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RESEARCH ARTICLE

Reuse of port industrial heritage in tourist cities: Shipyards as case studies

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Abstract The progressive deindustrialisation of many western cities since the 1980s has led to many industrial zones linked to port activities being abandoned or falling into disuse. Cities such as Barcelona, Naples, Lisbon, Amsterdam, and Hamburg have port industrial complexes of high tangible and intangible heritage value that could totally or partially disappear, resulting in an irreparable loss of their scientific, architectural, social, technological, and historical values. With that in mind, Adaptive Reuse (AR) of the built heritage allows the industrial memory of the ports to be preserved by turning them into new functional centres within the existing urban structure. That occurs in the context of the contemporary challenges of those cities, such as touristification, the circular economy and climate change, while guaranteeing the life cycle of those buildings. This article analyses two case studies—the Nederlandsche Scheepsbouw Maatschappij (NDSM) and the Rotterdamsche Droogdok Maatschappij (RDM) shipyards, both in the Netherlands—in order to contribute to the knowledge of AR of Port Industrial Heritage. They are two examples of good practices in port industrial heritage interventions, where the factors behind their acclaim can be easily highlighted. A multi-scale methodology is therefore used and tailored to the case of port industrial heritage, based on analysing previous studies of the heritage in different spheres and on different scales. A relationship matrix tool is thus defined. It enables a comparative study to be conducted, using key variables and indicators, and considering qualitative and quantitative data. That provides extensive output information for each case study, which is summarised in the most favourable factors for the success of the AR of this port industrial heritage.
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1. Introduction

Cultural heritage currently plays an important role in cities as social and economic assets and is considered a resource for local development strategies (Daldanise and Clemente, 2022; Ikiz Kaya et al., 2021). Since the end of the 1990s, a certain social conscience and awareness of the importance and value of industrial heritage has existed throughout Europe (Benito, 2012; Krige, 2010). The considerable research into industrial heritage, with diverse scientific methods and a wealth of study perspectives and content, bears witness to this (Fitzgerald, 2007; Palmer, 2012; Zhang et al., 2020). The initiatives have evolved from the recovery of the building—as a driver to revitalise the territory—to actions with strategic perspectives, such as elements of a network of peer industrial activities (Pardo, 2010), and even industrialisation pathways being defined (Sabaté and Benito, 2010). However, their museumization and trivialisation in the context of the growing urban tourism can also saturate and jeopardise those landscapes that are deeply rooted in the memory and meaning of the place.

Researching and protecting the industrial heritage have become more exhaustive, integrated, far-reaching and interdisciplinary after decades of development, as the reuse has become more diverse (Bottero et al., 2019; Gholitabar et al., 2018; Zhang et al., 2020). These are ranging from more spontaneous processes to rigorous strategies for the city (Colomb, 2012; Hentilä and Lindborg, 2003), and their contribution to the regeneration of the environs is an opportunity and a challenge. Industrial buildings embedded in the urban fabric and affected by functional obsolescence processes are reoriented for local activities, thus guaranteeing that the local urban activity remains in the living memory (Bullen and Love, 2011; Mısırlısoy and Günçe, 2016; Stratton, 2000).

However, even though the industrial heritage is widely studied and the interest in the adaptive reuse (AR) of industrial buildings has grown considerably, the industrial heritage linked to port activities and its AR has received very little academic attention. In fact, those historical buildings are often not perceived as a cultural asset as they are part of an infrastructure such as the port. So much so that they no longer have value when they lose their usefulness, with the ensuing risk that the port industrial heritage overall progressively declines due to lack of interest and financial support. Attending the industrial past of these port-cities, it is still common to find these old industrial buildings in disuse. In this context, the AR changes the port heritage from a "cost" to an "investment" for society. They are interventions requiring low financial investment in existing spaces and structures, with realistic expectations, and offer local solutions to the challenges of urban planning. This is an example of a neighbourhood-building approach that uses short-term, low-cost, controlled-scale interventions and policies to catalyse long-term change (Glick, 2012). The AR provides an opportunity, and the reuse of buildings is becoming a form of redevelopment of the port-city interface spaces (Andrade and Costa, 2020), where the tangible and intangible heritage of the past is now valued and preserved for the future, while being given a new purpose as part of the ongoing social, economic, environmental, and cultural transformation of the city.

In recent decades, port cities have been facing challenges where AR has an important role to play. The historic docks, for example, are practically unrecognisable after their adaptation to cruise ship tourism, which also intensifies the city's touristification to the point of making it uninhabitable for residents. Accordingly, Andrade et al. (2021) analyse the contributions of those port heritage interventions and their role for urban regeneration and the dispersion of the cruise passengers from the standard routes, thus leading to a balance between visitors and residents. Other challenges are the circular economy, where Gravagnuolo et al. (2019) analyse eight European port cities where the AR of their industrial heritage has been key to address its implementation in the historic built environment; or the climate change and environmental sustainability, where Daldanise and Clemente (2022) analyse the role of port heritage in the specific case of Naples, as cultural and creative responses to it.

Therefore, challenge and opportunity in that complex situation are allied with the industrial past of European port cities and the central position of the port in those locations, thus giving port heritage an essential role in that context. The AR of historical buildings allows the industrial memory of the ports to be conserved, by converting them into new functional centres within the existing urban structure. That said, being able to find a new use compatible with the essential characteristics of the heritage element is key for its sustainability in time (Alemany, 2019). The new contemporary uses for those historical buildings and places must be identified from a systematic perspective, compatible with their complex cultural importance, authenticity, integrity, and social value. Sometimes emblematic places were adapted in an unconscious manner, eliminating, or transforming their formal, structural features or meanings, through unconnected actions that responded only to particular interests. Heritage intervention for speculative purposes, mass tourism or urban renewal policies sometimes turn the AR into an effective instrument for the destruction of urban heritage or the promotion of gentrification in the historic city. There is no doubt that public-private stakeholders have intervened in different types of port heritage, such as ice factories (Valencia, Spain), silos (Marseille, France), warehouses (Hamburg, Germany). The structures have sometimes been restored as part of an urban regeneration strategic plan. In other cases, they are reused for temporary and shared purposes that tend to become permanent. However, port heritage needs to be seen in the long term, by reinforcing the perception that there is strong compatibility and synergy between its reuse and sustainable development, given its adaptability to the changing social and economic conditions (Andrade and Costa, 2020).

In most cases, port heritage is located at the port-city interface. As Hein (2021) well explains, beyond the historical and governmental line that separates the port from the city, the interface better defines this mediation space, and even more so with the phenomenon of the urban waterfront. These areas tend to be spatially dynamic and less stable, presenting accelerated transformations, less-

defined boundaries, and increased territorial and management complexity, combining transversal approaches. The porosity of these areas described by Hein (2021) in line with the threshold analysed by Moretti (2019), situates these buildings in changing territories. The characteristics of these mediation spaces must be considered in permanent buildings, with AR playing a vital role, highlighting the adaptability, flexibility and mix of uses of these interventions as key factors.

Therefore, this paper contains a comparative study of two large shipyards in similar geographical locations, but with different uses, and a distinct way of managing the AR: one bottom-up and the other top-down. The first is the Nederlandsche Scheepsbouw Maatschappij (NDSM) shipyard of Amsterdam, while the second is the Rotterdamsche Droogdok Maatschappij (RDM) shipyard in Rotterdam.

Considering the lack of comparative cases studies on the AR of the port industrial heritage, and specific features of those buildings in the context of the contemporary city-port, a specific methodological tool has had to be generated for the research. It is based on previous heritage studies in different areas and on different scales, but this time it is linked to the industrial aspect in the port sphere from a multi-scale perspective. A relationship matrix tool is thus defined. It enables a comparative study to be conducted using key variables and indicators, and considering qualitative and quantitative data in the analysis, which provides extensive output information for each case study. As a result, a summary of the most favourable factors for the success of the AR of the port industrial heritage is presented. The methodology can be used for a direct analysis of a complex reality, and it also can be extrapolated to other cases of port cities, allowing comparison between them and their evolution over time.

2. Background

2.1. Heritage: its conservation and reuse as a global interest

Protecting, conserving and the sustainable use of tangible assets and the intangible cultural heritage of cities continue to be a theme of great interest globally. As regards heritage, UNESCO has done extraordinary work in studying and providing information sources of resources for the sustainable development of cities. In particular, the HUL, Historic Urban Landscape (UNESCO, 2011) approach is being successfully applied in different cities around the world, with the integration of new global approaches for sustainable cities (UNESCO, 2011; 2015a). However, the study by Pereira (2019) on the implementation of the HUL approach in heritage planning worldwide, shows the great difference that exists between the initial targets and the actions for their implementation. The paper concludes that the spectrum needs to be complemented or expanded for a more realistic result. One such case is Rijeka (Croatia), where the HUL approach was implemented in the post-industrial port area from a multi-scale format. However, a large group of participants needed to be used for more robust results (Pintossi et al., 2021).

The Heritage AR is increasing in importance among current conservation policies, as it is a type of restorative, regenerative and sustainable conservation that prolongs the life of intangible and tangible assets, fosters tradition and responsibility, and preserves cultural values for the coming generations. The AR of industrial heritage plays a strategic role that not only affects buildings but can also stimulate a renovation process in large urban areas (Gravagnuolo et al., 2017). Apart from being a cost-effective strategy, it is a sustainable approach that minimises energy consumption, transport costs and waste generation in all aspects (economic, ecological, social, human, and cultural).

