A methodological essay in transport studies: applying the PRISMA method

Ensayo metodológico sobre estudios de transportes: aplicación del método PRISMA

Um ensaio metodológico em estudos de transporte: aplicando o método PRISMA

FERNANDA DE LIMA LOURENCETTI
CIDEHUS-University of Évora
Dirección de correo electrónico: flima@uevora.pt
ORCID: https://orcid.org/0000-0001-5649-8774

KEITTY DE OLIVEIRA SILVA
CIDEHUS-University of Évora
Dirección de correo electrónico: keitty.silva@uevora.pt
ORCID: https://orcid.org/0009-0008-5410-4565

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Resumen: Este artículo contribuye a las reflexiones metodológicas sobre la investigación en materia de transporte. Además, aborda el reto que supone estudiar el desarrollo de las conexiones entre puertos y ferrocarriles en las ciudades portuarias. Tomando como referencia tres países del Espacio Atlántico, Brasil, Portugal y España, aplicamos un análisis sistemático de la bibliografía utilizando el método PRISMA, recurriendo a bases de datos nacionales, archivos de bibliotecas nacionales y una base de datos de relevancia internacional. Para 2024, creamos una base de datos con 36 artículos y 20 materiales iconográficos relevantes para el tema, identificando cinco motivaciones principales para conectar el puerto y el ferrocarril: desarrollo económico y logística; integración ferroviaria; mejora de la movilidad y la conectividad; reducción de costes; y ruta geográfica. Este ensayo propone la utilización de una herramienta metodológica aplicada a la investigación histórica, argumentando que su uso puede contribuir a la comprensión del avance

de los estudios sobre movilidad y de las transformaciones urbanas asociadas a las conexiones ferroviario-portuarias.
Palabras clave: Método PRISMA; conexión puerto-ferrocarril; urbanismo; ciudades atlánticas; intermodalidad.

Abstract: This article contributes to methodological reflections on transport research. In addition, it discusses the challenge of studying the development of connections between ports and railways in port cities. Taking three countries of the Atlantic Area as references, Brazil, Portugal, and Spain, we apply a systematic analysis of the literature using the PRISMA method, making use of national databases, national library archives, and an internationally relevant database. By 2024, we had built a database with 36 articles and 20 iconographic materials relevant to the topic, identifying five main motivations for connecting the port and the railway: economic development and logistics; railway integration; improved mobility and connectivity; cost reduction; and geographical route. This essay proposes the use of a methodological tool applied to historical research, arguing that its use may assist in understanding the advancement of mobility studies and the urban transformations associated with railway-port connections.
Keywords: PRISMA method; port-rail connection; urbanism; Atlantic cities; intermodality.

Resumo: Este artigo contribui para reflexões metodológicas sobre a investigação sobre meios de transporte. Além disso, discute o desafio de estudar o desenvolvimento das conexões entre portos e ferrovias em cidades portuárias. Tomando como referência três países da Área Atlântica, Brasil, Portugal e Espanha, aplicamos uma análise sistemática da literatura utilizando o método PRISMA, recorrendo a bases de dados nacionais, arquivos de bibliotecas nacionais e uma base de dados internacionalmente relevante. Até 2024, construímos uma base de dados com 36 artigos e 20 materiais iconográficos pertinentes ao tema, identificando cinco motivações principais para conectar o porto e a ferrovia: desenvolvimento económico e logística; integração ferroviária; melhoria da mobilidade e conectividade; redução de custos; e rota geográfica. Este ensaio propõe a utilização de uma ferramenta metodológica aplicada à investigação histórica, argumentando que o seu uso pode auxiliar a compreensão do avanço dos estudos sobre mobilidade e das transformações urbanas associadas às conexões ferroviário-portuárias.
Palavras-chave: Método PRISMA; conexão porto-ferrovia; urbanismo; cidades atlânticas; intermodalidade.

INTRODUCTION

This essay considers various studies of Atlantic port cities, introducing a systematic analysis that evaluates the reasons behind the connection between railways and ports. As D'Andrea et al. (2011) point out, there are many methodological challenges and innovations into movement, mobility and motility studies. Thus, the main goal of this article is to apply the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) method, contributing to research on the construction of port-rail connections in Atlantic cities on the Iberian Peninsula and in Brazil.

Originating in Health Sciences, the PRISMA method applies explicit and organised procedures to collect and integrate the results of studies investigating a specific question (Page et al., 2021). This method presents guidelines for the proper construction of systematic analyses and meta-analyses to help researchers improve the transparency and completeness of reports on a given topic in a clear and structured way. The organisation of this article was inspired by the work of experts such as Oliveira and Bonito (2023), researchers who apply the PRISMA method within the Humanities, in the area of Education. It also takes into account studies such as that by Lico et al. (2023) focused on the Brazilian railway.

In line with Lame (2019), the application of the PRISMA method in the field of transport studies is presented as a scientific process that uses the principles of empirical research, rather than simply analysis of the literature. It is a contribution to gathering evidence of the development of studies on the subject over the years. In addition, it is a method that can be reapplied, offering a comprehensive view of knowledge in the field of transport studies and helping to define priorities for future research.

A systematic analysis of the literature aims to provide answers to questions that individual studies could not address, as well as identifying flaws in primary research that need correcting in future studies. This method also has the potential to generate or evaluate theories about the causes or mechanisms behind some relevant fact found during research (Page et.al., 2021).

