International Congress for Heritage Digital Technologies and Tourism Management
June 20th – 21st, 2024. Valencia, Spain
Doi: https://doi.org/10.4995/HEDIT2024.2024.18086

Analysis of the online public opinion on the web platform Tripadvisor on Spain's industrial mining heritage by structuring the data for sentiment analysis

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How to cite: Soto-Rumiche, M. & Rodríguez-Marín, F. (2024). Analysis of the online public opinion on the web platform Tripadvisor on Spain's industrial mining heritage by structuring the data for sentiment analysis. In *International Congress proceedings: International Congress for Heritage Digital Technologies and Tourism Management HEDIT 2024*. June 20th – 21st, 2024. Valencia, Spain. https://doi.org/10.4995/HEDIT2024.2024.18086

Abstract

This study examines visitors' perceptions of industrial mining heritage in Spain, a sector of significant cultural and economic value that has led to the establishment of museums and mining parks, which have been transformed into tourism products. Using text mining and natural language processing techniques, Tripadvisor's online reviews of nine industrial mining heritage resources distributed across different autonomous communities in Spain were analysed. The primary objective was to investigate how visitors describe and evaluate their experiences at these sites. The results indicated a generally positive perception, with visitors frequently citing terms such as "interesting," "recommendable," and "spectacular." However, critical points were also identified, particularly in relation to the duration and physical demands of the visits. This study highlights the educational and aesthetic importance of these sites, recognising their value in teaching the history of industrial mining and in offering cultural tourism.

Keywords: *mining park, Tripadvisor, sentiment analysis, text mining, NLP, qualitative research.*

1. Introduction

The legacy of mining in Spain constitutes a relevant tangible testimony, where the recognition of historical, cultural and sentimental values stand out (Cañizares, 2016), through which they become a pillar for the understanding of the industrial and social history of Spain.

The vestiges of the industrial mining heritage not only have histories of development and exploitation of resources but have also constituted the economic base of numerous territories, which have been part of the prosperity of the mining towns (Cañizares, 2011). Likewise, these sites have a unique landscape and ecology that offers a wide spectrum of study and enjoyment; however, they are currently becoming spaces of environmental awareness by way of reinvigoration in the field of tourism (Cole, 2004).

The interest in this type of industrial heritage has been demonstrated in intervention and revaluation initiatives since the end of the last century and the beginning of the present (Pérez & Verde, 2010), generating museums and interpretation centres that invite reflection on the facts or implications (Jelen, 2018). Nowadays, these opinions or reflections are shared on digital platforms such as social networks or opinion web platforms (Google and Tripadvisor), allowing us to analyse public perceptions towards industrial mining heritage.

This study explores visitors' perceptions of this type of heritage through sentiment analysis of online reviews issued on Tripadvisor, applying text mining and natural language processing techniques to examine how visitors describe and evaluate their experience. The data for this analysis comes from the Tripadvisor web platform, considered a benchmark in the cultural tourism sector (Taecharungroj & Mathayomchan, 2019) and influential in tourists' decision-making (Banerjee & Chua, 2016).

Through data collection and structuring, this study focuses on nine industrial mining heritage sites distributed in the autonomous communities of Asturias, Castilla-La Mancha, Catalonia, Extremadura and Murcia. The web scraping method was used to obtain reviews and then subjected to preprocessing to ensure relevance and accuracy in sentiment analysis. This research aims not only to reveal the general impression of visitors but also to identify specific aspects that generate interest or dissatisfaction. In this way, it seeks to provide information for the development of strategies to improve the tourist experience and, consequently, the socio-cultural value of these historical spaces.

