

Conservation and revitalization of port industrial heritage under the historic urban landscape framework

A case study of Great Harbor in Qingdao, China

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Abstract

Ports are foundational to port cities, initiating urban development. However, as the city grows economically and spatially, industrial land uses shift, and the transportation role of ports diminishes. This change necessitates finding new purposes for former port areas and reinterpreting the significance of port industrial heritage. This paper explores how to treat the port industrial heritage in Qingdao's Great Harbor area, initially established by the colonizers but later advanced through local autonomous research, using the framework of historic urban landscape (HUL). We counted 121 heritage elements, identified typical heritage elements with both isochroneity and diachroneity, and prioritized their preservation and utilization on the basis of heritage value and vulnerability. For typical heritage elements, we examined their spatial status and evolution, and discussed their regeneration concepts and strategies. The findings indicate that the typical elements of port industrial heritage include docks, coastlines and railways, etc., which were built throughout various developmental phases and spread throughout the port area, reflecting the advanced planning and design concepts and technologies, and should be preserved intact and prioritized. Other heritage elements, such as warehouses, tide gauging stations and bridge cranes, mainly located on docks and along the coastlines or railways, should be selectively preserved and flexibly utilized. This is because, although they are numerically dominant, they are mostly post-1990s (late stage of port life cycle) in terms of time. Moreover, with the goal of awakening the collective memory of the city, we propose strategies for regeneration of port industrial heritage and port space, which are based on the concepts of "productization of development, publicization of use, and ecologization of landscape". Therefore, the HUL framework effectively guides the protection and utilization of these heritage elements, and these results will help planners and policy makers to better develop action plans for the preservation and reuse of the port's industrial heritage.

Keywords

Port industrial heritage, HUL, layering, Uniqueness, Integrity

1. Introduction

In the process of contemporary industrial development and urban transformation, industrial upgrading and transfer, urban renewal and expansion have resulted in a large number of industrial sites facing functional adjustment and a large number of industrial heritage facing demolition. For port cities, ports are the origin of urban construction, and they have greatly driven urban development, but in the process of urban transformation, they have encountered an existential crisis (Hein, 2021; De Rosa, 2013). With the transfer

of port industrial land, the original role of port transportation is gradually reduced, the original land needs to find a new use, and the port industrial heritage needs to be re-conceptualized, re-positioned, re-interpreted and re-translated (Alemany, 2019). In China, due to historical reasons, many port cities (e.g. Qingdao, Dalian, etc.) were initially built as ports of trade for colonizers. Research on the topic of “how to deal with the industrial heritage of ports that were initially built by colonizers and then automated through independent research and development” is important for correctly recognizing the value of this type of heritage, dealing with the relationship with colonizers and building cultural self-confidence.

Generally speaking, the port consists of port waters, quay shoreline and land facilities, including five major functional systems, such as ship navigation, loading and unloading, storage, marshalling, information and commerce (Hein, 2019). Port industrial heritage is the industrial heritage with the function of sea-land intermodal transportation hub after the industrial revolution, which takes the wharf as the material main body and includes two kinds of field space of sea and land (Hetteema, 2020). It not only has a wide variety of elements, but also often has a construction history of hundreds of years, so its full recognition should be based on both ephemeral and time-penetrating, and should comprehensively consider both tangible and intangible cultural values, as well as highlighting the industrial characteristics and its role in urban development. Therefore, we introduce a research theory and method that is holistic, dynamic and sustainable, i.e., Historic Urban Landscape (HUL).

2. The HUL framework

The HUL framework is a template for integrating heritage into development. In the 2016 UNESCO's The HUL Guidebook, the HUL is the urban area understood as the result of a historic layering of cultural and natural values and attributes, extending beyond the notion of “historic centre” or “ensemble” to include the broader urban context and its geographical setting (UNESCO, 2015; UNESCO 2016). In the document, the term “layering” is used five times, and its meaning is both conceptual and practical (Deng, 2018). The conceptualization is reflected in the fact that the urban historic landscape is the material entity of the urban area, and the various values and characteristics are the result of the continuous superposition and accumulation of historical remains in different periods on a specific spatial scope or spatial object (Zhang, 2017). The practicality is reflected in the presentation of history and tradition. Researching, documenting, understanding and presenting the lamination is a process of lamination that responds to the value by spatial analysis in different time slices (Grazuleviciute-Vileniske, 2021; Jiang, 2022).

