

Heritage valorisation of Madrid's bridges and stations. Applications and new dissemination tools[☆]

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ABSTRACT

The heritage of public works combines technological and social values and is closely linked to the development of cities. Bridges and railway stations are two types of infrastructure of particular importance. On the one hand, they are the most visible elements of urban communication networks demonstrating the technology and the era in which they were built. On the other hand, they are hubs of activity in urban life and have cultural and symbolic significance. This article presents two related research and dissemination projects, analysing the bridges and railway stations of the city of Madrid. The methodology followed in their development is presented: selection, documentation, analysis and evaluation; transferable to other public works and cities. The resulting digital dissemination tools consist of rigorous databases based on interactive cartographies. These tools have more attractive and flexible interfaces than the traditional ones, offering new uses and applications. Geolocation and the diversity of content (text, images, 3D models, videos, etc.) ensure a comprehensive technical and cultural understanding of the heritage, while highlighting its role in shaping the city. The projects serve as a model for heritage enhancement and communication with citizens through digital applications and innovative dissemination tools.

1. Introduction

1.1. General approach and objectives

The emergence of cities is rooted in the fundamental act of demarcation. The need to distinguish between the inside and the outside is evident in the medieval walls, which became the defining element of growing cities. In the 19th century, cities were shaped by their flows. Roads, railways, water and sewage networks and power lines crystallised into streets, dams and aqueducts, collectors and power stations. In the 20th century, mobility expanded with the development of ring roads and suburban motorways. These new axes, which also acted as barriers, gave rise to tunnels, bridges and suburban links. In addition, as transfers multiplied, stations and interchanges grew in number and size (Aguiló, 2013b).

Today's city is the main repository of our collective memory and the

nerve centre of our civilisation. These and other public works have always been abundant in representational images of cities. Their scale makes them dominant features of the urban scene, where their presence is always striking, if not conspicuous. Moreover, even if their function changes or becomes obsolete, their physical presence remains, acquiring new symbolic meanings that contribute to the formation of the city's identity (Bernabéu & Aguiló, 2011).

This article presents two successive research projects aimed at enhancing the value of public works heritage in the city of Madrid. Both were carried out by the Miguel Aguiló Foundation, dedicated to the study of built heritage and landscape and based at the School of Civil Engineering of the Universidad Politécnica de Madrid. The first project, entitled '*Bridges of Madrid. Technique and Culture*' (*Puentes de Madrid. Técnica y cultura*), was carried out in collaboration with the company INES Ingenieros Consultores and focused on understanding and disseminating the role of Madrid's bridges in the history and

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development of the city (Gil, Hernández, Martín-Caro, et al., 2024). The second project, ‘*Stations, places of interchange*’ (*Estaciones, lugares de intercambio*), was dedicated to the study and subsequent dissemination of the Spanish capital’s railway heritage.

Based on the results of these studies, this article seeks not only to highlight the intertwined relationship between these two types of public works and Madrid’s urban development, but also to explore how new and effective geolocation and dissemination tools can help convey the value of civil engineering heritage in the shaping of large cities.

1.2. Theoretical framework

Public works, unlike architecture, were not really recognised as cultural heritage until the end of the 20th century. In Spain, the Monuments Commission was created in 1844, and from 1884 onwards, only bridges and other Roman works were included (Aguilar, 2014; Chías & Abad, 2012), giving relevance only to their historical value. In the late 19th and early 20th centuries, new values began to be recognised for certain public works: scientific, technical and engineering (Crespo, 2017). Over time, Riegl or Giovannoni postulates also allowed the recognition of contemporary and functional constructions (Riegl, 1988 [1903]; Giovannoni, 1913).

From the 1960s onwards, important Spanish civil engineers developed their work on the basis of these postulates. Carlos Fernández Casado (Fernández, 1972, 1976, 1980, 1983) was decisive in the progressive approach to civil engineering heritage through its typological and structural variables and its specific characteristics (Nárdiz, 2014a): formal, archaeological, compositional and stylistic. However, his studies focused more on history than on heritage, concentrating on Roman works. It was not until 1970 that José Antonio Fernández Ordóñez’s research (Fernández, 1984, 1985a, 1985b, 1986, 1988) really addressed the heritage of public works in all its breadth, including medieval and even modern and contemporary constructions (Aguiló, 2001; Nárdiz, 1997, 2014a). He founded the CEHOPU (Centre for the Historical Study of Public Works and Urban Planning) (Navarro, 2009), and his theoretical contribution has been followed and nuanced by other Spanish engineers and historians (Martínez, 1997; Sánchez, 1997).

During this decade, the concept of cultural heritage began to expand (Ballester, 2014), thanks to international documents such as the Amsterdam Declaration or the Granada Convention (Council of Europe, 1975, 1985). In addition, the concept of cultural landscape emerged, allowing civil engineering to come into its own. The strong link between public works and the territory, shaped by its scale and characteristics, began to be understood; a territory that gives meaning to them, just as they give meaning to it; and it began to be understood that public works are formed by sets of individual elements or by systems of nodes and networks (Aguiló, 1999; Menéndez de Lurca & Soria, 1994; Nárdiz, 2014a). This was a new approach that combined engineering with the cultural geography idea of landscape -built space- (Besse, 2006; Jackson, 1984, 1994; Meinig, 1979) and with the growing attention that industrial archaeology was giving to linear industrial landscapes and networked industrial landscapes (Casella & Symonds, 2005; Palmer & Neaverson, 1998).

In this sense, transport infrastructures have also been claimed, extending the chronological framework by highlighting the heritage of the 19th and 20th centuries (Aguilar, 1995; Nárdiz, 1997; Sánchez, 1997). The 21st century has seen an increase in conceptual and methodological research (Rodríguez et al., 2009; Menéndez de Lurca, 2004, 2011; Nárdiz, 2014b; Aguiló, 2013a, 2013b, 2014), as well as in inventorying and cataloguing (Aguilar, 2005; de las Casas, 2014; Tarragó, 2003). In addition, research on specific works and sites has led to the consolidation of diverse and enriching approaches. These approaches emerge within the framework of the territorial approach, which requires the identification, evaluation and conservation of the heritage of public works.

With regard to the protection of this heritage, the heritage categories

of Spanish laws and regulations on culture, whether national or regional, do not adequately address the territorial scale of civil engineering (Lozano, 2019; Nárdiz, 2012; Ruiz et al., 2016). On the one hand, they focus on the protection of isolated elements within the traditional concept of ‘monument’, and the few protected linear public works are inadequately catalogued (Rodríguez et al., 2009). On the other hand, the works that receive the highest level of protection (Bien de Interés Cultural), due to their historical value or antiquity, have Roman or medieval origins (Nárdiz, 2012). In general, they are rare due to the mistrust that they generate among administrations, as most of them are in use. It is complex to reconcile their functionality with protection, which often leads to their modification or destruction in order to replace them with other, more modern ones.

About the use of new technological tools in the promotion of cultural heritage, recent years have seen an increase in the development of digital applications and interactive maps. This new reality has contributed to faster, more intuitive, efficient and creative data acquisition, management and visualisation (Domínguez et al., 2020; Hernández et al., 2021; Parcero et al., 2013), which has favoured their application in heritage assessment and dissemination (Díaz et al., 2007; Gaitán et al., 2022).

Of all these new digital tools, those aimed at cartographic consultation, navigation and visualisation make it possible to link cultural assets to the territory, linking geography and place to a sense of identity and belonging (Rees et al., 2022). Interactivity has been key in this process (Bellido, 2008; Colorado, 2003; Pizarro et al., 2008), giving the user an active role. This process began in 2005 with the popularisation of Google Maps and similar applications (Allheib et al., 2022) and has led to the inclusion of interactive maps in heritage dissemination (Bonacini, 2013; Soriano & Pino, 2017; GIPC, 2017).

Thanks to them, the awareness of the place is increased (Marconcini, 2018). They allow to communicate the values of cultural assets through resources such as timelines (Casanova et al., 2024) or the overlay of historical cartography (Bollini & Begotti, 2017); they are particularly effective tools for assets and sites of tourist interest (Fernández, 2011); and they are fundamental to ensure universal accessibility (Marconcini & Pracchi, 2019; Stefanov et al., 2023).

New technologies make it possible to highlight the territorial dimension of the heritage of public works through geolocation, as demonstrated in dissemination projects using GIS mapping such as ‘*The Culture of Water*’ (Domínguez et al., 2020), educational projects using ArcGIS Story Map (Mauro et al., 2021) and tourism-oriented projects such as VIDA-HTL (Hidalgo et al., 2024).

More specifically, in the field of tourism promotion, there are web platforms that disseminate routes and itineraries, especially in historic centres. However, there are still few examples related to public works (Loren et al., 2016; Loren et al., 2018; Ruiz et al., 2020), except for cases related to railways and from a landscape perspective (Rolando & Scandiffio, 2022; Sang et al., 2022). However, engineering heritage can have a place in the new ‘heritage corridors’, regional tourism products for territorial dynamization that take advantage of routes defined by commercial, religious or public works, benefiting from existing linear spaces with clear geographical markers, such as rivers, walls, railways and roads (Li et al., 2023).

1.2.1. Madrid’s bridges heritage

Among the different types of public works, bridges are the most appreciated and known. They stand out ‘for their privileged meaning, as the very symbol of connection over the obstacle’ (Aguiló, 2013b). This symbolism is particularly relevant in urban centres, where bridges cannot be considered simply as structures that overcome an obstacle, but as key elements in the construction of the city. Bridges condense in their structures the evolution of communication, accessibility and mobility conditions, as well as the development of the occupation process, which makes habitability possible. Each historical period has left its mark on the infrastructures created in response to the needs of a growing

population, works designed and built according to specific techniques (Bonet Correa, 1994).

Even before Madrid was a city, its origins were linked to communications. In the centre of the Iberian Peninsula there were some of the most important Roman roads. These networks were transformed into a system of centres that prioritised territorial defence and control. In the 9th century, the Muslims founded Madrid to dominate the valley of the Manzanares River and the Guadarrama mountain range (de Terán, 2006).

Bridges over the river are recorded between the 11th and 15th centuries, but the first monumental and permanent structures were built when Madrid became the capital. During Felipe II reign (16th century), a radial road network began to take shape, leading to the Segovia and Viveros bridges, and culminating in the 18th century with the baroque Toledo bridge. In the 19th century, the basic network of streets in the historic quarter was consolidated. It was defined by the *Paseo de Ronda*, a “ring road” that followed the perimeter of Felipe IV’s walls. It continued along the Prado axis and the entrances to the radial streets, with a layout that remained in force until the 1950s (Aguiló, 2006; Fernández, 1974, 1975).

In the same century, the construction of the Isabel II Canal led to an increase in population. This led to the expansion of the city centre –*Ensanche*– and the urbanisation of the Castellana and Abroñigal streams (Pedraza et al., 1985). With the arrival of the railway in 1851, a new transport network was superimposed on the existing road network and new iron bridges were built. These included bridges for the railway (Franceses br.) but also for the new roads (Princesa br.) and for the reorganisation of the central road network (Bailén viaduct) (Fernández, 1971; Martín-Caro, 2013).

At the beginning of the 20th century, this material was replaced by reinforced concrete. After the First World War, cars became the main means of transport, marking the beginning of a period increasingly linked to travel and tourism. Traffic density increased to such an extent that Madrid’s historic radial expansion was no longer viable. A new ring road was needed to connect the peripheral centres, and new bridges were built to improve access to the main roads (Avenida de América for Barcelona, Puerta de Hierro for La Coruña, etc.) [Fig. 1].

