Economic Zone and the second central business district of Guangzhou. As a transition point between the internal and external channels of the Pearl River and a water gateway of Guangzhou, it enjoys excellent geographical location and enormous development potential.

5.3.1 Upper level planning

According to relevant upper level planning, the main direction for the transformation and upgrading of Wenchong Shipyard's waterfront industrial area is to "retreat from two and advance to three," develop a high-quality marine economy demonstration zone, and promote the development of green technology and green industries. Additionally, the development of industries such as ports, headquarters economy, shipping culture, and cruise tourism in the shipyard area is encouraged to facilitate the construction of the economic belt along the river and drive economic growth in the hinterland.

Establishing a new trade and innovation center serving Hong Kong and Macau

In January 2021, the Urban Renewal Bureau of Huangpu Development Zone in Guangzhou solicited public opinions on the overall plan for urban renewal of Huangpu District, Guangzhou Development Zone (2020-2035). The plan proposes the overall positioning of building a world knowledge city, a bay area innovation source, and an international talent port in Huangpu District, and comprehensively enhancing the overall strength, industrial development momentum, and livability vitality of Huangpu District through urban renewal. The plan outlines the spatial layout structure of "One Belt, Four Zones, Four Centers," with Wenchong Shipyard located within the modern service innovation zone of the Huangpu Port Greater Bay Area. This area, centered around the Huangpu Comprehensive Service Center, connects the Guangyuan South Integrated Group, the West Zone Industrial Group, the Linjiang Economic Zone, and Changzhou Island development clusters, aiming to establish a new trade and innovation center serving Hong Kong and Macau (Fig. 5- 15).

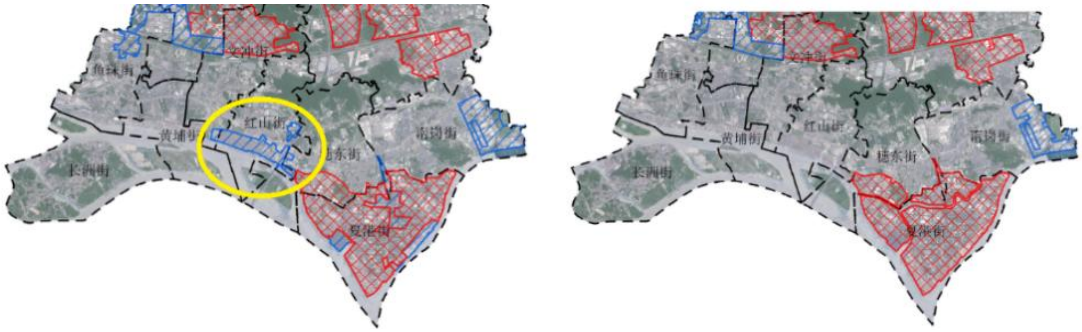


a) Macro Location Map (b) Mesoscopic Location Map

Fig. 5- 15 Overall Location Map of Guangzhou Development Zone Urban Renewal Master Plan
Source: Adapted by the author based on the "Shuangsha Old Village Renovation Project Implementation Plan (Area Planning)

Wenchong Shipyard will no longer be designated as industrial land.

On November 24, 2022, the Industry and Information Technology Bureau of Huangpu District, Guangzhou City, announced the "Adjustment of Industrial Blocks in Huangpu District", which classified the industrial blocks in Guangzhou City into primary and secondary control lines. There will no longer be control lines or industrial land within the Wenchuan factory area. (Fig. 5- 16).



(a)Current industrial land blocks (b) Adjustment of industrial land blocks

Fig. 5- 16 Industrial Zone Adjustment
Source: Industrial and Information Technology Bureau of Huangpu District, Guangzhou

5.3.2 Socio-economic Potential

As early as 2019, the southern adjustment plan for the Huangpu Port Economic Zone showed that the Wenchong Shipyard plot had been adjusted from industrial land to commercial and commercial land. The strategic positioning of Wenchong Shipyard Plot Project in the Comprehensive Strategic Cooperation Series Project Planning between Poly Real Estate and Zhigang Think Tank released on the official website of Zhigang Think Tank in February 2020 is described as: to make Wenchong Shipyard Reconstruction Project a benchmark and super destination for Guangzhou to build a national marine industry and marine culture experience, and integrate industry and city development, and become a mold project for Guangzhou to drive urban renewal with cultural renaissance (Fig. 5- 17).

(a) Master Plan (b) Cultural Paths

Fig. 5- 17 Master Plan and Cultural Paths of the Huangpu Lingang Economic Zone South Area
Source: https://mp.weixin.qq.com/s/mwY1DEuGTONY5vFtoIKv_A

5.3.3 Historical and Cultural Potential

Guangzhou Wenchong Shipyard witnessed the rapid development of the shipbuilding industry during the New China era due to socialist transformation. There are a large number of buildings and structures and shipbuilding equipment with the characteristics of shipbuilding industry in the site. For example, the 15000 ton dry dock built in 1963 is the first 10000 ton dry dock designed by China in South China, which is of pioneering significance nationwide.

In addition, the structures used in buildings built during different periods also vary greatly, and preserving these typical buildings can fully showcase the temporal context of the shipbuilding industry. The old warehouse established in the 1960s adopted a brick and wood structure. The hull workshop, Dehui workshop, wheel safety workshop, mechanical processing workshop, and electrical workshop established in the 1970s adopt reinforced concrete structures; The hull workshop built in 2008 adopts steel structures, etc (Fig. 5- 18).

(a) Docks 1 and 2

(b) Old warehouse built in the 1960s

(c)Shipbody workshop built in the 1970s

(d) Shipbody workshop built in 2008

Fig. 5- 18 Industrial buildings constructed in different periods within Wenchong Shipyard
Source: Aerial photography

5.3.4 Waste Recycling Potential

Due to the continuous expansion and improvement of production facilities at the Wenchong Shipyard over the past 60 years, the construction materials often have value for recycling. The project site contains several material yards and warehouses for steel, wood, and other materials, and the buildings are mainly composed of steel frames, concrete, and bricks (Fig. 5- 19). The existing or demolished decorative asphalt, old concrete, recycled bricks, rusty metal, rough pavement materials, as well as abundant dismantling residues, can all be used as raw materials for new construction or industrial landscapes. This not only reduces the initial construction costs but also greatly stimulates the unique memories of the shipyard industry on the site.

Fig. 5- 19 Multiple material yards and structures within Wenchong Shipyard
Source: Aerial drone photography

5.3.5 Ecological Landscape Potential

According to the upper level planning, large parks and green spaces are planned around the Wenchong Shipyard site. Several industrial heritage parks and waterfront wetland parks are planned for the riverside plots on the east side, extending to the Huangpu Bridge. Not far to the east lies the Nanhai Temple-Nanwan Fuxu Canal Scenic Area, which incorporates shipbuilding silk road cultural elements. Once the transformation of this area is completed, it will provide ample recreational space for the public. Additionally, plans are in place to shape distinctive waterfront areas along the Pearl River. Among them, the Huangpu waterfront has a length of approximately 43 kilometers and is designated as the central business district of Huangpu Port and the eastern modern service center. Two cultural paths are planned: the Changzhou Island Revolutionary Cultural Path and the Huangpu Ancient Port-Nanhai Temple Shipbuilding Silk Road Cultural Path.

5.4 Design Vision

Guangzhou Wenchong Shipyard has been continuously producing and manufacturing for over 60 years. The buildings with shipbuilding characteristics within its factory area are relatively well preserved, reflecting the temporal development of modern shipbuilding industry and possessing significant historical and cultural value. And its geographical location is superior, and the surrounding ecological landscape of the site is relatively rich, with huge socio-economic and regional ecological landscape potential. However, due to long-term industrial construction, the current situation of the site is relatively chaotic and ecologically sensitive. Therefore, the author attempts to apply resilience design theory and incorporate future uncertainty factors into the design system in the early stages of the plan. Starting from five aspects: historical culture, functional space, ecological landscape, infrastructure, and socio-economic factors, the author aims to reshape the value of the shipyard and enhance the ability of the area to resist external environmental changes.

This plan is based on the shipping history of Huangpu Old Port and the future development trend of the area. The Wenchong Shipyard area is positioned as a modern port new city that integrates industrial sites, commerce, international scientific and technological innovation, marine economic industrial park, and ecological park. Using the Marine Economic Industrial Park and Memory Factory area as engines, we aim to diversify the development of urban smart innovation economy, cultural tourism economy, leisure business, and mass service industry economy, and incorporate considerations for future cities, comprehensive transportation, and resilience renewal into the overall planning. Guided by ecological planning, diversified transportation interconnection, and creating a comprehensive slow moving system; With the goal of inheriting the industrial spirit, preserving, transforming, and activating industrial heritage, and continuing historical memories; Prioritizing public interests, improving policy and regulatory management, promoting public participation, and strengthening awareness of heritage values. The ultimate goal is to maximize the value of the heritage area, explore and utilize the inherent energy resources, and enhance the restoration and sustainable development of the site (Fig. 5-20).

Fig. 5- 20 Design Vision (Source: Author's Self drawn)

5.5 Overall Planning and Design

5.5.1 Overall Design

Urban design, as a "public policy," has gradually evolved towards interdisciplinary fields that emphasize multi-dimensional collaboration. It advocates extracting, integrating, and reconstructing complex elements and their relationships within a site through systematic and holistic thinking.

This project adopts a multidimensional perspective and embraces the design concept of "the fusion of the past and present." It focuses on the study of resilience renewal models for industrial heritage, the creation of waterfront public spaces, and the design of street spaces. The site is divided into five major functional zones, and based on Guangzhou's "Industrial Cultural Tourism Heritage Retrieval" path planning, three secondary industrial heritage retrieval paths are designed within the site to activate the heritage area from the aspects of historical and cultural significance, socio-economics, and public participation. The core area's landscape design focuses on the south-side waterfront promenade and permeable waterfront

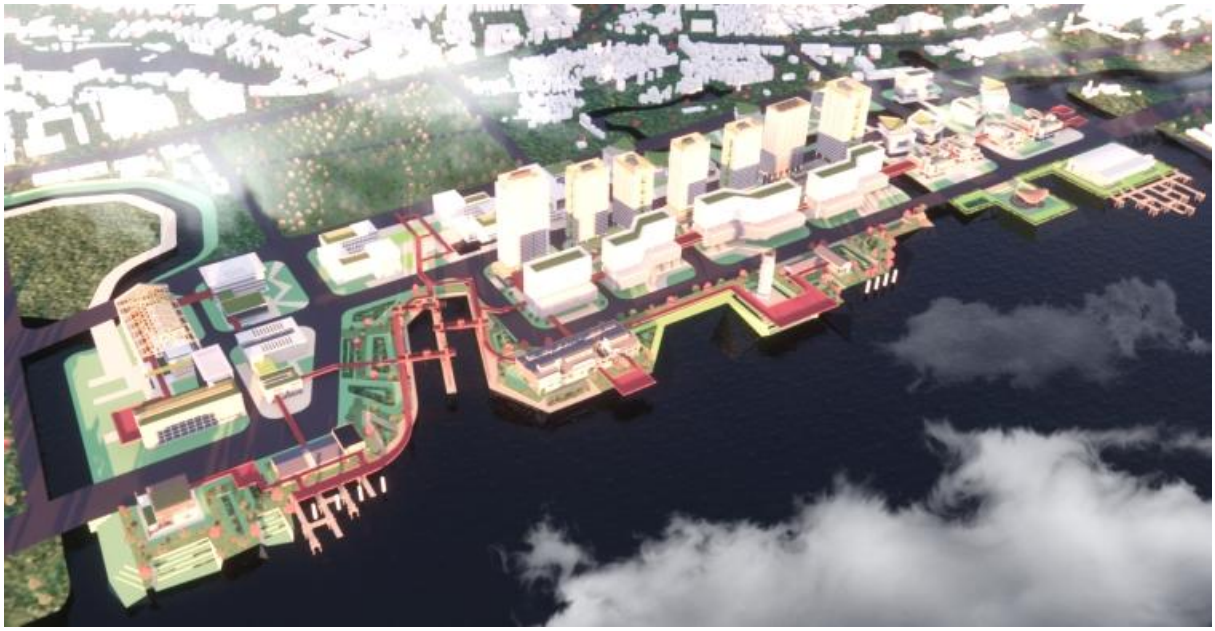
landscape on the east side, while four radial landscape axes radiate towards the site, enhancing the site's permeability and connecting it to the city's green veins (Fig. 5-21).