2. Data collection and research methodology

Through sentiment analysis of online reviews, it is possible to interpret how visitors describe and reflect on their experiences on web opinion platforms (Gao & Yu, 2024), the results of which can be relevant in understanding users' interests and detecting trends, which can be relevant in developing strategic plans (Dang et al., 2020). For example, authors such as Sánchez-Vargas et al. (2022) evaluated the titles of online reviews published on Tripadvisor about 3- and 4-star hotels in the city of Cáceres (Extremadura); on the other hand, authors such as Seok et al. (2020) analysed graffiti tours, detecting the value of sustainable tourism, through the online reviews of users of social networks, applying text mining and sentiment analysis of opinions, and finally, authors such as Cheng & Jin (2019) conducted a research study on the attributes that influence the experiences of Airbnb users through online reviews.

For the development of the sentiment analysis, data collection and structuring were carried out, following the objective of applying a methodology that ensures that the data set is well-organised, relevant, and optimised for the study, as shown in Figure 1.

The elements of the industrial mining heritage in Spain were obtained from the database of the International Committee for the Conservation of the Industrial Heritage (TICCIH). Their presence on the Tripadvisor web platform was confirmed, which is considered one of the most relevant tools in the decision-making process of visitors (Ali et al., 2021). As shown in Table 1, nine elements were considered and distributed in different autonomous communities.

As a first step, the web scraping process was carried out using the Octoparse software, as an initial part of the data collection necessary for the initial experiments in sentiment analysis (Barbado et al., 2019). The data extraction was performed for Tripadvisor Spanish reviews, whose percentage rate in the detection of fake reviews has been 3.6%, preventing 67.1% of the simulated reviews from being admitted to the platform (Tripadvisor, 2021). Research by authors such as Reyes-Menendez et al. (2019), Glazer et al. (2020), and Tufail et al. (2022), establishes parameters for the detection of fake reviews, avoiding the extremism of ratings, which can be an indicator of distrust among users. These guidelines have been considered in this study. In total, 10,160 sentences were processed, corresponding to 4,540 online reviews, whose files have been extracted in CSV format.

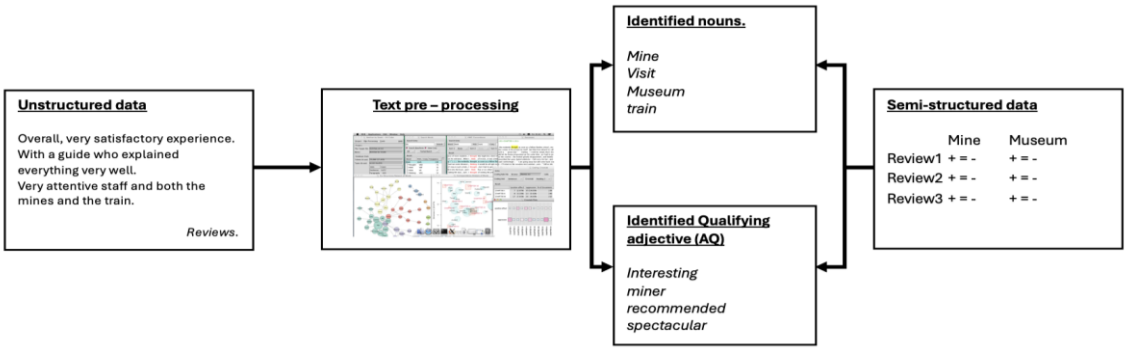

Figure 1. The methodology applied in the data structuring process. Source: Own elaboration.

Table 1. List of industrial mining heritage resources analysed in this study.

Name of the Resource	Province
Museum of Mining and Industry	Asturias
La Jayona Mine Natural Monument	Badajoz
The Salt Mountain Cultural Park	Barcelona
Arnao Mine Museum	Castrillón
Almadén Mining Park	Ciudad Real
Rio Tinto Mining Park	Huelva
Interpretation Centre of the Mining Village of Bustiello	Mieres
La Unión Mining Park	Murcia
Bellmunt del Priorat Museum of Mines	Tarragona

The extraction of raw data is a source of unstructured data that has been treated through the pre-processing phase, which can refer to the manipulation or elimination of data that, prior to its use, can guarantee or improve the performance of the analysis (Choudhary et al., 2022) through the process of cleaning and transforming the data into a structured format (Pandey et al., 2020).

