METALLICO

Deliverable 6.1

Comparative experience worldwide to analyse secondary resources extraction treatment and their social acceptance

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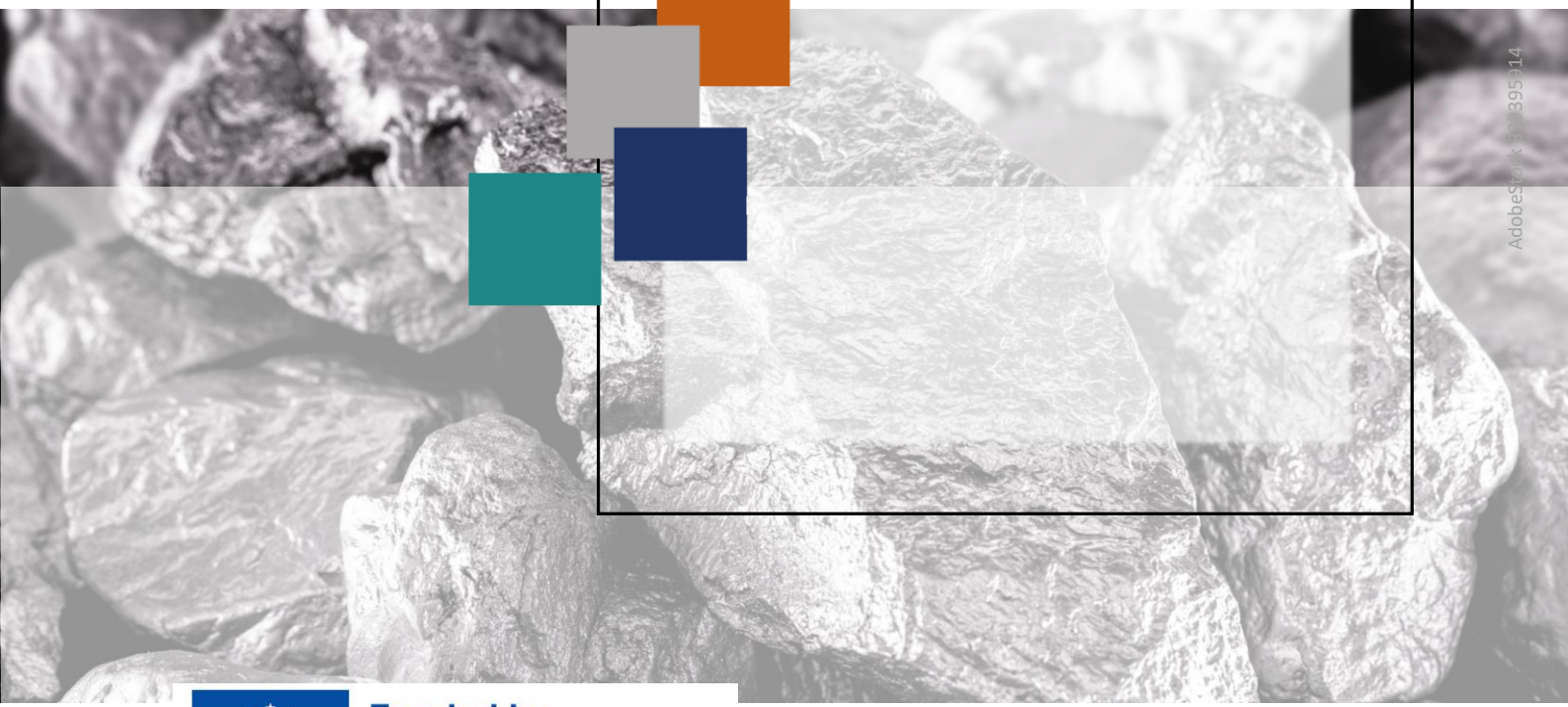

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[1] PU = Public PP = Restricted to other programme participants (including the Commission Services) RE = Restricted to a group specified by the consortium (including the Commission Services) CO = Confidential, only for members of the consortium (including the Commission Services)

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V	Date	Beneficiary	Authors
1	June 2023	At Clave	Virginia del Río Ramón Rodríguez Juan Requejo
2			
3			

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Summary

This deliverable is aimed to elaborate a conceptual framework for the analysis of the social dimension of secondary resources mining and establish the "state of the art" in relation to this topic. Another objective is to understand the public perception on circular economy on mining sector at different scales, and to identify drivers and barriers to social acceptance of management of tailings and extractive waste facilities, considering the mismatch between the societal perception of this issue and the public available scientific information.

Our study uses a mixed-method approach incorporating both qualitative and quantitative methodologies, supported by the use of *Computer Assisted/Aided Qualitative Data Analysis Software* – CAQDAS (Atlas.ti, a leading software, has been selected to develop this task).

Various sources of information have been employed, including: 1) a thorough review of relevant literature; 2) analysis of social media data from Twitter; 3) examination of podcasts; 4) collection of news clippings; and 5) conducting semi-structured interviews with key stakeholders. These multiple sources were employed to obtain a comprehensive understanding of the public discourse and diverse perspectives of stakeholders regarding the circular economy and raw materials recovery within the mining industry in Europe.

This combination of literature review, discourse analysis of social media, semi-structured interviews podcasts and news clipping will provide an extensive and nuanced understanding of the public and stakeholder discourse on this innovative topic. The valuable insights derived from this comprehensive methodology will guide the development of strategies aimed at enhancing public comprehension of the need for CRM self-supply in Europe. In this framework, recovery of metals from mining waste (secondary resources mining) means a strategic activity that not only reduces the need for primary extraction but also contributes to rehabilitate mining sites. It must be ensured that these processes are designed based on the lessons learned in relation to territorial and social integration of mining.

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Disclaimer

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1. Introduction and objectives

This deliverable is the first report proposed as a preliminary basis for the analysis of the social dimension within the overall framework of the objectives of the METALLICO project belonging to the WP6.1 task.

The scope of the research was preliminarily conceived worldwide due to the initial hypothesis that not enough case studies would be found at the European level, but after the literature review, a large number of sites of interest in different European countries were identified, so the objective was focused on their analysis. Nevertheless, relevant projects around the world have been analysed in order to enrich the conclusions of the report, although the study cases are focused on the European level.

Social aspects and public participation have been integrated into the project in a double sense:

1. To deepen the knowledge of the bases of the gap between the demonstrable scientific facts and the social perception of recovery of metals activities and circular economy in mining. This will help to create communication and engagement instruments that improve their social awareness.
2. To integrate the participation of the local communities and relevant stakeholders.
   The design was based on the premise that the social acceptance of an activity, and also of the project, has different scales of influence: from the most immediate local level (communities), generally concerned with health, environmental, socio-economic and identity issues; to the more general scale of public opinion (societal dimension).

Considering this, this report has the following main goals:

- To create a conceptual framework for the analysis of the social dimension of secondary resources mining from literature review and expert round of interviews.
- To establish the “state of the art” in relation to this topic.
- To understand the public perception on circular economy on mining sector at different scales and the existing mismatch between the societal perception of this issue and the available scientific-technical and institutional information.
- To identify drivers and barriers to social acceptance of management of tailings and extractive waste facilities.

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2. Methodology

Our study uses a mixed-method approach incorporating both qualitative and quantitative methodologies, supported by the use of *Computer Assisted/Aided Qualitative Data Analysis Software* – CAQDAS (Atlas.ti,a leading software, has been selected to develop this task).

Various sources of information were employed, including: 1) a thorough review of relevant literature; 2) analysis of social media data from Twitter; 3) examination of podcasts; 4) collection of news clippings; and 5) conducting interviews with key stakeholders. These multiple sources were employed to obtain a comprehensive understanding of the public discourse and diverse perspectives of stakeholders regarding the circular economy within the mining industry in Europe.

After the selection process, the most relevant documents and data obtained from these sources are subjected to analysis using Atlas.ti software. This analytical tool assists in organizing and interpreting the data effectively.

This combination of literature review, discourse analysis of social media, semi-structured interviews podcasts and news clipping will provide an extensive and nuanced understanding of the public and stakeholder discourse on this innovative topic. The valuable insights derived from this comprehensive methodology will guide the development of strategies aimed at enhancing public comprehension and acceptance of circular economy practices within the mining industry.

2.1.1. Literature review

The first task of the research has involved the identification and analysis of the diverse literature available regarding circular economy in mining, aiming to focus, to the extent possible, on their social perspective and dimension.

The search has taken place not only among globally published academic literature but also in various publicly available documents from other European projects that have worked on this subject. It includes institutional documents related to these policies, international standards or protocols on best practices in mining, as well as relevant documents on the issue published by different stakeholders, such as those presented by various companies in the sector or by environmental groups expressing their positions on this matter.

Academic papers were sourced from the Web of Science based on specific keywords related to the project's goals, such as "social acceptance," "circular economy," "waste management," and "tailings valorisation". Once the papers were gathered, a thorough review and screening process took place. The selection criteria included factors such as the relevance of the topic, the methodology employed, the quality of research, and the depth of analysis.

2.1.2. Social Media Discourse Analysis

The objective has been to approach to the social perception disseminated through social media platforms (Twitter) in the main sites where the treatment of secondary mining resources takes place in Europe. Through this subtask, the aim is to gain a nuanced understanding of public discourse on social media regarding the circular economy in the mining sector in Europe, and to identify areas of potential public concern or misunderstanding that could impact social acceptance of this activity.

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The methodology has involved the following steps:

1. Keyword Selection: We have identified a set of relevant keywords and expressions related to the topic, such as: “mine waste facilities”, “tailing management facility”, “tailing storage facility”, “mine tailing recycling”, “recovery of mine waste/extractive mine waste”, “reprocessing of mine waste/tailing”, “mine waste valorisation/processing”, “mine waste recycling”, “extractive mine waste”, or “tailing pond”.

These keywords will serve as the primary filter for identifying relevant Twitter posts.

2. Geographical Location: In addition to keyword-based filtering, geographical identifiers have been used to track posts from specific mining areas relevant to our research. These sites have been selected as a result of the literature review, particularly from reports prepared to support the design and evaluation of European policies on this matter, as well as the review of other European projects that have worked on the recovery of secondary mining resources and manual searches on internet browsers.

A total of 13 study areas have been selected: Olovo (BA), Sillamae/Kukruse (EE), Sotkamo (FI), Asakaeton and Aughinish Island (IE), Olkusz (PL), Bukowno (PL), Minas de RioTinto (ES), Penouta (ES), Gerena (ES), Aznalcóllar (ES), Gällivare (SE), Cornwall (UK) and Chvaletice (CZ).

Due to poor results in extracting information from Twitter related to the keywords in each of the 13 locations, the focus was expanded to a country-wide scale, exploring Twitter posts from the 9 countries where the research has been conducted. The same keywords have been used, along with a general set of keywords composed with "mine” and “mining”.

3. Data Collection via Twitter API: Twitter's API to access has been used to collect public posts that meet the former keyword and location criteria. To ensure compliance with Twitter's data usage policies and ethical considerations, only publicly available posts and anonymous users data have been included in our analysis. The monitored dates have been from June 2021 till end of May 2023.

4. Data Cleaning & Preprocessing: Once the data is collected, cleaning and pre-processing phase is undergone. This phase involves removing irrelevant content, correcting typos and standardizing text. On the main process has been selecting the posts using an exclusion list containing mining words related to “digital mining” topic as "blockchain", "#mining", "#cryptomining", "#bitcoinmining", "#ethereummining", "#miningrig", "#ASIC", "#GPUMining", "#cryptocurrencymining", "#miningfarm", "#miningpool", "#hashrate", "#blockreward", "#mininghardware", "#miningsoftware", "#miningprofits", "#miningcommunity", "#miningsetup", "#miningnews", "#mininginvestment", "#miningdifficulty", "blockchainGaming". All keywords were processed in the corresponding site language.

5. Data Analysis: The cleaned and pre-processed data was imported into Atlas.ti in order to perform both quantitative and qualitative analysis of the Twitter posts.

6. Interpretation and Reporting: The findings from the data analysis phase were interpreted in the context of our research objectives and results presented in a clear and concise manner.

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2.1.3. Podcasts content analysis

In order to achieve the highest level of triangulation and complementarity of information sources, the content of various podcast episodes related to the topic, mining in Europe and the treatment of secondary resources, has been analysed.

Exploring podcast platforms such as Spotify, ivoox, Apple Podcasts, Google Podcasts, SoundCloud, among others, podcast channels and episodes containing keywords such as mining, critical raw materials, or circular economy were identified. Once the episodes were identified, their content was verified for relevance and then downloaded to be processed. In total 47 podcast episodes were included.

After downloading the audio file, it was transcribed and translated into English, ultimately resulting in a text file that was then imported into Atlas.ti for qualitative and quantitative analysis. Using tools such as word frequency, coding and quote generation, and semantic analysis, the main concepts and ideas were identified.

2.1.4. News clippings analysis

In order to enhance the results in gathering relevant information on social perception regarding the topic, we utilized the *Google API* and Python programming to request and retrieve news articles from *Google News*. The methodology consisted of the following steps:

1. Using project-related keywords such as "mine", "mining", "mining waste treatment" or "tailings", we employed the mentioned platform and program for each of the 9 countries under study (Bosnia and Herzegovina, Estonia, Finland, Ireland, Poland, Spain, Sweden, United Kingdom and Czech Republic).

2. By leveraging the capabilities of the Google API and Python, we requested the 500 most relevant news articles in each country. The API enabled us to access crucial information about the articles, including fields such as "title," "content," "date, "media outlet" and the "link" to the news article. This process resulted in a comprehensive collection of over 8.500 news articles.

3. Once the title and content fields were transformed into a text file format, it was imported into Atlas.ti. to proceed with the quantitative and qualitative analysis.

4. Within Atlas.ti, we employed various tools, including word frequency analysis, coding and quote generation, and semantic analysis, to identify and extract the main concepts and ideas present in the news articles.

2.1.5. Semi-Structured interviews

An important part of our methodology involves conducting semi-structured interviews with key agents from various stakeholder groups related to the research topic. These stakeholders include industry professionals, policy makers, academics and community representatives, among others. Their diverse perspectives offer a multifaceted understanding of the current state and future prospects of mining in the context of the circular economy.

The purpose of these interviews is to gain insights into the participants' experiences, opinions, and perspectives on circular economy practices in mining in Europe, as well as their views on the public acceptance of these practices.

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The interviews have proceeded as follows:

1. Participant Selection: We have identified and recruit a diverse range of participants who have a significant stake or interest in the European mining sector and its shift towards a circular economy. The participant list is as follows:

From academic sector:

- Marta Conde (CSRM - The University of Queensland-Australia, ICTA - Universitat Autónoma de Barcelona, BcnUEJ - Barcelona Lab for Urban Environmental Studies).
- Pauline Häßler. Harz University of Applied Sciences (Germany)
- Manuel Caraballo Monge. University of Huelva (Spain)

Policy-makers sector:

- Konstantinos Georgitzikis. Joint Resarch Center (JRC-European Commission, Ispra)
- Giovanni Andrea Blengini (Politecnico di Torino-former EC RM policies assistant)

Civil society:

- Juan José Fernández Garrido. Aznalcóllar municipality major (Andalusian mining area)

Mining sector

- Jesús Caballo. Atalaya mining (operating Rio Tinto mine, Spain)

In this regard, it is noteworthy to mention that the remarkable efforts to involve environmental groups in the round of interviews have not achieved any results.

2. Interview Design: The interviews have been semi-structured, allowing for both predetermined questions that ensure coverage of key topics and the flexibility to explore emerging themes in more depth. The interview guide has included open-ended questions aimed at eliciting participants' experiences, perceptions, and opinions on mining and circular economy practices, and their perspectives on public acceptance of these practices.

This is the interview guide sample:

- Mining in Europe, the Green Deal and the Energy Transition.
- Circular economy in European mining.
- Public information about mining and circular economy in Europe.
- Social perception of mining and resource recovery from mining waste in Europe.
- Conclusions about the possible mismatch.

And for each of them different perspectives were searched:

- Personal experience.
- Policies-regulations (identification and knowledge about them)
- Companies and projects
- Social agents or stakeholders

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- Barriers and facilitators
- Personal assessment

3. Conducting the Interviews: Interviews were conducted via video conferencing platforms, based on what is most convenient for the participants. All interviews were recorded with the participants' consent for accuracy.

4. Data Analysis: Interview data was transcribed and translated into English to facilitate analysis and interpretation of the responses. The transcriptions were carefully reviewed to extract the key points, main ideas, and noteworthy reflections shared by the interviewees. These key elements were then organized thematically to identify common themes and trends across the interviews.

The transcriptions were also imported into Atlas.ti for qualitative and quantitative analysis. We used thematic coding to identify common themes, sentiments, and narratives in the interview responses.

The analysis of the interview data involved a systematic review of the information and the identification of recurring patterns and perspectives. The main concepts, insights, and suggestions expressed by the interviewees were synthesized and summarized to provide a comprehensive overview of the discussions.

2.1.6. Integration in ATLAS.ti software

As mentioned above, our research methodology sought to explore the multifaceted discourse around mining and circular economy in Europe. Leveraging the exposed wide range of data sources and the capabilities of ATLAS.ti software, we were able to delve deep into the narratives and discourses shaping the conversation around this topic.

1. Data Collection: The first step was the comprehensive collection of the different sources data. This included:

- Academic literature pertinent to the subject
- Relevant news articles and press releases
- Social media content from Twitter discussing mining and circular economy
- Podcast transcripts, which provide insight into public sentiment and expert opinion
- Transcriptions of interviews conducted with key stakeholders in the mining industry

2. Primary Document Import: After transcribing and converting the collected information into text documents, these were imported into ATLAS.ti as primary documents. We then grouped these documents into the source categories ("academic papers", "reports", "clipping news", "interviews", "podcasts", and "social media content"). This classification allowed to easily navigate the data pool and facilitated future comparative analysis across different data types.

3. Word frequency tool: This tool was used to identify recurring terms in the discourse, offering an initial understanding of the themes and trends. Word frequency was applied to the different groups of documents and ulterior codes.

4. Coding and Quotations: The core of our methodology was a two-pronged approach to coding and creating quotations. Our coding schema was a mix of self-constructed categories and those identified using the 'Word Frequency' tool in ATLAS.ti. With the 'Coding Tool', we scanned the documents for paragraphs containing words or word families associated with each code, and subsequently assigned the corresponding code. These coded segments, known as 'quotations', offered a detailed look into how

specific ideas were being discussed across different data sources. We further made use of ATLAS.ti's feature allowing us to assign multiple codes to a single quotation, ensuring a nuanced and multifaceted analysis.

5. Additional Tools: We also employed other ATLAS.ti tools, including 'Text Search', 'GREP Search', 'Code Co-occurrence', 'Code-Document Table', 'Memos', 'Comments', and 'Networks', to supplement our analysis.

6. Analysis: Once the data was coded and organized into quotations, the 'Query Tool' was used to cross-reference and analyse the patterns and relationships between different themes. Moreover, ATLAS.ti's semantic analysis feature allowed us to visualize and better understand the relationships between different codes, facilitating a deep and nuanced understanding of the discourse. We also used "concept analysis" tool to detect significant noun phrases (for example, "local community") in order to identify the most frequently occurring concepts in the data.

3. Results

3.1. Literature review: a conceptual framework for the social dimension of secondary resources mining

3.1.1. The ethics of circularity

The "ethics of circularity" refers to an ethical approach that promotes the adoption of economic and consumption practices that foster sustainability and waste minimisation. This concept is based on the principle of the circular economy, which seeks to close production and consumption cycles, minimise the extraction of natural resources and maximise the reuse, recycling and recovery of materials.