In the 1940s and 1950s, the post-Civil War city reconstruction and the development of the Greater Madrid urban plan, which annexed municipalities that increased the size of the city by a factor of nine, required new bridges. Some were built over the Manzanares River, which had just been canalised. Others were built over the Abroñigal stream, whose north-south axis was used to reinforce the Castellana axis. The plan was to turn it into a main road that would connect the historic road to France with the Barcelona, Valencia and Andalusia roads (de Fuentes, 1958; Navarro, 2001).

The ring road proposed in the 1920s began to take shape, and its first bypass was the *Paseo de Ronda*, designed in the 19th-century Castro plan. In the 1960s, several flyovers were built over this road¹ to ease traffic flow. Despite these new roads, a third ring road soon became necessary, occupying almost all the waterways around Madrid (Aguiló, 2013c). Called the M-30, it was designed with the characteristics of an expressway: it was built ex novo, with new entrances, multiple directions of traffic and different level crossings. It also connected entire neighbourhoods, with Ventas being its most iconic bridge.

More recently, between 1987 and 1997, the M-40 motorway was completed. This second major ring road was designed to strengthen the links between the peripheral sectors of the metropolitan area, whose population and activity began to grow. Its main bridges correspond to nodes (Puerta de Hierro, La Zarzuela, Norte) and there are some notable

works (Ensanche de Vallecas, Valdebebas) in the new urban growth areas of the city. There, new pedestrian bridges connect green spaces (Ambroz, in Vicálvaro) and are used for leisure activities (Martínez, 1997; Bernabéu, 2004; Manterola, 2017; VV.AA., 2018).

In the 21st century, the M-30 has been buried along the Manzanares. The *Madrid Río* project resulted in a new landscape for the capital: the river was transformed from a boundary to an integral part of the urban fabric. It also created new and varied routes, linking the neighbourhoods on either side of the river. In this park, historic bridges coexist with new landmarks that have been transformed into vantage points over the river (Cáscara and Arganzuela). For these details, *Madrid Río* incorporates landscape and territorial elements in the form of an ecological corridor, linking the city’s different green areas (Corres et al., 2010; Corres et al., 2011).

1.2.2. Madrid’s stations heritage

In the second half of the 20th century, the cultural and landscape values of railways and stations began to be claimed and protected. Since then, this heritage has been recognised and has been the subject of studies and innovative projects (Aguilar, 2003). The creation, extension and improvement of communication and transport routes have had a decisive influence on the structure of cities, a process that is also evident in Madrid.

The railway arrived in the city in 1851. As mentioned in the previous section, in the 19th century Madrid began to expand beyond the historic walls of Felipe IV. This expansion gave rise to the *Paseo de Ronda*, but also provided the necessary space to integrate the incipient presence of the railway. The Atocha wharf and the Aranjuez branch line were built to the south, and the northern station, now Príncipe Pío, was built parallel to the *Paseo de la Florida* (de Terán, 2006; Navascués, 2007).

In the 19th century, the railway had a greater territorial impact than the road network and was more capable of generating vital intensification around it. From the beginning, the city of Madrid and the Atocha station were key components of the Spanish railway system, as having a central station was considered essential to connect the network of lines and stations throughout the peninsula (Almazán, 1857).

In the 20th century, the 1930s Public Works Plan is worth mentioning, as it marked the future of mobility in Spain. In Madrid, it led to the project of railway connections, with lines coming from the west, south and southeast concentrated in Atocha, and those coming from the north, northeast and northwest in Chamartín. Both stations were eventually connected by a tunnel that crossed the entire *Paseo de la Castellana*. In fact, the neighbourhoods along this axis owe their origins to these railway connections and the subsequent Zuazo Jansen plan. During the same period, the suburban network was extended to the cities of Toledo, Guadalajara, Segovia and Ávila, and the growth of Madrid towards the north was encouraged with new metro and railway stations (Nuevos Ministerios, Recoletos, Chamartín) (Aguiló, 2013c; García, 2013).

The 1930s projects were interrupted by the Civil War and the subsequent economic paralysis: it was not until 1968 that the last rail link, the Madrid-Burgos line, was inaugurated. In the same year, Delicias station was closed, Atocha took over Extremadura services and Catalan trains moved to Chamartín, inaugurated in 1976 after the last project by Vázquez, Molezún and Olquiaga. In the 1980s, the operation of the *Green Corridor* allowed the burial of the outlying railway lines, regenerating the south of the city. Finally, from 1990 onwards, the suburban networks and connections were resolved, with particular attention paid to interchanges (Méndez Álvaro, Príncipe Pío, Plaza de Castilla) and the construction of park and ride facilities (Aguiló, 2013c).

The Madrid metro was created in 1917, and both the network and ridership grew steadily until 1969, when it reached 500 million passengers per year. After a period of decline, line construction resumed in the 1980s. Between 1995 and 1999, 56 km of tunnels and 37 stations were built in a construction effort unparalleled in the world. In the following five years, the 40.5 km of the Metrosur circular line were

¹ The Atocha flyover (known as the Scalextric), Cuatro Caminos and Joaquín Costa flyovers were among these Ronda urban bridges. However, the bridge that stands out is Juan Bravo, a pioneer in Spain for its mixed structure and for housing, beneath its deck, the country’s first open-air museum.



Fig. 1. Madrid's main roads and bridges in relation to the topography of the city and its watercourses.
Source: [Hernández and Martín-Caro \(2022\)](#).

completed ([Aguiló, 2009](#); [Trabada, 2005](#)).

Despite the expansion of the periphery, the centre remains an important point of reference for positioning or travelling, concentrating many transport lines. An example of this situation is the construction of the Sol metro station, a true technical masterpiece that has strengthened the square's function as a true central hub. Madrid itself is the centre of the High-Speed Train (AVE), whose arrival in 1992 meant a qualitative leap for the railway, with services comparable to those offered in other European countries. Today, the AVE serves as a commuter train to Madrid for cities such as Ciudad Real, Valladolid or Cuenca, and as an unbeatable link to the capital for Zaragoza, Cordoba or Valencia. As a necessary step to channel these new fast connections, Atocha station is undergoing its third remodelling and Chamartín is being completely renovated, works that always have a significant impact on the urban fabric of the cities ([Aguiló, 2011, 2013c](#); [Rodríguez et al., 2010](#)) [Fig. 2, Table 1].

2. Methodology and structure

The methodology used in the research was divided into five stages:

Works selection

The strategy was to select specific bridges and stations of unquestionable technological interest, with symbolic and cultural significance, and those that were part of a wider network of communication that would allow us to study and understand the urban development of Madrid. A total of 53 bridges and 44 stations were selected based on the basis of their uniqueness and typological diversity, construction techniques, materials and social and historical importance, among other criteria. The aim was to obtain a limited but homogeneous and sufficiently representative sample from a historical and typological point of view. A wide period of time was also chosen, from the first bridges and stations to the inclusion of more recent works, which are generally less studied.

Documentation

Extensive archiving and documentation work has been carried out in order to collect various types of information on all the bridges and stations studied. Reports, plans, old photographs and images of the construction process helped to analyse them in depth. This work made it possible to get to know both types of structure, their environment and their relationship with the city, and to evaluate them according to each of the criteria listed below.

Analysis

The physiography and lithology of Madrid, its historical and urban development and the technical, cultural and social aspects of each bridge and station were studied. This included their presence in historical events, images, narratives, paintings and films. As a result, the extensive and rich intangible heritage associated with these structures has been highlighted.

Valorisation

Based on the axiology of cultural heritage ([Riegl, 1988 \[1903\]](#); [Fernández, 1985a](#)) and consolidated and more updated programmes such as the IEA Engineering Heritage Recognition Program ([IEA, 2017](#)) and the ASCE Historic Civil Engineering Landmark Program ([ASCE, 2024](#)), five different criteria have been proposed ([Hernández et al., 2020](#); [Hernández et al., 2022](#); [Hernández & Martín-Caro, 2022](#)) [Fig. 3, Table 2]:

- Historical value: This value is higher for a bridge or station that represents a significant activity or period in history, maintains the continuity of a historical process, is part of a historic railway or road network that also provides system value, or whose authorship in terms of its designer or his team is relevant.

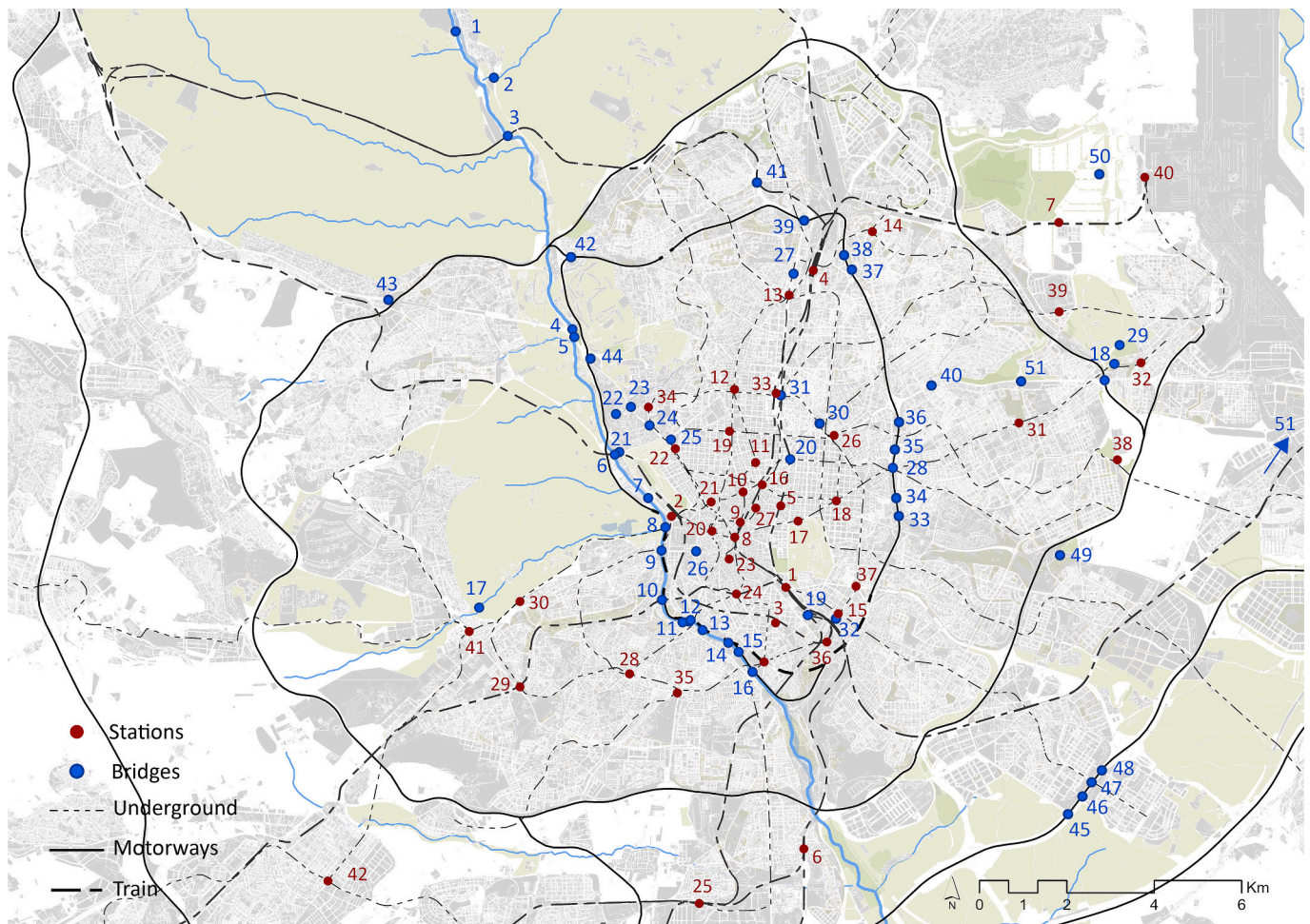


Fig. 2. Map of bridges and railway stations in Madrid selected for the study, as well as motorways and railway lines: Metro and Cercanías. Source: Author's own work.