In this process, punctuation marks in the text and icons that did not contribute meaning and were irrelevant at this stage were omitted. Similarly, common and intranscendent empty words were eliminated, which were obtained by means of a list of stop-words[1]. For this study, the open-source software KH Coder 3 was used for the procedure, quantitative analysis, and text mining for the language (Blasco-Gil et al., 2020; Higuchi, 2017).

3. Material field of work: heritage resources

As mentioned above, the working methodology was applied to nine heritage products belonging to the industrial mining heritage modality. Among the numerous mining elements existing in the country, those with the greatest tourist relevance or the greatest number of visitors were selected, with the aim of covering the entire national territory.

[1] The list of empty words omitted in the pre-processing section of the data has been obtained from the github. Retrieved 10 April 2024, from https://github.com/Alir3z4/stop-words/blob/master/spanish.txt

3.1. Bellmunt del Priorat Mines Museum (Tarragona)

Within the Priorat region (Tarragona), dedicated to the agricultural activity of vineyards and olive groves, its mining wealth, exploited since ancient times, also stands out. The Priorat mines, dedicated to the exploitation of galena, were active from 1920 to 1960, characterising the landscape and the economy of the mining town that arose nearby. The galena was transformed into lead ingots, and the sulphur was used, combined with oxygen, to produce sulphuric acid, which was in great demand and useful in the chemical industry. In order to save costs, the process was carried out in pits so that mining activity underwent an evolution in terms of extraction and transformation techniques, from the most traditional (auger and chopper) to the use of pneumatic hammers. The installations had their own electricity production plant.

The existence of its own cinema or brass band in a town of just over 1,000 inhabitants is an example of the considerable standard of living that the town has achieved, which changed drastically when the mine was closed. In 2002, the museum was opened to the public, whose visit includes the interpretation centre and access to the Eugenia mine, the largest and deepest, in which part of its galleries were fitted out and made into a museum, making them suitable for visits. The import centre, in addition to the technical aspects, pays attention to the social aspects and the memory of the people and their workers. One aspect to highlight is that the museum, owned and initiated by the municipality, was integrated into the system of the Museum of Science and Technology of Catalonia, made up of more than twenty visitable industrial spaces that do not repeat contents and benefit from a common design and promotion (Font, 2003).

3.2. The Salt Mountain Cultural Park (Cardona)

The existence of a mountain made entirely of mineral salt is not something common in geology, and the one in Cardona (Barcelona) has been exploited since prehistoric times, although the beginning of the exploitation of potassium salts by the company Unión Española de Explosivos Riotinto intensified the activity, although the working conditions were very hard. The abandonment of the exploitation led to the start of visits in 1997, but the creation of the Mining Park in 2007 allowed for a more profitable tour, which includes the possibility of guided and dramatised visits. The current management has proved to be very beneficial, and in 2022, 66,000 people visited the mine, a significant increase from previous years[2].

3.3. Museum of Mining and Industry of Asturias (MUMI)

The closure of the coal mines, first for economic reasons and then for environmental reasons, has put many towns in the north of Spain, whose main activity was mining, in a difficult situation. To alleviate the social and economic effects of this measure, several projects were undertaken. One of them was the creation of the MUMI, which, with significant institutional support, erected an emblematic circular building in front of which a large recovered derrick was installed. It was inaugurated in 1994, although a train ride to the San Vicente well was added later. The museum's collection is notable for its quantity and quality of machinery, as evidenced by Figure 2. Additionally, the museum's didactic approach to its museographic project is noteworthy, with a particular focus on the various mining professions and the social aspects of the workers' movement.

The visit includes the (simulated) descent into a mine, which has been reproduced by means of a tunnel excavated ex novo, and whose scenography manages to transmit the sensations experienced in a real mine. Its location, relatively close to Oviedo, and its good communications explain its success: an average of 66,000 visitors a year, compared to other less-promoted authentic mining museums[3].

