Exploring Andalusian industrial heritage through data science: breaking down the gaps and concerns to visualise opportunities

Estudo do património industrial andaluz através da ciência de dados: diminuindo as lacunas e dificuldades para visualizar oportunidades

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Abstract

Industrial heritage, understood as the group of elements related to the work culture and production activities that emerged during the industrial revolution, has been surveyed and documented extensively in Spain in recent decades. This is particularly the case of recent years thanks to the advent of digital tools and systems. In the case of Andalusia, the efforts to document, disseminate and protect industrial heritage have been the subject of a variety of actions and projects. This paper describes the methodology used and the results obtained from a review of the existing 1,443 records of immovable assets of industrial heritage. The results point to deficiencies in the updating and incorporation of information in the Digital Guide, and to the need to carry out actions geared more towards understanding the elements as an integral whole made up of the landscape in which they appear.

KEYWORDS
Industrial heritage documentation
Heritage data science
Heritage database
GIS analysis
Assessment of heritage data records

Resumo

O património industrial, entendido como um conjunto de elementos ligados à cultura de trabalho e atividades de produção que surgiram durante o processo da revolução industrial, tem sido objeto de estudo e documentação em Espanha, nas últimas décadas e, em particular, com maior impulso nos últimos anos, graças à utilização de ferramentas e sistemas digitais. No caso da Andaluzia, os esforços para a sua documentação, divulgação e proteção têm sido objeto de várias ações e projetos. Este artigo descreve a metodologia utilizada e os resultados obtidos a partir de uma revisão dos 1443 registos existentes de elementos imóveis do património industrial. Os resultados mostram deficiências na atualização e incorporação de informação na Guia Digital, e a necessidade de executar ações orientadas para compreender e documentar os elementos de maneira mais integral, considerando os aspetos da paisagem em que aparecem.

PALAVRAS-CHAVE
Documentação do património industrial
Ciência de dados do património
Base de dados do património
Análises SIG
Avaliação dos registros de dados do património

Introduction

Industrial heritage, understood as the "remains consisting of buildings and machinery, workshops, mills and factories, mines and sites for processing and refining, warehouses and stores, places where energy is generated, transmitted and used, transport and all its infrastructure, as well as places used for social activities related to industry such as housing, religious worship or education" [1] has close ties with the production, technology, culture, economy, ecology and knowledge produced during the industrial revolution. Furthermore, it has enormous value as a testament of the past and as an asset that can be reused today. Industrial heritage encompasses a wide range of elements and relations, both tangible and intangible, which demand a series of actions: from the identification, documentation and analysis of the assets to their treatment and intervention. Documenting, analysing and managing such a large volume of assets and information is extremely difficult with traditional tools and methods, and becomes even more challenging when we consider the different disciplines involved. It is of the utmost importance to ensure that this information is visible and to recognise its tangibility because both (information and tangibility) are sources of knowledge and play a vital role in preserving and promoting the memory of industrial heritage [2].

In Spain, industrial heritage has a different chronology from other countries, stretching from the mid-eighteenth century, with the advent of mechanisation, until the introduction of automated systems in the 1960s. Likewise, the industrial phenomenon did not occur homogeneously or at the same time across Spain. In the regions themselves, the difference is significant, with periods of greater impact in Catalonia and the Basque Country than in other regions. In the case of Andalusia, the pioneering experience occurred in the province of Malaga, in the steel and textile sectors. Until the early decades of the twentieth century, the contribution of Andalusian industry to the national industry largely reflected its population weight (between 17 % and 18 %) [3].

In recent decades, different national and regional bodies have gradually compiled an inventory of these assets. In the case of Andalusia, between 1993 and 1997 the Directorate General for Cultural Assets (the DGBC, after the Spanish acronym) compiled the "Inventory of Popular Architecture", and following the enactment of Law 14/2007 [4], three assets have been designated "sites of cultural interest" as assets of ethnological heritage: 1) the Alquife Mines; 2) the pier and village of Puerto de la Laja, the old mining railway and the village of Cañada del Sardón; and 3) La Tortilla Mine-Foundation, plus other assets in the Rio Tinto heritage area. In 1996 the DOCOMOMO (*Comite Internacional para Documentação e Conservação de Edifícios, Sítios e Bairros do Movimento Moderno*) carried out a survey on industrial architecture in Spain, leading to the publication in 2004 of *La arquitectura de la industria, 1925–1965. Registro Docomomo Ibérico* [5]. Of the 160 buildings documented, 12 are located in Andalusia: *Presa del Jándula* (Jándula dam); *Hilaturas y Tejidos Andaluces* (textile plant); *Instalaciones mineras de producción de oro* (gold mines); *Presa de Anchuricas* (Anchuricas dam); *Central Térmica Cristóbal Colón* (thermal power plant, water control centre); *Industrias Lácteas Colecor* (dairy plant); *Industrias Textiles del Guadalhorce* (textile plant); *Gran Bodega del Tío Pepe* (winery); *Fábrica de cervezas El Águila* (brewery); *Compañía Internacional de Telecomunicaciones y Electrónica* (telecoms and electronics company); *Cydeplas* (plastic container plant); and *Fábrica Tecosa* (electronics factory). In 2006, aimed at disseminating a wider public knowledge, the Regional Housing and Land Management Ministry published *Patrimonio Industrial de Andalucía. Portfolio Fotográfico* with photographs of 28 industrial assets and spaces in the region [6]. Between 2005 and 2008, the Andalusian Institute of Historical Heritage (the IAPH, after the Spanish acronym), in collaboration with the DGBC and the University of Seville, compiled the Andalusian Register of Contemporary Architecture, which includes 67 industrial heritage assets. In 2011, the IAPH Documentation and Research Centre carried out a Research, Development and Innovation (R&D&I) project to analyse and diagnose the existing information about Andalusian industrial

heritage [7-8]. In this document, Santofimia sets out guidelines for improving the systematisation of information in the Regional Ministry of Culture's information system. The project diagnosed the information on 203 Andalusian industrial heritage assets. That same year, the IAPH embarked on a collaboration with the Institute of Spanish Cultural Heritage (ICE, after the Spanish acronym) to draw up and monitor the National Industrial Heritage Plan [9]. Since then, the IAPH has been carrying out different actions and initiatives to document disseminate and raise public awareness about industrial heritage, especially in schools.

On a pan-Spain level, the first National Industrial Heritage Plan listed 49 assets [9]. Ten years later, the list had reached 100 and today it stands at 177 assets, all with basic information including the name and area occupied by the asset (or assets in the case of ensembles and landscapes), land registry details, situation with respect to the immediate vicinity, photographs, description, industrial sector, ownership and protection regime, state of repair, uses, etc. Of these 177 assets, 17 are located in Andalusia [10]. The actions and efforts for the inventory of industrial heritage at the national and local levels were carried out in a complementary manner. Currently, the National Industrial Heritage Plan is under review in collaboration with the IAPH for the Andalusian region.