Regarding industrial heritage renewal and protection, the plan considers the assessment of important industrial buildings and structures within the Wenchong Shipyard by relevant departments and proposes three renovation measures: complete preservation, partial transformation, and demolition and reconstruction. The No. 1 and No. 2 dry docks and gantry crane within the site are fully preserved. Partial upgrades and transformations are conducted for the hull workshop, Dehui workshop, Luo'an workshop, machinery processing workshop, distribution warehouse, as well as the No. 3 dry dock and slipway, while buildings with low conservation value and disorderliness are demolished and reconstructed.

In terms of ecological landscape, efforts are made to establish and restore a complete ecological landscape system, connecting urban green veins and enhancing the vitality of the urban waterfront area through the incorporation of restoration elements and the creation of diverse landscape nodes (Fig. 5-22).

Fig. 5-21 Master Plan
Source: Author's Self drawn

(a)



(b)

Fig. 5- 22 Rendered bird's-eye view
Source: Author's Self drawn

5.5.2 Planning Structure

The planning structure of this proposal follows the concept of "Three Paths, Four Axes, and Five Zones. (Fig. 5-23)"

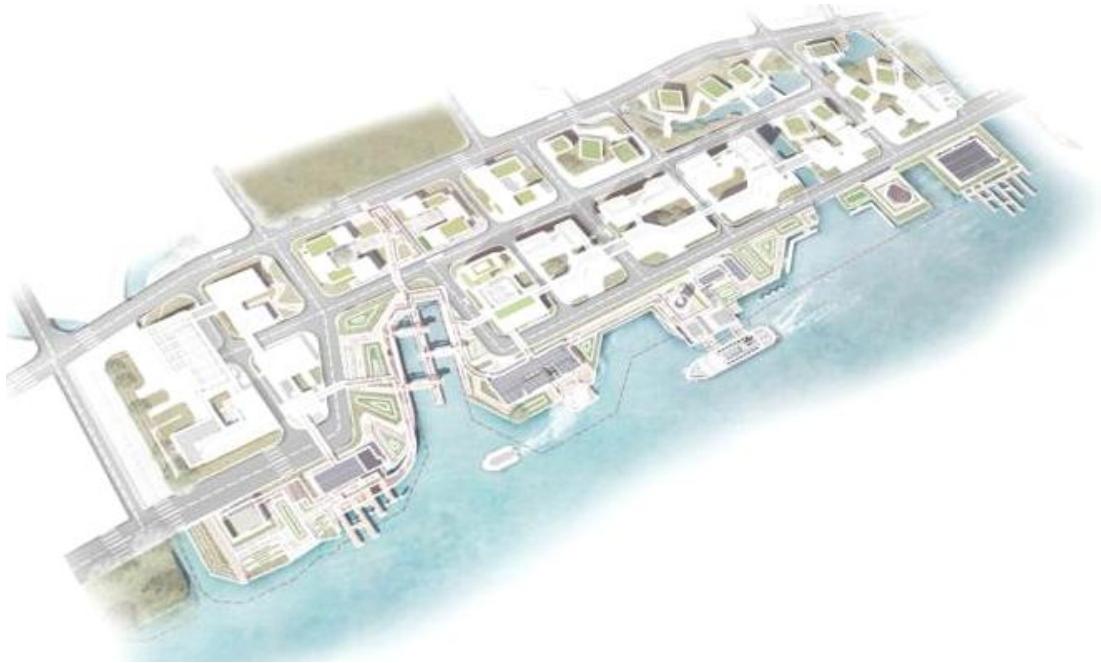
"Three Paths" refer to the secondary pedestrian paths planned based on Guangzhou's "Industrial Cultural Tourism Heritage Retrieval" path, namely the Memory Workshop Path, Waterfront Vitality Landscape Path, and International Science & Tech Innovation Path.

"Four Axes" represent the four radial landscape axes that continue the existing green axes of the site, integrating with the landscape to create visual corridors, connecting the urban green veins and radiating towards the project site and both sides of the Pearl River.

"Five Zones" divide the site into five major functional zones based on Guangzhou's future development plan: the Memory Workshop Area (Zone A), Commercial Complex Area (Zone B), Science & Tech Innovation Area (Zone C), Marine Economic Industrial Park (Zone D), and Waterfront Vitality Area (Zone E). The zones are differentiated through variations in spatial forms and scales, creating diverse spatial nodes and incorporating various forms of grey spaces to enhance spatial interest while softening the boundaries between zones.

(a) Planning Structure Diagram

(b) Industrial Cultural Tourism Heritage Retrieval Path Diagram

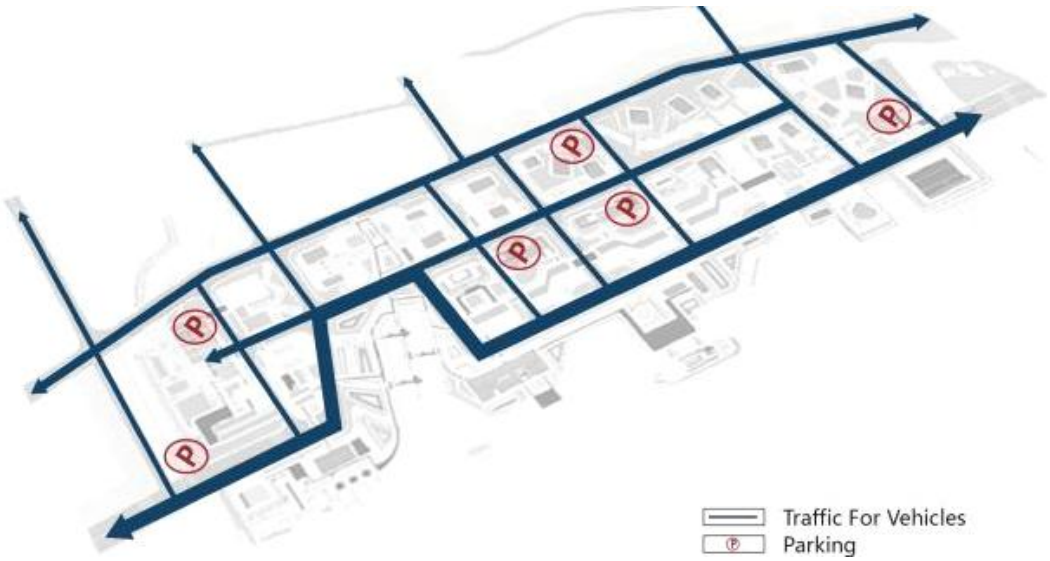


(c) Ecological Landscape Structure

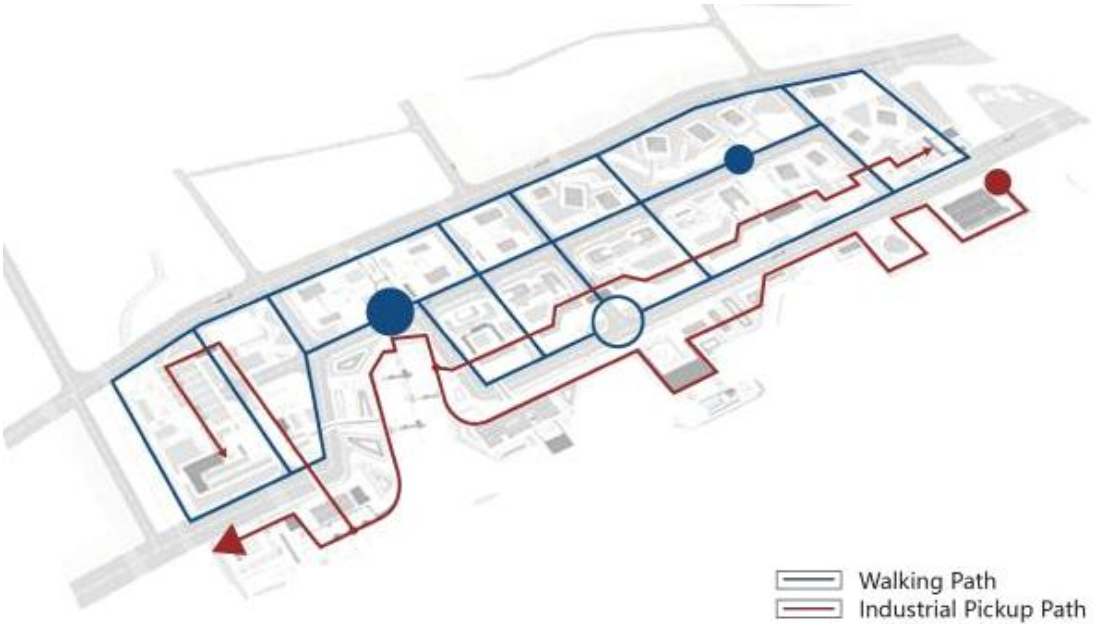
Fig. 5- 23 Planning Structure Diagram (Source: Author's Self drawn)

5.5.3 Traffic Analysis

The site incorporates a diverse and integrated public transportation system, unlike traditional wide single-vehicle roads. It establishes a multi-level public transportation and slow travel system within the site, aiming to enhance accessibility and meet the needs of low-carbon urban travel. Three waterfront pedestrian systems are integrated into the site, taking advantage of the preserved industrial buildings and structures, thus maximizing the utilization of the site's landscape elements (Fig. 5- 24).



(a)Vehicular Traffic Structure Diagram



(b) Pedestrian Path Diagram

Fig. 5- 24 Traffic Structure Diagram (Source: Author's Self drawn)

5.5.4 Functional Zoning

According to the higher-level planning, Wenchong Shipyard is located within the Modern Service Innovation Zone of the Huangpu Port Greater Bay Area. The functional positioning of the site is to become a benchmark and super destination for the integration of national-level marine industry and marine cultural experiences with urban development. Therefore, considering the surrounding environment and urban development needs, the proposal divides the site into five major functional zones (Fig. 5- 25):

1) Memory Workshop Area: It includes exhibition spaces, an industrial art gallery (transformed from the hull workshop), and a cultural and creative market (transformed from the Dehui workshop).
2) Commercial Complex Area: It comprises commercial mixed-use buildings as well as urban squares and green spaces.
3) Science & Tech Innovation Area: The mid-rise buildings along the waterfront are dedicated to independent office headquarters, while the high-rise buildings serve as an international science and technology innovation center, corporate office buildings, and a hub for technological innovation.
4) Marine Economic Industrial Park: It includes a Future Valley, marine economic headquarters, a conference center, and a marine economic industrial park.
5) Waterfront Vitality Area: It features unique ship-themed restaurants (transformed from the Luo'an workshop), a gantry crane (transformed from the No. 1 and No. 2 dry docks), a yacht service center (transformed from the machinery processing workshop), a waiting hall (transformed from the distribution warehouse), as well as landscape elements such as an observation tower and a waterfront viewing platform.

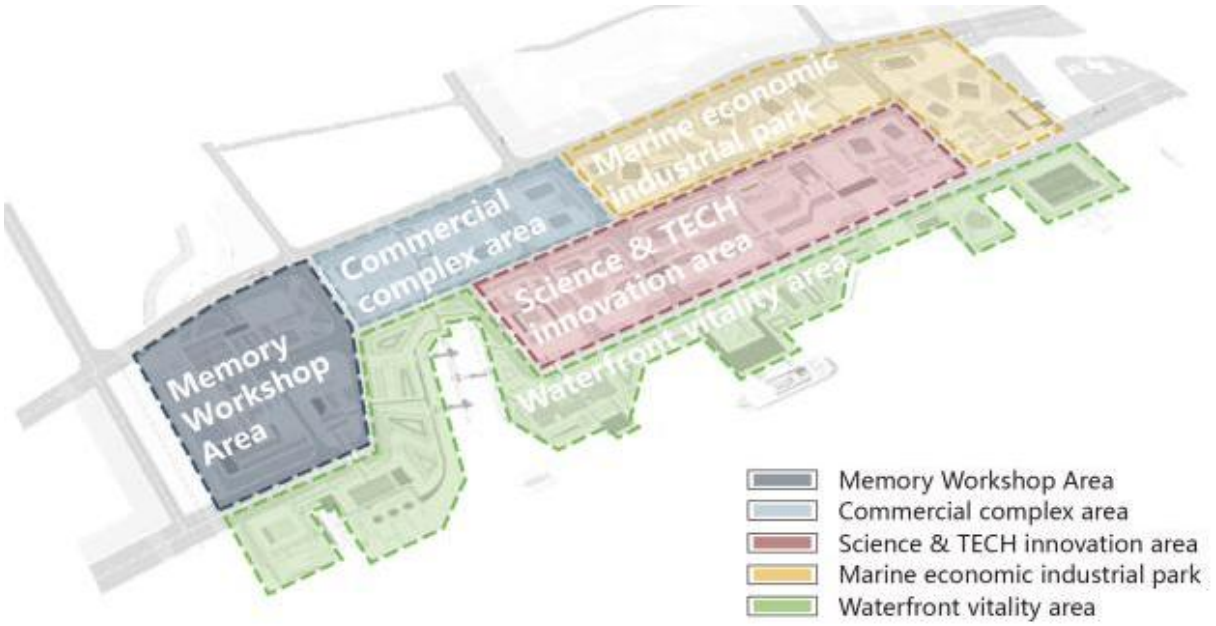


Fig. 5- 25 Functional Zoning (Source: Author's Self drawn)

5.5.5 Heritage Preservation Status

In terms of industrial heritage renewal and protection, according to the evaluation of important industrial buildings and structures in Wenchong Shipyard by relevant departments, the plan has carried out three renovation measures: complete preservation, partial renovation, and demolition and reconstruction (Fig. 5-26).