[2] Parque Cultural de la Montaña de sal de Cardona. (n.d.). Retrieved 17 April 2024, from https://patrimoni.gencat.cat/es/coleccion/parque-cultural-de-la-montana-de-sal-de-cardona

[3] Museo de la Minería y de la Industria de Asturias (n.d.). Retrieved 17 April 2024, from http://www.mumi.es/es/mumi/tren_minero.html

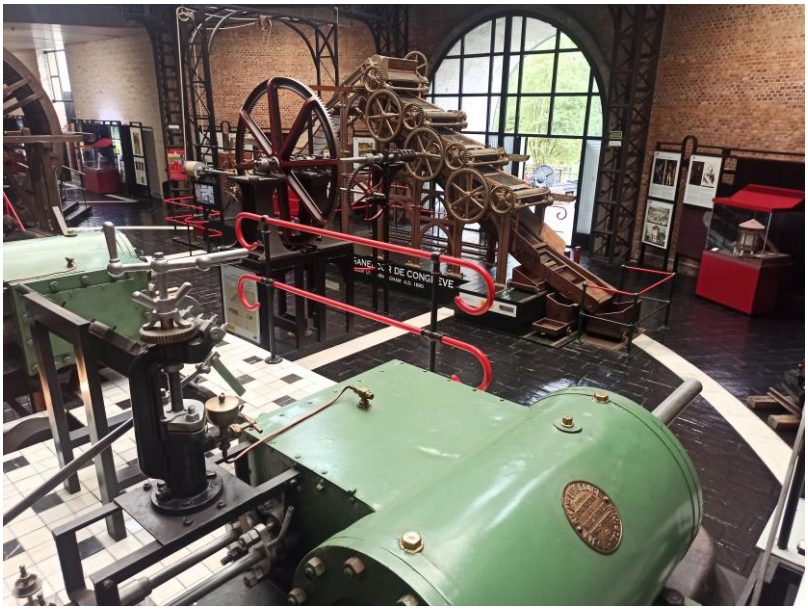

Figure 2. Details of the exhibits at the Museum of Mining and Industry of Asturias. Author: F. Rodríguez

3.4. Arnao Mine Museum (Castrillón, Asturias)

In contrast to the previous example, the Arnao Mine Museum offers the seal of authenticity and uniqueness: the coal seam, although there were previous extractions, was massively exploited in the 19th century, and in fact, the castle that can be seen is the original one, dated 1856. It has the particularity that the vein runs under the sea, so a vertical shaft of 80 m was dug and then a horizontal gallery of 250 m. It can be considered the cradle of the Industrial Revolution in Asturias, as it was the first mine to use a blood-traction railway or to employ women, for example. The flooding of the gallery in 1915 led to its closure, but this allowed the mine to remain intact. Visitors have the option of joining a guide who accompanies them in the original cage to a depth of 20 metres, the only accessible point not flooded by the sea. However, this museum, which is less well equipped with exhibition material but characterised by authenticity, receives barely 10,000 visitors a year[4].

3.5. Interpretation Centre of the Mining Village of Bustiello (Mieres, Asturias)

Bustiello complements all of the above, as it focuses on the human aspect: it is a village built by the Marquis of Comillas for the engineers and workers of his mining companies, equipped with services and very well cared for in terms of aesthetics. It is an example of the bourgeois paternalism that was widespread at the time and which implied the assumption of Catholic principles. Visits are always guided and start at the interpretation centre installed in the engineer's house. The complex, also exceptional in its type, has been declared an Asset of Cultural Interest and receives just over 1,000 visitors each year[5].