This article presents the application of the PRISMA method, which focuses on identifying peer-reviewed scientific articles that contribute to answering the central question: how have port-rail connections developed within Ibero-American Atlantic port cities? The geographical delimitation defined for the research was Portugal, Spain, and Brazil, since their historical relations may have influenced the dynamics of the links between their means of transport. The selection of references was based on the time period during which the chosen digital databases were available, and included publications released up to 2024 (year in which the research was carried out).

1. Transport Connections and Urban Mobility Studies

'Intermodality' is a fundamental expression to this study. The term is mainly used to emphasise the importance of integrating transport modes and other systems into national, regional and local planning in order to

promote sustainable development, which is an important goal in today's mobility agenda. A port-railway city is linked to the transport and circulation of people, goods, capital and information. The urban expansion surrounding it bears the marks of the intersection between shipping and railways. In the case of the Atlantic ports, this connection favoured transoceanic shipping and determined the economic activities developed in various cities, namely foreign trade, fishing, salt extraction, ship repair, and the canning industry.

Despite being an integrated system, ports and railways are often studied as independent entities. As large-scale infrastructures, the creation of a port or the establishment of a railway made a significant mark on cities, determining their spatial organisation in the urban landscape. Since the beginning of the 20th century, major transport infrastructures have been expanding their connections. After the Second World War, many river ports lost their relevance due to the growth of railway construction, while seaports developed, as did the cities around them, which gained industrial and suburban residential characteristics. Consequently, in the 1960s, this led to mobility problems in the port areas, which prompted the search for solutions such as the need to move the port to another area or find a way to coexist with urban fabric. Around the second half of the 20th century, port infrastructures began to be designed according to the networks established with the arrival of new means of transport (Lourencetti, 2022).

Authors such as Alvarez-Palau (2016) point out that although before the railway, there were other means of transport to take production from the hinterland to the port areas, the arrival of the railway created an integrated market on an international scale. In addition, it made it possible to transport a volume of cargo that was previously not viable. The implementation of the railway resulted in the emergence of economic sectors such as transport, storage, and export of goods over long distances by land.

According to Müller et al. (2019), the railway mode is capable of transporting goods and products in large quantities and varieties over long distances at a lower cost and in a more sustainable way than other modes of transport. These factors contribute to reducing producers' expenses, increasing competitiveness in the international market, promoting regional inclusion, and present lower risks of accidents when compared to road transport. Oliveira et al. (2021) also indicate that the use of these means of

transport saves environmental resources and reduces greenhouse gas emissions, especially concerning rail integration.

Although both ports and railways are part of everyday life, it has been noted that they have not been approached in historical studies as an integrated complex, an essential perspective for the application of current sustainable mobility strategies. As the geographer Horacio Capel (2011) illustrates, there has been no plan to explain in detail the relationship between the railway and other urban elements that would guarantee a functional railway system that is also part of a metropolitan area's set of services. The relationship between the port and the railway is no exception. The deployment of each of these modes of transport over time and their integration is mostly for reasons of economic development rather than urban mobility.

Considering that the adoption of PRISMA method is still infrequent in the Humanities, its use has the potential to provide more reliable selections of bibliography, identify research gaps in the area of port-railway cities, and encourage the development and use of homogeneous keywords that facilitate research processes. As this is an area that has been little explored, it is considered appropriate to use a systematic analysis of the literature to propose a research system that makes it easier to locate scientific productions on the proposed central question and that enables a structured growth of the theme. Therefore, based on the application of a systematic analysis of the literature on port-rail connections in Atlantic cities in Portugal, Spain, and Brazil, the following chapters will present an essay on the PRISMA method.

2. Applying the PRISMA Method

Before applying the PRISMA method, the port cities in the countries under analysis were identified. Subsequently, cities with railways linked to the port complex were selected and georeferenced. Here we faced our first challenge. Some railways are no longer part of cities' urban grids or connected to their ports. However, an attempt was made to identify port cities with this intermodality throughout history by analysing historical iconography, such as aerial photographs. Thus, the digital archives, which have materials referring to the 19th century and the first half of the 20th century, make available historical documents that allowed us to identify some cities and see the evolution of the city, as well as to visualise the expansion of railways and the development of ports. This system identified

eight Portuguese, 12 Spanish, and 19 Brazilian cities directly connected to the Atlantic Ocean, totalling the 39 cities shown below:

- Portugal: Viana, Matosinhos, Aveiro, Lisboa, Setúbal, Sines, Portimão, and Lagos.
- Spain: Algeciras, Bilbao, Cádiz, Huelva, Santa María, Pasajes, Gijón, Avilés, Santander, Ferrol, La Coruña, and Vigo.
- Brazil: Santana, Cabedelo, Candeias, Paranaguá, Fortaleza, Antonina, Recife, Vitória, Itaguaí, Aracruz, Serra, Angra dos Reis, São Luís, Rio Grande, São Francisco do Sul, Pirapora, Imbituba, São Gonçalo do Amarante, and Santos.

