

Study on Construction of Corridor for Conservation of Port Heritage under Interdisciplinary Perspective

By

Ling Shen

Faculty of Engineering, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia.
School of Urban Planning & Environmental Science, Hunan University of Technology, Zhu
Zhou, Hu Nan, China
Email: shenling2019@sina.com,

Asmawan Mohd Sarman

Faculty of Engineering, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia.
Email: asmawan@ums.edu.my

Mohamad Ibrahim bin Mohamad

Faculty of Engineering, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia.
Email: drmim@ums.edu.my

Guo Min Wei

Faculty of Engineering, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia.
School of Urban Planning & Environmental Science, Hunan University of Technology, Zhu
Zhou, Hu Nan, China
Email: lwgm_mail@163.com

Abstract

Port heritage as a crucial element for urban redevelopment is attracting more attention while facing many challenges. Though many big inspirational waterfront revitalization projects merged during the past decades, much more tragedies of port infrastructure degrading in urbanization are ongoing all over the world due to the limitation of methods for identification and preservation. This paper aims to bring a new perspective to understand port heritage by conceiving a “corridor”, from which, the scattered lineal remains are expected to act more significantly and effectively for urban redevelopments with the help of integration with dynamic landscape infrastructures. Firstly, reviews on heritage corridor give a sight for awareness that not only the heritage resource but also the surroundings need to be preserved multidimensionally. Additionally, a simplified research framework is proposed for identification and ranking the port heritage based on Analytic Hierarchy Process (AHP), in which, an adaptive evaluation with quantitative and qualitative consideration is being operated through attributor-reconstruction under the morphological configuration. At last, a net-worked landscape system is introduced to cover the space in and between the heritage sites, which forms the spatial skeleton of the corridor, meanwhile, contributing to the landscape infrastructure to serve, improve and beautify the urban waterfront.

Keywords: Port heritage; heritage corridor; Landscape infrastructure; Heritage conservation; Urban waterfront

Introduction

Port Heritage, as a not yet unified concept independent from industrial heritage, is frequently discussed when it became more crucial for recognition and revitalization of port

cities during the transformation era, and due to the unique geographical location—between city and waterway, the establishment of a new relationship between large-scale infrastructure sites and urban waterfront (Otto et al., 2004) is ongoing through a special language of urban context, which is, unlike traditional landscapes, a broad disciplinary perspective including industrial archaeology, architecture, urban planning and ecological environment as well.

Generally speaking, port heritage refers to all buildings, structures, facilities, tools, and related materials as well as intangibles with historical, technical, social, architectural or scientific values built for port transportation and production activities, all of which integrated as the epitome of port cities and represented the cultural evolution concentrating on the water edge. Recently, research drives the conservation of the port heritage stick to the urban redevelopment project as well as converted the mode of regeneration itself. Many influential successful cases revealed the trend that other than individual objects, the entire settlement around the heritage site especially together with the environmental elements can preserve the port heritage and revitalize the city's waterfront in efficiency, among which landscape potentials have been emphasized for attracting all stakeholders by coordinating atmosphere of complexity in urban development. But because of shortage in comprehensive theory discussing port waterfront redevelopment and limitation with only a few large projects of world port cities affected the spread of historical preservation ideas (Brown, 2009). Though preservation plans in appealing cities offered experience featuring with port remnants and nature surroundings, they are always considered as high-level version that average port cities hesitate to compare themselves for exploring the more precise method for application. Besides, confusing identification in the heritage group, tremendous port infrastructures became a victim of the urbanization process in the eyes of short-term benefits.

However, as born near the waterways and paralleled with the routs, port area absorbs the nature advantage as well as makes symbiosis with human civilization(cities), and the remains of which have an access relying on linear open spaces to build high-quality ecological corridors to alleviate and compensate for the loss and fragmentation of habitats, which is particularly important for the fragile and sensitive urban waterfront (Steelman & George, 2009). In addition, nowadays, the concept of heritage has long transcended the category of cultural relics and the scope of preservation continues to expand to the overall historical locations, even cities and regions (Wang & Sun, 2001) with increasing ecological consciousness (Everard & Moggridge, 2012), which can arouse more people's attention for port heritage at different levels and bring new perspective for examination, evaluation, conservation and regeneration. Thus, a new preservation framework based on “heritage corridor” is proposed aiming not only to construct a more systematic mechanism for conservation and regeneration of port heritage, but also to conduct the revitalization of industrial waterfront for more port cities. It is proposed that using heritage corridor theory to integrate scattered port heritage resources can optimize the allocation of heritage structure, break through the development limitations of waterfront areas from general port city, and finally gain a dynamic balance of economy, society and the environment.

Methodology

The core issue from this study is to identify the regular principles contributing for heritage corridors and adapt to port-related category with consideration of unique character and cultural significance, from

which a new sight for conservation of cities' historical waterfront may affect the plan of urban revitalization and redevelopment. To achieve these goals, a simplified research framework is proposed concerning the heritage theme and its supporting linear-

space with multidimensional methods for the analysis of each respectively, including an adaptive plan targeting port heritage is being operated through attributor-reconstruction under the morphological configuration of urban landscape along the rivers. The procedure consists of two inquiries: firstly, review on heritage corridor research gives primary awareness that not only the heritage but the surroundings need to be preserved multidimensionally and finally as a whole. Furthermore, port heritage as a key component of the heritage theme along the river and the indispensable infrastructure at urban waterfront is worthy to be discussed with the potentiality of building a corridor-like conservation system to solve urban problems.