The No.1 and No.2 docks and gantry cranes on the site have been fully preserved, and partial upgrades and renovations have been carried out on the hull workshop, Dehui workshop, ship safety workshop, mechanical processing workshop, distribution warehouse, as well as the No.3 dock and shipway. Buildings that are messy and lack protection value on the site have been demolished and rebuilt.

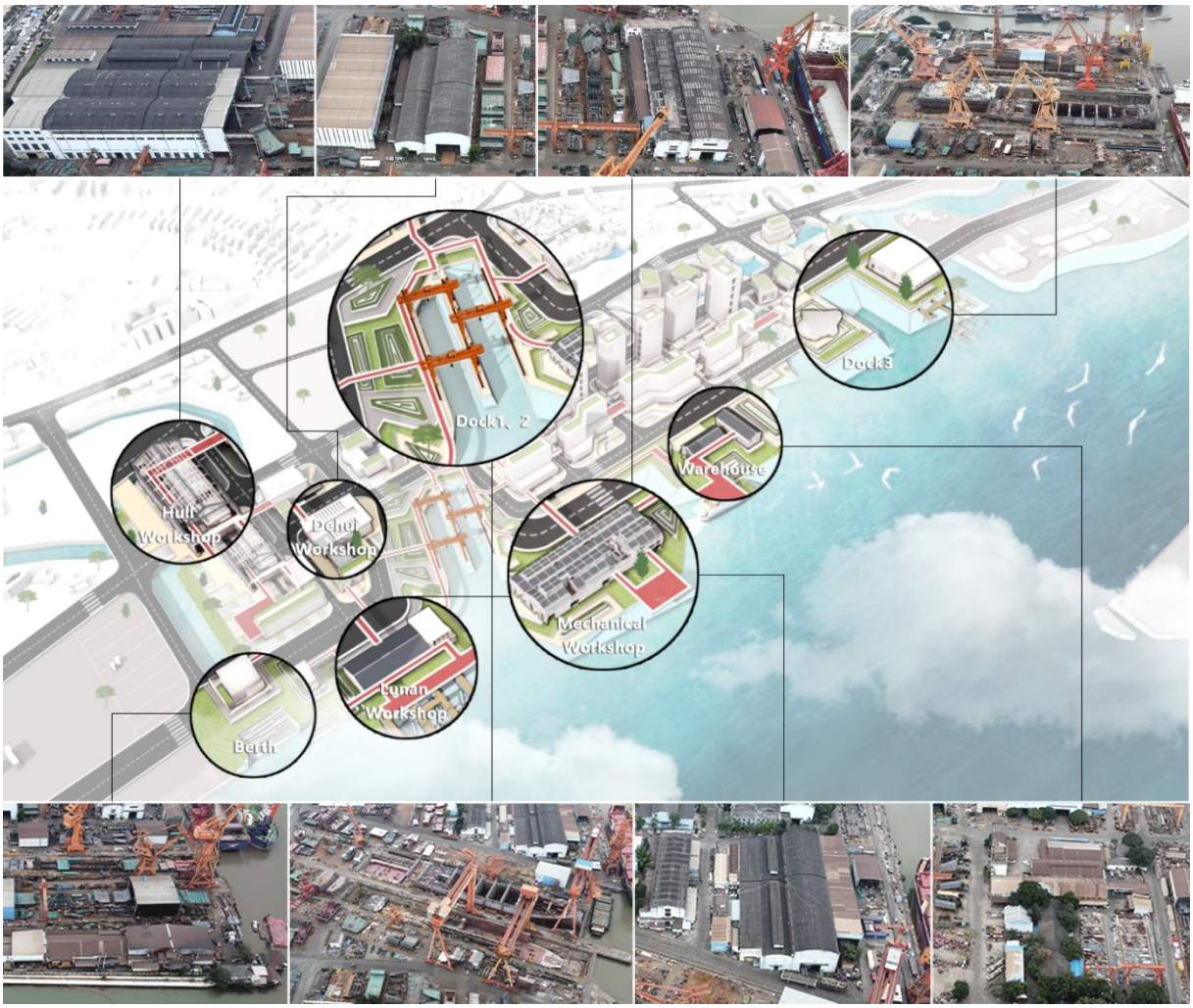


Fig. 5-26 Preserved Industrial Heritage Nodes
Source: Author's Self drawn

5.6 Application of Resilience Design Concept in the Project

5.6.1 Cultural Resilience

In terms of cultural resilience, the site's resources are integrated to enhance connectivity among different resources within the system, allowing the aggregation of resources in various areas of the site. Modern materials and structures are used to create a contrast between the old and the new. Digital technologies are employed to showcase the shipbuilding industry culture, and the existing large-scale hydraulic equipment on the site can be utilized to create new urban landmarks or incorporate new iconic buildings and structures, thereby enhancing the historical and cultural resilience of the site from multiple perspectives. This approach facilitates the inheritance and continuation of the shipbuilding industry culture.

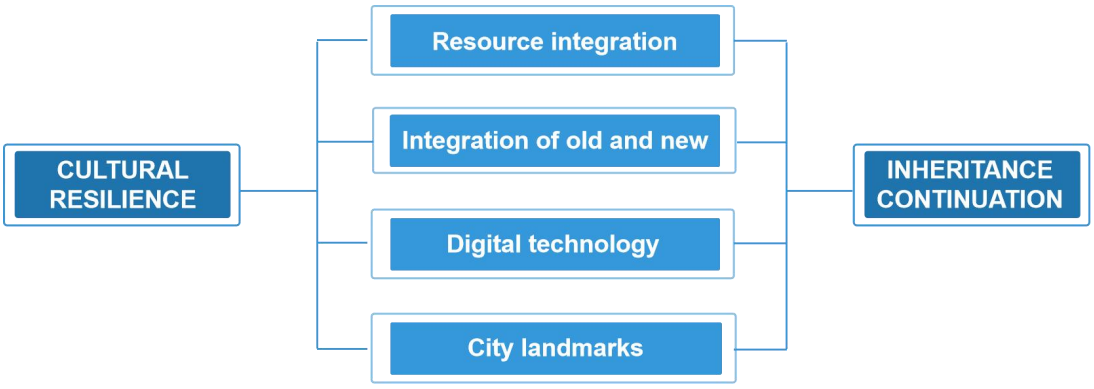


Fig. 5-27 Role of Cultural Elements in Enhancing System resilience
Source: Author's Self drawn

Integration of Heritage Area Resources and Restructuring of Site Fabric

Due to the diverse elements within Wenchong Shipyard, it is necessary to integrate and modify the elements on the site. Relying on the urban waterfront public spaces, a complete road transportation system and public space system are established, connecting various key elements of the site in a networked manner to activate the heritage area (Fig. 5-28). Based on the analysis of building conservation grades mentioned earlier, important and well-preserved buildings and industrial facilities on the site are protected and appropriately renovated. Partial transformations are conducted for significant industrial buildings, while buildings and structures with low conservation value are removed, and their architectural components and materials are reused to create new uses within the site. The main roads on the site are preserved, and roads connecting to the urban hinterland are opened up to integrate the public transportation system with Guangzhou's industrial heritage retrieval path, linking the industrial heritage areas in Guangzhou.

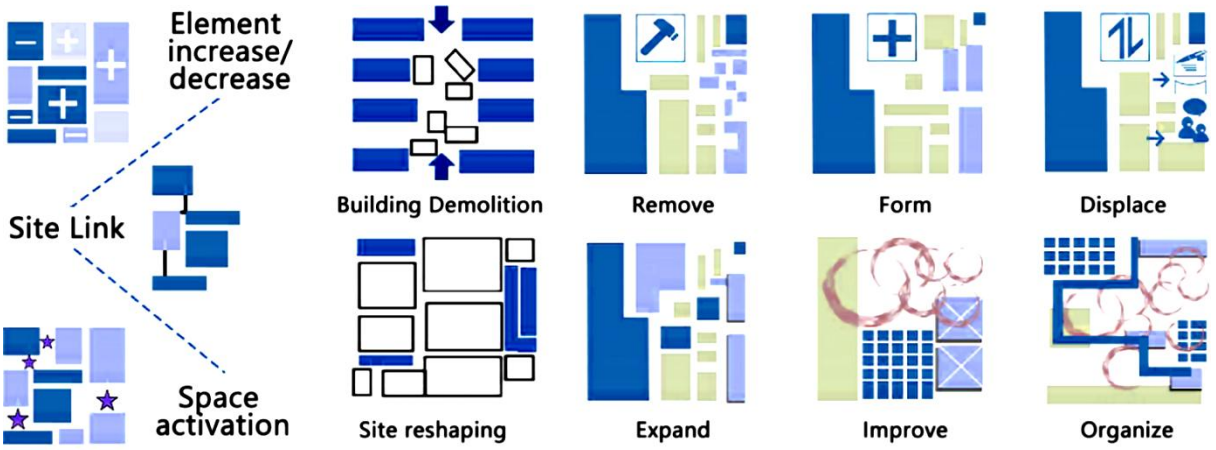
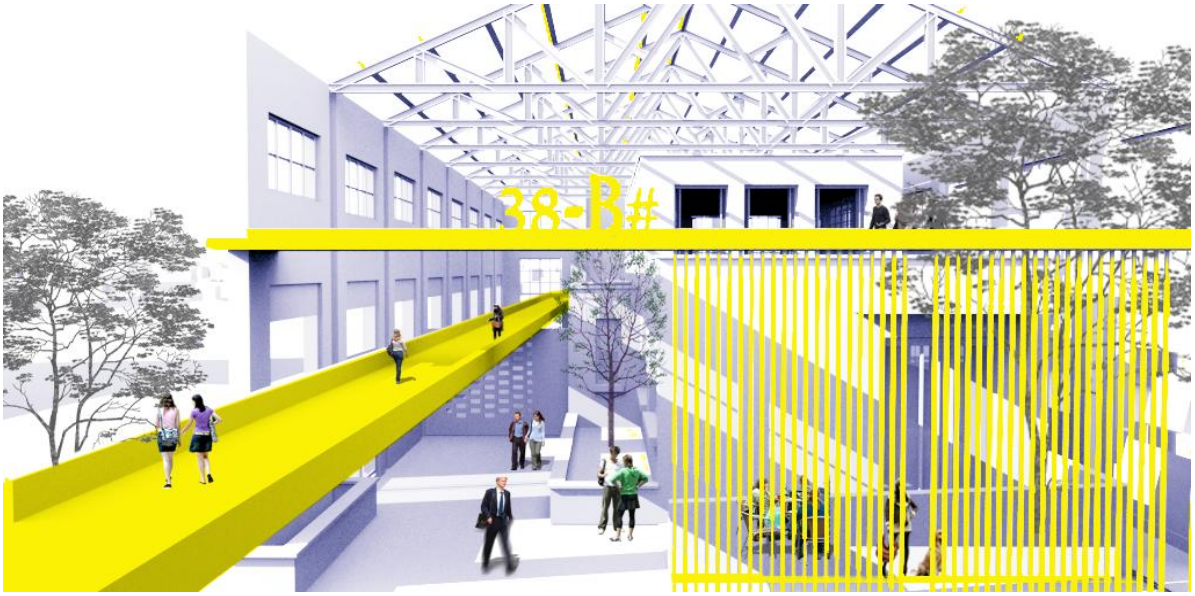


Fig. 5- 28 Principles of Integration of Heritage Area Resources
Source: Author's Self drawn

