

Socioeconomic reconversion of post-mining territories: stakeholder engagement in mine closure processes

Reconversão socioeconômica de territórios pós-mineração: engajamento dos stakeholders em processos de fechamento de minas

Reconversión socioeconómica de territorios post-minería: participación de los grupos de interés en procesos de cierre de minas

Rodrigo Silva Barreto¹

Jacques Demajorovic¹

Adriano Augusto França Pimenta¹

Received on March 3rd, 2024; accepted on November 24th, 2024.

DOI: <http://dx.doi.org/10.20435/inter.v26i1.4458>

Abstract: Mining activity, especially in vulnerable contexts, fails to convert economic gains into sustainable development for post-mining, intensifying social impacts upon mine closure. This research argues that an integrative approach involving stakeholders through engagement and social dialogue appears as an alternative in understanding the territory's trajectory and establishing governance that is sustainable in the long term. The main aim of this work is to systematize a set of analytical categories aimed at strengthening engagement processes applied to the mine closure process. The chosen research strategy was indirect documentary research, which seeks articles and academic productions that support the exposed content. The academic literature is still relatively incipient when studying the themes related to social issues in mine closure and post-closure processes. It is also highlighted that effective participation will only occur when the impacted communities participate in the discussions and decision-making processes related to the present and future use of the territories.

Keywords: mining; social impacts; engagement; mine closure.

Resumo: A atividade de mineração, especialmente em contextos vulneráveis, falha em converter ganhos econômicos em desenvolvimento sustentável para o pós-mineração, intensificando impactos sociais na desativação de minas. Argumenta-se, nesta pesquisa, que uma abordagem integrativa, envolvendo os *stakeholders* por meio do engajamento e do diálogo social, mostra-se como uma alternativa na compreensão da trajetória do território e estabelecimento de uma governança que se sustente no longo prazo. O objetivo central do trabalho é sistematizar um conjunto de categorias analíticas voltadas ao fortalecimento de processos de engajamento aplicadas ao processo de fechamento de minas. A estratégia de pesquisa escolhida foi a pesquisa documental indireta, em que se buscam artigos e produções acadêmicas que sustentem o conteúdo exposto. A literatura acadêmica ainda se mostra relativamente incipiente quando no estudo dos temas relacionados às questões sociais em processos de fechamento de minas e pós-fechamento. Destaca-se também que uma participação efetiva somente ocorrerá quando as comunidades impactadas participarem das discussões e dos processos de decisão relacionados ao uso presente e futuro dos territórios.

Palavras-chave: mineração; impactos sociais; engajamento; fechamento de minas.

Resumen: La actividad minera, especialmente en contextos vulnerables, falla en convertir las ganancias económicas en desarrollo sostenible para el post-minería, intensificando impactos sociales en la desactivación de minas. Se argumenta en esta investigación que un enfoque integrador que involucre a los grupos de interés a través de la participación y el diálogo social se presenta como una alternativa en la comprensión de la trayectoria del territorio y el establecimiento de una gobernanza que se sostenga a largo plazo. El objetivo central del trabajo es sistematizar un conjunto de categorías analíticas orientadas al fortalecimiento de procesos de participación aplicados al proceso de cierre de minas. La estrategia de investigación elegida fue la investigación documental indirecta, en la que se buscan artículos y producciones académicas que sustenten el contenido expuesto. La literatura académica todavía se muestra relativamente incipiente al estudiar los temas relacionados con las cuestiones sociales en procesos de cierre de minas y post-cierre. También se destaca que una participación efectiva solo ocurrirá cuando las comunidades impactadas participen en las discusiones y los procesos de decisión relacionados con el uso presente y futuro de los territorios.

Palabras clave: minería; impactos sociales; participación; cierre de minas.

¹ Centro Universitário FEI, São Paulo, São Paulo, Brasil.

1 INTRODUCTION

In countries with a strong mining tradition, such as Canada and Australia, the activity has significantly contributed to their economic and social growth. Noteworthy are the payment of royalties, job creation, and social investment actions implemented by companies (Vivoda; Kemp; Owen, 2019). In Latin America, the economic contribution of mining does not differ from similar contexts around the globe. The beginning and peak of mining activities are marked by their significant financial contribution to the territories, proving to be a major pillar of the economy for many countries. Specifically, in Brazil, a country that boasts a great wealth of non-renewable mineral resources, especially in the states of Minas Gerais (MG) and Pará (PA), the economic contribution of mining in the territories is represented by the volume generated with the Financial Compensation for Mineral Exploration (CFEM). In 2021, approximately 103 billion reais were collected, with about R\$ 78 billion (almost 76%) concentrated in just 10 municipalities of MG and PA among the 2,635 municipalities with mining operations that year (Agência Nacional de Mineração, 2021). Beyond the economic contribution, the generation of jobs and investments in public infrastructure, many of these as conditions for operation, stand out as positive social impacts (Xavier, 2013).

However, mining activity, especially in contexts of vulnerability, has demonstrated an inability to transform the economic gains generated into a process of economic diversification and to ensure sustainable development of the territory throughout the operation cycle (Pimenta *et al.*, 2021). Reality has shown that the progress brought by mining enterprises is also accompanied by numerous negative socio-environmental impacts. These include health damage to local residents and the environment (Vivoda; Kemp; Owen, 2019), as well as violence, reduction of traditional economic activities, and violation of human rights (Mancini; Sala, 2018). The recognition of these impacts, commonly associated with the operation of mineral projects, advances timidly in the discussion of mine closure processes.