3.6. Almadén Mining Park (Ciudad Real)

The municipality of Almadén is the second largest accumulation of cinnabar in the world, exploited since the Roman period but which began a period of splendour in the 16th century when mercury - obtained by distilling the mineral - was demanded for the process of amalgamating silver in the mines of Potosí and others. In this way, the initial settlement became a prosperous mining town, which in the 18th century was exemplary in many ways: the construction of a bullring to subsidise a mining hospital, the later location of the School of Mines, and the

[4] Mina de Arnao (n.d.) Retrieved 17 April 2024, from https://asturias.com/mina-de-arnao/

[5] Centro de Interpretación Poblado Minero de Bustiello (n.d.). Retrieved 17 April 2024, from https://www.turismoasturias.es/descubre/cultura/museos-y-espacios-culturales/otros-espacios/centro-de-interpretacion-poblado-minero-de-bustiello

gloomy side, provided by the existence of the prison for forced labourers which supplied the workforce. The mining installations are inland, with kilometres of galleries and baritels for the extraction of ore and people through vertical shafts, mining fences and shaft furnaces for distillation.

In 2003, a European environmental directive brought production to a halt after more than 2000 years, and almost immediately, steps were taken to make the enormous mining heritage accessible to the public. The inscription of the mines on the UNESCO World Heritage List in 2012 was a clear endorsement of the interest in the project. The public visit includes access to an exhibition area, a guided tour of the galleries and a trip outside by mine train. There is no doubt that the opening of the Mining Park provides a unique experience for the visitor and has contributed to the socio-economic recovery of an area that needs to overcome the absence of effective communication routes and which would require greater promotion.

3.7. La Jayona Mine Natural Monument (Fuente del Arco, Badajoz)

Located in the municipality of Fuente del Arco in the province of Badajoz, very close to Andalusia, iron ores such as haematite, oligist, goethite and limonite began to be mined between 1900 and 1901, initially in an unscientific manner and, from 1905, by means of an overhead cable that transported the ore to the town's railway station, from where a railway line transported it to Peñarroya (Córdoba), which took over all production. Between 400 and 500 miners of both genders and different ages worked the deposit following the veins for two decades until it became unprofitable.

Mining usually has a negative impact on the environment. However, in this case, the paradox of nature, of its own accord, recolonised the space with vegetation and animal species. Some species, such as different types of bats, even made the galleries their usual habitat. The recognition of its natural values came in 1997, with its declaration as a natural monument, which generated a growing flow of visitors that it became advisable to control. At present, the area houses a visitor reception centre, an interpretation centre, various itineraries for the public to follow and the possibility of exploring the galleries on 11 different levels, where large openings allow visitors to contemplate the colourful landscape. The complex receives about 20,000 visitors per year and about 220,000 in the first two decades of its opening (VV.AA., 2018). Two guided tours are offered daily, which are managed by the local council.

3.8. Riotinto Mining Park (Huelva)

As is often the case with areas that have been privileged by nature and geology in the form of mineralogical wealth, the Andévalo area of Huelva has been exploited uninterruptedly since Roman times. This presence has been attested to in the form of a rich archaeological mining heritage, including the water extraction wheel, which, now restored, can be seen in the Huelva Museum. However, the sale by the State to the Riotinto Lmtd. Company in 1873 marked a turning point in the intensification of copper ore mining, the introduction of new techniques and the opening of the impressive Corta Atalaya open-cast mine. The Spanish state took them back in 1954, and since then, profitability has fluctuated depending on the world's copper price. Although iron pyrites (gossan) did not cease to be mined, the resumption of copper mining began in 2015. In 1985, the Riotinto Foundation was created as a non-profit charitable and educational institution with the aim of recovering and maintaining the immense industrial and documentary mining heritage and contributing to the social and economic reactivation of the region.

Through a progressive and lengthy process, the mining museum (located in the former company hospital), visits to Corta Atalaya and the Peña del Hierro indoor gallery, Victorian house no. 21 in the Buenavista district as an ethnographic museum and part of the mining railway line were opened to the public, including the restoration and commissioning of the oldest steam locomotive in Spain. At the same time, it is worth highlighting the careful marketing work, which has included the creation of a brand, the design of a logo and the choice of an identifying colour palette, the reactivation of social networks, direct marketing with tour operators and educational centres, which has resulted in a total of 96,935 visitors in the past year of 2022.