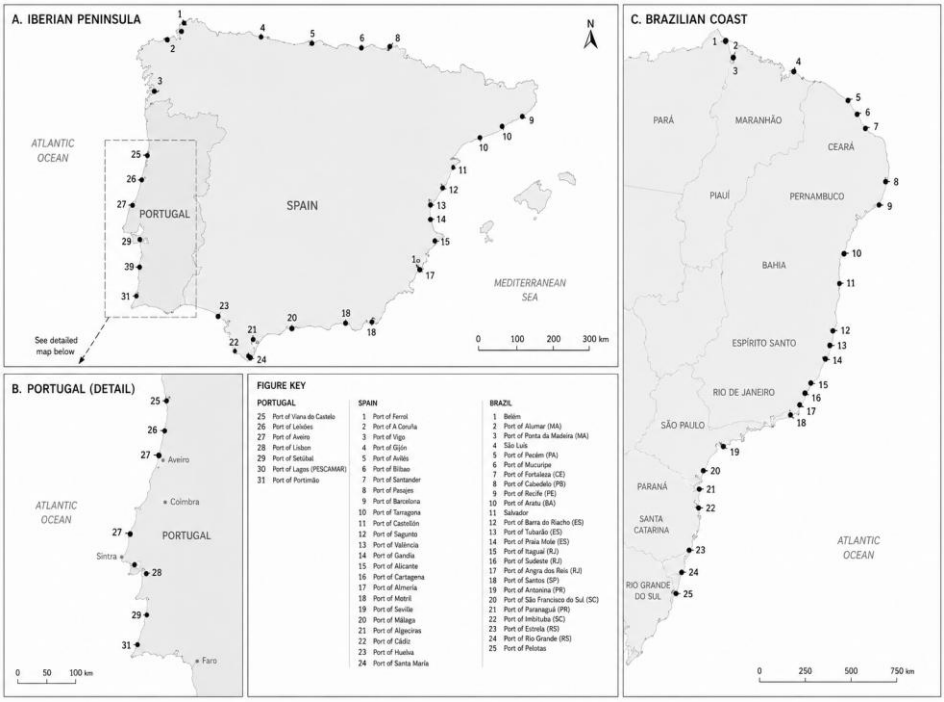
To start applying the PRISMA method, the RCAAP, Scopus, Scielo, and Dialnet repositories and the archives of the National Libraries of Brazil, Portugal, and Spain were chosen, totalling the use of seven databases. These databases were explored between July and October 2024. The keywords initially defined for the searches were the names of the selected cities and the expressions:

- Port;
- Railway;
- Hinterland;
- Intermodal.

These expressions were used in three different languages: Portuguese, Spanish, and English. However, the searches were very limited, and in some cases, no results were found. The same occurred when only the names of the cities were inserted. For this reason, it was decided to broaden the search by using the name of each port. Considering how search engine algorithms work - especially the use of inverted commas so that the system recognises a sequence of words as an exact expression - the names of the ports were searched with and without inverted commas (for example: Viana Port and "Viana Port"). This increased the number of references that could potentially be analysed.

Like this, it was possible to identify that in Fortaleza (Ceará/Brazil), the port is named in two different ways: Mucuripe Port and Fortaleza Port. Since searching for each name generated different results, the selection and systematisation of references to this port were treated as if they were two different ports. In the end, the 43 ports identified, distributed among the 39 cities selected, became 44 ports, resulting in a total of 1,320 database searches (Figure 1).

Figure 1: Ports in Brazil, Portugal and Spain



From the selection of materials found, between 1883 and 2023, the highest number of publications, a total of nine, were published in 2020. However, the years 2021 and 2022 also saw a significant number of publications on the subject, resulting in six and eight articles, respectively. Besides them, the other years had between three and no publications, which suggests that the topic has been explored more in the last three years.

The inclusion and exclusion criteria used to filter the references found were designed to identify the most relevant publications aligned with the central question of the study. The inclusion criteria included open-access, peer-reviewed studies on ports and railways published in scientific journals from different regions of the world. Therefore, undergraduate final papers, master's dissertations, and doctoral theses were excluded, and only published scientific articles and iconographic documents were considered.

As mentioned before, the language of the publications was taken as an "inclusion and exclusion criteria". Only materials written in Portuguese, Spanish, and English were selected. The choice of Portuguese and Spanish

relate to the official languages of the countries analysed. English was chosen for both the search for materials and the writing of this article, because it is a widely used and accessible language for disseminating academic studies. At this point, a further challenge was found. When the chosen databases were explored, it was realised that the searches carried out in English, in many cases, did not generate very different results from those found in the research carried out in Portuguese.

It was also realised that historical documents are often not transcribed, which makes it difficult to find them using keywords, which could only be identified in the title of the document. In this task, it became clear that there was a need for standardisation in the search methods used, i.e., the creation of specific keywords, to facilitate access to and retrieval of relevant information on a given topic.

Initially, the material found was organised in Zotero, a reference and citation management programme, using the bibliographic reference classification standard provided by the software itself. This resulted in a grouping of 182 productions, including articles, final year papers, dissertations, theses, maps, photographs, videos, books, and conference papers. Of the 182 selections, 162 come from specific materials on each selected port, and 20 are materials that cover more than one port, such as a map showing the location of railway networks that connect various port systems.

After this initial compilation, exclusion criteria were applied, resulting in the elimination of duplicate materials (n=20), course completion papers, dissertations, and theses (n=46). Historical iconographic productions, namely maps, were kept, resulting in 116 elements considered eligible for analysis, consisting of 91 articles and 25 iconographies.