Historically, mine closure focuses on the deactivation of facilities, environmental recovery and remediation, and the adoption of measures and programs that promote the physical and chemical stability of the area (Beckett; Keeling, 2019; Vivoda; Kemp; Owen, 2019). This important concern with the physical and environmental aspects of closure has allowed the accumulation of knowledge about the technical-environmental themes of mine closure. Yet, the valorization of social impacts in this process is much more recent (Beckett; Keeling, 2019; Xavier, 2013) and emerges as an evolving knowledge, increasingly attracting researchers' attention in mining. It is recognized that the effects of a mine's closure on a community can persist for several years after its closure, potentially resulting in numerous negative socioeconomic impacts on the physical and mental well-being of residents (Xavier; Veiga; Zyl, 2015). In this scenario, a new business model is necessary, one that improves the management of technical, environmental, and social risks (Fraser; Xavier, 2021). To embrace the challenge of sustainable development, the mining industry must balance economic gains, environmental costs and benefits, and social impacts. Therefore, collaboration between the industry, government spheres, and civil society (organized or not) requires an understanding of the needs and viewpoints of each key stakeholder (Babi; Asselin; Benzaazoua, 2016). Thus, promoting community engagement, as well as building with them and with the local government a participatory governance of the territory encompassing the planning, operation, and closure phases are fundamental aspects to ensure the socioeconomic sustainability

of the territory in the post-mining period (Xavier, 2013). In this context, two research questions emerge: how have social aspects been integrated into mine closure processes; and how to favor engagement processes in mining communities. The main goal of this work is to systematize a set of analytical categories aimed at strengthening engagement processes applied to the mine closure process. The chosen methodological procedure was the systematic literature review.

2 METHODOLOGY

The conducted documentary research is based on a bibliographic review, that is, the theoretical foundation of the studied topic, which is a known research technique as indirect documentary research, where articles and academic productions that support the exposed content are sought (Marconi; Lakatos, 2003). The systematic consists of: 1. Identification (articles found in the database scan; duplicate filter); 2. Screening (Dynamic reading: title, keywords, and abstracts- filter for misalignment with the research); 3. Eligibility (Raw portfolio: qualitative analysis by the researcher- inclusion and exclusion); 4. Included (Total articles for analysis; articles for methodology).

2.1 Identification

In the study, multiple sources were consulted until the final version was consolidated, seeking relevant articles and high impact factor studies on themes that, although considered recent, gather a significant number of authors discussing their texts and defining a standard. The present study started from a literature review made on the WoS site, a referential platform for access and support to scientific research that has an extensive database from various academic disciplines. The analyses done on the platform initially sought to identify studies that had as their main topics the following terms in English related to the process of mining operation closure: Mining Closure, Post Mining Transition, Closure Relinquishment, Mining Downscaling, Decommissioning, resulting in a total of 1,851 articles identified.

2.2 Screening

The second phase of the study is based on the qualitative research approach (Richardson; Peres; Wanderley, 1985). The qualitative approach, besides being an option for investigation, is justified mainly because it is an appropriate way to understand the nature of a social phenomenon, having a descriptive character. However, in descriptive research, the aim is to discover when the phenomenon occurs and what its relationship and connection with other variables that impact it are. Therefore, the analytical script unfolded to narrow down the results and facilitate qualitative deepening. Thus, it was used: the Autocode function of NVivo, which seeks to analyze the frequency of synonym words; cluster/dendrogram in VOSviewer / NVivo to observe the areas of higher concentration of studies. Given the 1,851 articles, after running two tests- synonym word frequency and auto-code of literature (NVivo), and cluster/dendrogram (VOSviewer/NVivo)- a greater presence of studies on the environmental and regulatory aspects of mine closure was observed in 418 articles. Refinements were made to identify articles with the terms environmental, social, and local development. In total, 418 articles or 23% presented the term environmental in their topics. Meanwhile, the terms social and local development were

identified in 217 documents, that is, 12%. An analysis was then made from the environmental theme's perspective, seeking greater attention to social aspects in texts about mine closure. Complementing the given analysis with the help of NVivo, the VOSviewer software will be used in text analytics or text mining to create, visualize, and explore scientific maps (Van Eck; Waltman, 2019). The possibility of an author co-citation analysis (ACA) or co-authorship using the data exports generated by the VOSviewer algorithm and consolidating them into tables in MS Excel was also considered. The VOSviewer algorithm allows identifying the references cited among the previously filtered and selected articles and presents them in a ranking based on the number of times each work is cited, allowing identification of those works of greater relevance and influence that could be considered seminal. This enables the expansion of the selection of articles in an attempt to identify the most important ones that may have been excluded in previous filters. For example, an article that is cited numerous times within the filtered base deserves to be investigated for its why. The results of these analyses are presented in the Discussion section.