The identification and documentation of built heritage is the preliminary step to deal with any work, research, management or problem related to it and forms part of the initial phases in the heritage value chain [11]. The procedure for identifying and documenting a specific immovable asset consists in gathering and processing different types of data, from the name, location and historical context to the physical description. This same heterogeneity is also found in the types of documentary sources and data formats, which range from texts and photographs to maps, site plans and other media. Digitalisation and the development of computational methods have speeded up the generation, editing, analysis, management and dissemination of the data gathered to document heritage. At the same time, they have facilitated the cross-disciplinary creation of information. In the field of industrial heritage, computational data provide specific solutions for a range of problems while offering different actions for saving, representing and understanding the elements involved. However, this complex system of digital processes and objects requires the definition of criteria and methods for differentiating between the nature of data, their analysis, processing and interpretation, and the results obtained: in other words, data, information and, knowledge [12].

Another point to bear in mind is that the maintenance, updating and dissemination of heritage information require constant and meticulous management by the competent public bodies, something which is often underestimated. In this respect, and in addition to actions to improve the dissemination and quality of heritage information, the primary objective of this survey is to offer a diagnosis about the records of immovable industrial heritage assets in Andalusia. The research was prompted by the need to revise and update the Andalusian Digital Guide Platform [13] to improve the quality of the open data, ensure greater access and reuse of the data, and develop a documentation plan for Andalusian industrial heritage in line with current needs. The following objectives were established:

- Gather and select records of assets belonging to the ten sectors of industrial heritage [7]: agri-food; railway; energy; chemical and cement; construction, ceramics and glass; cork, wood and furniture; textile; steel, metallurgy and metal construction; naval; and mining.
- Carry out a quantitative and qualitative analysis of the data.
- Generate visualisations of the data analyses to provide a clearer picture of the gaps and deficiencies detected.
- Develop a guideline for the documentation of the Andalusian industrial heritage.

Methodology

Main source: Digital Guide of Andalusian Cultural Heritage

It is important to point out that the Digital Guide Platform [13] is an open resource containing a large structured database of heritage records created with a controlled and systematised vocabulary. For example, it uses a specific terminology to classify and describe types, activities, events and historical periods based on the IAPH Heritage Thesaurus.

This digital resource was chosen as the main source of information for the survey because of the large and easily accessible volume of heritage data, which we were able to download as tables organised by fields, as shown below. The Digital Guide is also linked to the MOSAICO, an information system for the management of cultural heritage in Andalusia, ensuring the reliability of the data we proposed to analyse.

In the Guide users can search and explore the collections classified by heritage type: movable, immovable, intangible and, cultural landscapes. Most of the records are georeferenced and users can therefore view a base map to locate them and identify the spatial relationships between the heritage assets and the physical and human geographical aspects. Each asset is clearly identified and the descriptions also include the people involved in their construction, remodel or restoration. Lastly, the records contain details of the level of protection, bibliographic references, and links to other records in the guide as well to the institutional repository [14].

Information and data surveyed

Since the primary objective of this survey was to diagnose the state of the quantitative and qualitative information and data about the industrial heritage in Andalusia, we began by defining a set of general criteria to select the records. Accordingly, we only analysed records from the late modern period (the period from the mid-eighteenth century to the present, also referred to as the "contemporary period" by heritage professionals in Spain) and that belonged to the immovable heritage type. The scope of our diagnosis did not include records from earlier historical periods, although there are currently over 300 such records in the Digital Guide.

For the analysis, we surveyed the records that are open to public access from the Digital Guide Platform. Having established the preliminary criteria – historical period, heritage type and source – we then defined specific search criteria for each sector of industrial heritage. For this purpose, we selected a list of sectors, types and activities from the IAPH thesaurus that had been previously defined by Santofimia [7]. It covers 10 sectors, 76 types and 11 activities (Table 1).

The survey methodology consisted of six phases:

1) Identification of previous actions carried out to document industrial heritage.
2) Definition of the search criteria and sample selection.
3) Definition of the criteria and parameters for the quantitative and qualitative analyses.
4) Data gathering, downloading and processing.
5) Analysis and visualisation.
6) Interpretation of the results and proposed action plan.

The first phase consisted in gathering and summarising the actions carried out at the regional and national level to determine how the documentation process has evolved over time and to identify the gaps. This search was largely concentrated around the sources in situ (reports) and easily accessible online sources (DOCOMOMO, IAPH and Spanish Ministry of Culture and Sport).

Table 1. Potential examples of a conservator's caring thinking theory

Sector	Types	Activities
1. Agri-food	1. Sugar cane factories 2. Distilleries 3. Sugar cane mills 4. Olive presses 5. Water mills (flour) 6. Flour mills 7. Oil mills 8. Windmills 9. Tide mills 10. Oil factories 11. Olive pomace oil factories 12. Salting factories 13. Flour factories 14. Breweries 15. Tobacco factories 16. Soap factories 17. Soap plants 18. Semolina factories 19. Salt pans 20. Silos 21. Wineries 22. Tuna fisheries 23. Crushing plants 24. Canning factories 25. Bakeries 26. Wine presses 27. Granaries 28. Essence factories	1. Wine production 2. Vine growing 3. Olive oil production 4. Olive growing 5. Oil production 6. Flour production 7. Milling
2. Railway	1. Railway buildings 2. Railway stations (transport) 3. Transport infrastructures 4. Railway networks 5. Bridges* 6. Loading bays	
3. Energy	1. Electric energy factories 2. Electric infrastructures 3. Electric power plants 4. Hydraulic infrastructures 5. Energy plants	1. Energy production
4. Chemical and cement	1. Cement factories 2. Lime plants 3. Quarries 4. Gunpowder factories	
5. Construction, ceramics and glass	1. Pottery yards 2. Pottery workshops 3. Brick yards 4. Ceramic factories 5. Glass factories 6. Tableware factories 7. Brick factories	
6. Cork, wood and furniture	1. Carpentry workshops 2. Sawmills 3. Barrel and cask factories 4. Cork factories	
7. Textile	1. Weaving sheds 2. Fulling mills 3. Cotton plants 4. Spinning mills 5. Tailor's shops 6. Leather workshops 7. Paper factories	1. Dressmaking
8. Steel, metallurgy and metal construction	1. Forges 2. Smithies 3. Steel plants 4. Aircraft factories 5. Iron oxide factories 6. Artillery factories 7. Pellet factories 8. Car factories	
9. Naval	1. Shipyards 2. Docks 3. Ship repair yards	1. Ship construction
10. Mining	1. Extractive plants 2. Settling basins 3. Foundries 4. Mineral washing plants	1. Mining

*Since "railway bridges" does not exist as a type, we searched by "bridge" and then checked each record to verify whether it belonged to the railway sector or not.

Table 2. Attributes and respective descriptions. The first eight attributes are borrowed from the Digital Guide of Andalusian Industrial Heritage. The last two, "Information quality" and "Graphic resource", were added to supplement our analysis of the record contents.

