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The social impacts in the supply chain of a cement industry: A case study under the lens of paradox theory

Impactos Sociais na Cadeia de Suprimentos de uma indústria cimenteira: Um estudo de caso sob as lentes da teoria do paradoxo

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Abstract: The mineral industry is complex, considering its many stakeholders and the divergent perspectives regarding its impacts. While many companies consider themselves accountable for complying with legislation and allocating profits to shareholders, society expects a reduction in environmental impact and respect for the local community. This context can generate tensions, especially considering a temporal spectrum, including the mine's operations beginning and closing. For instance, if, on the one hand, there are positive effects (e.g., generation of revenue, jobs creation), on the other, there are negative ones (e.g., pollution, diseases, dependence). The present study adopts paradox theory as a lens to stimulate this analysis. We investigate: what are the social impacts of the mineral supply chain, and how do they relate to sustainability tensions? We conducted a case study on a company from the mineral industry, with interviews, observation, and document analysis, focusing on the local community

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perspective. We present emerging categories of social impact in the post-closure context, and the interaction between social impacts and paradoxical tensions, highlighting the power disparity between agents. We contribute by depicting the types of tensions that generate social impact among the main actors: the focal company, the supply chain, the government, and the community. We also intend to contribute by stimulating the debate around why the negative impacts of mineral supply chains persist over time, despite being often known and even predictable.
Keywords – Social impacts; Mineral supply chain; Cement industry; Tensions and paradoxes of sustainability.

Resumo: A indústria mineral é complexa, considerando seus muitos stakeholders e as perspectivas divergentes em relação aos seus impactos. Enquanto muitas empresas se consideram responsáveis por cumprir a legislação e alocar lucros aos acionistas, a sociedade espera uma redução no impacto ambiental e respeito pela comunidade local. Esse contexto pode gerar tensões, especialmente considerando um espectro temporal, incluindo o início e o encerramento das operações da mina. Por exemplo, se, por um lado, há efeitos positivos (como a geração de receita e a criação de empregos), por outro, há efeitos negativos (como poluição, doenças e dependência). O presente estudo adota a teoria do paradoxo como uma lente para estimular essa análise. Investigamos: quais são os impactos sociais da cadeia de suprimentos mineral e como eles se relacionam com as tensões de sustentabilidade? Conduzimos um estudo de caso em uma empresa do setor mineral, com entrevistas, observação e análise de documentos, focando na perspectiva da comunidade local. Apresentamos categorias emergentes de impacto social no contexto pós-encerramento, bem como a interação entre os impactos sociais e as tensões paradoxais, destacando a disparidade de poder entre os agentes. Contribuímos ao retratar os tipos de tensões que geram impacto social entre os principais atores: a empresa focal, a cadeia de suprimentos, o governo e a comunidade. Também pretendemos contribuir estimulando o debate sobre por que os impactos negativos das cadeias de suprimentos minerais persistem ao longo do tempo, apesar de muitas vezes serem conhecidos e até mesmo previsíveis.
Palavras-chave – Impactos sociais; Cadeia de suprimentos mineral; Indústria cimenteira; Tensões e paradoxos da sustentabilidade.

Introduction

The Triple Bottom Line (TBL) perspective indicates that sustainability demands integration and balance of three dimensions: social, environmental, and economic (Elkington, 1997). In this context, the pursuit of sustainability within the supply chain (SC) assumes that social and environmental practices related to economic performance, at the same time, to achieve a sustainable SC (SSC) (Carter and Rogers, 2008; Beske and Seuring, 2014; Seuring *et al.*, 2022). The paradox perspective, in turn, points out that environmental and social sustainability have autonomous purposes, and it is not necessary that they invariably contribute to the economic success of the company (Smith and Lewis, 2011; Hahn *et al.*, 2018; Sharma *et al.*, 2023).

Studies that used the paradoxical perspective to investigate sustainability tensions are still scarce (Zhang *et al.*, 2021; Zehendner *et al*., 2021), as well as studies on tensions for SSC management (SSCM), especially when it comes to empirical ones (Van Der Byl and Slawinski, 2015; Brix-Asala *et al.*, 2018). However, tensions are recognized in the SC context (Wu and Pagell, 2011; Matthews *et al.*, 2016; Shareef *et al.*, 2020), only a few studies explicitly adopted the paradox perspective (Zhang *et al*., 2021) and consider its research potential in SSCM (Mathews *et al.*, 2016; Zehendner *et al.*, 2021). Sandberg (2017), for example, outlined emerging paradoxical elements in global sourcing contexts. Brix-Asala *et al.* (2018) investigated SSCM practices addressing paradoxical tensions of sustainability in SC. Wilhelm and Sydow (2018) studied management approaches to the paradox of supplier network competition. Xiao *et al.* (2019) identified responses to paradoxical tensions arising from conflicts between cost competitiveness and sustainability. Carter *et al.* (2020) used paradox theory to conceptualize the emergence of unintended consequences of SSCM initiatives. Zhang *et al.* (2021) identified multiple paradoxical elements through a systematic literature review. Zehendner *et al.* (2021) dealt with sustainability tensions in the electronics sector. They pointed out the lack of empirical studies from the perspective of different and unconventional actors in the multilayer SSC, as well as analysis of possible responses to these tensions. Sharma *et al.*, 2023, inspired by the paradox theory, identified SSCM and operational performance elements to

understand their complementary and contradictory nature. Dahlmann *et al.* (2023) investigate the tensions firms experience in organizing the processes of managing their SC emission.

One of the sectors in which it is necessary to deepen this debate into the SC context is the mineral sector due to its economic importance (Agarwal and Agarwal, 2017) and sustainable issues (Sauer and Seuring, 2017). The main activity of the mineral industry involves transforming natural resources into raw materials that supply the most varied production processes. At the same time, its process is directly related to the generation of impacts and, in this sense, demands attention to enable sustainability in the sector (Azapagic, 2004). If, on the one hand, there are positive effects concerning the generation of income and jobs, on the other hand, they generate profound negative socio-environmental impacts, making it a paradox to say that sustainability is a reality in the mineral industry (Peplowski *et al.*, 2011; Demajorovic *et al.*, 2019; Freitas *et al.*, 2019). Among these impacts, the disappearance of traditional economic activities, increased economic dependence and greater demand for social services stand out (Esteves and Vanclay, 2009; Mancini and Sala, 2018).

It is also important to point out that as part of the extractive activities operate with finite resources, the negative impacts observed in the period of operation tend to increase in processes of closure of activities, affecting the local production chains in different ways. Research on mineral SCs, however, tends to focus on assessing environmental issues (Lee et al., 2020), also on emphasizing the perspective of large company managers facing sustainable issues along the SC (Schoggl et al., 2016; Sauer, 2021). However, economic stagnation and aggravation of social problems are common problems observed in territories with mineral activity as an economic pillar (Xavier, 2014). The more dependent the territory is on this main economic activity, the greater the probability of expanding social impacts throughout the production chain developed as an offer of complementary services to the focal company. Other common characteristics identified in high-dependency territories that aggravate this problem are: the fragility of local governance systems and the dominance of the mineral project in political, economic and social life (Cole and Broadhurst, 2020); the low understanding of local governments of the social impacts linked to closure processes and the deliberate attitude of companies in not engaging in closure processes and

investing resources in this transition (Bainton and Holcombe, 2018) and the limitations of local communities in redefining their identity after long periods of dependence (Assche *et al.*, 2021).

Van den Brink et al. (2019) reviewed existing literature and company policies on 'responsible sourcing' of minerals, but only from a theoretical perspective. Empirical investigation is still needed. In this sense, research on mineral SCs could benefit from a deeper investigation of its social impacts, especially from the local community perspective regarding the territory impacted.

This research focuses on understanding the closing process of the cement industry and its consequences on the local SC. The cement industry is part of the mineral industry complex, fundamental in the social and economic countries development. Often, the cement consumption index serves as an indicator of the development of nations. Its SC is complex, considering the number of stakeholders and their divergent perspectives on sustainability in the sector, generating tensions. The perspective of the paradox offers an opportunity to deepen the nature of tensions and how to manage them to advance sustainability (Sauer and Seuring, 2017). Adopting paradox theory as a lens to this phenomenon can promote a contrast analysis related to its social impacts and shed some light on understanding why the negative impacts of mineral SCs persist over time.

Considering the cement industry, its relevance, and existing theoretical and empirical research gaps, we investigate: what are the social impacts of the mineral supply chain and how they relate to sustainability tensions? The present research aims to analyze the social impacts of mineral SCs, focusing on its closing process and investigating sustainability tensions from the community's perspective. To achieve this, we propose to (i) Identify the social impact of the cement industry from the perspective of the community; (ii) Identify sources and types of paradoxical tension in the SC of the cement industry; and (iii) Analyze the relationship between social impacts and sources of tension in SC of the cement industry.