- Technical value: In this case, the value will be higher if the bridge or station has played an important role in the development of engineering; if it retains its authenticity despite the interventions it has undergone; if it is a work that represents a technical milestone or the overcoming of a technological challenge, taking into account its innovative nature.
- Social value: This value will be more important for bridges and stations that have appeared in songs, films, literature, photographs, etc.; also for those that have a greater capacity to be a cultural reference in the collective memory and have a symbolic character; and for those that possess the 'genius loci', giving the work a strong local character that determines its image.
- Uniqueness: This value is higher when a bridge or station is complete and authentic, i.e. not an imitation; when it belongs to a unique typology or is the first realisation of more common ones; when its typology is related to its historical moment; or when it is the last representative of a typology of which few examples have survived.
- Aesthetic value: Finally, this value will be more relevant in those bridges and stations with greater aesthetic and formal consideration, such as monumentality and belonging to styles in stations, or slenderness and lightness in bridges; and in works that relate more to the environment, adapting through their materials or volumes or creating new landscapes as a reference to the place.

Dissemination

The results have been presented at seminars and congresses on cultural heritage, in the Madrid City Council News Journal, in academic

articles, in scientific journals and in various media, including regional and national radio programmes and press articles.

Analysing the bridges from a new perspective, focusing on their real context, made it possible to appreciate their nuances and peculiarities and to objectify their values. Similarly, studying these structures in relation to their location, rather than chronologically or by material, has highlighted the importance of the bridges' function, their integration into the city and their impact on the lives of the people of Madrid (Hernández & Martín-Caro, 2022).

In the same way, the urban railways have a remarkable presence in everyday life. However, their configuration, distribution, history and impact on the urban layout are still unknown to the public. Through the research carried out, it has been possible to convey the relevant role played by its most representative elements: the terminals or stations (Brull et al., 2023).

In summary, the series of works selected has made it possible to construct a line of argument to analyse their heritage values, the relationship between them and, of course, their role in the evolution of Madrid city.

The article is structured in such a way that, after a brief overview of the evolution and current state of the evaluation and protection of public works heritage, it goes on to contextualise the role of bridges and railway stations in Madrid's development. It then discusses the importance of mapping and geolocating elements for the dissemination of this type of heritage, and how these tools have been used to communicate the value of the heritage to the public. Finally, the conclusions reflect on the different research results and the achievement of the objectives set.

Table 1
Map legend with Madrid’s bridges and stations.

Manzanares River - First Railway Bridges			Urban Bridges		
1	Capuchinos Bridge	19	Comercio St. Bridge	36	Avenida Badajoz Bridge (M30)
2	Bridge over Nava stream	20	Juan Bravo Bridge	37	Pio XII Bridge (M30)
3	El Pardo Railway Viaduct	21	French Bridge in Ciudad Universitaria	38	La Paloma Junction Footbridge (M30)
4	San Fernando Bridge	22	Air Viaduct over the Cantarranas stream	39	Castellana North Junction (M30)
5	Strictly High Bridge	23	Quince Ojos Viaduct	40	CEA Bridge
6	French Railway Bridge	24	Cardenal Cisneros Square Bridge		Peripheral Bridges
7	Reina Victoria Bridge	25	Ciudad Universitaria Tramway footbridge	41	Herrera Oria-Colmenar Bridge
8	King’s Bridge	26	Segovia Viaduct	42	Zarzuela junction (M-30 - M-40)
9	Segovia Bridge	27	Castellana Footbridge	43	Barrial Bridge over A-6
10	San Isidro Bridge	28	Ventas Bridge over M-30 road	44	M-30 Puerta de Hierro Junction
11	Toledo Bridge Western branch	29	Capricho Bridge	45	Avenida Mayorazgo Roundabout
12	Toledo Bridge		Round Roads Bridges	46	Cerro Milano Bridge
13	Monumental Bridge of Arganzuela	30	Joaquín Costa Bridge (disappeared)	47	Avenida Ensanche de Vallecas Roundabout
14	Praga Bridge	31	Raimundo F. Villaverde-Castellana Bridge	48	Av. de las Suertes Bridge
15	Greenhouse Shell Bridge	32	Pedro Bosch - Dr. Esquerdo Bridge	49	Ambroz Footbridge
16	Princesa de Asturias Bridge	33	Marqués de Corbera Bridge (M30)	50	Felipe Juvara Bridge over A-2
17	Culebra Bridge (Meaques stream)	34	Fuente del Berro Footbridge (M30)	51	Gemelos Bridges of San Fernando
18	Alameda de Osuna Railway Viaduct	35	Av. Donostiarra Bridge (M-30)		
Train Stations					
1	Atocha	11	Chamberí (museum)	22	Moncloa
2	Príncipe Pío	12	Cuatro Caminos	23	Tirso de Molina
3	Delicias (museum)	13	Plaza Castilla	24	Embajadores (+ commuter rail)
4	Chamartín	14	Pinar de Chamartín	25	Villaverde Alto (+ commuter rail)
5	Recoletos (commuter rail)	15	Pacífico	26	Avenida de América
6	Villaverde Bajo (commuter rail)	16	Alonso Martínez	27	Chueca
7	Valdebebas (commuter rail)	17	Retiro	28	Oporto
	Metro	18	Goya	29	Aluche (+ commuter rail)
8	Sol (+ commuter rail)	19	Canal	30	Casa de Campo
9	Gran Vía (+ commuter rail)	20	Opera	31	Suances
10	Tribunal	21	Plaza España	32	El Capricho
				33	Nuevos Ministerios (+ commuter rail)
				34	Ciudad Universitaria
				35	Plaza Elíptica
				36	Méndez Alvaro (+ commuter rail)
				37	Conde Casal
				38	Estadio Metropolitano
				39	Feria de Madrid
				40	Aeropuerto T4 (+ commuter rail)
				41	Colonia Jardín
				42	Puerta del Sur
				43	El Casar

Source: Author’s own work.



Fig. 3. Cultural and social impact of four bridges in Madrid: (A) Toledo bridge on a postage stamp, 2013; (B) Bailén viaduct in a frame from Pedro Almodóvar’s film ‘Los amantes pasajeros’, 2013; (C) Poster for the film ‘Historias del Kronen’, with protagonists hanging from the deck of the Juan Bravo bridge, 1995; (D) Madrid Río ‘peel’ bridge, with mosaics by Daniel Canogar depicting neighbours from the surrounding neighbourhoods.

Sources: Fundación Miguel Aguiló, Correos, El Deseo, Alert Film et al.

3. The potential of interactive maps for the dissemination of public works heritage

The current context of recognition of new types of heritage (industrial, vernacular) and new scales (cultural landscapes) provides an opportunity to raise awareness of the aspects and values of public works heritage. However, despite the efforts made in recent years to

disseminate information, mainly through congresses, publications, and exhibitions, these initiatives have not succeeded in reaching the general public.

In Spain, National Plans are the main instrument for conservation, management and dissemination at national level. These plans are implemented by the Instituto del Patrimonio Cultural de España, which is part of the Ministry of Culture. Although public works do not have a

Table 2
Heritage values and comparison between the heritage values of four bridges in Madrid.

Historical value	Very relevant	Significant	Rarely relevant	Little relevant	No relevant
Technical value	Very high interest	High interest	Medium interest	Low interest	No interest
Social value	Very high reference in collective memory	High reference in collective memory	Medium reference in collective memory	Low reference in collective memory	No reference in collective memory
Singularity	Very singular	Singular	Slightly singular	Very Little singular	No singular
Aesthetic value	Influences the location atmosphere	Identifiable in the location atmosphere	Not affect the location atmosphere	Alien to the location atmosphere	Detracts from the location atmosphere

Name	Historical value	Social value	Aesthetic value	Technical value	Uniqueness
(A) Toledo bridge	A	A	A	B	B
(B) Bailén viaduct	B	A	A	A	A
(C) Juan Bravo bridge	B	A	A	A	A
(D) 'Peel' bridges	C	B	B	C	A

Source: ‘Bridges of Madrid. Technique and Culture’.

specific plan, they are included in others. In particular, in the Industrial Heritage Plan, since civil engineering has certain structural characteristics or typological affinities with industrial complexes. As José María Ballester (Ruiz, 2023) points out, this category of heritage also coincides with the Archaeological Plan, through the conservation of historic roads, bridges, aqueducts, reservoirs, harbours and other pre-modern constructions (Camino de Santiago, Canal de Isabel II). Furthermore, with the Cultural Landscape Plan for its decisive impact and because it is the protagonist on many occasions (Riotinto). Finally, in the Contemporary Architecture Plan, there are many examples of 19th, 20th and 21st century architecture (Grandas de Salime Power Station).

In other countries, most heritage protection institutions have limited themselves to compiling inventories of the most emblematic public works, such as in England (Addis & Miller, 2017), Ireland (Cox & Gould, 1998) or Japan (Isohata, 2016). Organisations specialising in civil

engineering heritage have promoted the recognition and evaluation of this type of work through commemorative plaques, online databases and specialist publications (IEA, 2019; ASCE, 2022). However, these catalogues, whether physical or digital, have also struggled to establish a strong connection with the public and are generally limited to researchers or professionals with an interest in the field.