Attribute	Description
Code	Record code that appears in the asset identification in the Digital Guide
Province	Province to which the record belongs
Town	Town to which the record belongs
Name	Name of the asset
Type(s)_Activity(ies)	Asset type(s) and/or activity(ies)
Historical period(s)	Historical period(s) to which the asset belongs
Protection regime	Legal entity responsible for the asset
Legal type	Classification of the asset according to the Andalusian Historical Heritage Act
Information quality	Classification of the information found in the "Description" and "Historical description" fields in the asset record, according to three categories: 1) Good, ii) Historical information missing, and iii) Incomplete
Graphic resource	Existence or not of a graphic resource of the asset in the Digital Guide

In the second phase consisting of the definition of the search criteria, we determined that the searches would focus exclusively on records from the contemporary period belonging to the ten sectors of immovable industrial heritage, with their respective types and activities.
In the next phase we defined the criteria and parameters for the quantitative and qualitative analyses (attributes) that we wanted to analyse. The first step in this process was to conduct a graphic analysis of a sample of 100 assets to test the data visualisation and the type of information gathered. After conducting the tests and verifying the results, we defined ten attributes to gather data from each record (Table 2).

Having selected the assets according to the above criteria, we proceeded to download the data from the Digital Guide as CSV files for processing as XLSL files. For this survey, the data processing phase consisted in "cleaning the data", i.e. correcting characters not recognised when importing the data to XLSL and removing data repeated in certain fields (for example, in many records the "Type" field repeats the name, i.e. the same field might contain "sugar cane factory, sugar cane factory").

Having completed the fourth phase of gathering, downloading and processing data, we proceeded to perform the different qualitative analyses. As the first step, we checked each record to analyse the "Documentation" and "Graphic resource" fields and insert the attributes in these fields into the analysis table. Having completed this analysis, we then performed the quantitative and qualitative analyses using data visualisations, statistics, graphs and maps. As the final step, we proposed a plan for documenting immovable industrial heritage in Andalusia.

Results and discussion

During our survey we identified 1,443 records, including four records (three in the railway sector and one in the mining sector) that straddle two provinces rather than a single province. Figure 1 shows the provinces with the largest number of records are Huelva (280), followed by Jaén (237) and Almería (225).

In relation to records by sector, the largest number of records corresponds to agri-food (542), mining (317), energy (226) and railway (227). Naval (9) and cork, wood and furniture (11) are the sectors with the fewest records. As for the distribution of sectors per province, certain sectors predominate, as shown in Figure 2. Based on the large number of records analysed, this is indicative to a certain extent of each province's history in terms of its production and economy. At the beginning of the contemporary period, agriculture was one of the pillars of the Andalusian economy, when compared both with Spain as a whole and Europe [15]. Agriculture retained its importance in Andalusia until the end of the twentieth century, at which point its relative weight in the region's economic structure began to decline [3]. This process impacted the development of the region in two ways: in aspects related to its physical morphology and

structure, and in the gradual introduction of mechanisation and technology that ultimately changed the business model, labour relations and the new logistical dynamics created.

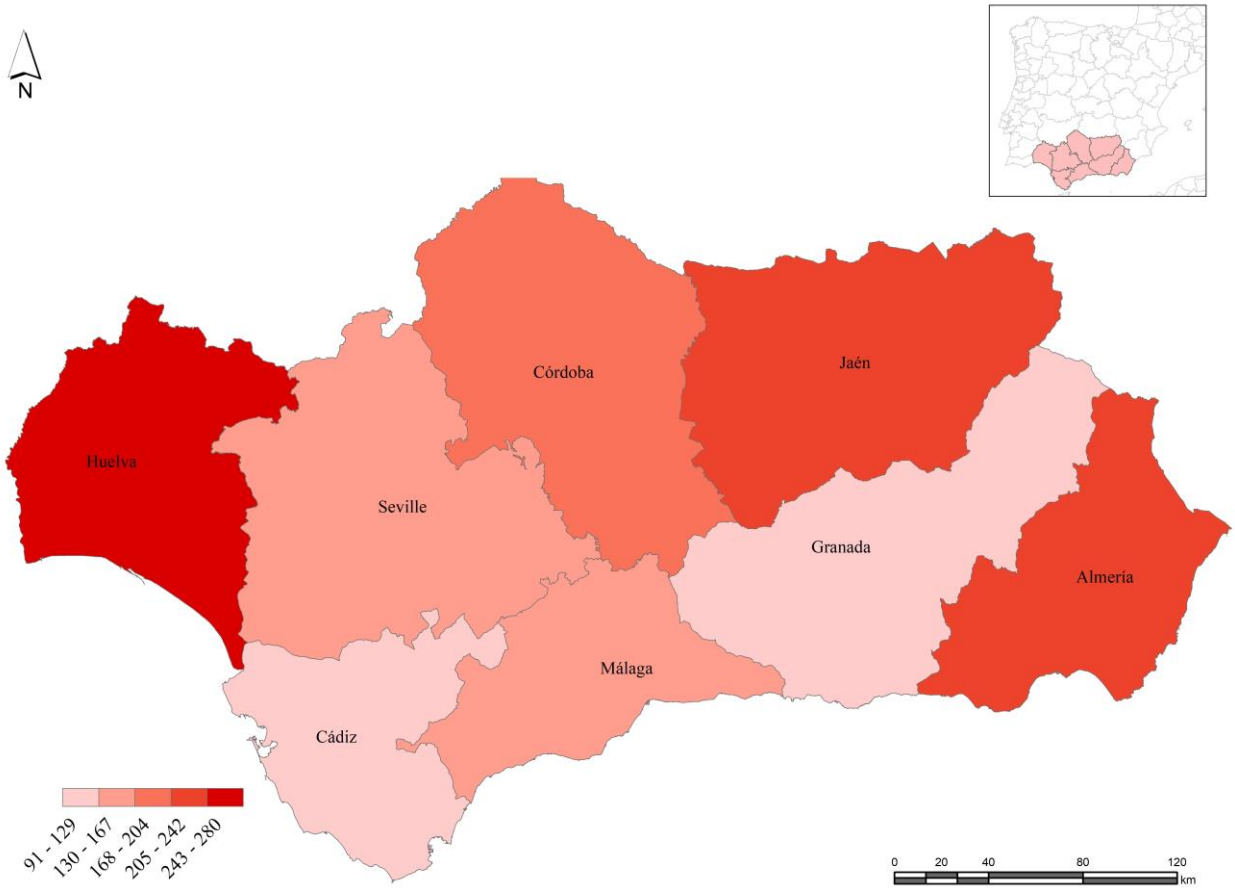

Figure 1. Map showing the number of immovable industrial heritage records per province in Andalusia.