2.3 Eligibility

Focusing on validating the thematic labels and achieving the rigor and relevance of the research (Yin, 2015), it was decided to hold meetings with three experts in mining and sustainable development linked to two universities in Canada, Spain, and Brazil, as well as with the participation of an expert from the NVivo software. The discussion meetings for choosing the thematic labels confirmed the validation of the aspects identified through the key terms. This work results in inclusions and exclusions of texts supported by criteria agreed upon by the experts and not solely at the discretion of the researcher. That is, tie-breaking criteria for inclusion and exclusion criteria from the text base were defined. To achieve the final classification, the abstracts and validated keywords were organized in NVivo to select the articles with the highest volume of discussion on social issues. Thus, the third phase of the study identified 35 articles whose themes presented units of analysis focused on social issues. To reach this identification in the third phase, the abstracts and keywords of the 217 articles were framed in NVivo to select the articles with the most extensive discussion on social issues. After this organization in NVivo, the authors and experts conducted a detailed reading of the most relevant articles that address the social dimensions associated with mine closure. This led to the delineation of the third phase with 35 articles defined in this research, where the literature review and analyses were conducted with the support of the VOSviewer and NVivo software. The reading of the abstracts validates the final classification.

2.4 Included

In the last phase, the remaining articles whose themes present units of analysis predominantly focused on social aspects among the studies of mine closure in academia were known. A detailed reading of this base was conducted to carry out the theoretical and methodological analysis. Dynamically, as the detailed reading of the articles progressed, it was identified the need to include new works referenced in the read articles that suggested additional reading material for clarification and better understanding of key subjects discovered during the investigation process. This method, which expands the possibility of rescuing relevant articles for the research topic, is known as snowballing. In it, references from the articles included in the final

base are sought to identify articles of potential interest for this research, that is, it enriches the base with more relevant studies from the central theme. Twenty-seven additional articles were identified and included for qualitative deepening of the engagement discussion in contexts of mine closure. Thus, in this fourth phase, 62 articles in the context of mine closure were reached, 35 with emphasis on the social theme and 27 focusing on engagement, as synthesized in Table 1.

Table 1 – Summary of the methodological procedure. Topic: Mine Closure

Stage	Filter	Result	Observations
Identification	WoS Collection (sample)	1,851 (100%)	Mine Closure Post-Mining Transition Closure Relinquishment Mining Downscaling and Decommissioning and Mining
Screening	Environment	418 (22.6%)	Scope: environmental
	social and/or local development	217 (11.7%)	Scope: social
Eligibility	Initial reading of abstracts and keywords (qualitative)	35 (1.89%)	Social approach within the field of mine closure and accessible
Included	Snowball method (qualitative): engagement	62 total 27 included	Scope: engagement

Source: Elaborated by the authors.

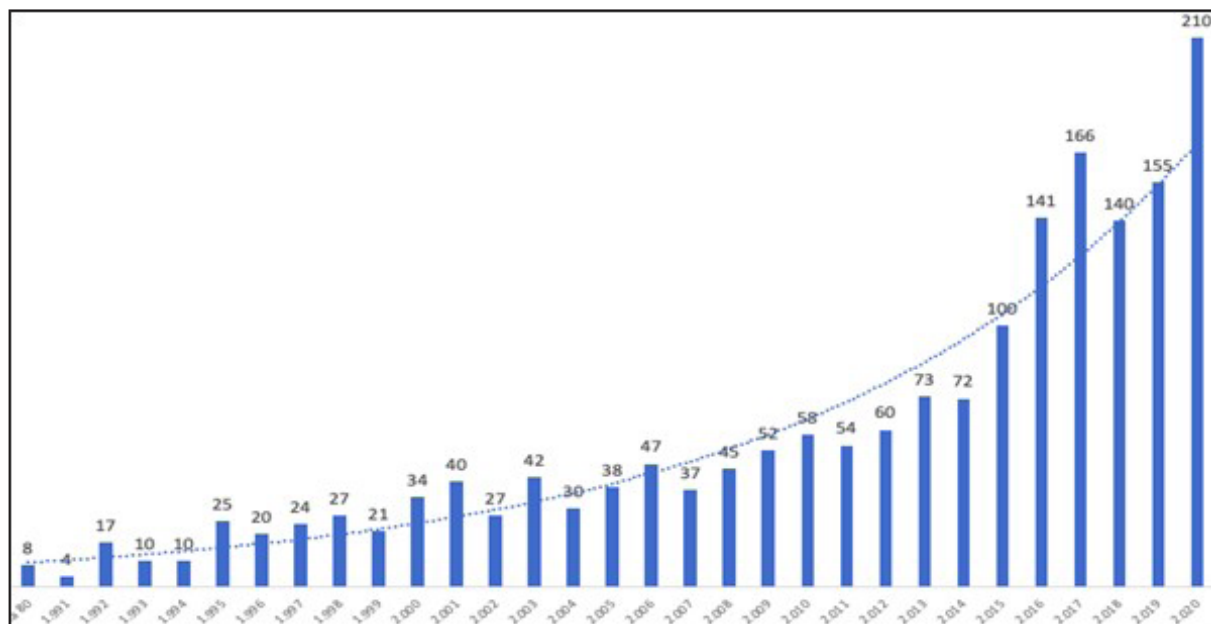
3 DISCUSSION

In this section, we will present and delve into the results obtained regarding the two research questions presented: the evolution of the integration of social aspects in the debate on mine closure and the transition to post-mining, and the construction of analytical categories of engagement processes especially in the context of mine closure.