To solve this problem, several Spanish organisations specialising in this heritage have adopted more far-reaching strategies, such as the development of interpretive mobile applications that geolocate heritage sites and provide comprehensive information, both technical and cultural. Some of these take the form of interactive cartographies (Horbiński & Smaczyński, 2023), where old maps and photographs can be compared (Cascón et al., 2018). Others also allow the customisation of routes with time and access indications, even incorporating concepts such as road, network or historical territory, thus improving the

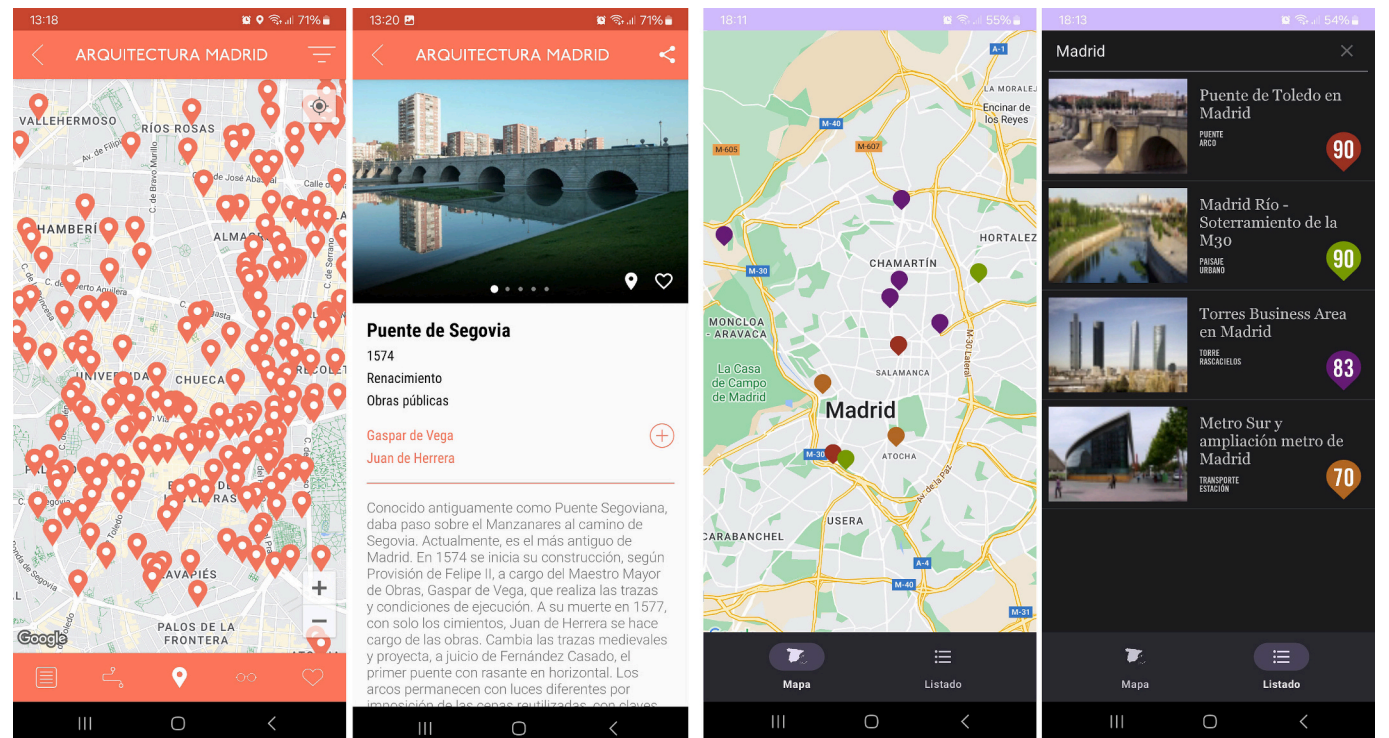


Fig. 4. Left, two screenshots of the ‘Arquitectura Madrid’ mobile application. Right, two screenshots of the ‘GOING’ application, showing some of the public works included for Madrid city.
Source: Fundación COAM/Fundación Miguel Aguiló and Asociación de Ingenieros de Caminos, Canales y Puertos.

understanding of both the material and immaterial values of public works heritage.

Based on interesting precedents in architectural and urban assets (Fundación COAM, 2014; Fundación Docomomo Ibérico, 2018), various research initiatives and projects have sought to link heritage dissemination with new technologies. The main work has been carried out at the Cátedra Demetrio Ribes (Aguilar, 2005; Aguilar & Aguiló, 2016) and at the Miguel Aguiló Foundation, where applications have been developed for specific typologies or geographical areas (Miguel Aguiló Foundation, 2013, 2014; de Castro & Sarabia, 2014; Ruiz et al., 2014; Hernández & Ruiz, 2019). These include GEOPACK (Geolocalización del Patrimonio Construido), which focuses on the cities of Madrid and Málaga, and GOING (Grandes Obras de la Ingeniería), which includes the 200 most significant public works in Spain, many of them urban [Fig. 4].

Such digital tools are essential for the widespread dissemination of the characteristics and values inherent in the civil engineering heritage. New and updated georeferencing systems (GIS), public geographic information systems, open databases, navigators that generate GPS routes and 3D models or augmented reality can help to showcase their specificities (Arcila & López, 2021; Carrasco, 2013; Hernández et al., 2014; KEA and PPMI, 2019; Pardo, 2019; Peinado et al., 2021).

These various digital tools allow the dissemination of public works in a global, accessible, attractive and territorial way, linking them to cartography and reflecting their true scale and extent. The most recent and up-to-date systems facilitate the understanding of the construction, evolution, technical transformation, adaptation to the environment and social dimension of civil engineering (Hernández et al., 2021).

They also help to improve tourism management and user experience (Aitken, 2023). Several case studies show how these different tools create synergies with the tourism sector and provide new opportunities for visiting and interpreting cultural assets (Caro et al., 2015; Nieto, 2015; Yin et al., 2021), especially those with limited access (Stefanov et al., 2023). Moreover, there are more specific examples, such as those of civil engineering, which are unknown, and there are several that “became tourist attractions when the digital revolution started” (Pardo, 2019).

In addition, other studies show how these tools allow citizens to connect with their environment. Mobile applications, by their very nature of use, are easily linked to mobility and can turn any routine trip or walk into an opportunity for learning: “Passive familiarity with places that people regularly pass by but do not bother to learn about also tends to inhibit sensitivity to the built environment without an external force of change, such as participation in walking tours or the introduction of mobile apps” (Wang & Wong, 2020). In this respect, it is essential to combine new technologies with the dissemination capacity of cultural itineraries or routes, as is already happening with industrial heritage (Szpakowska-Loranc & Matusik, 2020).

4. Promoting Madrid's public works heritage

4.1. Knowing to appreciate

The heritage of public works still requires greater attention in terms of understanding its values and implementing strategies to promote tourism and the dissemination of the heritage. To achieve these objectives, it is essential to work with the local heritage, which is the most important in terms of identity and, in many cases, the most fragile due to lack of knowledge and neglect.

It is essential to involve society in the processes of valuing and protecting these cultural assets, which are closest to us both physically and emotionally (Li et al., 2020). However, in order to value heritage, it must first be understood, because only what is known can be valued, and only what is valued can be protected. Any action that brings local heritage closer to society will promote the development of values of respect and empathy for their cultural heritage (Gil, Hernández, Bernabéu, et al., 2024).

With the aim of bringing the civil engineering heritage closer to the public, new technological tools have been used to promote Madrid's public works heritage. With this premise in mind, the digital platforms discussed in this article were designed. Both platforms were created to have a significant impact on the promotion and conservation of the heritage, the revitalisation of different districts and neighbourhoods in Madrid, and the development and diversification of its tourism.

4.2. Geolocation as a basis for the dissemination of public works heritage

In order to design these platforms, the most important and innovative Spanish and international websites and mobile applications were analysed [Table 3]. Several good practices were identified that could be applied to the project. The selection was based on two criteria: firstly, they had to be focused on the dissemination of civil engineering or industrial heritage and, secondly, they had to use the geolocation of their elements for interactive mapping as the main channel of communication with users.

The comparison of the different parameters analysed facilitated the identification of content and functionalities for the new platforms. Among other things, it was decided that the platforms should be websites that could be accessed from mobile devices by adapting their interface to the change of screen. They also needed to offer a variety of content, including video and three-dimensional models, in addition to the usual text and images.

The scope of the new platforms had to be broader than the websites consulted, bringing together the four types of dissemination observed: scientific, professional, educational and tourist. Flexibility was also sought in the working methodology and the digital structure, so that both the process and the results could be transferred to other cities and other types of public works.

4.3. Digital applications and new dissemination tools: Madrid's bridges and stations

The main result of the work carried out was the online platform ‘Bridges of Madrid. Technique and culture’, accessible from any device [Fig. 5]. Designed to reach the widest possible audience, it displays a total of 55 geolocated bridges, each with a data sheet analysing their historical, technical, and cultural context, as well as the five heritage values mentioned above. Together with complementary graphic documentation (photographs, plans and reports) and three-dimensional models of the main works, the system of geolocated data sheets provides a wealth of information and facilitates urban development analysis.

On the one hand, the research commitment to understanding the city is reflected in the inclusion of a map layer in the interactive map. Eleven of these are historical, covering the city of Madrid from the early 17th century to the 1960s (maps by Mancelli, Texeira, Chalmardrier, Madoz y Coello, Ibáñez de Íbero, etc.). Users can also add a land use map from 2012 or orthophotos taken between the 1950s and 2000s.

On the other hand, users can follow six different routes along the main bridges. In addition to the interactive map, downloadable brochures with detailed information on distances and means of transport have been created to allow citizens and tourists to follow the routes in a self-guided manner. To encourage the use of sustainable transport, the itineraries have been designed to be followed on foot, by bicycle, by bus or by metro, linking the bridges to public transport and to the stations from which they can be reached. It is important to note that the itineraries correspond to the four groups of bridges into which the research was divided, based on different geographical situations that show their role in shaping the city:

- Group 1: Valleys, ridges and the Manzanares River. A route through the oldest bridges, built to overcome Madrid's first obstacles.
- Group 2: Urban Bridges. Two routes along bridges that have become part of the city fabric and its streets.

Table 3

Comparison of seven websites for the dissemination of industrial and public works heritage.

	CDR	GOING	P. N. P. I.	CSCE	ASCE	Structurae	ERIH
Platform type	Web	Web and app	Web	Web	Web	Web	Web
Mapping start year	2016	2018	2020	2022	2022	1998	2019
Country(ies)	Spain	Spain	Spain	Canada	United States	Germany	European Union
Ownership	Private (Found.)	Private (Assoc.)	Public (Gov.)	Private (Assoc.)	Private (Assoc.)	Private (Personal)	Private (Assoc.)
Funded by	GVA	ACICCP	Ministerio de Cultura	CSCE	ASCE	Structurae fees	Council of Europe
Developer	CDR (UPV)	FMA (UPM)	IPCE	CSCE	ASCE	Nicolas Janberg	ERIH Association
Organisation's start year	2003	2018	2001	1887 (1983)	1852 (1964)	1998	2003
No. of public works	/	220	35 P.W. / 177 Ind.	77	465	+81.000	2.300 Ind.
Type of information	Text / Image	Text / Image	Text / Image	Text / Image	Text	Text / Image	Text / Image / Video / Audio
Assets geographical scope	Regional	National	National	Int.	Int.	Int.	Int. (Europe)
Use	Scient. + edu. Diss.	Scient. Diss.	Scient. Diss.	Scient. + prof. Diss.	Scient. + prof. Diss.	Scient. + prof. Diss.	Touristic
No. of categories	6 - 15	25	14 - 6	19	12	12	18
Time frame (centuries)	1-21st	1-21st	1-20th	17-20th	1-20th	1-21st	18-20th
Cultural heritage type	Civil Eng.	Civil Eng.	Ind.	Civil Eng.	Civil Eng.	Civil Eng.	Ind.
Technical organism involved	Is technical Found.	Yes	No	Is technical Assoc.	Is technical Assoc.	No	No
Off-line access	No	No	No	No	No	No	No
Scope	Reg. + Nat.	Nat.	Nat.	Nat.	Nat.	Int.	Int.
Plaques/Boards	No	No	No	Yes	Yes	No	No
Itineraries	Yes	No	No	No	No	No	Yes (undefined)
Documents	Books sale / download	No	Studies + Catalogues	No	No	Books / art. sale	Brochures + studies
Citizen participation	No	No	No	Yes (proposals)	Yes (proposals)	Yes (proposals)	No
Registration for access	No	No	No	No	No	Yes (more services)	No
History	Yes	Yes	Yes	Yes	Yes	No	Yes
Technique	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cultural / Social	No	Yes	No	No	No	No	No
Location	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Heritage assessment	No	Yes	No	No	No	No	No
Bibliography	No	Yes	Yes	Yes	Yes	Yes	No
Landscape / Territory	No	Yes	No	No	No	No	No
How to get there	Yes	No	Yes	Yes	No	No	Yes
Tourism	Yes	No	No	No	No	No	Yes
System / Network	Yes	No	No	No	No	No	No
Geographical	/	Mun., reg.	Reg.	Not in map	No	Mun., reg., nat., int.	Reg., nat.
Chronological	/	Yes	No	No	No	No	No
Typological	Yes	Yes	No	No	No	No	Yes
Sub-typological	No	No	No	No	No	No	Yes
Others	No	Autor	No	No	No	No	No
Defined map symbols	Yes, by colours	Yes, by colours	Yes, by symbols	No	No	No	No
	CDR	GOING	P. N. P. I.	CSCE	ASCE	Structurae	ERIH

Information on digital platforms

Information on maps and datasheets

Information on search filters

Digital platforms: CDR ([Cátedra Demetrio Ribes](#)); GOING ([Grandes Obras de Ingeniería españolas](#)); P. N. P. I. ([Plan Nacional de Patrimonio Industrial](#)); CSCE ([Canadian Society of Civil Engineering](#)); ASCE ([American Society of Civil Engineering](#)); Structurae ([International Database and Gallery of Structures](#)); ERIH ([European Route of Industrial Heritage](#)).