The study adopts as a methodological strategy the case study, investigating a cement chain located in the city of Pedro Leopoldo. Located in Minas Gerais, until the 1940s its population lived from agriculture, livestock, small businesses, handicrafts, and a fabric factory. After the 1950s, with the arrival

of the cement company, the city underwent a complete transformation, with the company being the main source of income for the city and its population. The business was maintained until 1997 by its founder and his heirs, being sold that year to a group, forming part of the holding. With this operation, the company's general management ceased to be local. In 2019, the cement plant temporarily suspended its operations. Thus, the community and suppliers waited for the possible reopening of the factory, but in 2022 the factory was dismantled, the machines being removed and taken to other plants in other cities. The case stands out as relevant for investigation since it presents a retrospective view of a paradox in which the local community, with the arrival of the focal company, received positive impacts, such as jobs, an increase in per capita income, economic and infrastructure development, in addition to other negative impacts, considering the disorderly increase in population, health problems, environmental degradation, excessive dust, and noise.

The structure of this study was organized as follows: first the introduction, then the theoretical framework; then the methodological approach, data analysis, and presentation of the results; the theoretical and practical implications are discussed; and, finally, the conclusion, presenting its limitations and outlining future studies.

Literature Review

Over the years, the impact of mining on the economy, the environment and society has been analyzed from different perspectives (Festin *et al.*, 2018). For Sheoran *et al.* (2010), the impacts of mining can be both positive and negative. Worlanyo and Jiangfeng (2021) analyze the impacts of mining in three broad categories: economic, environmental, and social. The present study deepens its investigation into the scope of the social impacts of mining, expanding its analysis of its management in SC. As we intent to investigate the social impacts of the mineral SC and how they relate to sustainability tensions, we rely on paradox theory as a lens that enables the development of multilevel analysis (Matthews et al., 2016)

and embrace complexity in the search of unusual and interesting findings (Hitt et al., 2007). This theoretical choice also favors the analysis of contrast (e.g., as we assess social impacts before and after the closure of a mineral SC operations). It also supports our attempt to understand why the negative impacts of mineral SCs persist over time.

Paradox theory and types of paradox

Paradoxes can be defined "as contradictory but interrelated elements that exist simultaneously and persist over time" (Smith and Lewis, 2011, p. 382). Paradoxes are tensions raised by conflicting demands or perspectives inherent to organizations, denoting the complexity, diversity, and ambiguity of organizational life (Lewis, 2000; Luscher and Lewis, 2008; Poole and Van De Ven, 1989). The paradox theory suggests that, faced with a paradox, organizations tend to choose the side that is more familiar to the group, creating defense mechanisms that block the other side of the paradox. Defensive mechanisms inhibit the organization from dealing with ambiguity, restricting its ability to deal with conflicting demands. To counteract these defensive mechanisms, organizations must manage tensions by exploring ways to simultaneously address seemingly opposing forces (Smith and Lewis, 2011).

Sustainability tensions arise in broad contexts, often due to the incompatibility of temporal and spatial scales at different levels (Van Der Byl and Slawinski, 2015; Hahn *et al.*, 2015), they also arise when the short-term sustainability and efforts of organizations fail to match the subordinate and long-term sustainability concerns of stakeholder society (Hahn *et al.*, 2015; Slawinski and Bansal, 2015).

Regarding sustainability, the paradox can also be applied to the three dimensions of TBL (i.e., environmental, social, and economic). If each of them is considered individually, they seem logical, but when juxtaposed, a contradictory interaction. According to the paradox lens, companies and actors should embrace tensions rather than avoid or resist the occurrence of tensions between dimensions of sustainability. After identifying and understanding the tensions, the actors must accept them by admitting the coexistence of contradictory elements (Smith and Lewis, 2011; Hahn *et al.*, 2015).

Zehendner et al. (2021) present a framework for categorizing sustainability tensions in SC contexts, as illustrated in Figure 1. The authors argue that tension elements emerge within larger contexts and across different levels (i.e., individual, organizational, SC, and systemic) and that it is important to identify and understand sustainability tensions that generally arise due to incompatible temporal and spatial scales across different levels. The four main types of tensions are classified into learning tensions, organizing tensions, belonging tensions, and performance tensions.

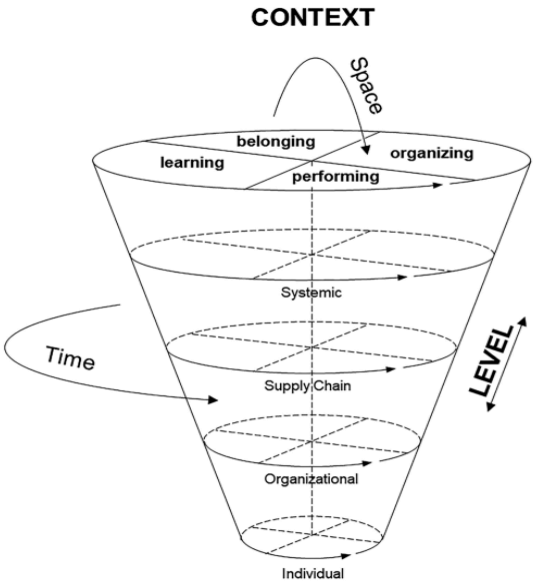

Figure 1. Framework for categorizing sustainability tensions in SC contexts.

Source: Zehendner et al., 2021, p. 885.

Learning tensions arise when dynamic systems change, renew, and innovate (Smith and Lewis, 2011). To ensure long-term sustainability, it is often necessary to tear down the old system and build a new one to generate new opportunities. Description of tensions could include old *versus* new; stability *versus* change; present *versus* future (Schad et al., 2016). Since sustainable development requires changes

in sustainable business practices, SSC becomes ubiquitous. Learning tensions arise between the need to move away from business practices and products and the need to develop routines and systems (Hahn *et al*, 2018). The learning paradox concerns the tensions between internalized knowledge, the uncertainty of the future and new challenges. It is the ability to integrate new knowledge, allowing adjustment to variations and changes (Smith and Lewis, 2011).

Belonging tensions arise between the individual and the collective, as well as within and between organizations in SCs (Schad et al., 2016). They are usually driven by different and often divergent identities, values and visions of actors in specific contexts (Smith and Lewis, 2011). These tensions normally arise between individuals and/or organizations with different values and views on sustainability (Hahn et al., 2018). Often, tensions and paradoxes of belonging become more salient due to global sourcing contexts, cultural differences and divergent perspectives *(*Sandberg, 2017). With the definition of goals made by individuals and organizations based on their identity and beliefs, belonging tensions can be seen as foundations of performance tensions (Mason and Doherty, 2016). The paradox of belonging concerns the tensions between the individual and the collective and between competing roles, aggravated by conflicts of belonging to multiple groups and subgroups. The challenges refer to respecting individuals while promoting integration and interconnections within groups. Tensions increase with decisions about how much time/effort to dedicate to the group (Lewis, 2000; Smith and Lewis, 2011).

Organizational paradoxes arise from the need to fully integrate sustainability activities into core business operations, having to follow and maintain a commercial business logic (Hahn et al., 2018). The organizational paradox results from the effort to balance forces that encourage commitment, trust and creativity, while maintaining efficiency, discipline and order (Lewis, 2000). Therefore, it relates to opposing forces of empowerment and direction; flexibility and control (Smith and Lewis, 2011). Organizational tensions arise when organizations and SC create competing structures and processes to achieve desired results (Smith and Lewis, 2011). These tensions arise from difficulties in determining and establishing appropriate methods for specific purposes. Organizational tensions and paradoxes often manifest themselves as conflicts between cooperation *versus* competition (Manzhynski and Figge, 2020;

Wilhelm and Sydow, 2018), and integrating *versus* separating. The integration of socio-environmental sustainability into core business structures and processes often leads to the emergence of organizational tension activities (Smith and Lewis, 2011; Sandberg, 2017).

Performance tensions stem from the plurality and variety of objectives, typically imposed by demands and expectations of internal and external audiences. Performance tensions arise within and between organizations in SC contexts when simultaneously pursued objectives and strategies conflict with each other (Smith and Lewis, 2011). Concerning sustainable development and corporate sustainability, performance tensions are often portrayed and operationalized through the three dimensions of TBL as the bottom line. However, these elements of tension also arise in larger contexts and at different levels of SC; and systemic (Brix-Asala *et al.*, 2018; Sandberg, 2017). It is particularly relevant for identifying and characterizing sustainability tensions that commonly arise in larger contexts, often due to the mismatch of temporal and spatial scales at different levels (Van Der Byl and Slawinski, 2015; Hahn *et al.*, 2015). The performance paradox arises from conflicting demands from different stakeholders that lead to competing measures to assess managerial success. In other words, in this type of paradox, the company and its members are obliged to achieve multiple goals (Smith and Lewis, 2011).

As we intend to investigate the social impacts of the mineral SC and how they relate to sustainability tensions, the next topic is dedicated to presenting the social impacts of mining and mineral supply chain management (SCM). We also entail an initial analysis to bring the framework for categorizing sustainability tensions in SC contexts closer to the context of the social impacts of the mineral SC.

Social impacts of mining and mineral supply chain management

Society depends on mineral resources since these are used to produce practically all the products it consumes. However, this extraction greatly impacts the environment and the community close to its operations (Esteves and Vanclay, 2009). There is a growing concern about understanding the potential impacts generated by mining operations and analyzing its socio-environmental aspects (Amon *et al.*, 2022;

Mudd and Jowitt, 2022; Domínguez-Gómez, 2016). In general, aspects related to environmental guidelines are more solid in the evaluation processes of companies, while social aspects are still incipient and seen as more complicated (Domínguez-Gómez, 2016).

