



SUSTAINABILITY TENSIONS: IDIOSYNCRASIES PRESENT IN THE BRUMADINHO DAM TRAGEDY IN THE PERCEPTION OF DIFFERENT STAKEHOLDERS

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ABSTRACT

Based on the theoretical framework of sustainability tensions, this study aims to analyse how the different stakeholders understand the tragedy that occurred with the Brumadinho Dam in Brazil and its emerging tensions. This tragedy is considered the largest work tragedy to occur in Brazil and one of the largest in the global context. The study was developed from interviews and media documents, that is, secondary data. The results show that the tensions that emerged can be codified into environmental, social, economic, cultural, and institutional groupings. The tragedy may be examined from multiple perspectives, one of which is from the position of the actor involved in the enterprise of the collapsed tailings dam structure. Each actor defends his principles, values, and rights. It is a fact that the lives of the people affected and those who died are not recoverable. Environmental damage can be minimized through long-term mitigation measures, but social, demographic, historical, and cultural damage is irrecoverable. Thus, the study offers the following contributions: (i) the tragedy has different interpretations by the different stakeholders; (ii) paradoxical tensions impact differently on the lives of those affected; (iii) trade-offs from tragedy need to be managed; (iv) Brazil urgently needs to learn relevant lessons arising from the tragedies experienced and described in our article. Therefore, an immense and complex challenge that is on the agenda at that moment in Brazil is ripe for analysis.

Keywords: Sustainability. Paradoxes. Contradictions. Mining Sector.

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1 INTRODUCTION

Sustainability is a concept that address to the social, environmental, economic, cultural and institutional dimensions (Elkington, 2001). Sustainability issues, often in goals and conflicts, are understood in the scientific literature as being the tensions of sustainability (Brix-Asala et al., 2018). Sustainability tensions comprise the interrelated but occasionally contradictory elements that exist simultaneously and persist over time (Smith & Lewis, 2011). These elements are present in the mining sector in Brazil, which has a huge potential for generating income, jobs, and development of the municipalities where the plants are located. Mining is understood as an economic means to achieve social aspirations (IBRAM, 2013). However, mineral wealth does not invariably lead to an improvement in economic and social conditions for all. Enjoying the benefits of natural resources does not guarantee the country to avoid the "abundance paradox" (Auty, 2001).

Investments in large mining projects, the attraction of foreign direct investments, the representation of a big player (Vale) in the mining segment in Brazil, are representative elements of the gigantism and a significant contribution that the mining sector offers to the Brazilian GDP and to local economic development. The Brazilian GDP is 1,868,180M\$ (Country economy, 2019). More specifically, the Mining GDP is 31,500 M\$ (Brasil Minerals, 2018). Mining is 1.7% of the Brazilian economy. Therefore, in economic terms, the mining industry remains critical to millions of people globally. The social challenges of job creation, decent work, and adequate compensation are

tensions that emerge from the mining sector. By extension, socio environmental sustainability is a major strain on mining, especially in environmentally sensitive regions (near rivers, upstream from small towns, areas with lots of groundwater etc.). A benchmark strain can be seen in the case of Brazil's Brumadinho Dam tragedy. Also, we analyze a company with a strategic position which lead to higher environmental reporting (Shwairef, Amran, Iranmanesh, Ahmad, 2019). But, environmental scandals are very bad for the companies (Utz, 2017). So, the gap of our research is the tensions emerging about big industries and their impacts. Specially in a case that happened a tragedy.

The following research questions were defined for the study: What kind of sustainability tensions can be identified in the Brumadinho Dam tragedy? How are the tensions experienced by the different actors around Brumadinho Dam? What practices does Vale address to engage the paradoxical sustainability tensions that emerged from Brumadinho's tragedy?

Based on the constant sustainability tensions present in the context of mineral exploration and the decommissioning of the mine, this study aims to analyse how the different stakeholders understand the tragedy that occurred with the Brumadinho Dam in Brazil and its emerging tensions. The justification for the choice of case is associated with the worldwide repercussions of this environmental tragedy.

The Brumadinho Dam tragedy occurred on January 25, 2019, early afternoon, in the central region of Minas Gerais State, state of Minas Gerais, Brazil. The breakup occurred at the Feijão mine, an installation operated by mining company Vale do Rio Doce in Minas Gerais. Some 26 million tons of iron ore tailings were stored at the tailings dam that had been shut down since an earlier disaster in 2015. In the dam collapse, the tailings reached the company's administrative area and moved into the dining hall that was full of individuals during the lunch hour; it next advanced toward the Vila Ferteco community. As of 15 February there were 166 dead and 144 people missing. Data updated in October 2019 signal 249 deaths and 20 remain missing. And at 23 November there were 253 dead and 17 people missing. This tragedy is already considered the biggest work tragedy in Brazil, since it caused the largest number of victims of a company in a single tragedy. The Brumadinho Dam tragedy also ranks as the second biggest industrial tragedy, given the denomination for large-scale disasters caused by business activities. Further, this tragedy is considered the most

deadly of the 21st century worldwide, according to a ranking compiled by experts by BBC News Brazil.