Discussion on heritage corridor

Heritage corridor, as a product of the combination of regionalization trends in the field of cultural heritage preservation and greenway ideas, not only emphasizes the cultural significance of heritage conservation, but also targets ecological and economic value involved (Li et al., 2004). It refers to linear landscape with a collection of special cultural resources, from which there are obvious economic centers, thriving tourism, adaptive reuse of old buildings, leisure spaces and environmental improvement (Charles et al., 1993). The scale differs, mostly mesoscale, as large as an inter-regional watershed, or it can be only a part of the waterway through one city (Wang & Sun, 2001), and due to spanning different geographic units and cultural sectors, it reveals a common work of long-term coexistence, coordinated development, and organic evolution between man and nature which highlights the balance between economic linkage and natural ecosystem.

The innovations for building a “heritage corridor” mainly reflects in three aspects. Firstly, historical traceability and national cultural identity are emphasized at the ideological level. Besides, the conservation concept advocates the trinity of “culture, nature and intangible heritage”, from which continues increase in value is expected following the strengthened multi-objective “live inheritance” preservation system. The last but not the least, it promotes a comprehensive regional and integrated heritage preservation strategy at the methodological level.

The mechanism of heritage corridor construction

The construction of a heritage corridor barely has specified criteria, because the aims and the targeted national operation systems differ, which force us turn to combing summary through literature research- a conclusion that reflects and reveals the historical stages, forms and laws of the development and evolution of subjects for the identification and feature analysis of the constituent elements of heritage corridors. There are two spatial components contributing to corridor construction and preservation planning- heritage resources and corridor space (green corridor, transportation framework, recreation space and interpretation system) (Fig.1), which are usually illustrated as that, the former decides the preservation theme and content while the latter explains the way for construction. Heritage resources represent all cultural resources (structures, buildings and other historical and cultural relics) along the linear space which depend and reflect on the longitude and width of the “corridor”. The corridor space emphasizes the conservation of the natural environment as well as connection with cultural heritage and shares responsibility with traffic routes for recreational activities and tourism, from which, the interpretation system explains the connotation and historical importance of heritage resources to people, based on which the context can be sorted out (Fig.1).

Due to diversities involved in corridor construction, methodologies cover a broad range, such as historical research methods having been used to excavate and evaluate heritage

resources, landscape ecology and urban(rural) planning methods to combine heritage preservation with greenway and landscape construction concerning ecological environment protection and promotion, tourism management disciplines to tourism and regional economic development, and so on.

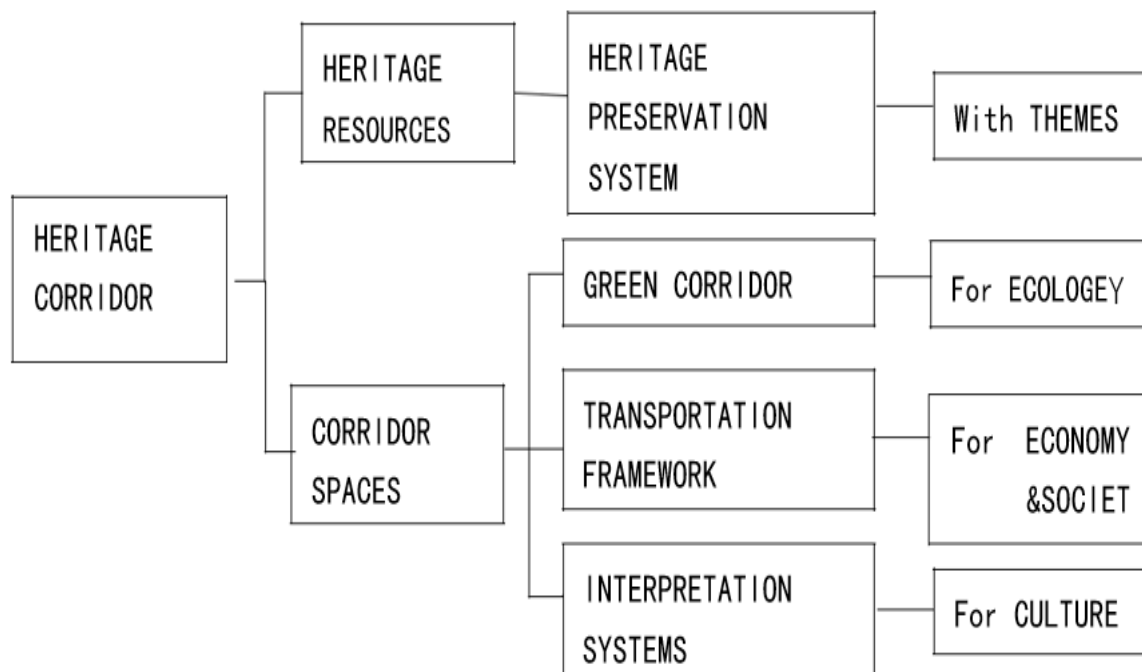


Fig.1 Constitution of traditional heritage corridor (Drawn by the authors)

Identification and value evaluation of heritage resources

In the existing heritage corridor framework, whether it is a river-line type or road-traffic group, the determination of heritage corridor theme, including the scope of heritages and the criteria for identification, always depends on the linear subject, like the Black Stone River Valley(74km) or the Erie Canal(843km) in US, water body sets the theme tone and organizes the heritages in tandem, from which human activities and culture have derived. Meanwhile, the heritages stick to the “corridor” are not only a simple gathering, but an overall representative of a common historical theme with the characteristics of large-number, wide-range, and rich-types. Therefore, a clear and scientific definition of the theme (like industrial heritage), is always the basis for grasping the integrity of the heritage corridor and fully understanding the values and implementing unified preservation.