According to the HUL methodology, a conceptual framework on the port industrial heritage was formed (Figure 1). Firstly, the main stakeholders to be considered are the employees of the port, the enterprises of Qingdao Port and the local government, especially the Natural Resources and Planning Bureau. Then, the port's industrial heritage should be recognized and evaluated from the perspectives of dynamic (layering), wholeness and uniqueness, and conservation plans and sustainable development strategies should be formulated (Liu, 2015; Liu, 2014). Layering is the unveiling of the history of port's development in layers from the perspective of time, and the presentation of the layers of continuous, superimposed history in a material form to form a sustainable, life-improving space (Xu, 2023). Currently, the process of dynamism encompasses the entire history of the industrial development of the port area and the transition from industry to services. Uniqueness is an important expression of heritage value, and attention should be paid to the linkages between tangible and intangible, natural and cultural, local and international values (Pereira, 2019). The origin, value and continuing significance of tangible cultural expressions come from intangible cultural practices, and it is important to see the value of practices and spiritual heritage in the economic, social and cultural spheres. Integration is a spatial approach to realize the protection of the integrity of heritage elements and the synergistic development of the port area and the city. Heritage

elements should be protected as a whole according to the production and transportation flow lines. In addition, port-driven city development and city-driven port upgrading often exist in different stages of port city development, and the understanding of the relationship between port and city affects the judgment of heritage value, and is also of decisive significance for future heritage revitalization.

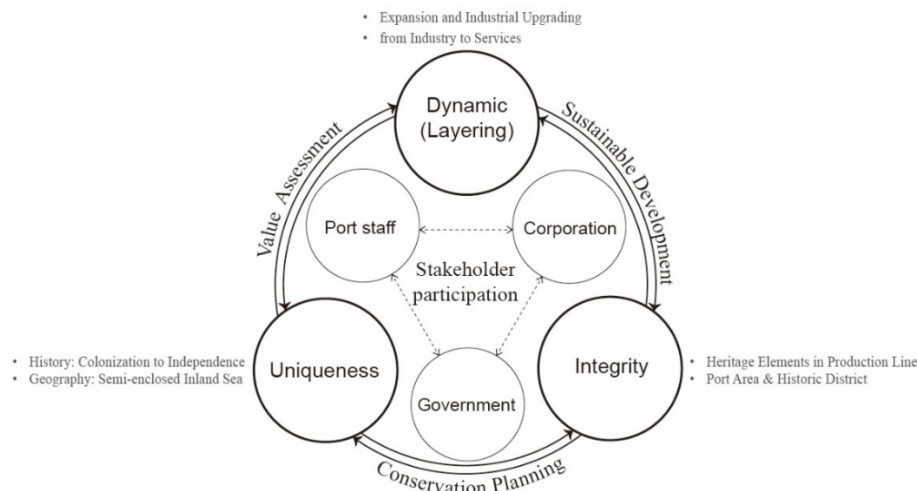


Figure 1. Conceptual framework (based on HUL).

3. Object of study

In this paper, the Great Harbor in Qingdao, China, which is the starting point of urban construction and facing transformation, is selected as the research object to explore the preservation and revitalization of its heritage.

3.1. History and overview of Great Harbour in Qingdao

Qingdao is a typical colonial port city in China, which now has a population of 10 million inhabitants. It was founded in 1891 and built by the Germans after the signing of the *Sino-German Treaty of Jiaoao* in 1897, which laid down the basic framework for the industrial development of Qingdao. The Great Harbor is located on the northwest side of the old city, close to the Guantao Road historic district, but separated by an elevated highway (Figure 2). It was originally (1890s) planned and built by German colonists as a military and commercial port, and was later (1980s) deep-watered and automated by the Chinese themselves. It was at one time the second largest port in the country, ranking eighth in the world in terms of container throughput (Anonymous, 2006). At present, Qingdao Port has realized the transfer of its focus, and the Great Harbour is facing the problems of industrial heritage renovation and spatial regeneration of the waterfront dock area, which need to be planned in a comprehensive manner with the development trend of the times, the characteristics of the population's demand and the city's industrial layout (Figure 3).