On the other hand, Van der Byl and Slawinski (2015) suggest new empirical research to understand how firms deal with sustainability tensions, attempting to balance conflicting issues rather than avoiding them. Some studies have been conducted since 2015, such as work by Ferns, Amaeshi, and Lambert (2017); Sharma and Jaiswal (2017); Stadler (2017); Brix-Asala et al. (2018); Fayezi, Zomorodi, and Bals (2018); Tura, Keränen, and Patala (2018), among others. However, a study that addresses the tensions of sustainability that emerge in one of the largest global environmental tragedy is relevant to scientific advancement. Brix-Asala et al. (2018) also reiterate that there is still room for exploratory studies to strengthen the theoretical basis on sustainability tensions. An integrative perspective on the antecedents and consequences of sustainability tensions is still lacking (Fayezi, Zomorodi, & Bals, 2018). If we do not understand the tensions of sustainability we cannot manage them (Fayezi, Zomorodi, & Bals, 2018). The social relevance of a study of this nature evidences the role of the different actors as protagonists of sustainability or only decision makers in face of the economic, social, and environmental trade-offs that come from the productive activity of the mining.

On 31 January 2019 (i.e., a few days after the disaster), a group of institutional investors led by the Church of England Pension Fund and the Swedish Public Pension Funds with more than \$6 trillion in investments set up an “Investor Mining and Tailings Safety Initiative,” stating that “Simply put these failures of tailing dams should not be happening.” (Robeco, 2019, p.1). “Following the disaster investors made a public call to establish a new independent and publicly accessible international standard for tailings dams based upon the consequences of failure. In response to that request a global review was announced and co-convened by the International Council on Mining and Metals (ICMM), the Principles for Responsible Investment (PRI) and the United Nations Environment Programme (UNEP)” (The Church of England, 2019, p.1).

The study is divided into sections. Section 2 deals with theoretical aspects of sustainability tensions. Section 3 describes the methodological course of the study. Section 4 presents, codifies, analyses, and discusses the results of the research carried out. Section 5 presents the main conclusions and contributions to the relevant stakeholders, and this academic work concludes with the references consulted.

2 SUSTAINABILITY TENSIONS

Mainstream businesses care for economic benefits, which, in turn, generate trade-offs with new business models from a sustainable business perspective and adhere to practices that seek to strike a balance between economic, social, and environmental dimensions (Brix-Asala et al., 2018). Tura, Keränen, and Patala (2018) state that tensions can refer to the different ways in which interorganizational relationships are organized and governed within a network, which may include, for example, tensions between structural flexibility and rigidity. Van der Byl and Slawinski (2015) classify emerging sustainability tensions in organizational contexts as win-win, trade-off, integrative, or paradox categories.

a) Win-win: notes that tensions are circumvented by opportunities to align environmental and/or social goals with economic goals. It is based on the assumption that the improvement of one dimension of sustainability concomitantly implies one of the other two dimensions: at least, none of them decreases. Win-win emphasizes an analysis of how companies achieve financial performance by increasing their sustainability performance.

b) Trade-offs: recognizes that conflicts between sustainability goals occur and cannot be achieved simultaneously. This category implies a company must choose one objective / dimension of sustainability to the detriment of another one.

c) Integrative: does not prioritize any of the three dimensions of sustainability. It assumes that social, environmental, and economic factors can be balanced. To reach sustainability in a holistic way, one may assign similar weights to each of the dimensions.

d) Paradox: tries to understand the tensions, their nature, and how the actors deal with it. Organizations face the coexistence of contradictory elements. The contradiction is eliminated by the adoption of one goal over the other. The actors aim to transform the situation so that interrelated demands can be pursued simultaneously without actually eliminating the tension.

Starting from the paradoxical definition, Brix-Asala et al. (2018) derive the following typology:

a) Actors accept the tensions between objectives instead of resisting or avoiding tensions;

b) The actors meet the competing and interrelated demands simultaneously;

c) Paradoxes are dynamic demands that can be managed only by continuous cyclical responses in the form of practices.

Smith and Lewis (2011) classified the paradoxical tensions into four categories:

a) Emerging tensions between the categories of learning and knowledge: it occurs when organizational leaders need to determine the time horizon of an action. This paradox emerges during the process of change and adjustment as well as during the incorporation of innovations.

b) Emerging tensions between identity categories and interpersonal relations: they arise when the individuality and the homogeneity of individuals and groups are simultaneously sought. They emerge when there are concurrent values, roles, and associations simultaneously sought and the division of tasks in the company.

c) Emerging tensions between the categories organizations and processes: they arise when a company decides how it will work and when there are competing processes to achieve a specific result. Example: tensions between collaboration and competition.

d) Emerging tensions between performance categories and targets: they occur when competing strategies and objectives emerge. For example, shareholders' financial objectives may conflict with the social or environmental expectations of other stakeholders.

According to Tura, Keränen, and Patala (2018), tensions can be coded by internal and external, and by multiple actors and multiple levels (individuals, groups, and organizations). Often, sustainability tensions are limited by market characteristics, such as the availability of sustainable materials and services (Brix-Asala et al., 2018).

Although the literature considers that the implementation of sustainable business practices improves well-being and positive results, Tura, Keränen and Patala (2018) argue that tensions and conflicts can emerge in the networks of multiple actors. These authors classify the tensions that emerge in economic, structural, psychological, and behavioral activities.