Generally, the macro-scale preservation strategy of heritage corridor covers the delineation of the corridor scope, the identification of the heritage resources, and the reconstruction of the spatial relationship between heritage elements. The research scope is mostly based on administrative boundaries as well as relatively clear geographical elements such as roads, water bodies, ridges, and transportation facilities (Andresen et al., 2004). Considering the distribution of heritage and the habitant nearby, it is recommended the field survey (major manner) or Geographic Information System (GIS) technology to establish a database for documenting the temporal and spatial information and related attributes of the heritages, which will also help to determine the reasonable boundary (especially the width) of the heritage corridor. While, at the micro level, heritage conservation guideline design needs to target both on individual and group, however, diversities among which determine the complexities for investigation, registration, evaluation, and multi-index decision-making problems. So Analytic

Hierarchy Process (AHP), a relative comprehensive evaluation method that combines qualitative and quantitative analysis is used to handle discrete heritage sites by layering and structuring multi-faceted characteristics into systematic judgment matrix. After calculation and analysis all the heritage resources, determination and management for the specific nodes of heritage corridor could be proceeded, which contribute to realize

the spatial conversion between the green corridor and the heritage area and provide a premise for the establishment of interpretation system and staging preservation.

Configuration of landscape infrastructure

Heritage resource acts the essential part in preservation and utilization, while without sound corridor space based on landscape infrastructure system, it is hard to maintain the heritage corridor in good operation. Take another word, a heritage corridor on a certain scale can also become a strategic landscape infrastructure to protect and restore the environment of the corridor region through appropriate ecological restoration measures, scenic design and tourism development methods. By providing ecological services such as recreation, leisure and education for urban and rural residents, bring more attraction on land cover, wildlife, habitat and suitability, it rejuvenates some point-shaped heritage that was originally lacking in vitality and it particularly important for those areas where the economy is underdeveloped and the relationship between man and land is in serious danger.

As Pierre Belanger illustrated that landscape infrastructure refers to the systematic large-scale landscape that serve and supervise the city by carrying resource and energy flows (Belanger, 2009). Due to the different emphasis on function from physical form to ecological habitats, two concepts called “grey infrastructure” and “green infrastructure” dedicate to explain the way how to manage the landscape infrastructure. Followed the regulation that the “green” element (green ways, parks, etc.) usually behave like the foundation on which “grey” part (utility corridors, streets, etc.) can be rooted (Rouse & Bunsterossa, 2013), stories like in the Heritage Corridor of Ohio and Erie Canal revealed the dynamic trend that the transformation from “grey” to “green” is undergoing because through the construction of green infrastructure the ecological service functions such as providing fresh air and clean water environment, protecting wild species and ecological diversity, reducing floods, absorbing carbon emissions, etc., as well as social functions like leisure, recreation, cultural conservation can be simultaneously presented. Therefore, it is spread as the adaptive manner to integrate multi-scale strategies and diversified goals for overall preservation and development (Benedict & Edward, 2006) and it also leads us to use landscape infrastructure as a coordinated system for linking economy, community and environment and organize the corridor space smoothly as a significant media for supporting and promoting the conservation of cultural heritages and even the development of city. In addition, the landscape framework from the green infrastructure guarantees the harmonious transition of urban space, thereby maximizes the promotion of the continuation of urban context, the construction of space, and the preservation of natural and cultural heritage as well as responses to urban space expansion issues.

Principles for integrated planning of port heritage corridor

The conservation planning of a heritage corridor requires integrity and authenticity. More specifically, for port heritage corridor, setting the corridor’s boundaries, rethinking the heritage system and reorganizing the landscape backup contribute to guarantee the preservation procedure and pave the way proceeding for regeneration, from which a clear idea guiding port heritage preservation can be drawn out (Fig.2).