In terms of the principles of the circular economy, AR can be defined and recognised as a driving force of circularity in the construction industry (Gravagnuolo et al., 2017; Ikiz et al., 2021; Foster, 2020). The aim of the adaptive reuse of historic structures, as per the Burra Charter of the International Council on Monuments and Sites (ICOMOS), is to preserve the importance of a building for a place or community, while guaranteeing its continued usefulness (ICOMOS, 2013). Accordingly, a conference was held in 2018 on the Adaptive *Reuse and Transition of the Built Heritage*, as part of the EYCH—*European Year of Cultural Heritage (*De Jesus et al., 2017), when the importance of restoring industrial buildings and environments was stressed. The results are set out in the *Leeuwarden Declaration* (2018), which highlights the need to face the challenges of reuse with more flexible regulations.

The interest in the benefits of adaptive reuse as part of the circular economy has led to different studies. Even though the majority are mainly focused on the cultural heritage (Potting et al., 2017; De Jesus et al., 2017; Gravagnuolo et al., 2017; Ellen MacArthur Foundation, 2015), the approach is very similar in terms of the implementation criteria and policies, even when oriented at other sectors. Using different principles such as The 9Rs approach, CE principles and ReSOLVE framework, 37 assessment criteria are broken down from a multiscale perspective (regional, urban and architecture), and taking into account four dimensions (cultural, social, economic and environmental). With that in mind, they analyse policies that endorse adaptive reuse practices, and assess their usefulness and viability in greater depth, to drive and expand AR towards circularity (PESTEL-CA analysis) (Ikiz et al., 2021).

2.2. The conservation of the industrial heritage

The International Committee for the Conservation of the Industrial Heritage (TICCIH) defines industrial heritage as the remains of industrial culture which are of historical, technological, social, architectural, or scientific value. In other words, buildings and machinery, places where energy is generated, transmitted, and used, transport and all its infrastructure, as well as policies used for social activities related to industry, such as housing, religious worship, and education (Douet, 2016). Therefore, the industrial heritage element has characteristics that make it very different, both in substance and in form, from other types of heritage. The clearest difference is that its importance does not lie in

its singularity, but rather in its implementation and impact on a specific place (Rahola, 2001).

The main function of the conservation of the Industrial Heritage is to maintain the collective memory of the history of the last two centuries, apart from being a subject of study that enables us to learn about everyday life and the ways and means of work of that time (Vicenti and Arroyo, 2007). That global interest has helped us to accurately define the steps to be followed to intervene in the industrial heritage, the aspects that must not be ignored, and the importance of those processes socially, culturally, and historically for the cities.

The Nizhny Tagil Charter signed in 2003, is one of the main documents to analyse the TICCIH guidelines and is an annex to *The TICCIH Guide to Industrial Heritage Conservation* (Douet, 2016), which set out the key concepts and methodologies formulated in the framework of industrial archaeology, and which provides advice on the most significant of the remains of industrialisation. Together with the "*Dublin Charter*" (Gravagnuolo et al., 2017), signed by the TICCIH and the International Council on Monuments and Sites (ICOMOS) in 2011, they are a starting point to research the conservation of places, structures, areas, and landscapes of the Industrial Heritage.

2.3. Adaptive reuse in the port-city integration process

Adaptive reuse of industrial buildings is a field that is increasingly being studied. It plays a strategic role that not only affects buildings but can also stimulate a renovation process in large urban areas. The port has always been related to the development processes of the city, and both have historically been a real cog in the driving of trade. The Industrial Revolution marked a turning point in the port-city relationship. The technological change, the increased scale of activities, the size of the vessels, warehouses, railway …, led to different transformations in their morphology that modified the relationship between the cities and their ports. Since then, this port-city interface has been a mediation space with dynamics and transitory characteristics throughout history, in continuous response to the socioeconomic changes that have become more intense in recent decades (Hein, 2021).

Those industries not only left a physical, but also intangible footprint of people's activities, customs, and experiences. In the post-industrial era, those docks have fallen into disuse in the centre of their cities with the appearance of the container and the new port activity sites, but there are many cases of their being given an urban use, leading to the waterfront phenomenon (Breen and Rigby, 1994, 1996; Bruttomesso, 1991; Marshall, 2001; Meyer, 1990). Reclaiming those spaces is no easy task given the local and global challenges, but, in turn, offers potential for conserving and reusing the industrial heritage. Accordingly, their enhancement, and the ensuing preservation of their identity, are of vital importance.

However, even though it is not the aim of this paper to provide an exhaustive analysis of the port-city relationship, it needs to be taken into account that the aim is not to consider one-off interventions to reclaim and reuse port industrial areas of value, but rather to approach them as part of the city, maintaining its changing and dynamic port-city character, and which, therefore, must be integrated in it. Accordingly, Andrade et al. (2012) published their *Port-City: Comparative Study of Good Practices*, focused on twelve international case studies. Subsequently, the AIVP (Association Internationale Villes et Ports) established some good practices (AIVP, 2019) for the physical-functional reintegration of the port in the city. Both studies identify common factors that are the starting point for the case studies in this paper, such as: i) the mixtures of urban and port uses, ii) the proximity of the industrial landscape from the city both visual and physical, iii) the connectivity and accessibility, iv) the flexibility both in the uses, in the borders, that have characterised these mediation spaces throughout history, in the intervention processes themselves, so that they can respond to a changing demand. These factors are present in the adaptive reuse interventions with greatest acceptance.

Reviving the location with temporary uses for the available spaces is a way to diversify the economy, make it more resilient to changes and create an attraction, and even a source of financing in the long term. That was the case of the project for the temporary occupancy of the Melbourne Docklands (Development Victoria, 2012). However, some authors have claimed that the reuse of the industrial heritage does not need to involve its development, and the pursuing tourist and speculative interests that lead to the degradation of the identity of the heritage and encourages the scenography facadism that many cities suffer today (Fernández-Carnicero, 2016).

According to the AIVP, each element of heritage value needs to be identified and highlighted, and consciously reused, to safeguard the identity. This strategy was applied in Strasbourg (France) in 2012, where apart from reusing silos as a media library (Hettema and Egberts, 2020), the economic development strategies included attracting residents, visitors, and companies, by enhancing competitiveness, with maritime features such as leisure sailing and angling, other maritime attractions and businesses, marine power, and cultural activities, together with other mixed uses. Such projects require strategies to make them possible and cost-effective in the long run, where the active participation of the local communities is particularly important, as has been the case in Bremerhaven (Germany). The old fishing packing warehouse was turned into premises for 15 stores, hospitality outlets and companies, along with a multimedia centre (former dispatch room at the train station for transporting fish) which offers information on fish and the sea (Hettema and Egberts, 2020).

As regards specific interventions in shipyards, special mention should be made of the one at the Venetian Arsenal, which is a challenge for current conservation and the search for contemporary reuse in the framework of the overtourism affecting the Italian city (Clark, 2017). The comparative study on the adaptive reuse of three small shipyards by Hettema and Egberts (2020) shows the emphasis on cultural use, with the Kromhout (Museum) in Amsterdam, the Verftet in Ny-Hellesund (Norway) and the Maritime Museum in Helsingør (Denmark). The mix of uses in adaptive reuse with drivers of local industries that are also attractive for tourism is essential to achieve the

sought-after balance between visitors and inhabitants (Andrade and Costa, 2020). This article therefore studies two examples of AR of large shipyards, with implementation of mixed uses. Even though they are in a single geographical and cultural context, the adaptive reuse took place at two different moments of history and in two distinct management forms, bottom-up and top-down. Both are considered success stories and have been the origin and inspiration of subsequent master plans to reuse whole industrial zones, such as in the case of San Francisco or Gdansk. The article specifically refers to the study of the NDSM and RDM shipyards, in the Netherlands, where improvements to the economic, regulatory, and administrative structures endorse adaptive reuse practices towards circularity, and, therefore, are a good example from which to learn (Ikiz et al., 2021).

3. Methodology: a relationship matrix

As could be seen in the previous section, even though different research has been conducted into analysing heritage (De Jesus et al., 2017; Ellen MacArthur Foundation, 2015; Ikiz et al., 2021; Potting et al., 2017), into adaptive reuse (Gravagnuolo et al., 2017; Pintossi et al., 2021) and into good policies and practices in its conservation and reuse (Foster, 2020; Gravagnuolo et al., 2017; Ikiz et al., 2021; Pintossi et al., 2021; Plevoets and Sowińska-Heim, 2018; Zuidhof, 2009), where adaptive reuse is considered a booming conservation strategy, safeguarding the heritage through cultural programmes still continues to be more common, and which often involves the museumization phenomenon. The experiences are very varied, but as Pardo (2010) points out, adaptive reuse is the most widespread way to conserve and use the heritage.

Even though it is a well-documented and advanced field of knowledge, many aspects regarding port industrial heritage are still to be studied when it specifically comes to ports. Therefore, this research proposes exporting the methodologies, factors, and indicators of the analysed references (see Table 1) to the specific field of Port Industrial Heritage.