Fang et al. (2011), in turn, classify the tensions in psychological and behavioral regions. Psychological tensions are those that refer to cognitive aspects, such as

attitudes and perceptions of different actors in the network. Typical psychological stresses in networks may be related to issues such as (dis) confidence and temporal orientations. Behavioral tensions refer to the activities, routines, and communicative practices of the actors. They may relate, for example, to active or passive activities, or to cooperative or competitive behavior (Tóth et al., 2018). In addition, both marketing literature and sustainability literature often refer to the typology of economic tensions, which are usually related to differences between capture logics and actor appropriation (Hahn et al., 2010; Chou and Zolkiewski, 2018). Stresses can emerge among multiple actors, as Burton et al. (2016) states, including individuals, groups, and organizations; these stresses provide a good analytical lens for analyzing the activities, outcomes, and consequences in multi-actor networks. In sum, Wittneben et al. (2012) emphasizes that existing literature recognizes that sustainability issues are often broad and complex and require an understanding of the impacts and consequences experienced and perceived in larger networks. Also needs means of implementation for disaster risk reduction (Marchezini, 2020).

3 METHODOLOGICAL PROCEDURES



This work consists of a single holistic case study, which intends to analyse how different stakeholders understand the tragedy associated with the Brumadinho Dam in Brazil and its emerging tensions. Considering the worldwide repercussions of this tragedy, we elaborated this research based on interviews with survivors, victims' relatives, Vale managers, employees of outsourced companies, and the federal government of Brazil. We relied on the wide reportage of two communication channels with public access: the National Newspaper/BBC News and the printed/electronic journal Folha de São Paulo, considered the most important journalistic communication vehicle in the country.

So this study used secondary data. Different kinds of sources, as for example, interviews, news, testimonies and documents. The searches of the documents and recorded interviews analysed were mapped on February 16, 2019 and comprised the time space of 22 days after the occurrence of the tragedy. The criterion for selecting the materials consulted consists of one hundred percent of the materials published in the listed sources as the object of analysis of this research, namely, the National

Newspaper / BBC News and the printed / electronic journal Folha de São Paulo. The quality criteria followed were based on the national journalistic expressiveness of the websites consulted.

Table 1 shows the profile and the quantity of materials that were mapped and online for the accomplishment of the documentary analysis and of interviews used for the elaboration of this study.

Table 1. Specification of the materials analysed for the elaboration of the research

Type of Material	Material Source	Specification
Printed/online journalistic reports	Journal Folha de São Paulo	55 different news stories in the Journal
Journalistic reports in the Jornal Nacional	Jornal Nacional	15 reports
Press reports on BBC News	BBC News	11 reports
News about the accident of Brumadinho	Site da Vale	84 news
Interviews with survivors	BBC News Jornal Nacional	2 interviews
Interviews with lifeguards	BBC News Jornal Nacional	2 interviews
Interviews with the President of Vale	BBC News Jornal Nacional	6 interviews
Interviews with relatives of victims	BBC News Jornal Nacional	4 interviews
Interviews with subcontractors	BBC News Jornal Nacional	2 interviews
Interview with the President of Brazil	BBC News Jornal Nacional	2 interviews
Interview with Brazilian public agencies	BBC News Jornal Nacional	6 interviews
Interviews with the UN	BBC News	1 interview
Technical Reports	The company's website	5 reports
Description of the plant characteristics		3 news links
Vale's Sustainability Report	Site	179 pages

Observation: look for links in appendix 1

For the classify and analyse the data, we followed the premises of the authors Yin (2010) and Eisenhardt (1989), who presented guidelines to build theory from a case study research. There was concern to understand the phenomenon from the

perception of different subjects and different perspectives. Care was taken to compare different sources of access to information. Impartiality was maintained in the process of judgment and analysis of the data.

The theoretical sample is comprised the sources described in Table 1. We stopped including new perceptions of different subjects and sources at the moment the theoretical saturation was reached. The juxtaposition of evidence allowed to close the value judgments and the bias of the different sources consulted for the elaboration of this study. Analytical categories were defined through data codification using categorical thematic analysis (Bardin, 2011). Subsequent categories of analysis, derived from news reports and fragments of interviews analysed, were established. In the sequence, cross-case analyses were performed, as Eisenhardt (1989) recommends, to understand the dynamics present in cases with unique configurations, in which the study of Brumadinho Dam fits.

The constructs and variables of the research are presented in Table 2.

Table 2. Constructs and search variables

Constructs	Constitutive Variables	Operational Variables	Key Authors
Sustainability Tensions	It is the tensions that emerge from the process of operationalising sustainability practices and that generate trade-offs between the social, economic, and environmental dimensions.	- At the firm level - At the industry level - At the societal level	Stadtler (2017) Lewis (2000)
Environmental Tensions	These are the tensions that arise from the operationalisation of the environmental dimension, ordinances, resolutions, laws and legal guidelines that support the practices of preservation of natural resources, rational exploration, management of environmental risks, and	- Soil, water, air, flora, fauna, natural beauty.	Sachs (1993) Sachs (2002)

	recovery of degraded areas.		
Economic Tensions	These are the tensions that emerge from the operationalization of the economic dimension, from the allocation and more efficient management of financial resources and from a constant flow of public and private investments. It concerns the economic efficiency evaluated in macrosocial terms and not only through the microeconomic profitability criterion.	- Conflicts between cost allocation (in technologies, processes, new practices).	Tura, Keränen and Patala (2018)
Social Tensions	It is the tensions that emerge from the operationalisation of the social dimension, which ensures the construction of a just society, which values labour rights, dignity in the work environment, adequate remuneration for the exercise of the profession, quality of life, equity in distribution income and goods, in order to reduce the asymmetries between those who hold the highest assets and the most vulnerable.	Universal access to human rights, fundamental freedoms, justice, decent and safe subsistence, gender equity, ethnic, social and religious groups, universalization of basic sanitation, access to information, health services and education	Sachs (2002)
Cultural Tensions	It is the tensions that emerge from the operationalisation of the cultural dimension, which seeks to preserve the local	- Historic, artistic, tourist, landscape and archaeological heritage	Sachs (2002)

	patrimony, traditions, customs, knowledge, specificities of habits and capacities acquired by man as a member of society.		
Institutional Tensions	It is the tensions that emerge from the operationalisation of the political dimension by the different actors in the institutional context of a country, for the universal appropriation of human rights, the development of the State's capacity to implement the national project in partnership with all entrepreneurs, control actors and mediators of conflicts and ensuring the promotion of peace and cooperation. It seeks to maintain a holistic view of the problems of society, in addition to the management of natural resources.	<ul style="list-style-type: none"> - Structure - Complexity - Dynamic - Supervisory system - Regulation mark 	Sachs (2002)