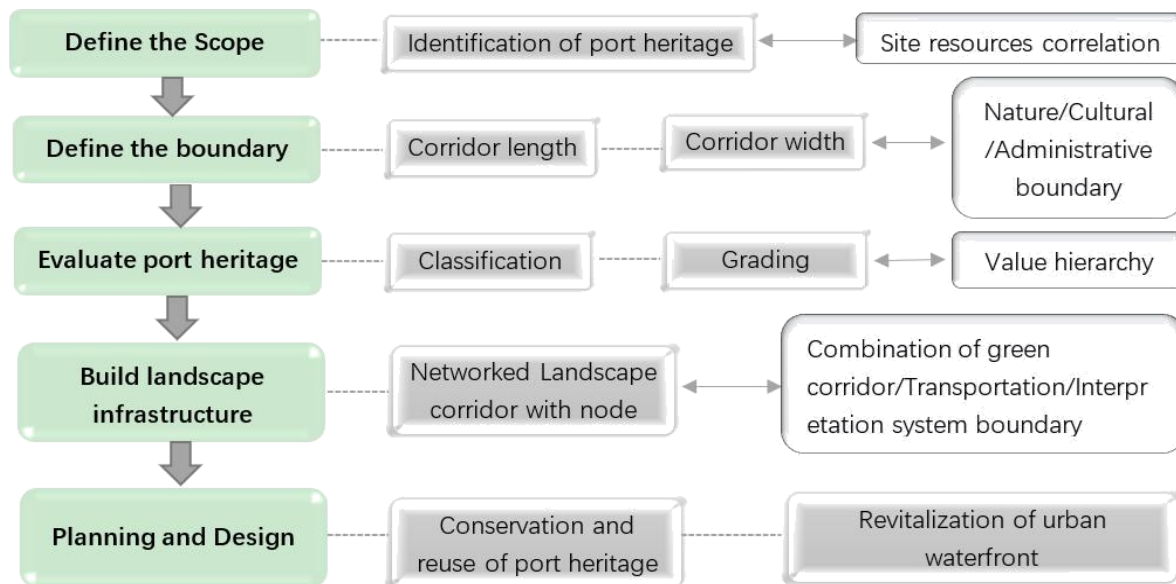


Fig. 2 *The proposed framework for building the port heritage corridor (Drawn by the authors)*

Due to the complexity of the components and functions of heritage corridors, there has never been an authoritative conclusion on the reasonable width of corridors. But it seems possible to determine a reasonable boundary under the context of research on river corridor/canal corridor for port heritage because of the typical theme and dominant position along with inherent linear water body as series nodes. Besides, with the inherent interactions with cities, definition about urban waterfront further clarified the differences between port heritage and historical district around.

Port heritage is different from the traditional concept of cultural heritage, as it often includes the whole historical port sites in the memory of ordinary groups with “outstanding universal value”, which can also be called a memory place (Nora,1999). It also meets the dynamic of today’s world heritage movement: the research object of architectural heritage is shifting from cultural relics used by a few elites to the places experienced by ordinary people (Kenneth Hudson,1979), which gives an opportunity to embrace all related constructions, places and object image concerning water transportation, production and trade, and even expand the influence on consolidating the heritage element in-between landscape infrastructure system. So the gradation analysis and evaluation of material port heritage could be a process of combining qualitative and quantitative means that jointly determined by the intrinsic material value and the status quo, for which, the method of qualitative description combined with the quantitative assignment of scores is proposed to determine the calculation of the intrinsic value, while the current statue evaluation is based on the qualitative description to classify the evaluation results and determine the grade coefficient (0-1). At last, the comprehensive finally identified by the score of intrinsic value multiply the grade coefficient. Since intangible port heritage mainly exists in intangible form, there is no current preservation problem, so it focuses on qualitative description and summarizes its comprehensive value.

Analysis and Result

Scope and level setting for preservation planning

According to the previous analysis, port heritage corridor seems a simplified but adjustable formulation version for heritage corridor based on linear water body (basically river) and it mainly could be divided into a region (between cities or in a city), a port heritage node

(landscape node), a port-related cluster, and port heritage site-a four-layer construction mode with corresponding preservation and reuse countermeasures (Fig.3). As shared the theme “port” and the same waterway, “region” gives a new sight to breaks the ministrative boundaries in order to prolong the longitude of the corridor. In a port heritage node, inherent relationship between port zone and riverfront brings the perspective focusing on the revitalization of urban waterfront, while port-related cluster refers a close group radiated from one port heritage site which provides potential collaboration with transportation and recreation space. Tracing every piece of port memory leads the dedicate analysis and rearrangement on port heritage units, from which all-in-one value could expand the effect to the upper layer.

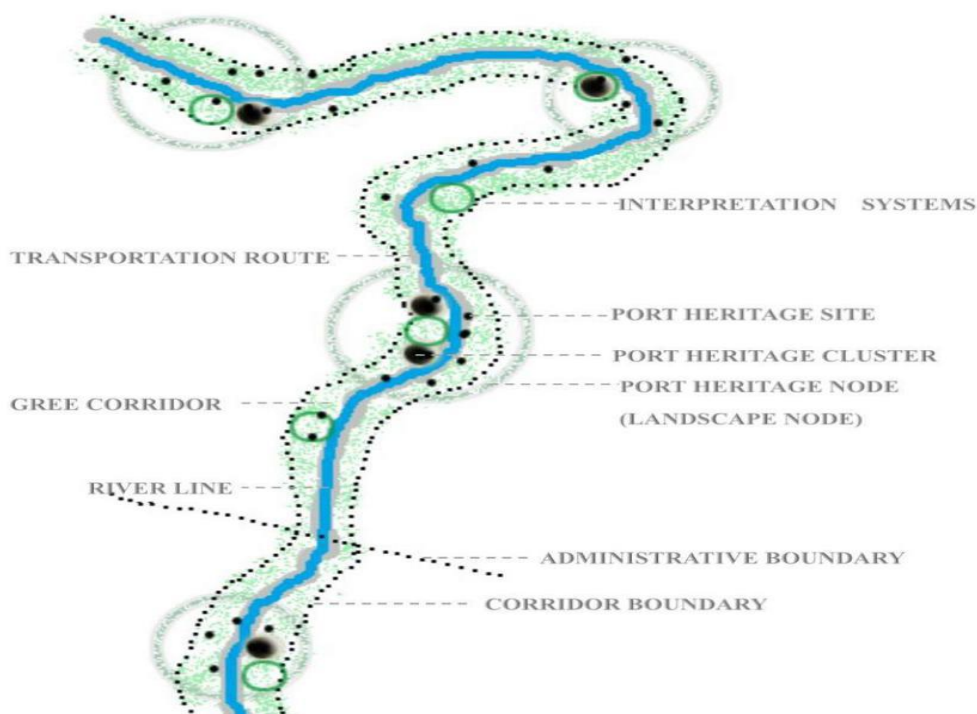


Fig. 3 *Spatial structure of port heritage conservation corridor (Drawn by the authors)*