Other abbreviations: P.W. (Public works); Assoc. (Association); Found. (Foundation); Gov. (Government); Eng. (Engineering); Ind. (Industrial); Mun. (Municipal); Reg. (Regional); Nat. (National); Int. (International); ACICCP (Asociación del Colegio de Ingenieros de Caminos de España); FMA (Fundación Miguel Aguiló); GVA (Generalitat Valenciana); UPM (Universidad Politécnica de Madrid); UPV (Universidad Politécnica de Valencia); Diss. (Dissemination); Scient. (Scientific); Edu. (Educational); Prof. (Professional); Art. (article).

Source: Author's own work.

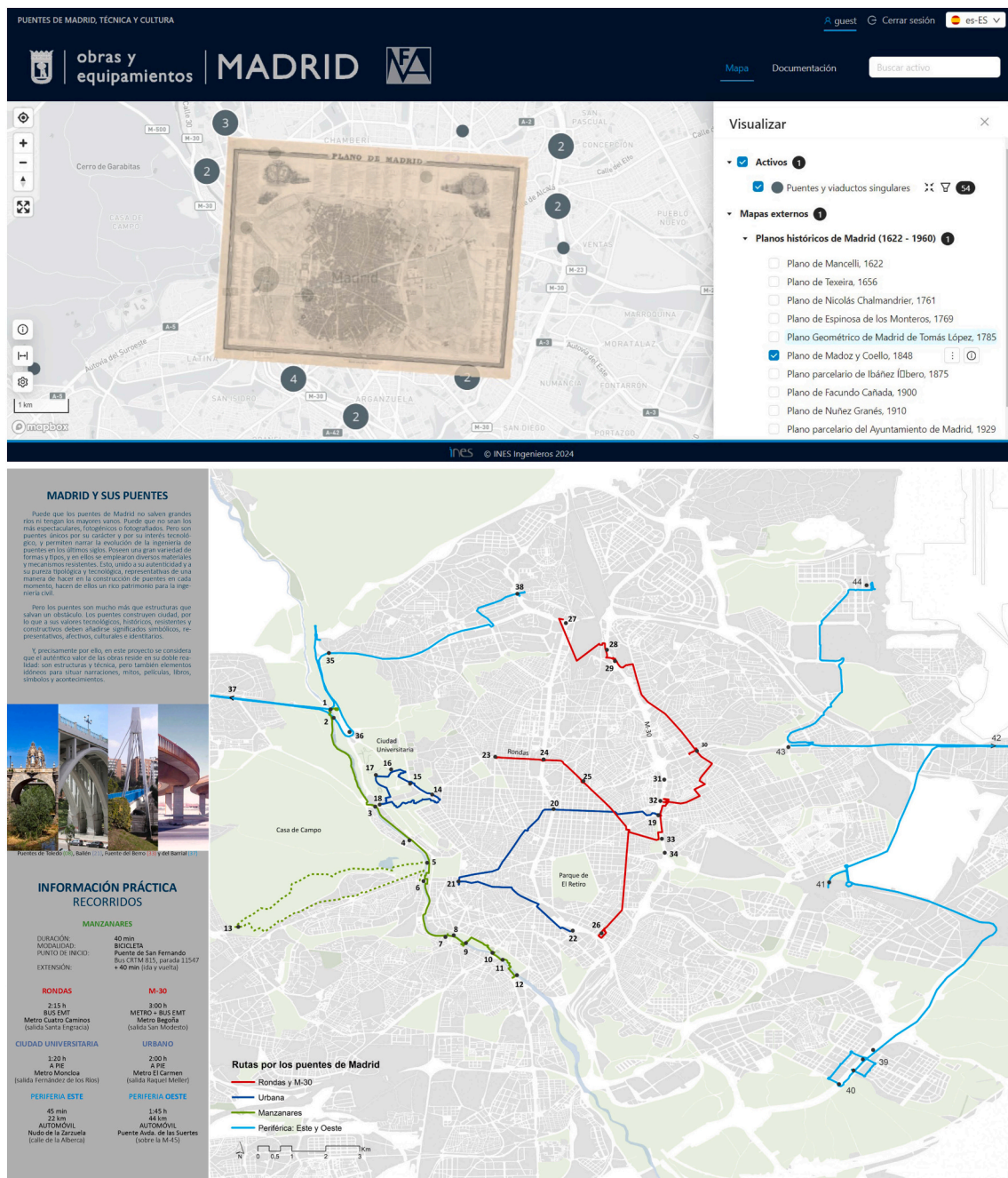


Fig. 5. Above, screenshot of the 'Bridges of Madrid. Technique and culture' platform (<https://madrid.puentes.app/>) showing an example of overlaying layers with historical maps. Bottom, downloadable brochure available on the platform with seven self-guided routes through the four groups of Madrid bridges. Source: Fundación Miguel Aguiló and INES Ingenieros Consultores.

- Group 3. Rondas and M-30. A route along the capital's first motorways bridges, which link the city centre to the neighbourhoods that have sprung up on the other side.
- Group 4: Periphery. Two routes along the bridges that connect Madrid's new urban developments.

Madrid City Council collaborated in the dissemination phase of the project by installing metal posts, next to the bridges, with QR codes that allow users to access the information on the digital platform. This measure ensured that the search for information was not limited to remote visits. On the contrary, it was considered essential that it could be linked to the physical structures, allowing any user to access the information while standing in front of each bridge.

The other important result was a publication by the CSIC (*Consejo Superior de Investigaciones Científicas*), summarising the research carried out. Instead of the usual analysis of the bridges according to historical periods or artistic phases, a global view was adopted, linking the evolution of the bridge's to the growth of the city.

The combination of these different actions has resulted in a portable, dynamic and updatable guide, available in physical and digital versions. This guide promotes visits to these cultural assets, integrating them into the life of the city and bringing them closer to both residents and visitors. It also provides access to quality information that is useful and interesting for the public and researchers, marking an important step in the mobility of information.

Finally, a new digital platform has been created to promote part of

Madrid's railway heritage, entitled “Stations, places of interchange” [Fig. 6]. Similar in functionality to the previous one, this new free database geolocates 44 notable examples of the capital's station heritage. The datasheets correspond to Metro, Cercanías, Media Distancia and Alta Velocidad stations, as well as interchanges with bus or tram services (Metro Ligero). They provide comprehensive information, ranging from technical details to transfer modes, and highlight the relationship between different artistic exhibitions and railway lines and their impact on the collective imaginary. This analysis has allowed a better understanding of the meaning of these places and their relationship with citizens (Brull et al., 2023).

Both studies, *Bridges* and *Stations*, formed the basis of an educational project developed and awarded at the School of Civil Engineering of the Universidad Politécnica de Madrid. Emphasising the importance of itineraries as a basic tool for exploring cities and their public works, the students used the content of the projects to create two types of guided tours: physical and virtual. On the one hand, free tours of the bridges were organised over the Manzanares River and the Atocha and Chamartín train stations, with the students themselves acting as guides. More than 200 people participated, including citizens and vulnerable groups. On the other hand, 100-second videos produced by the students were included in the files of both digital platforms, providing users with summaries of each bridge and station included (Gil, Hernández, Bernabéu, et al., 2024). Both initiatives made it possible to combine education with new technologies and contributed greatly to diversifying and enriching the dissemination of public works.

This type of digital tool is characterised by its adaptability and ability to be constantly updated. In fact, in the last four years, new bridges and their data sheets have been geolocated and included. However, these tools also have their limitations.

One of their main problems, apart from their dependence on Internet coverage, is their need for maintenance. Although they are open and inexpensive applications, they require a minimum of periodic support (operating system updates, compatibility with new versions, etc.) and depend on the server on which they are hosted. In this case, INES Ingenieros guarantees the continuity of the platform. However, there is a

risk that the lack of maintenance by the responsible institutions could lead to a loss of access to the public or to the tool itself.

In the same vein, it should be noted that an increasing number of dissemination platforms have mechanisms for citizen participation, allowing users to add goods and complete their information. However, this possibility requires verification of the data and information provided, so the more open the tool, the more time and control it requires.

Finally, although the aim of this type of digital multimedia tool is to make heritage more interesting to the general public, it is difficult to find a balance between rigour and attractiveness. This is a project born in a university environment, where the aim is to maintain the rigour of the information, and it deals with engineering, the dissemination of which cannot dispense with the explanation of technical issues. Combining these requirements with accessible communication and media that facilitate different approaches to these works is a challenge that is constantly being met.

5. Discussion and conclusions

Madrid has been a fortress, a city and, above all, a crossroads. The study of the city's growth and its transport network has allowed us to analyse the origins of the city and its first bridges, the consolidation of the road and railway networks in the second half of the 19th century and the growth of the motorways in the 20th century. The twentieth century began with the incorporation of steel and concrete in the new crossings and stations, followed by the development of the roads network in the Madrid metropolitan area after the Spanish Civil War, the establishment of railway connections and the expansion of the suburban railway with the arrival of democracy. The 1980s marked the beginning of Madrid's emergence as a global metropolis, culminating in the most recent operations of the 21st century, from the burial of the M-30 and the creation of Madrid Río to the extension of the metro network and the Atocha and Chamartín stations.