There is a concern in the sector to map the social impacts caused by its activities. However, there is still a need to improve processes and actions that allow for maximizing these project's benefits and minimizing the negative impacts (Parsons *et al.*, 2014). Trying to circumvent these impacts, the extractive sector was among the first to apply the Social Impact Assessment (SIA) (Aledo and Domínguez-Gómez, 2018).

SIA is an instrument that allows a broad view of the causes and consequences of mining in the communities in which it operates. Mancini and Sala (2018) presented the main social impacts of the mining sector. The authors mapped twenty-eight social impacts, which were grouped into six categories, namely: a) economy, income, and protection; b) employment and education; c) land use and territorial aspects; d) demography; e) environment, health and safety; f) human rights; defined the categories presented as the main areas of social impacts, and classified them as positive or negative, identifying the level of their extension – local or national. Table 1 presents a summary of the proposals.

Table 1.
Mining Social Impact Categories

Social Impact Category	Subcategory	Positive or negative	Impact description
Economy, income, and security	Income	Positive	Local income contribution; poverty alleviation
	Business	Positive	Business opportunities, direct and indirect, in other sectors of the community due to economy revitalization
	Bribery	Negative	bribery and corruption
	Thefts and Accidents	Negative	Thefts and accidents in the community adjacent to mineral activity
	Inequality	Negative	Rent inequality; Low level of economic stimulus
	Social Tensions	Negative	Conflicts and social tensions due to unequal distribution of benefits and costs among communities in the region
	Poverty	Negative	Adverse economic outcome, increased poverty due to loss of livelihoods; Government failure to reinvest mining revenues

Employment and Education	Job	Positive	Increased employment opportunities (direct and indirect in the local community)
	Training and Education	Positive	Employee skills development and community education
	Forced and child labor	Negative	Child labor and forced/compulsory labor
	Precarious Working Conditions	Negative	Poor working conditions and low wages; Impacts on workers' health, fatalities and accidents at work
	lack of freedom	Negative	Lack of freedom to organize in trade unions and non-compliance with the requirements of the International Labor Organization conventions
	Temporary Jobs	Negative	Creation of mostly temporary jobs in relation to permanent ones; Low job and workforce stability
	Unemployment	Negative	Increased unemployment; Volatile employment due to dependence on mineral prices
Land use and territorial aspects	Infrastructure	Positive	Improved infrastructure (telecommunications, road network, energy and water supply); Better access to health and education
	Expropriation	Negative	Expropriation, displacement and resettlement of the population (consequently unemployment, landlessness, homelessness, loss of common resources, impoverishment of living standards)
	access to land	Negative	Limited access to land and consequent impact on livelihoods, food insecurity and loss of protected areas
Demography	Population growth	Positive	Positive impacts due to demographic change and population growth
	Migration and gender imbalance	Negative	Population growth, migratory flow and gender imbalance in mining communities
	Inflation	Negative	Inflation, rising costs and access to accommodation for non-mining workers
Environment, health and safety	Dispute over water use	Negative	Reduced water supply,water contamination, competition with other uses and increasing water scarcity
	Health impacts	Negative	Negative health and safety impacts on the mining community (damage to homes from explosives, injuries during expanding mining activities); Social impacts related to boom and bust cycles (increased pregnancies, sexually transmitted infections, mental health problems; community health problems, burden on health and social services, family stress, violence against women, etc.).
	Environment Impacts that affect health	Negative	Environmental impacts that affect social and health conditions
Human rights	Human rights	Negative	Human rights abuses
	Cultural and Aesthetic Resources	Negative	Impact on cultural and aesthetic resources
	Discrimination	Negative	Lack of stakeholder inclusion and non-involvement of indigenous communities; Lack of informed consensus and social acceptability

	Inclusion of *stakeholders*	Negative	Unequal opportunities and discrimination (based on gender, groups vulnerable to marginalization)
	Right of native peoples	Negative	Lack of respect for the rights of indigenous peoples

Source: Adapted from Mancini and Sala, 2018, p. 6-7.

Regarding the positive impacts, it should be noted that in many places around the world, especially in remote areas, mining can be the only development option and ends up becoming fundamental in the local economic matrix (Enríquez *et al.*, 2018). The generation of jobs and the increase in financial resources from taxes coming from mining activities are presented as obvious positive impacts (Esteves and Vanclay, 2009). Negative impacts include conflicts related to the availability and quality of water in the region, dust and noise caused by trucks that carry out the transport of ores, and changes in the landscape due to the collection of minerals (Parsons *et al.*, 2014).

Mineral exploration highlights an important paradox: despite being rich in natural resources, many cities concentrate high levels of poverty and social inequality (Enríquez *et al.*, 2018). Freitas et al. (2019) consider that if mining activity is one of the economic pillars of hundreds of municipalities in the country, a development project that has solid foundations is necessary, such as reducing the economic dependence of municipalities, environmental sustainability and social justice as fundamental for a national project. However, reality has shown in most cases the inability to generate this necessary process of economic diversification, which guarantees the improvement of social indicators in the operation and the sustainability of the territory during the closure of activities.

Everingham *et al.* (2023) argue that, in this case, the loss of the main economic engine exposes the narrow economic base of the region, generating a reduction in jobs and leading to cascading effects in SC. There is a substantial reduction in the flow of income through local economies, which affects retail, food services and other related sectors, as well as social services. This vision of tensions that emerge, between positive and negative impacts, linked to a temporal continuum (i.e., the beginning of mine operations versus the closure of mine operations) and to a spatial specificity (i.e., the reality of the explored

territory, with different vocations and vulnerabilities) dialogue with the model presented in the previous topic (Zehendner et al., 2021), to be investigated considering the SC of a cement industry.

The cement industry is part of the mineral industry complex, being fundamental in the socioeconomic development of countries, since it participates in their infrastructure and development, considering population growth, job creation and economic growth (Brodny and Tutak, 2022; Hodge *et al.*, 2022). Often, the cement consumption index serves as an indicator of the development of nations, considering its importance in the world economic scenario. In the cement industry, there are no dam constructions; its main risks are related to dust (chemical risks) and noise (physical risks), in addition to work accidents in all stages of cement production, such as health, ergonomic, chemical, and biological risks (Augusto Junior *et al.*, 2011). A vertical structure characterizes the cement industry. Its main inputs (e.g., limestone, gypsum and clay) are mostly obtained from mines operated by the companies themselves. This upstream integration, controlling the supply of these inputs, is an important condition for cement producers. Some cement companies, due to their high level of productivity and surplus quantities, make these mineral deposits a source of revenue, obtained through sales to third parties (Sauer and Seuring, 2017).

Cement consumption in Brazil, in 2022, reached the level of 69 million tons. Although it handles large volumes of inputs and finished products, its downstream SC depends on road transport, highlighting a deficient logistics infrastructure, which does not fit the ideal model, with greater capacity, such as rail and sea. This situation makes efficiency in this sector depend on creative solutions that integrate the company's strategic decisions (SNIC, 2020). Also, because it is a perishable product with low added value, transport emerges as a strategic factor for maintaining competitiveness and the market (SNIC, 2022). The cement industry is characterized by strong competition between producing companies that seek to optimize their processes to win. SCM is an extremely relevant process, its configuration needs to be adequate to guarantee the expected level of service at the minimum cost, to guarantee a satisfactory return on the capital invested by shareholders (Sauer and Seuring, 2017). The main links in SC cement are those

related to acquiring raw materials, production processes, transport system, storage, and dispatch to the final consumer.

One of the factors that define the viability, competitiveness, and performance of the cement industry is its SCM, as it allows the company to improve the internal efficiency of its services, promote collaboration between teams and all stakeholders, SC members (Sauer and Seuring, 2017).

The concept of the mineral SC encompasses all companies involved in the upstream and downstream flows of products, services, finances, and information to the end supplier. It also incorporates stages of this chain and the deviation to both upstream and downstream SCs. In other words, the SC takes place from a segment, product, or company and extends from the end consumer to the basic raw material. Finally, recycling and reuse operations, which supply secondary inputs within the downstream SC, are also covered (Geyer and Blass, 2010; Prior *et al.*, 2013; Sauer and Seuring, 2017). However, its management occurs only from a company referred to as the focal company (Sauer and Seuring, 2017).

One of the factors that define the viability, competitiveness and performance of the cement industry is its SCM, as it allows the company to improve the internal efficiency of its services, promote collaboration between teams and all stakeholders, SC members (Sauer and Seuring, 2017). Figure 2 presents a SC basic structure applied to the generic concept of mineral SC.