3.1 Evolution of the social theme in mine closure processes

The first publication addressing the theme of mine closure dates back to the late 1960s. However, until the 1990s, fewer than ten publications had been made on this theme. It was from the beginning of the 1990s that publications began to increase, growing steadily until the early 2010s. More than 50% of the articles were written from 2015 onwards, with the peak of publications occurring in 2020 with 210 articles, thus showing a strong trend towards an increase in academic interest in this area. Thus, considering the period from 1968 to 2020, 1,851 articles addressing the theme of mine closure were identified (Figure 1).

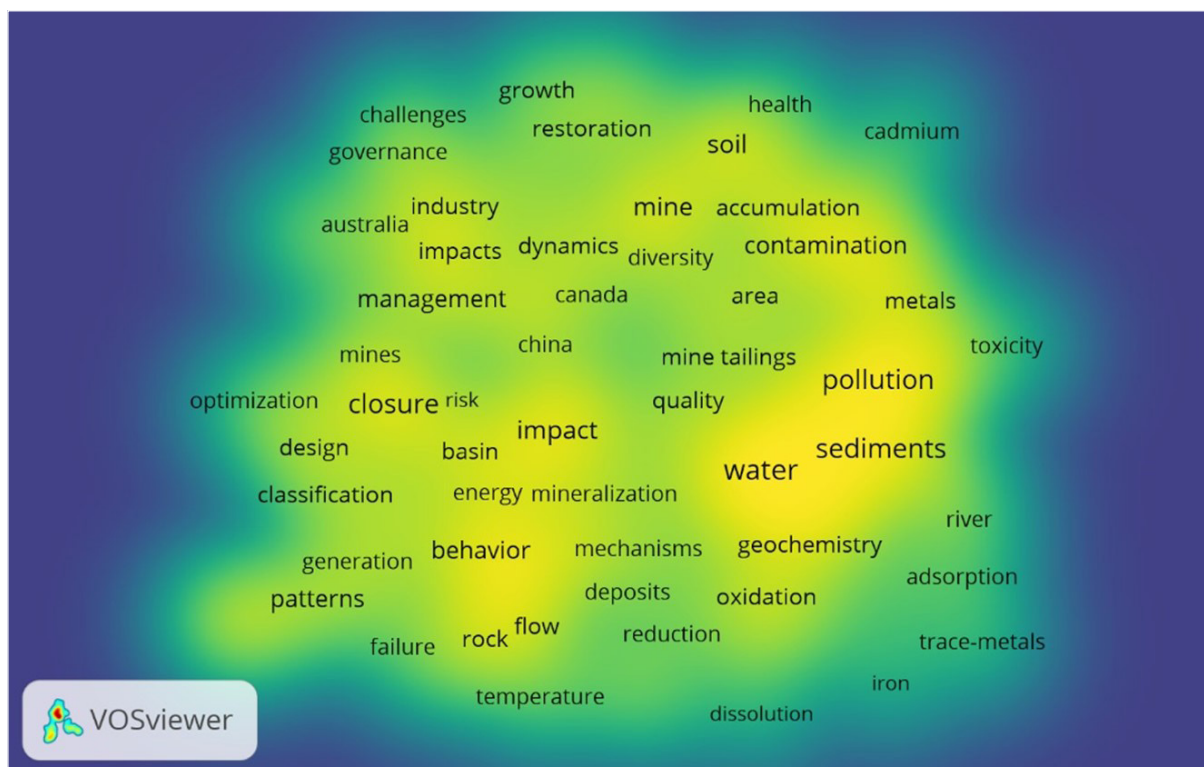
Figure 1 – Evolution of publications on mine closure



Source: Elaborated by the authors from the WoS data.

Most of the articles, however, focus on themes related to the deactivation of facilities, the recovery of the environment, and the physical-chemical stability of the area (Beckett; Keeling, 2019; Vivoda; Kemp; Owen, 2019). Therefore, for the mine closure processes, the concern with the physical and environmental aspects of closure promoted an accumulation of knowledge and practices regarding the technical-environmental aspects. The presentation of the word cloud by VOSviewer corroborates the findings from the NVivo algorithm, even though both use different algorithms. Such inference is not invalid, considering that the database is the same, using a large enough "n" ($n=1,851$) to conclude that there is statistical significance in this comparison (Chung; Zhong, 2001), even if by mere graphical observation. A dense region of studies concentrated on contamination, pollution, sediments, water, and geochemistry is observed; a second region focusing on themes of risks, impacts, watersheds; a third region grouping the management of impacts and ecosystems. Thus, the argument of the emphasis of the environmental perspective when the theme is mine closure is reinforced, as shown in figure 2.