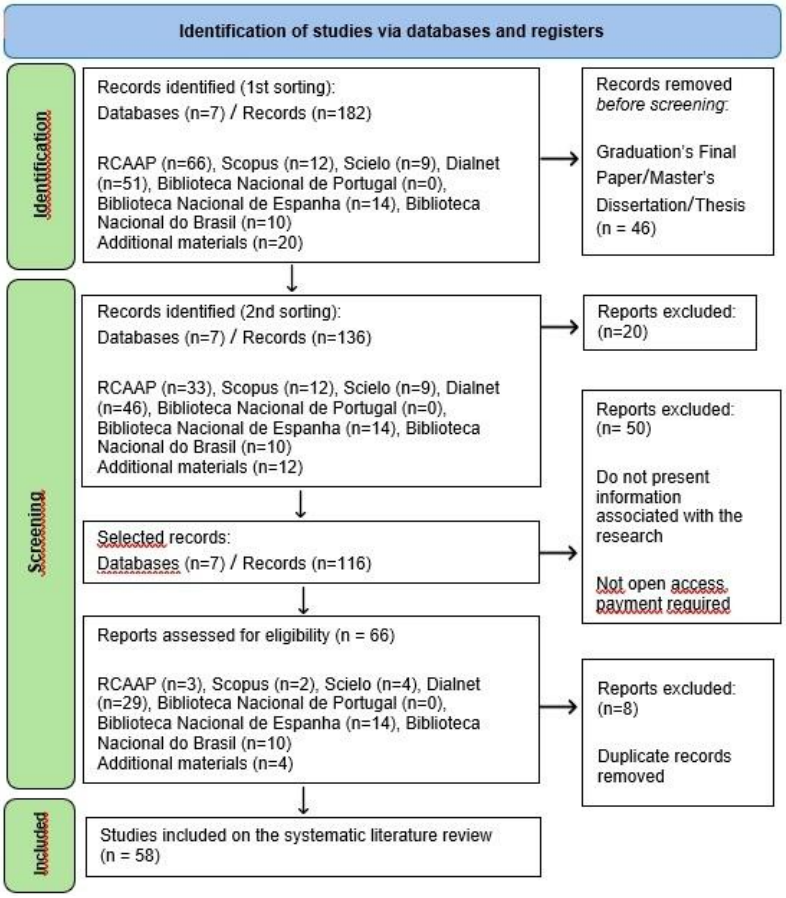
The titles and abstracts of each publication were then read. When the abstract did not directly relate to the central question of this article, the content of the publication was analysed, looking for the general terms defined as keywords (‘railway’, ‘port’, “hinterland”, ‘intermodal’), to ensure the presence of information that suited the research. The productions that contained some information about the port and the railway were selected.

The third screening involved a detailed reading of the publications and analysis of the iconographic productions previously selected. This activity was used to identify points of similarity and difference in each selected publication and relevant data to answer the central question, such as the

establishment dates of the ports, their modernisation, their connection to the railway system, and what motivated this connection.

After identifying a further eight duplicates, the analysis process was finalised, and the corpus consisted of 58 publications, of which 36 were scientific articles and 22 were iconographies. By applying the PRISMA method diagram (Figure 4), the process of forming the final selection corpus can be seen.

Figure 2: Flow of identification and formation of the final corpus using the PRISMA method.



This final corpus was organised by establishing codes for each reference according to the country in which each port is located (S =

Study). Portuguese ports were categorised from S1 to S6, Spanish ports from S7 to S27, and Brazilian ports from S28 to S36. (Table 1).

Table 1: Systematisation of the selected literature. Source: Own production.

Country	Category	Author(s)	Country of publication	Port´s Name
Portuguese	S1	Pacheco & Alves, 2019	Portugal	Leixões and Douro Ports
	S2	Rodrigues, 2019	Portugal	Aveiro Port
	S3	Lourencetti, 2022	Portugal	Setúbal Port
	S4	Santos & Guedes Soares, 2017	Portugal	Leixões, Aveiro, Lisboa, Setúbal, Sines Ports
	S5*	Antúnez Trigo, 2007	Spain	Lisboa and Sevilla Ports
	S6	Prata & Arsenio, 2017	Portugal	Sines Port
Spanish	S7	Sendin Garcia, 1983	Spain	Algeciras Port
	S8	Redondo Vidal & Benítez López., 2023	Spain	Algeciras and Róterdam Ports
	S9	Álvarez Martínez, 2021	Spain	Avilés Port and Estuary
	S10	Serrano Abad, 2012	Spain	Bilbao Port
	S11	Macías Munõz, 2003	Spain	No specific port
	S12	Rodríguez Bugarín, Novales Ordax & Orro Arcay, 2021	Spain	Ferrol Port
	S13	Díaz Fernández, 2022	Spain	Ferrol, Vigo and La Coruña Ports
	S14	Roces Felgueroso, 2006	Spain	Gijón (El Musel) Port
	S15	Quiros Linares, 1980	Spain	Gijón (El Musel) Port
	S16	Delgado Domínguez, Campos Torrado & Fiñana López, 2007	Spain	Huelva Port
	S17	Merino Esteban, 2011	Spain	Huelva Port
	S18	Lara Rubido, 1996	Spain	Vigo, Marín, Villagarcía de Arosa, La Coruña and Ferrol Ports