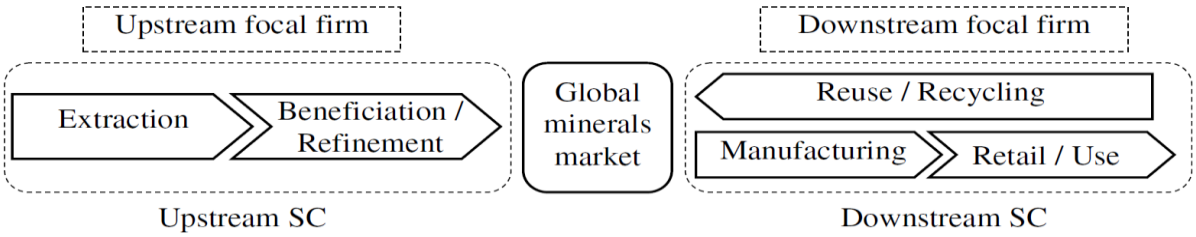

Figure 2. Mineral Supply Chain Generic Model
Source: Sauer and Seuring, 2017, p. 237.

Mineral SCM is complex and contains different types of stress, especially when considering multilayer mineral SC (Sauer and Seuring, 2017). By comparing the framework for categorizing sustainable tensions in SC contexts with that of social impacts in the mineral SC, figure 3 attempts to bring the framework closer to the social impact of mining.

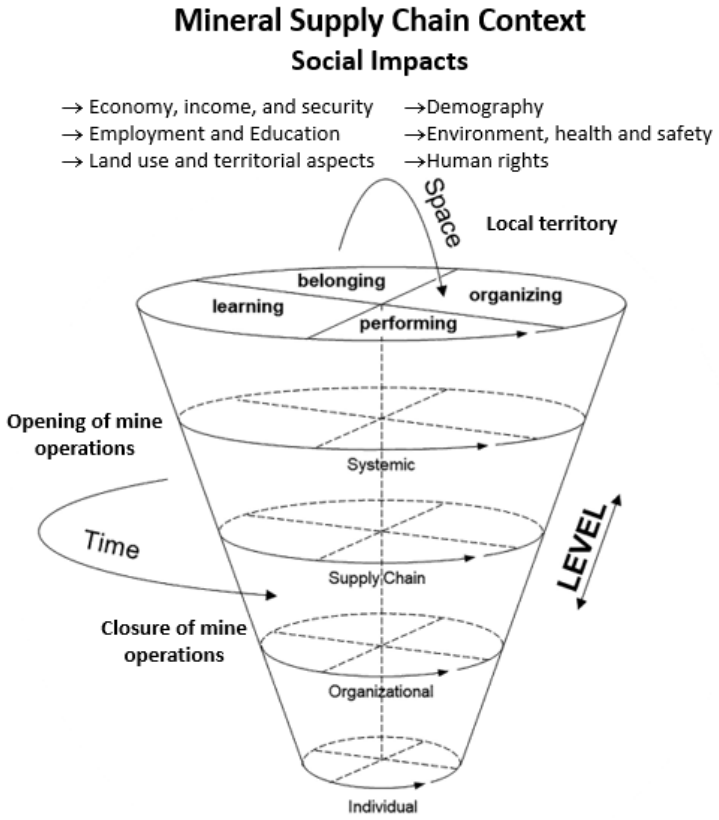

Figure 3. Framework for sustainability tensions considering mineral SC and its social impacts.

Source: Adapted from Zehendner et al. (2021) and Mancini and Sala (2018).

Thus, we present the framework mentioned earlier, which addresses sustainability tensions in SC contexts, highlighting the categories of social impact for the mining context and emphasizing the temporal

and spatial aspects. The first is by contrasting the beginning and the closure of mine operations, and the latter by proposing to explore the reality of the explored territory with its varied vocations and vulnerabilities. This analysis is relevant given the search for deepening the understanding of why the negative impacts of mineral SCs persist over time, despite being often known and even predictable.

Methodological Approach

The research question that guides this research paper is: How do the social impacts of the process of closing an operation in the mineral SC occur? To answer this question, we investigate the source of such impacts and their relationship with the tensions and paradoxes of sustainability, from the perspective of the local community. To this end, it conducts exploratory research, which made it possible to analyze the complexity of relationships (Yin, 2015) involving social tensions. The case study allows in-depth analyzes of organizations or communities, especially when the boundaries between the phenomenon and the context are not clearly defined (Yin, 2015). This strategy is adequate, as it allows understanding the dynamics in specific contexts (Eisenhardt, 1989).

The case study analyzed one of the plants of one of the largest limestone mining companies in the world, a Brazilian cement producer, with private capital, operating in 5 countries: Brazil, Argentina, Egypt, Mozambique, and South Africa. Deputy leader in Brazil and holder of regional leadership in South Africa and Egypt. In total, it operates with thirty-four production units with an active capacity of over 33 million tons of cement per year, employing more than six thousand professionals. As it is a large company, this case study was limited to a limestone extraction and processing mine, with an installed production capacity of 1.2 million tons/year. The case was in operation from 1952, in Pedro Leopoldo, and its factory was closed in 2019. The unit of analysis was selected due to the opportunity to study the phenomenon in two different moments: the sustainability tensions arising from the SC operations of the cement factory in the community at the time of operation and at the time of closure of operations.

The document analysis followed the guidelines of Creswell (2010) and included elements published via the company's website as public documents, such as the company's sustainability reports, the company's socio-environmental and economic balance sheet, books that talk about the history of the municipality, the City Hall website, the Ministry of the Environment (MMA) website, the National Mining Agency website, city newspaper, films, among others. We analyzed documents from the arrival of the mining company in 1952 until the year 2022, which corresponds to the date when the data collection was completed. In-loco observation was carried out between 2021 and 2022. On-site observations sought to obtain an overview of the municipality and the organization, to know the operational process and understand the evolution of the cement manufacturing process, and to obtain a vision of the city within the community and the social impact on the structure and social infrastructure.

One of the most important sources of information for a case study is the interviews since this technique allows for identifying the different ways of perceiving and describing the different groups of stakeholders (Yin, 2015). The participation of different social actors is a crucial point and becomes a central methodological and political element for this investigation, including agents linked directly or indirectly with the cement manufacturing company and the community of Pedro Leopoldo.

Former employees of the focal company, former employees of service providers to agents of the Public Sector of Pedro Leopoldo, president of the Union of workers in the cement industry, a journalist from the local newspaper, a researcher and mine engineer from the Federal University of Minas Gerais, members of the civic committee of the community, members of a religious entity, and members of the local community were interviewed. Table 2 presents the Table .

Table 2.
Segment and number of respondents

CATEGORIES	CODE	AGE	GENDER	EDUCATION
Public sector	E1	50	Male	Postgraduate
	E2	40	Male	Postgraduate
Former employees	E3	60	Male	Undergraduate degree
University	E4	36	Female	Postgraduate
Media	E5	69	Male	Undergraduate degree
Former employees of the Company	E6	85	Male	Primary Education

	E7	35	Male	Undergraduate degree
	E8	38	Female	Undergraduate degree
	E9	34	Male	Undergraduate degree
	E10	53	Female	Technical High School
	E11	52	Male	Technical education
Service Provider Company (Company indirect)	E12	54	Male	Undergraduate degree
	E13	72	Male	Undergraduate degree
Religious institution	E14	62	Female	Undergraduate degree
	E15	77	Female	Undergraduate degree
	E16	74	Female	Undergraduate degree
Association of Residents and Community Leaders	E17	52	Male	Undergraduate degree
	E18	53	Female	Undergraduate degree
Community	E19	45	Male	High School
	E20	54	Male	Undergraduate degree
	E21	50	Male	Undergraduate degree
	E22	64	Male	Undergraduate degree
	E23	65	Female	Undergraduate degree
	E24	65	Male	Postgraduate
	E25	33	Male	Undergraduate degree
	E26	52	Male	Undergraduate degree
	E27	61	Male	Undergraduate degree
	E28	48	Male	Technologist
	E29	41	Female	Postgraduate
	E30	40	Male	Undergraduate degree
	E31	35	Female	High School
	E32	35	Female	High School

Source: Own elaboration.

The interviews were conducted in person and were recorded with the consent of the interviewees and later transcribed. The script was carried out based on the theoretical framework involving a sequence of open questions, allowing the interviewee the freedom to address the subject, but in a targeted way (Flick, 2009), seeking to understand how the interviewees understand the social impacts on the community arising from the company's activity, in addition to how they perceive the tensions in SC in the mining industry in the cement sector. In total, the script had 24 questions, including initial questions about the interviewee, questions about the interviewee's experience in the territory during and/or after the mining company's operations, considering points such as: preparation for the mine closure, impacts in local businesses and suppliers, community participation, and social impacts perceived. There were 32 face-to-

face interviews carried out during the fieldwork in the following periods: from April 21 to 26, 2021; from November 15 to 20, 2021; from 22 to 28 July 2022.

The first stage was the reading and coding of the data, with systematization of the information and documents for triangulation, then the inference was carried out, which allows the passage to the next stage, the interpretation, in which the meaning of the phenomenon occurs (Bardin, 2016) based on the categories of the study and the articulation and discussion of the results with the theory. Coding involves micro-analysis of the raw data to identify concepts related to the categories, performed from the material available through attentive and careful reading by the researcher. Finally, selective coding is performed, in which the central category of the phenomenon is identified (Costa and Itelvino, 2018), thus emerging categories and subcategories.