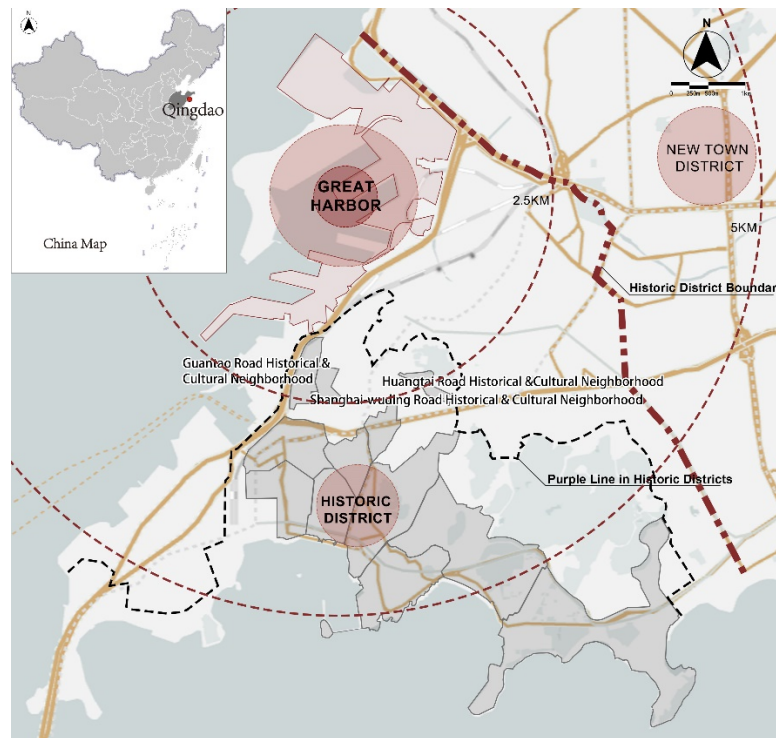


Figure 2. Location of the study area.



Figure 3. 100 years of changes in the whole landscape of Qingdao's large harbor - from the beginning of the 20th century to the beginning of the 21st century. Source: Qingdao Port 120 Years Picture Album. (2012).

According to the process of the construction of the big port and the development of shipping, the development of Qingdao port industry is roughly divided into five stages (Wang, 2022). During the beginning stage (1891-1914), Germany began to build a port in Qingdao as well as a railroad connecting the mainland with the seaport, a large harbor on the east side of Jiaozhou Bay in the low granite hills, railroads along the east coast of Jiaozhou Bay, and industries along the railroads. The stage of rapid development (1915-1949), including the periods of the Japanese Occupation, the rule of the Nationalist Government (Nanjing and Beijing), and the second Japanese Occupation, port was further expanded on the basis of the original construction, and continued to develop and improve. After nearly 30 years of slow development, there was the maturity stage (1980-2010). In the 1980s, deep water and automation were carried out by the Chinese themselves. In 1985, the port construction command was moved from Dagang District to Huangdao, and the reconstruction of Dagang District was carried out. With the gradual substitution of the shipping function by new port areas, the Great Harbour had been entering the transition stage (2011-present). In 2014, Qingdao Municipality put forward the transformation of the Great Harbour

into “Qingdao Future Port”, which integrates tourism, vacation, and international business with the cruise industry as the leading one. (Figure 4)

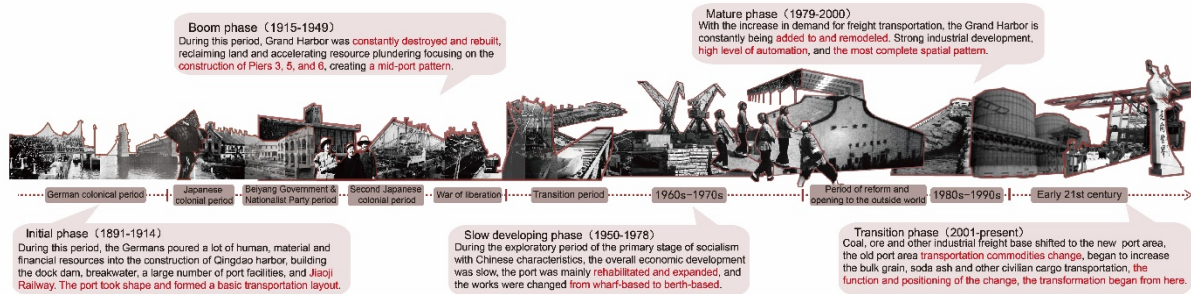


Figure 4. Analysis of historical evolution. Source: Evaluation, conservation and reuse of port industrial heritage under the background of stock renewal: A case study of Qingdao Port. (2022).