The aim is to prepare a relationship matrix as a tool, which considers a selection of the different factors and criteria in the framework of conserving port industrial heritage. First, a systematic review of the scientific literature is conducted to establish the state of play. The information is gathered and compiled, with 5 procedures being pinpointed, which can be applied in the framework of the port industrial heritage to determine good practices in conservation and adaptive reuse. Those approaches have been previously mentioned, along with the benefits and importance of their study and application, their use and how they can be applied in general to another research. The aim here is to specifically address each one (see Table 1). Those procedures are:

- HUL (Historic Urban Landscape);
- WHS (World Heritage Sites);
- PESTEL−CA Analysis;

Table 1 Methods of evaluation of good practices, within the framework of conservation and adaptive reuse of heritage.

Methodology	Ambit	Type	References analysed
HUL (Historic Urban Landscape)	Cultural heritage	Qualitative	Assessing cultural heritage adaptive reuse practices: multi-scale challenges and solutions in Rijeka (Pintossi et al., 2021)
	Urban landscape conservation	Qualitative	The historic urban landscape approach in action: eight years later. In: Reshaping Urban Conservation. The Historic Urban Landscape Approach in Action (Pereira, 2019)
	Urban landscape conservation	Qualitative	The HULGuidebook. UNESCO Recommendation on the Historic Urban Landscape (2015)
WHS (World Heritage Sites)	Industrial heritage	Qualitative and Quantitative	Good practice for industrial heritage sites: systematization, indicators, and case (Oevermann, 2019); Guidance and Toolkit for Impact Assessments in a World Heritage Context (UNESCO, 2022)
	Cultural heritage	Qualitative	Managing Cultural World Heritage (UNESCO, 2013)
PESTEL-CA frame	Adaptive reuse of heritage as part of the circular economy	Qualitative	An empirical analysis of driving factors and policy enablers of heritage adaptive reuse within the circular economy framework (Ikiz Kaya et al., 2021)
9 Rs of CE, 12 principles of CE, ReSOLVE	Adaptive reuse of heritage as part of the circular economy	Qualitative and Quantitative	Evaluation criteria for a circular adaptive reuse of cultural heritage (Gravagnuolo et al., 2017).
The Nizhny Tagil Charter	Industrial heritage	Qualitative and Quantitative	The Nizhny Tagil Charter (Douet, 2016)

- 9Rs of the CE (Circular Economy), 12 principles of the CE, ReSOLVE framework;
- The Nizhny Tagil Charter.

The UNESCO HUL Recommendation (UNESCO, 2011) is an empirical and qualitative methodology that needs to be assessed using an extensive sample of individuals for more scientific results. A very positive aspect is that it can be adapted to each local context, and new tools can be continually adapted as the city changes over time.

The variables and indicators used in The HUL Toolkit (UNESCO, 2011) would be:

- Planning tools and expertise (planning, GIS, Big Data, morphology, impact/vulnerability, and assessment, policy);
- Tools for the community (advertising, dialogue and consultation, empowerment, cultural mapping);
- Regulatory systems (legislation and regulations, tradition, plans and policies);
- Financing tools (economy, subsidies, public and political cooperation.

According to the good practices criteria in the management of industrial sites of the UNESCO World Heritage Sites (UNESCO, 2015a), Oevermann (2019) determines 8 criteria, and 24 indicators (Management, Conservation, Reuse, Community Commitment, Sustainability/Climate Change, Education, Urban Development, Research). The indicators are set out in the interrelationship diagram (Fig. 1) with the aim of identifying criteria and examples of good practices in the management of heritage within the specific field of

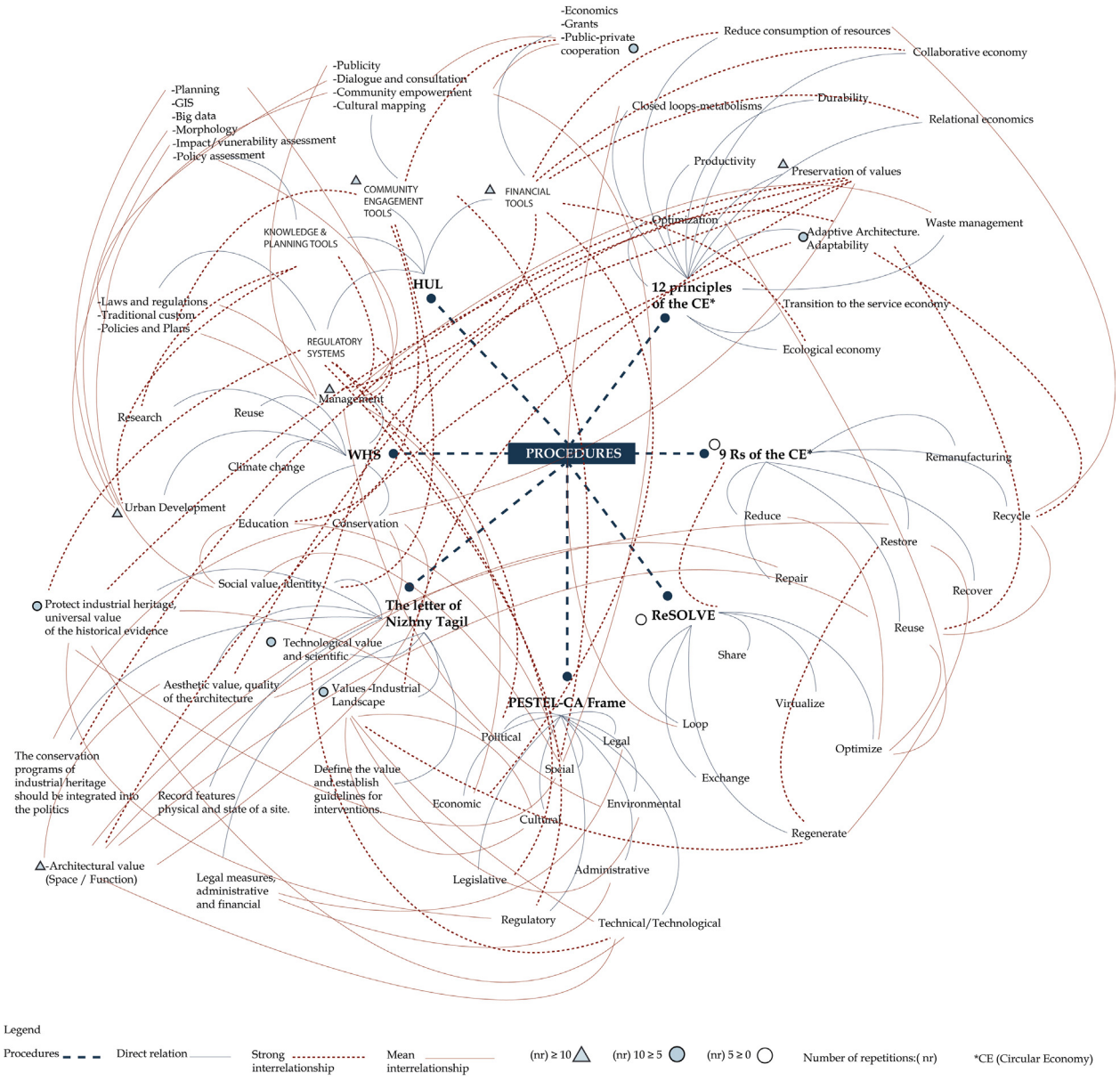


Fig. 1 Interrelation diagram. Source: The Authors.

UNESCO industrial heritage sites. They are qualitative and quantitative criteria depending on the variable being assessed.

To achieve a more holistic approach to assessing the drivers and policy instruments that facilitate adaptive reuse practices (Ikiz Kaya et al., 2021) the PESTEL−CA analyses the political-economic-social-technical-environmental-legislative as well as the cultural-administrative framework. Although it is a mix of quantitative and qualitative indicators, its major limitation is that if it is only applied in a case study, the survey needs to be used as a tool for more scientific results. It puts forward 8 criteria or variables to be analysed in adaptive reuse practices: Political, Economic, Social, Technical/Technological, Environmental, Legal/legislative/regulatory, Cultural and Administrative. The indicators involved are shown in the interrelationship diagram.

The 9Rs of the CE (Circular Economy), the 12 principles of the CE, and the ReSOLVE framework point to the adaptive reuse of the heritage as key in the circular economy.

(1) The 9R approach: Refuse—avoid the use of raw materials; Reduce: reduce construction and landfill waste; Reuse (second hand, sharing products); Repair and maintenance; Refurbish; Remanufacture—making new products using (parts of) old products; Repurpose and Rethink a product; Recycle—processing and reusing materials; Recover energy from materials.
(2) CE Principles: Decouple growth from the consumption of resources; Closed loops/closed metabolisms—short loops able to stimulate symbiosis and cooperation; Improved productivity (less consumables, more products; Factor 10, Factor 5, etc.); Optimisation in the use of existing resources; Prolonging the use values and the provisions of the buildings in the long term; Extending the life of goods (durability); Adaptability over time (for example, open buildings, etc.); Transition to the service economy (the gains come from the effective maintenance during that time); Waste Management as resources; Collaborative economy, cooperative economy, social and solidarity-based economy; Regeneration capacity of the cooperative relations (relational economy); Economic interdependencies—green economy.
(3) ReSOLVE Framework of the Ellen MacArthur Foundation: Regenerate; Share; Optimise; Loop; Virtualise, Exchange.