It considers ethically responsible to take a holistic and long-term approach to the economy and the environment and proposes that companies, society and individuals should take responsibility for the impacts of their actions throughout the entire life cycle of products, from design and production to use and disposal. Some key ethical principles associated with circularity include:

1. Environmental responsibility: Companies and individuals should consider the environmental impact of their activities and seek to minimise it by adopting sustainable practices. This involves reducing waste generation, promoting recycling and reuse, and minimising the consumption of natural resources.

2. Social justice: The circularity ethic is also concerned with social aspects and seeks to ensure an equitable distribution of the benefits and costs associated with the transition to a circular economy. This involves ensuring fair working conditions, promoting social inclusion and considering impacts on local communities.

3. Transparency and accountability: Companies and individuals should be transparent about their practices and take steps to ensure accountability in relation to the implementation of circularity. This includes sharing information on the origin of products, their environmental and social impacts, as well as enabling traceability and monitoring of product life cycles.

The ethics of circularity aligns with Sustainable Development Goals and seeks to foster a more equitable, resilient and environmentally friendly economic model. By adopting this ethical approach, companies and individuals are expected to contribute to the conservation of natural resources, reduce pollution and promote a more sustainable society.

The EU has developed various instruments and policies to support and advance the circular economy agenda. Here are some of the main ones:

- Circular Economy Action Plan: In March 2020, the European Commission presented a new Circular Economy Action Plan, which sets out a comprehensive strategy to make the EU's economy more sustainable. The plan focuses on areas such as sustainable product design, waste prevention and management, and promoting circularity in sectors such as textiles, plastics, construction, and electronics.

- Waste Framework Directive: The Waste Framework Directive establishes the legal framework for waste management in the EU. It sets out waste hierarchy principles, which prioritize waste prevention, followed by preparing for reuse, recycling, and other forms of recovery, and as a last resort, disposal.

The directive also promotes the concept of extended producer responsibility (EPR), making producers responsible for the entire life cycle of their products.

- Circular Economy Package: In 2018, the EU adopted a set of legislative measures known as the Circular Economy Package. It includes revised waste directives, such as the Waste Framework Directive and the Packaging and Packaging Waste Directive, which aim to increase recycling targets, strengthen waste management, and promote separate collection of waste streams.

- Financing and Funding: The EU provides financial support to circular economy projects through various funding programs (Horizon 2020-Europe program includes specific funding opportunities for research and innovation in the circular economy), while the European Investment Bank (EIB) also offers financing for circular economy initiatives, including through the Circular Economy Platform.

The EU has implemented or proposed other instruments and policies to advance in the circular economy. Its "agenda" is continuously evolving as new initiatives and measures are developed to address the challenges of resource efficiency, waste management and sustainability.

3.1.2. Circular economy and mining

The transition to a circular economy is closely linked to raw material policies, given that RM play a crucial role in the production of goods and services, and the extraction and processing of these materials can have significant environmental and social impacts. The relationship between the circular economy transition and mining is complex and multifaceted:

1. Resource Efficiency: The circular economy aims to optimize the use of resources and minimize waste generation. By implementing strategies such as recycling, reusing, and remanufacturing, the circular economy seeks to reduce the demand for primary raw materials, including those obtained through mining. As the circular economy promotes resource efficiency, it can help reduce the overall reliance on mining activities.

2. Material Substitution: The circular economy encourages the substitution of raw materials with more sustainable alternatives. In some cases, this may involve finding substitutes for materials that are traditionally mined. For example, in the construction sector, using recycled aggregates or alternative building materials can reduce the need for primary resource extraction. Material substitution can help decrease the environmental impact associated with mining activities.

3. Recycling and Recovery: The circular economy emphasizes the importance of recycling and recovering materials from products at the end of their life cycle. Primary resource extraction can be reduced when valuable materials are extracted from waste streams and reintroduced into the production cycle through recycling (which is the main objective in METALLICO project) and also via the so-called "urban mining," or the extraction of precious metals from electronic waste (e-waste), construction and demolition waste, and other discarded products in urban areas is another burgeoning field.

4. Responsible Mining Practices: While the circular economy seeks to minimize the extraction of raw materials, it does not eliminate the need for mining altogether. In this context, responsible mining practices become crucial. Mining operations need to be conducted in an environmentally and socially responsible manner, minimizing negative impacts on ecosystems, communities, and workers. This includes adopting responsible mining practices, ensuring proper waste management, and mitigating the use of hazardous substances.

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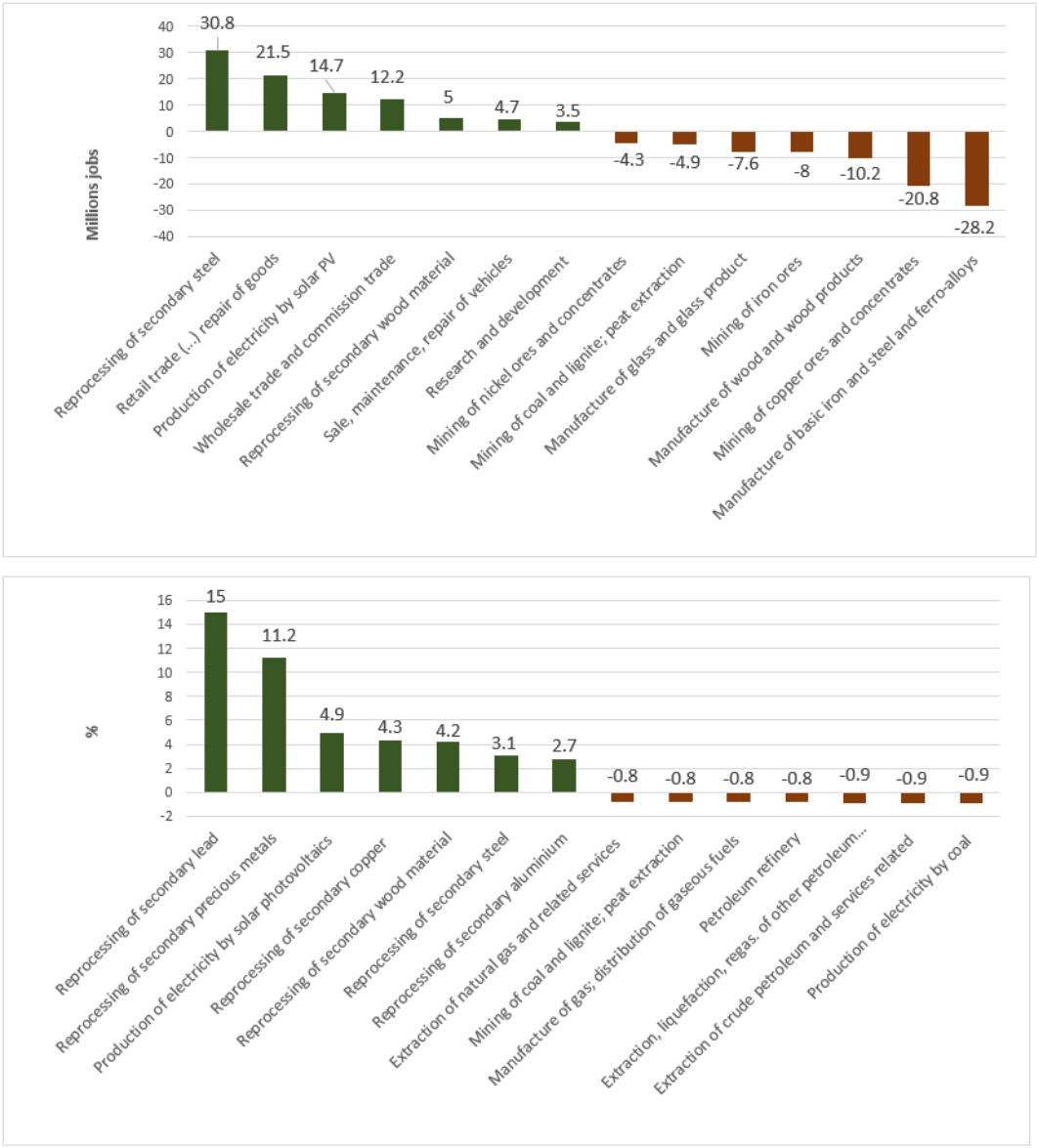
5. Circular Economy Opportunities in Mining: The circular economy can also create opportunities within the mining sector itself. For example, the extraction of minerals can be done in a way that maximizes the recovery of valuable by-products, reduces waste generation, and enhances resource efficiency. Additionally, the circular economy can drive innovation in the mining sector, promoting the development of new technologies and processes that optimize resource use and minimize environmental impacts, i.e. integrating renewable energy sources or minimizing fresh water consumption.

Thus, according to a study from *International Labour Organization* (ILO), the sectors experiencing the **highest job demand growth under a circular economy scenario would be the reprocessing of metals** (e.g. lead, copper, precious metals), reprocessing of steel and wood materials (source: *Raw Materials Information System (RMIS)* - European Commission-JRC).

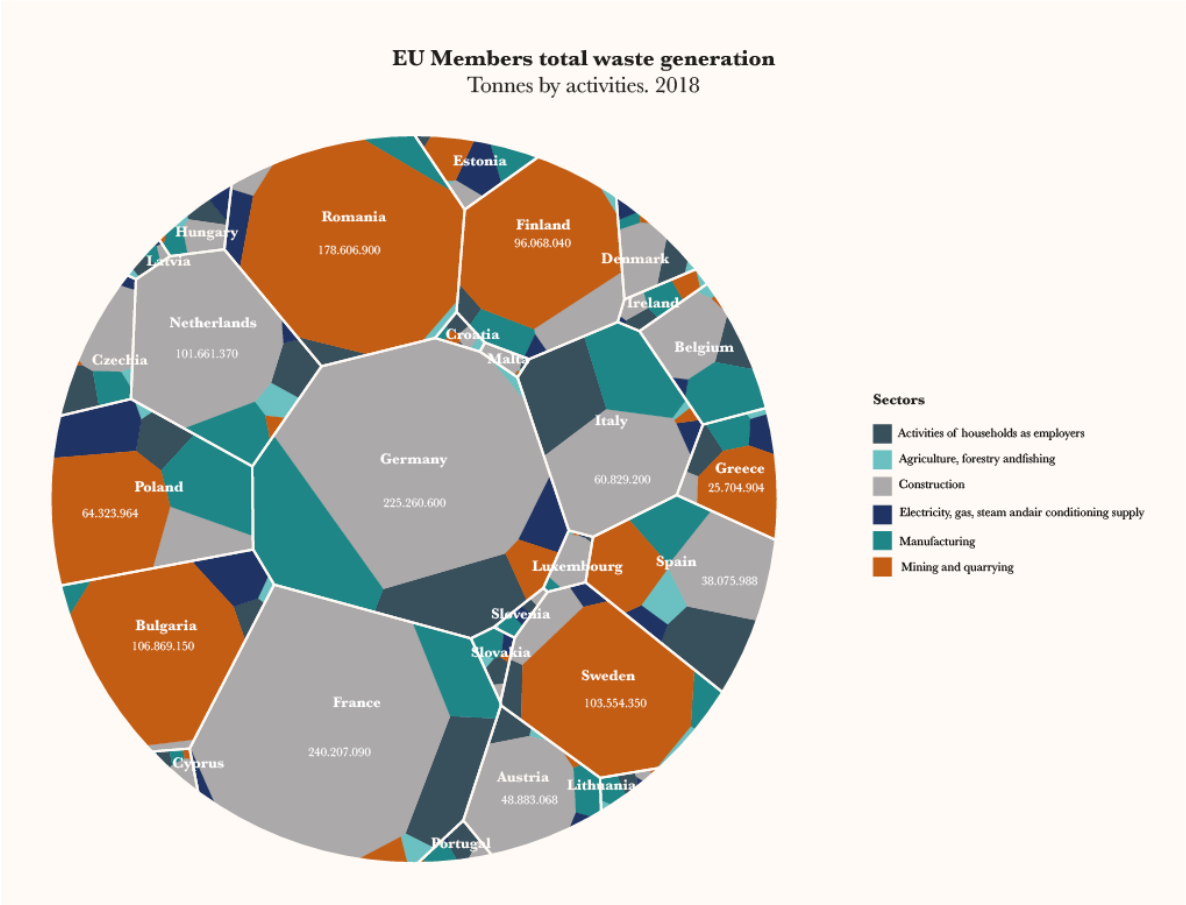
Figure 1. Sectors most affected by the transition to a circular economy in terms of jobs demand, in a) absolute terms (millions of jobs); b) percentage.



Source: JRC elaboration based on data from ILO 2018

It is important to note that the circular economy transition does not solely focus on mining but encompasses a much broader set of strategies and instruments to achieve a more sustainable and resource-efficient economy. While mining will continue to be part of the resource supply chain, the circular economy encourages responsible mining practices and reduces the reliance on primary raw materials through resource efficiency and recycling-recovery to minimize the environmental impact of mining activities.

Figure 2. EU members total waste generation per sector



Source: Own elaboration based on data from https://ourworldindata.org/waste-management.

In this regard, some experts insist on not considering the treatment and recovery of tailings as part of circular economy because this would imply considering that they are waste, while the very conception of mining activity grants tailings the consideration of "resources for the future", which may be exploited when the technical and economic conditions make its use viable.

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3.1.2.1. Benefits of circular economy in mining[1]

Recycling of mining waste can turn liabilities into assets
Several technologies are available and specifically fit for purpose
A high impact on CO_2 reduction per ton of raw material produced
Wide range of positive side effects for the environment: reduction of land usage, risk of erosion, reduction of water pollution, less use of natural resources per ton of raw material produced
Socio-demographic impact by involvement of local communities and enforcement of international working standards in remote regions

Mining sites typically manage waste from mining activities by constructing ponds secured by dams, commonly known as "tailings". The management of tailings, therefore, requires water management. Treatment alternatives for different types of tailings (which exhibit high diversity) are based on various physical and chemical processes (although some kind of bioremediation process are also being tested) that allow for the recovery or removal of different metals.

In addition to the economic and strategic value of numerous raw materials, tailings management also has a significant environmental component. This applies both at the local level, involving the regeneration of degraded environments and potential contamination risks due to the presence of harmful metals in acidic waters, and at the global level. Advancements are being made in various methods of accelerated carbonization of mining waste, which significantly enhances their function as a carbon sink or carbon capture (contributing to climate change mitigation). Moreover, valuable metals and other by-products can be recovered for a variety of uses.

However, some experts conclude that “very little knowledge is currently available concerning the potentials for Secondary Raw Materials that can be found in mining waste, municipal solid waste, and industrial waste. Despite statistics on waste flows being available from the Eurostat website, no systematic and consistent collection of data relevant to (critical) raw materials contained in these wastes flows is carried out. These data gaps are not only demonstrated by the practices analysed in this report but also by other initiatives. For example, the SCRREEN H2020 project has recently drew conclusions about the insufficient information about CRMs compositions and volume characteristics in mining

[1] CRONIMET Group (in NEMO Project “Recycling mining waste study cases”)

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waste, both in abandoned mines and mines in operation. Compositional data (including the presence or not of CRMs) is currently only available for a few sites in Europe. These data gaps are usually observed for both abandoned mines and for mines in operation"[2].

3.1.3. Energy transition and Critical Raw Materials

The shift towards a more sustainable and low-carbon European energy system and to achieve the objectives of the European Green Deal, relies on specific materials that are categorized as critical raw materials (CRMs) as they are crucial to Europe's economy. A reliable, uninterrupted supply of CRMs is necessary to enable a strong industrial base to produce the goods and technologies we have come to rely on in daily life[3] and to accomplish Climate Change goals. The EU's commitment to the energy transition and Green Deal policies has been accelerated by the need for energy self-sufficiency and CRMs following the Russian invasion and war in Ukraine.

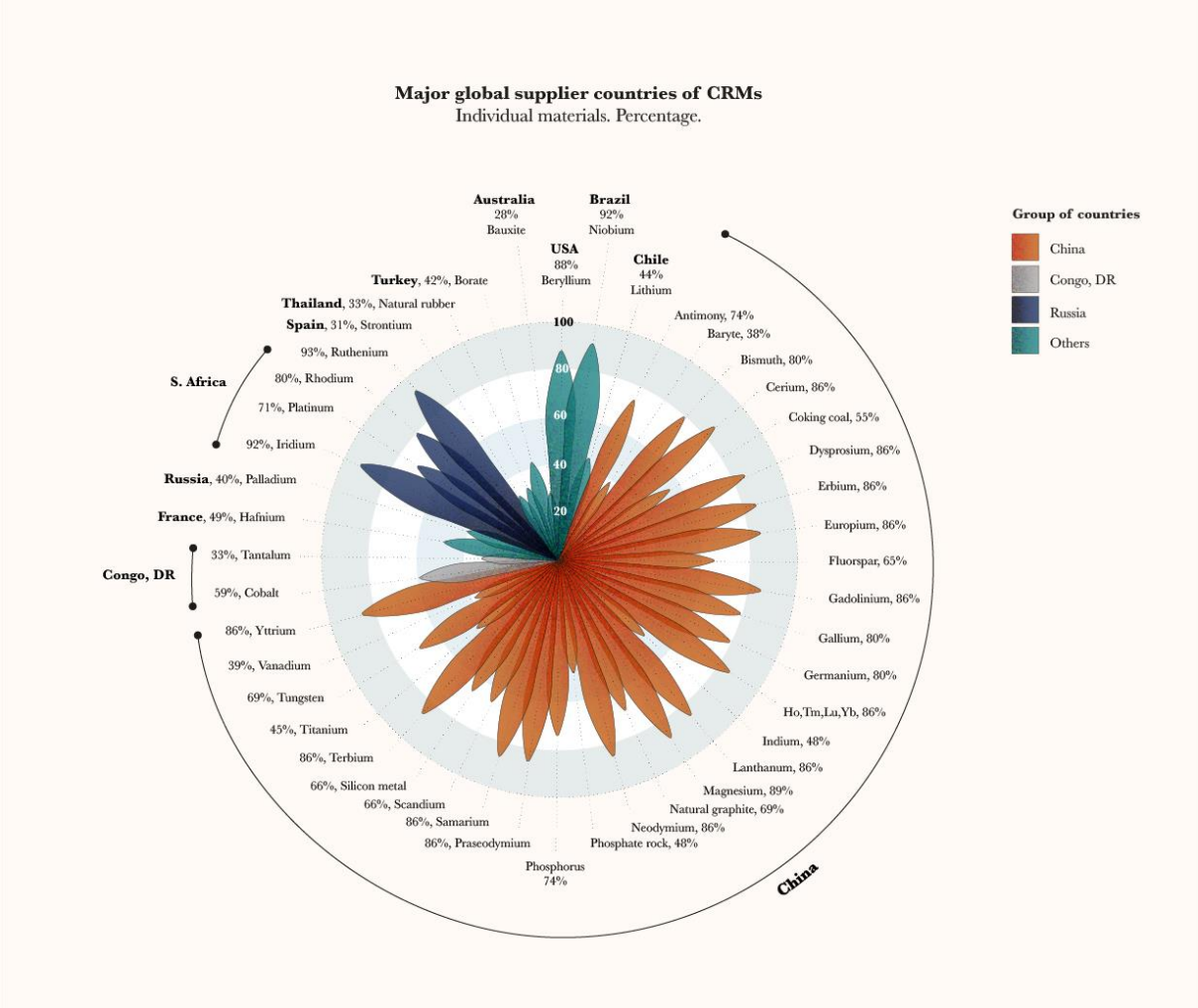
The energy transition involves a significant expansion of renewable energy technologies such as solar photovoltaics (PV), wind turbines, and energy storage systems. These technologies require certain critical raw materials for their production. For example, solar PV panels require materials like silicon and Rare Earth Elements (REE), while wind turbines use materials such as neodymium or cobalt for their magnets and energy storage systems rely on lithium-ion batteries and other metals.