Qualitative research is adopted as one of the data analysis strategies, and we have transcribed representative excerpts from the statements / documents consulted. In the first stage of data analysis, the authors of this article developed their strategy of presenting relevant information. In the second stage, emergent voltages were coded. The coding process took place *a posteriori*. Based on the mapped aspects, the literature was returned to compare between the tensions mentioned in the scientific literature and the identified tensions.

The datasets were grouped and regrouped by means of codes to identify recurrent patterns. Initially the interviews and file documents were separated into perceptions of the different actors involved or affected by the Brumadinho tragedy. Subsequently, sets of sentences or paragraphs were identified that conveyed a coherent point about the tensions that emerged in the case. The guidelines recommended by Stadtler and Van Wassenhove (2016) were used to identify the tensions, namely fragments of sentences that dealt with "but", "challenging", "in a certain way", "complex", "telling the truth", "at the same time", or "on the other hand". The research's second stage consisted of transcribing the descriptive codes into first order codes, called operational variables of our research (see Table 2). In the third stage, the operational variables were regrouped and gave origin to the research constructs, considering the variety of voltages mapped in the analysed case. Practical findings were compared with theoretical insights alluding to sustainability tensions.

4 DATA PRESENTATION AND DISCUSSION

The dam that broke up in Brumadinho had as its purpose the disposal of tailings. According to Vale (2019), it was built in 1976 and was currently inactivated. There were currently no operational activities in progress. To date, the causes of the disruption are considered unknown. Irregularities in the elaboration of technical documents are being investigated. Vale informs that the dam had physical and hydraulic safety.

It must be considered that mining activity is highly polluting (ANM, 2019). It affects hydrological, atmospheric environments, as well as the biosphere, soils, and relief forms. The environmental impacts of mining are many and present in scales of the different levels of damage caused. Especially impactful are major biological, geomorphological, water, and atmospheric changes (ANM, 2019).

To activate the mining sector in a given geographic area, you must remove the vegetation sector in all extraction areas. Pollution of water resources (surface and underground) occurs through the use of chemicals in the ore extraction process. Of course, there is soil contamination due to the toxic elements involved. In addition, erosion processes proliferate, especially in old or decommissioned mines that have not been properly repaired and monitored by mining companies. There is a risk of sedimentation and pollution of rivers due to improper disposal of materials that are not

used, such as damaged rocks, minerals, and equipment. There is also air pollution from the outdoor burning of mercury. Fish mortality is likely to occur in areas of rivers polluted by the chemical elements that originate from the mines in operation. Wild animals in the region are forced to migrate to other regions. Noise pollution occurs around the premises. Finally, surface waters (sweet and salty) are contaminated through direct leaks of minerals and materials extracted from mines. Therefore, there are many risks that need to be observed and properly managed.

Considering Vale's past history in Brazil, after the Mariana episode (which reached 39 municipalities and deposited ore tailings on 650km of rivers), several promises were made to ensure the safety of the surrounding dams. However, very little has been done to minimize the risks (Mortari, 2019). There are many social and environmental damages that occur, several of which are reversible in the long term. They are considered by many specialists as resulting from Brazil's regulatory weakness (Mortari, 2019). There are 31 regulatory agencies in Brazil for the dam sector (Ana, 2018). But fiscal bureaucracy is not enough to summon stakeholders to take more effective action for imminent risk management.

Vale informs its stakeholders in the sustainability report (2018) that since 2015, following the Mariana tragedy, investments in the management of all its structures have been expanded. In December 2015 they created the risk management area geotechnical.com for a specific focus on dams. In 2016, Vale invested R \$ 109 million in dam control improvements and reinforced their commitment to continue mitigating the impacts of the Fundão dam rupture. In 2017, it invested around 180 million in maintenance, monitoring, improvement works, audits, risk analysis, revisions of the Mining Dams Emergency Action Plan, and implementation of warning systems. By a justified decision, the Renova Foundation was created to manage and execute the repair and compensation programs of the areas and communities affected by the Fundão dam rupture. However, the local population is still awaiting compensation. Three years after the breach of the Mariana Dam, of the 53,000 claims made, 84% were not yet paid (Tajra, 2019). The criminal case continues to hear witnesses and no one has been convicted or arrested. In addition, none of the three destroyed communities was rebuilt. The mining company filed a lawsuit in court and gained the right to deduct from donations the donations made to local fishermen. The Renova Foundation, which was created after the crisis, says it spent R \$ 1.3 billion in financial

aid and compensation. "The MP-MG had to intervene in at least 283 cases in which the Renova Foundation breached the agreements in Mariana. In 2018 there were 118 cases" (Tajra, 2019, p.1). There are 20 lawsuits filed by the Public Prosecution Service of Minas Gerais, 19 civil, and 1 criminal. But these lawsuits are not yet scheduled to be tried (Tajra, 2019).