	S19	Hernández Soto, 2020	Spain	La Coruña and Vigo Ports
	S20	Murillo Romero & Aladro Prieto, 2020	Spain	Santa María Port (Cádiz)
	S21	Villegas Cabredo, 2022	Spain	Santander Port
	S22	Delgado Viñas, 2019	Spain	Santander Port
	S23	Lourencetti, 2020	Spain	Vigo Port
	S24	Díaz Fernández, 2020	Spain	Several Galician ports
	S25	Sánchez Sellero & Cruz González, 2012	Spain	Vigo Port
	S26	E. Chao, 1883	Spain	Vigo Port
	S27	E. Chao, 1884	Spain	Vigo Port
Brazilian	S28	Rios, 2009	Brazil	Aratu Port
	S29	Simonini, 2022	Brazil	Fortaleza Port
	S30	Suzuki Júnior & Wosch, 2000	Brazil	Paranaguá Port
	S31	Müller, Zucatto & Simon, 2019	Brazil	Rio Grande Port
	S32	Alves, 2020	Brazil	Santos Port
	S33	Costa, Soares-Filho & Nobrega, 2022	Brazil	Santos, Santarém, Barcarena and Paranaguá Ports
	S34	Cruz & Ornelas, 2014	Brazil	Santos Port
	S35	Oliveira et al., 2021	Brazil	Itaqui, Aratu and Santos Ports
	S36	Weser, 2016	Spain	Sudeste (Itaguaí) Port

Although this article mentions the port of Seville, the central case is the port of Lisbon, which is why we have chosen to classify it as a reference on Portuguese ports.

3. ANALYSING THE DATA

Through the systematic literature review, most of the scientific production was found in Dialnet, a Spanish database, and the largest number of primary sources was found in the National Library of Spain. Therefore, by applying the PRISMA method, Spain was identified as the country with the greatest amount of scientific production on the connections between the port and railway infrastructures of Ibero-American Atlantic cities.

In addition, references were found for all 12 Spanish cities chosen for analysis, while this was not the case for Portugal and Brazil. In Portugal,

of the eight cities initially selected, references were found for five: Aveiro (Aveiro Port); Matosinhos (Leixões Port); Lisbon (Lisbon Port); Setúbal (Setúbal Port), and Sines (Sines Port). In Brazil, of the 19 cities selected, references were found for eight: Candeias (Aratu Port), Fortaleza (Fortaleza/Mucuripe Port), São Luís (Itaqui Port), Antonina (Antonina Port), Paranaguá (Paranaguá Port), Itaguaí (Sudeste Port), Rio Grande (Rio Grande Port), and Santos (Santos Port). Therefore, the lack of data on Brazilian ports is the greatest among the three countries, which may indicate a low number of publications on this subject.

Most of the Spanish studies came from Regional History, Geography, Heritage, and Engineering journals, while in Portugal, we found studies published mainly in Heritage, History, and Architecture journals. In Brazil, publications were found more widely in journals in the areas of Social Sciences, Business Management, Rural Sciences, Engineering, and Economics. This reinforces the multidisciplinary nature of the subject, which can be approached from different perspectives, and makes the establishment of comparative studies possible to help in answering the central question: how have port-rail connections developed within Ibero-American Atlantic port cities?

The selected literature revealed that only six studies present port and railway as integrated modes of transport (S3, S4, S15, S22, S23, S34), and 12 references present the exact and/or approximate dates of the formation of the port they analyse (S1, S7, S9, S10, S14, S15, S16, S21, S22, S28, S29, S34). These dates are usually presented when there are references to the granting of permission for the construction of the port and/or the inauguration of some part of its infrastructure. Regarding the rehabilitation of ports, only nine studies date the start of the modernisation of these spaces (S1, S2, S3, S7, S9, S10, S14, S21, S28).

The analysis of each mode in isolation can create a challenging environment for the comprehension of the interdependence between ports and railways. This underscores the necessity for the promotion of studies that focus on the connection between these two modes of transport. Only 21 references show the dates of the establishment of connections between port and railway infrastructure (S1, S2, S3, S5, S7, S9, S10, S11, S12, S13, S14, S15, S16, S17, S19, S20, S21, S22, S23, S29, S34). In line with the above, most of the publications presenting this data refer to Spanish ports.

Analysing the data from two different perspectives, mobility and urban space, the following sections of this article outline the most common points found in the selected references on the subject.

3.1. Macro Scale

The goals identified for the establishment of the connections between the port area, and the railway were classified into five categories: economic development and logistics; railway integration; improved mobility and connectivity; cost reduction; and other factors, namely the geographical route. Some articles contain information that can be categorised into two or more categories. Due to the different types of data found, some subcategories were created for each reason.

The first category, 'Economic Development and Logistics', was divided into: competitiveness; regional development; and production outlets and logistics (Table 2).

Table 2: Port-rail connections in terms of Economic Development and Logistics.

Subcategories	**Studies**		
	Portugal	**Spain**	**Brazil**
Competitiveness	S6	S19, S25	S30, S31, S32, S33, S34, S36
Regional development	S2, S3, S5	S7, S11, S13, S22, S23	S28, S30
Production flow and logistics	S5	S7, S8, S9, S10, S12, S14, S15, S16, S17, S18, S19, S21, S24, S26, S27	S31, S34

In the first subcategory, studies S6, S19, S25, S30, S31, S32, S33, S34, and S36 mention that this interconnection takes place for competitiveness purposes. In Portugal (S6) and Spain (S19 and S25), these connections are emphasised to improve the competitiveness between ports in their respective countries. In Brazil (S30, S31, S32, S33, S34, and S36), in addition to the aforementioned reasons, these links are beneficial for increasing the competitiveness of agribusiness and integrating São Paulo's economy into the global market.