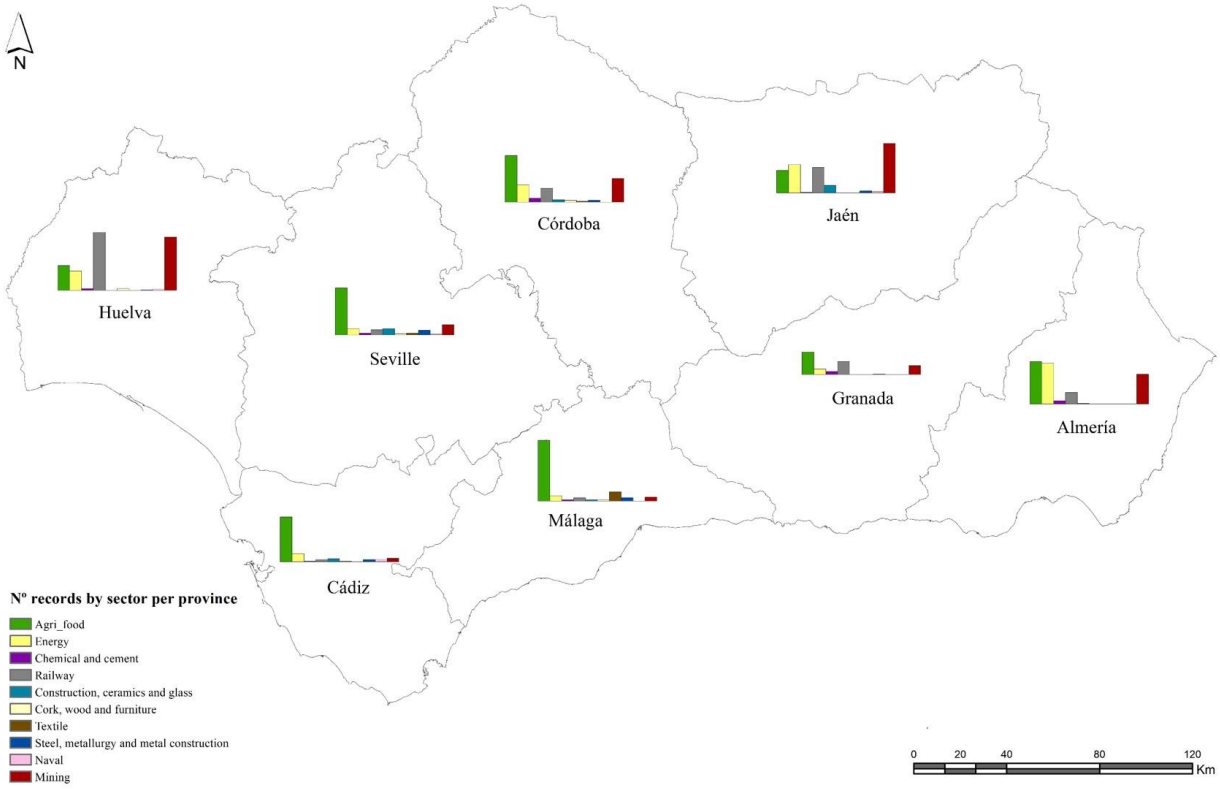

Figure 2. Map showing the sector breakdown of records for each province in Andalusia.

Detailed sector analysis of each province

To obtain more information about the quantity and quality of the records, we created detailed visualisations of each province aimed at gathering more specific data with which to devise a documentation plan more in keeping with the real situation. The data visualisation reveals a greater number of records in the agri-food, railway and mining sectors. Furthermore, these sectors present a greater diversity in relation to the distribution of records per province; this is especially the case of the railway sector, where Huelva is by far the province with the greatest number of records (Figure 3).

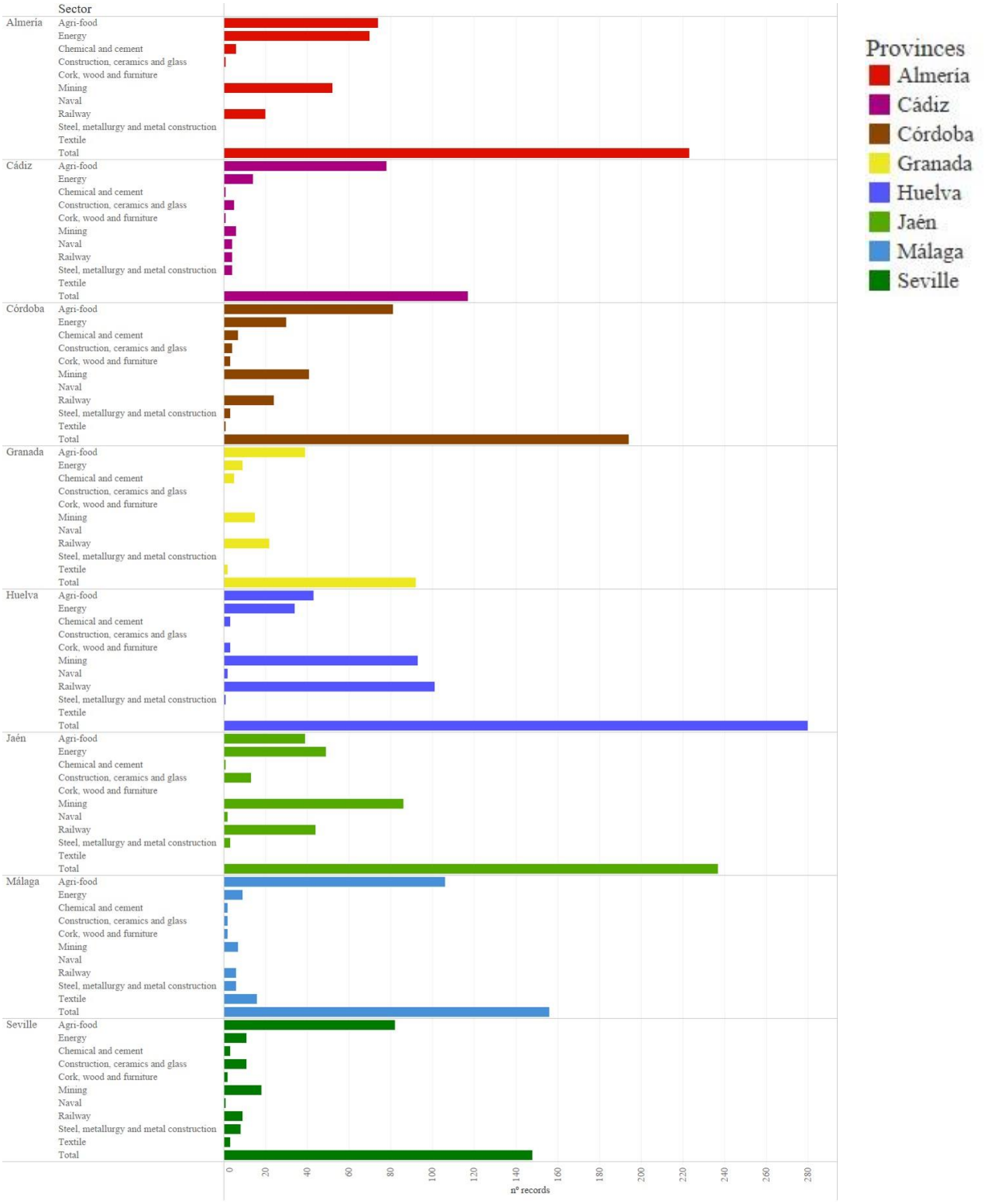

Figure 3. Detailed data visualisation by province and sector.

Typological analysis

We also analysed the records by type, 1) to ascertain whether any sector types were missing from the Thesaurus, and 2) to identify the types with the fewest records in order to determine whether there are any surveys and/or assets in Andalusia that have yet to be documented. The main cases detected are analysed below.

The agri-food sector is characterised by a fairly diverse distribution of records by type: of the 28 types in this sector, eight have more than 20 records. We observed a very small number of records for certain types. For example, there are only five records of the "Silos" type, whereas other surveys corroborate the existence of 148 silos in Andalusia [16]. Likewise, there are only five records of the "Canning factories" type, whereas other surveys point to as many as 45 and around of 4,300 workers [17-18] in the town of Ayamonte alone (Figure 4).