The increasing demand for critical raw materials in the energy transition can create supply challenges, as some of these materials are geographically concentrated in a few countries, which raises concerns about supply security and potential geopolitical tensions. Diversifying the sources of critical raw materials and promoting responsible sourcing practices are essential for ensuring a stable and sustainable supply chain.

[2] Recovery of critical and other raw materials from mining waste and landfills. State of play on existing practices. JRC, 2019. [Blengini, G.A. et al. Recovery of critical and other raw materials from mining waste and landfills: State of play on existing practices, EUR 29744 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-03391-2, doi:10.2760/494020, JRC116131

[3] CORDIS EC (ISSN 2599-8293, June 2022)

Figure 3. Countries accounting for largest share of global supply of CRMs. 2020.



Source: European Commission, Study on the EU's list of Critical Raw Materials – Final Report (2020)

China, Russia, USA, South Africa, or Brazil are significant producers of different CRMs and play a crucial role in the global market. In contrast, Europe faces certain challenges that limit the extraction of these resources. These challenges include geological constraints, limited resource reserves, stricter environmental regulations, higher production costs, and societal concerns regarding the potential environmental and social impacts of extraction activities. As a result, Europe relies more on importing them from other regions rather than extracting it domestically.

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According to JRC[4], one of the main causes of this dependency are economic and societal factors that negatively affect exploration (for deposit discovery and characterisation, estimation of resources and reserves) or extraction (closure of existing mines, reluctance to open new mines, etc.). Many CRMs lack the upstream steps of the value chain in the EU (antimony, beryllium, borates, magnesium, niobium, PGMs, phosphorus, rare earths, scandium, tantalum, and vanadium).

It also concludes that recovery process cannot regard a specific material alone (especially if present in low concentration), but most of the available resources must be recovered and valorised in order to make the process economically viable and resource efficient. In addition to the economic value of recovered materials, *environmental and social aspects emerged as relevant drivers for the treatment of extractive waste. Indeed, the process can lead to the environmental restoration of abandoned mining areas and to the release of new land space. Community engagement is very important for the successful deployment of waste treatment projects as environmental risks and opportunity have to be clearly communicated*.

To address this challenge, the European Commission has created a List of CRMs for the EU that is subject to review and update every 3 years. In parallel, as part of the Action Plan on Critical Raw Materials, European Raw Materials Alliance (ERMA), an industrial alliance dedicated to securing a sustainable supply of raw materials in Europe, was launched in 2020.

As the demand for critical raw materials grows, it becomes crucial to improve recycling and material efficiency to reduce the reliance on primary extraction. Developing technologies and processes that enable the efficient recovery and recycling of critical raw materials from end-of-life products and waste streams can help address supply constraints and minimize the environmental impact of their extraction.

The energy transition is driving technological innovation and research and development efforts focused on finding alternatives to critical raw materials or developing more efficient ways to (re)use them. This includes exploring new materials, as well as improving the performance and efficiency of existing technologies to reduce the overall need for CRMs and to improve the recovery processes from mining secondary resources, as METALLICO project is aimed to.

In this context, it can be concluded that Europe represents one of the areas of the world with the highest demand and consumption of CRMs, especially of certain metals that ensure the quality of life of its population, as well as guaranteeing the fulfilment of its climate objectives, as mentioned above. Their supply depends on the export of raw materials from third countries where compliance with international standards of environmental protection and respect for social aspects is often not guaranteed. It can therefore be considered not only an economic, strategic, but also an ethical issue that Europe should take responsibility for increasing its own supply and self-sufficiency of these CRMs, and the recovery of by-products in extractive waste plays a fundamental role in this task.

[4] Recovery of critical and other raw materials from mining waste and landfills. State of play on existing practices. JRC, 2019. [Blengini, G.A. et al. Recovery of critical and other raw materials from mining waste and landfills: State of play on existing practices, EUR 29744 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-03391-2, doi:10.2760/494020, JRC116131

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3.1.4. Social acceptance of mining and tailings management

3.1.4.1. About Social License to Operate and social acceptance of mining

The literature review based on the results of other H2020 research projects working on social acceptance or Social License to Operate (SLO) concept in mining (some authors have published articles that can be considered as "meta-studies" about SLO) show different views:

1. The SLO concept is characterized by a limited conception of stakeholder engagement and by insufficient attention towards the local, regional and global, social and environmental impacts of extractive operations. So based on this, suggestions are addressed to widen the scope of the SLO concept by[5]:

- Including a diversity of local and non-local stakeholders
- Improving the ability of these stakeholders to actively engage by creating long-term spaces for active and meaningful deliberation and co-production
- Enabling the co-production of knowledge about impacts and risks of extractive operations, and incorporating international sustainability targets.

2. Five critical factors of SLO are identified:

- context is key
- a social license is built on relationships
- sustainability is a dominant concern for communities
- local benefits provision and public participation play a crucial role
- adaptability is needed to confront complexity (Prno, 2013).

3. Companies must have ongoing communication with affected operational stakeholders as meaningful dialogue is crucial (Nelsen, 2006; Koivurova et al., 2015; Mercer-Mapstone et al., 2017); transparent disclosure of information to host communities is essential (Owen and Kemp, 2013); and strengthening community development agreements would be beneficial (Wilburn and Wilburn, 2011).

[5] The Social Licence to Operate and the legitimacy of resource extraction (Meesters et al, 2020). This article has been published under the research funded from EU H2020 projects NEMO; CROCODILE and TARANTULA.

Figure 4. Drivers in a Scalar SLO Model

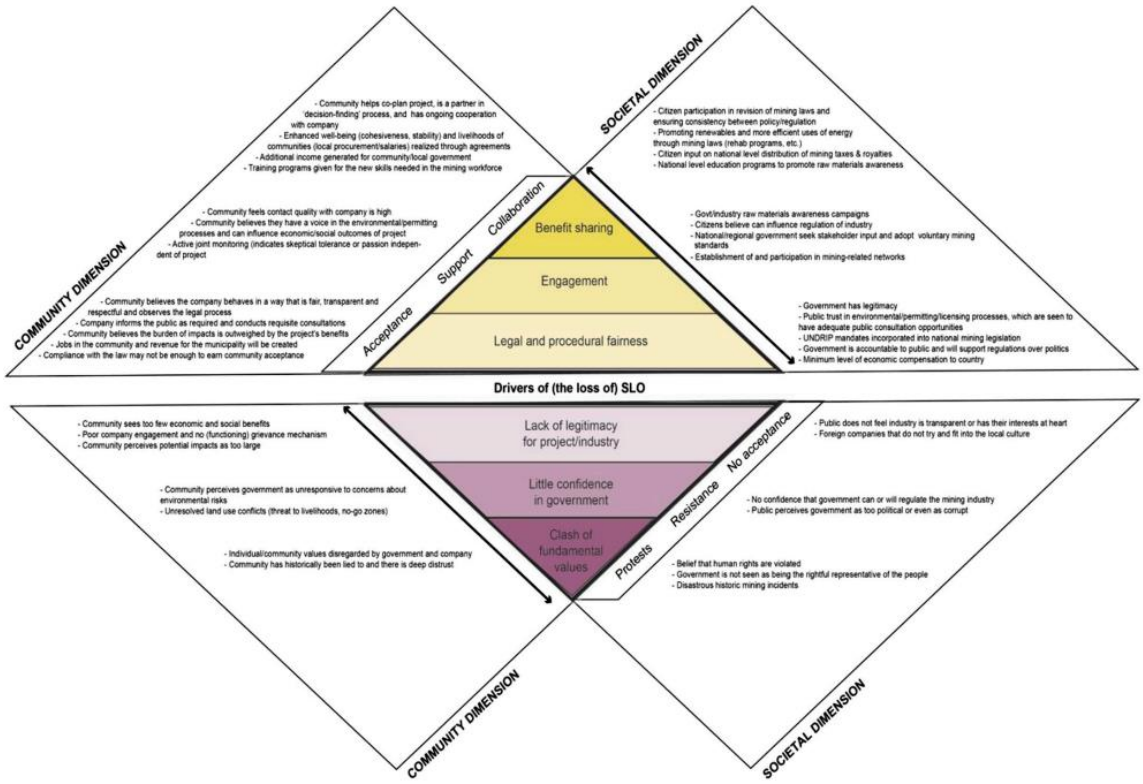

Fig. 3. Manifestation of the drivers in the Scalar SLO Model

Source: Lesser et al (2021)

4. The relevance of taking scalar issue in SLO and European identity into account has been highlighted by other authors[6], that conclude the SLO is not so functional where there are strong governance institutions and frameworks and an educated and generally wealthy society. *For Europe itself, however, entering the debate is crucial because there simultaneously exists a concern about the dependence on RM imports, the desire to restart mining and emerging tensions both at the project level and across society.*

5. These authors conclude that *"at least in the context of mining, SLO as a local concept cannot be scaled up to a societal concept and therefore may not be the best mechanism to leverage industry-wide change.*

[6] Lesser et al "European mining and the Social License to Operate" (2021). Extractive Industries and society. This article This article has been published under the research funded from EU H2020 project MIREU.

If the European Commission desires to restart mining on a grand scale, these results indicate that messages around supply security, the energy transition and climate change are unlikely to sway the public. Instead, the focus should be on the economic benefits of mining for every European. (…) As most societal questions need to be raised at the community level first, such as revenue and benefit distribution, legal and procedural fairness and economic development, it is not surprising that the community frames have more influence on the societal frames. What is clear is that site level factors tend to be important predictors for local communities and more distant society, but broader societal benefits and costs are not important predictors at the local community scale and are only significant at the societal scale in combination with local factors[7]*"*.

The issue of scale in SLO (societal vs local community) is particularly relevant in this case. On one hand, there is a general discourse and positioning in favour of resource recovery, reducing the need for primary extraction, mitigating climate change, and cleaning up contaminated or degraded areas, among others. On the other hand, there is a local perspective characterized by uncertainty and mistrust regarding the possibility of accidents, increased pollution, and other health and environmental concerns.

Another H2020 project (INFACT) analysed *mining and mineral exploration reputation in Europe* and it was found to be *dependent on the following factors*:

1. Mining history and mining identity in the region. Regions and communities linked to mining tend to perceive its reputation higher.
2. Recent bad mining experiences. The memory of past accidents, tragedies, crisis or corruption scandals tend to make people oppose mining, mineral exploration and other economic activities related to this sector. It decreases mining reputation.
3. Trust in private companies and mining fairness. Reputation is directly proportional to this variable (the higher the trust, the higher its perception). It is higher in Southern Europe and lower in Northern Europe.
4. Trust in authorities and public governance. Reputation is also directly proportional to this variable (the higher the trust, the higher its perception). It is higher in Northern Europe and lower in Southern Europe.
5. Economic and social benefits. Reputation is directly proportional to the perceived benefits for the community, notably employment creation and regional development initiatives.
6. Environmental and health concerns. Reputation is inversely proportional to the expected damages to regional environment and public health. However, these fears are less relevant than the other factors when considering the reputation of mining perceived by the local community.

[7] "Exploring scale in Social Licence to Operate. European perspectives (Journal pre-proof)". Lesser P. et al. Journal of Cleaner Production, 2023

3.1.4.1.1. Drivers of social acceptance of mining

INFACT project reflected as well on the *drivers of social acceptance*, considering acceptance as the *lack of social concerns strong enough to negatively condition the success of a certain project*. It ranges from tolerance (people may still have major concerns or even a negative attitude towards the project, but the topic is not salient enough for them to go into opposition) to positive attitudes and positive collaboration.

1. First driver: Convincing narrative.

People need to find their bearings in the world, they need information about the reality that surrounds them and insight into the processes that give meaning to their lives by linking the past, present and future. A technological change in the neighbourhood is always an intrusion into the routines of life. In order to value such an intrusion, there needs to be a narrative that links the innovation to the life world in which the persons are anchored.

2. Second driver: Positive risk(cost)-benefit balance.

With all information, it is important to know whether the planned technological changes are useful to the residents or to others close to them. It must, in other words, serve their interests. People are more inclined to listen if someone claims that a particular piece of information can be to their benefit, than if they were to merely inform them of a particular series of facts. Without knowing people's assessment of costs and benefits, it is difficult for innovators to assess the relative desirability of the different options that are available.

3. Third driver: Self-efficacy.

People embrace technologies when they help them to enhance their choices and options to act. Technologies that seem to limit choices and that restrict freedom of action are rarely accepted. For technologies that affect the neighbourhood but not one's personal life it is essential that people have the feeling to be in control of the process of collective decision making. This is one of the main reasons for having stakeholders and citizens' involvement in siting and decision-making processes.

4. Fourth driver: Emotional identity.

Finally, technological changes can alter the ways that people define their own roles in their social environment and conceive of themselves as holistic, integral beings. These include moral considerations about ethical acceptability as well as personal preferences and tastes. If a technology helps them to develop and unfold their own personality it tends to trigger high rates of acceptance.

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3.1.4.2. About public perception and social acceptance of tailings or mining waste facilities management

EURO MANGANESE (Chvaletice)

It is important to note regarding the perception of these secondary resource exploitation, that while some stakeholders identify this activity as a phase or "moment" within mining activity or cycle as a whole, others clearly distinguish it, seeking to highlight the differences from primary resource mining:

"Chvaletice is not a mining project. It is a unique and innovative waste recycling initiative that avoids the negative impacts of traditional hard rock mining. As the project recycles historic mine tailings, it will clean up the contaminated site and eliminate a longstanding source of water pollution. Over the 25-year life of the Project, remediation and reclamation work will be conducted to bring the entire Chvaletice site into compliance with the Czech Republic's stringent environmental regulations and standards[8]".

- *avoids the negative impacts of traditional hard rock mining*
- *cleans up the contaminated site and eliminate a longstanding source of water pollution*
- *remediation and reclamation work will be conducted to bring the entire site into compliance with the national stringent environmental regulations and standards.*

As part of its stakeholder engagement work, the Project has hosted ten major public presentations for seven local villages, conducted numerous site tours of the Project site for local civic leaders and residents, and presented the project to many small groups and individuals, including regional and civic permitting authorities, mayors, municipal boards and local schools. Based on the outcomes of these intensive community consultations and the initial Ministry of the Environment screening procedure, the Project has been well-accepted by stakeholders, with no critical concerns.

The extensive literature review carried out for this report concludes that most of the publications referring to mining waste management worldwide focus on technical and scientific-technological aspects, while the social dimension, when cited, is only restricted in most cases to drawing attention to the need to inform the local community.
No analysis of social perception on this issue has been found. For this reason, it was decided to "actively listen" to a selection of relevant European mining sites including ore recovery and waste treatment in order to find out directly what has been expressed on social media in relation to this issue (see 3.3).

[8] EUROMANGANESE Chvaletice Project (Czech Republic) webpage (https://www.mn25.ca/chvaletice-manganese-project)

Other of the few case studies that have been found are the following:

PENOUTA MINE (Spain)

One of the most widespread experiences on the recovery of raw materials from abandoned mining waste and where the social dimension of the activity has been taken into account is the case of the Penouta mine in Galicia (northern Spain). This project is relevant for its integration of the local community in the process of its implementation, being well received mainly due to two causes:

- economic activation and job creation in a very depressed rural area
- the environmental regeneration of the degraded area, with the ultimate aim of integrating the restored areas into the adjoining Natura 2000 site.

CHROMIC Project

Social Treatment of waste materials is often perceived negatively by society on the basis of risk perceptions that may not always be substantiated. The CHROMIC consortium is aware that this is all the more the case for metals such as chromium, which are set in the collective memory as highly dangerous, based on real and perceived risks (Cr(VI) is carcinogenic, but in slags Cr is present in its non-toxic forms, e.g., like in cutlery). Therefore, care is taken from the start to list all associated risks within the overarching assessment, overcome them, and communicate this to all parties involved. Specific events are organized to involve local society in a process of co-creation and co-design through focus groups. Initial results of these activities have shown that it is important to tailor the communication to the level of knowledge of the audience, which may be different from what has been assumed. Nevertheless, people have an overall positive attitude towards the processes, and the potential gains for society are recognized.

On a global scale, recovery of metals from secondary resources reduces the overall environmental impact by the avoiding primary extraction. However, at a local scale impacts may increase due to the new treatment process that is implemented, or old landfills that are reopened. This impact shift between local and global communities, or between current and future generations, can create tension and requires a leading role by policy makers.

3.1.5. International protocols on tailings management and stakeholder relations

3.1.5.1. International Council for Metals and Minerals (ICMM) Mining Principles

ICMM's Mining Principles (Dec, 2016) seek to maximise benefits to host communities and minimise negative impacts to effectively manage societal challenges. ICMM principles of particular relevance to preventing catastrophic failure of tailings storage facilities are the following, two of them related to stakeholder consideration:

— Principle 1: Apply ethical business practices and sound systems of corporate governance and transparency to support sustainable development.

— Principle 2: Integrate sustainable development in corporate strategy and decision-making processes.

— Principle 4: Implement effective risk-management strategies and systems based on sound science and which account for stakeholder perceptions of risks.

— Principle 5: Pursue continual improvement in health and safety performance with the ultimate goal of zero harm.

— Principle 6: Pursue continual improvement in environmental performance issues, such as water stewardship, energy use and climate change.

— Principle 7: Contribute to the conservation of biodiversity and integrated approaches to land-use planning.

Principle 10: Proactively engage key stakeholders on sustainable development challenges and opportunities in an open and transparent manner. Effectively report and independently verify progress and performance.

3.1.5.2. Global Industry Standard on Tailings Management (ICMM, United Nations Environmental Program-UNEP and Principals for Responsible Investments-PRI, 2020)

— Principle 1: RESPECT THE RIGHTS OF PROJECT-AFFECTED PEOPLE AND MEANINGFULLY ENGAGE THEM AT ALL PHASES OF THE TAILINGS FACILITY LIFECYCLE, INCLUDING CLOSURE.

Requirement 1.1

Demonstrate respect for human rights in accordance with the United Nations Guiding Principles on Business and Human Rights (UNGP), conduct human rights due diligence to inform management decisions throughout the tailings facility lifecycle and address the human rights risks of tailings facility credible failure scenarios.

For existing facilities, the Operator can initially opt to prioritise salient human rights issues in accordance with the UNGP.

Requirement 1.2

Where a new tailings facility may impact the rights of indigenous or tribal peoples, including their land and resource rights and their right to self-determination, work to obtain and maintain Free Prior and Informed Consent (FPIC) by demonstrating conformance to international guidance and recognised best practice frameworks.

Requirement 1.3

Demonstrate that project-affected people are meaningfully engaged throughout the tailings facility lifecycle in building the knowledge base and in decisions that may have a bearing on public safety and the integrity of the tailings facility. The Operator shall share information to support this process.

Requirement 1.4

Establish an effective operational-level, non-judicial grievance mechanism that addresses complaints and grievances of project-affected people relating to the tailings facility, and provide remedy in accordance with the UNGP.

3.1.5.3. IRMA

The acronym "IRMA" stands for "Initiative for Responsible Mining Assurance." It is a set of standards and guidelines developed by the Initiative for Responsible Mining Assurance that aims to establish a framework for responsible mining practices by addressing various social, environmental, and human rights issues associated with mining operations worldwide.

The IRMA protocol covers areas such as community engagement, labour rights, biodiversity conservation, pollution control, and transparency in the mining sector. Its chapter 4.1 is devoted to waste management.

Chapter 4.1—Waste and Materials Management addresses both the management of waste materials (which in the chapter are separated into “mine wastes” and other wastes) and the management of other substances or materials such as chemicals or fuels that if not managed well could have impacts on the environment or people.