The boundaries of port heritage corridor are determined by the natural boundaries (watershed, water boundaries), cultural radiation boundaries and administrative boundaries for the longitude while urban waterfront boundary for the width. The width is always an obstacle issue, but when turn to the division of the waterfront area and specific port-related industrial project, it becomes more clear - under the inspection of accessibility to the waterfront and the range of public travel, the general width is 200 m to 300m from the water with a buffer area about 1km to 2km, which is approximately equal to the 15- to 30-minute walking distance of the public (Yang & Dong, 2007). Certainly, the width of corridor is affected by the actual planning and design needs, which is closely related to the planning layout, location characteristics (with physical barriers such as terrain, railways, and highways), and development levels of each city.

The overall conservation pattern of port heritage corridors

The traditional heritage corridor is introduced as one heritage preservation system consists of heritage resources, green corridor, routes and interpretation system (Wang & Sun, 2001), based on which

dedicated “port” version clarifies heritage features and rearranges the green-way-rooted supporting system. Stressing on port-related industrial characteristics gives the qualitative and

quantitative evaluation procedure more reliable and precise, meanwhile, reorganized corridor space serviced as an ecological landscape integration promotes the conservation and regeneration process at different levels.

Classification and value evaluation of port heritage

The specific valuation process is mainly divided into four levels: single building (construction), related units or industrial enterprises, heritage clusters, and urban waterfront. Each level contributes the evaluation system based on the corresponding value standards. At the same time, the four levels enhance a progressive relationship that the evaluation results of the lower levels constitute the basic information source for the evaluation of the previous higher level (Fig.4).

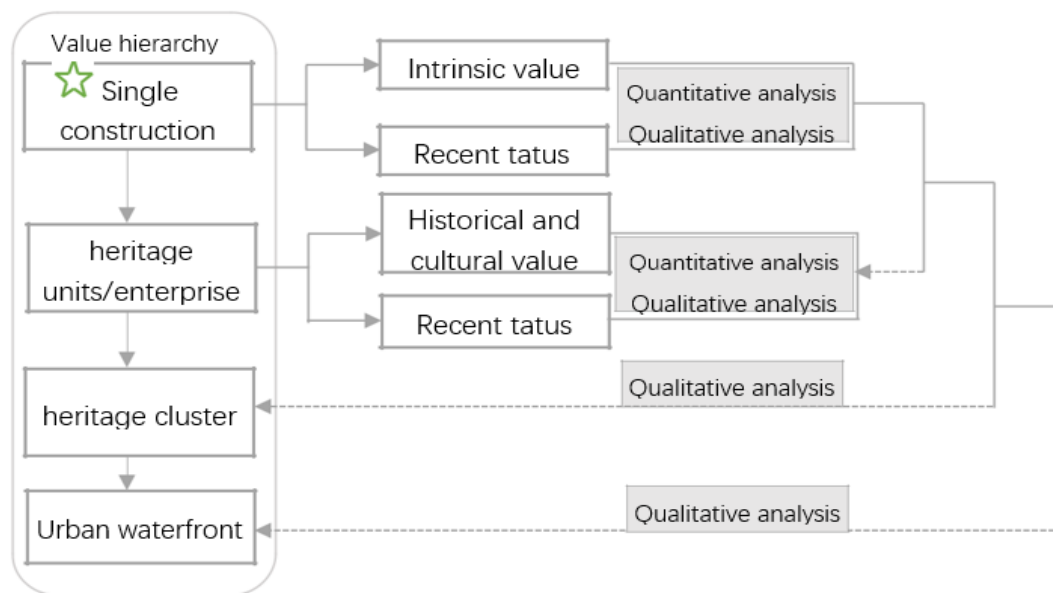


Fig. 4 The Technical Route of the Evaluation of Port Heritage Value (Drawn by the authors)

Comprehensive evaluation of single port heritage site (construction) plays the primary and core part in the value hierarchy system and it represents as the product of the intrinsic material value and current status. The equation goes as $V = I \times C$. V is the total value of the heritage site, C is current status of port heritage site ($C < 1$), I is the intrinsic material value of port heritage site.

The current status of port heritage site (construction) “ C ” is conducted by on-site research, document research and public scoring that decide the quantity of three evaluation factors such as current preservation situation, existing obstacles and future potentials, and from which, the rank coefficient (0-1) is determined at last.

The standard steps for measuring the intrinsic material value of port heritage site (construction) are as follows: (1) Establishing qualitatively described evaluation index based on the classification of port heritage values. In this section, the evaluation indexes are divided into five major categories such as historical value, scientific value, social and cultural value, artistic value, and economic value (Table 1).

Scientifically allocating the weights of the five major evaluation indicators. Due to the differences between conventional and unconventional construction, the distribution of weights needs to reflect the characteristics from both. (3) Classifying each evaluation index qualitatively to form representative evaluation factors and assign them corresponding scores

by layering the performance (percentage system). (4) Calculating the value of the port heritage site through the calculation formula, $\sum \Sigma$. is the weight ratio of evaluation index ($0 < < 1$), is the weight ratio of =1 =1 evaluation factor ($0 < < 1$), is the score of the evaluation factor, is the number of evaluation index, are the number of evaluation factor.