In the subcategory 'Regional development', it was identified that the Portuguese port-rail connections (S2, S3, S5) helped reactivate the local economy, expanded the regional economy, and helped develop agricultural, livestock, and mining activities in certain places. In Spain (S7, S11, S13, S22, S23), the economic boost that these links generate is emphasised, both in trade and in the industrial activities of certain regions. In Brazil (S28 and S30), these connections were built to meet the demands of the petrochemical and metallurgical sector in certain regions and to integrate the port with the agricultural and industrial outlets of a particular state.

In the third subcategory, studies S5, S7, S8, S9, S10, S12, S14, S15, S16, S17, S18, S19, S21, S24, S26, S27, S31, S34 refer to the role of port-rail connections in the flow of production and the logistics of these processes. In this context, Portugal (S5) mentions facilitating the transport of goods to ports, while in the Spanish case studies, in addition to facilitating and enhancing logistics, the fundamental role of this connection was identified in the export of iron ore and industrial products (S7, S8, S9, S10, S12, S14, S15, S16, S17, S18, S19, S21, S24, S26, S27). Brazilian cases also demonstrate the importance of this factor, even today, especially in the export of coffee and grains, particularly soya (S31 and S34).

The second major cause for interconnecting the two modes, 'Railway Integration', was divided into three subcategories: strategic planning; improving port and railway infrastructure; and hinterland (Table 3).

Table 3: Port-rail connections at Railway Integration level.

Subcategories	**Studies**		
	Portugal	**Spain**	**Brazil**
Strategic urban planning	-	S15, S18, S20, S23	S35
Improving port and railway infrastructure	S1, S2	S12, S24, S26, S27	S29, S32
Hinterland (land transport)	S3, S4, S5	S8, S10, S21, S22, S23	-

The first subcategory relates to the strategic planning of links within urban fabrics. No references were found for the Portuguese cases that mentioned specificities about the objectives of urban plans for port-rail connections. As for Spain, four studies are included, as they present these connections as strategic plans to support colonial merchant traffic, tourism, and to reduce road traffic (S15, S18, S20, S23). For Brazil, only one reference was identified, mentioning the possibility of decentralising soya exports from the Santos Port to ports in the north and northeast of the country (S35).

As indicated by the third subcategory, the interconnection of the port with the railway network also appears as an improvement for both modes. The Portuguese studies (S1 and S2) point out that intermodal connections improve port accessibility and integrate other ports into the national rail network, reasons also identified in the Spanish case studies (S12, S24, S26, S27). In Brazil (S29 and S32), intermodal connections are presented as a way of increasing internal port transport and building an export-oriented infrastructure.

The 'Hinterland' subcategory was identified as a reason only for Portugal (S3, S4, S5) and Spain (S8, S10, S21, S22, S23). In the case of the Iberian Peninsula, intermodal connections not only integrate the port with the interior of the territory but also connect Portuguese regions with Spanish regions and, more globally, connect Iberian railway structures with European railway structures.

The last categories established (Improving Mobility and Connectivity; Reducing Costs; and Others) present data related to improving intermodal mobility and connectivity, reducing costs, and, in one specific example, overcoming geographical obstacles (Table 4).

Table 4: Port-rail connections in terms of Mobility and Connectivity, Cost Reduction, among others.

Categories	**Studies**		
	Portugal	**Spain**	**Brazil**
Improved Mobility and Connectivity	-	S11, S12, S13, S17, S20, S25	-

Cost Reduction	S3, S6	-	S33, S35
Others	-	-	S29 (Geographical)

The first case, found only in the Spanish studies (S11, S12, S13, S17, S20, S25), encompasses regional connectivity and mobility expressed by improving the territorial connection between the capital and other cities, regions and the border, facilitating passenger transport and improving urban mobility.

The reduction in logistics costs caused by intermodal integration was only identified for the Portuguese (S3 and S6) and Brazilian (S33 and S35) cases. Finally, the last category was created due to the existence of a Brazilian case, the port of Fortaleza, which, due to natural geographical characteristics, had its railway connected to its port to transport the raw materials needed to build the port's infrastructure itself (S29).

3.2. Micro Scale

When applying the PRISMA method, few documents were found on the urban dynamics caused by the construction of the connections between the port and railway areas. Without analysing the impact of creating intermodal links, urban changes are usually dealt with separately, sometimes concerning the rail impact and sometimes about the port impact. In the selected corpus, the urban impact caused by these infrastructures was analysed in Portuguese studies S1, S2, and S3, Spanish studies S7, S9, S10, S15, S17, S20, S22, and S23, and Brazilian studies S29, S32, and S34.

Throughout the systematic analysis of the literature, five categories of urban change were identified: Urban Fabric Development; Economic Development; Landscape Change; Urban Infrastructure; and Land Use (Table 5).

Table 5: Urban changes caused by the port and/or railway.