4.1.7. Stakeholder engagement in mine waste management

> 4.1.7.1 “Stakeholders shall be consulted during the screening and assessment of MWF (mining waste facility) siting and management alternatives and prior to the finalization of the facilities”, except for the case of existing mines. In these cases, mines will be expected to have informed stakeholders about the current design and management of MWF.
>
> According to the Mining Association of Canada “there are a number of aspects that are important for an effective alternative assessment. External input is required through the steps described above. Input of COI (communities of interest), including regulators, informs the process and independent reviewers should also be engaged. COI should also be engaged during the screening of alternatives, detailed assessment of alternatives and facility definition/final design of tailings facility (from the explanatory note).
>
> 4.1.7.2 Emergency preparedness plans or emergency action plans related to catastrophic failure of MWF shall be discussed and prepared in consultation with potentially affected communities and workers and/or workers’ representatives and in collaboration with responders and relevant government agencies.
>
> 4.1.7.3 Emergency and evaluation drills (desktop and live) related to catastrophic failures of MWF shall be held on a regular basis.
>
> 4.1.7.4 If requested by stakeholders the operating company shall report to stakeholders on MWF management actions, monitoring and surveillance results, independent reviews and the effectiveness of management strategies.

3.1.5.4. Extractive Waste Directive (EWD)

In Europe, the Extractive Waste Directive (EWD) represents the regulatory framework for the management and treatment of mining waste and includes an explicit reference to access information and Public Participation.

> The **Extractive Waste Directive** (EWD, 2006) aims to ensure the proper management and control of waste generated from extractive activities, minimizing their environmental and human health impacts. It applies to both metallic and non-metallic mining operations, including

activities such as extraction, processing, and storage of waste. Its objective is to harmonize waste management practices across the EU and ensure a high level of environmental protection in extractive industries. By setting standards for waste management, permitting, and reporting, the directive contributes to a responsible management of extractive waste within the EU.

Key provisions of the directive include:

1. Definition of Extractive Waste: The directive provides a definition of extractive waste, which covers waste generated from prospecting, extraction, and processing of mineral resources. It includes both inert waste (e.g., rock, soil) and potentially hazardous waste (e.g., tailings, waste containing dangerous substances).

2. Permitting and Reporting Requirements: EWD establishes permitting and reporting obligations for operators involved in extractive activities. Operators must obtain permits from competent authorities, which specify conditions for waste management, monitoring, and closure of facilities. They are also required to report on waste management activities and submit waste management plans.

3. Waste Prevention and Best Available Techniques: The directive promotes waste prevention and the use of best available techniques (BAT) to minimize waste generation and environmental impacts. Operators are encouraged to adopt measures that prevent or reduce the amount of waste produced, such as optimizing resource use, implementing recycling and reclamation techniques, and implementing site restoration plans.

4. Safety and Stability of Waste Facilities: The directive includes provisions to ensure the safety and stability of waste facilities, particularly tailings dams and waste heaps. Operators must take measures to prevent accidents and limit risks associated with extractive waste storage. They are also required to develop and implement monitoring and emergency response plans.

5. Financial Provisions: The directive establishes financial provisions to ensure that operators can cover the costs associated with extractive waste management and facility closure. Operators must provide financial guarantees, such as bonds or insurance, to cover potential liabilities and ensure the availability of funds for environmental restoration and aftercare.

6. Public Participation and Access to Information: The directive emphasizes the importance of public participation and access to information in extractive waste management. It requires operators to engage with the public, provide relevant information, and enable public participation in decision-making processes.

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3.2. Insights from experts' perspective – conversations

Summary

The interviews collectively explore the concept of reimagining mining **waste and tailings as valuable resources**. They emphasize the need for a shift in perception and a more proactive approach to harnessing the potential of these materials. The discussions touch upon various aspects such as:

1) the consideration of tailings as resource (secondary raw materials),

2) the role of mining codes and regulations,

3) social opposition to mining activities,

4) stakeholder engagement,

5) and the communication gap between technical experts and the general public.

A recurring theme throughout the interviews is the idea that **tailings should not be seen as wastes but rather as untapped resources awaiting the right conditions for reutilization**. The interviewees challenge the notion of circularity and secondary raw materials, highlighting that tailings retain value and can contribute to the development of new industries. Examples of projects extracting battery-grade manganese and rare earths from historical tailings illustrate the potential economic and strategic significance of these endeavours.

The interviews also shed light on the complexities surrounding **mining regulations**. It becomes evident that mining legislation varies across European countries, resulting in different approaches to managing tailings and mining waste. This diversity in regulations further emphasizes the importance of understanding local contexts and engaging with relevant stakeholders when planning resource recovery projects.

The interviews also underscore the need for **early and transparent communication with local communities**, environmental authorities, and other stakeholders to address concerns, build trust, and ensure the responsible management of mining waste.

Social opposition to mining activities emerges as another significant aspect discussed in the interviews. While increased **environmental awareness** plays a role in shaping public sentiment, **conflicting economic interests** and **limited knowledge** about the potential benefits of resource recovery can fuel opposition. The interviews underscore the importance of **education and effective communication** to bridge the gap between technical experts and the general public. By providing accessible and accurate information, it becomes possible to dispel misconceptions, promote more responsible mining practices and garner support for the activity of recovery of Secondary Raw Materials.

In summary, the interviews present a collective call to rethink the perception and management of mining waste and tailings. They advocate for recognizing the intrinsic value of these materials, engaging stakeholders at various levels, and fostering open dialogue throughout the project lifecycle. By reframing waste as a resource, considering local regulations and concerns, and promoting transparency, the mining industry can navigate the complexities of resource recovery more effectively. The interviews provide valuable insights into the challenges and opportunities associated with sustainable mining practices, encouraging a step forward towards a more inclusive and environmentally conscious approach to managing mining waste.

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Key concepts are further elaborated upon.

1) The consideration of tailings as resource (secondary raw materials)

This idea challenges the traditional notion of waste and reframes tailings as a valuable resource waiting to be utilized. Here are some key points and reflections on this concept:

- **Shifting Perspectives:** Reclassifying tailings as secondary raw materials involves a shift in perspective. Instead of viewing tailings as mere waste products of mining operations, they are recognized as potential resources that can contribute to the circular economy. This reframing acknowledges that tailings contain valuable minerals and elements that can be extracted and utilized.
- **Economic and Technical Considerations:** This is based on economic and technical considerations. It recognizes that the viability of reprocessing tailings depends on various factors such as market conditions, technological advancements, and the economic feasibility of extraction and processing. The concept emphasizes that tailings should be seen as a waiting resource, with the potential to become economically viable when the right conditions are met. The reclassification of tailings as primary raw materials also depends on technical feasibility. The presence of valuable minerals, the development of efficient extraction and processing technologies, and the economic viability of these methods are crucial considerations. Technological advancements and innovation play a significant role in unlocking the potential of tailings as valuable resources.
- **Environmental Implications:** Reclassifying tailings as primary raw materials can have positive environmental implications. It promotes the reutilization of existing materials, reducing the need for new mineral extraction and minimizing the environmental impact associated with traditional mining activities. By treating tailings as valuable resources, there is an incentive to invest in their reprocessing and implement more sustainable practices for their management.
- **Social Acceptance and Perception:** The concept of reclassifying tailings requires addressing social acceptance and perception. As tailings are often associated with negative environmental and social impacts, there may be public scepticism and opposition to their reprocessing. Effective communication, stakeholder engagement, and transparency are essential in building awareness, educating the public about the benefits and potential risks, and fostering trust in the responsible management and utilization of tailings.

2) The role of mining codes and regulations

Some key points and reflections on the role of mining codes and regulations are as follows:

- **Mining legal framework:** Mining codes and regulations form the legal framework that governs mining activities within a specific jurisdiction. They outline the rights, responsibilities, and obligations of mining companies, as well as the procedures and requirements for obtaining permits and licenses. The purpose of mining codes is to ensure responsible and sustainable mining practices while protecting the environment and safeguarding the interests of local communities.
- **National variations:** The regulation of mining activities is primarily the responsibility of individual member states rather than the European Union as a whole. This means that each country has the freedom to establish and enforce its mining codes and regulations based on their national priorities and considerations. As a result, there can be significant disparities in mining

regulations across Europe. Mining codes and regulations can vary significantly between countries and regions. Each jurisdiction may have its own set of laws and regulations tailored to their specific geological, environmental, and socio-economic conditions. These variations can include differences in mineral rights ownership, environmental impact assessment requirements, financial obligations, and community engagement protocols.

- Harmonization and Best Practices: There is a growing recognition of the need for harmonization and best practices in mining codes and regulations across countries and regions. Sharing experiences, knowledge, and lessons learned can contribute to the development of more consistent, efficient, and sustainable mining regulations. International organizations, industry associations, and initiatives play a vital role in promoting dialogue and collaboration in this regard.
- Tailings Classification: Mining codes and regulations play a crucial role in determining the classification and treatment of tailings. They define whether tailings are considered waste or potential resources. Some mining codes may classify tailings as waste materials, while others may recognize their value and potential for reprocessing. The classification affects the legal obligations, environmental requirements, and feasibility of reusing or reprocessing tailings.
- Environmental Protection: Mining codes and regulations aim to ensure environmental protection and minimize the negative impacts of mining activities. They often include provisions for environmental impact assessments, mitigation measures, reclamation and rehabilitation of mining sites, and monitoring of environmental performance. These regulations help safeguard ecosystems, water resources, air quality, and biodiversity affected by mining operations.
- Adaptability and Flexibility: Mining codes and regulations should be adaptable and flexible to accommodate evolving technologies, environmental standards, and societal expectations. Regular reviews and updates are necessary to ensure that the regulatory framework keeps pace with scientific advancements, emerging challenges, and changing societal values related to mining.
- Balancing Interests: Mining codes and regulations face the challenge of balancing various interests, including environmental protection, social welfare, economic development, and resource extraction. Striking a balance between these interests requires careful consideration, stakeholder engagement, and evidence-based decision-making to promote sustainable mining practices.

3) Social opposition and stakeholder engagement

The interviews shed light on some of the underlying reasons behind this opposition and offer reflections on how to address them.

- Environmental Concerns: Increased environmental awareness and concerns play a significant role in shaping social opposition to mining activities. Communities often fear the potential environmental impacts associated with mining, such as habitat destruction, water pollution, and air pollution. These concerns are fuelled by a history of mining practices that have had detrimental effects on ecosystems and local communities.
- Health and Safety Risks: Communities may also express opposition due to perceived health and safety risks associated with mining operations. The extraction and processing of minerals can involve hazardous substances and processes that may pose risks to human health and well-being. Lack of trust in mining companies to prioritize safety measures and protect local communities further exacerbates these concerns.

- Conflicting Land Use and Economic Interests: Social opposition may arise when mining activities conflict with other land uses or economic interests in the area. For example, agricultural or tourism-based communities may resist mining projects that they perceive as a threat to their livelihoods or the integrity of the local environment. Conflicts over land rights, access to resources, and the distribution of economic benefits can further fuel opposition.
- Lack of Trust and Transparency: A lack of trust between mining companies, regulatory bodies, and local communities is a significant contributor to social opposition. Communities may feel that their concerns and voices are not adequately heard or considered in decision-making processes. Lack of transparency in communication, failure to disclose potential risks, and a history of negative experiences with mining operations can erode trust and increase opposition. On the contrary, trust is generated by trustworthy people who have demonstrated to the communities that they carry out their work with responsibility and transparency, and this trust is transferred to the project and even to the company.
- Communication and Information Gap: The interviews highlight the need for effective communication and bridging the information gap between technical experts and the general public, and specifically the local communities. Mining projects often involve complex scientific and technical concepts that may not be readily understood by lay people (sometimes only by older people that was related to former mining activities when the mine was active). It is crucial to provide accessible and accurate information about the potential benefits, risks, and mitigation measures associated with the activities. Building awareness, fostering dialogue, and actively engaging with communities can help address misconceptions and build trust, although this does not eliminate the possibility of opposition or rejection of the project or the NIMBY effect.
- Stakeholder engagement considerations:
  a) Tailored communication approaches: Stakeholder engagement strategies should consider the diverse needs and preferences of different stakeholder groups. Tailoring communication approaches, such as using local languages, employing various channels, and adapting to cultural norms, can foster effective dialogue and diverse participation, even with marginalised groups.
  b) Addressing stakeholder concerns in a two-way communication process: Recognizing and addressing stakeholder concerns and fears, such as environmental or landscape impacts, health risks, and economic implications, is essential for building consensus. This may involve proactive measures, such as impact assessments, mitigation plans, and long-term site restoration in which stakeholders should be involved and consulted.
  c) Awareness and education: Promoting awareness and understanding of the mining and recycling activities, their benefits, and potential risks can contribute to more informed stakeholder engagement. Educational initiatives, public consultations, and capacity-building programs can empower stakeholders to actively participate and contribute to project discussions, including monitoring tasks in which local communities may be involved.
  d) Continuous engagement and adaptability: Stakeholder engagement is an ongoing process that requires continuous efforts and adaptability. Regular communication, feedback loops, and monitoring mechanisms can ensure that stakeholder concerns are addressed throughout the project lifecycle, fostering collaborative and sustainable outcomes.
  e) Finally, one of the interviewee insists that not only the *Free Prior and Informed Consent* (FPIC, a good practice that is generally related to mining in indigenous peoples' areas) must be implemented but that the *"Right to say no"* principle should be also considered. The

issue that arises with this approach is the difficulty of achieving legitimate and honest representation, i.e., real and effective governance has to be promoted in this decisional context.

4) Communication gap between technical experts and the general public

Some key points and reflections on the communication gap between technical experts and the general public are as follows:

- **Technical complexity and information overload:** One of the main challenges in bridging the communication gap is the inherent technical complexity of mining and mineral recovering related processes. Technical experts often use specialized terminology and concepts that can be difficult for the general public to understand. Simplifying and translating technical information into more accessible language is essential to improve communication. It is crucial to present information in a concise and understandable manner, focusing on the most relevant aspects and addressing the specific concerns and interests of the audience.
- **Contextualizing impacts:** Technical experts should make a conscious effort to explain the real-world implications of the activities in a way that resonates with the general public and specially with local communities. Providing concrete examples, visual supports, and relatable scenarios can help individuals grasp the potential environmental, social, and economic expected impacts.
- **Engaging stakeholder intermediaries:** Recognizing the role of intermediaries, such as community leaders, local organizations, and NGOs, can facilitate communication between technical experts and the general public. These intermediaries often have a better understanding of the local context, cultural nuances, and community dynamics, making them valuable bridges for effective communication.
- **Multi-channel Communication:** Utilizing a variety of communication channels and platforms can reach a wider audience and cater to different communication preferences. This may include traditional media, social media, websites, community newsletters, and direct engagement with local communities. Adapting the communication approach to the specific needs and preferences of different target groups is essential.
- **Continuous Improvement:** Effective communication is an iterative process that requires continuous improvement and evaluation. Seeking feedback, monitoring public sentiment, and adapting communication strategies based on lessons learned and changing societal dynamics can help bridge the communication gap over time.

These reflections emphasize the need for technical experts to communicate in a way that is accessible, engaging, and responsive to the concerns and interests of the general public. By addressing the communication gap, it becomes possible to foster informed discussions, build trust, and facilitate more meaningful engagement in mining-related decision-making processes.

3.3. Social media analysis in selected study cases

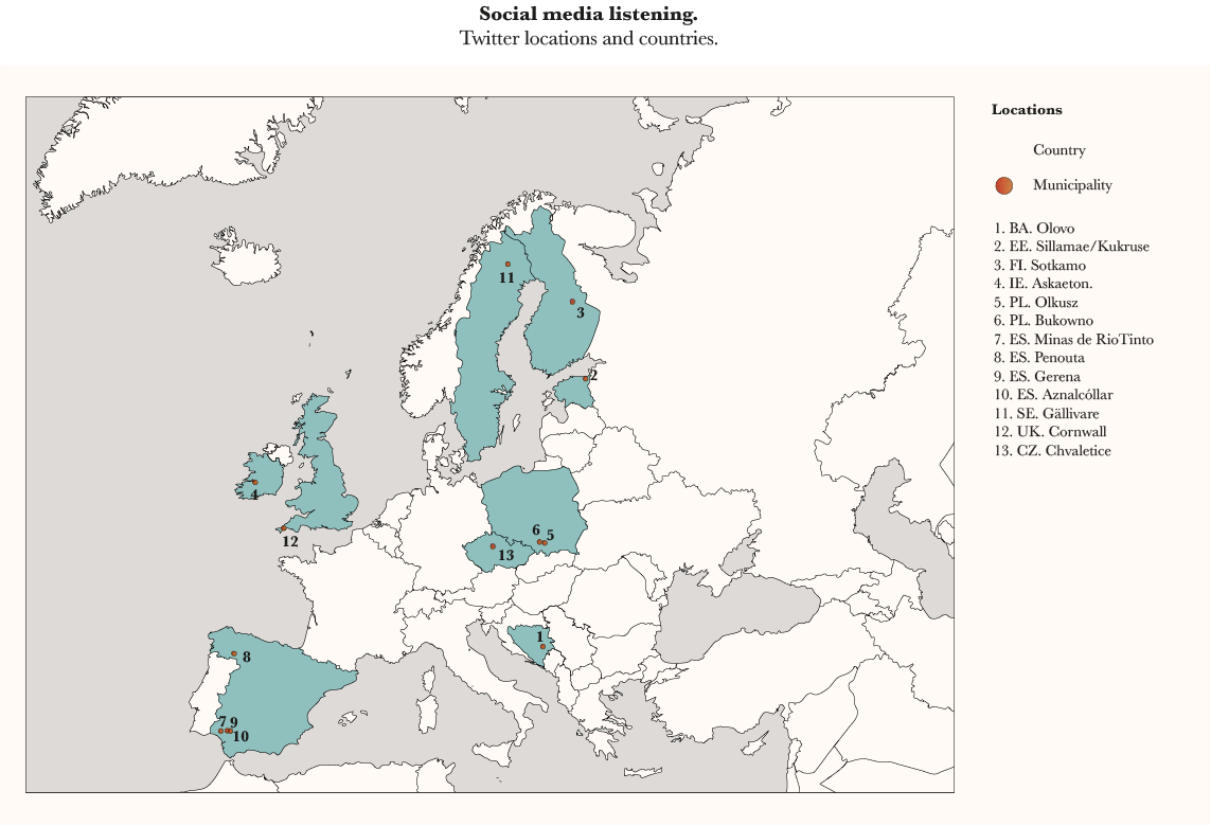
In order to further investigate the public's perception of the processes of *mineral recovery from mining waste and tailings management*, an identification of the relevant sites for this type of activity at

European level was carried out. Once the most relevant case studies had been identified through literature review and expert consultations (interviews), an "active listening" device was built on social media (Twitter) based on a set of key words (see 2.1.2) in order to identify the public discourse related to these specific activities and analyse the differences among regions and countries.

The following is a brief description of the different case studies and the results of this subtask.

3.3.1. Study cases

Figure 5. Social media listening. Study case locations by country



Source: Own elaboration

As reflected on the map above, 13 locations have been selected to listen to social media using Twitter channel. These locations are described as follows:

1. Olovo. Zenica-Doboj Canton. Bosnia and Herzegovina

Olovo Mine is a lead-zinc-silver mine located in the town of Olovo, Bosnia and Herzegovina. The region is rich in polymetallic ores and has a long history of mining activities dating back to the Middle Ages. Olovo Mine has been a significant economic asset for Bosnia and Herzegovina, contributing to the country's exports. Main minerals are lead, zinc and silver. Tailing reprocess is being carried out by Carmeuse/Mineco. The company has considered **reprocessing historic tailings** from the site, which could potentially recover residual lead, zinc, and silver, contributing to the circular economy in the mining sector. IMP@CT Horizon 2020 project is related to this location.