The data were transcribed and analyzed on Atlas.ti, a software used primarily, but not exclusively, in qualitative data analysis. This tool allows the data organization and systematization. Analysis is carried out by the researcher, in an analytical process in which data are collected in order to be interpreted, since the qualitative researcher must identify the value of what is said by the respondent (Costa and Itelvino, 2018), in order to answer the research question based on theoretical categories. At Atlas.ti, the different types of documents used in the research are attached and organized, which are the raw data, in this case, transcribed interviews and documents, in video and text, were used.

The research used deductive coding as a guide for the systematization and analysis of the data used in the software when considering the structure of categories and subcategories by Mancini and Sala (2018) of social impact (Table 3) in order to identify the social impacts arising from the case and the main types of paradoxes (i.e., learning, organization, belonging and performance) (Table 4).

Table 3.
Deductive analysis and coding categories related to the social impact on the community arising from mining activity.

Social Impact Category	Subcategory	Positive or Negative	Description of the impact
Economy,	Income	Positive	Income Contribution to the Local Economy;

Income, and Security			Poverty Alleviation
	Business	Positive	Direct and Indirect Business Opportunities in Other Sectors of the Community Due to Economic Revitalization
	Bribery	Negative	Bribery and Corruption
	Thefts and Accidents	Negative	Thefts and Accidents in the Community Adjacent to Mining Activities
	Inequality	Negative	Income Inequality; Low Economic Stimulus
	Social Tensions	Negative	Conflicts and Social Tensions Due to Unequal Distribution of Benefits and Costs with Communities in the Region
	Poverty	Negative	Adverse Economic Outcome, Increased Poverty Due to Livelihood Loss; Government Failure to Reinvest Mining Revenues
Employment and Education	Employment	Positive	Increased Employment Opportunities (Direct and Indirect in the Local Community)
	Training and Education	Positive	Employee Skill Development and Community Education
	Forced and Child Labor	Negative	Child Labor and Forced/Obligatory Labor
	Poor Working Conditions	Negative	Poor Working Conditions and Low Wages; Worker Health Impacts, Fatalities, and Workplace Accidents
	Lack of Freedom	Negative	Lack of Freedom to Organize in Unions and Non-Compliance with International Labor Organization Conventions
	Temporary Jobs	Negative	Creation of Mostly Temporary Jobs Compared to Permanent Ones; Low Job and Workforce Stability
	Unemployment	Negative	Increased Unemployment; Volatile Employment Due to Mineral Price Dependence
Land Use and Territorial Aspects	Infrastructure	Positive	Improved Infrastructure (Telecommunications, Road Network, Energy, and Water Supply); Better Access to Health and Education
	Expropriation	Negative	Expropriation, Displacement, and Resettlement of the Population (Resulting in Unemployment, Landlessness, Homelessness, Loss of Common Resources, Impoverishment of Living Standards)
	Land Access	Negative	Limited Land Access and Subsequent Impact on Livelihoods, Food Insecurity, and Loss of Protected Areas
Demography	Population Growth	Positive	Positive Impacts Due to Demographic Change and Population Growth
	Migration and Gender Imbalance	Negative	Population Growth, Migration Flow, and Gender Imbalance in Mining Communities
	Inflation	Negative	Inflation, Rising Costs, and Access to Accommodations for Non-Mining Workers

Environment, Health, and Safety	Dispute over Water Use	Negative	Reduced Water Supply or Water Contamination, Competition with Other Uses, and Increased Water Scarcity
	Health Impacts	Negative	Negative Health and Safety Impacts in the Mining Community (e.g., damages to residences from explosives, mining-related injuries during expanding mining activities); Social Impacts related to Expansion and Recession Cycles (e.g., increased pregnancies, sexually transmitted infections during crisis periods, mental health issues such as depression and anxiety; prominent community health problems during expansion and recession periods include burdens on health and social services, family stress, violence against women, etc.)
	Environmental Impacts Affecting Health	Negative	Environmental Impacts Affecting Social and Health Conditions
Human Rights	Human Rights	Negative	Abuses of Human Rights
	Cultural and Aesthetic Resources	Negative	Impact on Cultural and Aesthetic Resources
	Discrimination	Negative	Lack of Stakeholder Inclusion and Non-Involvement of Indigenous Communities; Lack of Informed Consensus and Social Acceptability
	Stakeholder Inclusion	Negative	Unequal Opportunities and Discrimination (Based on Gender, Vulnerable Marginalized Groups)
	Rights of Indigenous Peoples	Negative	Lack of Respect for Indigenous Peoples' Rights

Source: Own elaboration. Adapted from Mancini and Sala, 2018, p. 6-7.

In addition to deductive coding, performed in the first cycle of coding and analysis, emerging categories that emerged by inference, when identifying and recognizing patterns in the read data, were not discarded.

Table 4.
Deductive analysis and coding categories related to Sustainability Tensions.

Tension Category	**Subcategory**	**Description of Tension**
Sustainability Tensions	Learning Tensions	Occur as dynamic systems transform. Involve efforts to adjust, renew, change, and innovate, fostering tensions between the old and the new, between building and destroying the past for the creation of the future.

	Belonging Tensions	Emerge from the complexity and plurality of identities, fostering tensions between the individual and the collective and between conflicting values, roles, and associations.
	Performance Tensions	Arise from the plurality of both internal and external stakeholders, promoting the existence of multiple and competing strategies and objectives.
	Organizational Tensions	Refer to concurrent projects and processes generated within organizations to achieve desired outcomes. Include tensions between collaboration and competition, empowerment and direction and control, and flexibility.

Source: Own elaboration. Adapted from Smith and Lewis, 2011, p. 383.

Social impact and paradoxical tensions in the cement supply chain

In this section of the work, the investigated case is described and, subsequently, the concepts of social impact by Mancini and Sala (2018) and the post-closure impacts emerging in this study are articulated with the paradox theory, as an exercise to understand the paradoxical tensions that arose between the SC of the cement company.

Case description

The municipality of Pedro Leopoldo (MG) was created in 1923 and has its origins in agriculture and the textile industry, with production starting in 1895. The energy potential of the Três Moças waterfall led to the emergence of a hydroelectric plant to feed the fabric factory. The city is in a mountainous geographical area with limestone mines, attracting cement mining companies. From 1950 onwards, the main activity of the municipality was the extraction and transformation of limestone (cement) and other related industries settled in the municipality, thus constituting a solid base of economic and financial support. Its agricultural origin was maintained, with a significant share in the production of milk and its industrialization, however, the economy began to move from the cement industry (Martins, 2006).

The company promoted a great development in the city from the agricultural reality, transforming it into an industrial city of great movement and economic growth, the chain generated by the cement plant favored many businesses to the population that, migrated from social class.

> About 800 people [immediately]. And so, this was a chain, because the company generated other types of services, for the city itself, families consumed an English course, a supermarket, thus the city's economy turned indirectly through the company, direct and indirect professionals. Everything was a chain really. We felt and still feel in the city today, there was a general drop in the volume of service in the structure of the city as a whole (E8).

By shutting down the factory, the SC was drastically reduced. In the interviewee E8's report, it was noticed what happened with the transport company, butcher shop, warehouse of construction materials, restaurants, bicycle repair shop, in addition to other services. There is a unilateral view of the company, without considering its SC. Figure Figure **3**shows how the SC works, as reported by E8.

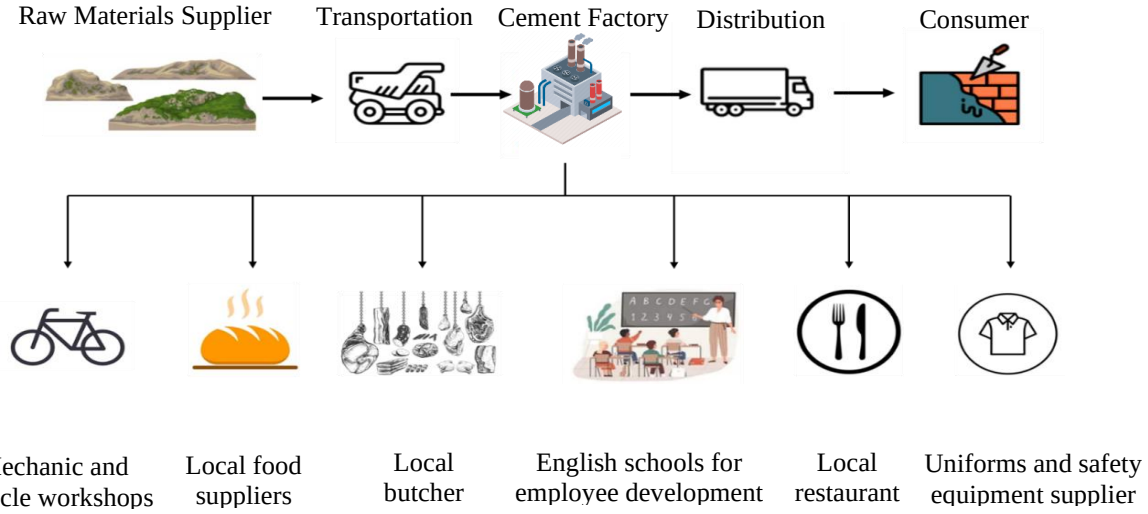

Figure 3. Supply Chain of the Case Studied
Source: own elaboration.