Categories	**Subcategories**	**Studies**
Urban Fabric Development	Port-City Integration	S1 (PT), S7 (ES), S9 (ES), S10 (ES), S17 (ES), S20 (ES), S32 (BR), S34 (BR)

	Reorganisation of the Urban Fabric	S9 (ES), S10 (ES), S22 (ES), S23 (ES)
Economic Development	Industrial and Commercial Areas	S1 (PT), S2 (PT), S7 (ES), S10 (ES), S20 (ES)
	Regional Trade	S15 (ES)
	Tourism	S20 (ES)
Landscape Change	-	S2 (PT), S3 (PT), S7 (ES), S9 (ES), S22 (ES), S29 (BR)
Urban Infrastructure	Transport and Mobility	S1 (PT), S2 (PT), S17 (ES), S23 (ES)
Land Use	Housing	S1 (PT), S3 (PT)

PT = Portugal, ES = Spain, BR = Brazil

The most common urban modifications involve developing urban fabric and addressing its impact on the integration between the port and the city (Portugal: S1; Spain: S7, S9, S10, S17, S20; Brazil: S32, and S34), as well as reorganising urban design (Spain: S9, S10, S22, and S23). In the first case, due to transformations driven by globalization (Serrano Abad 2012, Cruz & Ornelas 2014, Alves 2020), changes in interregional and international trade (Murillo Romero & Aladro Prieto, 2020), and the modernisation of the maritime sector (Pacheco & Alves, 2017), the surface area of ports has been enlarged and/or moved (Álvarez Martínez 2021, Serrano Abad 2012), contributing to a progressive distancing between port areas and urban centres. This has also altered port infrastructures.

As an example, the case of the Port of Leixões illustrates this transformation. Originally conceived as a shelter port complementary to the Port of Douro, Leixões gradually adapted to the demands of international navigation following the emergence of steamships, since the Port of Douro posed significant structural risks to this type of vessel (Pacheco & Alves, 2017). Although a railway connection between the two ports had been planned, it was never completed. Consequently, the Port of Leixões assumed a central role as the region's main commercial port, while the Port of Douro, despite its historical importance, became increasingly secondary.

The growth of port infrastructure and mechanisation to meet global economic demands (Serrano Abad 2012, Lourencetti 2020) has, in many

cases, resulted in the abandonment of older facilities and their installation on land that is further away from urban centres (Serrano Abad 2012, Delgado Viñas 2019, Álvarez Martínez 2021), increasing the disconnection from the city and affecting internal port organisation itself. In addition, the railways promoted an increase in the influx of passengers and goods destined for other regions (Sendin Garcia, 1983). In the case of the city of Algeciras (Spain), a steamer service between the city and Gibraltar was created in 1900, due to the physical impossibility of establishing a land-based connection for geopolitical reasons (Sendin Garcia, 1983).

In the second case (Spain: S9, S10, S22, S23), the areas surrounding the port-railway zones, previously sparsely populated, were transformed into economically significant urban centres (Delgado Viñas 2019, Lourencetti 2020). In some cases, the expansion of urban fabric (Serrano Abad 2012, Delgado Viñas 2019), with the drawing up of urban plans, has led to a distancing between the dynamics of the day-to-day running of the port and the city. The lack of coordination between the public management of the city and that of the port, together with visions that define the port only as a technological instrument for the movement of goods, were the main drivers of this distancing.

The second category identified covers economic development on both an urban and regional scale. The port and the railway brought about the formation of industrial and commercial areas (Portugal: S1, S2; Spain: S7, S10, S20), with these areas expanding into the vicinity of these modes of transport or even creating new industrial areas. Industry linked to maritime activities such as shipbuilding, rope making, rigging, foundries, and blacksmiths was favoured by the port-rail connection (Serrano Abad, 2012). The connection between the railway and the port was also a relevant factor for regional trade (Spain: S15) (Quiros Linares, 1980) and tourism (Spain: S20), as it helped to increase the regional importance of certain ports and improved access to the tourist offer, facilitating access to the cities' attractions (Murillo Romero & Aladro Prieto, 2020).

The third category identified indicates changes in the landscape as a result of port-railway installations, presented in studies S1 (PT), S3 (PT), S7 (ES), S9 (ES), S22 (ES) and S29 (BR). In these cases, these infrastructures redefined the industrial geography of the city and surrounding regions (Delgado Viñas, 2019), moving services that were related to the port, or even the port itself, to other areas (Pacheco & Alves, 2019), which would create a ‘waterfront’ in the former port area, as was

the case in Setúbal (Lourencetti, 2022). In some cases, the development of the port and the railway caused not only changes in the urban landscape, creating an industrial landscape in cases where large industries were installed on the estuaries (Álvarez Martínez, 2021), but also changes in the natural geography of the territory, altering the coastline. Siltation works were carried out in coastal regions, and a port environmental system was created that encompassed urban and natural boundaries, as was the case with the Brazilian port of Fortaleza (Simonini, 2022).

The urban infrastructure categories focusing on transport and mobility (Portugal: S1, S2; Spain: S17, S23) were identified in Portugal and Spain. The remodelling of riverside areas, urban redevelopment, the transformation of the road structure to support the intense flow of goods and passengers, the modernisation of urban infrastructure to support the heavy traffic generated by port-rail integration, and the construction of new railways and roads connecting the port to the hinterland, has led to a reorganisation of circulation and exchange spaces in cities. Rodrigues (2019), for example, indicates that the construction of an avenue connecting to the railway station had more influence on the urbanisation of the city of Aveiro than the establishment of the main factories. In addition, some cities have become logistics hubs (Merino Esteban, 2011), linking different regions of the territory. Furthermore, with the development of the railway infrastructure, there were changes in the road networks of some cities (Lourencetti, 2020), adapting roads and creating new connections to integrate the railway station into the urban framework.

Finally, in the fifth category identified - land use for housing (Portugal: S1, S3), it is pointed out that land use was altered due to the development and growth of working-class neighbourhoods near the railway-port axis, leading to the emergence of industrial and residential suburbs (Pacheco & Alves 2019, Lourencetti 2022).