The National Water Agency (2018) has listed 45 vulnerable dams with the potential risk of disruption. This is due to the fragile risk management performed by responsible companies. The reports issued by the National Water Agency (2018) indicate that the dams considered with associated potential damage and risk category, present as characteristics problems with low conservation level, spill insufficiency and lack of documents that prove the stability of the dam. There are a few inspections and security plans. This malevolent stance is adopted because the Brazilian regulatory framework is fragile. Thus, given the occurrence of disasters and tragedies, environmental crime is managed in such a way that does not result in extreme damage to companies that impact social and environmental resources. In fact, after the Mariana episode, although several promises were made, organizational practices signal that the country's ore production has increased. High prices of ore in the international market have stimulated increases in production (Mortari, 2019).

In Brazil, the National Dam Safety Policy (PNSB), established by Law No. 12,334 / 2010, nominates private or governmental agents with real rights over the lands where the dams and reservoirs are located. The law gives these entrepreneurs the responsibility to ensure the safety of dams. They are responsible for drafting and presenting the safety plan, emergency action plans, and for providing periodic inspections and reviews. In terms of enforcement, Brazil has 33 potential enforcement agents, of which 4 are federal and 39 states. The National Mining Agency is responsible for inspecting the tailings dams.

Another vulnerability of the Brazilian system is the entrepreneur's self-declaration of the risks associated with the dam. This self-declaration is based on our own technical assessments. The regular safety inspection is carried out by the dam safety team itself (Law No. 12,334 / 2010). Therefore, although Brazil has an organizational chart containing different supervisory entities, organizational practice is fragile. The supervisory system empowers the entrepreneur and gives him the autonomy to communicate whatever he sees fit for his venture. The Normative

Deliberation 217 of Copam (State Council of Environmental Policy), allowed Vale to accelerate the licensing for changes in the dam of the Bean Stream Mine. It allows for lowering the risk potential of dams in some cases, reducing the process of the three-step licensing process (pre-license, installation license, and operating license) to one step. And yet, the state law number 2946 / 2015 provides for the State System of Environment and Water Resources through an integrated, transversal, and participatory action. This law allowed the unlocking and guaranteed the environmental licensing speed, allowing at times the neglect of the analysis criteria. This stance clearly signals the institutional priorities of the Brazilian mining sector: productivity and income generation. Unfortunately, these priorities may have irreversible consequences for the regions where the dams are installed.

In the year 2016, the popular initiative bill 3695/2016 named Mar de Lama Never Again appeared in the state of Minas Gerais. The bill was filed on July 5, 2016, at the Legislative Assembly of Minas Gerais. Its central focus is to prevent tragedies such as Mariana and Brumadinho from happening. Despite 56,000 signatures endorse the project and public mobilizations have been made, the project finds it difficult to pass. According to Prosecutor Andressa Lanchotti, economic interests always overlap with environmental and social interests. And yet, the stoppages and barriers created to pass the Mar de Lama Never Again bill are linked to lobbying by miners, who do not want to invest in more modern and safer dams (MPMG, 2019). Bill 3695/2016 reiterates the requirement that companies adopt state-of-the-art technologies for waste disposal to contribute to the safety of enterprises. It highlights the alternatives of dry tailings disposal, the sandy tailings filtration, and the muddy thickening. However, the investment for the implementation of a dam with these characteristics is 20% higher than the installation of an upstream dam, such as the Fundão and Beans that broke. These are cheaper because they use their own tailings to make them higher, but they are also more insecure and obsolete in technology (MPMG, 2019).

In addition, the proposed project provides for an environmental bond that obliges the entrepreneur to take a kind of pre-insurance to cover the deactivation of dams and the socio-environmental and socio-economic consequences that may occur. The project also foresees the unfolding of the environmental licensing in three stages (previous license, installation license, and operating license), where the conditions imposed in the previous phase are logically related to the mitigation of damages and

the reparation of impacts are fulfilled so that the next stage can be implemented. Further, dams are prohibited in locations where populations reside in self-rescue zones (within a distance of 10km), most commonly areas just downstream below the dam. In the event of a disaster, these people do not have the time to be safe from the rapidly flooding mud waves (MPMG, 2019).

Therefore, it is clear that self-monitoring does not work. Nor does it issue its own technical reports. Above all, the Brazilian supervisory system is fragile in the context of the mining sector. In order to achieve a new operating status, state power must be used to effectively enforce it. Reassess the pressure for agility and flexibility in environmental licensing. The regulating system must function correctly. And for this to occur, it is necessary to correct the deficiencies in legislation, supervision, and planning highlights, asserts Prosecutor Andressa Lanchotti (MPMG, 2019).

4.1 The Surviving Victims of The Tragedy

Approximately 100 people were rescued alive from the tragedy. Reports of the desperation, the speedy escape, and the psychological effects of these survivors signal the moments of tension and dread through which these people lived. Reports of kindness, friendship, feelings of gratitude, compassion with the family of the people who died are constant. "We tried to flee to a higher region, we went into despair and we began to pray a father of ours, and suddenly when we realized we were at the top and I looked and from that, ohh, thank God we survived," points out one of the survivors. The place where the two officials were surrounded by mud was preserved by train wagons that erected the van used by them. The area is in a higher region.

The people who lived in Vila Ferteco, a distance of 500 meters, desperately rushed to save their own lives. Those who had no physical training for it unfortunately were sucked into the mud. "What will happen to my life?", "Where will I go?" were recurring questions from survivors. "I only have the clothes on my body."