The company's SC is involved in a set of activities, which include production, storage, transport, distribution, services, among others. This also covers the purchase of supplements, inventory control and the transport of the product to the final customer. In addition, it has considerable significance in services provided in the form of partnerships with businesses established in the city, such as: English schools for employee development, companies that supply uniforms and personal protective equipment, mechanic and bicycle workshops, transport companies for employee mobility, in addition to outsourced companies that operate in the transport of raw materials.

The arrival of the mining company to the city brought a new reality to the region, with positive and significant economic impacts. With the installation, there was an opportunity for local businesses, as well as the expansion and creation of other sectors. However, with the closure of the industrial operation, there was an increase in unemployment, as well as the departure of companies attracted by mining, which caused the income level of the local community to be reduced and even exhausted.

In the case studied, even before the closing of the operation, the decrease in job offers was felt. The arrival of technology, such as the systematization of the process, meant that some jobs within the factory were no longer necessary.

> In fact, we realize that it's all very procedural, right? Maybe when it installs, it was the great reference from the economic point of view of the municipality. It was the big employer; the one that developed an entire production chain around it and practically every family would have someone as an employee or as an associate of the company. But over time, with the technological modernization, gradually lost this reference as the main employer (E1).

According to interviewee E8, several social actions were carried out in the city and were discontinued with the factory closure. However, the company did volunteer work from its employees, with no cost, and reported on the company's social report.

> There was the Community Development Committee, with a partnership between the company, the municipal government, civil entities, and the population, we would sit down and analyze the social context of the city and what they demanded, and what the company could add, after the survey, partnerships were sought outside with the company's suppliers, transporters. The projects were a

> day that company employees worked voluntarily on behalf of the company, always on Sundays, the company did not pay. There was the Baby Week, activities aimed at children from 0 to 6 years old, carried out in day care centers. There was the Right-Hand Week, an activity that I did with drivers. The company promoted several actions, voluntarily, to improve the surroundings where it was installed, for it there was no cost. Inside the factory there was a green space that had animals, it was a space for environmental education of community schools (E8).

Direct observation made it possible to corroborate what was reported in the interviews, opposing what was seen in the document analysis. After the closure, the city has a high number of unemployed people with no income. A scenario that did not exist until the closure of the factory was still observed, the presence of many street dwellers, young people, men and women for not having housing, work and living in misery.

The SC made up of Small and Medium-sized Enterprise (SMEs), which operated around the factory, lost considerably its power of action, and many companies went bankrupt. Note what Carter et al. (2020) identified when he used the paradox theory to conceptualize the emergence of unintended consequences of SSCM initiatives, what happened in the city with the closure of the factory, in view of the report of interviewee E2, in which he claims that the company did not intend to harm its SC, but that it did not prevent what happened with the closure. The cement factory announced the interruption of its activities, pointing to the economic crisis as the reason for the end of production. The interviewees' reports point out that the company, to minimize the impact, waved to a possible return "when things get better".

In direct observation, it was possible to verify that the limestone deposits are still there, but according to what was reported by the interviewees, the cement that will be supplied to the market for the fulfillment of contracts is from another local cement company, which is bagging its product in the packaging of the closed factory. According to Xiao *et al.* (2019) responses to paradoxical tensions arising from conflicts between cost competitiveness and sustainability are natural to the corporate environment. For Van der Byl and Slawinski (2015) and Smith and Lewis (2011) managers, rather than avoiding contradictions, should recognize and embrace tensions to develop better responses and management strategies. However, in the case under study, the managers leveraged the tensions and embraced a trade-

off perspective, prioritizing economic outcomes at the expense of socio-environmental considerations (Xiao *et al.*, 2019; Zhang *et al.*, 2021).

From the documentary analyses, it was possible to perceive that the company has always been considered one of the main national brands and that it has even been involved in the construction of important works in the country (e.g., the city of Brasília).

> It was a big tragedy announced for the city… that saw as a consequence job lost, but mainly tributes lost. The factory had more than a thousand employees, and, in the last year, it worked with 53, half were fired, and the rest received transfer proposals (E8).

The city, however, "gained strength" with works such as the administrative city, the green line and the renovation of the Governador Magalhães Pinto Mineirão stadium (Mineirão), but in the immense plant of stopped ovens, only a few employees work for the dispatch of products and local security, to avoid invasions in the property.

Results Discussion

This section aims to understand the social impacts and paradoxical tensions that have arisen in the cement company's SC. Table 5 compares the categories of social impact related to the ongoing operations of the company's supply activity, contrasting them with the emerging categories that have surfaced in the results analysis, associated with the interruption of productive operations.

Table 5.
Social Impact Before and After Closure of Operations

During Mining Operation by Categories by Mancini and Sala (2018)	**Permanent interruption of operations Emerging categories of this study**
Economy, Income and Security	Loss of Income, Employment and Opportunity
Employment and Education	Highly Qualified Labor and Relocation Difficulty
Land use and territorial aspects	Loss of Infrastructure and Quality
Demography	Migratory Movement
Environment, Health and Safety	Health Impact
Human rights	Lack of Future Perspective

Source: Own elaboration based on Mancini and Sala (2018).

The permanent interruption had a negative impact on the community's perception, since in many aspects the feeling is one of loss, difficulty and lack. The uniqueness of the case studied and the way it was collected in the field can help to understand how much the issue of dependency and social vulnerability directly affect the community, validating what Aledo and Domínguez-Gómez (2018) stated regarding contexts that involve social vulnerability, projecting socioeconomic inequality and institutional fragility. The social impacts of the company differ during operations and after the interruption of production and closure. These categories can be related to Mancini and Sala (2018) categories, considering a contrary movement in some cases, as illustrated in Table 6.

Table 6.
Emerging categories of Social Impact After Closure of Operations

Emerging categories	Description	Power Quotes
Loss of Income, Employment and Opportunity	The subcategory Unemployment is described as one of the main impacts reported in the interviews, with 44 citations in total. The unemployment, which is directly related to two other categories: Income Reduction and Business Closing (Direct and Indirect). From the moment the company interrupts its operations and closes the factory, it negatively impacts all jobs fostered with its arrival and operations, directly linked through service provision and other companies in the cement SC, or indirectly such as restaurants, insurance for trucks in the transport fleet, local trade.	The city feels orphaned by a company that, despite the pollution produced, brought hundreds of direct and indirect jobs (E26). He worked only for the factory, transported all the cement, and took care of all shipments. Now, is abandoned, closed everything here and went to another distant city because with there was no more work here and everyone who didn't want to go was fired, mechanics, drivers, in addition to the office staff (E12)
Highly Qualified Labor and Difficulty of Relocation	The factory closure has led to an excess of Highly Skilled Labor, a result of significant private investment in cultivating specialized workers. Despite personal and familial investments made by employees, the loss of individual and city income, along with the closure of numerous jobs, has created challenges in replacing this surplus of skilled labor.	The city and the local market now cannot absorb all the manpower that the city has. We have a Senac every 6 months, it leaves several professionals there in the market, right, and it is not able to absorb everyone (E28).
Loss of Infrastructure and Quality of	The closure of the factory resulted in a significant loss of infrastructure and a decline in the community's quality of life. Despite substantial investments by the cement company and high tax	The population does not have leisure, you do not have a public playground, there are no places to go out at night, because the economy does not work, so commerce

Life	collections, essential facilities such as a hospital with an ICU, multiple colleges, and permanent recreational spaces are still lacking in the city. This infrastructure, directly linked to the private company's investments through social programs or public investments funded by tax revenues, did not leave a lasting legacy after six years. The loss of infrastructure has directly impacted the community's quality of life, as residents no longer have spaces for leisure and communal exchange. Numerous social assistance programs were discontinued without replacements from the city hall, creating a noticeable gap in the quality of life and leisure opportunities for the population.	does not work, restaurants do not work. And not even for the elderly, the population does not have access to leisure and also cannot dream of a better future because we do not have any project for the city development (E2). The company closure, for the city, was terrible, in all financial aspects, generation of jobs and income and social investment (E17).
Migratory movement	One of the direct impacts of the closure of the cement factory in Pedro Leopoldo was the economic impact of the closure of several businesses directly or indirectly related to the chain, impacting the community's income and triggering a high level of unemployment. The Migration subcategory, which was one of the side effects of unemployment and business closures in the city, was the migratory movement to look for jobs and opportunities in neighboring cities or even change the place of residence due to work and professional replacement. The Dormitory City subcategory is a type of Migration, but in which the person works in another city and returns to sleep and find the family, this type of movement negatively impacts the flow of the city, as a part of the city starts to consume outside during the week, returning only on weekends.	Many seek services outside the city. The remainder survives from local trade. A trade in decline, being undertaken by people who struggle a lot and have sudden death (E26). Now there are many unemployed people. So, there are people already experiencing difficulties, there are fathers leaving the city to work in other cities and leaving the family here, sometimes they send money and sometimes they don't, and the woman is left with the children in need. […] those who are young still find work in the nearby cities, those who don't find work close by, move to long-distance and those who are already old can't find anything else (E13). Pedro Leopoldo has become a bedroom town, as people leave the city to work and return only at the end of the day (E29).
Health impact	This category concerns the impacts caused by the cement company on the community of Pedro Leopoldo after its closure, which can be divided into the physical impact caused by pollution when the factory is still in operation, and the impact on mental health, an emerging item in the interviewees' reports as post closure impact, strongly related to the category of Lack of Future Perspective. The health impacts reported in this category are related to the economic impacts on the community and the loss of infrastructure, leisure and health.	There is a total passivity of the population today. Losses exist, but there is no reaction, yes there is, it seems like a depression, you know, a collective depression (E15).