Figure 2 – Density Visualization (incidence of keywords)



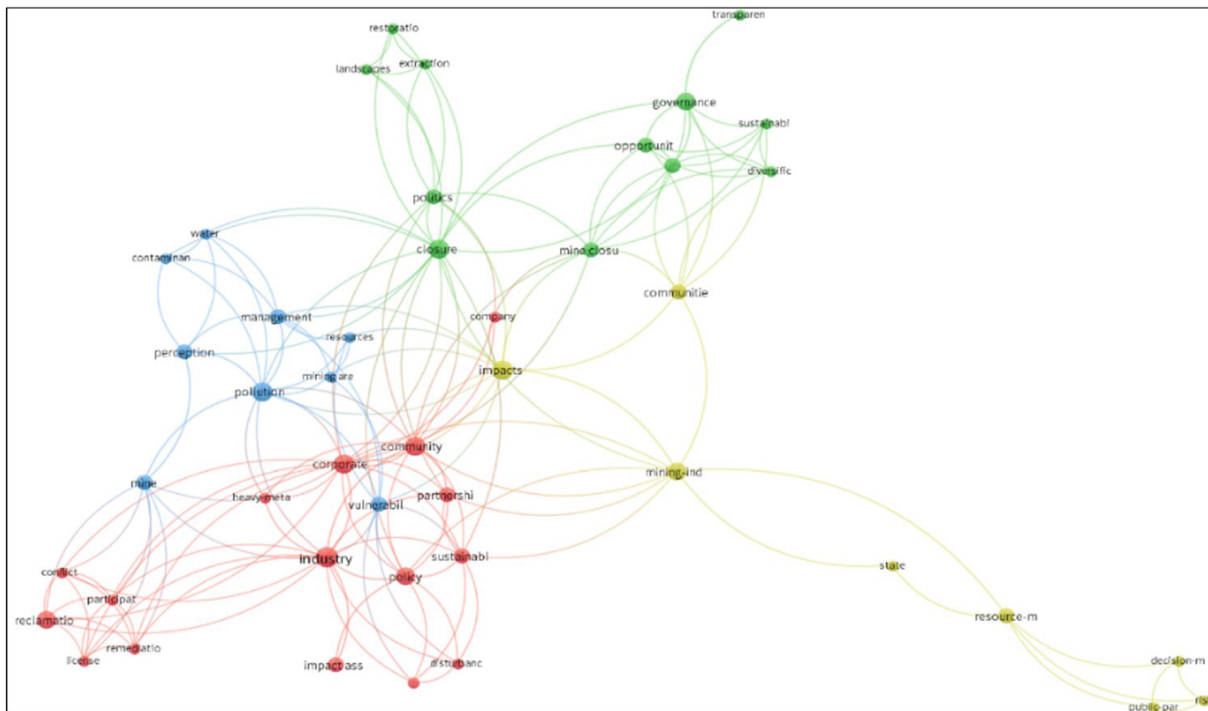
Source: Elaborated by the authors from the VOSviewer and WoS data.

If the issue of environmental impacts of mining seems well consolidated in the literature, the issue of social aspects in the mine closure processes is still relatively recent (Xavier, 2013; Xavier; Veiga; Zyl, 2015). Of the 1,851 articles identified in this research in the WoS, only 217 discussed the theme of mine closure from a perspective of social impacts on territories. Consequently, the knowledge base about the physical aspects of mine closure is significantly deeper and more developed than that of social aspects (Bainton; Holcombe, 2018).

In the study's second phase, which considers the base of 217 articles, an author co-citation analysis (ACA) was performed using the data exports generated by the VOSviewer algorithm and consolidating them into tables in MS Excel. This allowed organizing the articles considering the number of citations within the set of 217 documents. The algorithm identified 10,692 cited references among the 217 articles and presented a ranking based on the number of times each work is cited, allowing the identification of those works of greater relevance and influence, which could be considered seminal.

The same exercise was performed for the base of 35 articles obtained in the 3rd phase, and with the result of the ranking, a comparison of the two rankings was made. It was observed that 7 among the first 10 seminal articles from phase 3 were also among the first 10 of phase 2 (base of 217), which shows coherence in the filter used in the transition from phase 2 to 3, an exercise conducted in the observation of experts. Based on the 35 articles of the third phase, an analysis of co-occurrence of keywords was also performed with the VOSviewer software and is shown in Figure 3.

Figure 3 – Map of the co-occurrence relations of keywords



Source: Elaborated by the authors from the WoS data.

The map of terms identified 125 different keywords, 45 of which have some relation to each other (forming nodes) distributed in 4 clusters. Cluster 1 (red) consists of 16 terms with the strongest relationship among them, highlighting the relationship between participation, conflict, license, reclamation, industry, corporate social responsibility. This shows the academic discussion on the participation of the population in licensing processes, conflict resolution, and a process of corporate social responsibility. Cluster 2 (green) consists of 12 terms, highlighting the relationship of social license with governance, opportunities, sustainability, closure, mine closure, diversification, as well as with communities, which is in the yellow cluster. This result shows the importance of the discussion of social acceptance of communities through the social license in mine closure processes in views of the territory's sustainability. Cluster 3 (blue) concentrates the discussion around environmental aspects such as water, contaminant, metals, pollution. However, the node vulnerability also relates to impacts, sustainable development principles, policy, industry, pointing out the discussion of social vulnerability amid the impacts of the industry in the face of the need for sustainable development. In cluster 4 (yellow), which contains communities, impacts, mining-industry, it also highlights the relationships of public-participation with decision-making, resource-management, risk, showing the discussion of public participation in decision-making involving resource management and risk. Thus, the literature on mine closure underscores the importance of interactive dialogue between the entrepreneur (industry) and the stakeholders. In the qualitative reading of the texts, engagement showed itself as a central element, especially when discussing governance, social license, participation, and community in contexts of mine closure. Such discussion appeared recent and embryonic, which reinforces the need for deepening in the literature on engagement and bringing it closer to the debate on mine closure. The deepening of this discussion was carried out through the snowball

technique, identifying relevant articles within this scope, adding 27 more works to the 35 of the worked base, totaling 62 works.