When analysing the Nizhny Tagil Charter for Industrial Heritage, the International Committee for the Conservation of the Industrial Heritage (TICCIH) argues that the implicit historical, technological, social, architectural, and scientific values must be considered.

(1) Protecting the industrial heritage is based on the universal value of the historical evidence of the activities carried out.
(2) That the industrial heritage is of social value and, therefore, provides an important sense of identity.
(3) It is of technological and scientific value in the history of manufacturing, engineering, and construction.
(4) It may have considerable aesthetic value for the quality of its architecture, design, or planning.
(5) Those values are intrinsic to the site itself, its fabric, components, machinery and setting in the industrial landscape.
(6) Surveys of areas and of different industrial typologies should identify the extent of the industrial heritage.
(7) A full record of the physical features and condition of a site should be performed.
(8) The value of important sites should be defined, and guidelines established for future interventions. Any legal, administrative, and financial measures necessary to maintain their value should be implemented.
(9) Appropriate measures should be taken to reduce the risk of value sites and facilitate suitable schemes to repair or reuse them.
(10) Programmes for the conservation of the industrial heritage should be integrated into policies for economic development and into regional and national planning.
(11) Comprehensive adaptation and reuse may be an appropriate and cost-effective way of ensuring the survival of industrial buildings.
(12) Governments should have specialist advisory bodies that can give independent advice on questions relating to the protection and conservation of industrial heritage.
(13) Ensuring the consultation and participation of local communities in the protection and conservation of their local industrial heritage.
(14) The adaptation of an industrial site to a new use to ensure its conservation is usually acceptable except in the case of sites of particular historical importance. New uses should respect the significant material and maintain original patterns of circulation and activity and should be as compatible as possible with the original or main use. An area interpreting the former use is recommended.
(15) Continuing to adapt and use industrial buildings avoids wasting energy and contributes to sustainable development.

3.1. Application of the matrix as a tool: data collecting in the diagnostic process

The matrix was produced by interrelating the most important criteria, variables, and indicators, and which most stand out in their implementation using the aforementioned procedures. Six key variables were determined to study intervention case studies in Port Industrial Heritage, using the Affinity-Interrelationship Method (AIM) (Alänge, 2013) (See Table 2). They are mixed, with qualitative and quantitative indicators. The interaction diagram (see Fig. 1) of the different data was analysed to perform a selection for dependency of greater interrelationships and

Table 2 Relationship matrix.

Variable	Scale	Indicator	Description	Evaluation Criteria	Value
A. Management	Ma	A.1. Integral management	Evidence of management for the recovery and adaptability of industrial heritage: - Comprehensive management plan - Actors and form of organization - Organization of processes and policies - Financing and economic development - Legal compliance	Efficient management plan, with clear actors and organized in phases. It has financing strategies and is within the legal framework	5
				Efficient management plan, with some actors and organized in phases. It has some financing strategies and is within the legal framework	4
				Deficient management plan, with actors that can vary and a certain organization. Financing by a single entity that becomes scarce over time and is within the legal framework	3
				Deficient management plan, with actors that can vary and little organization. Scarce financing and it is within the legal framework	2
				Deficient management plan, with actors that can vary and without organization. Scarce financing and it is not within the legal framework	1
		A.2. Environmental management	- Environmental management plan	Excellent environmental management	5
				Good environmental management	4
				Medium environmental management	3
				Low environmental management	2
				No environmental management	1
B. Urban Development	Ma	B.1. Connections and Mobility at the city level	Situation at the city level, referring to urban development and at the local level, location, connections and accessibility to the place	Excellent connection at the city level, the site is accessible and has varied, sufficient and adequately frequent public transport	5
				Good connection at the city level, the site is accessible and has sufficient public transport and with adequate frequency	4
				Medium connection at the city level, the site has accessibility difficulties and has some public transport	3
				Low connection at the city level, the site has accessibility difficulties and has little public transport	2
				No connection to the city level, the site is not accessible and does not have public transport	1
	Me	B.2.Local Economy	How is the local economy supported? Sources of employment. Increase of the local economy	High increase in the local economy, increase in jobs 70% ≤ *LE* ≤ 100%	5
				Good growth of the local economy, job growth 50% ≤ *LE* ≤ 70%	4
				Medium increase in the local economy, increase in jobs 20% ≤ *LE* ≤ 50%	3
				Low increase in the local economy, increase in jobs 5% ≤ *LE* ≤ 20%	2
				Practically no increase in local economy, increase in jobs 0% ≤ *LE* ≤5%	1
C. Space / Function	Me	C.1. Universal Value and Historical Value	Historical evidence of activities, background in terms of uses, related to the original function. Geometry of the environment Composition, distribution, dimensions	High evidence of preserved heritage elements (adaptability to new uses) ≥ 70%	5
				Medium high evidence of preserved heritage elements (adaptability to new uses) ≥ 60%	4
				Medium evidence of preserved heritage elements (adaptability to new uses) ≥ 50%	3
				Medium low evidence of preserved heritage elements (adaptability to new uses) ≥ 40%	2
				Low evidence of preserved heritage elements (adaptability to new uses) ≥ 30%	1
	Mi	C.2. Architectural Value	Adaptability. New uses. Spatial distribution, materials and pre-existing industrial objects. Type of Rehabilitation: partial, total, overlapping, replacement. Rehabilitated (*R*)	70% ≤ *R* ≤100 %	5
				50% ≤ *R* ≤ 70 %	4
				20% ≤ *R* ≤ 50 %	3
				5% ≤ *R* ≤ 20 %	2
				0% ≤ *R* ≤ 5%	1
D. Image / Landscape	Me	D.1. Intrinsic aesthetic value to the industrial landscape	Visual comfort, visuals, scale	High presence of interesting visuals, the aesthetics of the industrial port environment are highlighted	5
				Medium high presence of interesting visuals, the aesthetics of the industrial port environment are highlighted in some points	4
				Medium presence of interesting visuals, the aesthetics of the industrial port environment are partially appreciated	3
				Average low number of interesting visuals, the aesthetics of the industrial port environment are practically not appreciated	2
				Low number of interesting visuals, the aesthetics of the industrial port environment are not appreciated	1
		D.2. Geometry and composition	Elements of the urban landscape, comfort of the public space: vegetation, shaded spaces, adequate cleaning, rest spaces and lighting	High level of comfort of public space	5
				Medium high comfort level of public space	4
				Medium comfort level of public space	3
				Medium low comfort level of public space	2
				Low comfort level of public space	1

Variable	Scale	Indicator	Description	Evaluation Criteria	Value
	Mi	D.3. Architectural Value	Authenticity, aesthetics	The property presents high authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤10% in rehabilitation)	5
				The property presents medium high authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤20% in rehabilitation)	4
				The property presents medium authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤30% in rehabilitation)	3
				The property presents medium low authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤40% in rehabilitation)	2
				The property presents low authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤50% in its rehabilitation)	1
E. Identity	Me	E.1.Social, technological and/or scientific value	Historical background of activities, customs and traditions of the site, unique elements that transcend to the present	A large number of elements are identified that highlight the identity of the site of a social, technological and/or scientific	5
				A medium-high number of elements that highlight the identity of the site of a social, technological and/or scientific are identified	4
				A medium number of elements that highlight the identity of the site of a social, technological and/or scientific are identified	3
				A low number of elements are identified that highlight the identity of the site of a social, technological and/or scientific	2
				Elements that highlight the identity of the site of a social, technological and/or scientific are not identified	1
F. Community Engagement	Me	F.1.Participation of local communities	Information, meetings, decision-making, interviews, joint collaboration with management bodies	High involvement of local communities	5
				Good involvement of local communities	4
				Medium participation of local communities	3
				Low participation of local communities	2
				No involvement of local communities	1

importance of the criteria. The use of multiple data compilation references avoids the constraint of unique data. The variables would be: i) Integral Management, ii) Urban Development, iii) Space/Function, iv) Image/Landscape, v) Identity and vi) Participation.

It was used as a diagnostic tool in 2 European case studies—NDSM (Amsterdam) and RDM (Rotterdam)—for their comparative study. The analysis of cases using those variables and indicators must consider the before and after, analysing the historical background for each case to determine the heritage values and which criteria have been used for the intervention in the present, whether the identity of the place prevails, and, in turn, the contribution to the development of the local economy, as part of Sustainable Development.

Thus, a historical overview was first conducted of the evolution of the port zone, its role at city level and its state prior to the intervention. The comparison was performed on the three scales needed for a broader understanding of the intervention process: the Metropolitan scale (Macro. Ma), the Local scale (Meso. Me) and the Architectural scale (Micro. Mi). The variables and indicators intervening in each scale (Macro, Meso, Micro) were defined (Table 2). That allowed a document to be generated with a great deal of output information and which is easy to understand, compiling the factors that led those projects to be considered a good practice.

3.2. Data analysis and section

The section compiles and analyses the information referring to measuring the indicators that influence each aforementioned scale for each example of interest. The obtained results are gathered, considering which aspects were positive or negative in each intervention. The study is accompanied by the relevant documentation for a better understanding, such as graphs, images, and tables. A comparative visual analysis is in turn guaranteed. Subsequently, the information is selected and classified.