Bridges are not only useful structures, they also play a key role in the construction of cities and serve as stages on which citizens move. For this reason, in addition to their technological and construction values, they

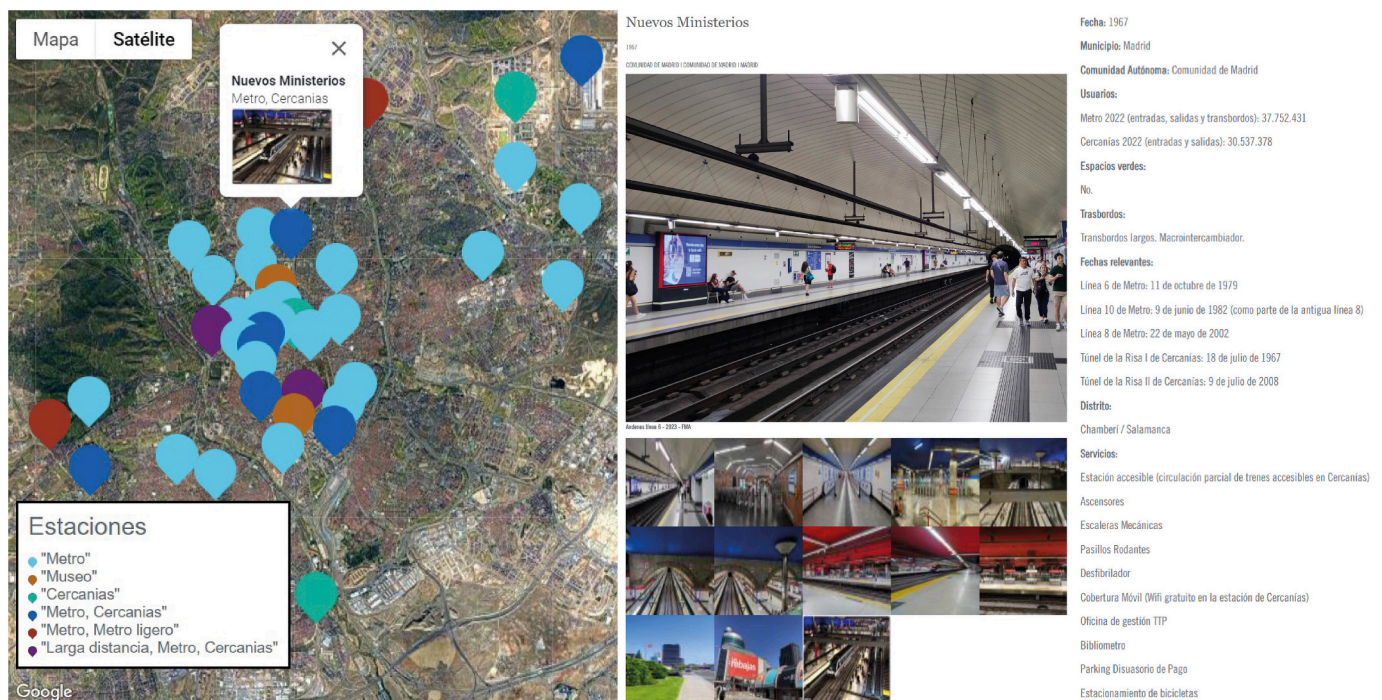


Fig. 6. Screenshots of the ‘Stations, places of interchange’ platform (https://nasservicios.myqnapcloud.com/Estaciones_de_Madrid/mapa.php) showing the main map with the 44 geolocated stations and the Nuevos Ministerios station data sheet, with photos and information.

Source: Fundación Miguel Aguiló.

also have symbolic, representative, cultural and identity-related significance. In short, bridges condense in their structures the evolution of communication, habitability and mobility in cities.

Similarly, the main function of stations is to connect, welcome and serve as places of passage, exchange, urban interaction and use. Like bridges, they help to build cities, bring together social groups and enrich the city and its citizens through their cultural and emotional dimension.

The digital platforms used to disseminate these values have been very well received. 'Bridges of Madrid' has been the most successful, with 64,000 visits in two years, and a total of 169,000 different consultations and interactions. Eighty-seven per cent of users are Spanish, although there have also been visits from foreign tourists. The most interested country is France, followed by the United States, Italy, the United Kingdom, Germany and Portugal. The most consulted bridges are those with the greatest cultural presence: Segovia, Toledo and the Bailén Viaduct.

Part of the success of this platform is undoubtedly due to the installation of QR panels. This type of dissemination tool is more widespread in the field of architectural heritage. Therefore, it can be said that one of the main results or achievements of this project is that in a city like Madrid, dissemination panels have been installed for lesser-known works such as bridges, considering that they are not as large as those in other European capitals crossed by wide and mighty rivers. It was also very satisfying to be able to involve a public administration of the stature of the City Council in this task of promoting civil engineering. The QR boards themselves guarantee the physical dissemination of the works, thus completing the accessibility presented by the digital tools.

By combining these physical and virtual tools, the project has not only aimed at general dissemination: thanks to its link with the university, the tool allows consultation by researchers and is also an educational tool available to students and the general public. Another achievement of this initiative is the bidirectional nature of the platform; students have used the information on the platform to record their videos or virtual visits, which now form part of the content of the tool itself.

Both platforms have successfully demonstrated to the public the relevance and value of these works, both from a technical and a cultural-social perspective. The public must have tools that enable them to learn about and understand these often lesser-known assets. These tools should emphasise that a city's heritage is much richer than is usually thought and should introduce new tours and itineraries that go beyond the historic centre. In Madrid, many bridges and railway stations are located in districts off the traditional tourist routes. Including them in the cultural offer can help citizens in these areas feel included and contribute to the diversification of the heritage, which in turn contributes to the necessary diversification of tourism in any large city.

Taken as a whole, these projects represent a pioneering experience that can subsequently be applied to the rest of the city's public works. Both the methodology and the research results are easily transferable to other elements of the civil engineering heritage - roads, canals, dams - and even to other geographical settings. It is precisely this great flexibility that allows the platforms to incorporate and geolocate elements from different sectors: gastronomy, leisure, nature, etc. In this way, cultural information at urban level could be extended and adapted more directly to the tourism sector in a future development of applications.

CRedit authorship contribution statement

Patricia Hernández Lamas: Methodology, Writing – original draft, Investigation, Formal analysis, Supervision, Conceptualization. **Jorge Bernabéu Larena:** Formal analysis, Writing – review & editing, Investigation, Conceptualization. **Beatriz Cabau Anchuelo:** Visualization, Methodology. **José Antonio Martín-Caro Álamo:** Supervision, Conceptualization, Investigation, Funding acquisition. **Álvaro Gil Plana:** Formal analysis, Writing – original draft, Data curation. **Óscar de Castro Cuartero:** Validation, Visualization, Software.

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.

Data availability

I have share the data base by link in the article

References

- Addis, B., & Miller, J. (2017). Civil engineering heritage: Country profile - England. *Proceedings of the Institution of Civil Engineers: Engineering History and Heritage*, 170, 80–86. <https://www.icevirtuallibrary.com/doi/10.1680/jenhh.17.00005>.
- Aguilar, I. (1995). *Estaciones y ferrocarriles valencianos*. Valencia: Generalitat Valenciana.
- Aguilar, I. (2003). Patrimonio industrial. Aprovechamiento cultural y reutilización. In *IV Jornadas Internacionales de Patrimonio Industrial INCUNA, 18–21 September, Gijón* (pp. 41–61).
- Aguilar, I. (2005). *100 elementos del paisaje valenciano*. Las Obras Públicas. Valencia: Conselleria d'Obres Públiques i Transports.
- Aguilar, I. (2014). La funcionalidad o el patrimonio: ¿amores reñidos? *Revista de Obras Públicas*, 3559, 13–26.
- Aguilar, I., & Aguiló, M. (2016). *Guía de puentes de la provincia de Valencia*. Generalitat Valenciana, Consejería de Infraestructuras y Medioambiente.
- Aguiló, M. (1999). *El paisaje construido. Una aproximación a la idea de lugar*. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos.
- Aguiló, M. (2001). El patrimonio histórico de los puentes. In VV.AA., *JAFO. Homenaje a José Antonio Fernández Ordóñez* (pp. 275–283). Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos.
- Aguiló, M. (2006). *El carácter de los puentes españoles*. Madrid: ACS.
- Aguiló, M. (2009). Obras públicas e ingeniería (2008). In S. del Campo, & J. F. Tezanos (Eds.), *Enciclopedia España siglo XXI* (pp. 411–448). Madrid: Biblioteca Nueva.
- Aguiló, M. (2011). Rafael Moneo en la estación de Atocha de Madrid. In *Cuadernos d'Obra* (3) (pp. 57–63).
- Aguiló, M. (2013a). Significado territorial de lo construido. In VV.AA., *Arqueología de la memoria reciente. Construcción de la ciudad y el territorio en España 1986–2012. Catálogo de la Exposición* (pp. 31–51). Madrid: CBA, UPM, CEDEX, Círculo de Bellas Artes.
- Aguiló, M. (2013b). *Qué significa construir*. Abada, Madrid: Claves conceptuales de la Ingeniería Civil.
- Aguiló, M. (2013c). *La construcción del actual Madrid*. Madrid: ACS.
- Aguiló, M. (2014). Las obras hidráulicas como patrimonio territorial. In F. Estrada, et al. (Eds.), *Obras Hidráulicas de la Ilustración* (pp. 17–25). Madrid: CEHOPU-Ministerio de Fomento.
- Aitken, J. (2023). *Seeing things differently: the use of mobile app interpretation and its effect on visitor experience at two heritage sites in Aotearoa New Zealand* (Awarded Research Master's Thesis). School of Art History, Classics and Religious Studies, Victoria University of Wellington, Australia.
- Allheib, N., Alraqdi, M., & Almukaynizi, M. (2022). Data Warehouse and Interactive Map for Promoting Cultural Heritage in Saudi Arabia Using GIS. *International Journal of Data Warehousing and Mining (IJDW)*, 18(1), 1–18. <https://doi.org/10.4018/IJDWM.314236>
- Almazán, J. (1857). *Memoria sobre el establecimiento de una estación central, donde se unan los principales ferrocarriles que han de ejecutarse en España*. Madrid: Suplementos a la Revista de Obras Públicas (pp. 52 et seq).
- Arcila, M., & López, J. A. (2021). La cartografía cultural como instrumento para la planificación y gestión cultural. Una perspectiva geográfica. *Periferia Internacional. Revista para el análisis de la cultura y el territorio*, 1(12), 15–36. <https://doi.org/10.25267/Periferica.2011.i12.01>
- ASCE. (2022). Historic Civil Engineering Landmarks. Retrieved April 08, 2024. American Society of Civil Engineering. <https://www.google.com/maps/d/u/0/viewer?mid=1h7KyJohxbvdXTobNsLy14ywmtPSU-H5X&ll=23.013656190426918%2C15.357563851407065&z=2>.
- ASCE. (2024). How to nominate an ASCE Historic Civil Engineering Landmark. Retrieved January 30, 2025, <https://www.asce.org/-/media/asce-images-and-files/history-and-heritage/documents/asce-hcel-nomination-form.pdf>.
- Ballester, J. M. (2014). Evolución del concepto de patrimonio cultural en Europa: la incorporación de las obras públicas. *Revista de Obras Públicas*, 3559, 7–12.
- Bellido, M. L. (2008). Los Fundamentos del Medio Digital. In M. L. Bellido (Ed.), *Difusión del patrimonio cultural y nuevas tecnologías* (pp. 37–53). Universidad Internacional de Andalucía.
- Bernabéu, J. (2004). *Evolución tipológica y estética de los puentes mixtos en Europa* (PhD Thesis). Universidad Politécnica de Madrid.
- Bernabéu, J., & Aguiló, M. (2011). Las Obras Públicas en la formación de la ciudad. *Ciudad y territorio. Estudios territoriales*, 169–170, 555–560.
- Besse, J. M. (2006). Las cinco puertas del paisaje. Ensayo de una cartografía de las problemáticas paisajeras contemporáneas. In J. Maderuelo (Ed.), *Paisaje y pensamiento* (pp. 145–171). Madrid: Abada.
- Bollini, L., & Begotti, D. (2017). The time machine. Cultural heritage and the geo-referenced storytelling of urban historical metamorphose. In O. Gervasi, et al. (Eds.),