3.2. Census and mapping of the current state of the heritage

Located on the east coast of Jiaozhou Bay, the Great Harbour in Qingdao consists of eight protruding wharves, carrying the memories of Qingdao's port industrial development and city construction. Throughout the century's history, the fusion of Qingdao's coastal spatial environment and colonial history and culture with the unique shipping industry culture of the Great Harbour has formed the unique, richly typed, and massive industrial heritage of the Great Harbour (Wang, 2023). Most of them is distributed in single point, line, group and network forms, and the combination of point and line is its main morphological feature. According to the census results, the total number of port industrial heritage is 121, distributed as shown in Figure 5.



Figure 5. Distribution diagram of Great Harbour industrial heritage elements.

From the perspective of industrial function, the Great Harbour industrial heritage includes transportation, warehousing, processing and living auxiliary, etc. Among them, the transportation category can best reflect the characteristics of the port and the city, such as wharves and dams, coastline, railroad line, etc., which is characterized by the dominance of the industrial status, the cross-border spatial distribution, the continuity of the historical evolution, the typicality of the value of the heritage, and the diversity of the cultural connotation. It is the core and foundation of the Great Harbour industrial heritage preservation, as well as the focus and difficulty of regeneration. There are about 30 transportation industrial heritages, accounting for about a quarter of the total industrial heritages of the Great Harbour, and most of them are located on top of the wharf dams and distributed along the shoreline or railroad lines.

4. Results

4.1. “Layering” of Heritage Elements

4.1.1. Evolution of dock dams

A wharf is a hydraulic building for ships to dock, load and unload cargo, and pick up and drop off passengers, and it is the main component (material entity) of a port. After a century of history, there are 8 wharves and 52 berths in the port. Pier 1 to 4 were built in the period of German occupation, pier 6 is the only one constructed in the period of the Republic of China, pier 7 is a mechanized wharf independently designed and constructed by Chinese after the founding of the country, and pier 8 was constructed after the reform and opening up and transformed into a containerized wharf. They are the witnesses of the whole production and development of the Great Harbour since the colonial period, from which a large amount of our country's materials have been plundered out of the country while a large number of foreign goods have flowed into the Chinese market.