Given the relevance found in the literature of engagement in the discussion of mine closure processes, and aiming to answer the research question, we now present the qualitative analysis of the 62 articles selected in the fourth phase of the methodology.

3.2 Characteristics of Engagement

A significant challenge in planning for post-mining is identifying areas of consensus among engaged stakeholders regarding the main issues and concerns (Akbar *et al.*, 2020). However, the context of engagement differs from the mandatory dialogue in licensing processes for approval by the regulatory entity, for which the licensing criteria may or may not be aligned with the aspirations of the stakeholders. Thus, discussing the duty of regulatory authorities to license a mining enterprise, whether its operation or its closure, is outside the scope of this research. The search for the Social License to Operate (LSO), that is, the community's acceptance and support for the implementation and operation of a mining project (Demajorovic; Lopes; Santiago, 2019), and the engagement practices associated with this process, is a voluntary practice that can influence the regulatory process (Holley; Mitcham, 2016). Thus, this research does not consider the regulatory process as a cause for engagement, but rather sees it as a corporate strategy to achieve the LSO.

Rowe and Frewer (2005) argue that the space for possibilities of engagement can be classified according to the direction of the flow of information, with three possibilities. It is characterized as Communication when activities originate from the entrepreneur and are intended for the public. Conversely, Consultation follows the opposite flow, that is, information flows from the public to the entrepreneur. In both, the flow of information is unidirectional, where there is no formal dialogue between the entrepreneur and individual members of the stakeholder group. Lastly, Participation is characterized by a dialogue, or rather, a bidirectional flow of information between the entrepreneur and the public. That is, Communication and Consultation occur simultaneously. From now on, these combined concepts are referred to as engagement, and the methods intended to enable this as engagement mechanisms (generically) or engagement initiatives (specifically). Examples of mechanisms for dialogue include consensus conferences, town hall meetings, voting activities, among others. Rather than simple and crude opinions being conveyed to Sponsors (entrepreneur), the act of dialogue and negotiation serves to transform opinions in members of both parties (Rowe; Frewer, 2005). Here, the entrepreneur is considered the main economic agent who commissions the engagement initiative. Other authors have suggested that organizations can go beyond interaction to bidirectional communication, but recognize that this may have a transactional approach to engagement, meaning that the organization would meet the minimum requirements for stakeholder involvement and relationship building in search of social acceptance (Mercer-Mapstone *et al.*, 2017).

At its core, the literature suggests three factors emerging as particularly significant for social acceptance: trust in mining, procedural fairness around mining decision-making processes, and the strong relationship between company-community (Mercer-Mapstone *et al.*, 2018). Research (Mercer-Mapstone *et al.*, 2017, 2018) indicates that trust between a company and its stakeholders is at the heart of the social licensing process and acts as a driver of social acceptance. The main

findings indicate that positive experiences of dialogue by community members lead to stronger relationships with mining personnel, increased perception of procedural fairness, and indirectly trust and social acceptance of the mining industry (Mercer-Mapstone *et al.*, 2018). High-quality involvement between communities and companies leads to a significant increase in trust and social acceptance (Moffat; Zhang, 2014). The process of seeking social acceptance is not the same as trying to create public and community acceptance for a project where the boundaries and objectives have been fully defined before engagement (Raman; Mohr, 2014). Often, engagement may involve communication based on advocacy, defined as communication based on persuasion with the aim of stimulating acceptance of a viewpoint or favorable representation of an individual, organization, or idea (Edgett, 2002). However, from a pro-social perspective, engagement should involve interaction characterized by mutuality/reciprocity, mutual action or effect, or the construction of an ongoing relationship (Hurst; Johnston; Lane, 2020; Johnston, 2018).

Social acceptance, therefore, requires a conceptualization of engagement at a societal level where value is constructed in collective actions and outcomes (Johnston, 2018). Engagement from a pro-social perspective would see the entrepreneur engaging with a wide variety of stakeholders, willing to relinquish power or at least attempt to overcome power dynamics, including those between stakeholders, and work to achieve mutual benefits with their stakeholders or at least build ongoing relationships with them (Hurst; Johnston; Lane, 2020).

The trend of communities demanding a larger share of benefits and greater involvement in decision-making has been stimulated by the growth of the sustainable development paradigm and changes in governance that have increasingly transferred authority from the government to non-state actors (Prno; Scott Slocombe, 2012). These changes have broadened the spectrum of governmental actors, with civil society and market actors now regularly sharing governmental duties with the state. Thus, governance processes include negotiation, accommodation, concertation, cooperation, and alliance formation instead of traditional processes of coercion, command, and control, where interaction emerges as a central component of the governance perspective, defined as a mutual influence relationship between two or more actors or entities. Which governance models work best and in which combination, and how the efficacy of the model varies in different social, political, and economic contexts are specific areas that still need further investigation (Prno; Scott Slocombe, 2012).