- Vol. 10406. ICCSA 2017, computational science and its applications. Cham: Springer. https://doi.org/10.1007/978-3-319-62398-6_17.
- Bonacini, E. (2013). Communication and enhancement of Italian cultural heritage by Google. *Palabra Clave (La Plata)*, 2(2), 49–63.
- Bonet, A. (1994). Naturaleza, ingeniería y vías de comunicación. In *Ingeniería y Naturaleza. Una carretera en Asturias* (pp. 9–34). Madrid: El Viso and Ferrovial.
- Brull, L., Alcolea, J., Hernández, P., & Bernabéu, J. (2023). “Estaciones, lugares de intercambio”: un Proyecto de Aprendizaje-Servicio para la difusión del patrimonio. In *I Congreso Internacional de Patrimonio de la Obra Pública y de la Ingeniería Civil*, 26–29 September, Cuenca-Toledo-Madrid (pp. 31–37).
- Caro, J. L., Luque, L., & Zayas, B. (2015). Nuevas tecnologías para la interpretación y promoción de los recursos turísticos culturales Special Issue. PASOS, *Revista de Turismo y Patrimonio Cultural*, 13(4), 931–945. <https://doi.org/10.25145/j.pasos.2015.13.063>
- Carrasco, S. (2013). Cultural mapping. Hacia un sistema de información cultural territorial (SICT). *Dos puntas*, 8, 57–82.
- Casanova, P., Sevilla, J., Coma, I., Morillo, P., Gaitán, M., & Portalés, C. (2024). Enhancing accessibility and navigation of heritage collections through interactive spatiotemporal maps. *Journal on Computing and Cultural Heritage*, 17(3), 39. <https://doi.org/10.1145/3652521>
- Cascón, J., Ruiz, A. A., & Alberich, J. (2018). Uses and applications of georeferencing and geolocation in old cartographic and photographic document management. *Profesional de la información/Information Professional*, 27(1), 202–212. <https://doi.org/10.3145/epi.2018.ene.19>
- Casella, E. C., & Symonds, J. (Eds.). (2005). *Industrial archaeology. Future directions*. New York: Springer.
- Chías, P., & Abad, T. (2012). El arte de describir el territorio: Mapas y planos históricos en torno al puente de Alcántara (Cáceres, España). *Informes de la Construcción*, 64, 121–134.
- Colorado, A. (2003). Nuevos lenguajes para la difusión del patrimonio cultural. *PH: Boletín del Instituto Andaluz del Patrimonio Histórico*, 46, 42–49.
- Corres, H., Romo, J., Sánchez, J., & Sanz, C. (2011). Pasarelas Cáscara del Matadero y del Invernadero sobre el río Manzanares en Madrid. *Revista de Obras Públicas*, 3520, 39–50.
- Corres, H., Seijo, C., García, J. D., Calvo, I., Grávalos, J., Chozas, V., Lample, R., & Viñolo, A. (2010). Aplicación de tecnologías avanzadas del hormigón en las pasarelas en cáscara sobre el río Manzanares para el proyecto Madrid Río. *Revista de Obras Públicas*, 3515, 7–18.
- Council of Europe. (1975). Amsterdam declaration adopted at the congress of the European architectural heritage.. Amsterdam: European Union <https://rm.coe.int/090000168092ae41>.
- Council of Europe. (1985). Convention for the protection of the architectural heritage of Europe.. Granada: European Union <https://rm.coe.int/168007a087>.
- Cox, R., & Gould, M. H. (1998). *Civil Engineering Heritage*. London: Thomas Telford Ltd.
- Crespo, D. (2017). *Preservar los puentes. Historia de la conservación patrimonial de la ingeniería civil en España (siglo XVI-1936)*. Madrid: Fundación Juanelo Turriano.
- de Castro, O., & Sarabia, A. (2014). El sentido de catalogar: De los estudios históricos y los inventarios a las nuevas aplicaciones. *Revista de Obras Públicas*, 3559, 73–78.
- de Puentes, L. (1958). La canalización del Manzanares. Antecedentes, características y situación actual de las obras. *Revista de Obras Públicas*, 2921, 549–555.
- de las Casas, A. (2014). *Guía de obras públicas en Andalucía*. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos.
- de Terán, F. (2006). *En torno a Madrid. Génesis espacial de una región urbana*. Comunidad de Madrid.
- Díaz, J. M., Villalón, D., & Pizarro, C. (2007). Nuevo producto de difusión del patrimonio a través de su localización cartográfica. *PH: Boletín del Instituto Andaluz del Patrimonio Histórico*, 64, 14–16.
- Domínguez, V., Rey, J., & Rivero, G. (2020). Contribution to the Knowledge of Cultural Heritage via a Heritage Information System (HIS). The case of “La Cultura del Agua” in Valverde de Burguillos, Badajoz (Spain). *Sustainability*, 12(3), 1141. <https://doi.org/10.3390/su12031141>
- Fernández, C. (Ed.). (1971). *Revista Hormigón y Acero*, 100. Asociación Técnica Española del pretensado.
- Fernández, C. (1972). *Acueductos romanos en España*. Madrid: Instituto Eduardo Torroja.
- Fernández, C. (1974). Madrid y el Manzanares: El río, la ciudad y sus puentes. *Revista de Obras Públicas*, 3–12.
- Fernández, C. (1975). Madrid y el Manzanares: El río, la ciudad y sus puentes. *Revista de Obras Públicas*, 147–158.
- Fernández, C. (1976). *Estética de las artes del ingeniero*. Madrid: Real Academia de Bellas Artes de San Fernando.
- Fernández, C. (1980). *Historia del puente en España. Puentes romanos*. Madrid: Instituto Eduardo Torroja.
- Fernández, C. (1983). *Ingeniería hidráulica romana*. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos.
- Fernández, J. A. (1984). *Catálogo de puentes anteriores a 1936*. León: Colegio de Ingenieros de Caminos, Canales y Puertos.
- Fernández, J. A. (1985a). The technical and industrial built heritage in the southern states of Europe. In *Council of Europe. Situation of the technical and industrial built heritage in Europe*. Strasbourg: Council of Europe.
- Fernández, J. A. (1985b). Un nuevo patrimonio: Las antiguas obras públicas europeas. *MOPU, Revista del Ministerio de Obras Públicas y Urbanismo*, 321, 3.
- Fernández, J. A. (1986). *Catálogo de treinta canales españoles anteriores a 1900*. Madrid: Ministerio de Obras Públicas.
- Fernández, J. A. (1988). *Catálogo de noventa presas y azudes españoles anteriores a 1936*. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos.
- Fernández, S. (2011). Aplicación de las Tecnologías de la Información Geográfica a la gestión del patrimonio cultural. *PH: Boletín del Instituto Andaluz del Patrimonio Histórico*, 77, 94–100. <https://doi.org/10.33349/2011.77.3110>. Especial Monográfico: Cartografía y patrimonio.
- Fundación COAM. (2014). *Guía Arquitectura de Madrid*. Retrieved May 05, 2024: <https://www.coam.org/es/fundacion/servicio-historico/guia-arquitectura-madrid>.
- Fundación DCOMOMO Ibérico. (2018). *Mapa interactivo Docomomo Ibérico*. Retrieved May 05, 2024: <https://docomomoiberico.com/mapa-interactivo-docomomo-iberico/>.
- Fundación Miguel Aguiló. (2013). GEOPACK. App para Geolocalización del Patrimonio Construido. In , vol. 5. *Cuadernos de Diseño de Obra Pública* (p. 36). Cercle d’Infraestructures.
- Fundación Miguel Aguiló. (2014). *Aplicación “PHDuero - Patrimonio Hidráulico del Duero”*. Confederación Hidrográfica del Duero. Ministerio de Agricultura, Alimentación y Medio Ambiente.
- Gaitán, M., León, A., Alba, E., Sebastián, J., Recio, R. C., Tudela, M., Sevilla, J., Casanova, P., & Portalés, C. (2022). SeMap: a tool for dissemination and heritage education. In *Actas del II Simposio de Patrimonio Cultural ICOMOS España. Cartagena*, November 17–19 (pp. 769–776). <https://doi.org/10.4995/icomos2022.2022.14935>
- García, A. (2013). *Indalecio Prieto y los enlaces ferroviarios de Madrid*. Madrid: Fundación Indalecio Prieto.
- Gil, A., Hernández, P., Bernabéu, J., Cabau, B., & de Castro, O. (2024). Puentes y estaciones de Madrid. Difusión ciudadana del patrimonio de la obra pública. In *Actas del XI Seminario Internacional de la arquitectura y la industria. Aula G+I PAI*, 18–19 April, Madrid (pp. 151–172).
- Gil, A., Hernández, P., Martín-Caro, J. A., Cabau, B., & Bernabéu, J. (2024). Sociedad y cultura en los puentes de Madrid. *Informes de la Construcción*, 76(573), 6359. <https://doi.org/10.3989/ic.6359>
- Giovannoni, G. (1913). *Vecchie città ed edilizia nuova*. Milano: Nuova Antologia.
- GIPC-Grupo de Investigación Paisaje Cultural. (2017). Narrando (100) paisajes culturales de España. *Revista PH*, 92, 4–5.
- Hernández, P., Cabau, B., de Castro, O., & Bernabéu, J. (2021). Mobile applications, geolocation and information technologies for the study and communication of the heritage value of public works. *Sustainability*, 13(4), 2083. <https://doi.org/10.3390/su13042083>
- Hernández, P., & Martín-Caro, J. A. (2022). *Puentes de Madrid. Técnica y cultura*. Madrid: Consejo Superior de Investigaciones Científicas, Ediciones La Librería.
- Hernández, P., Martín-Caro, J. A., & Gil, A. (2022). “Puentes de Madrid. Técnica y cultura”, una nueva plataforma digital para la difusión patrimonial de las obras públicas. *Revista de Obras Públicas*, 3637, 102–109.
- Hernández, P., Ramiro, M. J., Castro, O., & Hernández, V. (2014). Valoración del Patrimonio de la Obra Pública. In M. M. Lozano, & V. Méndez (Eds.), *El agua como recurso patrimonial y paisajístico/Water as Heritage and Landscape Resource* (pp. 63–67). Ministerio de Economía y Competitividad, Universidad de Extremadura.
- Hernández, P., & Ruiz, R. (2019). Proyecto piloto GOING, Grandes Obras de Ingeniería. *Revista de Obras Públicas*, 3613, 58–67.
- Hernández, P., Ruiz, R., & Cabau, B. (2020). G•O•ING Grandes Obras de Ingeniería. Una app para la identificación, valoración y difusión del patrimonio de las obras públicas. In *VII Seminario Internacional G+I PAI sobre Patrimonio de la Arquitectura y de la Industria*. 5–6 November, Madrid (pp. 113–132).
- Hidalgo, F. M., Merino, R., Mascort, E. J., Ruiz, I., Linares, M., & Tejedor, A. (2024). Digital reactivation of territories through geospatial cultural itineraries: The VIDA-HTL web application. *Heritage Science*, 12, 56. <https://doi.org/10.1186/s40494-024-01173-w>
- Horbiński, T., & Smaczyński, M. (2023). Interactive thematic map as a means of documenting and visualizing information about cultural heritage objects. *ISPRS International Journal of Geo-Information*, 12(7), 257. <https://doi.org/10.3390/ijgi12070257>
- IEA. (2017). Guide to engineering heritage recognition program. Retrieved January 30, 2025, <https://www.engineersaustralia.org.au/sites/default/files/2022-06/engineering-heritage-recognition-program.pdf>.
- IEA. (2019). Engineering heritage Australia. Retrieved April 08, 2024: Institution Engineers Australia. <https://www.engineersaustralia.org.au/engineering-communities/engineering-heritage-australia>.
- Isobata, H. (2016). Civil engineering heritage: Country profile - Japan. *Proceedings of the Institution of Civil Engineers: Engineering History and Heritage*, 169, 95–100. <https://doi.org/10.1680/jenh.16.00004>
- Jackson, J. B. (1984). *Discovering the vernacular landscape*. New Haven and London: Yale University Press.
- Jackson, J. B. (1994). *A sense of place, a sense of time*. New Haven and London: Yale University Press.
- KEA, & PPML. (2019). *Research for CULT committee - Culture and creative sectors in the European Union - Key future developments, challenges, and opportunities*. Brussels: European Parliament, Policy Department for Structural and Cohesion Policies.
- Li, J., Krishnamurthy, S., Pereira, A., & van Wesemael, P. (2020). Community participation in cultural heritage management: A systematic literature review comparing Chinese and international practices. *Cities*, 96, Article 102476. <https://doi.org/10.1016/j.cities.2019.102476>
- Li, M., Cao, Y., & Li, G. (2023). An approach to developing and protecting linear heritage tourism: The construction of cultural heritage corridor of traditional villages in Mentougou District using GIS. *International Journal of Geoheritage and Parks*, 11, 607–623. <https://doi.org/10.1016/j.ijgeop.2023.11.002>
- Loren, M., Mata, R., Ruiz, R., & Pinzón, D. (2016). An interdisciplinary methodology for the characterization and visualization of the heritage of roadway corridors. *Geographical review*, 106(4), 489–515. <http://www.jstor.org/stable/45210470>.