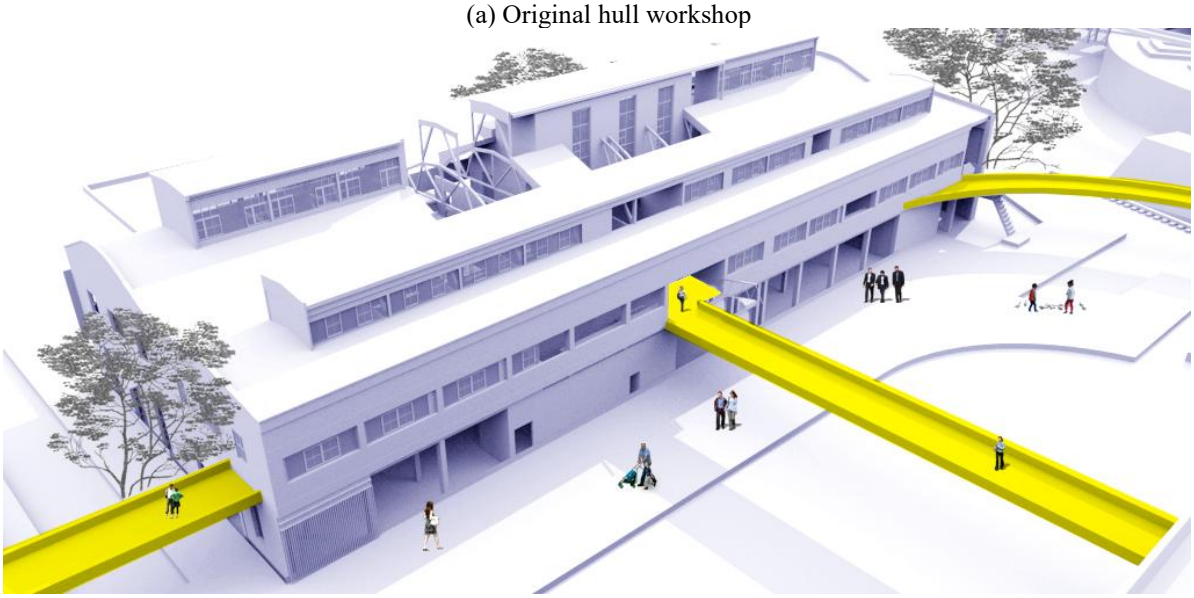
Integration of Old and New

Within the Wenchong Shipyard, there are multiple buildings constructed during different periods, representing the characteristics of different stages of shipbuilding industry heritage. Therefore, combining the old elements of the original buildings with updated new elements can better showcase the span of time and exhibit the shipbuilding industry culture. This is mainly reflected in the proposal through: ①Exposed structures； ②Clear differentiation of materials； ③Preservation of the scale of industrial buildings and iconic components; ④ Preservation of building structures while revitalizing Functional and Spatial (Fig. 5- 29).

Fig. 5- 29 Integration of Old and New in Architecture
Source: Author's Self drawn



(a) Original hull workshop



(b) Original mechanical processing workshop

(c) Original centralized distribution warehouse

Fig. 5- 30 Renderings of the relationship between some new and old buildings (Source: Author's Self drawn)

Integration of Digital Technology

Combining shipbuilding industry heritage with modern digital technology can create more sustainable and diverse heritage conservation and cultural exhibition solutions, which will also play a significant role in the operational mode of enterprises within the park. In this urban design proposal, the exhibition spaces will showcase the shipbuilding industry culture of Wenchong Shipyard. By using 3D virtual reality technology combined with the physical presence of the ships preserved in the shipyard, visitors will have an immersive experience and feel the visual impact brought by the shipbuilding industry (Fig. 5-31).

Fig. 5-31 Intended Effect of Exhibition Hall
Source: Website

Creating New Urban Landmarks

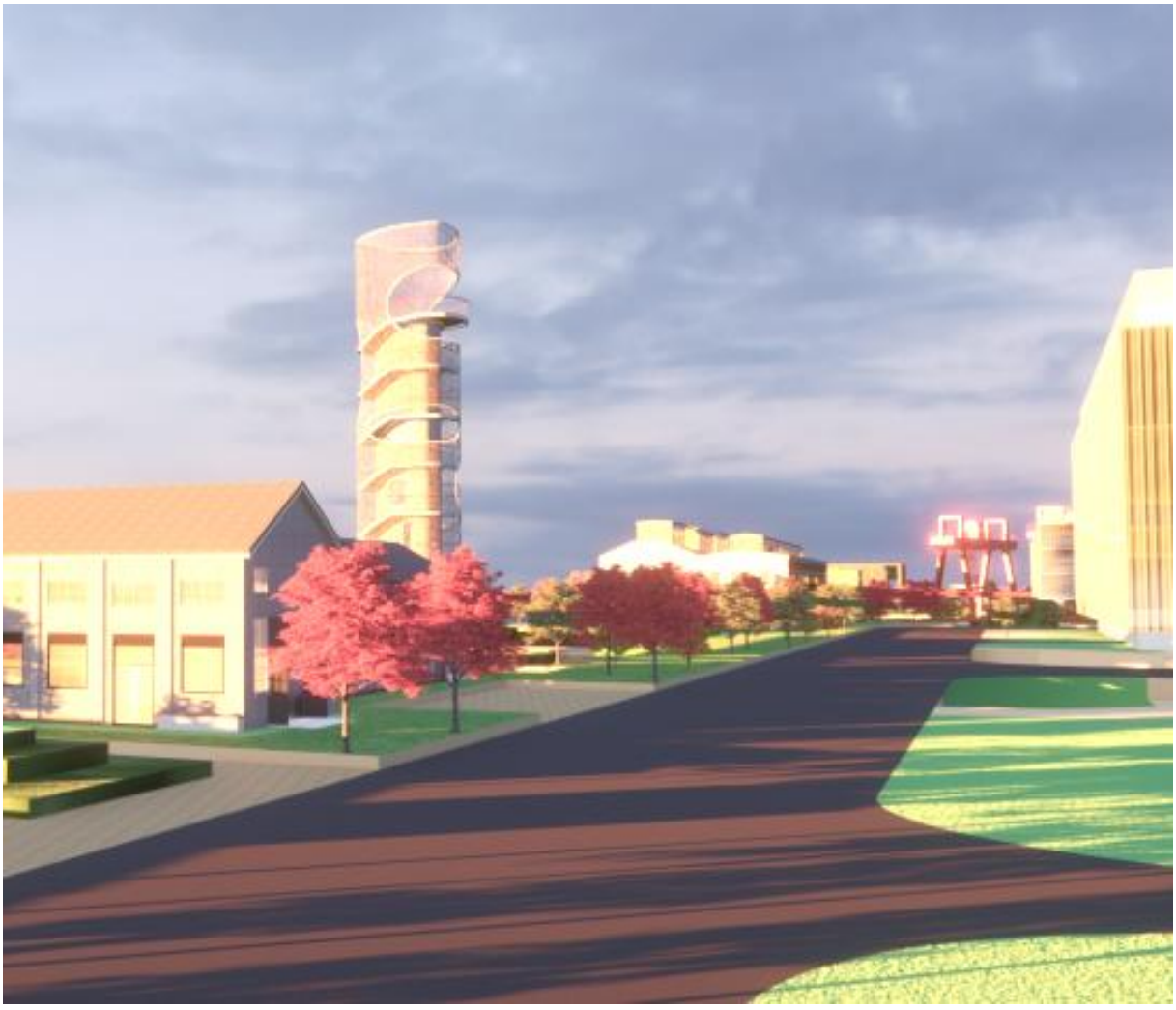
Within the site, the existing large-scale shipbuilding industrial equipment, the gantry crane, is utilized to create a new urban landmark with distinctive characteristics and cultural significance by controlling the height of surrounding buildings to highlight the crane's immense scale (Fig. 5-32).

Additionally, on the eastern waterfront space node of the site, an observation tower and a waterfront leisure observation platform are set up, combined with iconic structures, transforming this important industrial waterfront into a top-notch landmark landscape space. It will not only possess the characteristics of the shipbuilding industry but also serve as a vibrant cultural center (Fig. 5-33).

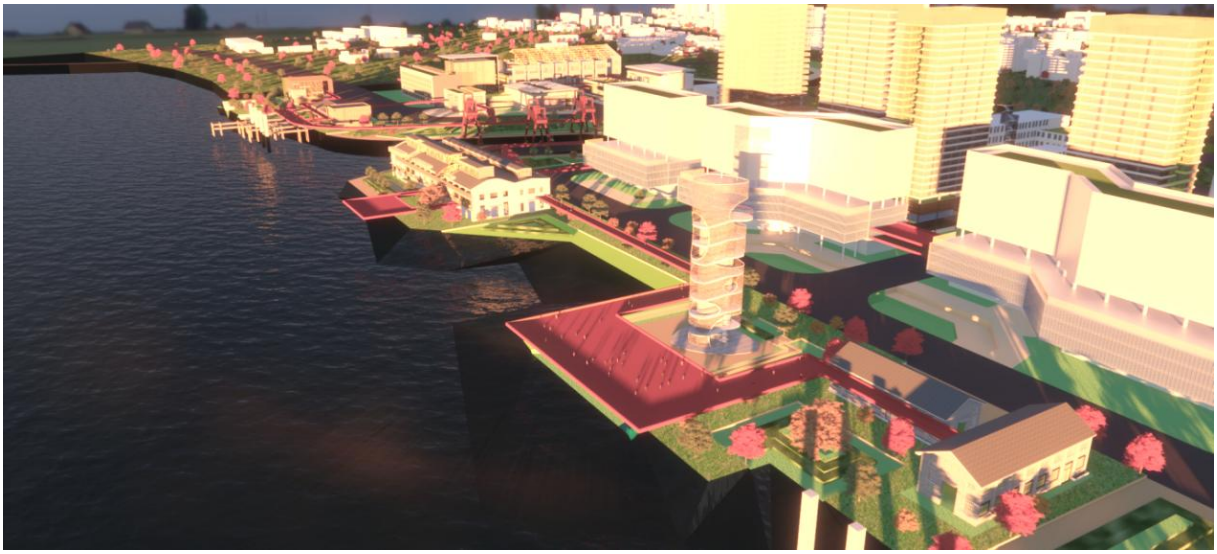
（a）

（b）

Fig. 5- 32 Original Docks 1 and 2 as New Urban Landmarks
Source: Author's Self drawn



(a)



(b)

Fig. 5- 33 Observation Tower along the Urban Axis
Source: Author's Self drawn

5.6.2 Functional and Spatial Resilience

From the perspective of functional and spatial elements of an resilience system, various functions within the system are mixed and boundaries are blurred. Predictable changes and variability spaces are incorporated, while creating flexible and diverse multi-level spatial sequences. This integration accommodates diverse social activities and enhances the complexity of functions and spaces, thereby increasing the system's variability and allowing for potential changes in future development.

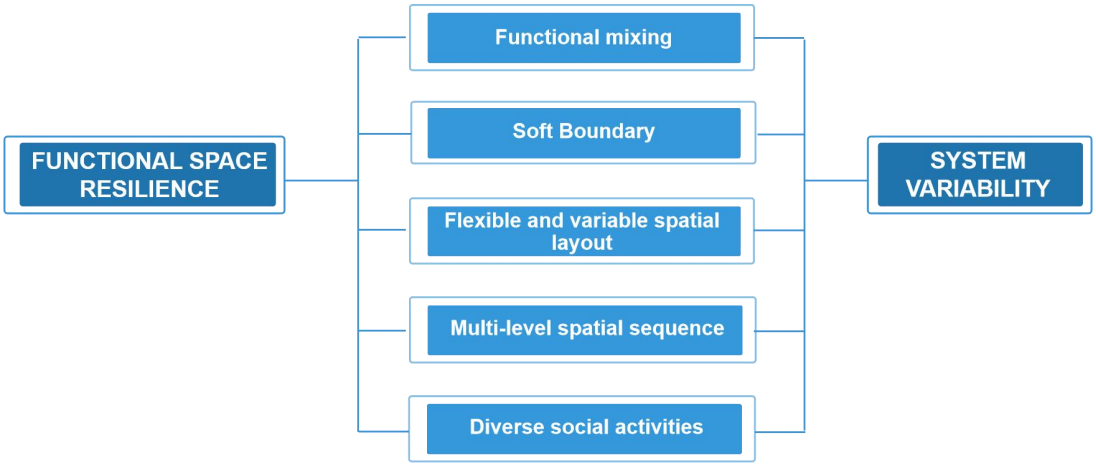
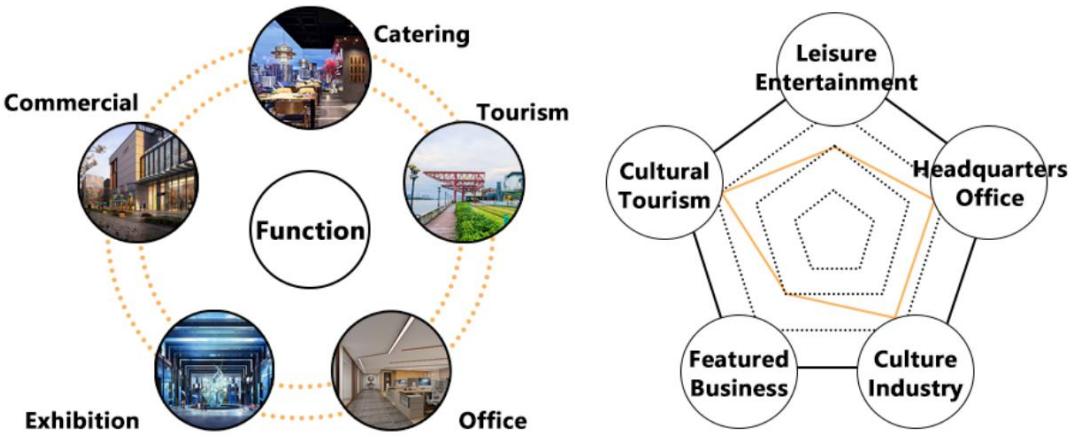


Fig. 5- 34 Role of Functional and Spatial Elements in Enhancing System Resilience
Source: Author's Self drawn

Function Mixing and Improved Supporting Facilities

From the perspective of functional resilience, through the mixed use of spatial functions, the heritage itself can be upgraded and the missing functions in the area can be fulfilled. Transforming shipbuilding industry heritage into spaces such as art exhibition spaces, industrial markets, restaurants, and yacht service centers not only preserves historical and cultural heritage but also injects new vitality and economic value into the city. By combining cultural exhibitions with commercial operations, cultural exhibitions with landscape parks, commercial and headquarters offices with industrial parks, research facilities with cultural activities and tourist attractions, etc., it can better serve the public and urban development. Additionally, in the face of external environmental changes, the relationships between different functions can be adjusted to achieve resource sharing and interaction (Fig. 5- 35).