The method (AIM) allowed to organise and analyse this information from its 10 fundamental steps: i) Formulation (problem raised); ii) Warm-up (general ideas and notes on the subject are formulated); iii) Collecting data (focused on the search and study of literature, with different examples of good practice procedures in heritage conservation and adaptive reuse, where the 5 aforementioned procedures were taken as a reference (see Table 1)); iv) Clarifying the meaning (the criteria and indicators of each procedure are analysed and organised); v) and vi) Grouping and Next level grouping (the procedures with their criteria and indicators are re-organized and grouped at different levels, according to the principle of affinity. Table 1 shows the levels of organisation of each group, starting from the 7 procedures in the centre, the criteria, principles, or indicators referring to each one is broken down (see the legend in the table for a better understanding); vii) Show connections (make connections between the different data, called interrelationships by the principle of affinity. Usually represented with dates to demonstrate cause-effect, or an input data and an output data. In this case, since they are already data sets defined in previous investigations, the procedures are understood as cause data, and the criteria and indicators associated with them as effect data. The graph in Table 1 shows the interrelation of the data sets, according

to their affinity, if this is direct, or strong. For example, as well as the number of repetitions, understanding that the more repetition of a criterion or indicator (the effect) that is interrelated with each other and with the procedures (the cause) would be an important element to take into account considered in good practice); viii) Final Layout (the summary of the interrelationships is considered, as they are finally connected); ix) Evaluation (this step is carried out by analysing the criteria with the highest number of repetitions in the interrelation, the criteria and indicators with the highest number of repetitions of 10—0 are indicated in the diagram); x) Concluding sentence (which allowed them to be classified and grouped into the 6 variables mentioned above, fundamental for the case study as the last step of analysis, being (Variables) the concluding sentence).

The AIM method can be used to assess according to the level of importance, and the lowest to highest impact, on a scale of 1—5, is defined in this case. Obtaining the related variables and indicators, Table 2 is prepared, a matrix of relationships between indicator variables and evaluation criteria. The classification to assess the impact level on the WHS (World Heritage Sites) procedure is taken as the benchmark in this case (Sarah et al., 2022).

Those results are set out in the comparative table and in radar charts, which allow data to be overlaid, and are a visual approach for direct comparative understanding. Thus, the results of analysis of the matrix in each case are obtained. In turn, the factors with a lower or greater impact on the port industrial heritage can also be determined.

4. Results

4.1. Case study: NDSM (Amsterdam)

De Nederlandsche Scheepsbouw Maatschappij, NDSM, was founded in Oostenburg, Amsterdam, in 1894. It became the largest Dutch shipyard of that time given the large size of the vessels that it built. In 1915, Amsterdam City Council decided to authorise the relocation of the dock to the other side of the IJ, on the shore opposite Houthaven. It continued to grow to such an extent that the Oostzaan neighbourhood and two floating docks had been built by the end of 1922. During World War I, the demand for vessels increased considerably due to the loss of transport space and subsequent revival of the economy. In the 1960s, after several crises and losses, the focus was on building huge oil tankers. Profits were made thanks to the increase in demand and the oil price until the 1973 oil crisis and the oil tanker market crash (Broerse, 2018). The NDSM shipyard eventually closed in 1985 and the industrial activity ground to a complete halt. The yard then became a blighted area and home to an illegal community of squatters during the 1990s and 2000s. It was stigmatised as a poor district with immigrants and ex-workers of the former ship-building industry (Havik and Pllumbi, 2020; Labuhn, 2018).

4.1.1. Management

4.1.1.1. Integral management (local scale). In this case, the ideas of the integral management plan of the project were at local level, as the result of Municipality−Local Community interaction.

- Management Plan

The management plan to refurbish and reuse the former NDSM shipyard started with the cultural initiative of the Dogtroep18 theatre group in 1994. In the year 2000, a design contest was launched to find who would carry out the project and how, and the Kinetisch Noord group was announced as the winners for the urban regeneration of the place. The plan was based on a 1987 manifesto entitled *De Stad als Casco* (The City as a Shell). It meant harnessing what was already there: the existing physical and social structures. It was the initiative of the artist Carolien Feldbrugge and Frank Bijdendijk. It was the subject of a book so that the plan would not disappear, as De Klerk (2018) put it. The proposal was to create, with and for cultural producers, a building of self-managed and shared businesses.

- Stakeholders and means of organisation

That was considered to be one of the fundamental aspects for successful outcome, the intervention in the shipyard, and the users were the key players of the transformation. The main stakeholders were the people behind the action plan for the site. The plan was devised and managed by a group of artists, immigrants, and entrepreneurs, who saw an opportunity to put the NDSM back on the map of the city, where life was affordable, and it was easier to find work. Eva De Klerk was one of the leading figures of that Kinetisch Noord group.

The plan received great support and, above all, economic backing from the Broedplaats Fund, which meant they could pay the architects and advisors who helped with the design contest entry. The study was entitled "De Usprong van Kinetisch Noord" (De Klerk, 2018). More stakeholders joined the project after it won the contest in 2000. The strategy was that the newcomers had to make a financial contribution and that anybody could move to Amsterdam Noord. Moreover, it was supported by directors of art institutions, famous festivals, and academia.

- Organisation of processes and policies

The plan was organised based on the design contest run by the municipality. The foundations of who, for whom and why the plan would be developed were laid right from the start of the plan drawn up by the Kinetisch Noord group. Accordingly, the project was devised by and was for the local community, with the goal being the urban regeneration and revitalisation of the site, driven by the creative industry. Once the group tasked with its management were set up, the processes gradually emerged, but with clear ideas. First, the old ship hangar was chosen as the starting point. Income was generated by alternative means, even though the project had certain financial support. The highly contaminated area from the previous industrial activity was cleaned up. According to De Klerk (2018), the site was prepared not to remove, but rather add and raise new

spaces, and reinterpret the existing ones. Thus, new jobs were created for the potential users themselves: "culture producers versus culture consumers" (De Klerk, 2018).

- Financing and economic development. Legal compliance.

The municipality announced a public tender for urban regeneration of the NDSM area in 1999. At that point the squatter community organized themselves into a workgroup, Kinetisch Noord, who won for the urban regeneration of the place. After many challenges in the project's execution, concerning fire regulation and the hangar becoming a protected monument, the construction was undertaken between 2004 and 2007 (Labuhn, 2018). Kinetisch Noord received an innovation subsidy from the state of 15 million guilders or 6.8 million euro for the renovation of the existing building (Džokić et al., 2003; Zimmermann, 2014). The users invested another 10 million in exclusive loans for the realization of the self-built ateliers (Labuhn, 2018).

The NDSM-project can be seen as marking the launch of a new era with an unprecedented kind of consensus emerged in Amsterdam in 2002: the municipalities, the real estate developers, and the community started to work together to build the cultural incubators, calling it a soft, slow, and sustainable kind of city development (Labuhn, 2018). The NDSM area became the first and biggest cultural incubator in Europe attracting tourists and new investors looking for a special place, which meant the massive regeneration of the area.

It was an efficient management plan, with clear stakeholders and organised in phases. It had financing strategies and fell within the legal framework.

4.1.1.2. Environmental management (local scale). The project was designed to ensure outstanding environmental management. The cleaning up of the zone was planned, as its industrial past had left it very contaminated. Furthermore, the intervention involved practically no demolition and the existing structure was used, which meant no great amounts of waste or polluting of the environment. This is one of Amsterdam's most important examples of adaptive reuse (Plevoets and Sowińska-Heim, 2018) which was implemented according to criteria of the four dimensions that emphasise sustainable development: in this case environmental sustainability (UNESCO, 2015-b, Art. 5).

4.1.2. Urban development (metropolitan scale)

4.1.2.1. Connections and mobility at city level. According to De Klerk (2018); Havik and Pllumbi (2020); Huib et al. (2010), before the shipyard became a cultural incubator, it was stigmatised as a poor neighbourhood, home to immigrants and ex-workers of the defunct shipbuilding industry, was occupied by squatters, who lived in caravans and shared the land with polluting chemical and shipbuilding industries, and an excess of other disadvantaged people. This situation led to the lack of accessibility to the place (Havik and Pllumbi, 2020). Amsterdam had forgotten that the place existed, and it was therefore not included as a destination within the transport network. The urban regeneration project made the city aware that the place needed to be made more accessible. There are now two means of access and with the ferry as the means of transport. It can also be reached on the bus network that connects the south to the north of the city, on both sides of the IJ River. There are 3 bus lines that run to the shipyard: two by day, the 35 and 36 routes, and one at night, the N93 route. Therefore, the site is well-connected at city level, is accessible and is sufficiently served by public transport and with adequate frequency (Fig. 2).

4.1.2.2. Local economy (local scale). As the Kinetisch Noord project advanced and progressed, the place became a cultural incubator (Labuhn, 2018) for artists in different branches of art and literature, along with the recreational development of the site. That helped to boost the local economy by producing and selling art. Many sources of employment were generated in rental cultural venues, offices, commercial and hospitality premises, etc., and cultural tourism increased positively. In turn, that allowed a greater boost to the local economy, with jobs up $70\% \leq LE \leq 100\%$. Residential projects are currently underway so workers will not have to travel.