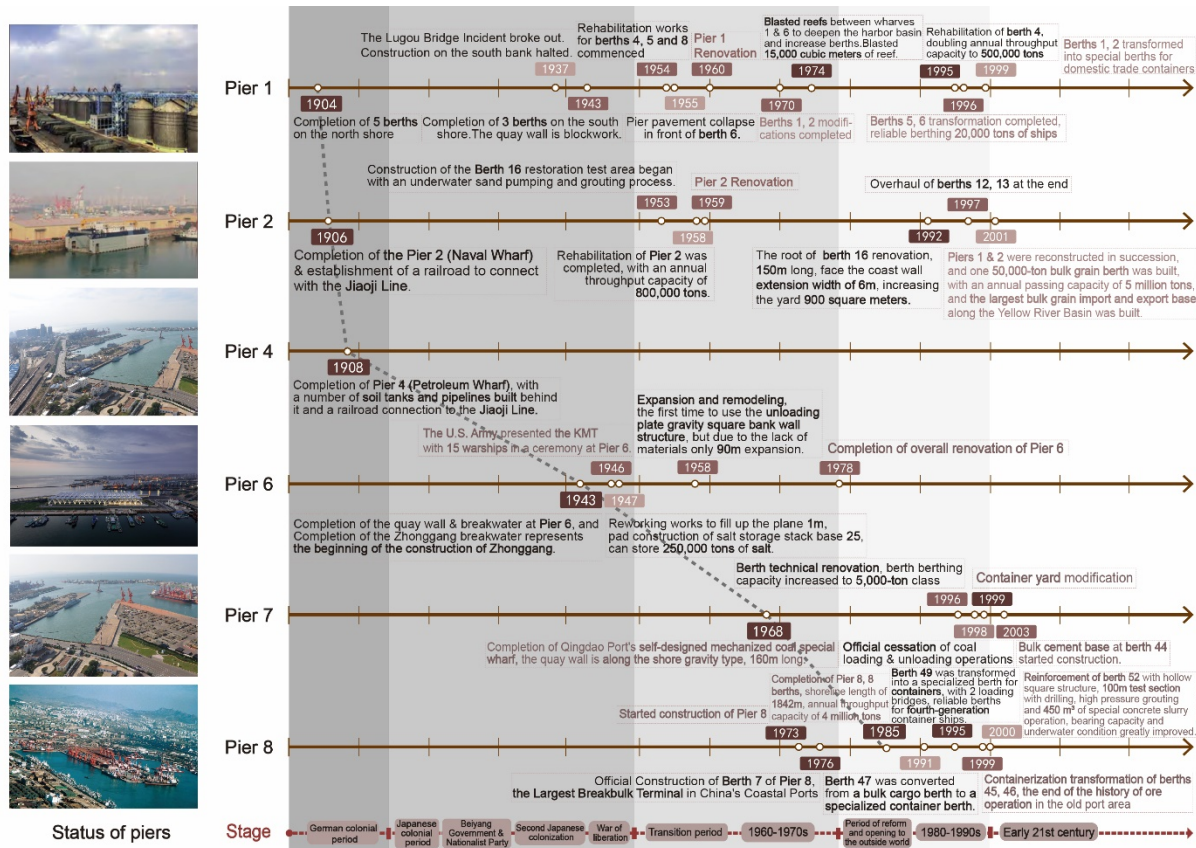


Figure 6. Evolution and current status of the terminals in the Great Harbour. Source: Evaluation, conservation and reuse of port industrial heritage under the background of stock renewal: A case study of Qingdao Port. (2022).

From the perspective of port hydraulics and port planning, we analyze the main processes of site investigation and selection, planning and design, construction, restoration and expansion, etc., extracting the scientific concepts and technologies, recognizing the scientific, technological and engineering values. In addition, the industrial characteristics are explored from the spatial and functional relationship, and the social and cultural connotations are explored from intangible heritage (Ron, 2012). The specific contents of which are shown in Table 1.

Table 1. Characteristic value analysis of dock dams

Aspect	Details	Value
construction	Different masonry techniques were used for different dams at different times: wood pile concrete bearing type in the early period (Pier 1, 2, 4) and concrete gravity type in the later period (Pier 6, 7, 8).	Reflecting the representative port construction technology and construction level at home and abroad in various periods, reflecting the difference in scientific and technological level between countries.
Space Function	Terminals that transport different goods (grain, oil, containers, etc.) vary in carrying capacity, berth	The relationship between land & sea maps the industrial layout, reflects the industry features and the port development, and is the basis for

	scales, and transportation & storage equipment.	the construction of the industrial chain, as well as the key to maintaining industrial operations.
Social & cultural	People carried goods, commanded management, and lift operations on the wharf, where labor and life coexisted, forming a collective memory of production and life, solidarity and collaboration.	Dock dams are not only the material carriers and basic platforms for production, but also carry the prosperous modern industrial scene from the exploitation of hard labor of many people to mechanized transportation.

4.1.2. Evolution of dockside

The length of the quay shoreline of the port is one of the important symbols of the scale of the port, indicating the number of ships it can accommodate and carry out loading and unloading operations at the same time, which is the embodiment of the transportation capacity. The 17.57km shoreline of the Great Harbour has three main uses, namely operation(5.6km), docking(5.4km) and protection(4.4km). The quay shoreline is a linear industrial heritage, a cross-section of the quay wall, an artificial interface between land and sea, contrasting and complementing with the gentle and changing nature of the beach shoreline along Qingdao's south coast. The existing coastline is of different ages, with the import and export coastline of the harbour constructed earlier, during the period of German occupation, and the internal reclamation, mostly after the founding of the PRC. The overall shape of the shoreline is circular. With the continuous construction of the wharf, the degree of curvature gradually increases. Until the wharf is saturated, the shoreline has the longest length and the greatest degree of curvature, which is utilized to the fullest extent and can berth most ships (Figure 7).