(a)Multi-demand Support (b) Integration of Diverse Industries

Fig. 5- 35 Illustration of Function Mixing
Source: Author's Self drawn

Opening City Boundaries

By utilizing elevated structures, shifting building volumes, and incorporating various forms of grey spaces, traditional hard boundaries are broken, and soft boundaries are created to enhance the flow of people and resources within the site. This also strengthens the connection between the heritage area and the urban core (Fig. 5- 36). In addition to the transformation of architectural spaces, multiple-event urban public squares and experiential complexes are also established. These open spaces can adapt to changes and needs of the city, enhancing the area's ability to anticipate and adapt to future changes (Fig. 5- 37).

Fig. 5- 36 Urban Boundary Analysis（Source: Author's Self drawn）

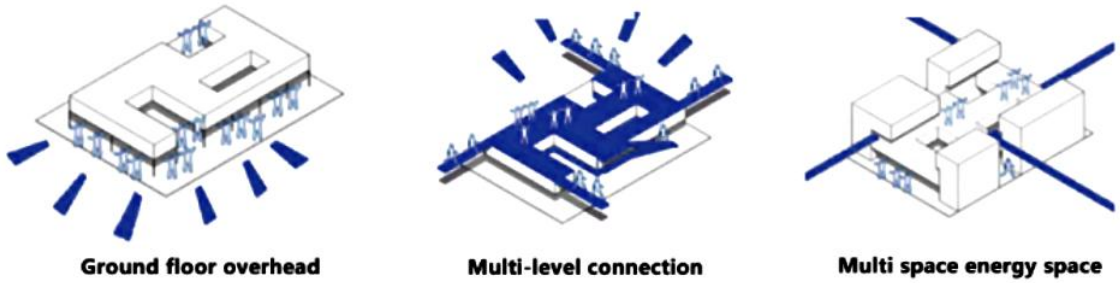


Fig. 5-37 Approach to Soft Boundary Treatment in the City
Source: Author's Self drawn

(a)

(b)

Fig. 5-38 Partial rendering of open space (Source: Author's Self drawn）

Flexible and Adaptable Spatial Layout

In the recombination of new and old buildings, flexible and varied spaces can be placed to adapt the buildings to different usage methods and needs; Secondly, through reasonable spatial layout and design, the interior space and resources of the building can be maximized. This can not only reduce operating costs, but also reduce the impact on the environment and improve sustainability (Fig. 5-39).

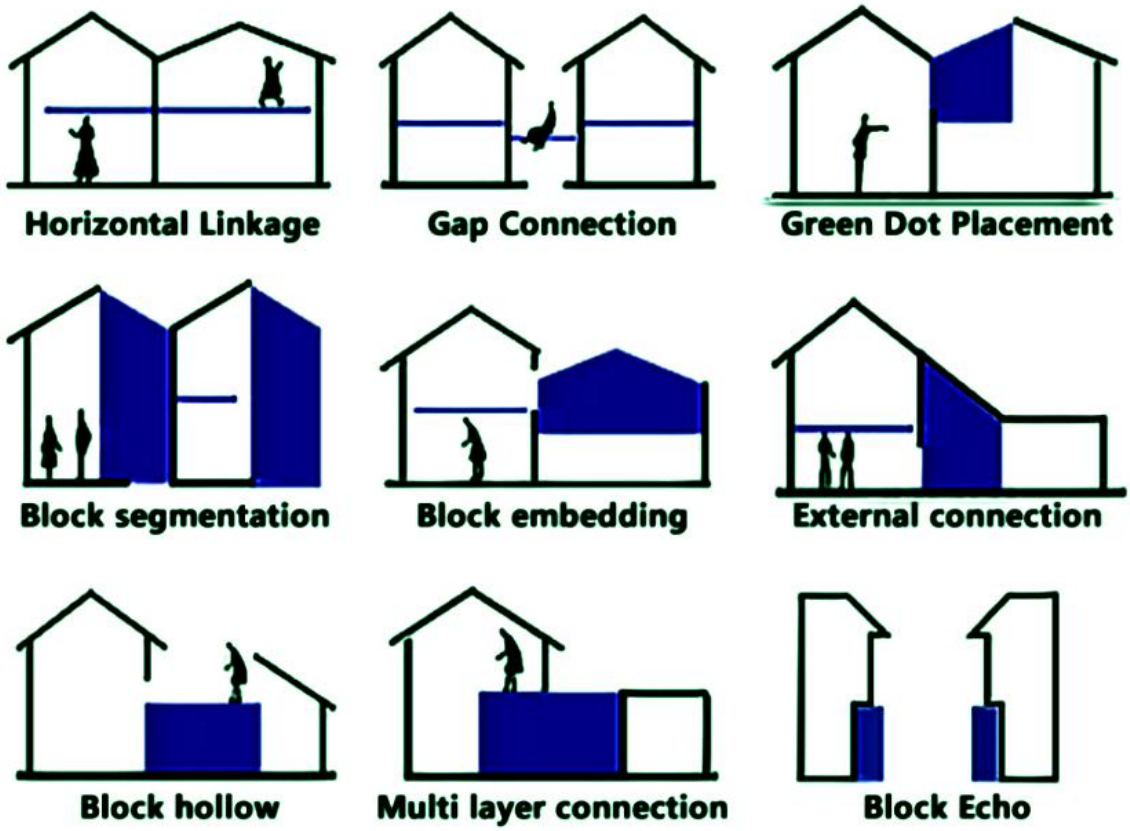


Fig. 5-39 Flexible and Adaptable Spaces
Source: Author's Self drawn

Multi-level Spatial Sequence

The proposal forms a multi-scale and multi-level spatial sequence horizontally. Vertically, it includes buildings of different heights, as well as stepped sunken plazas and composite public transportation systems of varying scales (Fig. 5-40). Sunken plazas, road networks, pedestrian bridges, waterfront promenades, and other elements are utilized to create a vertical spatial sequence that enhances site accessibility and facilitates diverse social activities (Fig. 5-41).

Fig. 5- 40 Vertical Spatial Sequence（Source: Author's Self drawn）

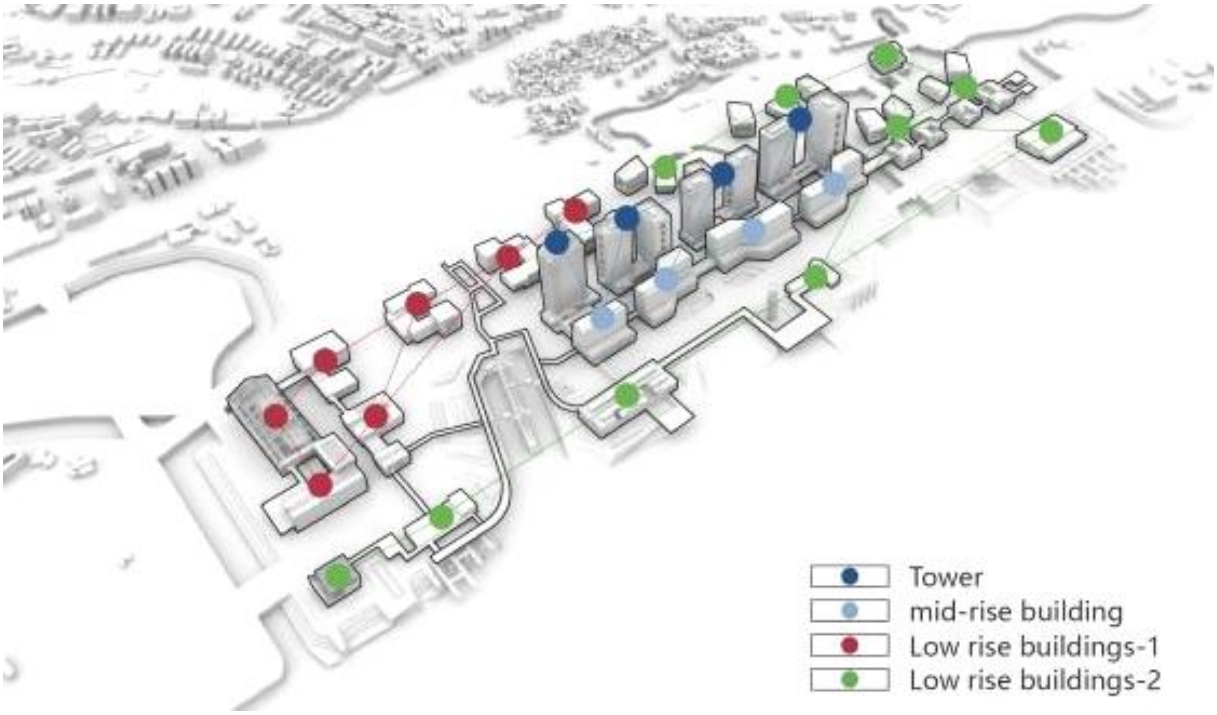


Fig. 5- 41 Building Height Control
Source: Author's Self drawn

Diverse Waterfront Social Activity Nodes

In the design of the vibrant waterfront landscape area, a comprehensive system for walking, entertainment, and leisure has been established (Fig. 5-42). By utilizing the existing gantry crane, industrial buildings, docks, and platforms, and combining them with modern landscape elements, diverse activity nodes are created based on the needs of the surrounding area and the city. This gradually repairs the disconnect between the urban core and the waterfront area.