Lack of Future Perspective	This category emerged from the pattern of reports by respondents who described a feeling of lack of prospects with the negative impacts arising from the closure of the factory in the city of Pedro Leopoldo. It is understood that this category is directly linked to other categories, such as: Unemployment, Loss of Income, Closure of Business (Direct and Indirect), among others. Since the closure of the factory that acted as a "safe haven" for the community, created a feeling of dismay among the population, which was left without reaction to protest or claim other possibilities, having to deal with the immediate impact that was the Reduction of Income, both for families and the collection of the municipality, such as the Closing of Businesses that moved the city, through direct and indirect companies to the community and region. This category is implied in all other categories, since it represents a feeling and sensation of the population for this event considered traumatic because the company closed without prior notice. The feeling of the population when comparing the past and the strength that the cement factory represented for the population, and now they are feeling "abandoned".	It is very difficult here with the factory closure. It makes me sad to see the factories closing, businesses closing, it seems that the city will only be for local businesses and will become a place for retirees. The question is: And how will young people be? (E12). The closure represented a lack of perspective, abandonment and lack of hope, especially for those who retired there and seeing their grandchildren now looking for work in distant places" (E15). It saddens me when I compare my past of a thriving city with the future of people who live without much expectation of growth (E26).

Source: Own elaboration.

Considering the concepts presented throughout the theoretical framework, Table 7 articulates the concepts of Social Impact and Paradoxical Learning Tensions. The literature points to the economic contribution to the municipalities where the mining industry is installed and the increase in financial resources arising from taxes is widely recognized (Esteves and Vanclay, 2009), in this study the interviewees corroborate what is presented in the literature, since they recognize the impact - positive – at the moment when the company is acting and generating investments in the structure of the municipality, and at the same time they feel the absence of operations and the tax contribution that it spent on the municipality, recognizing this impact as negative .

Table 7.
Articulation of Social Impact and Paradoxical Tensions of Learning

Social Impact and Learning Tensions			
Social Impact Categories	**Source of the Tension**	**Description**	**Source of Evidence**
Economy, income and security	Environmental *vs.* Economic	The generation of tension between the city's economic growth, arising from the positive impacts of income generation, the promotion of direct and indirect business to the SC of the cement industry and job creation in contrast to health problems due to the pollution emitted by the cement factory. As evidenced by the increase of respiratory diseases in the population, mainly children.	Letter forwarded to the district judge of the municipality and reports collected in the interviews.
Employment and Education			
Environment, Health and Safety			
Economy, income and security	Factory shutdown *vs.* future of the community	Anguish of community members about their own future, due to the increase in unemployment in the city after the closing of the cement factory, which generated the opposite movement of the arrival of the cement factory, that is, a large reserve of highly qualified workers and the migration of these workers to other cities in the region in search of employment, resulting in the transformation of the place into a dormitory city. In addition to the population's lack of perspective, the lack of job openings and the training of young professionals.	Direct observation (*in loco)* and report collected in interviews with community members (E1, E2, E3, E4, E5, E6, E7, E8, E9, E11, E13, E15, E17, E18, E21, E26, E27, E29).
All categories of Post-Closing Social Impact			
Employment and Education			
Demography	Agricultural Scenario *v.s.* Industrial Scenario	The city had to modify its structure to accommodate the cement industry. The community members had to adapt to the change, in terms of education and employment, in order to have a place in the new reality. While the transition from a rural setting brought income and employment to the community, it led to drastic changes in the region's infrastructure, increased flow of people, with migration and population growth, in addition to changes in the environment resulting from cement production (e.g. dust, noise, respiratory health problems)	Report collected in interviews (E1, E5, E6, E8, E9, E10, E15, E16, E17) and document analysis.
Land use and territorial aspects			
Environment, Health and Safety			
Economy, Income and Security			

Source: Own elaboration.

Thus, it was possible to identify that it is necessary to effectively establish actions around the learning system, thinking about the changes and the dynamic system that involves the reality of the

municipality, affirming the literature presented by Smith and Lewis (2011). To continue the analysis, Table presents the Articulation of Social Impact and Paradoxical Tensions of Belonging.

Table 8.
Articulation of Social Impact and Paradoxical Tensions of Belonging

Social Impact and Tensions of Belonging			
Social Impact Category	**Source of the Tension**	**Description**	**Source of Evidence**
Economy, Income and Security	Ownership Sense *vs.* mass layoffs	The disappointment and feeling of betrayal on the part of the community that had a life dedicated to the company and that, without prior notice, lost their source of income and livelihood. Mainly due to the dependence and vulnerability of the community on the riches and benefits of the operation and production of the cement company.	Direct observation (*in loco*), documents and interviews (E6, E7, E8, E10, E17).
Loss of Income, Employment and Opportunity			
Lack of Future Perspective			
Human rights	Company *vs.* *Stakeholders*	Bankruptcy of the company's SC stakeholders who provided services to the factory and were not previously aware of the closure of activities, thus not being able to sustain operations and business. That is, lack of inclusion of *stakeholders* due to lack of prior notice about the closure of activities or action plan to mitigate the impacts generated by this closure. The tension that the same company responsible for generating income and promoting business in the city was also responsible for undermining and generating several direct and indirect impacts on the city.	Interview with former employees of companies indirectly and directly related to the cement company, as well as a member of the community (E1, E7, E12, E17, E21, E26, E32) and direct observation.
Economy, Income and Security			
Loss of Income, Employment and Opportunities			
Loss of Infrastructure and Quality			
Lack of Future Perspective			
Health Impact			
Economy, Income and Security	Suffering *vs.* Gratitude	Perception of negative impacts on the community, but a continuing feeling of gratitude for the company's operations. That is, residents who, even after acquiring serious damage to their health, in the short and medium term, due to the company's activities and operations, show gratitude to the company, because thanks to it they managed to get a house and the constitution of their family, as well as if the company returned to operations, they would easily consider returning as employees again without any reservations. Tension between increasing income and promoting direct and indirect business to the city with little investment in diversifying the	Interview with a member of the community (E12, E15, E24, E26) and direct observation (*in loco*).
Employment and Education			
Land use and territorial aspects			
Environment, Health and Safety			
Lack of Future Perspective			

		economy and poor distribution of resources, without breaking the cycle of dependence and vulnerability of the city towards the company's activities.	

Source: own elaboration.

Tensions of belonging in the cement industry arise between the individual (community residents) and the collective (SC), given the issue of power disparity, both economic and power before the public sector, highlighting the disparity, vulnerability, and dependence on the company. According to Smith and Lewis (2011), the tensions of belonging are driven by diverse and often divergent identities, values and visions of agents in specific contexts. To continue the analysis, Table presents the Articulation of Social Impact and Paradoxical Tensions of Organization.

Table 9.
Articulation of Social Impact and Paradoxical Tensions of Organization

Social Impact and Organization Tensions			
Social Impact Category	**Source of the Tension**	**Description**	**Source of Evidence**
Economy, Income and Security	Company *vs.* government	Dependence and vulnerability of the municipality on municipal revenue and wealth arising from the company's operations. The company needs to effectively position itself on its permanence/departure from the municipality. Highlighting whether or not there is a movement around the return of operations or sale of the unit. Just as the municipality could demand a position from the company about the arrival of a new installation from another segment to cover the vacuum left after the closure of the factory's operation. Since it is clear the negative impacts for the community after the closure of the company.	Report collected in the interview with the representatives of the municipal government (E1, E2).
Employment and Education			
Loss of Income, Employment and Opportunity			
Loss of Infrastructure and Quality			
Economy, Income and Security	Company benefits *vs.* company harm	At the time of the opening of the factory, there was a manifesto of very positive expectations about the new reality, pointing out that the company brought a commitment to development for the city. Despite parallel demonstrations against impacts on the environment and health, which were being forgotten in the medium and long term of the company's operation. At the end of its operations, after closure, there was a complete abandonment	Interview with former employees of the company (E6, E7, E8, E9, E10, E11) and direct observation (in *loco*).
Environment, Health and Safety			
Employment and Education			

		of the facilities and the commitment made to the community, leaving them without economic support for jobs and tax collection, due to unsatisfactory profit in the unit.	
Employment and Education Economy, Income and Security Environment, Health and Safety	Job security *vs.* accident risks	The work carried out in the cement industry takes place in a risk category foreseen as grade 4, high risk. Even though the company offers PPE and follows labor and safety legislation, there are still frequent accidents, even if less serious, related to the factory operation itself and to storage and abandoned factory sites (with people not related to the operation).	Document analysis and interviews with former employees (E6, E7, E8, E9, E10, E11) and city residentes (E19, E20, E21, E22, E23, E24, E25, E26, E27, E28, E29, E30, E31, E32).

Source: Own elaboration.