Figure 6. Olovo Mine. Bosnia and Herzegovina

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

2. Sillamae/Kukruse. Ida-Viru County. Estonia

This location is one of the case studies of selected practices considered in the report *"Assessment of Member States' performance regarding the implementation of the Extractive Waste Directive, appraisal of implementation gaps and their root causes, identification of proposals to improve the implementation of the Directive, EC-2017).*

Figure 7. Sillamäe Metal Tailings Management Facility (TMF). Estonia

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

Sillamäe Metal Tailings Management Facility (TMF) is located in Sillamäe, a town in the Ida-Viru County in northeastern Estonia, situated on the coast of the Gulf of Finland. The facility is associated with the former Sillamäe Rare Earth Metals Plant (also known as Silmet), which processed uranium, rare earth metals, and other minerals during the Soviet era. The Sillamäe Metal TMF was used to store the radioactive and hazardous waste produced during these processing activities.

3. Sotkamo. Sotkamo region. Finland.

Talvivaara Mine, also known as the Terrafame Mine, is located in Sotkamo, in the Kainuu region of Finland. The mine is a major source of nickel, zinc, cobalt, and copper. The mining operations at Talvivaara have had a history of environmental challenges, which led to the restructuring of the mine's ownership and management. Currently, the mine is operated by Terrafame Ltd.

The Talvivaara Mine has an extensive tailings management system in place to handle the waste produced during mining operations, including the treatment of residual waters. The tailings management facilities (TMFs) or tailings storage facilities (TSFs) at the site are responsible for managing these waste materials. Efforts have been made to improve the environmental performance of the mine under Terrafame's management. The company has worked to enhance waste management practices and minimize the environmental impact of mining operations in compliance with Finnish environmental regulations.

Reprocessing from low-grade sulfidic mining waste is carried out at the facility, applying new methods for the recovery of valuable metals, minerals, and construction materials from low-grade sulfidic mining waste. NEMO H2020 European project is related to this location.

Figure 8. Talvivaara Mine. Finland

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

4. Askaeton and Aughinish Island. County Limerick. Ireland.

In Askeaton and Aughinish Island, County Limerick (Ireland), there's a significant Bauxite Residue Disposal Area (BRDA). The residue, often referred to as red mud, poses both environmental and storage challenges due to its alkalinity and the sheer quantity produced by the alumina industry. The BRAVO

initiative (coordinated by University of Limerick) aims, among other goals, to boost the innovation capacity of the aluminium value chain with respect to secondary raw materials recovery, fostering international co-operation among may key players across the aluminium value chain from extraction to recycling. BRAVO project aims also to test the viability of solutions and holistic processing concepts for secondary raw materials processing via pilot actions and to promote socially acceptable, environmentally responsible and economically viable technologies.

This location is also one of the case studies of selected practices considered in the before mentioned report by 2017-EC.

Figure 9. Bauxite Residue Disposal Area (BRDA). Ireland

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

5. Olkusz. Lesser Poland Voivodeship. Poland.

The Olkusz mine, located in the Lesser Poland Voivodeship near the city of Olkusz, is a significant zinc and lead mining operation in Poland. It is also referred to as the Olkusz-Pomorzany mine.

Grupa Azoty operates the mine since 2017 and on their installation they conduct **reprocessing of flotation tailings,** recovering zinc and lead in the form of zinc sulphide concentrates from wastes accumulated at zinc mines.

It is classified as good practices case and Green Circular Economy by Interreg Europe program.

6. BUKOWNO. Łódź Voivodeship, central Poland.

Zakłady Górniczo-Hutnicze Bolesław Plant (ZGH Bolesław) is a flotation tailings processing plant. The installation will have (2017) a processing capacity of 2 million tonnes of waste per year and is located next to an extractive waste facility. The aim is to produce zinc concentrates from flotation waste. The plant was expected to start operating at the end of 2016 and it will be the first large scale installation of the secondary processing of tailings in Europe. Min Novation European Project was related to this plant.

Figure 10. Olkusz mine. Poland

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

Figure 11. ZGH Bolesław. Poland

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

7. Minas de Riotinto. Huelva (Andalusia, Spain)

Minas de Riotinto is the location of the Cerro Colorado open pit mine. Ore from Cerro Colorado is processed at Riotinto's 15 Mtpa concentrator using conventional froth flotation to produce copper concentrates that also contain silver by-product credits. Atalaya Mining company operates the mining project Riotinto, where they are investigating the potential recovery of precious metals from historic

tailings at the site, including gold and silver. If feasible, this could offer an additional revenue stream while reducing the environmental impact of the existing tailings storage facility.

Figure 12. Minas de Riotinto (Spain)

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

8. Penouta. Ourense (Galicia, Spain)

The Penouta Mine, located in the Galicia region of Northwestern Spain, is a significant mining site known for its deposits of tin, niobium and tantalum. After the mine closed in 1985, in 2011, 2012 and 2013 surveys were conducted in the area, founding that during the earlier operations of the mine, large amounts of tin and tantalum minerals were deposited in the floatation tailings. These minerals are now valuable, in particular tantalum which is needed in many electronics devices such as mobile phones. Strategic Minerals Spain was provided with the right to exploit the resource and which is expected to be an important source to meet Europe's tantalum needs. The processing will be done through grinding of the ore, concentration of minerals and magnetic separation.

This location is also one of the case studies of selected practices considered in the before mentioned report by 2017-EC and has participated also in TARANTULA EU project.

Figure 13. Penouta Mine. Spain

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

9. Gerena. Sevilla, Andalucía. Spain.

Gerena is a municipality where Cobre Las Cruces mining and hydrometallurgical complex is located. It's known as one of the largest and richest copper reserves in the world, and it also contains significant amounts of other minerals, such as gold and silver.

Cobre Las Cruces (CLC), S.A, a subsidiary of First Quantum Minerals, a Canadian-based mining and metals company, runs the complex. The company uses an open-pit mining method and hydrometallurgical process to extract and process the copper ore. Their permanent water treatment plant (PWTP) is in a current expansion process. During 2023 they expect to successfully exploit the current secondary copper sulfide resources, but work is underway to continue mining additional polymetallic primary sulfide mineral resources containing copper, zinc, lead and silver. This new underground mine and polymetallic refinery project is called PMR *(*Poly Metallurgical Refinery). This refinery will produce four metals (copper, zinc, lead and silver) through the application of an innovative technology created and patented by Cobre Las Cruces.

Figure 14. Cobre Las Cruces (CLC) mining and hydrometallurgical complex. Spain

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

10. Aznalcóllar. Sevilla, Andalucía. Spain.

Aznalcóllar - Los Frailes mine has a significant history of zinc, lead, and silver production, although it´s also known for a major environmental incident occurred in 1998, where tailings dam at the mine failed, leading to a significant spill of toxic sludge into the surrounding environment. The incident led to a large-scale clean-up and remediation effort.

In the context of Reecovery UE project (EIT Raw Materials funding program), Minera los Frailes plans to efficiently manage the contact water from the complex's old mining liabilities, together with the large volumes (10 million m^3) of acidic water containing metals, stored in an old open pit during years of inactivity over the last decades.

Figure 15. Aznalcóllar - Los Frailes mine. Spain

Funded by the European Union

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

11. Gällivare. Norrbotten County, Lapland. Sweden

The Boliden Aitik mine in Gällivare, Sweden, serves as one of the test sites for the ITERAMS project. They are working on the development of closed-loop water systems for mineral processing plants, recycling the water and revalorizing the tailings.

The Aitik mine is one of Europe's largest open pit copper mines. In addition to mining, Aitik has an onsite concentrator, a facility that processes the mined ore to increase the concentration of valuable minerals. The concentrator is one of the largest of its kind in the world.

Figure 16. Boliden Aitik mine. Sweden

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

12. Cornwall. England, UK.

Kit Hill and Wheal Maid are disused mines in Cornwall, United Kingdom, known for its historic mining activities for copper, tin, and other metals. It's part of the Cornwall and West Devon Mining Landscape, a World Heritage Site.

One of the main issues with Wheal Maid and similar disused mines in the area is the environmental impact of the tailings dams. There are ongoing discussions and research into the potential for reprocessing historic tailings to extract residual metals. This is seen as a potential way to both mitigate the environmental impact of the tailings and potentially generate new economic activity.

Cornwall Resources Ltd, a 50:50 joint venture with Strategic Minerals Plc, has a project named Redmoor Tin-Tungsten project in Cornwall, which is considered one of the largest undeveloped tin-tungsten projects in the world. The company focused on the exploration and development of mineral projects in the south-west of England, with a particular emphasis on tin and tungsten.

13. Chvaletice. Pardubice Region. Czech Republic.

Chvaletice Manganese is a significant manganese deposit located in the town of Chvaletice, Czechia.

The Chvaletice tailings site contains significant amounts of manganese that were deposited there during the operation of a chemical factory from the late 1940s until 1975. These tailings were left untreated and have been a significant source of pollution. Euro Manganese Inc. (EMN), a Canada-based mineral resource company, is actively working on the Chvaletice Manganese Project, which aims to recycle waste from a decommissioned mine site to produce high-purity manganese products.

Figure 17. Chvaletice Manganese. Czech Republic

Source: Google. (2023). Google Maps. Retrieved 2023.05.30.

3.3.2. Results in study cases

Twitter posts generated in those locations were searched containing the following keywords: *tailing management facility, tailing storage facility, tailing recycling, tailing reprocessing, mine waste facilities, mine waste recovery, mine waste reprocessing, mine waste valorization, mine waste processing, mine waste recycling, tailing, red mud tailings, dam, pond and tailing pond*.

The results have been that none of these keywords have been used on Twitter posts in the study areas along the monitored dates: from June 2021 until end of May 2023.

There could be several reasons for not finding Twitter posts referring to circular economy processes at these specific locations:

1. Lack of Awareness: The general public may not be aware of this kind of activities, facilities or projects occurring in their vicinity, hence they do not post about it.

2. Limited Engagement: Even if some individuals are aware, they might not be relevant enough to share or discuss such topics on social media platforms like Twitter.

3. Technical Terminology: The language used in these kinds of projects can be quite technical. The average Twitter user might be discussing the issues without using the exact terminology.

4. Geotagging: Not all Twitter users geotag their posts. Therefore, even if there are discussions happening, if the tweets are not tagged with the specific location, it would be challenging to associate the conversations with the location.

5. Models of communication: the lack of Twitter posts could also be attributed to the preference for different modes of communication in the geographical areas under study. Particularly in rural communities, traditional face-to-face discourse, local community gatherings or conventional media often play a significant role in expressing opinions and discussing community matters. Therefore, it's possible that the local population in these areas may not rely on Twitter as a way to express their views on these processes. Instead, they might prefer other social media platforms like Facebook or Instagram, local community forums, or traditional media such as local radio or print newspapers. A comprehensive understanding of public sentiment in these areas might therefore require a multi-channel approach that includes both online and offline methods.

3.3.3. Results by countries

Due to poor results in extracting information from Twitter related to the keywords in each of the 13 locations, the focus has been expanded to a country-wide scale, exploring Twitter posts from the 9 countries where the research has been conducted. *The same keywords have been used, along with the general set of keywords composed of "mine" and "mining."* The results are as follows:

Figure 18. Twitter posts analyzed by countries. Mine-related conversations.

id	COUNTRY	COUNT
1	Bosnia and Herzegovina	2.471
2	Estonia	1.128
3	Finland	182
4	Ireland	29
5	Poland	16.105
6	Spain	8.277
7	Sweden	2.563
8	UK	114
9	Czech	2.333
	TOTAL	33.202

The analysis of the Twitter posts that contain mining-related keywords in the mentioned countries leads to the following conclusions, being the focus on the environmental, social and economic impacts of mining activities.

1. Operations: *Mining operations* are a recurring theme, with posts discussing a company's efforts to reduce freshwater consumption (Rio Tinto mine) or plans for quartz extraction over 1.300 hectares of fertile land in Segovia (SP).

2. Impacts: Numerous tweets highlight the environmental and social impacts of mining. Acid drainage from the Penouta mine contaminating a downstream river and potential radioactive and hydrological damages near Cáceres are among the issues raised.

3. Resistance and Public Opinion: There is significant resistance to mining projects, as seen in tweets opposing open-pit mining in Segovia and a mining project in San Quirce.

4. Uranium Mining: Tweets discuss the closure of the Ranger uranium mine and the need for natural areas rehabilitation. A potential change in government leading to a surge in Berkeley's stock market value, a uranium mine owner, is also mentioned.

5. Historical Mining: Some tweets refer to a Roman mine in Cueva del Hierro, now used for ethnographic visit projects.

6. Work Safety: The annual work safety conference by Svemin, the Swedish Mining Association, is mentioned, where over 300 participants discussed strengthening work safety in the mining industry.

7. Environment: The environmental impact of mining is a recurring topic, with tweets mentioning the need for long-operating mines to demonstrate they are not harming the surrounding environment.

8. Legal Issues: A copper mining incident in Zambia leading to a substantial Supreme Court ruling is discussed in some tweets.

9. Sustainability: Tweets discuss the concept of sustainably and the need towards more sustainable and environmentally friendly mining practices.

10. Child Labor: The issue of child labor in mining, particularly in relation to the extraction of minerals for electric vehicles, is raised in several tweets.

11. Local Opposition: Local opposition to fracking and mining in Leitrim is mentioned, with tweets noting unity between Leitrim locals and Lakota 'water protectors' against these practices.

12. Government Policies: Government policies on mining are discussed, with tweets mentioning the government's transition from mines to wind turbines, solar panels and gas.

13. Historical Events: A historical event where the police opened fire on striking miners in Jaworzno on May 19, 1931, resulting in the death of 5 people, is mentioned in some tweets.

14. Toxic Chemicals: Some tweets discuss the proposed ban on toxic chemicals used in mining.

3.4. Podcast content

By examining the frequently mentioned concepts in the analyzed content from mining-related podcasts, these words are: copper (2.230), companies (719), materials (382), period (364), waste (356) or people (340). Other noteworthy topics like economy, energy, recycling, impact, and environment have been explored. With this procedure we gain valuable insights into the key ideas and concepts surrounding the mining industry on the podcasts. Additionally, it contributes to explore social aspects, including historical and cultural factors, geopolitical issues, economic impacts, environmental sustainability, workforce skills, social standards, transparency and community engagement.

The analysis of transcribed mining-related podcasts reveals several main ideas and concepts that shape discussions within the industry. It highlights the need for sustainable practices, resource scarcity and circular economy approaches, geopolitical considerations, social and environmental impacts, economic factors, historical and cultural influences, technological advancements, regulatory concerns, and industry practices.

Main concepts are presented as follows:

Copper. Copper is mentioned in the context of China's demand for it. Due to China's demand for copper, there is significant Chinese capital investment in the mines. Specifically, it mentions that mines currently

open have 33% Chinese capital and 30% British capital. The document also discusses the historical and social aspects of mining in the region, including the impact of British and Chinese investments.

Waste. The concept of waste is broadly discussed, particularly in relation to the mining industry and the need for more sustainable practices. It is commented the need for a circular approach to mining, where waste is minimized and materials are recycled and reused as much as possible. Mining companies have a key role to play in implementing circular economy principles, which include minimizing waste production and increasing efficiency. The content also suggests that the expertise of mining companies in waste management can be valuable for other players in the value chain that want to become more circular. It is also emphasized that transitioning to a circular economy is necessary to create a safe and just environment for all, and that doubling the circularity of the global economy could help achieve the goals of the Paris Agreement. It is suggested that such a transition requires a clear definition of the final goal, consensus on the metrics and opportunities, and a commitment to share best practices.

Recycling. The concept of recycling is discussed in the context of the mining industry and the transition to a more sustainable and circular economy. The term "recycling" is not explicitly mentioned sometimes, but the need for a circular approach to mining, where waste is minimized and materials are recycled and reused as much as possible.

Resource scarcity and sustainability: One of the primary concerns highlighted in the podcasts is the issue of resource scarcity and the need for sustainable practices in the mining industry. It is widely recognized that the linear model of raw material extraction is not sustainable in the long term. Thus, there is a growing emphasis on transitioning to a circular economy approach, which involves minimizing waste and maximizing the recycling and reuse of materials. The circular economy is seen as crucial for addressing resource scarcity and promoting sustainable mining practices.

Geopolitical aspects. The geopolitical aspects of mining and the use of critical raw materials are discussed, mentioning the geopolitical divide between the East and the West and the importance of international cooperation and regulation in the mining sector. It is recognized that conflicts and tensions arising from geopolitical issues can impact mining operations, supply chains, and global resource distribution.

Social. The social aspects discussed in the podcasts are quite diverse and cover a range of topics:

- Social and environmental impacts: The podcasts reveal the awareness and concerns surrounding the social and environmental impacts of mining activities. Social aspects discussed include historical and cultural factors, social inequality, displacement, violence, and community dynamics. The historical and cultural context of mining regions, such as rebellion and independence movements, can influence social dynamics and acceptance of mining activities within local communities. The environmental impacts discussed encompass environmental degradation and the need for sustainable mining practices. The importance of addressing these impacts through improved regulation, corporate social responsibility, and the adoption of sustainable practices is emphasized.
- Workforce and skills aspects: The importance of having an adequately skilled workforce in the mining sector. Skills in waste management and recycling can be valuable for companies in the sector.
- Social standards and transparency: The importance of promoting high social standards and improving supply chain transparency in the mining sector. These measures can help prevent and address potential shortages and disruptions.

- Community and social engagement: The role of stakeholders in setting up a dedicated EU framework for preventing and addressing potential shortages. Community engagement and consensus-building can be important for implementing contingency planning and emergency measures.
- Historical and Cultural Factors: The podcasts delve into the historical and cultural aspects related to mining. Historical rebellion and independence movements, particularly in Spain are discussed, shedding light on their significance and potential influence on social dynamics and political relations. The role of mining in shaping regional histories and its subsequent impact on present-day perspectives and acceptance are explored.

Economic Considerations: Economic aspects related to mining are highlighted in the podcasts. The European Commission's goal of enhancing the mining capacity of the European Union (EU) is discussed, covering various stages of the mining process, including extraction, processing, refining, and recycling. Economic impacts and the role of capitalism and oligarchy in managing the mining industry are also explored. The distribution of benefits from mining activities and its potential contribution to social inequality are recognized as important considerations. It is mentioned the goal of the European Commission to increase the EU's capacity for mining, extraction, processing, refining and recycling. It also discussed the need for investment in the sector and the potential role of a European Sovereignty Fund.

Technological Advancements: Technological aspects related to mining are also touched upon in the podcasts. The use of rare earth elements in motors and the importance of technical skills within the mining sector are discussed. Technological advancements, including innovative extraction methods and sustainable mining practices, are recognized as essential for the industry's competitiveness and long-term sustainability.

Regulatory Concerns: Regulatory issues are raised in the podcasts, focusing on the need for effective regulations and frameworks within the mining sector. Specific regulations, such as the EU's RM Act and the US's Inflation Reduction Act are mentioned. The importance of regulations in shaping mining practices, operations, and their social and environmental impacts is highlighted.

Industry Practices: The podcasts shed light on industry practices within the mining sector. Discussions encompass the use of natural resources, such as copper, and the role of mining companies in implementing circular economy principles. Emphasis is placed on waste reduction, recycling, and the expertise of mining companies in waste management. The importance of sustainable practices throughout the whole value chain is recognized.

3.5. News clipping

After analyzing news clippings from countries of study focusing on mining topics, the main ideas and concepts identified are:

1. Mining accidents and safety: The content mentions several instances of mining accidents, such as a methane fire in a Slovak mine that resulted in injuries. This highlights the importance of safety measures and precautions in mining operations to prevent such incidents.

2. Environmental impact: The content identifies Turów mine, which is said to pose a threat to the environment. This underlines the environmental concerns associated with mining activities, including potential harm to ecosystems and groundwater contamination.

3. Economic significance: Mining can contribute significantly to the economy by providing jobs, contributing to GDP and generating export revenue.