As a paradigm of success and an example of good practice in the recovery of natural and cultural heritage, the project has received numerous awards and distinctions, including the Tripadvisor Certificate of Excellence in 2015 (Narbona & Delgado, 2018).

3.9. La Unión Mining Park (Murcia)

The municipality of La Unión treasures a great diversity and wealth of minerals (galena, blende, pyrite, gypsum, etc.) that have been exploited since ancient times. In its current configuration as a mining museum, it offers a visit to the exhibition area, a touristic train ride that allows visitors to contemplate the mineral washing and roasting areas and access to the Agrupa Vicenta mine, which is located at a depth of 80 metres. There is less to visit, but it follows a recovery plan for industrial assets of 50 elements, and in fact, the museum is currently closed for refurbishment[6].

4. Analysis of visitor perceptions

The first result, as shown in Table 2, corresponds to word frequency, an important tool for understanding the reiteration of terms and their context. This type of processing shows the frequency of words, determining relationships between them and establishing coding rules (Higuchi, 2017). In this case, adjectives related to the experience of visitors to the industrial mining heritage of Spain have been extracted, and, in this way, the terms with the highest frequency have been analysed. It should be specified that the words have been extracted in Spanish, making it necessary to translate them into English for the purposes of this study.

Table 2. Frequency of words in relation to Spain's industrial mining heritage

Words	Frequency	Words	Frequency	Words	Frequency
Interesting	767	Best	202	Beautiful	109
Miner	610	Impressive	181	Didactic	108
Recommended	472	Hard	168	Roman	107
Spectacular	253	Great	153	Major	105
Small	252	Curious	147	Kind	103
Old	250	Long	136	Only	95
Pleasant	232	Different	135	Excellent	94
Unique	227	Medium	133	Touristic	93
Beautiful	208	Pleasant	123	Amazing	91
Complete	208	Short	115	English	91

The predominance of the words "interesting" (767), "recommendable" (472) and "spectacular" (253) show a generally positive perception of industrial mining heritage among visitors. Likewise, the words "old" (250), "pleasant" (232), "complete" (208) and "beautiful" (208) reflect an appreciation of the symbolic and aesthetic value of this type of heritage. On the other hand, the terms "didactic" (108) and "English" (91) indicate the high degree of specification of the educational experiences that take place in these spaces, as well as the quality of the explanations in English for non-Spanish-speaking visitors.

Words such as "curious" (147), "different" (135) and "unique" (227) demonstrate the different appreciation of mining and diverse industrial heritage in terms of comparison with other types of heritage or tourism resources. Finally, the terms "hard" (168) and "long" (136) indicate physically challenging experiences for visitors, and also criticisms of the length of visits or tours. Figure 3 shows a word cloud with the word frequency results.

Figure 4 shows the result of the structural characteristics of the network formed by the co-occurrence of words. Using the network graph of word co-occurrences, we can detect the association of terms with patterns of similar appearances that are directly linked with network lines (Higuchi, 2017). The result, based on the top 100, shows us a graph of 39 nodes (N), 60 edges (E) and a density of 0.81 (D). The correlation coefficient between the nodes was also considered, which indicates the strength of the association between the terms, represented by the thickness and intensity of the edges.

[6] Parque Minero de La Unión (n.d.). Retrieved 17 April 2024, from https://www.ayto-launion.org/turismo/parque-minero-de-la-union/

Figure 3. Word cloud refers to the frequency of terms for industrial mining heritage. Source: Own elaboration.

The highest coefficient corresponds to 0.4, which, in relation to the high-frequency level, is located in the central part of the graph, in relation to the term "mine", which appears as a central node, as a consequence of the context studied, but has a strong link with the words "visitor", "history", "museum", and "miner", showing an association in the perception of the visitors, on the quality of the experience with the personnel linked to the industrial mining heritage and a recognition of the historical value of the mines. In this cluster of words, there is also a connection between the words "guide", "explanation", "recommendable", and "enjoyable", indicating a level of positive satisfaction with the guided tours and the informative quality of the visits.