The speed with which the episode occurred did not allow much action to be taken. Each one sought to care for his life, for his salvation, and then he regained his senses and realized the extent of the tragedy that had occurred. Despair is the term that depicts the speech of the survivors. Secondly, there is gratitude for preserved life and feelings of sorrow for the lives lost. "This kind of tragedy can still happen if society's

mentality does not change," one survivor points out. "We are going to mobilize ourselves, but nothing is going to change immediately. We need more conscious people to see the other side of life. It is not only money, I have spent millions in a house and I only went out with the clothes of the body," says another survivor. A consolation, a gesture of affection, in the face of so many losses, represents a lot for the survivors.

4.2 The Employees of Vale

"My sister was a struggler, she did not miss a day of work or go to the doctor because she had a home to support." This is the account of the brother of one of the victims. Several incredible stories of survival and struggle show that even in extreme danger, the sense of fellowship and empathy has been present to save the lives of colleagues. "The screaming people, run, run, run, we're going to die and the people down there buried" is another collaborator's speech.

4.3 The Residents of Vila Ferteco

The devastating muddy tsunami engulfed Vila Ferteco. It reached the administrative center, the refectory, houses, sites, until reaching the Rio Paraopeba. Most of the people who were on the dam and downstream were taken by the tailings wave. "They could have taken my house, my everything, except my husband, my son and my sister. Material goods are not worth anything to me at the moment." "I felt like I was inside a crusher grinding everything. The mud was dark and I could not see anything," said one survivor.

4.4 Vale

Vale reports that the Brumadinho dam has not been receiving tailings since 2015. People on the dam were carrying out routine activities and one of the tasks performed was collecting data to meet legal requirements. The dam was not under construction. He confirmed the installation of electronic piezometers, framed as part of a technological upgrade that allows remote monitoring.

The company has submitted documents and information voluntarily and contributes to the investigations. It has engaged in relief efforts and assistance to victims. 35 heavy machines were available for the search. From the perspective of the Vale managers, the episode of Brumadinho is simply an tragedy. The company periodically inspected the structure of the Brumadinho dam, accompanied by different indicators associated with the dam stability. Unfortunately, the tragedy resulted in lives lost.

In a note after the tragedy, Vale said that "the dam had a safety factor in accordance with the world's best practices and above the reference of the Brazilian Standard. Both statements of stability mentioned attest to the physical and hydraulic safety of the dam." According to the company, it went through biweekly field inspections. "All these inspections did not detect any change in the state of conservation of the structure."

Vale considers prisons unnecessary because the employees had already given testimony spontaneously and were always available for clarification. This is the view of the entrepreneur, who creates employment opportunities that generate income for the municipality of Brumadinho. From Vale's view, this work place moves the local economy and fulfills a role of social inclusion, economic leverage of a municipality, and serves as an environmental protagonist. Vale has been listed for many consecutive years in the ISE - Corporate Sustainability Index, which brings together the most sustainable companies on a global level. According to Vale's statement, the occurrence of detonations is inherent to the mining activity. That these activities were carried out in a monitored manner at the Mine do Feijão and were in accordance with the recommendations of the audit. "Vale is a jewel and cannot be condemned for an tragedy that happened in one of its dams, however great the tragedy may have been," says the Company's CEO. "The reports to which the company had access do not highlight the imminent risk of disruption," said Vale's President.

4.5 Outsourced companies

The periodic safety review of the dam stated that "avoidance of vibration, prohibition of nearby detonations, avoiding traffic of heavy equipment in the dam, [will] prevent the raising of the water level in the tailings." Even so, reports from Vale employees pointed out that the explosions in the area were constant.

"At the time I went down I do not know how many meters and I was tight that even in a funnel by the earth" emphasizes one of the collaborators that was rescued in the superior part of the dam. This collaborator broke his leg and was rescued by firefighters on the same day. He says he's been at Vale since last December and he had not noticed anything strange. But that day, well before the breakup, the movement of the animals had caught his attention. This is the testimony of outsourced contractor hired to install a piezometer, a device that measures the water pressure of the dam. Vale was replacing the manual piezometers with the electric ones. "In our assessment this would not be able to overturn the dam," notes the auditor's work.