4.1.3. Space/function (local scale and architectural scale)

4.1.3.1. Universal value and historical value. Since 2007, the NDSM has been protected for its values (Plevoets and Sowińska-Heim, 2018). Five buildings stand out, along with a set of heritage elements to be preserved. In particular, they represent the historical evidence of the previous industrial activity. The place is a proof of that. In general, all the conserved buildings are thus known to be in a clear industrial style.

The most important buildings were adapted to new uses, and other facilities on the site were reused for different functions (Fig. 3). The main function was related to the creative industry, along with coffee shops, bars, hotels, etc. One of the most representative is the warehouse of the NDSM-LOODS shipyards, which contains the Kunststad (Art City) with studios for 200 artists and designers, with a total aggregated area for workshops of 7500 m^2 (Labuhn, 2018). There is great evidence of conserved heritage elements (adaptability to new uses) $\geq$ 70%.

4.1.3.2. Architectural value. There are several buildings with a clear architectural value, which were given National



Fig. 2 Public transport map (NDSM). Source: The Authors.



Fig. 3 Uses (NDSM). Source: The Authors.

Monumental status in 2007 by the Cultural Heritage Agency (CHA). The former SCHEEPBUILDING LOODS was protected for its architectural value. Its façades, structure and materials were conserved. It is a steel structure with trusses with riveted joints. The large timber latticework columns support the large beams and the much lighter construction of the roof. The natural lighting is central, from pyramid-shaped skylights in the roof. They have been replaced due to their sorry state. The façade is exposed brick, with tall blue doors and tall narrow windows.

This hangar was the greatest achievement of the Kinetisch Noord plan. The designers behind this vision were artists of the NDSM community, Rienke Enghardt and Bob Bakhuijsen, who worked with Filip Bosscher, the philosopher and architect. They based their concept on Constant's New Babylon, Louis Le Roy and Joahn Huizinga Ludens's *Homo Ludens*. The interior layout used the existing structure and added new steel ones to create new large open spaces inside (De Klerk, 2018; Labuhn, 2018). It consisted of a system of huge steel frames positioned in the middle of the hangar and designed by Dynamo Architecten. The steel frames, configured over two floors, created "streets'' in between them.

The building previously known as LASLOODS was designed using a similar language to the former. Thus, the CHA recognised the general importance of the building's historical and cultural value as part of one of the most important shipyards of the Netherlands, along with the historical and architectural value for the closed design of the exterior and the silhouette of the building, the interior construction with two warehouses with pronounced steel colonnades, along with the beauty of the industrial interior design. It has a certain monumentality, uses materials such as bare bricks on the façades and has large blue doors. The windows are square with cross bars, and with blinds at floor level. The ceiling is flat with 4 slanting roofs that act as skylights and through which natural light floods into the complex. The structure consists of steel columns and beams.

Art now fills its façades. The interior was adapted to its new use as a gallery, even though very few modifications were made, or materials replaced.

The T.T. Neveritaweg building, the former carpentry shop, also formally consists of steel framework façades on the north and west sides, filled in with brick masonry and square continuous windows with steelwork. The facade on the south side is closed with an office extension, with a steel structure and the closed east façade was opened in around 2007. The former room inside, with timber latticework columns and English trusses, has also been converted into an office area. Its historical and cultural value has been recognised, along with its historical and architectural value, particularly for the use of English trusses, latticework columns, the partial glazing, and façades with timber latticework.

The SMITH building has façades with steel structures, alternating with brick masonry. The blue of the doors is again a stand-out feature, and the windows are square with steelwork. The sloping roofs are supported by English trusses and steel columns in the centre of the building. It has been recognised for its historical and architectural value. Another building has been added to the complex and replaces one of the spans. It is a 10-storey rectangular prism, with glazed façades and steel marquetry. This building is currently run as a hotel.

The heritage complex consisting of the ramps, the crane tracks and the crane were declared of general interest due to their historical and cultural interest as part of one of the

most important shipyards of Amsterdam, and of urban value for the shipyard for its decisive oblique location on the water. Specifically, the former NDSM crane was reinterpreted and turned into an architectural element, a hotel with 3 suites and a jacuzzi, which are reached by ladder and lift. The exterior materials were kept and used as a self-supporting structure. The suites are metal cubicles inside the tower with breath-taking views out to sea.

Approximately between $50\% \leq R \leq 70\%$ of the site has been refurbished, considering the 5 most significant heritage buildings. In general, the same criterion of *The City as a Shell* (De Klerk, 2018) was followed and a rather partial overlay refurbishment was carried out, keeping the original structure and façade of the buildings as far as possible. Mobile or modular structures were usually used for the interiors.

4.1.4. Image/landscape (architectural and local scale)

The setting clearly frames an industrial landscape, where the crane stands out as the shipyard's landmark, along with the warehouses with bare-brick façades, and metal straddle trusses. It is now very interesting and original thanks to its having been reinterpreted and merged with the art. It offers interesting visuals from any angle, and the skyline can particularly be appreciated during the boat trip there. The scrap metal turned into art also provides a new dynamism to the landscape. In short, it is a space of the dynamic city and with adequate visual comfort. It has a medium-high presence of interesting visual features, and the aesthetics of the port industrial setting is highlighted at certain points.

It has new urban agriculture green areas following the criteria of Gehl (2014), where the emphasis is on key aspects of the comfort and well-being needed for a public space. They include the activities in public spaces that foster creativity, physical activity, exercise and playing; the attractive visual features created by landscaped green areas with sheets of water, plants, trees and the sea are appropriately part of the design. The outcome is public spaces with interesting visual features, and which are pleasant places to be. The foundation oversaw the clean-up and infrastructure aspects such as lighting, which ensured greater safety and comfort at night according to Gehl. However, there are no public spaces with adequate rest areas or parks, for example. The focus has been more on individual premises and large empty areas for events. Therefore, the immediate environment is a public space with a medium level of comfort.

The complex still has a clear industrial aesthetic, and all the historic industrial features and buildings have been kept, with their form, materials and even aspects of the landscape remaining unchanged. Practically nothing has been demolished. The site has 5 buildings and features of the landscape with protected monument status, given their values. New buildings or structures were added to the landscape. One such example is the Hilton Hotel, but great care was taken to blend it into the site, imitating the aesthetics and even formal aspects. The buildings retain much of their original features, as regards aspects of their original function and a marked industrial aesthetics ($\leq$10% in their refurbishment).

4.1.5. Identity (local scale)

The place has a clear social value, its adaptive regeneration and reuse plan is based on the foundations of "inclusive social development" (UNESCO, 2015-b, Art. 5). The residents that began to repopulate the shipyards were the project developers themselves. Even though the current function does not continue in the tradition of the original one, there are a medium-high number of elements that highlight the scientific and/or technological social identity of the place.

4.1.6. Participation (local scale)

The participatory commitment of residents is, according to UNESCO (2012), a strategic goal (Oevermann, 2019). Accordingly, *De Stad als Casco* (The City as a Shell) was the main concept underpinning the urban regeneration project for the place. As has already been mentioned, the participation was there right from the start with the Design Contest launched by the Municipality in the year 2000. A specific group of residents, consisting of squatters, immigrants, artists, and entrepreneurs, took part. As previously mentioned, the Kinetisch Noord group, together with the community, set up as co-users and co-managers of the shipyard. As De Klerk (2018) explained, they wanted to make their own city, using existing buildings and including existing users.

The design process was collaborative, and the strict client-architect relationship was replaced by a more flexible one, where criteria and ideas were shared, and they worked together. Participatory workshops were typically used for the community to put forward its ideas for the development of the project. The Project showed greater participation of local communities.

4.2. Case study: RDM (Rotterdam)

The RMD (Rotterdamsche Droogdok Maatschappij NV) shipyard began operating in the maritime sector in 1902. It was founded by a consortium of nearly all the shipbuilders and with bank support. In around 1914 and given the remoteness of the facilities, RDM decided to build Tuindorp Heijplaat, a small town to house families who worked for the company. It was equipped with basic amenities along with the houses. In the mid-1960s, the Dutch shipbuilding industry found itself struggling as wages were lowered in other countries in the sector. In 1996, the last shipbuilding activities were completed, followed by the end to submarine servicing and maintenance in 1999. That worsened the situation of the Heijplaat residents, who were increasingly isolated from the city, with no type of development potential and without their main source of employment. That would be the case until the shipyard was bought by PoR ("Port of Rotterdam" Havenbedrijf Rotterdam) in 2002 (Van and Otgaar, 2017; Vries, 2014).

4.2.1. Management

4.2.1.1. Integral management (metropolitan scale and local scale). The RDM shipyard zone had become an abandoned area of the city. Consequently, there was a rise in the marginal, even criminal, population in a no-man's land on the outskirts of the city. Mainly from the town of

Heijplaat, where 1370 of the 3180 RDM employees were laid off at the end of the ship building activities, followed by the submarine maintenance in 1999.