Table1. Model of intrinsic evaluation of port heritage

Evaluation Index and weight(a)	Evaluation Factor and weight(b)	Indicator description and score of Evaluation Factor(P)	Score of intrinsic value (A)
Historical Value (20%) (10%)	Year of construction (40%) (50%)	Stage of port development I-100 II-75 II-50 II-25	
	Representative industrial period (60%) (50%)	Degree of typicality 1st- 2nd- 3rd- 4th- 100 75 50 25	
Technical Value (20%) (30%)	Engineering planning and construction skills (40%) (30%)	Representation of the same period 1st- 2nd- 3rd- 4th- 100 75 50 25	
	Structure and material (60%) (70%)	Selection rationality 1st- 2nd- 3rd- 4th- 100 75 50 25	
Art Value (20%) (30%)	Relationship with the environment (40%) (60%)	Degree of coordination 1st- 2nd- 3rd- 4th- 100 75 50 25	
	Architectural style Aesthetic Value (30%) (20%)	Embodiment of industrial style 1st- 2nd- 3rd- 4th- 100 75 50 25	
Cultural Value (20%) (10%)	Influence on local society and culture (40%) (50%)	Beauty of shape and decoration 1st- 2nd- 3rd- 4th- 100 75 50 25	
	Importance in the place (enterprise) (60%) (50%)	Single construction importance 1st- 2nd- 3rd- 4th- 100 75 50 25	
Economic Value (20%) (30%)	Scale and land value (40%) (30%)	Economic value of site space 1st- 2nd- 3rd- 4th- 100 75 50 25	
	Reuse value (60%) (70%)	Reusability of structure and space 1st- 2nd- 3rd- 4th- 100 75 50 25	

Conventional type (in black) and unconventional type (in blue) differ in weight of evaluation index and factor

Explanation: Regular structure typically differs from unconventional one in the aspect of weight of value-indicator which will influence the value results. For example, the dock (unconventional construction) shows more unique value in infrastructural aspect other than the industrial factory (regular industrial building) with representatives in scientific and artistic way. Therefore, two basic category named conventional and unconventional construction has been set down to introduce the proceeding evaluation steps.

Finally, the comprehensive value of the port heritage site (construction) will be presented in the form of a hundred-point system, and with the horizontal comparison, the result can be conceived into three levels as the high-level (richest value, 80 points and above), the middle-level (higher value, 60 points and above), and the low-level (value general), from which, the treatments of heritage sites at different level differs: (1) For the mandatory preservation of the first-class heritage sites, the historical and cultural connotations must be considered as primacy in the conservation.(2) At the second-level, it is recommended to retain the heritage with consideration of the authenticity combining with surrounding supporting facilities design for preservation and regeneration. (3) Though the lower instinct value in the heritage site at the third level, the more flexible appearance can be retained, simultaneously, the surrounding supporting facilities of which should appropriately consider its cultural history connotation.

It is undeniable that in the comprehensive evaluation, under the framework of the seemingly objective evaluation system, the evaluation factors still need to be assigned based on the perception of subjective feelings, so as for the determination of the weight of each factor according to the different resource characteristics.

Construction of landscape infrastructure

Although heritage resources are the main theme and core of the port heritage corridor, the corridor space is the framework that supports the entire corridor system, and the spatial pattern of green corridor, which is the core part of corridor space, assumes the strategic context of the entire corridor space. It not only decides whether the greenway can successfully play the ecological function at the regional level, but also influence whether its constituent elements fit the muscles of the city or the countryside at the city level, and even affects whether its space can reflect the function of port heritage conservation at the micro level. Therefore, in the process of planning and designing port heritage corridors, great attention should be paid to the construction of corridor space from the very beginning to the end.

Net-work of landscape infrastructure

As Kevin Lynch mentioned in his "Urban Intentions", "A series of nodes can be arranged closely side by side or visible to each other to form a structure... You can also use the common connection of a certain road and a certain edge to decorate and form a vast urban area" (Kevin Lynch, 2001), in the process of constructing the port heritage corridor space, the networked landscape infrastructure will facilitate organic integration of productive landscape and ecology of the city via interactions of points (green open spaces), lines (walkways and greenways) and faces (port heritage nodes), which not only provides more green infrastructure for the general public, but also contains the interpretation system to increase public participation in cultural facilities as well enhance the potential influence of port heritage sites in the form of dispersal. This kind of grid structure will expand the spatial scope to city and region, to establish a more systematic and comprehensive integrated protection pattern of culture, ecology and leisure, and improve the cultural influence and affinity of the city. When constructing the port corridor space, the landscape infrastructure will be closely arranged around the heritage sites in the form of green open space points, waterfront green spaces,

residential areas, commercial areas, etc., and using green linear space acts as a "binder" to form a new urban texture (Reed, 2013), finally reach a regional ecological and cultural network system with economic value (Zhang, 2002).

Linear landscape corridor space along the waterfront

It is an excellent choice to form a waterfront landscape belt (landscape infrastructure) across the port heritage sites, in which, the linear street-shaped greenway can increase the continuity of the landscape corridor. The general plan is to add 30-50m wide riverside green space, focusing on the construction of plant landscapes, new riverside trails, greening, landscape docks, etc., to ensure the unity of the urban waterfront space, improve environmental quality, and infiltrate green infrastructure resources into residential areas.