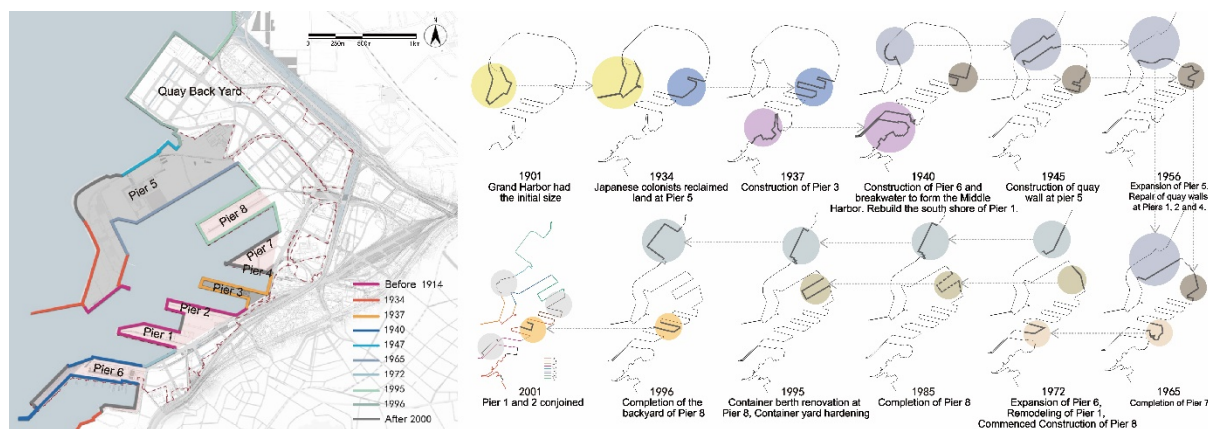


Figure 7. Diagram analyzing the completion age and evolution of dockside in the Great Harbour. Source: Evaluation, conservation and reuse of port industrial heritage under the background of stock renewal: A case study of Qingdao Port. (2022).

For the excavation of the shoreline's special value, it is mainly analyzed from the perspectives of history, space, landscape, relationship with transportation industry and sustainable development. First of all, the artificial shoreline recorded in various periods of construction, the south side of the import and export place is mostly the shoreline before the founding of the country, and the north side of the harbour is mostly constructed after the founding of the country, which has become a "corridor" to show the history of the development of the port. Secondly, the shoreline formed by the protruding dam, so that the sea and land interlacing, in keeping with Qingdao "Trestle Bridge" landscape characteristics. This creates favorable conditions for subsequent multi-dimensional landscape modifications. In addition, the berth is set according to the shoreline's length, the gate machine, bollards are also set along the shoreline, so the

shoreline is the basis for berthing and a reflection of the level of transportation. Finally, the setting up of wharves and breakwaters in the early stage leaves room for later construction, which is forward-looking and an example of practicing the concept of sustainable development planning.

4.1.3. Evolution of port railway lines

The railroad line in Dagang area started with the first port construction during the German occupation period, and is a part of Jiaoji Railway. The Dagang railroad line has been continuously expanded to all the wharves with the increase and decrease of wharves in each period, and it is an important historical witness to the development of Qingdao port, while its railroad construction technology also shows high scientific and technological values. The construction of Jiaoji Railway started in 1899, and the section from Qingdao to Jinan (394.05km) was opened to traffic in 1904, and the special lines in the harbor have increased from the initial 6 strands to the current 12 strands, and the intersection nodes in the harbor have been changed from one to two, and have been preserved until now, which is a structural material element with the highest value of the heritage in the harbor area. The increasing number of branch lines feeding into the main Jiaoji Railway reflects the increase in freight traffic and a more complete railroad network pattern (Figure 8).