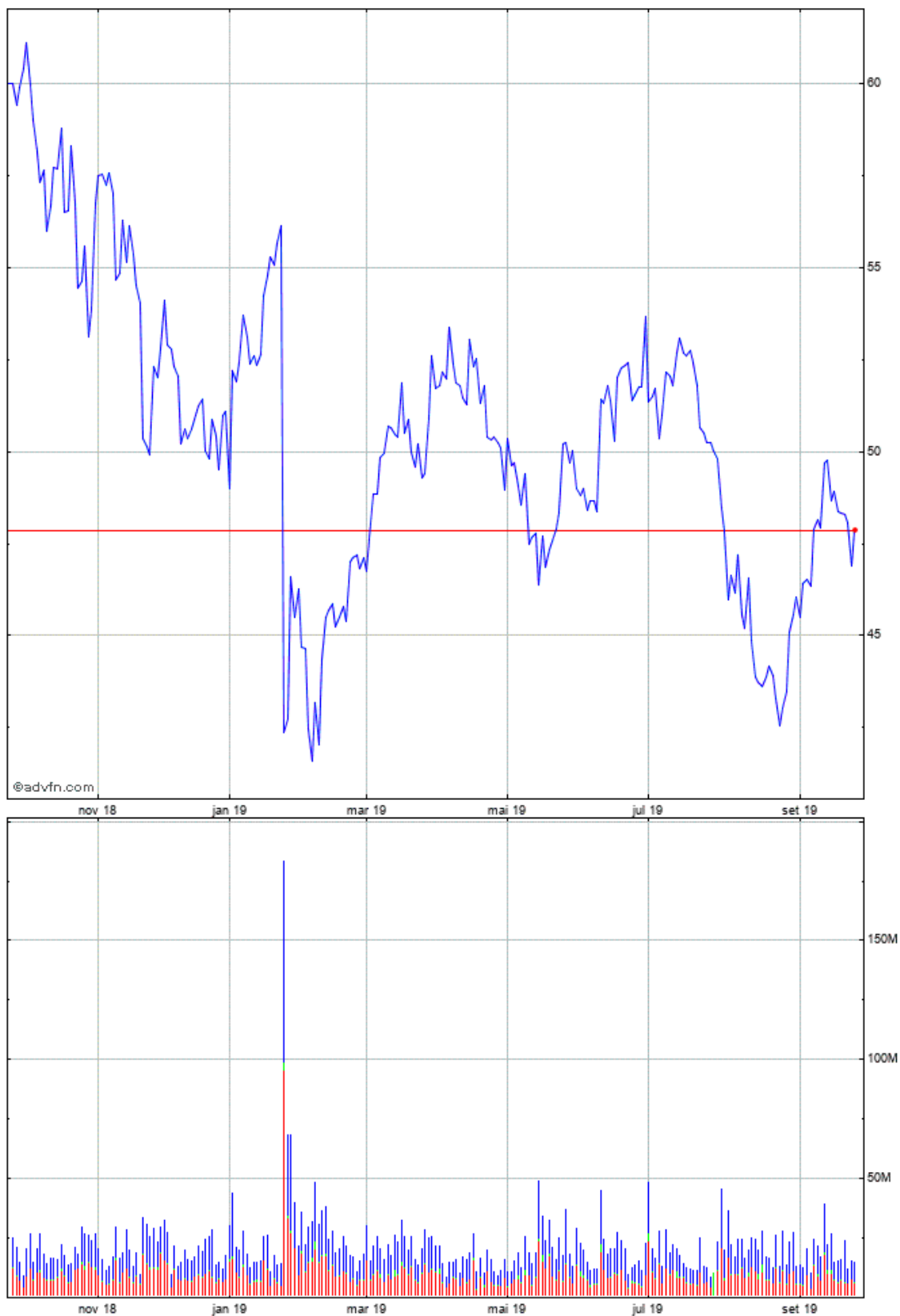
4.6 Rescue Teams - Fire And Civil Defense Corps

February 15, 2019 was the 22nd day of searching by the rescue teams in Brumadinho. There are still 144 people missing. About 200 military personnel search daily. More than a thousand agents got involved in the work in addition to the 136 military of the Israeli army.

4.7 The Shareholders of Vale

Vale's shares fell 23% after the Brumadinho tragedy. In New York, the registered drop in the shares of Vale was 14.93%. But it rose again after Vale closed several mines, thereby reducing the supply of iron-ore on the market, which caused a sharp rise in the price. Figure 1 depicts the variation of the share value.

Figure 1. Evolution of the price of share value of Vale



Source: <https://br.advfn.com/bolsa-de-valores/bovespa/vale-VALE3/grafico>

After the Brumadinho tragedy, Vale lost 70 billion in market value in a single day (Ferreira, 2019). Vale's share price went up again after Vale closed several mines, thus reducing the supply of iron ore market, which caused a sharp increase in price. The price of iron ore is quoted internationally and influences the movement of the company's shares. The devaluation of the Brazilian currency and the trading of ore in US dollars also influence the value of the company. A similar effect was seen after Mariana's tragedy. Between Mariana's tragedy in November 2015 and before the Brumadinho tragedy, the company's market value more than tripled. It went from R \$ 81.25 billion to R \$ 289.7 billion as announced in *Economática* (Ferreira, 2019). This shows a paradoxical tension, as well as described by Stadtler (2017). It clearly denotes that the economic pillar is sovereign and that tragedies do not have the breadth to echo the value of the company significantly. Figure 2 shows the value of Vale in January.