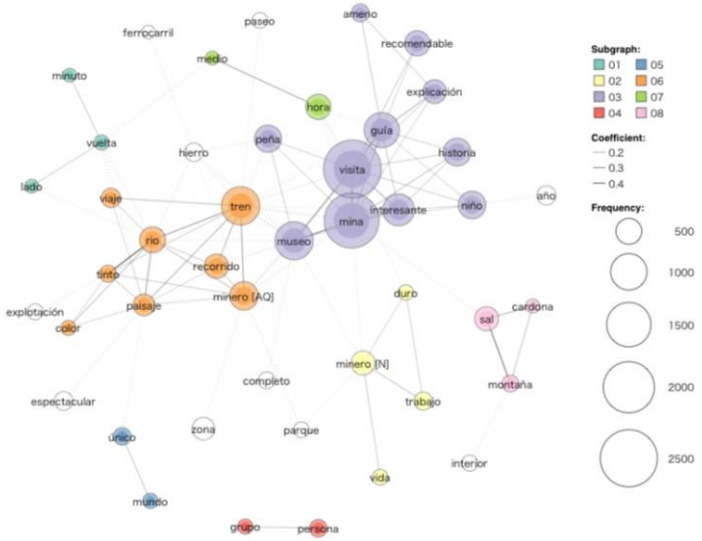

Figure 4. Word co-occurrence network associated with Spanish industrial mining heritage. Source: Own elaboration.

Another node with a high-frequency density corresponds to the term "train", which is associated with the terms "miner" (adjective), "journey", "trip", and "river", alluding to the Riotinto Mining Museum in the province of Huelva, whose terms form part of the museum experience, where the visitor can take a train ride and enjoy the scenic views. In addition, the words "river", "landscape", and "colour" are associated with the appreciation of the natural environment, highlighting the peculiarity of the river's reddish colour as a result of the dissolution of minerals.

A theme has been found around the word "miner" (noun), which is connected to the terms "life", "work", and "hard", demonstrating empathy and connection between the visitor and the historical conditions of the miners, calling for discussion of those situations and the risk posed by such work. The theme of "work" and "hard",

demonstrates empathy and connection between the visitor and the historical conditions of mine workers, calling for discussion of those situations and the risk involved in such work.

Similarly, a connection has been found between the terms "mountain", "salt", and "Cardona" in an allusion to the Salt Mountain Cultural Park, province of Barcelona, one of the areas with great acceptance and reception in the online reviews of Tripadvisor, and through which, the experience in relation to the visit to the geological formations of salt is highlighted. Finally, the words "unique" and "world" in the reviews demonstrate the visitors' perception of this type of industrial heritage, emphasizing the exceptional value and uniqueness of industrial mining heritage in Spain.

Figure 5 shows the result through the word correspondence network graph. Through the correspondence analysis graph of the extracted words, a two-dimensional scatter plot is produced, which is used to explore the types of words that possess a similar appearance pattern (Higuchi, 2017).

These terms are distributed between Dimension 1 and Dimension 2, representing the two main sources of variability between the terms. As far as Dimension 1 is concerned, it contrasts aspects related to the visual characteristics of the mining environment, with terms such as "landscape", "river", and "color", alluding to the Riotinto Mining Museum, one of the elements with the highest number of online reviews and good acceptance on the Tripadvisor web platform. These terms suggest an experience based on the aesthetic appreciation of the place, creating an emotional connection with the environment. However, in the same dimension, aspects more related to the direct experience stand out in relation to the words "museum", "visit", and "guide".