At the time of its operation, the company provided the community with actions around social sustainability, but when it closed its operations, all actions stopped. Organizational tensions arise from the need to integrate sustainability activities into core business operations, having to follow and maintain a business logic (Hahn *et al.*, 2018). In its performance, it was aligned with the paradox of the organization, but as soon as the activities stopped being carried out, there was an imbalance of the forces that encouraged commitment, trust and creativity (Lewis, 2000), generating a feeling of dismay, lack of perspective arising from impacts - negative - economic and structural in the city. To continue the analysis, Table presents the Articulation of Social Impact and Paradoxical Tensions of Performance.

Table 10.
Articulation of Social Impact and Paradoxical Performance Tensions

Social Impact and Performance Tensions			
Social Impact Categories	**Source of the Tension**	**Description**	**Source of Evidence**
Post-Closing Impacts	Lack of Technology (Obsolete Equipment) *vs.* Transparency	In the report, there was mention of the equipment being no longer adequate or sufficient for the operation of the business, which meant that activities at the unit were no longer a priority for the company because they did not yield in terms of production and cost. However, interviewees and employees claim that production increased with the change of owners, that is, the purchase of the	Interview (E1, E3, E7, E8, E10, E28).

		company by the Group.	
Economy, Income and Security Demography Environment, Health and Safety Employment and Education All post-closing impact categories	Social *vs.* Economic	The company's only manifesto regarding the closure of its operations was due to the economic crisis experienced, claiming that when things got better, the entire operation would resume its activities. However, there are reports in an interview that part of the operating facilities was scrapped (newer and used parts were taken to other company units). That is, the company did not communicate with the community in advance and did not hesitate to decide on economic indicators that affected a community and region as a whole.	Document analysis and interviews with former employees of the company (E6, E7, E8, E9, E10, E11) and residents of the city (E19, E20, E21, E22, E23, E24, E25, E26, E27, E28, E29, E30, E31, E32).
All post-closing impact categories	Cost Reduction *vs.* Business strategy	Cost reduction was the key point at the end of activities carried out by the cement factory. The reports point to factors such as: the reduction of processes, renegotiation of debts with suppliers; municipal taxation; lack of technology that made production more expensive.	Interview with former employees of the company (E6, E7, E8, E9, E10, E11) and community members (E19, E20, E21, E22, E23, E24, E25, E26, E27, E28, E29, E30, E31, E32).

Source: own elaboration.

It was noticed that the reality experienced by the community resulted from the plurality and variety of objectives, typically imposed by the cement SC, but from the moment that there were disagreements about the results of the operation and the continuity of the factory, conflicts began to arise, corroborating Smith and Lewis (2011), who claim that performance tensions usually arise within organizations in SC contexts when objectives and strategies conflict with each other (Smith and Lewis, 2011).

Mainly, after the company's management change, which went from family management to corporate management, the differences between the company and the community become more significant and conflicting, because when there was a need to choose between staying with the operation and reducing costs, the company's choice was to reduce costs, through mass layoffs of employees belonging to the community, which evidenced a conflict of interests. Including, the community's perception is that the company chose to close the factory instead of continuing its operation, with a feeling of betrayal and loss

of a haven. The theory points out that performance paradox arises from conflicting demands from different stakeholders, leading to competing measures to assess managerial success (Smith and Lewis, 2011).

By contrasting the beginning and the closure of mine operations, it was possible to observe how the potential of positive social impacts outweigh the posthumous reality of the myriad of negative social impacts. Promoting learning tensions (Zehendner et al., 2021) could be a source of change for this, considering tensions that emphasizes the debate around stability versus change; present versus future (Schad et al., 2016). Regarding the analysis of the reality of the explored territory, it is possible to notice the recurrence of the distancing of activities related to the vocation of the territory, focused on a dedication centred on the activities demanded by the mineral supply chain. In this case, encouraging belonging tensions could be a source of change, considering tensions that discuss the individual X the collective and the issue of power disparity, vulnerability, and dependence on the company (Zehendner et al., 2021). There is also a massive withdrawal of benefits offered during the mine's operating phase, when activities close, that can be associated with organizational tensions (Zehendner et al., 2021), reinforcing the need to integrate sustainability into core business and discouraging the need to maintain a purely economic business logic (Hahn et al., 2018); as well as performance tensions, generated by conflicting strategies over time (Smith and Lewis, 2011), exposing the local community to the imposition of different objectives in different stages. This analysis provides clues to discuss why the negative impacts of mineral supply chains persist over time, despite being often known and even predictable; and how sustainability tensions could be the start of changes.

Final Considerations

The cement industry is fundamental for the economic development of nations and serves as a benchmark for countries in relation to development, considering their infrastructure. Furthermore, it is an industry immersed in different tensions that impact, positively and negatively, the community through its

SC activities. It is an industry that has a high rate of initial employability and during its operations, at the same time, it is an industry that has a negative impact, due to its extractive character, generating socio-environmental impacts for the local community. The impacts and tensions of this industry and its SC can drastically change when considering different contexts, such as during active operation and during operation interrupted with the closure of the factory.

Through a single case study, carried out with thirty-two interviews, three field visits and document analysis, it was possible to analyze the social impacts and sources of tensions in the SC of the cement industry, in order to understand the phenomenon considering two moments of analysis: during operation (past) and after the closure of the factory (present). Thus, social impacts were analyzed for the moment of operation, when the chain's production and activities impacted the community in a specific way; and, emerging from the research results, categories of social impact were identified that explain the impact suffered by the population after interruption of activities and their complete closure. Six categories were identified, namely: Lack of Future Perspective, Loss of Income, Employment and Business Opportunities; Difficulty in Repositioning in the Market; Migratory Movement; Infrastructure loss; and Community Health Impact.

The present study also identified the sources of paradoxical tensions for the analyzed phenomenon, the main ones being the transformation of the city, which ceased to be agricultural and became industrial, the air pollution caused by the operations of the cement industry, the insecurity generated by the closure of the factory with mass layoffs and the bankruptcy of a good part of the companies belonging to the cement factory's SC. In addition, it was possible to analyze the community's perception of SC mineral stresses, observing the cement industry.

With this, we contribute to the topic by explicitly emphasizing the social impacts and tensions that may occur during operations and after the closure of the cement plant, bringing complex situations experienced by all stakeholders, but mainly the community that did not obtain any support after the closure. In addition, the lack of prior communication evidenced a greater difficulty, since there was no possibility of preparing to supply the needs of those interested in the factory's operations. Thus, in the

absence of the company's obligation to invest in the economic diversification of the territory, all components of the SC were negatively impacted. Services driven by the main economic activity such as food, clothing and education declined sharply with the closure of the operation. Another important aspect observed was the absence of the government, which did not take any action that took into account the development and protection of the municipality in the face of the operation and its closure. He expects that, by bringing these issues to the surface, we stimulate the debate around why the negative impacts of mineral SCs persist over time, despite being often known and even predictable. These reasons do not end there, but include points such as: the need to look for positive impacts in the short term versus the hope of reducing negative impacts in the long term; the local specificities in terms of vulnerability of the community and the territory, the types of tensions that generate social impact among the main actors (i.e., focal company, SCs, government, and community) amid the asymmetry of power between such actors.

This research dealt with the issue of sustainability tensions, analyzing social impacts and paradoxical tensions, based on the perception of the community, which, through their reports, demonstrated that the upstream SC was impaired as much as the downstream SC. Presenting the community perception represents a contribution to the topic, once research on mineral SCs so far tends to emphasizing the perspective of large company managers facing sustainable issues along the SC (Schoggl et al., 2016; Sauer, 2021). The study also contributes by providing: a) emerging categories of social impact considering a post-closure context and how this affects different stakeholders of a community; b) a perspective on paradoxical tensions with a focus on the social, expanding the analysis of tensions, in order to involve the tensions between the focal company, the chain, including the government and the community; and c) articulate categories of social impact with paradoxical tensions, from the perspective of the community. Thus, this research offers an opportunity to expand knowledge about social impacts and social tensions in the mineral SC, focusing on the cement industry.

This research has limitations, the main one being the impossibility of obtaining reports from all SC members, since, with the closure of the factory, many were no longer present in the territory. It is understood, however, that the limitation does not compromise the findings of this research, since the main

objective was precisely to capture and systematize the tensions arising from the impacts of the company's activities and its SC in the region, as well as the post-closure impact, the community perspective. For future studies, it is suggested to expand the scope of this research, applying more case studies, and expanding interviewees, in order to cover all interested parties and add limiting points. More social impact studies are also suggested for post-closing activities, as the emerging categories presented are exploratory and require confirmation in theoretical studies, both practical and theoretical. Another important recommendation for future studies includes expanding the analysis of the negative social impacts of mining activities, which are common when it comes to extractive chains, logging companies, construction of dams and hydroelectric plants, for example.

Therefore, and finally, this paper achieved what it intended, it was able to analyze the existing tensions in the closure of the operations of a cement factory, demonstrating how important it is to have knowledge about what a community lives and survives in this type of operation. Thus, the following reflection from the Pope is presented: our common future will depend on our common commitment, in the preservation of our common home that is Planet Earth.

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The social impacts in the supply chain of a cement industry: A case study under the lens of paradox theory

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