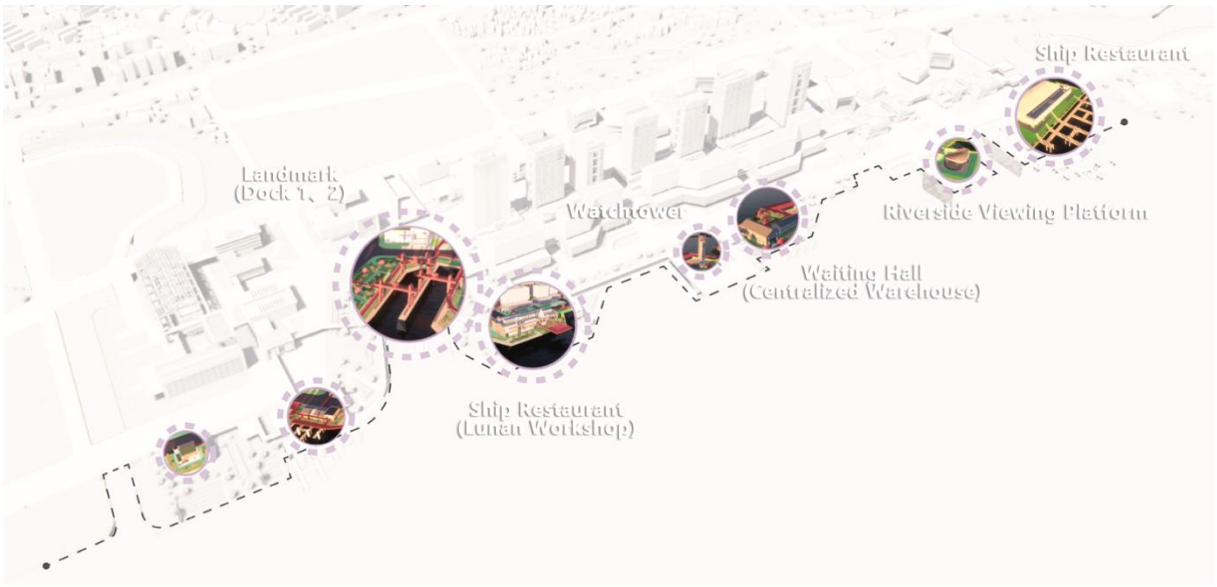
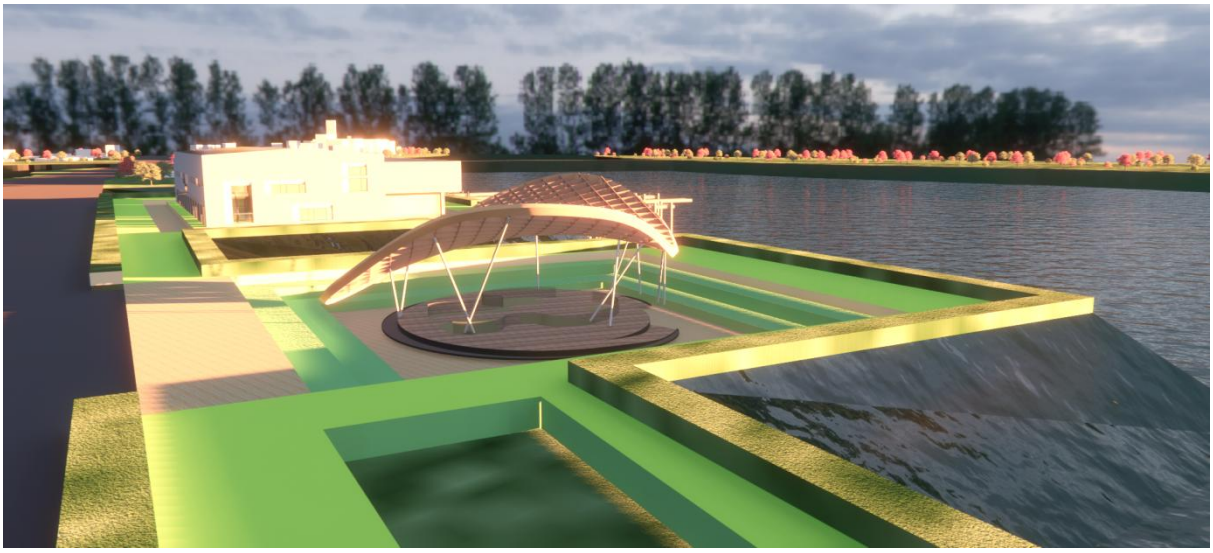


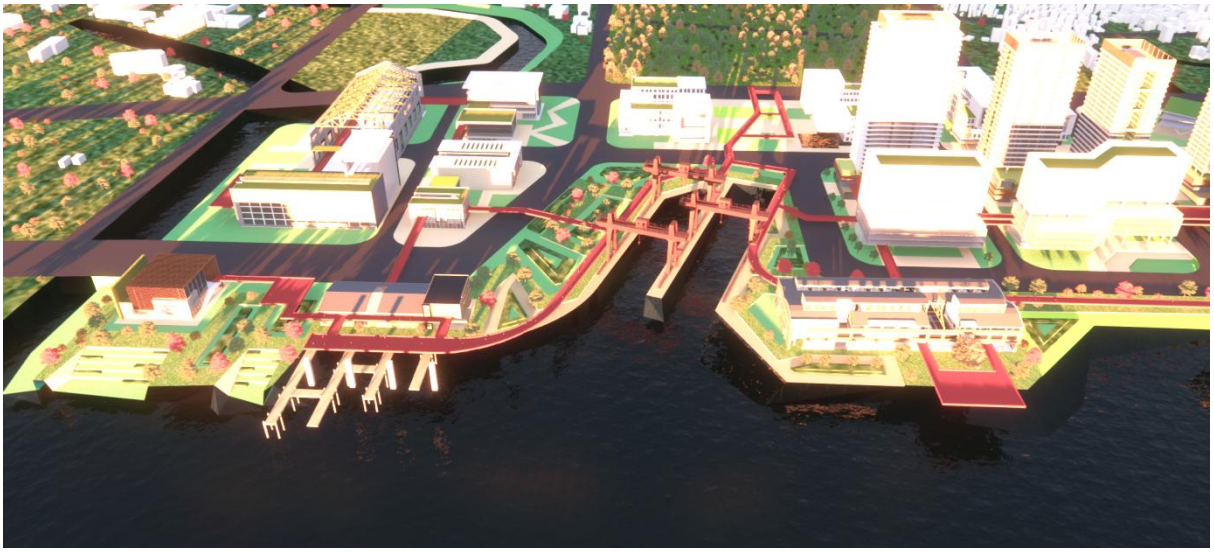
Fig. 5-42 Waterfront Vibrant Landscape System
Source: Author's Self drawn

(a)

(b)



(c)



(d)

Fig. 5-43 Rendering of Partial Landscape Nodes (Source: Author's Self drawn)

5.6.3 Ecological landscape resilience

From the perspective of ecological landscape elements in the resilient system, it is important to fully explore the material and ecological resources within the heritage site. This includes recycling and reusing materials from abandoned buildings within the site, as well as incorporating restorative landscape elements to enhance the self-repairing capacity of the waterfront ecosystem.

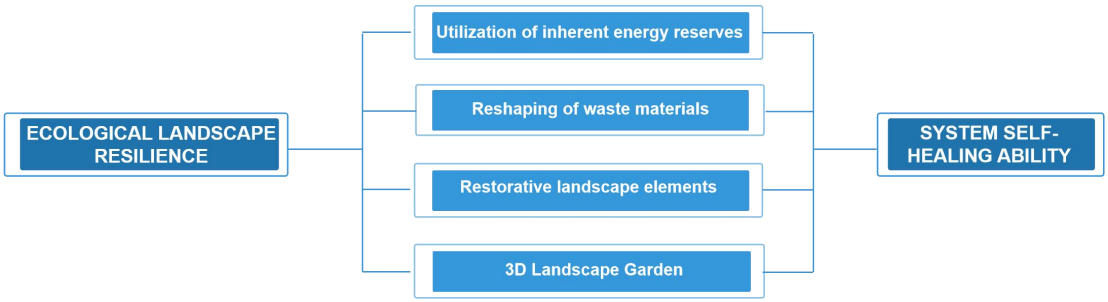


Fig. 5-44 Mechanisms of Enhancing System Resilience through Ecological Landscape Elements
Source:Author's Self drawn

By reorganizing the abundant material resources and natural environment resources within the Wenchong Shipyard site, as well as the industrial buildings and structures, the excavation and reuse of hidden energy within the site can be achieved. As the site is located in a waterfront area with a relatively low overall terrain prone to waterlogging, it is crucial to address and utilize the characteristics of the waterfront area. Additionally, due to the sensitive ecological environment of the Wenchong Shipyard area, care must be taken during the demolition and reconstruction process to avoid generating a large amount of construction waste and prevent secondary damage to the environment.

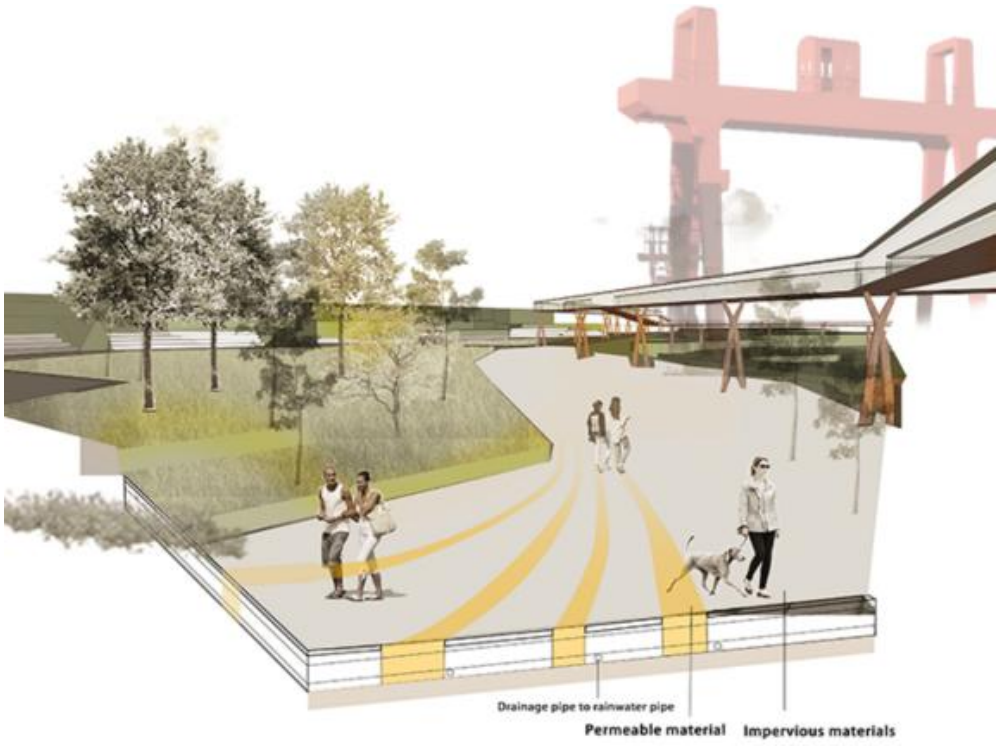
In this plan, the abandoned building materials within the site (Fig. 5-45), such as concrete debris, discarded steel plates, asphalt, etc., are used as materials for constructing the ecological landscape system. This approach not only facilitates water infiltration but also preserves the historical memory of the shipbuilding industry, minimizes the generation of construction waste, and reduces construction costs(Fig. 5-46). The incorporation of restorative landscape elements greatly enhances the site's ecological resilience and self-recovery capabilities. Furthermore, industrial equipment and components with shipbuilding industry characteristics can be retained and incorporated into both indoor and outdoor spaces as decorative elements, effectively showcasing the shipbuilding industry culture to society (Fig. 5-47).


(a) Steel Pipe and Plate Material Stockyard

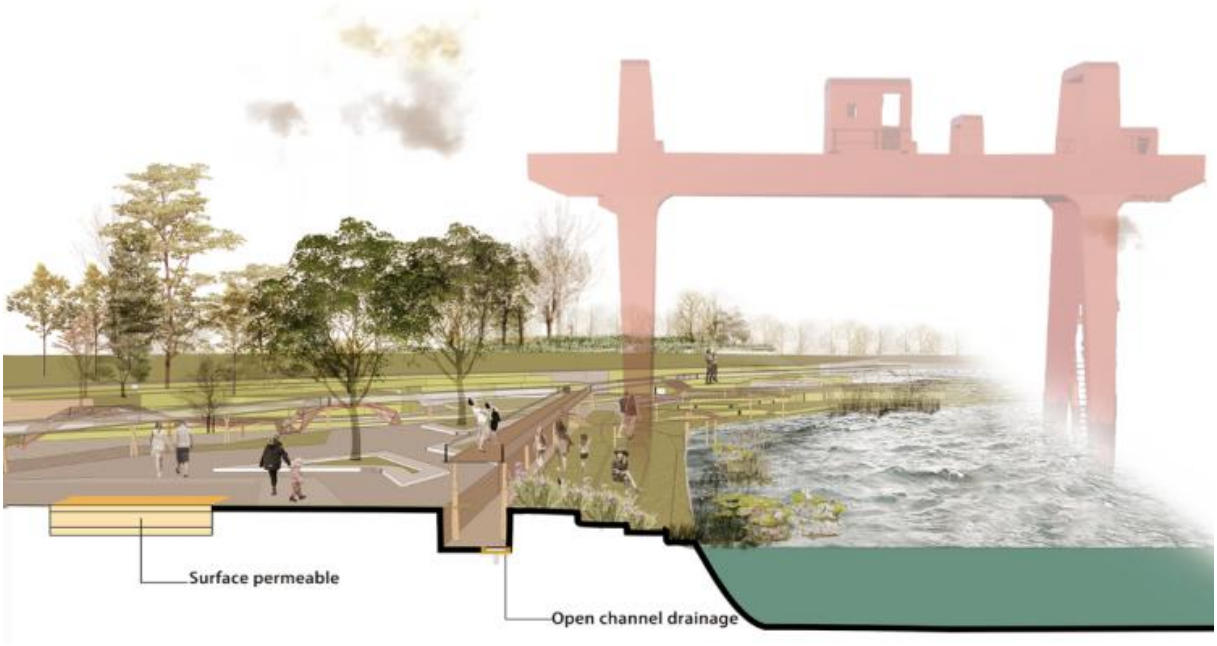

(b) Concrete Buildings (c) Brick Buildings

Fig. 5- 45 Building Material Resources at Wenchong Shipyard (Source: Captured by Drone)