4. Mining waste management and recovery: The content mentions equipment for mining waste, indicating the importance of waste management in mining operations. Proper waste management can minimize the environmental impact of mining and improve the efficiency of operations. It is also discussed the concept of mining waste recovery, which involves finding new uses for mining waste or reprocessing it to extract valuable materials. This includes the recycling of e-waste, the extraction of tin from mining waste, and the use of microbes for waste processing.

5. Mining and community: The content mentions the former Darkov mine, which may reopen. This suggests the role of mining in local communities, which can be both positive (through job creation and economic stimulation) and negative (due to potential environmental and health impacts).

6. Community engagement: The news emphasizes the importance of community engagement in mining operations. Mining companies are working closely with local communities to address their concerns and ensure their participation in decision-making processes. This approach is helping to build trust and foster long-term relationships between mining companies and local communities.

7. Tailings reprocessing: Tailings reprocessing refers to the process of treating tailings – the waste material left over after the extraction of valuable minerals – to recover more minerals or to reduce environmental impact. The document mentions several instances of tailings reprocessing, such as the efforts of EnviroGold Global and Barrick Gold.

8. Mining operations: The news contain several references to specific mining operations and incidents. These include mine collapses and landslides at mining sites. The contents also mention specific mining companies, such as BHP and South32, and discusses issues related to mining investment and regulation and the discovery of new mineral deposits.

Funded by the European Union

4. Conclusions

4.1. General conclusions

- "There is no waste, only potential future resources"

Although it clearly falls within the framework of the circularity ethic, the recovery of valuable raw materials from mining waste is a good example demonstrating that materials destined for further use with other technologies after primary extraction cannot be labelled as waste. "There is no waste, only potential future resources", as one of the experts interviewed stated.

- "An emerging activity in Europe"

While it is not a new activity in general, and there are flagship and interesting projects showing it within Europe, it can be considered an emerging activity that is being activated thanks to the EU policies of Raw materials, Circular Economy and the Green Deal, and which has been accentuated by the Russian invasion and war in Ukraine.

- "Still no data"

There is currently very little knowledge available on the potential of secondary raw materials that can be found in mining waste. Although statistics on waste streams are available on the Eurostat website, there is no systematic and consistent collection of data on the (critical) raw materials contained in these waste streams. This lack of data is often observed for abandoned mines as well as for operating mines.

- "Joint materials recovery is preferred"

Often the objective is only the extraction of a few minority valuable elements (metals), although it is desirable, and scientific-technological developments point in this direction, to seek the joint recovery of several valuable constituents.

- "Long-term preliminary research is needed"

In this type of reclamation projects, it is necessary to start with a preliminary long-term research phase and to develop numerous preliminary studies.

- "Recovery of metals from mining waste to fund environmental regeneration"

A possible approach that is already being applied (e.g. applicable to the restoration-regeneration of historic mining areas with significant environmental liabilities) is that the value of the recovered materials offsets the cost of environmental restoration of tailings / tailings. This is especially interesting in an integrative and strategic vision of the design of mining policies for the competent administrations in this type of areas (such as the Iberian Pyrite Belt, where the METALLICO project is working).

Funded by the European Union

4.2. Regarding the social dimension analysis

Understanding and evaluating local perceptions of mining and mining waste valorisation is a challenging endeavour, particularly when many community members may not be familiar with these concepts or the nuances of the mining industry. This lack of knowledge or understanding can contribute to misconceptions, fears, and miscommunication, which can further complicate efforts to gauge and address local perceptions.

The general public often has limited exposure to the intricacies of mining operations and waste management practices. For most people, these processes are out of sight and thus out of mind, and their understanding of them may be based largely on broad societal narratives, often negative due to widely publicized mining accidents or environmental issues.

This gap in knowledge and understanding presents both a challenge and an opportunity. On one hand, it complicates efforts to meaningfully engage local communities in discussions about mining and waste valorisation, because these discussions require a basic understanding of the topics at hand. On the other hand, it provides an opportunity for educational initiatives to increase awareness and understanding of these issues.

Educational initiatives could involve community workshops, *open houses* at local mines, school programs, or online resources, and these initiatives could be undertaken by a variety of stakeholders, including mining companies, environmental organizations, government agencies, or academic institutions. By increasing public understanding of mining and waste valorisation, these educational initiatives could help to ensure that local perceptions and opinions are based on accurate and relevant information. This, in turn, could lead to more productive discussions and better outcomes for both the mining industry and the communities it impacts.

Nevertheless, it is also important to understand that local perceptions of mining and waste valorisation may be influenced by a variety of factors beyond just knowledge and understanding. These factors can include historical experiences with mining, cultural values, economic conditions, and trust in mining companies and regulatory institutions. Therefore, efforts to engage with and address local perceptions need to take a holistic approach that considers all of these factors.

- The mismatch between demonstrable scientific facts and the perception of mining activities

The disconnection between scientific facts and public perceptions of mining and waste valorisation, particularly around secondary resources, presents a significant challenge.

From a scientific perspective, mining and the valorisation of secondary resources are critical to society. They provide the raw materials needed for a wide range of industries, from construction to electronics, and play a pivotal role in modern life. Moreover, the valorisation of secondary resources - essentially, the recycling and repurposing of waste products - can significantly mitigate the environmental impact of mining, reducing the need for new extractions and minimizing the amount of waste that needs to be managed.

However, these scientific facts can often be overshadowed by the negative perceptions associated with mining. These perceptions are influenced by a variety of factors, including historical mining incidents, concerns about environmental impacts, and issues related to social justice and indigenous rights. Additionally, the technical complexity and the often remote location of mining operations

can contribute to a lack of understanding about the industry and its practices, further exacerbating these negative perceptions.

One of the primary challenges here is the communication of scientific information. Technical jargon, complex processes, and nuanced trade-offs can be difficult to convey in a way that is accessible and engaging to the general public. This is further complicated by the fact that public perceptions are not solely based on facts but are also influenced by values, emotions, and personal experiences. Simply providing more information may not be sufficient to shift perceptions if that information does not also address these other influencing factors.

A key to bridging this gap could lie in enhancing public engagement efforts. This might involve not just communicating the scientific facts in a clear and understandable way, but also listening to and addressing the concerns and values of local communities. This could help to build trust and foster a more open and constructive dialogue around mining and waste valorisation. Additionally, involving local communities in decision-making processes and giving them a stake in the outcomes of mining operations could help to align the interests of the mining industry with those of the public.

The importance of this mismatch and the need to address it is increasingly being recognized, and there are ongoing efforts in many parts of the world to improve public understanding and acceptance of mining and waste valorisation. However, it is a complex issue that requires a thoughtful and multifaceted approach.

- Substitute SLO for "social acceptance"

Although it has also been noted that the term Social Licence to Operate (SLO) is also cited in relation to tailings management and utilisation, the conclusion from our own experience and that of other European projects that have worked on the social dimension of mining in Europe, is that it is not advisable to use this term due to:

- Mature projects generate less rejection. Because they are located in highly transformed mining areas in which operations are carried out to treat secondary resources (very advanced stage of mining activity). Although there are sectoral permits or authorisations, the SLO is usually related to the early stages of the mining project, it is less common that local opposition to mining arises in a mature mining project.
- Due to the ambiguity and conflicting nature of the concept, especially in Europe, the expression "social acceptance" is more appropriate.

- "Stop mining" and urban mining discourse in contemporary Europe

This statement, held by some social groups in Europe (and around the globe), represents a shift towards a more sustainable and circular perspective on mining and the use of Earth's resources. It aligns with principles of the circular economy and sustainability, which are increasingly relevant in our current global context. The recovery of metals from mining waste (secondary resources mining) and urban mining (extraction of precious metals from electronic waste, construction and demolition waste, and other discarded products in urban areas), has the potential to significantly reduce these environmental impacts. It is also highlighted that mining waste often contains valuable metals and minerals, which can be recovered and reused and that this not only reduces the need for new mining, but also helps to clean up and rehabilitate mine sites.

- The importance of considering different social scales

It is also concluded that it is particularly relevant in this case (use of secondary resources) to distinguish the "scale" of social acceptance, as the "societal scale", the broader public opinion, may be very different from the local community scale of the project.

- *General societal scale: environmental issues.*
  In this case an essentially *positive discourse linked to sustainability* predominates: the fight against climate change, circular economy, environmental regeneration of spaces and rural economic reactivation, self-sufficiency of CRM, etc.
- *Local community scale: perceived benefits and risks.*
  In this scale, the balance between benefits and risks perceived by the “mining territory” comes into play.

- At the local community level

In relation to primary resource mining, this phase or tailings recovery activity has "advantages" from a territorial (environmental, social) point of view. It also has some differences of negative bias (although these can be quite similar to those of mining in general) as shown in the table below:

Social dimension of secondary mining resource recovery processes (local community scale)	
BENEFITS (maximise)	NEGATIVE PERCEPTION-RISKS (minimise)
Employment-training opportunities	Risks related to tailings management (accidents or failures, safety and health) (generates mistrust and fear in the population)
Economic activation (historically-dependent mining areas and development of other complementary activities)	Risk of indirect pollution (diffuse/fugitive) and impact on water system-environment (generates mistrust of population and environmental groups)
Creation of technological innovation nodes (integration with renewable energies)	Changes in the territory-landscape and impact on identity (maintaining the image of the territory as it is, already assumed as part of its identity, history and value).
Creation of new territorial assets (new land for alternative activities, heritage) Positive legacy instead of "environmental liabilities".	
Regeneration of degraded areas	

- Arguments within the Societal scale discourse

- Circular economy and progressive decrease of primary extraction.
- Raw Materials and energy self-sufficiency, reducing Europe's dependence on imports of raw materials for batteries and other CRMs.
- Fight against climate change and energy transition (Green Deal, climate goals and SDGs).
- Regeneration of degraded areas and reduction of disaster risk (control and environmental monitoring of tailings).
- Socio-economic activation of rural areas in the process of depopulation (depending on the location of mining sites).

- Scarce accessible information and very technical

One of the main conclusions of this report is that there is little information available to the public on the subject, and the information that is available is highly technical nature. This is a relatively recent field, which has hardly transcended the scientific-technological sphere and has only very recently integrated the social (lay) dimension.

- About risk perception

Another conclusion drawn in relation to "active listening" in social networks (Twitter) around mining sites where recovery of Secondary RM is being developed is that risks are not perceived, or at least have not been transferred to the "public debate", as is the case in primary resource mining. This may be closely related to the "emergence" of a new activity in the territory (esp. greenfield mining) as opposed to the continuity of an activity already present in the territory, and often with a strong historical and identitarian component.

However, it can be concluded that the treatment of waste (and especially hazardous waste such as that derived from metal mining due to its heavy metal content, acidity of the water, etc.) is generally perceived negatively by society, very often on the basis of a perceived risk that is not always substantiated by facts or real data, so that what often prevails is a "fear of the unknown", which is accentuated by the lack of transparent and accessible information and the mistrust that this generates.

- Further work needs to be done to include the variety of social discourses

There is the need to go forward in a very deep and comprehensive identification of stakeholders and social and institutional actors in order to be able to include all points of view and the different social discourses that have to be part of this narrative.

- The need to create a narrative and good communication both at local and societal scale

Therefore, the incorporation of fluid and transparent communication with clear and accessible information, including the involvement of the different stakeholders concerned in decision-making, is a "good practice" that needs to be systematically integrated from the early stages of the project and maintained until its completion.

Finally, at a higher scale, it is concluded that Europe, at the societal and political-institutional leadership level, must move forward on the challenge it faces of how to simultaneously address the supply of its Critical Raw Materials, the maintenance of its high environmental and social standards, and its commitment to climate goals. This challenge requires innovative solutions, which must be based on creating a convincing narrative and good communication strategies and resources.

As final conclusions:

- An essential requirement for these projects is the deep knowledge of the local environment, both from an environmental and social point of view.

- There is an emerging opportunity to improve the integration of the mining activity-RM recovery and reclamation of tailings with the regional-local productive ecosystem by seeking synergies with other activities-sectors and planning for their closure (post-mining scenario).

- The need to engage in a broad and proactive dialogue with local authorities and various members of the local community. The company will benefit from their valuable feedback to improve the project design, development plan and closure scenario, with the ultimate aim of successfully integrating the RM recovery and remediation project into the local development model and improving environmental conditions (significant improvement of water and soil quality as a result of tailings remediation).

- In relation to wider society, the opportunity is identified to improve social awareness of the origin of the RM we consume on a daily basis and to bring the ethics of circularity (circular economy principle) closer to society.

- In relation to the mining sector as a whole, we conclude that there is an opportunity to link its activity (strategic vision, ESG performance) not only to a discourse, with solid arguments such as the above mentioned, but a real change in the way it is carried out, with a firm and robust commitment to these Green goals and with a way of mining that is respectful and integrated into the local territorial development model, and to show this in a transparent way to society.

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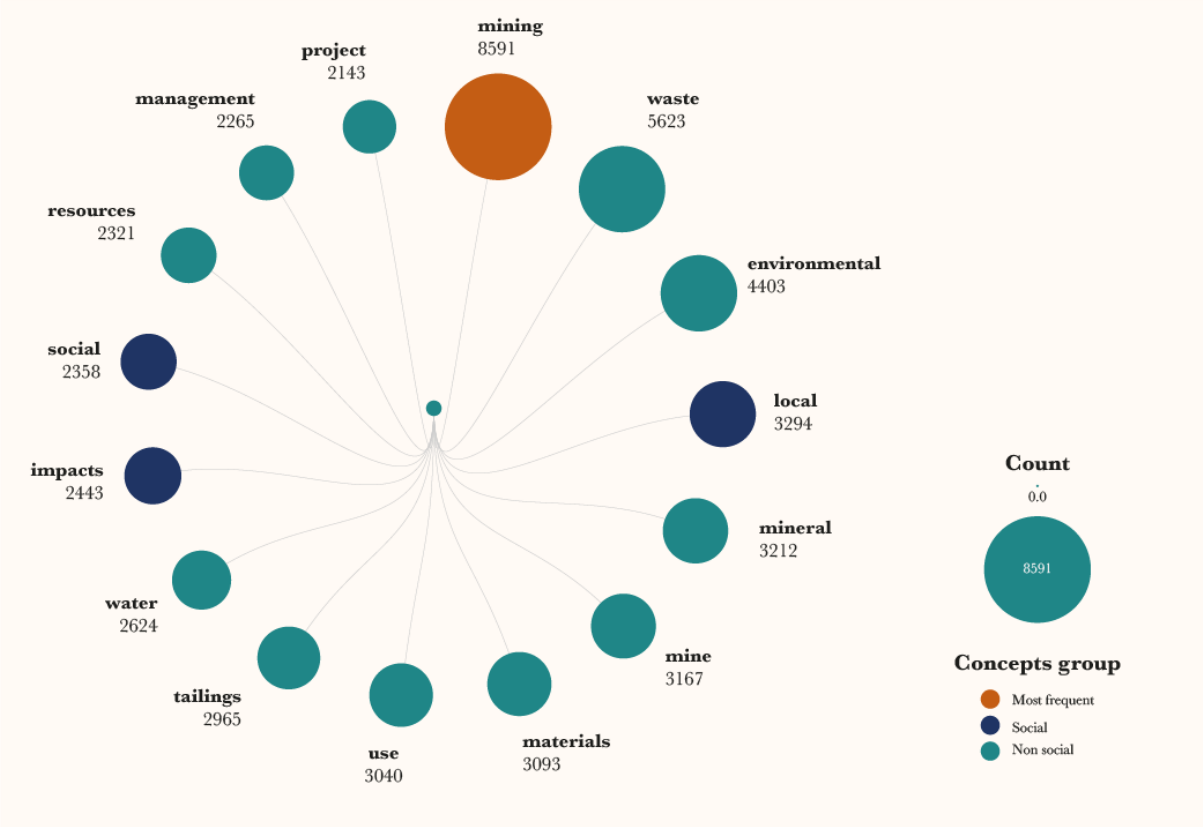
Annex 1

4.3. Atlas.ti literature review

4.3.1. Word frecuency

Figure 19. Word Frequency. Secondary source of information



After analysing all documents and running the word frequency tool, the top five keywords are as follows: mining (8591), waste (5623), environmental (4403), local (3294), and mineral (3212). The concept of "local" stands out as directly associated with the social sphere, while the others are more closely related to mining activities, processes, and resources.

In addition to "local" (3294), the frequencies of some concepts directly related to the social sphere are as follows: impact (2443), social (2358), health (1170), SLO (423), communication (223), participation (183), and governance (168).

4.3.2. Results

Before formulating the conclusion derived from the literature review and constructing the conceptual framework for the social dimension of secondary resource mining, a comprehensive analysis was conducted. This analysis involved both qualitative and quantitative approaches to identify word frequencies, key concepts, and primary ideas within the relevant data. The findings can be summarized as follows:

Local (3294).

The concept of local is associated with 6 fundamental ideas: mining (1084), community (813), social (554) as you mentioned, company (432), impact (395), environment (116), and SLO (205).

- Mining is commonly associated with mining companies and the industry, mining projects, mining activities, waste management, coal, communities, and conflicts. The significance of mining is debated in both economic and social aspects, with a focus on its ability to generate employment and contribute to local development. Mining companies are analyzed from various perspectives, emphasizing the need for responsible operations that respect the environment and local communities. The mining industry is examined as a key sector for economic growth and the implementation of Sustainable Development Goals. Regarding mining projects, the importance of engaging communities and ensuring social acceptance is highlighted, along with the proper management of waste generated by mining activities. The interaction between mining communities and the industry is addressed, underscoring the necessity of promoting dialogue, participation, and sustainable development in these areas.
- Community is commonly associated with local communities, their relationships, and community members. The concepts of community involvement and community acceptance are of lesser importance. Therefore, community relates to society members and how they engage with a project, upon which the social acceptance of an activity depends. The topics most discussed in relation to the community are the importance of establishing strong and positive relationships with local communities, active participation and collaboration of communities in the development of mining projects, and consideration of social and economic impacts on communities. The need to understand the perceptions and concerns of local communities is emphasized, as well as promoting social acceptance through transparency, effective communication, and support for community initiatives. Additionally, the importance of addressing issues such as local employment, sustainable development, protection of cultural and environmental heritage, as well as improving the quality of life and well-being of community members is mentioned.
- Company is related to mining companies and local companies. To a lesser extent, it is associated with foreign companies, company activities, and small companies. The importance of social acceptance and the concept of Social License to Operate (SLO) is discussed, highlighting the need to establish trust and mutual benefit between companies and local communities. Challenges and criticisms associated with lack of transparency, environmental impact, and inequities in benefit distribution are also mentioned. Furthermore, emphasis is placed on the active participation of stakeholders, development of social infrastructure, creation of local employment, and promotion of sustainable practices. The need for a balanced approach that promotes economic development while protecting community rights and ensuring long-term sustainability is emphasized.
- Environment is associated with concepts such as the environment and local environment. Notable concepts include the surrounding environment, the natural environment, or a clean and healthy environment. Concerns and opinions regarding the environmental impacts of mining, waste management, water and soil pollution, as well as risks to the health and well-being of local communities, are highlighted. The importance of maintaining a clean and healthy

natural environment is underscored, along with the need to implement policies and technologies that reduce negative impacts on the environment. The collaboration between companies, governments, non-governmental organizations, and local communities to achieve sustainable development and protect the natural environment is also mentioned. In summary, the preservation and promotion of a clean and healthy environment for both local communities and the overall environment are emphasized.