FINAL CONSIDERATIONS

As a contribution to the embryonic stage of the systematic analyses in investigations of port-rail connections, this introductory article presented an essay using the PRISMA method. In doing so, the article initiated the identification of some intersections that mark the mobility established between these two means of transport in the Iberian Peninsula and Brazil. Geographical delimitation was established based on the historical relationships among these countries, which may have influenced transport

dynamics. The PRISMA method highlights a lack of knowledge about the construction periods, of the link between them, as well as their impact on the urban dynamics. In total, only five authors have analysed both modes of transport in association: Lourencetti (2022, 2020), Delgado Viñas (2019), Santos & Guedes Soares (2017), Cruz & Ornelas (2014), Quirós Linares (1980). It was thus concluded that there is a lack of scientific production that deals with the port and the railway as interconnected modes.

In response to the central question, ´how have port-rail connections developed within Ibero-American Atlantic port cities?´, among the selected cases from the Iberian Peninsula, the connections between the port and the railway are shown to have occurred mostly in the second half of the 19th century, while in the Brazilian cases, it was not possible to identify a specific period. It was also identified that the Iberian Peninsula uses its railways both for loading and unloading goods from ports and for passenger transport, while in Brazil, the railways that reach the port are usually reserved for cargo handling logistics.

Although the terms 'intermodality' and 'hinterland' are related to the subject and appear constantly in the scientific production analysed, they are not associated with the establishment of connections between ports and railways. The literature on these modes of transport mainly expresses the advantages of intermodality.

Throughout the analysis, economic development was identified as the main reason for the construction of port-rail connections, especially for freight transport and improving logistics, which consequently led to the development of several regions. Rail connections are presented as contributing to the economy, in some cases forming part of strategic planning that affects commercial and road traffic and also influencing the activities of the socio-economic sector.

The interconnection of different railway lines is presented as an improvement in transport infrastructure, expanding the reach between ports and the interior of the countries under analysis. This results in new mobility dynamics between localities that can also result in better territorial cohesion. Consequently, it can be concluded that port-rail integration is presented as a more sustainable alternative to other modes of transport, as most studies consider that this connection reduces costs and improves mobility and urban and regional connectivity.

The urban dynamics resulting from port-rail connections seem to be more directly related to the development of the urban fabric, highlighting

the new dynamics that are established and reconfigured over time between ports and cities. This process marks the transition from an integration that was originally intrinsic to urban fabric to a growing separation of port infrastructures, in which the participation of cities is becoming increasingly limited.

Although these themes have not been addressed directly in this article, the literature consulted on the ports and railways of the Atlantic cities analysed points to various possibilities for future research. From a historical point of view, the authorisation granted to the Spanish ports of Santander, Gijón, and Vigo for trade with the Americas is worth highlighting. In economic terms, there is potential to further study coal production in the ports of Santander and Gijón, as well as iron ore exports through the ports of Bilbao, Ferrol, Huelva, and Santander. In the Brazilian context, the impact of the oil industry on the ports of Aratu and Paranaguá stands out.

International comparisons are also promising: the ports of Setúbal and Fortaleza, for example, underwent relocation processes to expand services, while the ports of Fortaleza-Mucuripe and Leixões were repositioned due to geoclimatic conditions. In terms of urban impact, the expansion of the ports of Santos, Setúbal, and Bilbao was limited by the rapid expansion of the surrounding urban areas. In terms of infrastructure, the cases of the ports of Gijón - El Musel, Bilbao - El Abra, and Fortaleza - Mucuripe, which have developed 'annex ports' to meet specific demands, offer relevant material for future analyses.

The corpus selected shows a difference in the number of scientific productions from each country that relates to the port-rail mobility within the urban layout. More information was found in Spanish productions than in those from other countries. Portuguese productions rely more on the contextualisation of ports that make part of the Faixa Portuária Portuguesa (Portuguese Port Belt), i.e., the coastline where seaports are located.

Therefore, this essay, applying the PRISMA method, has not only highlighted a gap in the number of publications on the establishment of port-rail connections but also points to the need to define keywords to systematise this research field.

> Systematic assessments of methodological strategies remain necessary in mobilities research, in order to ensure that research practices (of design, formulation, data collection, testing, analysis, representation and generalization) are capable of capturing diverse forms and conditions of

> (im)mobilities, and, productively inform and intervene in debates about the epistemological and politico-ethical foundations of knowledge production. (D' Andrea et al., 2011: 151)

Thus, this essay constitutes an endeavour to emphasise the significance of standardisation as a means of streamlining the process of locating references across diverse databases. It is a contribution to the field of transport research by means of the application of a contemporary method of systematic literature review.

This article does not aim to present a definitive research outcome; rather, its purpose is to demonstrate the application of a research method intended to support a clearer and more impartial approach to the subject. In this sense, the study should not be understood as a conventional historical investigation based on an extensive review of documentary sources or on the use of a specific econometric model to solve a clearly defined historical problem. Instead, it represents a preliminary step toward a broader research agenda, making use of analytical tools such as the PRISMA protocol, Zotero, and the exploration of well-established academic databases. The value of the study therefore lies not in achieving a predetermined interpretative result, but in the transparency and rigour of the methodological procedure employed, which is described in detail throughout the article. Consequently, the bibliographic selection presented here should be assessed according to the consistency and clarity of the procedure adopted, rather than according to a particular research outcome. Future studies and expanded datasets may contribute to refining these conclusions.

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