Significant community engagement is carried out as a continuous process throughout the mine lifecycle with the aim of ensuring that local community concerns are heard and addressed. True collaboration, rather than mere consultation, is key to the success of mine closure recovery (Bjelkevick; Bohlin, 2021). Bjelkevick and Bohlin (2021) believe that stakeholders, communities, and regulatory bodies need to be engaged from the initial planning process until the point of responsibility transfer in post-closure. However, they consider that despite being theoretically simple, in reality, this process is challenging, mainly due to the lack of trust among the parties due to a history of unilateral communication flow (informative) and the lack of clarity of responsibility among the parties.

The broad scope of mechanisms for involving stakeholders in the planning process for closure does not imply a consensus on the effective means to accomplish them (Everingham *et al.*, 2018). The most suitable mechanism should consider information management, legitimacy, social dynamics, and costs (Rauschmayer; Risse, 2005), or alternatively, scope, representativeness, opportunity, comfort, and convenience, and influence (Eiter; Vik, 2015). In any case, better trust

in the outcomes of engagement in the closure process can be achieved if a collaborative process involving an expanded stakeholder group is conducted, aiming for a greater understanding of the factors that may influence the decisions of this group (Everingham *et al.*, 2018).

3.3 Dialogue and engagement in the context of mine closure

Participation is considered an indicator of the quality of the relationship between the company and the community. Bowles, MacPhail and Tetreault (2019) establish a link between participation and fair procedures, a concept supported by Zhao *et al.* (2020). For Moffat and Zhang (2014), procedural justice is a determining factor for establishing trust and approval of a project, which is directly related to the foundations of LSO. Cesare and Maxwell (2003) argue that the involvement of governments, communities, and other stakeholders can contribute to the development of a strong mineral policy and further emphasize the important role that communities have in developing plans and activities for mine closure, a view also defended by Odell, Scoble and Bullard (2011).

Cesare and Maxwell (2003) remind us that mining activity results in negative externalities for communities, and the increasing scrutiny, demand, and expectation from communities, consumers, civil society, and authorities force mining companies to demonstrate their contribution to the development of societies and the physical, social, and economic environment. This expectation results in a pressure for greater participation in decision-making processes about the future use of mined territory. Thus, there seems to be a consensus among the analyzed authors about the importance of local community participation in mine closure processes (Bowles; MacPhail; Tetreault, 2019; Cesare; Maxwell, 2003; Odell; Scoble; Bullard, 2011; Vivoda; Kemp; Owen, 2019). Another point of consensus among the authors analyzed is that the process of effective and inclusive consultation should encompass the entire lifecycle of a mine and not just the closure phase (Bowles; MacPhail; Tetreault, 2019; Cesare; Maxwell, 2003; Everingham *et al.*, 2018; Odell; Scoble; Bullard, 2011). Odell, Scoble and Bullard (2011) argue that planning activities for mine closure should be expanded to include the concerns of local communities related to the population's well-being. These elements should be monitored with the development of specific indicators that make sense at the local level and highlight the importance of participatory monitoring, whether in environmental aspects or socioeconomic aspects.

The process of stakeholder identification is considered a vital activity for the closure process (Cesare; Maxwell, 2003). Everingham *et al.* (2018) suggest that individuals representing the diversity of local communities potentially affected by closure and decisions about future land use should participate in the decisions. The authors also recall that representatives of local communities hold empirical knowledge that gives them unique perspectives and insights, turning them into critical data and information for territory management. Although there is a consensus on the importance of participation, there does not seem to be much clarity on how to define the way in which participation occurs (Everingham *et al.*, 2018), nor on how to ensure the existence of adequate conditions for effective participation. A strong legal framework can force companies to involve communities and broaden consultation processes; on the other hand, it does not guarantee effective participation (Cesare; Maxwell, 2003).

Fragile participation of communities in the debate about the future of the territory can amplify impacts in the post-mining period. Kivinen, Vartiainen and Kumpula (2018) observed

that even 20 years after the closure of a mine in Finland, community members continue to be concerned about flora, water quality, and soil contamination. The authors assert that communities lack information and knowledge about local environmental conditions, generating a continuous feeling of distrust, influencing their relationship with the local territory and landscape. Thus, it is necessary to bring to the debate concrete experiences of mine closures to deepen how the process of engagement can be more or less effective.

The table below systematizes a set of preliminary categories that may integrate the engagement process in mining contexts.