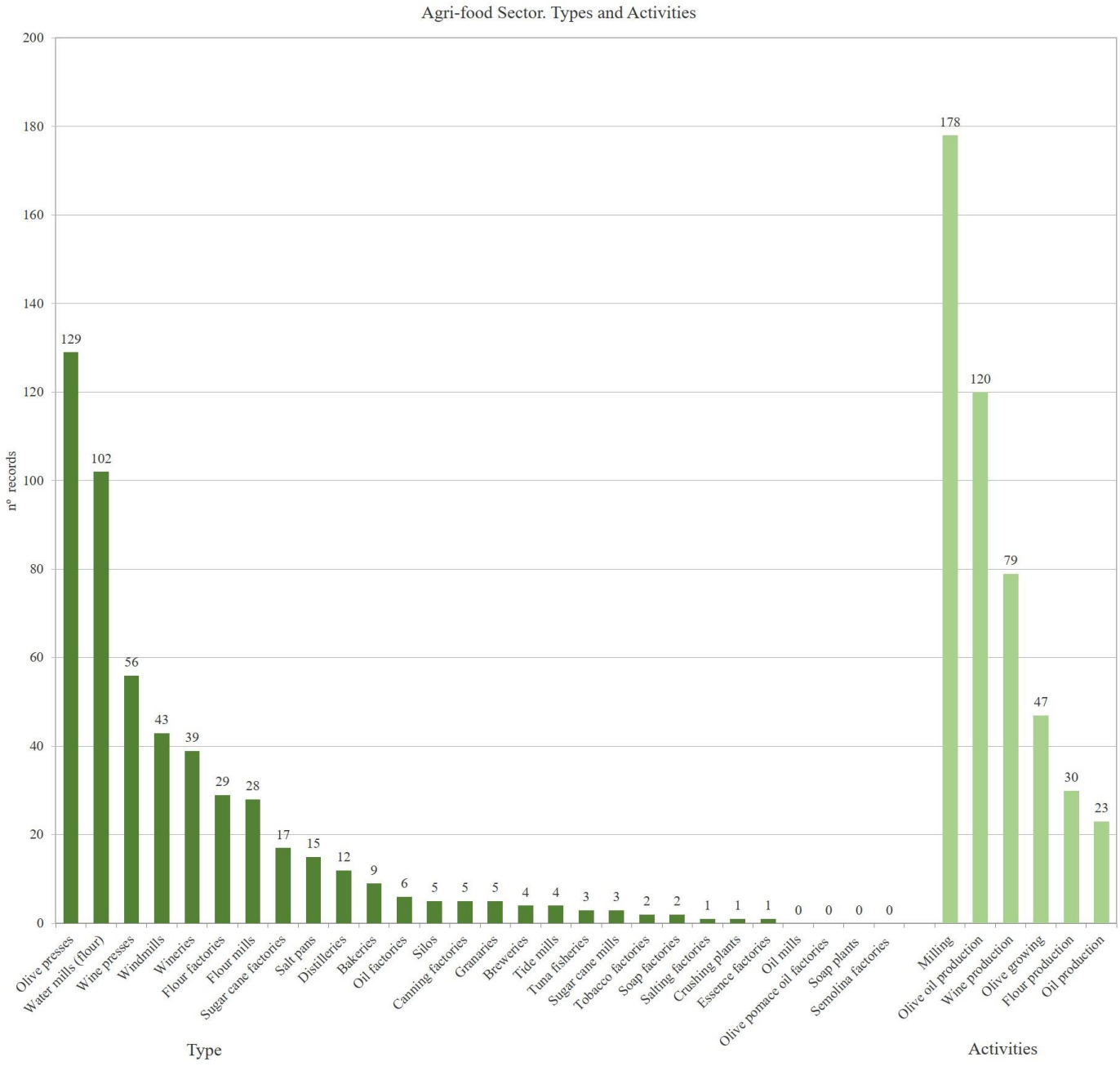

Figure 4. The number of records per type and activity in the agri-food sector.

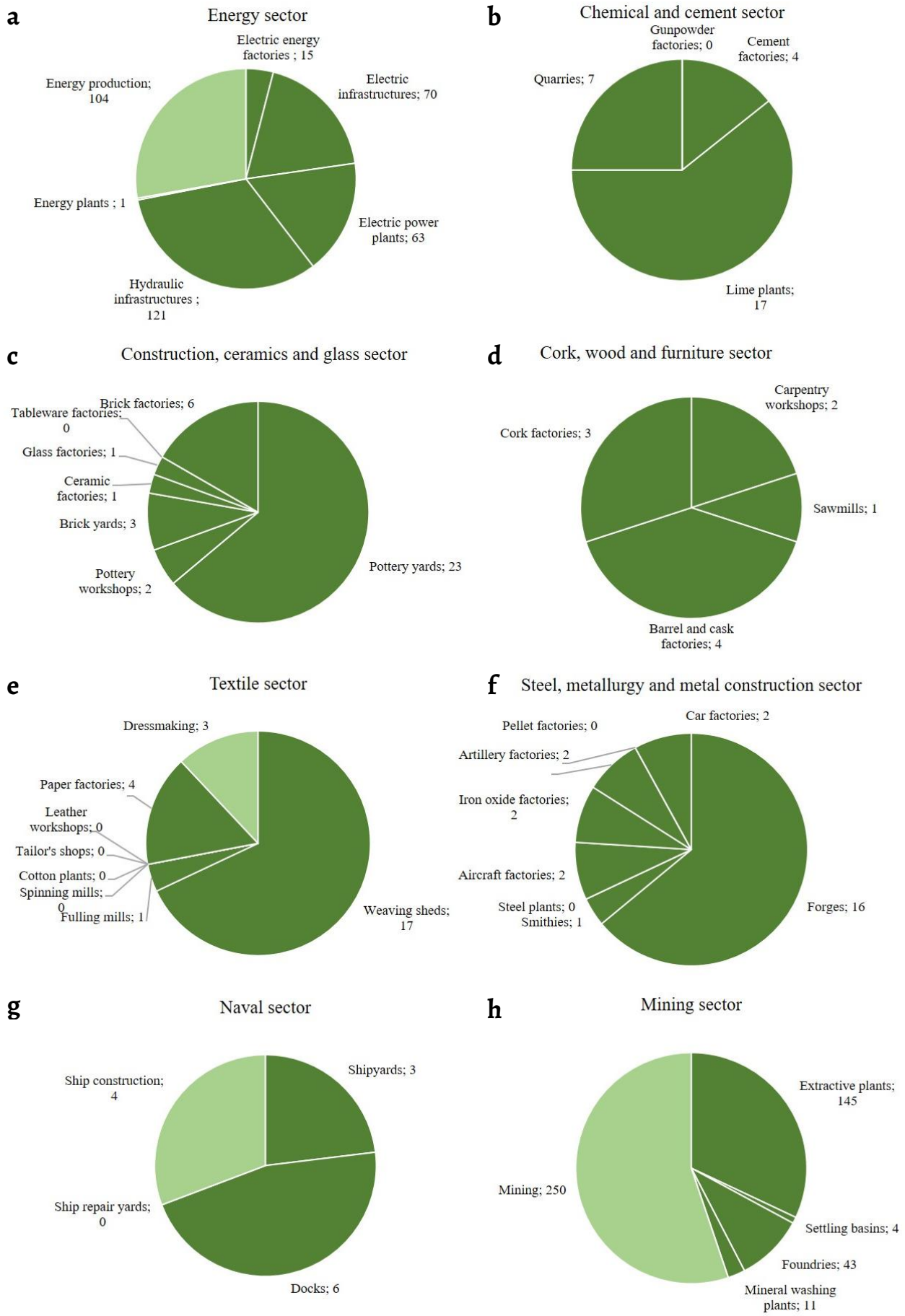

Figure 5. The number of records per type and activity in the eight remaining sectors: *a)* energy; *b)* chemical and cement; *c)* construction, ceramic and glass; *d)* cork, wood and furniture; *e)* textile; *f)* steel, metallurgy and metal construction; *g)* naval; *h)* mining.