- Social License to Operate (SLO) is related to SLO thinking, SLO literature, and to a lesser extent, local-level SLO and the SLO process. Different approaches and perspectives within the literature and thinking related to SLO are discussed. The importance of trust and legitimacy as fundamental components to obtain and maintain an SLO is highlighted. Additionally, the need to consider dynamics of trust and distrust, as well as the role of civic vigilance in the SLO acquisition process, is emphasized. The influence of ideological factors and power relations in obtaining an SLO is also underscored, along with the importance of addressing institutional and local dimensions in this process. In general, a critical and reflective view of SLO is discussed, highlighting the need for a deeper understanding and a more comprehensive integration of trust dimensions in SLO research and practice.

Impacts (2443)

The concept of impact is related to 6 fundamental ideas: mining (1649), environmental (1058), social (781), waste (627), mine (439), local (403), water (368), and health (353). The documents discuss several key concepts related to mining, particularly focusing on its environmental and social impacts. The main points are:

- Process Design and Waste Management: The design of mining processes can influence the properties and amount of waste produced. Different waste management methods are mentioned, with the understanding that changes in the process can affect waste properties.
- Environmental Impact Assessment: The importance of assessing the potential environmental impacts associated with mining waste management. The quotes include examples of environmental accidents and their consequences, as well as management strategies for these impacts.
- Legislation: The results refer to various pieces of European legislation related to environmental management in mining. This includes the Directive on classified installations and the Directive relative to the assessment of environmental impact, which requires the assessment of the effects of certain projects on the environment.
- Environmental Impact: Environmental impact is explored in depth. It is defined as a change in the initial environmental parameters due to mining activity. The impact must be assessed against environmental quality targets for the affected zone, not against the initial environmental aspects. Main concepts and ideas related are: health effects, environmental pollution, compensation for environmental impacts, social and environmental impacts of small-scale mining, community connection to ancestral states and non-environmental effects (such as mining accidents and pit closure).
- Social Impact: Social impacts of mining is discussed, particularly in the context of small-scale mining in Europe. The quotes emphasize the importance of managing these impacts and presents results from case studies. Main concepts and related ideas are: public engagement

and trust, social acceptance and Corporate Social Responsibility (CSR), Compensation for Environmental Impacts, Impact on Homeowners and Legislation and Permits.

- **Trust and Public Engagement:** The documents highlight the role of innovative procedures in maintaining trust between mining companies and communities, particularly during challenging periods of negotiation.
- **Raw Material Production:** The documents discuss the potential for improving the framework for regional production of raw materials, with a focus on the social and environmental impacts of small-scale mining.
- **Aggregate Production:** The documents discuss the production of aggregate in mining, including the process parameters that can be adjusted to obtain the aggregate product.

Social (2358)

The concept of “social” is related to next fundamental ideas: mining (1615), environmental (694), economic (497), impacts (481), local (465), community (461) and acceptance (410).

- **Mining.** The concept of "mining" is related to various topics. It is highlighted that mining is a symbol of social value, representing the technical genius that catalyzed the Industrial Revolution in Europe. It is also suggested that the reputation and actions of mining companies can significantly impact how mining activities are perceived and accepted by the public. The documents also discuss the importance of community relations engagement in the context of mining and the relationship between mining, Corporate Social Responsibility (CSR), and the community.
- **Environmental.** The idea of "environmental" is associated with several topics. It is noted that environmental considerations play a role in establishing mutual understanding in company and community dialogues. Environmental factors can also influence the sequencing of events in mining operations. Furthermore, environmental issues can become contested in the context of power relationships and politics in rural areas, and environmental considerations can influence the diffusion of innovations in the market.
- **Economic.** The concept of "economic" is related to several ideas. The economic aspect of metal recovery from raw ore and the use of non-toxic materials in the construction industry are discussed, suggesting that these practices can have both economic and environmental benefits. The documents also suggest that innovations in the mining industry can have a significant economic impact if they are successfully diffused in the market.
- **Impacts.** The term "impacts" is associated with various topics. The role of environmental reporting in providing transparency to stakeholders or potentially manipulating stakeholder perceptions is discussed, suggesting that the tone of disclosure and the role of the board of directors can have significant impacts. The impacts of company philosophy and actions on various participants are also discussed, as well as the impact of resource allocation for social investment in mining operations.
- **Local.** The term "local" is associated with various topics. It is noted that mining is perceived as a symbol of social value, representing a key page in social history. The documents also discuss the importance of community relations engagement in the context of mining, suggesting that interviews with key stakeholders can help understand the experience of community relations

processes. It is also mentioned that the mining activity is likely to attract workers from other regions causing migration flows and a change in the local demographic structure.

- Community. The concept of "community" is related to several ideas. It is discussed the importance of community relations engagement in the context of mining. Same local cases are mentioned: Rio Tinto, Richards Bay minerals, and the Mbonambi, discussing the relationship between mining, CSR, and the community. It is suggested that community acceptance of mining can be positively influenced by trust in the mining industry.
- Acceptance. The term "acceptance" is associated with various topics. It is suggested that trust in the mining industry can positively influence the social acceptance of mining. The documents also discuss the role of corporate environmental commitment in influencing product innovation performance, which can foster procedural fairness, generate trust, and develop regional identity, crucial parameters for securing acceptance.

Acceptance (599).

The concept of “acceptance” is related to next fundamental ideas: mining (587), social (532), community (327), public (235), local (185), trust (185), impacts (177) and SLO (177). Main concepts are developed as follows.

- Geographical Proximity: The quotes suggests that the physical closeness to mining sites can lead to a form of 'compelled acceptance' among residents. This implies that geographical factors can significantly influence the acceptance of mining activities, with those living near the sites having little choice but to accept their presence due to their unalterable location.
- Perception of Impacts: The documents highlight the role of perception in shaping acceptance. It indicates that if the perceived negative impacts of mining, such as air pollution, are mitigated, acceptance levels can rise. Moffat and Zhang (2014) propose an integrative model explaining community acceptance of mining. Their model suggests that acceptance is not a linear process but is influenced by various factors, including the community's perception of the mining operation's impacts.
- Social Capital: The documents introduce the concept of social capital and its role in acceptance. It is suggested that social capital, generated within a voluntary network, can influence the acceptance of mining activities. The consistency of actions within the group can affect the economic goals and goal-seeking behavior of members, which in turn can influence their acceptance of mining activities.
- Perceived Impacts: The documents explore the role of perceived impacts in acceptance. It suggests that if the experienced impacts of mining are worse than expected, the community may reject the mining project. Conversely, if the actual impacts are more positive than expected, it may contribute to community acceptance. This highlights the importance of managing expectations and delivering on promises to gain community acceptance.
- Environmental Fiscal Reform: The documents discusse the role of environmental fiscal reform in acceptance. It is suggested that aligning taxes and tax-like instruments with environmental goals can help improve acceptance of mining activities. This introduces the idea of 'economic incentives' as a tool to gain acceptance.
- SLO. The path to gaining a social licence to operate is not linear but is influenced by various factors, including the community's perception of the mining operation's impacts. This implies

that to gain and maintain an SLO, mining companies need to manage their operations in a way that aligns with the community's expectations and perceptions.

Governance (230).

The concept of governance (230) is associated with six fundamental concepts: Mining (93), SLO (61), Community (57), Company (51), Impact (45) and Resource (33).

- Governance, whether it is local, corporate, or relating to resources, is crucial to ethical and sound business operations. It's a complex concept that plays a crucial role in industries such as mining, underlining the importance of trust, procedural fairness, and confidence. Good governance practices foster accountability and transparency, mitigating negative environmental and social impacts. This is particularly essential in intricate situations like nuclear waste management, where the dynamics of trust can vary within local communities. The adoption of holistic approaches and multi-stakeholder collaboration is key to achieving sustainable resource management and promoting ethical business practices.
- The mining industry, encompassing mining companies and their projects, is multifaceted and demands sustainable and socially responsible practices. The acceptance of mining operations by local communities, or the social license to operate (SLO), is a critical factor. This acceptance is influenced by factors such as trust in mining companies, governance, procedural fairness, and distributional fairness. Ensuring local benefits and minimizing negative impacts require targeted activities and context-specific approaches. Transparency, accountability, and responsible practices are key in fostering trust and obtaining the SLO.
- SLO. The SLO concept is evolving, particularly in regions like Europe. It's crucial to adapt this framework to fit regional experiences, considering societal values and the intersection of mining discussions with sustainability and climate change. The Scalar SLO Model proposes understanding SLO dynamics from multiple perspectives, considering the community, companies, wider society, civil society, industry, and governments. The drivers of SLO loss and potential conflicts need to be understood and addressed.
- Local. Local communities are portrayed as important governance actors, and their involvement is crucial in decision-making processes. For mining companies to operate, they must gain acceptance and support from these communities. This highlights the importance of community engagement, effective communication, and the equitable distribution of benefits. A cooperative relationship based on transparency, shared value, and sustainable development is essential for responsible resource extraction.
- Mining companies are increasingly implementing sustainability initiatives, both globally and locally. The behavior of the companies and the influence of local communities are important considerations in this context. For instance, fly-in, fly-out mining companies are recognized as governance partners in remote, mine-affected localities. The SLO concept plays a crucial role in these dynamics, and community acceptance is integral to effective governance.
- The impact of mining, whether it's perceived, health-related, industrial, environmental, or long-term, needs to be thoroughly understood for sustainable practices. Communities often base their acceptance of mining activities on these perceived impacts. Transparent communication, thorough research, and a comprehensive approach to mitigating environmental effects are

essential. Long-term impacts demand perpetual management plans to balance risks and ensure responsible stewardship.

- Lastly, **natural resources** and their governance are a key focus area. Good governance, respect for human rights, and compliance with environmental and social standards are vital for sustainable development. Reliable models for mineral resources and ore reserves ensure transparency and confidence. Resource efficiency and circularity are crucial to reduce demand for primary minerals and promote a circular economy approach. Effective resource governance, supported by robust regulations and stakeholder engagement, is key to ensuring sustainable and responsible resource extraction practices.

Tailings (2965).

The concept of tailings is based on four fundamental ideas: tailing (2403), waste (923), mine (616), and mining (532).

Concerns regarding the management of mining waste, water pollution, environmental impacts, and the need for effective remediation strategies are discussed. The challenges associated with waste oxidation and the formation of acid mine drainage (AMD) are highlighted, as well as the importance of understanding the reasons behind the lack of oxidation in certain tailings deposits. Analogies with other mining sites in different geographical locations are also mentioned.

Tailing. Is related to mine tailings (210), tailings management (32), or flotation tailings (22). Strategies and challenges associated with the management of mine tailings are extensively discussed, including safe disposal, pollution control, and minimizing environmental impacts. Innovative technologies and approaches used in tailings management, such as the utilization of alternative construction materials and efficient filtration systems, are highlighted. The importance of proper planning, continuous monitoring, and collaboration among different stakeholders in the mining industry to ensure effective and sustainable tailings management is emphasized.

Waste. Waste is related to mining waste (57), waste rock (41), mine waste (35), or industrial waste (10). Mining waste has the highest representation, demonstrating the different types of waste in mining activities. The issues associated with these forms of waste and their impact on the environment and human health are extensively discussed. Processing techniques used in the mining industry, such as froth flotation, which generate tailings and waste containing toxic minerals and metals, are mentioned. The importance of understanding oxidation processes and the generation of acid mine drainage, particularly in relation to pyrite deposits, is emphasized. The need to research and develop strategies to minimize the formation of acid mine drainage and reduce associated environmental impacts is highlighted. Additionally, the documents mention the importance of considering cultural and environmental aspects in the remediation of contaminated sites and emphasizes the relevance of education and preservation of mining heritage in local communities.

Mine. The concept of mine has several entries in acid mine drainage (31), mine tailings (22), copper mine tailings (14), mine waste (12), and mine closure (11). The management of mining water, mine tailings, mine waste, and mine closure is discussed, with a particular focus on acid mine drainage (AMD). AMD refers to metal-laden solutions produced by the oxidative dissolution of iron sulfide minerals exposed to air. This issue represents a significant challenge due to the environmental impacts and health risks associated with the release of toxic metals into water. Copper mine waste and the tailings generated in the copper mining process are also mentioned to a lesser extent.

Opposition

The concept of Opposition (81) is associated with 6 other fundamental concepts: Project (76), Mining (61) Community (54), SLO (42), Conflict (33) and Company (32).

- Opposition. Opposition is a complex concept that encapsulates various forms such as public, social, local community, and emerging opposition, especially in the context of different industries and projects. Understanding the drivers of opposition necessitates a grasp of trust dynamics, including trust, mistrust, and distrust within communities. Opposition can manifest in numerous ways, from discourse and debate to protests, and is influenced by factors like institutional trust, perceived benefits distribution, socio-economic concerns, and legitimacy. Contrary to popular belief, the absence of explicit protest does not necessarily denote strong acceptance, as smaller opposition groups may struggle with resources or organizing themselves effectively. Thus, it's crucial to establish inclusive, transparent processes that address local grievances and foster dialogue, thereby promoting civic vigilance.
- Projects. The relationship between projects, particularly mining, and opposition is nuanced. It involves alliances and networks among communities and organizations, which allow information exchange, resource mobilization, and resistance. Framing local struggles within the broader global demands for environmental justice, climate action, and democratic rights is significant. Yet, the bias often displayed by governments and increasing repressive measures against resistance complicate matters.
- Mining. Mining projects often face opposition due to issues like distrust towards companies and governments, unequal benefits distribution, and irreversible environmental impacts. The role of alliances, networks, and global movements in mobilizing opposition is critical, as is the need for ongoing dialogue and responsible mining practices.
- Community. Communities play a central role in shaping the planning and location of mining projects. Strong opposition from community members is often linked to environmental impacts, social non-acceptance, and the NIMBY phenomenon. Acknowledging internal divisions within communities and the lack of trust towards mining companies, the state, and external expertise is important, as these contribute to opposition.
- SLO. The strength of acceptance, referred to as social license to operate (SLO), can be influenced by suppressed conflicts or opposition movements' lack of resources. Current SLO frameworks should incorporate potential benefits of mistrust and distrust, recognizing their role in fostering vigilance and conditional acceptance. Understanding trust dynamics and integrating opposition voices are key to ensure harmonious relationships.
- Conflicts. Local conflicts, often associated with mining activities, can arise due to the appropriation of space and are influenced by factors like inadequate participation in decision-making, insufficient information dissemination, and distrust in authorities and businesses. Resistance at various scales is enabled by alliances and networks. Understanding these oppositional behaviors and addressing the underlying factors that contribute to conflicts is crucial.
- Company. Companies often focus on avoiding harm rather than fostering shared benefits. The concept of SLO is seen as a means of reducing opposition rather than fostering sustainable development collaboration. The potential virtues of mistrust and distrust, along with the

importance of vigilance in achieving equitable relationships, cannot be ignored. Recognition of opposition and minority voices can contribute to socioeconomic revival and the consolidation of open democracies.

4.4. Social media discourse analysis

4.4.1. Results in study cases

Twitter posts generated in those locations were searched containing the following keywords: *tailing management facility, tailing storage facility, tailing recycling, tailing reprocessing, mine waste facilities, mine waste recovery, mine waste reprocessing, mine waste valorization, mine waste processing, mine waste recycling, tailing, red mud tailings, dam, pond and tailing pond*.

The results have been that none of these keywords have been used on Twitter posts in the study areas along the monitored dates: from June 2021 until end of May 2023.

Figure 20. Twitter posts analyzed. Keywords related conversations

	Location id												
Keywords	1	2	3	4	5	6	7	8	9	10	11	12	13
Mine waste	0	0	0	0	0	0	0	0	0	0	0	0	0
Tailing dam	0	0	0	0	0	0	0	0	0	0	0	0	0
Tailing pond	0	0	0	0	0	0	0	0	0	0	0	0	0
Red mud tailings	0	0	0	0	0	0	0	0	0	0	0	0	0
Tailing	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine waste processing	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine waste valorisation	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine waste reprocessing	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine waste recovery	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine waste facilities	0	0	0	0	0	0	0	0	0	0	0	0	0
Tailing reprocessing	0	0	0	0	0	0	0	0	0	0	0	0	0
Tailing recycling	0	0	0	0	0	0	0	0	0	0	0	0	0

Funded by the European Union

	Location id												
Keywords	1	2	3	4	5	6	7	8	9	10	11	12	13
Tailing storage facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Tailing management facility	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Own elaboration

As an alternative, new broader keywords were searched: mine and mining. This allowed us the get the results from twitter when people on these locations is talking about mines. Results are as follows:

Figure 21. Twitter posts by location. Mine related conversations

	Locations												
Keywords	1	2	3	4	5	6	7	8	9	10	11	12	13
Others: mine, mining	0	2	0	0	0	25	142	2	0	4	70	0	0

Source: Own elaboration

When searching for these more general keywords related to mining, the majority of locations still do not yield results, except for Minas de Riotinto study case.

- Sillamae: 2 posts;
- Bukowno: 6 posts;
- Minas de Riotinto: 142 posts;
- Penouta: 2 posts.
- Aznalcóllar: 4 posts.
- Gällivare: 70 posts.

The most common keywords found in these contents are: mine (128), Riotinto (64), mining (31), Huelva (21), together with other locations in Huelva (Andalusia, Spain). The term "minero" (miner) appears 11 times, and "hierro" (iron) appears 10 times. Most of the content is generic, dealing with the importance of mining for certain communities, or its significance as cultural heritage and its preservation as a museum (case of Riotinto). The Riotinto mine is the only one that holds some importance, being mentioned as an iconic location in some of the posts. Huelva is occasionally referred to as the center of mining in Europe.

4.4.2. Results by country

Due to poor results in extracting information from Twitter related to the keywords in each of the 13 locations, the focus has been expanded to a country-wide scale, exploring Twitter posts from the 9 countries where the research has been conducted. *The same keywords have been used, along with the general set of keywords composed of "mine" and "mining".* The results are as follows:

Figure 22. Twitter posts analysed by countries. Mine related conversations.

id	Country	Posts
1	Bosnia and Herzegovina	2.471
2	Estonia	1.128
3	Finland	182
4	Ireland	29
5	Poland	16.105
6	Spain	8.277
7	Sweden	2.563
8	UK	114
9	Czech	2.333
	TOTAL	33.202

Source: own elaboration.

These are the conclusions detailed by country:

1. Bosnia (2.471 posts)

The most common words are: Rudnik/Mine (1.628), Rudari/Miners (423), Mine/Mines (298), Ljubljana/Ljubljana (capital city of Slovenia) (82), Uglja/Coal (68).

The key points about the mentions of mines and mining are:

- There are discussions about the need for a lithium mine in Serbia with strict environmental standards control, and the production should be stopped each time the conditions are not met.
- Some citizens from various cities, including Loznica, Požega, Kosjerica, Dobrinje, Mionica and Jagodina, express their opposition to lithium mines.
- The existence of an iron mine in Gluhavica is mentioned. There are also references to the Borski and Kolubarski mines.
- Some other posts relate to the potential for mining in the area of Topola, Milanovac and Rudnik, with citizens expressing their opposition to those activities. There are also discussions about the potential for mining lithium near Loznica, and in the area of Žagubica, showing concerns about the impact on the Mlava river.
- There are mentions of the Resavica mine and the celebration of the Day of Miners in Serbia.

2. Estonia (1.128 posts)

Most frequent words are: mine (228), people (41), Finland (30), work (24) and hope (18). The contents analysed include several mentions of mining-related topics. Here are some of the key points:

- There are discussions about the potential for mining in the Tana Belt, just next to the border of Russia. There are some conflicting interests among indigenous groups, but the stronger opposition comes from non-local groups that are against any kind of new mining.
- The posts mention a funding grant for mining wastewater metagenomes for disease markers.
- The posts mention Sandvik Mining's business segment announcement on 10 March 2023 that the company will invest in a production unit in Malaysia for manufacturing underground loaders and trucks.