- Loren, M., Pinzón, D., Ruiz, R., & Alonso, R. (2018). Mapping heritage: Geospatial online databases of historic roads. The case of the N-340 Roadway Corridor on the Spanish Mediterranean. *ISPRS International Journal of Geo-Information*, 7(4), 134. <https://doi.org/10.3390/ijgi7040134>
- Lozano, M. M. (2019). La caracterización y protección del patrimonio de las obras públicas. In *I Foro Patrimonio Cultural de la Obra Pública*, 21–22 October, Madrid (pp. 25–27).
- Manterola, J. (2017). *Historia de los Puentes*. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos.
- Marconcini, S. (2018). ICT as a tool to foster inclusion: Interactive maps to access cultural heritage sites. *IOP Conference Series: Materials Science and Engineering*, 364, Article 12040.
- Marconcini, S., & Pracchi, V. (2019). Inclusive cultural heritage sites: ICT as a tool to support the design process and share knowledge. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-2/W11, 793–800. <https://doi.org/10.5194/isprs-archives-XLII-2-W11-793-2019>
- Martín-Caro, J. A. (2013). *Puentes de fábrica*. ADIF.
- Martínez, J. (1997). 25 Años de Puentes Mixtos en España. *Primeras Jornadas Portuguesas de Construcción Metálica y Mixta*. Escola de Engenharia. Universidade do Minho.
- Mauro, G., Battaini, C., Segantini, S., & Soliani, M. (2021). Cultural heritage and storytelling: Didactic applications in Trieste with ESRI Story Maps. *J-READING, Journal of Research and Didactics in Geography*, 1(10), 23–37.
- Meinig, D. W. (1979). The beholding eye. Ten versions of the same scene. In D. W. Meinig (Ed.), *The interpretation of ordinary landscapes. Geographical essays*. New York: Oxford University Press.
- Menéndez de Lurca, J. R. (2004). Los caminos en la historia del territorio. *Revista OP. El patrimonio de las obras públicas*, 69, 68–77.
- Menéndez de Lurca, J. R. (2011). *Los sentidos del camino*. Madrid: Ineco.
- Menéndez de Lurca, J. R., & Soria, A. (1994). El territorio como artificio cultural. *Corografía histórica del Norte de la Península Ibérica. Ciudad y Territorio. Estudios Territoriales*, 11, 99, 63–93.
- Nárdiz, C. (1997). Los caminos españoles anteriores a 1900: Patrimonio cultural, urbano y territorial. *Revista OP. El patrimonio de las obras públicas*, 11, 41, 66–75.
- Nárdiz, C. (2012). La estética de lo viejo, treinta años después. El reconocimiento progresivo y limitado del Patrimonio de las Obras Públicas. *Revista de Obras Públicas*, 3531, 19–34.
- Nárdiz, C. (2014a). El discurso patrimonial de los ingenieros de Caminos. *Revista de Obras Públicas*, 3559, 51–62.
- Nárdiz, C. (2014b). El patrimonio de las obras hidráulicas. In F. Estrada, et al. (Eds.), *Obras Hidráulicas de la Ilustración* (pp. 55–63). Madrid: CEHOPU-Ministerio de Fomento.
- Navarro, J. R. (2001). *El puente moderno en España. 1850–1950. La cultura técnica y estética de los ingenieros*. Pozuelo de Alarcón, Minor Network.
- Navarro, J. R. (2009). *Pensar la ingeniería. Antología de textos de José Antonio Fernández Ordóñez*. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos.
- Navascués, P. (2007). *Arquitectura e ingeniería del hierro en España (1814–1936)*. Madrid: Fundación Iberdrola.
- Nieto, A. (2015). Sistemas de Información Geográfica para la difusión web del patrimonio ambiental y cultural: El caso de la Ribera del Marco en Cáceres. *Estudios geográficos*, 76(279), 739–750.
- Palmer, M., & Neaverson, P. (1998). *Industrial archaeology. Principles and practice*. London: Routledge.
- Parcerro, C., White, P. V., Gümil, A., Blanco, R., López, M. F. P., Herrero, A. S., Caballero, A. H., & García, C. G. (2013). GIS-based tools for the management and dissemination of heritage information in historical towns. The case of Santiago De Compostela (Spain). *International Journal of Heritage in the Digital Era*, 2(4), 655–675. <https://doi.org/10.1260/2047-4970.2.4.655>
- Pardo, C. J. (2019). Application of digital techniques in industrial heritage areas and building efficient management models: Some case studies in Spain. *Applied Sciences*, 9(20), 4420. <https://doi.org/10.3390/app9204420>
- Pedraza, J., González, S., de Dios Centeno, J., & Ascaso, E. (1985). *Memoria del Mapa Fisiográfico de Madrid*. Consejería de Agricultura y Ganadería de la Comunidad de Madrid.
- Peinado, S., Hernández, P., Bernabéu, J., Cabau, B., & Martín-Caro, J. A. (2021). Public works heritage 3D model digitisation, optimisation and dissemination with free and open-source software and platforms and low-cost tools. *Sustainability*, 13(23), Article 13020. <https://doi.org/10.3390/su132313020>
- Pizarro, C., Villalón, D., & Díaz, J. M. (2008). El localizador cartográfico del patrimonio cultural andaluz. *PH: Boletín del Instituto Andaluz del Patrimonio Histórico*, 67, 16–29.
- Rees, G., Hunt, A., Vitale, V., Horgan, J., & Strachan, P. (2022). Discovering the local in national cultural heritage collections. How web maps can help the UK public engage with their ‘own places’. *Information, Communication & Society*, 26(15), 2885–2903. <https://doi.org/10.1080/1369118X.2022.2113819>
- Riegl, A. (1988 [1903]). *El culto moderno a los monumentos*. Madrid: Visor.
- Rodríguez, F. J., Coronado, J. M., & Ruiz, R. (2009). El camino de Valencia en Alarcón y Contreras (1845/1998). Análisis de viabilidad para su recuperación como carretera histórica. In *Vol. 5. Cuadernos de investigación del CEHOPU*. Madrid: CEHOPU/CEDEX.
- Rodríguez, J. M., Serrano, C., & Gallego, J. (2010). Nueva estación de cercanías de la Puerta del Sol-Gran Vía. Proyecto y construcción de la caverna de estación. *Revista de Obras Públicas*, 3511, 71–98.
- Rolando, A., & Scandiffio, A. (2022). Multimodal access to minor places in heritage-rich landscapes: GIS mapping to define slow-tourism routes from the stations in the railway networks in-between Turin and Milan. *Sustainability*, 14, Article 15723. <https://doi.org/10.3390/su142315723>
- Ruiz, M. L., Hernández, P., & de Castro, O. (2014). Difusión del paisaje y del patrimonio rural de las obras públicas a través de las nuevas tecnologías. In *REHABEND congresses*.
- Ruiz, R. (2023). La conservación del patrimonio de la Obra Pública debe ir precedida de una identificación correcta y completa. Entrevista a José María Ballester Palazón. *Revista de Obras Públicas*, 3644, 14–19.
- Ruiz, R., Moyano, A., García, M. R., & Hernández, P. (2020). Strategies for the correct contextualisation and management of drove roads in urban historic landscapes. *Landscape Research*, 45(7), 854–872. <https://doi.org/10.1080/01426397.2020.1778660>
- Ruiz, R., Rodríguez, F. J., & Coronado, J. M. (2016). Civil engineering heritage in Spain: Public protection strategies. *Proceedings of the ICE: Engineering History and Heritage*, 169(2), 84–94. <https://doi.org/10.1680/jenhh.15.00005>
- Sánchez, T. (1997). Las carreteras españolas del siglo XX. *Revista OP. El patrimonio de las obras públicas*, 41, 76–81.
- Sang, K., Fontana, G. L., & Piován, S. E. (2022). Assessing railway landscape by AHP process with GIS: A study of the Yunnan-Vietnam railway. *Remote Sens*, 14, 603. <https://doi.org/10.3390/rs14030603>
- Soriano, P. J., & Pino, M. T. (2017). La difusión patrimonial mediante visores cartográficos en Internet. In M. Delgado (Ed.), *Vol. 2. Rescate: Del registro estratigráfico a la sociedad del conocimiento: el patrimonio arqueológico como agente de desarrollo sostenible* (pp. 447–454). Tomo 2.
- Stefanov, T., Varbanova, S., Stefanova, M., & Tsenkova, Y. (2023). Mobile applications for cultural tourism – Past, present, and future. Criteria for a successful mobile app. *International Journal of Interactive Mobile Technologies*, 7(24), 54–78. <https://doi.org/10.3991/ijim.v17i24.42819>
- Szpakowska-Loranc, E., & Matusik, A. (2020). Łódź – Towards a resilient city. *Cities*, 107, Article 102936. <https://doi.org/10.1016/j.cities.2020.102936>
- Tarrago, S. (2003). *Obras Públicas a Catalunya. Present, passat y futur*. Barcelona: Real Academia de la Ingeniería.
- Trabada, J. (2005). Metrosur, una gran obra colectiva. *Ingeniería civil*, 137, 7–23.
- VV.AA. (2018). *Puentes, viaductos y acueductos en la Comunidad de Madrid*. Dirección General de Vivienda y Rehabilitación; Consejería de Transportes, Vivienda e Infraestructuras, Comunidad de Madrid.
- Wang, Y., & Wong, Y. D. (2020). Repositioning urban heritage for active mobility: Indications from news coverage in Singapore. *Cities*, 98, Article 102525. <https://doi.org/10.1016/j.cities.2019.102525>
- Yin, C. Z. Y., Jung, T., Dieck, M. C., & Lee, M. Y. (2021). Mobile augmented reality heritage applications: meeting the needs of heritage tourists. *Sustainability*, 13(5), 2523. <https://doi.org/10.3390/su13052523>

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