Under the new owner, PoR (Port of Rotterdam) (2002), the RDM became part of the City Ports urban regeneration project. Its key strategy was to optimise the development of former port areas of the city and thus re-establish the port-city link. The *Stadshavens Rotterdam* project headed that initiative for four key central port areas: Merwe-Vierparaísos, Rijn-Maashaven, Waal-Eemhaven and the RDM along with Heijplaat. This urban regeneration project meant those port areas could be included within the city's sustainable development plan (Vries, 2014).

- Stakeholders and means of organisation

The main stakeholders of the management plan were the PoR which had been the owner since 2002, the Albeda College Higher Education Institute and Rotterdam University, as tenants, and Woonbron, the housing corporation that looks after the interests of the Heijplaat redevelopment. The processes were organised by the management authorities, and according to the Stadshavens project guidelines. This initial Chain Approach, a more pluralist view with a public—private partnership within a governance context has been shifting towards a flexible, network-based strategy and a more private engagement in development of the coming phases of this project (Kermani et al., 2020).

- Financing and economic development

The funding of the RDM Campus project was divided into three phases. The private institutions Albeda College and Rotterdam University invested €14 million and there was €10 million in public money for Phases I and II (second sector of 2007). Despite the good results, there were difficulties along the way. There were details that were not considered due to the deplorable state of the infrastructure and the existing services, along with the presence of asbestos in one of the buildings. That increased the construction costs. The whole project was managed within the legal framework and was part of an extensive management process, which complied with the national development perspectives (Campus Bookazine).

It was an efficient management plan, with clear stakeholders and organised in phases. It has some financing strategies and falls within the legal framework.

4.2.1.2. Environmental management (local scale). The RDM came with environmental, economic, and social problems as the result of its abandonment in the framework of the de-industrialisation of the city. Its conservation and adaptive reuse process led to sustainable development at city level. Furthermore, that approach included caring for the environment, related to driving new technologies, as a centre driving knowledge, innovation, and the economy. Accordingly, low-carbon renewable technologies are used, and the plan is for the climate of the campus to be regulated in the future of a heat exchange system using water; the use of solar and wind power; responsible and sustainable mobility, with low or no CO_2 emissions; the use of friendly materials; inter alia (Jansen et al., 2021). In general, the environmental management has been good.

4.2.2. Urban Development (metropolitan scale)

4.2.2.1. Connections and mobility at city level. The site is currently integrated in the transport infrastructure. It is easy to reach and with connections by water and on land. Well-connected at city level, it is accessible and is sufficiently served by public transport and with adequate frequency (Fig. 4).

4.2.2.2. Local economy (local scale). The local economy is steadily developing and on the rise. The RDM is most certainly part of the zone's revival with SME companies, and the interrelation with research and innovation including new technologies. It is attracting a more active population, in terms of workers, students, entrepreneurs and tourists, as the centre is also used for conferences, symposiums and workshops, and organises art exhibitions, theatre productions, dance and music performances, and opera. Such cultural events are increasingly attracting more visitors (Jansen et al., 2021). The project strongly boosted the local economy and jobs increased by $70\% \leq LE \leq 100\%$.

4.2.3. Space/function (local scale and architectural scale)

4.2.3.1. Universal value and historical value. The RDM occupies an area of 40 ha. With the redevelopment project of the site, in 2005, the Rotterdam University of Applied Sciences and Albeda College would begin to work with the PoR to develop a campus model to expand their facilities to the area. The campus came to fruition under the title "Research, Design and Manufacture (RDM)" (Vries, 2014). The place is recognised for the intrinsic architectural value of its industrial style, where the aesthetics of the existing buildings were respected with high evidence of conserved heritage elements (adaptability to new uses) $\geq$ 70%.

4.2.3.2. Architectural value. During the refurbishment works, the façades, noted for their prevailing industrial aspect, were respected. In the case of Onderzeebootloods and Innovation Dock, special mention should be made of



Fig. 4 Public transport map (RDM). Source: The Authors.

the spans asymmetrically inserted as gables and flats, in exposed brick veneer, with red metal trusses visible from the exterior, and glass and metal large windows with iron work in the same colour, reticulated, and nearly floor to ceiling in height, in the case of the second. The first has a more enclosed aspect. Both have metal structures with large columns and trusses supporting the roof, along with triangular-shaped skylights. In general, approximately $50\% \leq R \leq 70\%$ of the buildings were refurbished, adapting the inside to the new uses.

Innovation Dock was one of the most important conservation and change-of-use projects. The commission was awarded to Groosman Partners Architecten studio. For the interior to be able to take on the new planned uses, they designed a suspended 1000 m^2 space for office areas, with a second grid system added 8 m high to double the useful surface of the passageways (Fig. 5). The additional structure can be expanded and dismantled and is made of steel with light and flexible fillers (Campus Bookazine).

4.2.4. Image/landscape (local scale)

The place has retained its characteristics as an industrial landscape in development, thanks to its clear aesthetics kept up to the present. It has been regenerated, with a new transport route and ancillary infrastructure (Vries, 2014). The visual features are pleasant and unbroken, easy to identify and user oriented, both from the water and towards it, which contributes to its great visual comfort. There is a high presence of interesting visual features, the aesthetics of the port industrial setting stands out, a great level of comfort of the public space, and the buildings show great authenticity in terms of the genuine elements of their original function and clear industrial aesthetics (demolished $\leq$10% during their refurbishment).

4.2.5. Identity (local scale)

At RDM, the planners retained the physical aspects of the buildings and the area to the extent that they can tell their story in the future. They did not aim to make the area attractive or turn it into a museum, but instead highlighted its industrial legacy and its relation to water (Kermani et al., 2020). Despite the adaptability to new uses, the place retains its identity as an industrial area, with a high scientific, technological, and social value, not only due to its traditional activity, but also as it has acquired a new meaning as a centre of research, technological innovation, and business entrepreneurship (Stubbs, 2004). The project even envisaged that some aspects of the original activity would transcend to the present and contribute to the sustainable development project of the ports of Rotterdam. The activities related to designing industrial products, managing water, automotive, mechanical, and robotic engineering are one such example. A large number of elements are identified that highlight the identity of the scientific and/or technological social site.

4.2.6. Participation (local scale)

The management authorities did not show any interest in integrating the participation of the community during the different project phases. There was therefore no participation of local communities. However, ensuring the conservation of the heritage values was considered, and there was even a focus on who would improve the quality of life of the local community, with the adaptability of the site to



Fig. 5 Uses (RDM). Source: The Authors.

new uses, and accessible public space. That led to the opportunity for new sources of employment.

5. Discussion and conclusions

This research is based on international good practice benchmarks in Heritage Conservation studies such as UNESCO, ICOMOS and the International Committee for the Conservation of the Industrial Heritage (TICCIH), to develop a multivariable tool to evaluate and compare interventions of interest in the AR of port industrial heritage. This specific methodology is applied to two case studies, the NDSM (Amsterdam) and the RDM (Rotterdam). The comparative assessment highlighted which factors are decisive to identify good practices in AR intervention in port industrial heritage. The methodology used can be applied to analyse more case studies and can even expand the scope and extension of the gathered data. However, it cannot be claimed that the results can be systematised translated into Conservation and Reuse plans without considering the specific characteristics and background of each place, as it is a complex process, involving different economics, physical, administrative, political, cultural, and social factors. Each case must be analysed individually and the characteristics that make it unique must be identified.

The tool is considered to be more exhaustively useable, with more detailed inventories of elements of value, and the management assessment of broader and more specific spatial and environmental aspects for each case study. The scope of this study did not achieve that level of accuracy but leaves the field of study and analysis open to future research.

The comparative case analysis was summarised in Table 3 and Fig. 6 highlighting the most important aspects of each one, and they were rated on a scale of 1—5 depending on the level of compliance of the indicators based on the Affinity-Interrelationship Method AIM. The limitations are related to the extension of the case studies, which is constrained by the depth of the information and the extension of the document.

According to the results, the clearest difference of Industrial Heritage is that its importance does not lie in its singularity, but rather in its implementation and impact on a specific place, as Rahola (2001) indicated. Likewise, the AR of this Industrial Heritage plays a strategic role that not only affects buildings but can also stimulate a renovation process in large urban areas (Gravagnuolo et al., 2017). In the case of port heritage, it has the particularity of being in spaces of mediation, spaces such as urban waterfronts, where port and city interests overlap and often conflict, that respond to different and continuous challenges through dynamic transformations. The on-going transformation of the old parts of the port, is making the current interface between city and port an experimental zone for new land-use combinations, and an interesting laboratory for port-urban research. That is why AR in these buildings is key for the regeneration of the entire area, for the maintenance of its identity, always from the flexibility that allows continuous adaptation to future challenges. While in Amsterdam city planners seem to keep dominating the development of the interface, with a clear predominance of urban use, in Rotterdam the port authority conserves port uses that coexist alongside the proposed urban uses (Daamen and Louw, 2016). This context provokes in Rotterdam the need for a careful top-down planning to establish balances between the past and the future, port and the city, urban and port uses. Meanwhile, in Amsterdam, the NDSM is characterised by the spontaneity of the initial bottom-up strategy.