When shaping the traffic path of port heritage corridors, vertical green landscape gives a full play to connect heritage sites and urban space, which can integrate urban infrastructure or transform it to landscape infrastructure. Hence, parallel the green belt, recreation activities and attractive places can grow and affect the green landscape in turn (Esban, 2009), such as making full use of the existing river courses to carry out "water bus" tours, relying on the existing main roads to identify areas where port heritage and natural resources, setting up scenic trails and slow non-vehicle lanes to encourage tourists to travel by leisure and fitness methods such as walking and cycling. The interpretation system is installed closely around the open space of the heritage node as well as combined with the greenway node, which can not only explain the existing heritage sites in detail in the sub-sections, but also complement the environment to highlight the value of the heritage in the city. The treatment of vegetation in specific areas are combined with the historical, cultural and natural background, and the methods of "replacement", "indulgence" and "conservation" are adopted respectively. For areas where the landscape effect is not ideal and the overall atmosphere of the community is incompatible with the historical and cultural connotation of the heritage site, new green parks and recreational spaces, etc., shall replace the originals. While, for the large-scale communities with better landscape effects which play a positive role in the overall cultural landscape atmosphere, a laissez-faire form is chosen with the rules to ensure that the natural succession of communities within the area can grow naturally without human interference.

Landscape infrastructure penetrating the city

The horizontal span of the landscape corridor space represents the penetration from the water system to the waterfront shoreline, and then to the urban construction area. Connecting the traffic function through the slow walking path, extending the ecological function of the waterfront via wedge green space, and organizing the sight line of the waterfront landscape corridor to strengthen the extension of the spatial function from the water area to the land area and form an organic whole as well. From the perspective of ecological space composition, landscape space can be divided into three parts: water area, revetment area, and land area.

Using landscape infrastructure to improve the water network system throughout the entire region and the biodiversity of the water area can ensure the normal operation of the urban ecosystem, more importantly, guarantee the implement of urban flood control system and the healthy water system for residents.

The hydrophilicity of the revetment space is the focal point for awakening the memory of port-orient time and scene, from which, people can also enjoy the waterfront activities with different feelings from other urban public space. The design starts forming landscape features with facilities of the docks in the port heritage area and is followed by adding green space elements to make it a new landscape application infrastructure. Between the heritage sites, the

revetment can join the overall planning of the riverside scenery belt, or maintain the natural style with trails and squares to create leisure and scenery space for the citizens (Fig.5).

Revetment between the port heritage sites (in landscape belt)

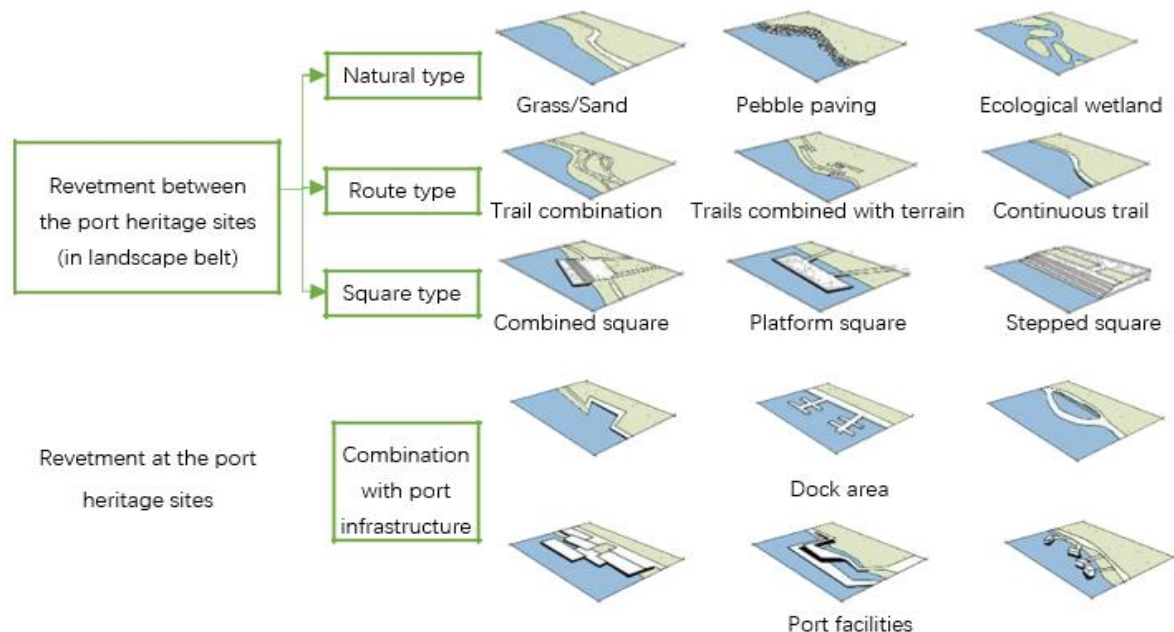


Fig.5 Types of revetment space in and between the port heritage area (Drawn by the authors)

In the land area, the application of environmental fusion method is emphasized to construct landscape infrastructure, that is, when planning port heritage nodes, make natural fusion such as plants, water bodies and topography to increase the “natural affinity” and achieve a coordinated development pattern. Assignments focus not only on complement the green infrastructure around the heritage site, but also adjustment for arranging the existing green space form and content in line with the theme of the port-related landscape, so as to keep consistent of the external form and the connotation of the landscape as well as build a green barrier to reduce the negative impact of urban development on the port heritage. In terms of specific practices of creating surrounding landscape, it is possible to strengthen the heritage site with the aid of the garden method, the method of contrast and artistic conception, and the method of sight construction.