Table 3 – Categories and subcategories on engagement in mining context

Category	Subcategory	Description
Information Flow (Mercer-Mapstone <i>et al.</i> , 2017; Rowe; Frewer, 2005)	Unilateral	Communication – originates from the entrepreneur and is intended for the public. Consultation – flows from the public to the entrepreneur.
	Bidirectional	Participation – interactive dialogue between the entrepreneur and stakeholders. Transactional – seeks to build relationships with various stakeholders.
Engagement Context (Holley; Mitcham, 2016)	Mandatory Dialogue	Characterized as not effective engagement. It's about meeting normative and legal obligations.
	Voluntary Dialogue	Does not consider the regulatory process as a motivator for engagement but rather the pursuit of obtaining and maintaining the LSO or LSF.
Scope of Involvement (Hurst; Johnston; Lane, 2020; Raman; Mohr, 2014)	Community	Tries to create public or community acceptance where objectives were defined before engagement.
	Variety of Stakeholders	Articulates various perspectives among place communities, other interested parties, and includes those viewed as marginalized and vulnerable.
Type of Engagement (Edgett, 2002; Hurst; Johnston; Lane, 2020; Johnston, 2018)	Information-based	Emphasis on persuasion through advocacy with selective participation of stakeholders to stimulate acceptance of a viewpoint or favorable representation of the organization.
	Dialogue-based	Collective action, shared knowledge, or reflective or experiential interaction with a wide variety of stakeholders in search of mutual benefits or continuous relationship building.
Choice of Engagement Mechanisms (Eiter; Vik, 2015; Rauschmayer; Risse, 2005)	Pre-defined Objectives	Perspective 1: Information management, legitimacy, social dynamics, and costs. Perspective 2: Scope, representativeness, opportunity, comfort and convenience, and influence.

Category	Subcategory	Description
Critical Elements of Social Acceptance (Cesare; Maxwell, 2003; Everingham <i>et al.</i> , 2018; Mercer-Mapstone <i>et al.</i> , 2018; Prno; Scott Slocombe, 2012)	Procedural Justice	The opportunity to have a 'voice' in decision-making processes is a central factor that people consider in the development of perceptions of social justice.
	Trust	Trust acts as a driver of social acceptance. The construct can be captured using three factors: integrity, benevolence, and credibility.
	Strong Company-Community Relationship	Frequent face-to-face communication is central to building interpersonal relationships. Community members' dialogue experiences are positively linked to their perceptions of their relationships with company personnel, where the core is the mutually beneficial relationship, the fulfillment of promises, the feeling of some control in interactions.
	Governance	Adoption of governance processes with participation of private, public, and civil society entities that include negotiation, accommodation, concertation, cooperation, and alliance formation, providing greater stakeholder representativeness in decision-making.
	Stakeholder Identification	Inclusion of individuals who represent the diversity of local communities potentially affected by closure and decisions about future land use.

Source: Elaborated by the authors.

From the discussion presented, it is evident the multidimensional nature of the engagement processes. Deepening this debate in the Brazilian context is essential, considering the economic importance of the activity and the challenges of social control of mining activities in the different stages of a project.

4 CONCLUSIONS

Recent research shows that the processes of mine closure and their associated social impacts need to broaden their space in the debate on the management of mining activities in mine closure processes. Considering the first research question, the results show the challenges still to be faced in incorporating social aspects into the planning of the post-mining period. While the environmental dimension in mine closure processes, driven by legislative advances, fostered knowledge in business practices and in the advancement of literature, social impacts remain relegated to a secondary plane. The recent but still limited contribution of academia and the lesser capacity and interest of companies in ensuring effective governance, engagement, and dialogue processes exacerbate the worsening of economic, environmental, and social impacts in the period of mining activities cessation, especially in contexts of vulnerability.

Regarding the second research question, it is argued that engagement processes enhance the relationships between an entity and its stakeholders, providing a means for an entity to understand the expectations of its stakeholders. The responses to these expectations have a

direct effect on an entity's reputation. Effective participation, however, will only occur when the impacted communities participate in the discussions and decision-making processes related to the present and future use of the territories. Moreover, it must be ensured that all stakeholders have technical capabilities for participation, therefore, the allocation of resources and investment in training programs for communities for strengthening capacities for dialogue and decision-making in groups, as well as training on technical aspects related to operation, closure, and post-closure, are indispensable.

The analyzed literature also reveals the need for legal frameworks and public policies related to mine closure to be promptly revised. Finally, the article contributes with a proposal of analytical categories that can be applied in future studies to deepen the theoretical knowledge and practices of engagement in mine closure processes. The application of these categories in the reality of mining territories may contribute to stimulating actions that promote the empowerment of the local community in order to reduce the power asymmetry between companies and communities and enable a true participation process. These are some future research paths that can contribute to a mining process that is socially just, committed to the maintenance of ecosystem services, and that places at the center of the debate alternatives to minimize the social, economic, and ecological vulnerability of populations in territories with mining throughout the operation cycle.

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About the authors:

Rodrigo Silva Barreto: PhD in Business Administration from the Centro Universitário FEI. Master in Business Economics and Finance from the Fundação Getúlio Vargas (EGPE/FGV/RJ) and Professor at the Centro Universitário FEI, Business Administration. **E-mail:** rodrigobarreto@fei.edu.br, **Orcid:** <https://orcid.org/0000-0002-6353-0434>

Jacques Demajorovic: Post-doctorate from the University of Alicante (Spain) and Professor of the Postgraduate Program in Business Administration at the Centro Universitário FEI. **E-mail:** jacquesd@fei.edu.br, **Orcid:** <https://orcid.org/0000-0001-6131-8790>

Adriano Augusto França Pimenta: PhD in Business Administration from the Centro Universitário FEI. Master in Administration from the Centro Universitário FEI. **E-mail:** pimentadriano@gmail.com, **Orcid:** <https://orcid.org/0000-0003-2918-8564>