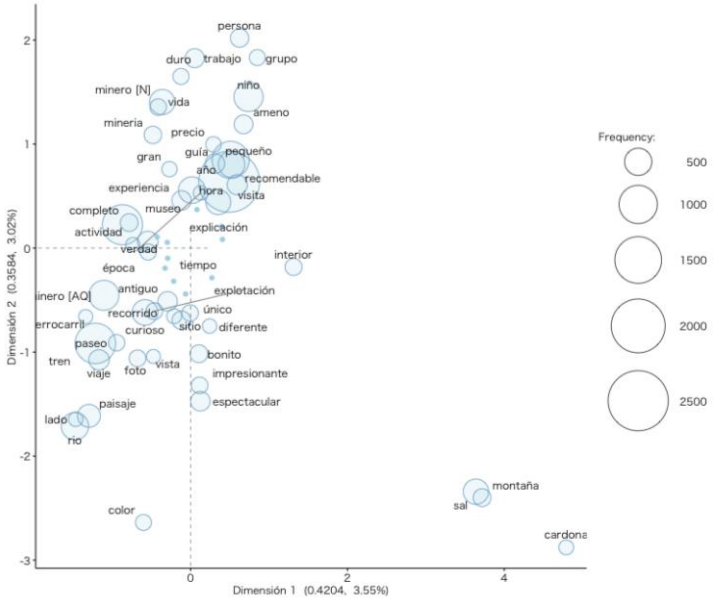

Figure 5. Correspondence graph of words associated with Spain's industrial mining heritage.
Source: Own elaboration.

Terms such as "history" and "experience" demonstrate the intangible (historical) or conceptual aspects that are often central to the symbolic value of this type of industrial mining heritage. Therefore, these terms demonstrate that Dimension 1 is related to the visual perception of the landscape environment of industrial mining resources as well as the museum experience. With regard to Dimension 2, these terms represent the polarity of the experiences described in the online reviews. At one extreme are the terms with positive connotations, which are associated with emotions, reactions, and appreciations towards the industrial mining landscape, with the words "impressive", "spectacular", "beautiful", and "curious" standing out. These terms reflect an emotionally favourable perception of the visits, which are described as unique experiences. On the contrary, the terms associated with the most challenging, critical aspects and points of improvement in the visitors' experience are located; however, negative terms are not prevalent, which shows a generally positive perception.

In addition, terms such as "old", "trip", "excursion", "walk", and "tour" demonstrate the activity-based experiences and the logistical factor in these resources, reflecting the relevance of the infrastructure and easy access to the mining sites analysed. Such terms in Dimension 2 demonstrate the emotionality of the experience and the physical description of the industrial mining heritage environment.

5. Conclusions

The study of Spain's industrial mining heritage through online reviews on Tripadvisor has provided relevant information on how visitors experience and value these sites of historical and cultural importance. The methodology used revealed a generally positive appreciation of industrial mining heritage, with adjectives such as "interesting", "recommendable", and "spectacular" standing out.

The frequency of words and the network of co-occurrences highlight the educational elements, the quality of the guides and the landscape impression, details that show a positive tourist experience towards industrial mining heritage. In addition, the study shows several mentions that highlight the uniqueness of this heritage and the historical narratives that manifest the potential of these sites that can be used to create authentic and enriching tourist experiences. However, areas for improvement have also been highlighted, as indicated by the terms "hard" and "long", alluding to the duration and physical intensity of some tourist routes, which should be taken into account in order to improve the experiences offered.

The recognition of the revaluation of the industrial mining heritage is highlighted by the inclusion of interactive and educational elements, as well as adequate promotion and access to information in several languages, elements that have been highlighted as an important part of the positioning of this type of heritage in the cultural tourism offer in Spain.

Finally, the studied elements of the industrial mining heritage, as reflected in the visitors' reviews, are seen as dynamic spaces for learning and appreciation, fostering a deeper understanding of Spain's industrial history, as well as living spaces, generating an integral local development.

Two possible lines of future research are suggested. The first would focus on how online reviews from web platforms such as Tripadvisor or Google influence visitors' decisions when planning visits to industrial mining heritage sites and how managers can use this information to attract a non-captive audience. Similarly, studies could be developed to monitor visitor perceptions and experiences at these sites over time to inform improvements or changes to exhibits.

Another point, based on the information obtained, is to investigate the sustainability practices implemented at industrial mining heritage sites and how these practices attract environmentally conscious visitors through web-based opinion platforms.

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