Project supported by the Innovation and Entrepreneurship Training Program General Project of Hunan Province (NO.3581), the Postgraduate Assistance Scheme, UMS(UMS/PASCA8.4/700-10/2) and also the Research Foundation of Education Bureau of Hunan Province, China (Grant No.20B177)

4 Conclusion

Port heritage conservation remains challenging in the process of identification, evaluation and confusing in the preservation mode offered by big redevelopment project at the waterfront in big port cities. Those average port cities with less reputation in economy and culture but gradually increase in consciousness for their valuable history are seeking a strategy to unite all positive factors to regain the city’s prosperous port waterfront. The concept of a heritage corridor based on a holistic view just fit the needs. It puts historical and cultural connotations in the first place then emphasizing an effective preservation model for balancing society and ecology, which also offers an opportunity decomposing large projects into small

ones that are easy to manage and perceive citizens to understand and accept in the regional level. An excellent historical spatial framework has a huge and far-reaching impact on the spatial form of a city, the significance of which lies on the guidance of urban development at the regional or higher level and also based on contemporary diversified needs such as ecological protection, resource management, recreation and leisure, etc. Urban waterfront can be further deepened under this unified framework, so that the protection of natural resources and cultural heritage has a strong continuity (Erickson , 2004).

With the help of "corridors" to form a regional consortium, the potential of regional port heritage can be maximized. When formulating conservation strategies, taking the waterfront advantages of the port heritage and constructing a bundled resource combination give the possibility to create an urban port heritage brand jointly. Using qualitative and quantitative methods to evaluate the bunch of masses with precious memories can avoid the relic-only guidance of heritage and propose ways to solve the difficulties in determination and preservation of port heritage caused by over-distribution, off-concentration and out-hierarchy. In addition, documenting and ranking the port heritage laid a theoretical foundation for the further development of typified conservation. Meanwhile, construction the basic landscape infrastructure to integrate the originally scattered port heritages into a whole, combining with systematic interpretation and recreation management, guarantee the redevelopment of urban waterfront. it will accelerate the cultural exchanges at the macro level, exerts the effect of industrial linkage, as well as stimulates innovated integration in diversified multi-format in different dimensions so as to enhance the life qualities of residents along the "corridor" at last.

Conflict of interest

There is no conflict of interest.

Acknowledgement

The authors are grateful to the Innovation and Entrepreneurship Training Program General Project of Hunan Province (NO.3581), and the Postgraduate Assistance Scheme, with the grant number UMS(UMS/PASCA8.4/700-10/2), and the Research Foundation of Education Bureau of Hunan Province, China (Grant No.20B177)

Reference

- Andresen, T., Aguiar F. B. & Curado M.J. (2004). The Alto Douro Wine Region Greenway. *Landscape and Urban Planning*. 2004(3):289-303
- Belanger, P. (2009). Landscape as Infrastructure. *landscape journal*, 28(1), 79-95
- Benedict, M. A., &Edward, T. M. (2006). *Green Infrastructure: linking landscapes and communities*. Washington, D.C.: Island Press
- Brown, P. H., ed. (2009). *America's Waterfront Revival: Port Authorities and Urban Redevelopment*. Philadelphia: University of Pennsylvania Press.
- Charles, A.F., & Robert, M.S. (1993). *Greenways*. Washington, IslandPress.1993,167
- Erickson, D. (2004). The Relationship of Historic City Form and Contemporary Greenway Implementation: a comparison of Milwaukee, Wisconsin (USA)and Ottawa, Ontario (Canada). *Landscape and Urban Planning*, 2004(68): 199-221.
- Esban, H., Cook, E.A., & Ewan, J. (2009). Effects of Increasing Urbanization on the Ecological Integrity of Open Space Preserves. *Environmental Management*, 2009, 43: 846-862
- Everard, M., & Moggridge, H. L. (2012). Rediscovering the value of urban rivers. *Urban*

- Ecosystems*, 15(2), 293–314.
- Hudson, K. (1979). *World Industrial Archaeology*. Cambridge: Cambridge University Press.
- Li, W., Yu K.J., & Li, D. H. (2004). The Theoretical Framework of the Integrated Protection of Heritage Corridor and Grand Canal. *Urban Problems*, 2004(1), 28
- Lynch, K. (2001). *The Image of The City*. Huaxia Press.
- Nora, P. (1999). *Les lieux de mémoire, dans Jean-Claude Ruano-Borbalan (cordonné), L'histoire aujourd'hui*. Paris: Science Humaines Editions, pp:346.
- Otto, B., McCormick, K. & Leccese, M. (2004). Ecological riverfront design: restoring rivers, connecting communities. *landscape architecture*.
- Reed, N. (2013). City-making Based on Landscape Infrastructure. *Landscape Architecture Frontiers*, 2013(1), 60
- Rouse, D. C., & Bunsterossa, I. F. (2013). Green infrastructure: a landscape approach. *Apa Planning Advisory Service Reports*, (571), 1-164
- Steelman, T. A. & Hess, G.R. (2009). Effective Protection of Open Space: does planning matter? *Environmental Management*, (44): 93-104.
- Wang, Z.F., & Sun, P. (2001). Heritage Corridors — A Comparatively New Protection and Conservation Method of Heritages. *Chinese Landscape Architecture*, 2001/5:85-88
- Yang, B.j. & Dong K. (2007). Discussion on urban design of waterfront area. *Architecture Journal* (07), 11-14
- Zhang Q.f. (2002). Urban green networks and its construction framework. *Urban Planning Forum* 2002 (1), 75-76, 78