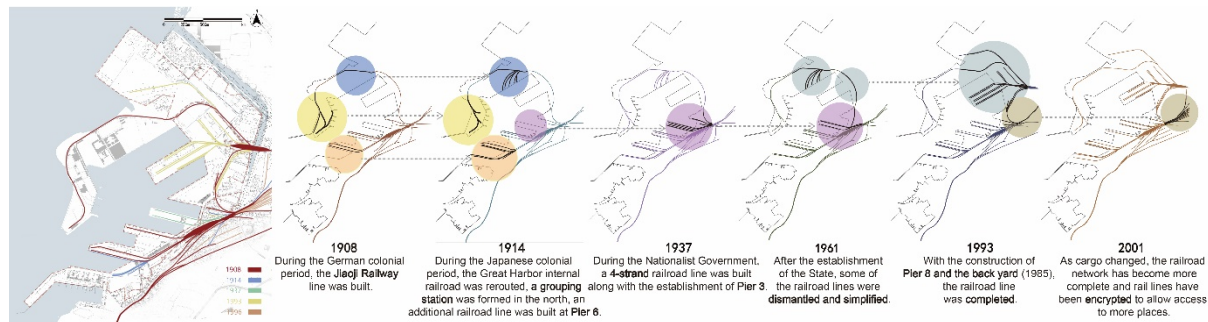


Figure 8. Diagram analyzing the completion age and evolution of railroad lines in the Great Harbour. Source: Evaluation, conservation and reuse of port industrial heritage under the background of stock renewal: A case study of Qingdao Port. (2022).

For the excavation of the characteristic value of the railroad line, it is mainly analyzed from the perspectives of historical status, mode of transportation, relationship with the storage industry, structure and material technology, spatial morphology, and standardization. Undoubtedly, Jiaoji Railway is one of the earliest railroads in China, the first electrified railroad in Shandong, an important record of Shandong's modern economic and social development, and is listed in the first batch of China's industrial heritage protection list [14]. The Dagang railway, in turn, is the origin of the Jiao-Ji Railway, the first railroad in China with the initial intention of contacting the port, which has lasted for a hundred years and is basically well-preserved to this day, and is an important witness to the plundering of resources by foreign invasion. What's more noteworthy is that the ship transportation is closely integrated with Jiaoji Railway, which is an example of the transportation industry layout of sea-railway intermodal transportation, reflecting the more advanced transportation mode and concept in the world at that time. The layout of the railroad line is closely related to the wharf warehousing, and the main warehouses and silos are arranged with a railroad line on one side, which facilitates the unloading of goods or loading of trucks for transportation directly. In addition, Dagang railroad line is a unique record of railroad line construction in different periods. The evolution of sleepers materials from "iron" to "wooden" to "reinforced concrete" reflects the railroad technological progress. In the Great Harbour industrial heritage, the railroad line is one of the most unique types of heritage, which is an independent and complete system spreading all over the port area. The railroad line and the shoreline act as the tandem line of the landscape of the land area and the shore area respectively, and the two lines

have their own characteristics, and they run in parallel and interweave with each other, which can constitute the two characteristic landscape belts of the Dagang area.

4.2. Holistic framework

4.2.1. Holistic conservation of heritage elements

The holistic conservation of port industrial heritage involves industrial production and transportation flows, which can reflect the technical conditions of production and the technical characteristics of the products, and are also an important part of the intangible cultural heritage of the industrial heritage. The holistic conservation of heritage elements based on industrial production and transportation flow lines is a tangible demonstration of intangible technology and culture, which will profoundly explain the significance of heritage conservation.

In this study, six production and transportation flows were identified. First of all, the transportation function is embodied in the international container sea-rail intermodal line & container transportation EDI system (Pier 8, 1989). The combination of the wharf and the railroad line is the material embodiment of “sea-rail intermodal transportation”, an intangible concept and technology, which fully demonstrates the concept that “the origin, value, and continued significance of tangible cultural expressions come from intangible cultural practices,” and therefore needs to be conserved in a holistic manner. Secondly, on the wharf, the ship unloader unloading operation process, bulk grain receiving and unloading system (Pier 1, 2001) and coal wharf mechanization system (Pier 4, 1966) play the role of temporary storage and transshipment; in the hinterland at the back of the port area, the role of production and processing is played by the mechanical processing production line of the port machinery factory and the production line of processing soybeans in the port (2005). In the port, the transportation function is the first priority, and the construction of the storage area is earlier than the processing area, so the protection priority of the storage area located on the wharf is higher than the production and processing area in the hinterland.