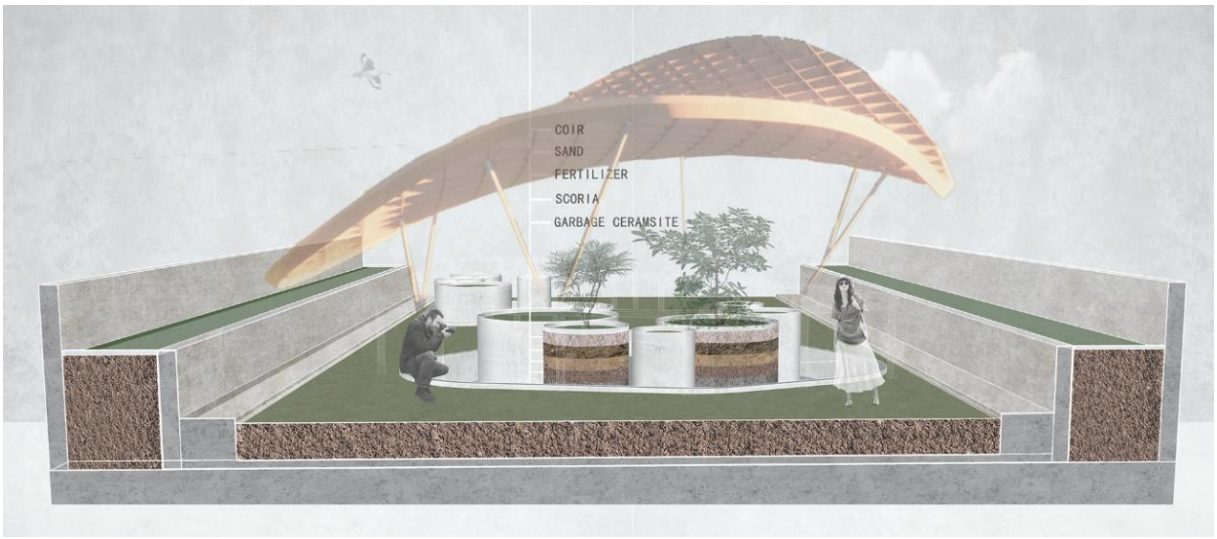
Fig. 5- 46 Recycling of Waste Materials
Source:Author's Self drawn



(a)Schematic Diagram of Linear Permeable Road System



(b)Cross-section Illustration of Waterfront Staircase Design



(c) Cross-section Illustration of Planting Pool Design

Fig. 5- 47 Sponge City Design Illustration
Source:Author's Self drawn

5.6.4 Infrastructure Resilience

From the perspective of infrastructure elements in an resilience system, modular design of various functional zones within the site ensures the speed and standardization of system construction. Subsequent management and supervision can be carried out through platform control to ensure the sustainable operation of the system.

Fig. 5- 48 Mechanism of Enhancing System Resilience through Functional and Spatial Elements
Source: Author's Self drawn

Modular Design

By analyzing the characteristics of industrial heritage in the Wen Chong Shipyard, the main components and functional modules of heritage buildings are identified. Modular design standards are formulated and implemented. Modular manufacturing and assembly are carried out in new buildings, followed by testing and debugging to ensure the proper functioning of the modules. Regular monitoring and maintenance are conducted after construction to ensure their long-term preservation (Fig. 5- 49).

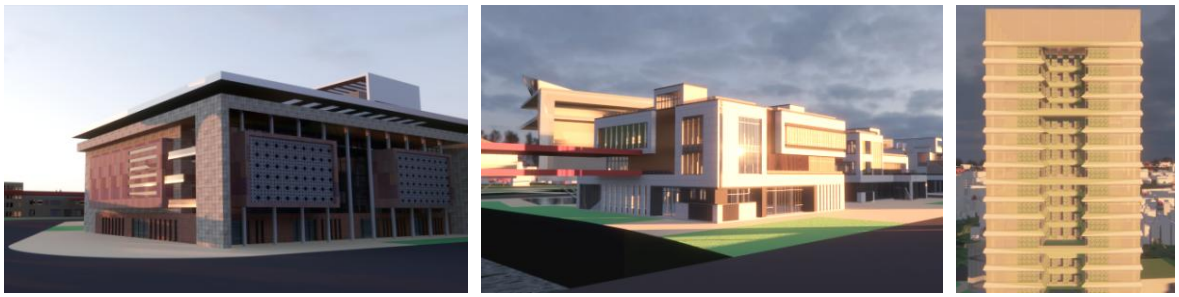


Fig. 5- 49 Modular Architecture
Source: Author's Self drawn

Platform Control

In future urban construction, it is crucial to establish a comprehensive platform management system. Collect information and data within the area through devices such as the Internet of Things, the Internet, and wireless networks, embed them into the system, and monitor them in real-time. At the same time, strengthen the management and supervision of the platform, promptly identify and handle problems.

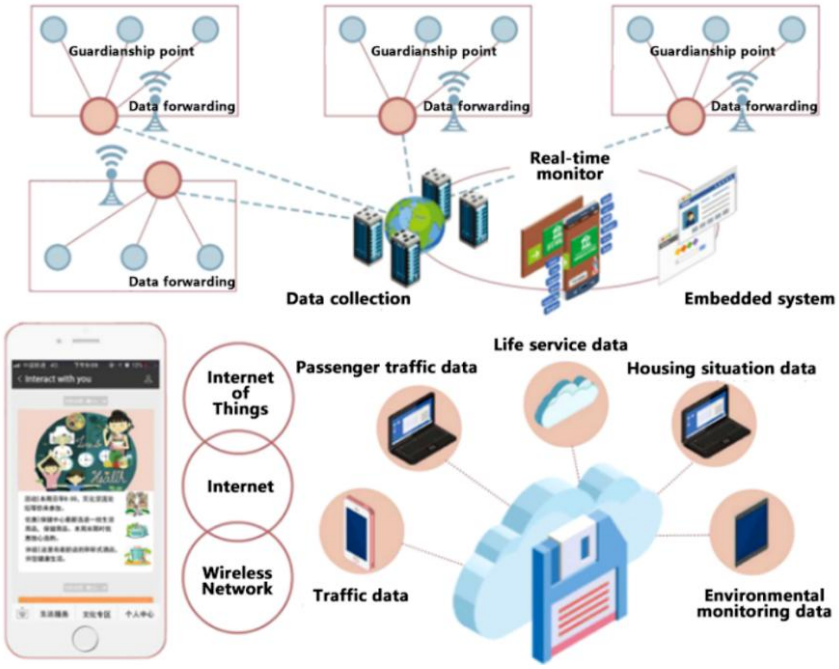


Fig. 5- 50 Platform Control Model
Source: Author's Self drawn based on available information

5.6.5 Socioeconomic Resilience

From the perspective of socioeconomic elements in an resilience system, emphasis is placed on the role of the government, relevant institutions, and citizens in the protection of industrial heritage. By establishing a comprehensive policy and regulatory framework, it encourages spontaneous participation from the public in heritage conservation efforts based on a sense of protection awareness.

Fig. 5- 51 Mechanism of Socioeconomic Elements Enhancing System Resilience
Source: Author's Self drawn

Establishing a Comprehensive Safeguard Mechanism

Recognizing shipbuilding industry heritage as a new type of heritage, it should be fully incorporated into the levels of protection for historical and cultural cities and industrial heritage, enriching the cultural connotation of Guangzhou as a famous city and establishing a comprehensive safeguard mechanism. In response to government management needs, a systematic framework for the protection and utilization of shipbuilding industry heritage is proposed, transitioning from planning and design to institutional design (Fig. 5- 52). This

includes establishing a protection system that encompasses protection planning, institutional development, and implementation management. Work suggestions and implementation strategies that link these three aspects are proposed to align with statutory planning, inclusion in the heritage list, and the promotion of policy development (Fig. 5- 53).

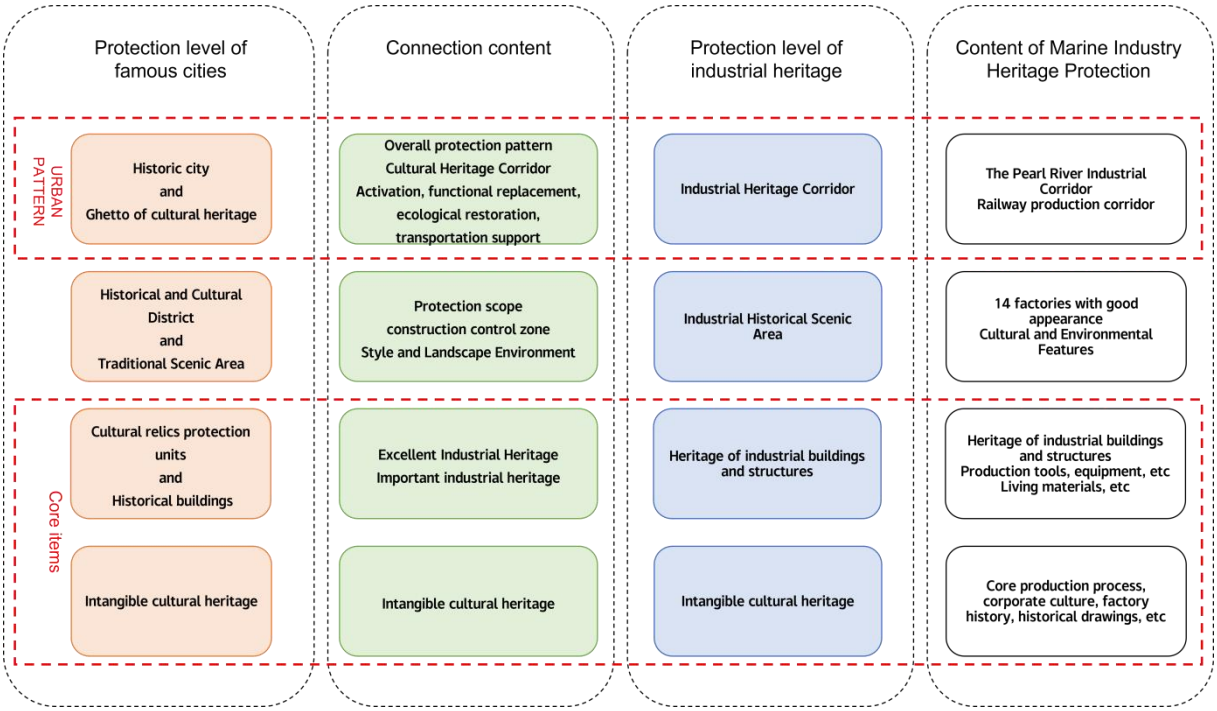


Fig. 5- 52 Guangzhou's Shipbuilding Industry Heritage Integrated into the Protection System of Historical and Cultural Cities and Industrial Heritage（Source: Author's Self drawn）

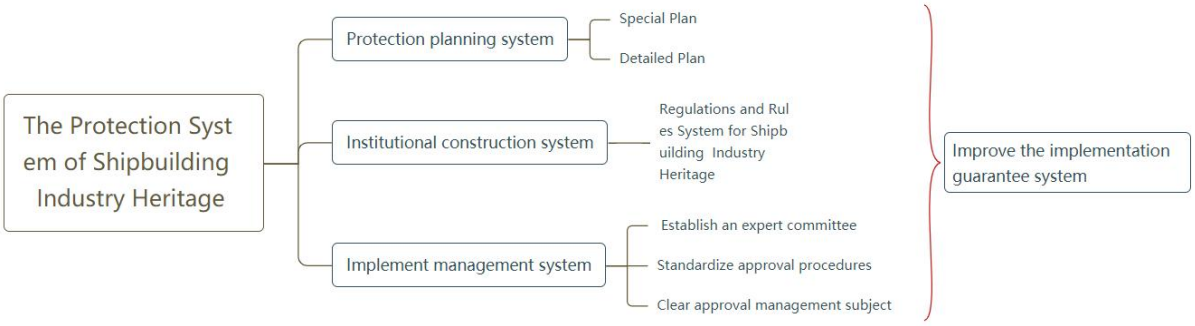


Fig. 5- 53 Framework for the Protection of Guangzhou's Shipbuilding Industry Heritage
Source: Author's Self drawn

Establishing an Urban Cooperation Mechanism

Establish a dedicated joint working group to coordinate, manage, and promote the protection of industrial heritage. Develop unified planning and standards, and enhance information sharing and communication among departments to achieve comprehensive protection of shipbuilding industry heritage.