3. Finland (182 posts)

Most frequent words are: mine (145), mining (45), amethyst (21), Finland (11), Lapland (11), Pyhätunturi (8). Main concepts found are:

- The posts discuss Arctic mining, particularly at the Kevitsa mine. It mentions a workshop by the EU Commission in Rovaniemi where Arctic mining was a key topic. The discussions revolved around the idea that mining is possible if done correctly.
- The posts highlight the need for renewing the Mining Act in Finland to better protect nature. It is suggested that the current legislation may not be sufficient to prevent environmental damage from mining activities.
- There are discussions a workshop on the Social License to Operate (SLO), where sustainability in mining was a key topic.
- There are mentions to the Amethyst Mine in Pyhätunturi, Lapland. It refers to how amethyst forms and the mine is presented as a tourist attraction with a beautiful natural setting.
- Smart and Green Mining: The document mentions the REMIX project, which is about smart and green mining. It suggests that there is a movement towards more sustainable and environmentally friendly mining practices.
- Impact of mining on local communities: The document discusses the potential cost of the gold record made by Agnico Eagle Mining to local people and nature in Finnish Lapland. It suggests that mining activities may have significant social and environmental impacts.

4. Ireland (29 posts)

Most frequent words are Mining (6), Minerals (5), new (5), child (3), earth (3). The posts discuss several aspects of mining in Ireland. Main ideas are:

- The posts discuss the environmental impact of mining, particularly in relation to the extraction of minerals for electric vehicles. It mentions the cost to ecosystems in Peru and Chile and the use of child labor in Congo. The posts suggest that setting up a new mine ethically takes 15-20 years.

- There are discussions about child labor in mining, particularly in relation to the extraction of minerals for electric vehicles. It questions whether the use of child labor can be supported, particularly when it's not white children.
- The posts mention local opposition to fracking and mining in Leitrim. It mentions a unity between Leitrim locals and Lakota 'water protectors' against these practices.
- There are comments about toxic chemicals used in mining, providing a link to a letter to send to councillors to get this ban included in the new County Development Plan.

5. Poland (16.105 posts)

The most frequent words are "górnik" (miner) (7129), "mine" (2813), "kopalnia" (mine/colliery) (1997), "górnicy" (miners) (1924), "kopalnie" (mines) (1592), "zabrze" (Zabrze) (1280), and "wieliczka" (Wieliczka) (1013). The posts discuss several aspects of mining in Poland. Here are the main concepts and their developments:

- The posts discuss the hard work conditions of miners. It mentions that miners work hard and, as a result, they receive 100% downtime.
- There are discussions on the impact of COVID-19 on mining, mentioning the suspension of mining in two JSW mines and ten PGG mines. Miners are going on downtime for three weeks.
- The posts discuss the public opinion on mining, mentioning that miners from the Zofiówka Mine do not share the enthusiasm of Mr. Sasin. It also mentions that miners thank for the defensive hand and suggest that miners should vote for Trzaskowski, or there will be crying and gnashing of teeth.
- It is discussed the legal issues related to mining. A copper mining incident in Zambia is mentioned, that led to a substantial Supreme Court ruling.
- Mining and toxic chemicals issues are discussed, commenting the proposed ban on toxic chemicals used in mining. It provides a link to a letter to send to councillors to get this ban included in the new County Development Plan.
- The documents discuss the government's policies on mining, mentioning the government is closing mines and transitioning to wind turbines, solar panels, and gas from Merkel.
- The documents also mention a historical event where the police opened fire on striking miners in Jaworzno on May 19, 1931, resulting in the death of 5 people.

6. Spain (8.277 posts)

Most frequent words are as follows: "mina" (mine) (1025), "Cáceres" (44), "oro" (gold) (44), "elecciones" (42), "votos" (votes) (41), "vida" (life) (27), "litio" (lithium) (23) and "proyecto" (project) (17). A summary of the main ideas related to mining is as follows:

- There are mentions of mining operations in different contexts. For instance, there's a reference to a company reducing its freshwater consumption by 13.6% at its Riotinto mine. There's also mention of a mining company planning to sift through over 1,300 hectares of fertile land in six municipalities of Segovia for quartz extraction. This open-pit mining operation is opposed by locals due to its severe impacts.
- There are several references to the environmental and social impacts of mining. There's a mention of acid drainage from the Penouta mine contaminating a river downstream. There's

also a discussion about the radioactive and hydrological damages that a mine could cause near Cáceres.

- There are several mentions of resistance to mining projects. For example, there's a call to stop open-pit mining in the northeastern part of Segovia. There's also a mention of opposition to a mining project in San Quirce.
- There's a mention of the closure of the Ranger uranium mine and the subsequent need for natural space rehabilitation. There's also a mention of Berkeley, the owner of a uranium mine, experiencing a 22% surge in its stock market value due to a potential change in government.
- There's a reference to a Roman mine in Cueva del Hierro, which is being used for ethnographic visit projects.

7. Sweden (2.563 posts)

The most frequent words are "mine" (1764), "gruva" (mine) (555), "falu" (Falu) (390), "quot" (quote) with a frequency of 185, "gruvor" (mines) with a frequency of 111, "mines" (mines) with a frequency of 107, and "falun" (Falun) with a frequency of 84. These words, along with their English translations, have varying frequencies within the given dataset, indicating their significance in the context.

The main concepts found on the analysed posts are as follows:

- Mining and Work Safety. There are mentions of the annual work safety conference by Svemin, the Swedish Mining Association. Over 300 participants discuss how to further strengthen work safety in the mining industry and learn from good examples.
- Mining Operations: There are mentions of mining operations, such as the opening of a new mine and the operation of existing ones. The document also mentions the mining of "black gold.
- Mining and Public Opinion: The public opinion on mining is discussed. It is mentioned the resistance to mining operations, with references to stopping mines in Sweden and becoming import-dependent on something (like chalk) that is abundant in the country.
- Historical Mining: The posts mention a historical mine in Dalarna, which is being used for tours.
- Mining and Environment: The post discussed the environmental impact of mining. It is mentioned the need for mines that have been in operation since the 1850s to show that they are not harming the surrounding environment.

8. United Kingdom (114 posts)

The most frequent words are "mine" (mine) (25), "Boliden" (17), "day" (14), "work" (7) or "world" (6) and “city" (4). The posts contain several references to mining, particularly in the context of mines in Sweden and the use of technology in mining. The main concepts related to mining are:

- Use of technology in mines: The posts mention the use of technology in mines, including the use of VR (virtual reality) environments and the testing of UWB (Ultra-Wideband) in Boliden Kristineberg mine. There's also mention of SIMS (Sustainable Intelligent Mining Systems) showcasing their VR environment and discussing about sustainable mines.
- Sustainable mining: There are references to sustainable mining practices, including the use of technology to improve safety standards in mines. There's also mention of SafeMine, an EU-funded research school, visiting the mine to learn more about future mining work.

- Mining and community: There are mentions to a career fair in Luleå, where SIMS showcased their VR environment and discussed sustainable mines. This suggests a focus on community engagement and education in the mining sector.
- Falun Mine: The Falun mine is a significant part of Swedish heritage. It ceased operations in 1992, and today visitors are allowed to go inside the mine. During the 1600-1700s, 70% of all copper in Europe came from this mine. There's a belief that a goat named Kare led his owner to the pit a thousand years ago.
- Iron Ore Mining in Kiruna: There are mentions of Kiruna, the city that's being moved to accommodate the iron ore mine beneath it. This highlights the significant impact of mining on local communities and landscapes.
- Testing in Mines: There are mentions of testing in mines, including "intense test days in Kvarntorp, Epiroc's underground test mine". This suggests ongoing research and development in underground mining practices and technologies.

13. Czechia (2.333 posts)

The most common words are “minarový” (mining) (1.436), “mine” (271), “arar” (170), “doly” (mines) (162) and “mining” (107). The posts contain several mentions of mining-related content with the following key points:

- Resource Extraction: The posts contain numerous references to the extraction of various resources, including oil, rare metals and coal. There's a discussion about the ecological impact of mining rare metals and the environmental destruction it causes. The posts also mention the extraction of oil and its contribution to the GDP of the Russian Federation.
- Environmental impact: The posts highlight the environmental crimes that are decimating the third world. It mentions illegal logging and mineral extraction, deforestation for pastures, poaching and trading of animals, displacement of indigenous people, and the murder of environmental activists. The document also discusses the potential environmental catastrophe that could result from uranium mining.
- Energy production: The posts discuss the production of electricity and the role of coal in this process. It also mentions the extraction of oil and the production of electricity.
- Economic impact: The posts discuss the economic impact of resource extraction. It mentions the contribution of oil extraction to the GDP of the Russian Federation. It also discusses the economic consequences of uranium mining, noting that the costs of extraction are often higher than the global price.

4.5. News Clipping

After analyzing news clippings from countries of study focusing on mining topics, the main ideas and concepts identified are described in 3.5 section. The analysis of the Google News clippings by country is as follows:

Bosnia (8 news clipping)

Most frequent words are: otpad (waste, 12), rudarstv (mining, 8), bosni (Bosnian, 8), recikliranje (recycling, 3) or oduzetnik (expropriator, 3). Based on the analysis of the document, several key concepts related to mining in Bosnia can be identified.

- Waste management in mining: It is found that "Postrojenja za odlaganje otpada iz rudarstva" (Facilities for the disposal of mining waste) are mentioned. This suggests that waste management is a significant concern in the Bosnian mining industry. Proper waste management is crucial in mining to mitigate environmental impacts and ensure the sustainability of mining operations.
- Recycling mining waste: Another concept that emerges is "Recikliranje otpada iz rudarstva" (Recycling of mining waste). This indicates a focus on circular economy principles in the mining sector, where waste materials are repurposed or recycled, reducing the need for new raw materials extraction and minimizing waste.
- Sustainable supply of key Raw Materials: It is found that "Održiva opskrba ključnim sirovinama neophodna" (Sustainable supply of key raw materials is necessary) is mentioned. This suggests an emphasis on ensuring a steady and sustainable supply of essential raw materials, likely to support Bosnia's industrial and economic growth.
- Extraction of precious metals: The phrase "Kako iskopavati dragocene metale u vašoj rodeno" (How to excavate precious metals in your homeland) indicates an interest in the extraction of valuable metals, which could be a significant source of revenue for the country.
- Innovation and entrepreneurship in mining: It is found that "Vjekoslav Majetic je EY poduzetnik godine" (Vjekoslav Majetic is the EY entrepreneur of the year) is mentioned. This suggests that some service companies are being recognized for their innovative contributions to the mining sector, such as DOK-ING, which designs and manufactures robotic systems that protect human lives in the most dangerous operations, including mining.

Ireland (1.444 news)

Most frequent words are: "tailings" [1247], "mining" [676], "waste" [609], "mine" [421] or “storage" [305]. Main themes are: Mining waste facilities, Mining waste recovery, Mining waste processing and Tailings reprocessing.

- Mining waste facilities: It is found that this topic revolves around the management and impact of waste generated from mining activities. News articles discuss topics such as the storage and disposal of mining waste, the environmental consequences associated with mining waste, and the challenges involved in its management. Notably, the news clippings mention the growing scarcity of mining waste facilities in Australia, shedding light on the pressing issue of insufficient infrastructure to handle mining waste and the resulting pollution.

- Mining waste recovery: Within this theme, news clippings explore the recovery and recycling of mining waste, highlighting innovative approaches employed in the field. Discussions encompass the utilization of microbes for waste recovery and the recycling of battery waste. Noteworthy coverage includes reports on mining company Vale investing in waste recovery initiatives and the development of environmentally friendly practices within the mining industry.
- Mining waste processing: The concept of mining waste processing emerges, focusing on the extraction of valuable materials from mining waste or the implementation of methods to mitigate its environmental impact. News clippings refer to bio-mining as a technique used to process solid waste, as well as the potential for mining waste to serve as a source of rare earth elements—an area of growing interest and exploration.
- Tailings reprocessing: The practice of tailings reprocessing, involving the treatment of waste material remaining after valuable minerals have been extracted, garners attention in the news clippings. Instances of tailings reprocessing initiatives are highlighted, including the efforts of EnviroGold Global and Barrick Gold in this domain, emphasizing the importance of recovering additional minerals and minimizing environmental consequences.

Poland (2.723 news)

The most frequent words are "kopalnie" (mines, 3.000), "gornictwo" (minería, 591), "Olkusz" (541), "Zabrze" (533) and "odpad" (waste, 477). Based on the news analysis, several key concepts related to mining in Poland can be identified:

- Traditional mining: Traditional mining, with a particular focus on coal mining, emerges as a significant topic in Poland. The news clippings mention employment crises within the mining sector, mining exhibitions that showcase the industry, and the historical context of mining in the region. Furthermore, discussions revolve around the reduction of methane emissions and the influence of EU directives on Polish mining practices.
- Miners: Miners play a central role in the mining industry and the news clippings extensively cover their experiences and challenges. The contents references miners' resignations, wage increases, and protests related to working conditions and compensation. Additionally, there are mentions of accidents and injuries involving miners, indicating the inherent risks associated with this job.
- Recycling mining waste: The recycling of mining waste is also addressed in the document. It highlights the transformation of waste into concentrate and the establishment of facilities dedicated to producing recycled materials from mining waste. This indicates a growing focus on recovery practices within the mining industry.
- Mining in specific locations: The news clippings specifically mention mining activities in locations such as Olkusz, Zabrze and Bukowno. The news explores topics such as the reclamation and development of post-mining areas, the formation of new lakes due to sinkholes caused by mining and the overall impact of mining on local communities and their surroundings.
- Mining accidents and safety: The document places significant emphasis on mining accidents and safety concerns. It discusses incidents that have occurred in mines and the broader impact of mining activities on the environment and local communities. Safety regulations and measures to mitigate risks are a recurring issue in the news clippings.

Spain (2.292 news)

The most frequent words are "mina" (mine) (519), "minería" (mining) (450), "minero" (miner) (518), "minera" (mining-related) (177), "proyecto" (project) (165), "residuos" (waste) (123), "relaves" (tailings) (108), and "oro" (gold) (105). Based on the information extracted from the news in Spain, we can identify next key concepts:

- Mining and environment: Mining activities have an impact on the environment, as it is the case for the restoration of degraded areas due to mining in León by TRAGSA and the potential degradation of the coast due to the El Gorguel project.
- Waste recovery: It is mentioned the creation of 25 jobs in Ariño with a new waste recovery center, the investment of 6.8 million euros in the Samca mining facilities, and the investment of 471 million euros for environmental recovery and waste management. It is also mentioned the recovery of critical raw materials from acidic mining waters in Andalusia.

Sweden (190 news)

The most frequent words are “Sweden” (188), "gruv (mining)" (364), "nyheter" (news) (69), "ruvan" (pit) (49), and "dagens" (daily) (40). Based on the news clippings analyzed, the following key insights emerge:

- Sustainability in mining: The news clippings highlight the growing emphasis on sustainability within the mining sector. Mining companies are increasingly adopting environmentally friendly practices and technologies to reduce their carbon footprint. This includes utilizing renewable energy sources, recycling waste materials and implementing efficient mining processes. The Swedish mining industry is at the forefront of this sustainable transformation, leading the way in adopting eco-conscious mining practices.
- Digitalization and automation: The analyzed news clippings underscore the pivotal role of digitalization and automation in modern mining operations. Advanced technologies such as AI, machine learning and robotics are revolutionizing the industry, enhancing operational efficiency, improving safety standards and reducing environmental impact. Swedish mining companies are heavily investing in these technologies to remain competitive and meet the growing global demand for minerals and metals.
- Regulations and policies: The news clippings shed light on the regulatory landscape of the mining industry in Sweden. Stringent regulations are being implemented by the government to ensure responsible mining practices. These regulations aim to protect the environment, ensure worker safety and promote sustainable development. Compliance with these regulations is mandatory for mining companies operating in the country.
- Economic impact: The mining industry plays a significant role in Sweden's economy, as highlighted in the analyzed news clippings. It contributes to job creation, economic growth and the development of remote regions. The economic benefits of the mining industry are acknowledged, recognizing its potential to drive Sweden's future economic growth.
- Community engagement: The news clippings emphasize the importance of community engagement in mining operations. Mining companies are actively working in collaboration with local communities to address their concerns and ensure their involvement in decision-making processes. This approach helps build trust and fosters long-term relationships between mining companies and local communities.

Finland (84 news)

The most frequent words are “Talvivaara” (33), “Sotkamo” (32), “kaivos” (mine, 24), “yhtiö” (company, 13), “Finnish” (10), “Terrafame” (20), “hopeakaivoksen” (silver mine) (9), “kaivostoimin” (mining operations) (5) and “Kainuu” (4). Based on the news clippings analyzed, it can be concluded that the main discussion in Finished news relates to the Talvivaara mine in Sotkamo, now known as Terrafame. Here are some of the main highlights of the debate:

- Relationship with local community: how the mine did not become the "saviour" of the community that some had hoped for, although there were some economic benefits of the activity on the local economy, including job creation.
- Environmental impacts: The environmental impacts of Talvivaara mining, including pollution of nearby lakes area highlighted. Also the Finnish Nature Conservation Federation has accused against the Terrafame mine for selling uranium without proper permits.
- Legal framework: The extension of time granted to the Terrafame mine by the government. The expansion of Sotkamo Silver's mining operation and the implementation of a new environmental monitoring programme. The Supreme Court decision on an environmental permitting dispute related to the Talvivaara mine.
- The bankruptcy of Talvivaara Sotkamo Oy (company operating the mine): and the controversy surrounding the mine's operation, including its history of financial difficulties and environmental problems.

United Kingdom (1.822)

The most frequent words are "Cornwall" (1.604), "mine" (1.498), "miner" (1.321), "mining" (1.128), and "news" (994). Additionally, "Cornish" (322) and "waste" (161) are also mentioned. Based on the analysis of the document from Google News UK, the main concepts related to mining can be categorized into the following four main topics:

- Mining waste facilities. The news clipping contains numerous references to "tailing ponds" and "mining waste facilities". The news mention several incidents related to tailing ponds, such as worker disappearances, pollution issues, and dam wall collapses. It also mentions the use of biosolids to treat tailings ponds and the potential environmental risks associated with them.
- Miners. The news clippings shine a spotlight on traditional miners, shedding light on safety issues prevalent in the industry. Instances of mine collapses and landslides are mentioned, highlighting the inherent risks faced by these miners. Furthermore, labor concerns are also addressed, indicating challenges related to fair compensation and working conditions in the traditional mining sector.
- Mining waste recovery: The news analysis reveals a focus on mining waste recovery, which involves finding new uses for mining waste or reprocessing it to extract valuable materials. Examples discussed include the recycling of e-waste, the extraction of tin from mining waste, and the utilization of microbial treatments for waste processing. Additionally, specific projects and initiatives related to mining waste recovery in Cornwall are mentioned, showcasing ongoing efforts in this field.
- Mining operations: The news analysis encompasses several references to specific mining operations and incidents. It covers topics such as mine collapses, landslides at mining sites, and

the discovery of new mineral deposits. Specific mining companies, including BHP and South32, are also mentioned, with discussions centered around issues related to mining investment and regulation.

Czech Republic (57 news)

The most frequent words are "Chequia" (Czech Republic, 57), "soud" (court) (14), "zpravy" (news) (14) and "polsko" (Poland) (13). Several key themes emerge:

- Mining operations: A significant focus is on the Turów brown coal mine near the Czech-Polish border. The Polish government aims to keep the mine operational until 2044, despite environmental concerns. The Warsaw Administrative Court's ruling that the mine's activities could pose environmental threats has sparked controversy.
- C-Energy Planá Expansion: The company, which supplies heat and energy to Tábor, Sezimovo Ústí, and Planá nad Lužnicí, has initiated a licensing process for expansion.
- Environmental Activism: Greenpeace has appealed against a decision to extend mining in the Bílina mine in Teplice until 2035. There is also opposition to the planned mining of Šterkopísk.

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