4.2.2. Holistic regeneration of the port area and the old town

Initially, Qingdao was born because of the port and prospered towards the sea, and the port drove the development of the city. Later on, urban & port expansion, the port changed from a suburb of the city to the central area of the city. With the technological change and the shortage of land, the port partially relocated outward to Huangdao, and with the internal industrial upgrading, it is still a pillar industry in the city. With the appreciation of the land in the city and the shortage of the scale of the old port area, the port relocated as a whole, and the urban renewal pushed the renewal of the port area. In the future, the preservation of the port's industrial heritage to the city's memory will make it an engine for the development of the port area and even the whole city space, transforming the port into a new functional center in the existing urban structure (Vries, 2014).

Since the port area is a relatively independent industrial area in the city, its production and living system is obviously separated from other areas around the city, so the development link between the port area and the city is also concerned. In Dagang, the Jiaoji Railway and the viaduct cut off the port area from the old city (Gantao Road Historic District) on the southeast side and form an intermediary space with dynamic and ephemeral characteristics. The utilization of the intermediary space is the key to integrating the port area with the historic district, which is a comprehensive and dynamic process aimed at building a network of urban resources. Restoring usable space through transient uses in response to intense socio-economic changes is a way to diversify the economy, making it more adaptable to change and creating attractions, even as a source of long-term financing (María, 2024). In terms of the overall urban spatial pattern, the core elements, natural landscape, and humanistic environment that constitute the series of heritage of

port industry and history and culture should be integrated, highlighting the important heritage units, organizing the excursion routes around specific themes, and organically combine the protection of port industrial heritage with the protection of historical and cultural heritage (Whitehand, 2010). As far as possible, the continuity of the landscape and the connectivity between the port area and the urban area should be guaranteed.

5. Discussion and conclusions

This paper examines the conservation and revitalization of port industrial heritage in Qingdao, China, using the framework of urban historic landscape as an example. Typical heritage elements with both historical and co-temporal characteristics were identified from the 121 elements surveyed. Then, we analyzed “layered” characteristics of three typical heritage elements, including wharves and dams, coastlines and railroad lines. From the perspectives of continuity and wholeness, we discussed the renewal strategy of port industrial heritage, established the connection between intangible values and tangible heritage elements, and established the connection between port areas and the old town, in order to realize the regeneration of port industrial heritage and the living, publicizing and landscaping of port space.

Through the history of the construction of the Grand Harbor and the evolution of typical heritage elements, we can learn about its iterative construction techniques, and the spatial landscape features. Although the site was originally chosen and planned by German colonizers, the construction process was carried out by the local working people - a history of exploitation through hard work, but also a history of solidarity, collaboration, sweat and lives of the local underclass. In the 1980s, Chinese scientists automated machinery through their own research and development, and the legacy of the local people's thinking and technology is embedded in the heritage - a process that is imbued with national pride, from oppression to independence. Nowadays, with China's development and rising international status, the people's pride has replaced the feeling of suffering from the colonial past, but the contribution of our ancestors should not be forgotten, and this collective memory should be preserved and displayed in a tangible way. The complete preservation and revitalization of the industrial heritage of Dagang is not only a record of the colonial history of the past 50 years, but also a historical witness to the autonomous development and anti-colonialism of the following 70 years.

In theory, by applying the HUL methodology to the study of port industrial heritage, the concepts and principles of heritage conservation are emphasized, while the methodology is applied to a wider range of areas and objects. In addition, the hierarchical dissection of specific objects has led to a deeper understanding of the value and development dynamics of heritage, and the holistic regeneration of the port area and the historic city center has strengthened the continuity of urban space. In practice, the project “Conservation and Planning of the Industrial Heritage of Qingdao Dagang” has pointed out the direction and provided a reference for similar heritage conservation and revitalization projects.

This project has been more fully studied in terms of preliminary research and value evaluation, and detailed planning has been adjusted according to conservation. The next step will be in the implementation of the protection of the port's industrial heritage and the execution of the overall renewal of the port area, including the display of heritage elements, renovation, investment and operation.

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