In relation to the railway sector, we find a predominance of the "Bridge" type (144 records), the absence of "Railway housing" in the Thesaurus, and very few records for the other types in this sector - "Stations" (41), "Transport infrastructures" (23), "Loading bays" (eight) and "Railway networks" (four) since their combined total is lower than the total number of "Bridge" records. The data analyses and visualisations for the eight remaining sectors point to gaps in certain types where other surveys and projects corroborate a greater number of immovable assets, as shown in Figure 5. For example, this affects "Ship construction" in the naval sector [19]; "Spinning mills" and "Cotton plants" in the textile sector [20].

Analysis of the protection regime

An analysis of the protection regime for the different records reveals the sectors and provinces with the most and least information about the legal entity responsible for the assets. In this case, the records were classified according to three categories: "PCA" (Protected Cultural Asset); "GC" (for assets included in the General Catalogue); and "N/R" (No known protection regime).

The sector analysis revealed a higher percentage of records with a legal entity in the mining sector, followed by the energy and naval sectors. By contrast, the sectors with the highest percentage of records without a protection regime are cork, wood and furniture, followed by construction, ceramics and glass, and then steel, metallurgy and metal construction. Furthermore, although the agri-food and railway sectors account for a high share of records of industrial heritage assets in Andalusia, they also have a high percentage of assets without a protection regime. Figure 6 shows a high number of records without a protection regime, either because the Digital Guide has not been updated properly or because these assets have not yet been surveyed for possible inclusion in a protection regime.

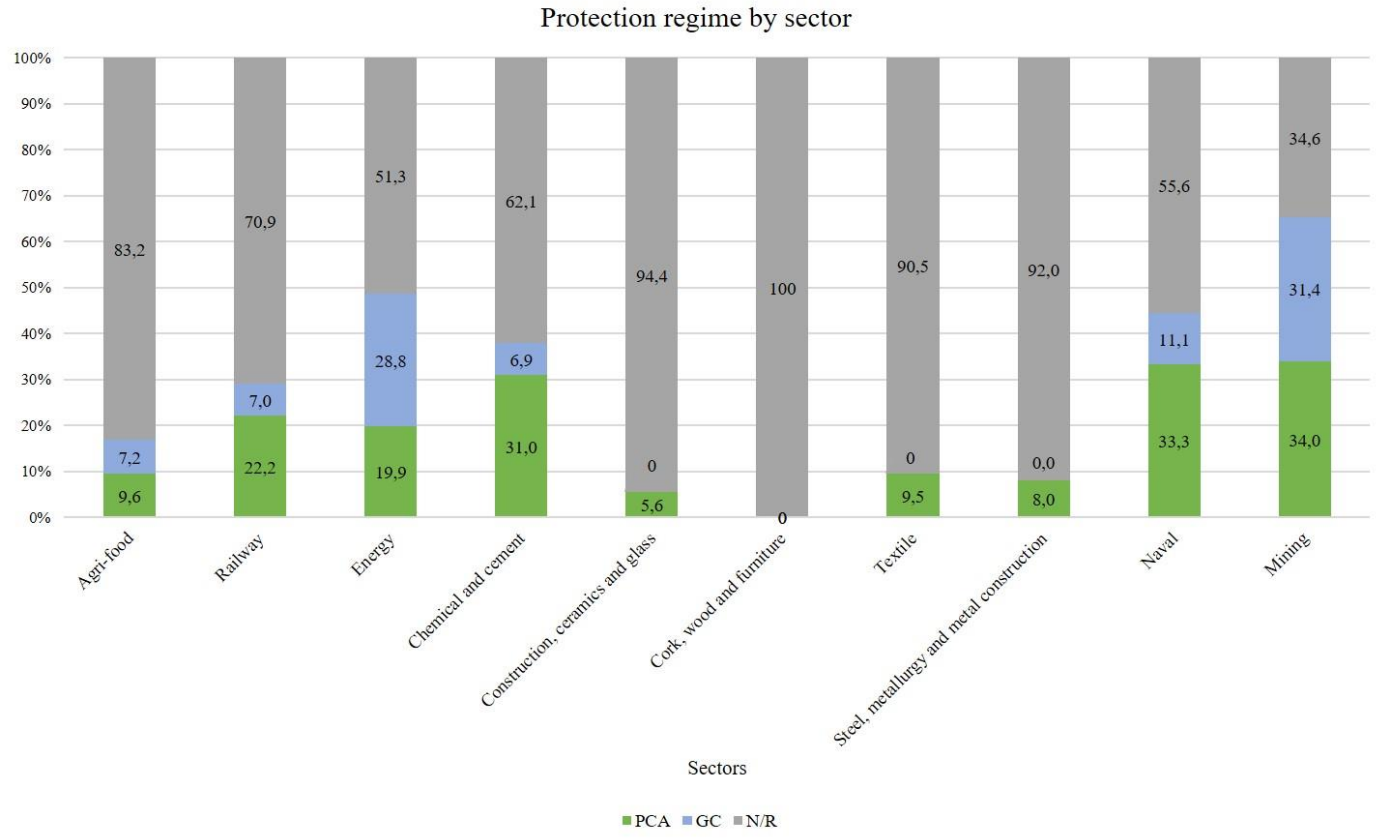

Figure 6. Percentage per sector of the assets analysed in this sample with a protection regime.