The AR of the NDSM shipyard, through an intervention characterized by the high degree of conservation of heritage elements, promoted the transformation of the entire area, introducing urban uses, connections with public transport on a city scale that provides accessibility to the entire urban proposal, facilities … The initial strategy evolved, adapting to different plans and investors in a flexible way. However, as can be seen from the results, the public space proposed, the zones between buildings remained partially unresolved. Likewise, despite correctly preserving the identity of the industrial landscape from its functional authenticity, the intervention could not reach that level from a social approach. In the case of the RDM, the exhaustive planning resolved more adequately not only the mix of uses, but also the reuse of port buildings and elements and the space between them. In fact, the public space has more optimal conditions to achieve its maximum use according to the proposed activities while highlighting the aesthetics of the industrial port environment. However, although the top-down planning remains flexible, citizen participation clearly plays a secondary role, especially when compared to the experience carried out in the AR of the NSDM shipyard.

These port-city areas present accelerated transformations, less defined boundaries, and an increased spatial complexity, which sometimes leads to a somewhat less favourable multivariate evaluation in terms of management, as in the case of the RDM. Contemporary challenges open new possibilities for planning in port and city areas, for example, through the (re)creation of multifunctional spaces where port and city can mix, through an interconnected port cityscape with particular spatial, institutional, social, and cultural challenges (Hein, 2019). This port cityscape is administered, planned, imagined, and represented by multiple institutions and rarely as part of a shared vision (Hein, 2021). The collective governance of these extensive landscapes and the logistics of the multiple flows and the multi-layered use of space in these regions require careful analysis and development.

The analysis of the studied cases led to the conclusion that those ARs play an important role in the port-city integration. Both cities have adopted those abandoned industrial ports as identarian places, opting for uses focused on the citizens, without succumbing to the temptation of museumization. In turn, mobility, the important public transport connection within the city, ensures that those places are well-connected hubs, has been fundamental for their development and acceptance. Therefore, those interventions have consolidated the port identity of the place, the industry and local economy, and have become even tourist attractions, which free up the city's traditional routes. They are also clear examples of the circular economy, where the emphasis has been on the pre-existing and local. Users in this space also value transversal

Table 3 Comparative table of results.

Variable	Evaluation Criteria	Value	Study Cases	
			NDSM	RMD
A. Management	Efficient management plan, with clear actors and organized in phases. It has financing strategies and is within the legal framework	5	A_1= 5	
	Efficient management plan, with some actors and organized in phases. It has some financing strategies and is within the legal framework	4		A_1=4
	Deficient management plan, with actors that can vary and a certain organization. Financing by a single entity that becomes scarce over time and is within the legal framework	3		
	Deficient management plan, with actors that can vary and little organization. Scarce financing and it is within the legal framework	2		
	Deficient management plan, with actors that can vary and without organization. Scarce financing and it is not within the legal framework	1		
	Excellent environmental management	5	A_2= 5	
	Good environmental management	4		A_2=4
	Medium environmental management	3		
	Low environmental management	2		
	No environmental management	1		
B. Urban Development	Excellent connection at the city level, the site is accessible and has varied, sufficient and adequately frequent public transport	5		
	Good connection at the city level, the site is accessible and has sufficient public transport and with adequate frequency	4	B_1= 4	B_1= 4
	Medium connection at the city level, the site has accessibility difficulties and has some public transport	3		
	Low connection at the city level, the site has accessibility difficulties and has little public transport	2		
	No connection to the city level, the site is not accessible and does not have public transport	1		
	High increase in the local economy, increase in jobs 70% ≤ *LE* ≤ 100%	5	B_2=5	B_2=5
	Good growth of the local economy, job growth 50% ≤ *LE* ≤ 70%	4		
	Medium increase in the local economy, increase in jobs 20% ≤ *LE* ≤50%	3		
	Low increase in the local economy, increase in jobs 5% ≤ *LE* ≤ 20%	2		
	Practically no increase in local economy, increase in jobs 0% ≤ *LE* ≤ 5%	1		
C. Space / Function	High evidence of preserved heritage elements (adaptability to new uses) ≥ 70%	5	C_1=5	C_1=5
	Medium high evidence of preserved heritage elements (adaptability to new uses) ≥ 60%	4		
	Medium evidence of preserved heritage elements (adaptability to new uses) ≥ 50%	3		
	Medium low evidence of preserved heritage elements (adaptability to new uses) ≥ 40%	2		
	Low evidence of preserved heritage elements (adaptability to new uses) ≥ 30%	1		
	70% ≤ *R* ≤100 %	5		C_2=5
	50% ≤ *R* ≤ 70 %	4	C_2=4	
	20% ≤ *R* ≤ 50 %	3		
	5% ≤ *R* ≤ 20 %	2		
	0% ≤ *R* ≤ 5%	1		
D. Image / Landscape	High presence of interesting visuals, the aesthetics of the industrial port environment are highlighted	5		D_1=5
	Medium high presence of interesting visuals, the aesthetics of the industrial port environment are highlighted in some points	4	D_1=4	
	Medium presence of interesting visuals, the aesthetics of the industrial port environment are partially appreciated	3		
	Average low number of interesting visuals, the aesthetics of the industrial port environment are practically not appreciated	2		
	Low number of interesting visuals, the aesthetics of the industrial port environment are not appreciated	1		
	High level of comfort of public space	5		D_2=5
	Medium high comfort level of public space	4		
	Medium comfort level of public space	3	D_2=3	
	Medium low comfort level of public space	2		
	Low comfort level of public space	1		
	The property presents high authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤10% in rehabilitation)	5	D_3=5	D_3=5
	The property presents medium high authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤20% in rehabilitation)	4		
	The property presents medium authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤30% in rehabilitation)	3		

Variable	Evaluation Criteria	Value	Study Cases	
			NDSM	RMD
	The property presents medium low authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤40% in rehabilitation)	2		
	The property presents low authenticity in terms of authentic elements of its original function and marked industrial aesthetics (demolished ≤50% in its rehabilitation)	1		
E. Identity	A large number of elements are identified that highlight the identity of the site of a social, technological and/or scientific.	5		E_1=5
	A medium-high number of elements that highlight the identity of the site of a social, technological and/or scientific are identified.	4	E_1=4	
	A medium number of elements that highlight the identity of the site of a social, technological and/or scientific are identified	3		
	A low number of elements are identified that highlight the identity of the site of a social, technological and/or scientific	2		
	Elements that highlight the identity of the site of a social, technological and/or scientific are not identified.	1		
F. Community Engagement	High involvement of local communities	5	F_1=5	
	Good involvement of local communities	4		
	Medium participation of local communities	3		
	Low participation of local communities	2		
	No involvement of local communities	1		F_1=1

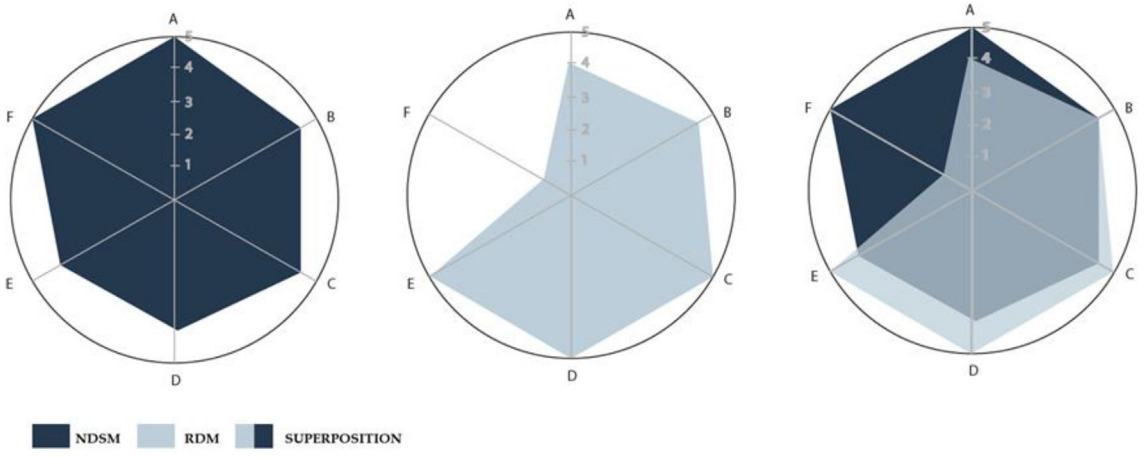


Fig. 6 Study cases comparative graph. Source: The Authors.

collaboration, social inclusion, creative design processes and contributing to an inclusive and sustainable society (Jansen et al., 2021). Even though they are two cases at sites with the same original use as a shipyard, with completely different AR processes at source and regarding intervention strategy, different uses and users, both cases have contributed to the identity of the cities by showing their tangible heritage, reusing the buildings and infrastructures, and its intangible heritage, with the local activity itself, making them more genuine, more different and achieving better coexistence between residents and visitors, and between their activities, while ensuring the conservation of the existing heritage and attracting economic and socio-cultural benefits.

Finally, the article contributes to existing literature that calls for a paradigm shift in waterfront regeneration, aligning it to a more progressive and long-term planning agenda calling for more socially responsible change. This port-city interface is a mediation space with a dynamic and changing character throughout history. Being dynamic and regularly reinvented spaces, spatial planning, public space, and architectural design processes should increasingly seek adaptability, flexibility, and openness to change. As has been shown, the AR of port industrial heritage is key in this context of constant adaptability that faces new challenges.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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