5.7 Chapter Summary

Based on the practice framework of resilience renewal of Guangzhou shipbuilding industry heritage and the research on the five elements of resilience and their strategies extracted, this chapter has formulated a Technology roadmap of resilience renewal for Guangzhou Wenchong Shipyard. Through in-depth analysis of the current situation, characteristics, and shortcomings of Guangzhou Wenchong Shipyard, the heritage ontology, social, and ecological issues faced by Wenchong Shipyard are clarified. Based on upper level planning, the potential for resilience renewal is analyzed, and the design vision of Wenchong Shipyard is described. Afterwards, further updating practices will be carried out on Wenchong Shipyard, starting from overall planning, heritage protection, and the establishment of social and institutional frameworks. The strategies will be verified one by one to enhance the system's adaptability to changes in uncertainty factors and provide reference for the updating of other shipbuilding industry heritage.

Conclusion and Outlook

Main conclusion

This article provides a relatively systematic review of the historical background and current status of renewal and protection of 14 shipbuilding industry heritage sites in Guangzhou. It attempts to apply resilience theory to Guangzhou shipbuilding industry heritage, establish a practical framework for resilience renewal, and based on the extraction principle of resilience elements, extract five major resilience renewal elements: historical culture, functional space, ecological landscape, infrastructure, and socio-economic factors, and further explore specific implementation strategies. Finally, taking Wenchong Shipyard, a typical heritage of Guangzhou's shipbuilding industry, as an empirical case, the resilience strategy is validated and the regeneration blueprint of Guangzhou Wenchong Shipyard is depicted.

Based on the comprehensive research conducted in this study, the following conclusions can be drawn:

（1）The Characteristics and Value of Guangzhou Shipbuilding Industry Heritage

The spatial distribution of Guangzhou's shipbuilding industry heritage mainly shows a concentrated distribution in the central urban area. With superior geographical location and dense river network, the central urban area of Guangzhou is the concentration place of shipbuilding industry heritage. The shipbuilding industry heritage in this area is mostly distributed along the the Pearl River Industrial Heritage Corridor and the Railway Industrial Heritage Corridor. In terms of time distribution, there are typical representative cases of shipbuilding industry heritage from the main historical periods of modern times. Witnessed the development process of Guangzhou's shipbuilding industry at various stages.

The characteristics of Guangzhou's shipbuilding industry heritage are distinct. The site selection is concentrated on both sides of the the Pearl River back channel, with the characteristics of waterfront construction; The planning layout presents a compact layout with flexible production lines as the production mode and ship production and manufacturing areas as the core; At the same time, the structures and spatial forms of buildings and structures are diverse, and there are many scale and iconic production equipment and building components preserved within the site.

Guangzhou's shipbuilding industry heritage contains rich value and resources. In terms of historical value, the Guangzhou Shipbuilding Industry Heritage records the development process of modern Guangzhou Shipbuilding Industry Heritage; In terms of technological value, the Guangzhou Shipbuilding Industry Heritage reflects China's advanced shipyard construction level and promotes the progress of China's shipbuilding technology; In terms of artistic value, the Guangdong Shipbuilding Industry Heritage reflects the development process of related building and structure styles and structures, and various types of ship hydraulic structures and industrial equipment showcase a unique style of the shipbuilding industry; In terms of social value, the Guangzhou Shipbuilding Industry Heritage has witnessed the construction of coastal defense safety and the development of shipping industry, carrying the memory of social groups, and is an important medium for spreading ship culture.

（2）Applicability of Resilient Renewal of Guangzhou Shipbuilding Industry Heritage

The shipbuilding industry heritage, as one of Guangzhou's highly distinctive industrial heritages, bears witness to Guangzhou's position as an important maritime trade center and has significant historical significance. In the context of urban renewal, some of these shipbuilding heritage sites face the fate of demolition due to inadequate protection, while others have been updated without considering the social ecological relationship with the surrounding environment. In addition, Guangzhou's shipbuilding industry heritage also faces dual threats such as loose internal elements, poor connectivity, high external urban development pressure, climate change, and rising sea levels, which may ultimately lead to the destruction and disappearance of the heritage. Therefore, Guangzhou's shipbuilding industry heritage needs a new way of renewal, so that it can effectively prevent and quickly adapt to various changes and threats in the internal and external environment, and ensure the sustainable development of the heritage.

The resilience theory regards cities as a complex socio-economic system, and its implementation targets include but are not limited to physical infrastructure, socio-economic structure, environmental ecosystems, and governance mechanisms. The resilience theory emphasizes the adaptability and resilience of the system, which is precisely the characteristic required for the renewal process of Guangzhou Shipbuilding Industry Heritage. This article extracts the five resilience elements of Guangzhou's shipbuilding industry heritage from the perspective of resilience theory, and further extends its implementation strategies. By

improving the material and ecological environment to avoid external disturbances, and adjusting the social and institutional framework to adapt to environmental threats, it can effectively prevent and quickly adapt to various internal and external uncertain risks and crises.

(3) The Resilience Design Strategy of Guangzhou Shipbuilding Industry Heritage

The resilience renewal strategy of Guangzhou's shipbuilding industry heritage can be explored from multiple perspectives. This article is based on the relevant theoretical foundations and research achievements of resilience theory. By analyzing the current characteristics and social ecological threats faced by Guangzhou's shipbuilding industry heritage, five major resilience renewal elements of Guangzhou's shipbuilding industry heritage are extracted, namely historical culture, functional space, ecological landscape, infrastructure, and socio-economic; Starting from the social framework, institutional framework, as well as the material environment and ecological environment, we will further explore the specific implementation strategies of the five major elements. By rebuilding the social ecological system of the shipbuilding industry heritage, enhancing its system control and resilience, we aim to create a renewable, adjustable, scalable, and sustainable urban area.

In terms of cultural resilience, it is mainly divided into four design points. Firstly, integrate the heritage area from heritage protection to resource integration. Relying on the "Industrial Heritage" path planning in Guangzhou, the ship craft heritage will be connected twice to form the ship industry heritage path. Secondly, due to the continuous production and manufacturing of Guangzhou's shipbuilding industry heritage, the buildings in the factory area are mostly built in different historical periods. In the new construction, presenting the collision of new and old elements can better showcase the history of shipbuilding craft heritage. In addition, using modern digital technology to protect and showcase the heritage of the shipbuilding industry can better achieve the inheritance and continuation of the history of the shipbuilding industry. Finally, due to the large amount of production equipment, buildings, and structures often left behind within the site, they can be utilized to create a new urban landmark with contemporary characteristics and cultural connotations.

In terms of functional and spatial resilience, due to the lack of resistance to unknown impacts in the original single business format, and the resilience theory needs to adapt to different

needs of multiple scenarios, urban functions need to develop in a more complex direction. In future development and construction, functions can be regulated according to different development states of cities in different time periods. The flexibility and variability of spatial layout, as well as the shaping of soft boundaries, can enable buildings to adapt to different usage methods and needs, maximizing the utilization of internal space and resources. In addition, the design of multi-level spatial sequences and diverse social activity nodes in waterfront areas can form spatial sequence relationships, establish a comprehensive walking, entertainment, and leisure system, organically connect the waterfront area with the urban hinterland, and form a complete urban spatial system.

At the level of ecological landscape, resilience theory emphasizes the ability to adapt to the ecological environment, including various development methods that conform to nature, By stimulating the formation of an adjustable and organized "life landscape" in the city, achieving coordination between urban functions and environmental ecology. Through the exploration and utilization of inherent energy, the reshaping of waste materials, the placement of restorative ecological landscapes, and the design of three-dimensional landscape gardens, the degree to which industrial heritage adapts to the ecological environment can be greatly improved.

In terms of infrastructure, as the basis for the normal operation of a city, it is not only the guarantee of people's quality of life, but also a necessary condition for a Urban resilience. Infrastructure resilience emphasizes the independent existence of various facilities while also being interrelated, highlighting the resilience system's resistance, adaptability, and ability to recover from damage to various hazards. In implementation, methods such as modular organization and platform control can be used to ensure the sustainable operation of infrastructure.

At the socio-economic level, it is necessary to integrate resources from all sectors of society, coordinate multiple rights and interests, strengthen awareness of heritage value, and promote heritage protection work. By formulating relevant policies and regulations, promoting the voluntary participation of the public in the protection and renewal work can better enhance the socio-economic resilience of the shipbuilding industry heritage.

Limitations and Outlook

This study on Guangzhou's shipyard heritage has encountered certain limitations that need to be acknowledged. Firstly, the quantity and complexity of the shipyard heritage in Guangzhou, as well as the wide range of issues involved, pose challenges to conducting comprehensive and in-depth research. The scarcity of reference materials on the subject further hampers the thoroughness and depth of the study. Additionally, restricted access to certain shipyard areas due to military management and the ownership of data by the respective enterprises have limited the researcher's ability to conduct complete and in-depth investigations.

The study of shipyard heritage encompasses multiple aspects, and the breadth of knowledge in this field may be limited. This study primarily focuses on architectural and urban design perspectives, which may result in incomplete and less comprehensive analyses in certain areas. Future research should aim to deepen the study of Guangzhou's shipyard heritage from broader perspectives.

The Guangzhou Shipbuilding Industry Heritage has witnessed the development process of modern industry in Guangzhou and even in China, and is a valuable industrial heritage. This article summarizes and summarizes the distribution characteristics, heritage value, and core item characteristics of Guangzhou's shipbuilding industry heritage. Based on the theory of resilience, it proposes a practical framework and specific implementation strategies for the resilience update of shipbuilding industry heritage. Based on the current situation of Wenchong Shipyard, we will carry out updating practices and deeply explore its potential for resilient renewal, thereby enhancing the flexibility and adaptability of the heritage area and resolving the contradictions and complexity of the heritage status quo.

With the changes of the times, Guangzhou's shipbuilding industry heritage may face new challenges and problems, which require continuous attention from all sectors of society. In the field of theoretical research and practical work of updating, all parties' rights and interests should be coordinated to jointly promote the updating and protection of Guangzhou's shipbuilding industry heritage.

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攻读硕士学位期间取得的研究成果

一、已发表（包括已接受待发表）的论文，以及已投稿、或已成文打算投稿、或拟成文投稿的论文情况**（只填写与学位论文内容相关的部分）：**

序号	发表或投稿刊物/会议名称	作者（仅注明第几作者）	发表年份	与学位论文哪一部分（章、节）相关	被索引收录情况

二、与学位内容相关的其它成果（包括专利、著作、获奖项目等）

Acknowledgement

At this point in my writing, I finished writing. At the age of 25, my student life came to an end. I lamented that time is fleeting, and I cherish the hard time to catch up with. I have read some heartwarming thanks and thought about what I want to write, but when I write here, I am filled with thoughts and mixed emotions, but I don't know how to describe it. Looking back, every step has a trail to find, and every step taken counts.

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3.答辩委员会对论文的评语

（主要内容包括：1.对论文的综合评价；2.对论文主要工作和创造性成果的简要介绍；3.对作者掌握基础理论、专业知识程度、独立从事科研工作能力以及在答辩中表现的评价；4.存在的不足之处和建议；5.答辩委员会结论意见等）

硕士研究生聂萌所完成的题为《韧性理论视角下的广州船舶工业遗产更新策略研究——以广州文冲船厂为例》的学位论文，选题具有一定的理论意义和较好的的实用价值。

作者较全面的归纳和评述了一定量的有关文献，较好的掌握了该领域国内外的研究现状和发展方向。论文研究内容较深入，研究方法较正确，完成了下列研究成果：1、通过对文献和资料的整理，对广州 14 处船舶工业遗产的历史背景和更新保护现状进行了的梳理；2、通过对韧性理论发展历程的总结以及在城市设计领域该理论的实践分析，提出了广州船舶工业遗产的更新策略及实践框架；3、以广州典型船舶工业遗产——文冲船厂为例，对上述更新策略加以运用，为广州船舶工业遗产未来的更新设计提供了参考。研究成果具有一定的理论价值和实用价值。

论文概念较清晰，结构较完整，叙述适当，分析较充分。答辩中作者较好的回答了提出的问题。

答辩委员会同意通过硕士学位论文答辩，同意毕业，并建议授予硕士学位。

论文答辩日期：2023 年 09 月 04 日　　答辩委员会委员 6 人

表决票数：同意毕业及授予学位（5）票

同意毕业，但不同意授予学位（1）票

不同意毕业（0）票

表决结果（打"√"）：同意毕业及授予学位（√）

同意毕业，但不同意授予学位（　）

不同意毕业（　）

答辩成员签名	（主席）　（在线答辩秘书代签）
答辩秘书签名	