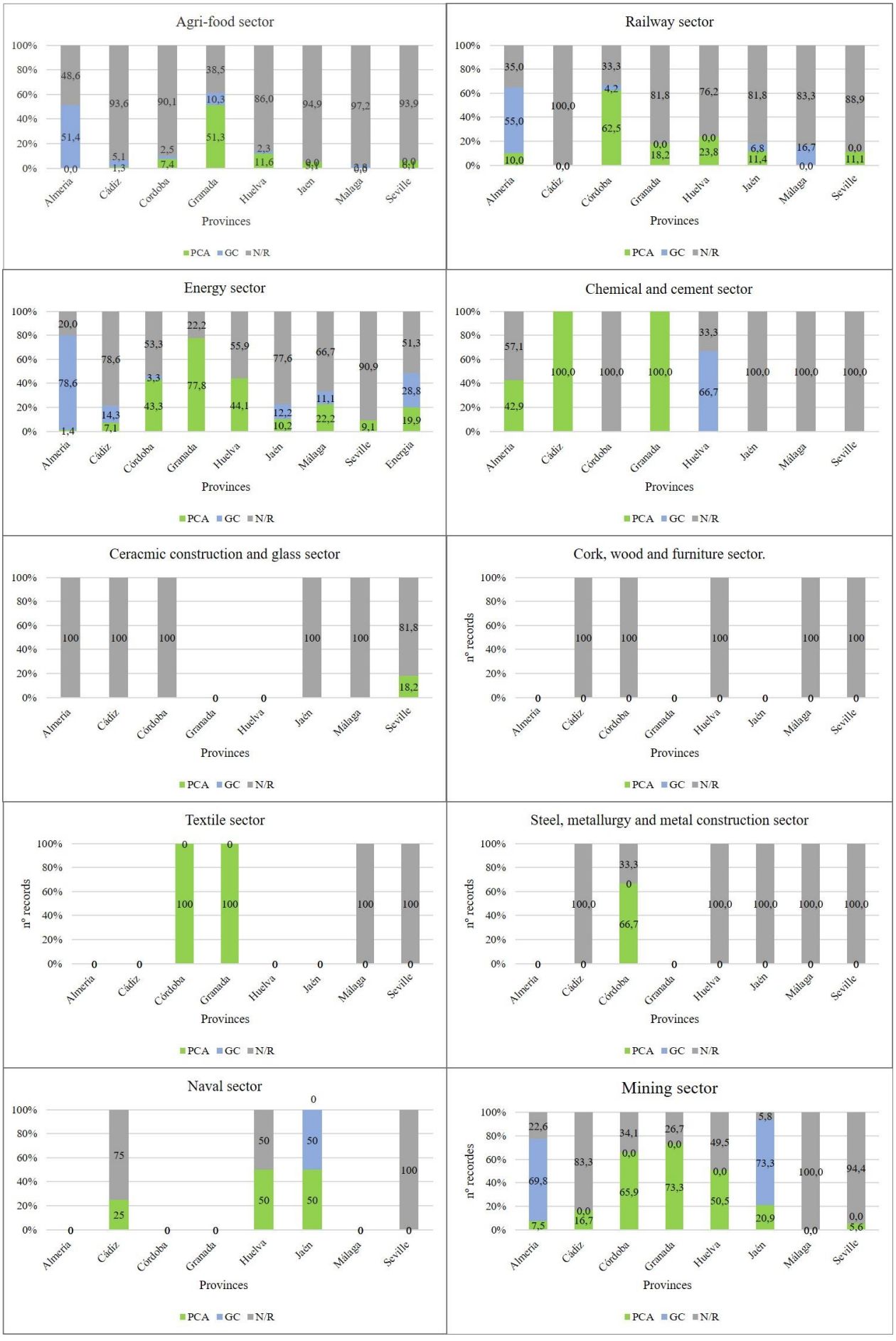

Figure 7. Detailed analysis by sector and province of the protection regime for the immovable assets of industrial heritage.

To gain a clearer picture of the status of the protection regime of immovable industrial heritage assets, we conducted a more detailed analysis of each sector and province, as shown in Figure 7. In relation to the agri-food sector, the highest percentage of assets with a legal protection entity corresponds to the provinces of Granada (61.6 %) and Almería (51.4 %), and GC is only the category of protection regime observed in Almería. With regard to the railway sector, the provinces of Córdoba and Almería have the highest percentages: 66.7 % and 65 %, respectively. In the energy sector, the percentage of assets with a protection regime is distributed more evenly between the provinces. Seville, Cádiz and Jaén are the provinces with the lowest percentages: 9.1 %, 21.4 % and 22.4 %, respectively. We find the same phenomenon in the mining sector, where at least five provinces have a higher average percentage of assets belonging to the PCA and GC protection regimes, while the provinces of Málaga, Seville and Cádiz have the highest number of assets without a protection regime: 100 %, 94.4 % and 83.3 %, respectively.

In the chemical and cement sector, there are greater provincial differences but it is important to put this into context: there are only 29 records in total in this sector, far fewer than in the above sectors analysed. In the provinces of Cádiz (one record) and Granada (five records), all the assets belong to the PCA category, while in Almería (seven records) and Huelva (three records), 42.9 % have PCA status and 66.7 % are included in the General Catalogue, respectively. None of the records in the remaining provinces belong to a protection regime.

In the other sectors, some provinces do not have any records. In the case of cork, wood and furniture, none of the records in the provinces that have them belong to a protection regime. In the construction, ceramics and glass sector, only the province of Seville has records with a protection regime: 18.2 % with PCA status. In the textile sector, only the provinces of Granada and Córdoba have records with legal protection, in this case representing 100 %. In the steel, metallurgy and metal construction sector, the only province with records belonging to a protection regime is Córdoba: 66.7 % with PCA status. Lastly, in the naval sector, the province of Jaén has one PCA record and one GC record, the province of Huelva has one PCA record (50 % of its records), and of the four records in the province of Cádiz, one has PCA status.

Information quality analysis

By analysing the "Description" (specific description of the property, such as building characteristics) and "Historical description" (the historical context of the property and its changes over time) fields we were able to verify the quality of the current information in the Digital Guide. Of the 1,443 assets, 551 records have complete information in both fields, while 665 records (approximately 46 % of the total) only have complete "Description" fields, with no information in the "Historical description" field. Furthermore, 227 records – approximately 15 % of the total – have incomplete information, with no data in either the "Description" or "Historical description" fields.

To provide more detailed base information for the future action plan, we also conducted a sector analysis. Figure 8 shows the sector percentages according to the following categories: "Good", "Missing historical description" and "Incomplete". The sectors with the highest percentage of information classified as "Incomplete" are construction, ceramics and glass and steel, metallurgy and metal construction. Likewise, if we analyse the number of records, we see that the agri-food sector has the highest number with gaps in these fields.

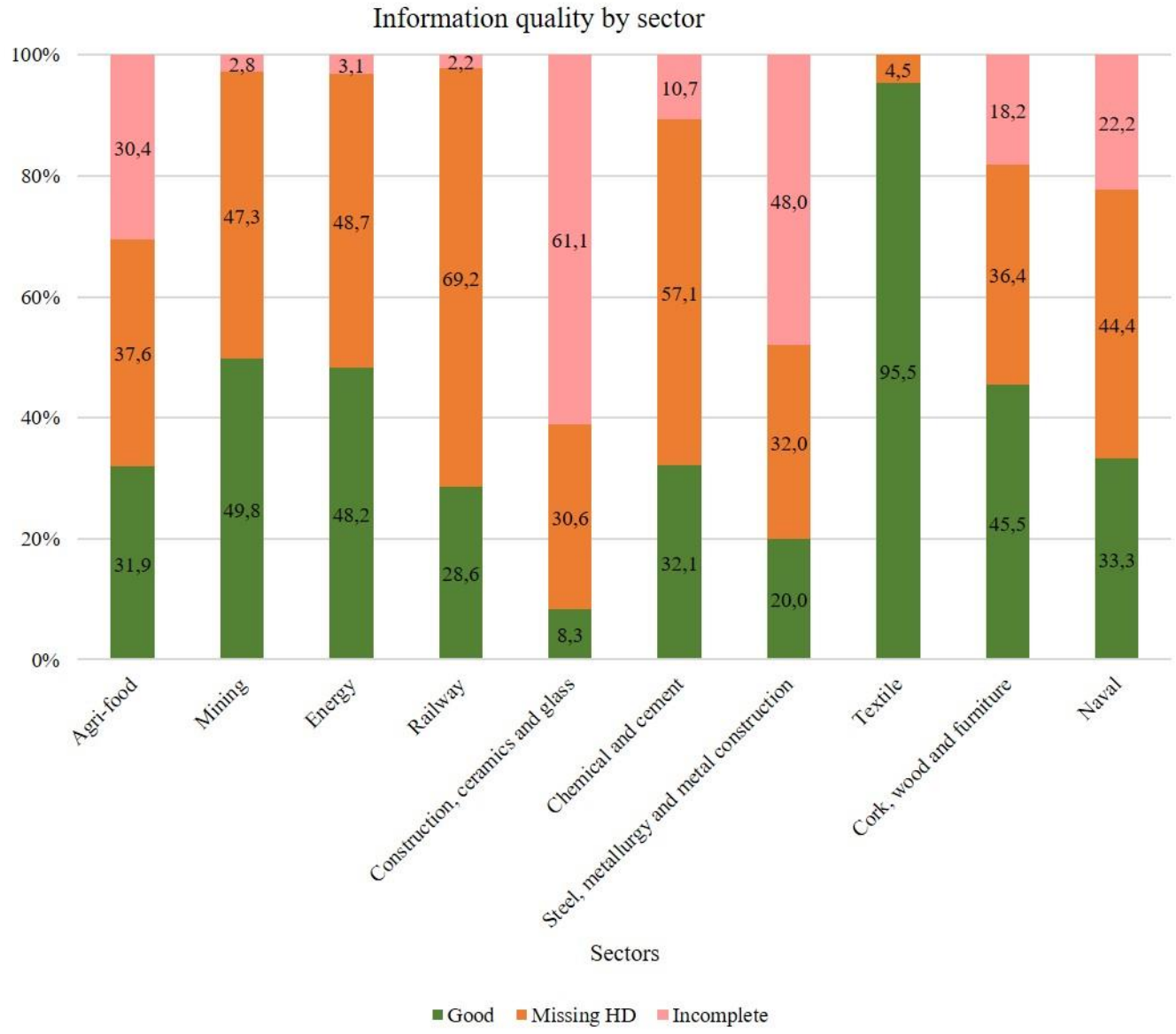

Figure 8. Information quality by sector. The graph shows the percentage corresponding to "Good", "Missing historical description" and "Incomplete".

Analysis of graphic resources

One of the resources used in the Digital Guide to provide visual information about the records is a photograph of the asset in question. Our diagnosis revealed that approximately 46 % of the records do not have photographs (660 records).

Conclusions

Considering their urban and even territorial scale, we may conclude that the origin and formation of immovable industrial heritage assets was neither definitive nor static, and that remains true today. On the contrary, these assets adopt the form of small systems immersed in larger and more complex systems with a dynamic organisation. This dynamism is an intrinsic characteristic of heritage, in which the passage of time and the relationships between the assets and "actors", whether natural or not, are the determining factors of their transformation. This survey analysed a large sample of immovable assets of Andalusia industrial heritage by sector, type and province to verify the status of the documentation in the records in the Digital Guide. We understand that this is a necessary and important preliminary step for establishing guidelines in the medium and long term.

Firstly, the diagnosis points to the need to complete and update the existing records in the Digital Guide. This updating process affects aspects of the protection regime and the information in the "Description" and "Historical description" fields. As observed from our analysis, approximately 65 % of the assets in the Digital Guide do not belong to a protection regime; this high percentage may be owing to the fact that the guide has not been properly updated over the years. Furthermore, nearly 46 % of the records are missing information in the "Historical description" field, which highlights the need to carry out more thorough research and documentation regarding this aspect with a view to generating and disseminating more complete information about those assets.

Secondly, we also detected a lack of records for certain types and activities, despite the existence of considerable information and surveys already undertaken that can be used to add new records and/or complete and update existing records. For example, this affects silos, canning factories, ship construction, spinning mills and cotton plants. Furthermore, the lack of a specific "railway bridge" type in the IAPH Thesaurus greatly slowed down the sample gathering process and will undoubtedly be a key point for researchers and the network of agents who want to contribute information, as well as providing greater visibility and connecting such assets to other types of railway heritage. The same is true of "railway housing": the absence of this type meant that we were unable to map and search for these records. We also detected the lack of other types and activities and the need to improve the terminology of some of the existing ones in the Thesaurus. For example, the agri-food sector needs to include "slaughterhouse", "storage building", "fish farm", "ice factory", "snow pit" and "cheese factory"; the chemical and cement sector should include "resin factory", "medicinal products factory", "plastering", "lime kiln" and "plaster kiln"; and the naval sector needs to include "port" and "lighthouse" [21]. The same is true of "activities", especially as regards conducting analyses that include intangible heritage in the future. The Thesaurus needs to be improved to include activities in all industrial sectors, such as "chemical and cement", "construction, ceramics and glass", "cork, wood and furniture" and "steel, metallurgy and metal construction".

Thirdly, the analyses show that 46 % of the records in the sample do not have a graphic resource, even though such resources offer key information for improving the dissemination, knowledge and recognition of these assets.

Having completed our survey, we were able to establish the following preliminary guidelines for future actions:

- Update the Digital Guide to include records already identified in municipal plans or catalogues.
- For assets where robust surveys and research already exists, gather the information to include in the records and/or create new records. Human resources in public management are still limited and the information validation processes often require fieldwork, which slows down the input of new data.
- Attract and bring new "informers" to the IAPH network of stakeholders [22] to improve citizen participation in the construction of industrial heritage documentation.
- Identify the towns that have no records but for which there is historical evidence of a secondary activity related to a specific sector, even if it is not the primary sector.
- Apply for grants and subsidies to carry out data gathering activities and fieldwork. In relation to this action, the IAPH recently obtained a grant from the Ministry of Universities for the documentation of the industrial heritage of the Guadiana Eurocity, which will enhance the value of heritage values in cross-border landscapes.
- Review and propose a new categorisation of industrial heritage in order to create a detailed list and improve data systematisation.

The IAPH network of stakeholders could play a key role in improving industrial heritage identification and documentation. This network is an agile way of involving social groups and heritage agents in the generation of knowledge available in the Digital Guide, in line with

international recommendations and the Andalusian Innovation Strategy 2020 RIS3. Different actors can participate in this network, such as institutions (museums, town councils, provincial councils, etc.); the academic world (universities, research groups and centres, etc.); entrepreneurs (production, crafts, culture, design, etc.) and civil society (associations, fraternities, social movements, etc.). To collaborate, the actors initially fill out a form available on the "IAPH network of stakeholders" website [22] or contact by mail. In May 2022, this network of cultural heritage reporting agents comprised 130 members. They belong to all the categories and types of agents contemplated in the network, providing the Digital Guide with information about different territorial and heritage aspects [23].

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