Figure 2. Vale's market value

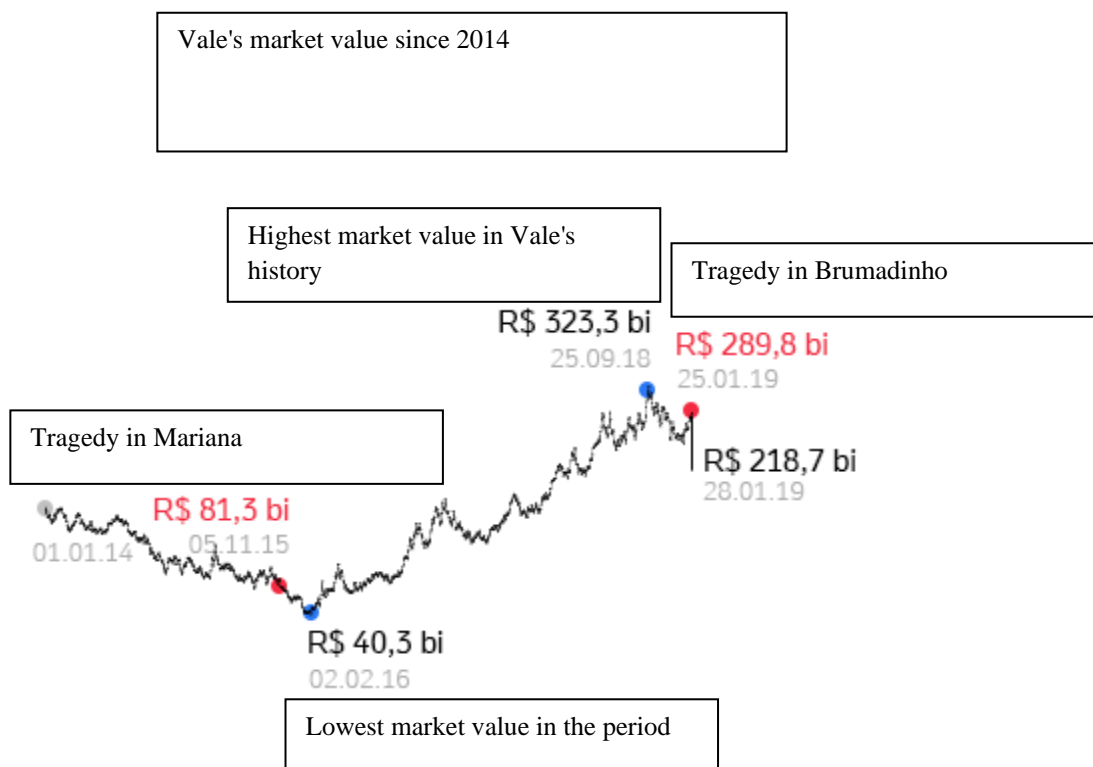


Source: *Economática* (2019)

It is noticeable in Figure 1 that environmental tragedy do not have the potential to economically shake large enterprises over a long period of time. Although the tragedy was immense, the market reacted quickly and the company regained its stock market prestige while maintaining its high market value. A longitudinal analysis proves this evidence (See Figure 3).

Figure 3. Vale's market value

R. gest. sust. ambient., Florianópolis, v. 9, n. esp, p. 392-436, ago. 2020.



Source: Economática (2019)

Vale's market value today is 246.20 billion. That is, from January 28, 2019 to October 5, 2019, the company appreciated 12.57%, despite having experienced one of the greatest tragedies in its history. This proves how much the economic pillar is considered sovereign in the business context.

4.6 The government

The mining inspectors in 2016 evaluated the Brumadinho Dam as being small, with low risk, but with high potential damage. After the tragedy occurred, the President of the Republic of Brazil signaled his concern about the fiscalization process which is the responsibility of the federal government. This inspection is carried out by IBAMA, a body linked to the Ministry of Environment. It understands that the government must seek means to anticipate problems, but these means must first come from the company, which executes the work and the mining services.

With the occurrence of the tragedy, the Federal Government created a Crisis Office to monitor actions in the region and to define what can be done. The speeches of different people who work in public positions denote a fragile position of the federal

and supervisory bodies. In Minas Gerais alone, there are more than 450 dams that accumulate waste from mining. The inspection is not so rigid and the periodicity is not declared with transparency.

According to IBAMA, the federal institute responsible for environmental monitoring at the national level in emergency situations, the monitoring authority is the licensing body, which for Brumadinho is the state of Minas Gerais. IBAMA will only assume responsibility for the tragedy if the waste exceeds the territorial limits of Minas Gerais, or if the results of the tragedy end up significantly affecting the good of the Union. The mayor of Brumadinho announces that Vale will be fined 100 million reais. The mayor also said he would demand from Vale that all employees be paid even if they were not working at the time, and that support to the victims' families should be awarded. "We hoped that Vale would have learned a lesson from what happened in Mariana and let this happen with our municipality," said the Mayor. According to him, the city has no responsibility with the breaking of the dam. "It was Vale's responsibility. A company as big as Vale that will leave the restaurant below the dam? The containment plan is the responsibility of Vale and the State," he said.

4.7 Public Ministry and Federal Police

Five managers investigated and arrested four days after the disaster, and they were released ten days later. One of them collaborated with an outsourced contractor to do the stability studies for the dam that collapsed. There were reports that the Geotechnical Risk Management team was aware of the stability conditions of the dam. They declared that efforts to increase security would be made, but that they would be long-term solutions. Despite the science of gravity of the dam structure, the stability declaration was signed in September 2018 by an outsourced company. In this issue there are tensions aimed at breaking the contract between the outsourced company and Vale, in case the contractual document was not signed. This indicates that the economic interest was considered more important than the environmental, structural, and social risks of the dam's possible rupture.

Despite the critical situation of the dam, there was no preventive referral and no triggering of an emergency action plan, which could have prevented hundreds of deaths. This evidence shows that the human being, as a rational being, has adopted

an irrationality guided by monetary figures, contractual stability, and the desire to strengthen partnerships between Vale and outsourced companies despite the associated risks and the potential foreseeable losses in a circumstance of tragedy. This tragedy occurred in less than 5 months after an evaluation of the dam structure.

On February 15, the task force investigating the Brumadinho tragedy arrested eight employees of the mining company. According to the Public Ministry they knew of the instability of the Dam (Jornal Nacional, 2019). The researchers emphasized that the four managers (three technical staff and a director) were directly involved in the safety and stability of the dam. A 30-day temporary arrest was declared for the determination of all the facts associated with the rupture of the dam.

In the opinion of the judge investigating the case, there is evidence of authorship or participation of those investigated hundreds of qualified homicides, which the law considers a heinous crime in Brazil (Jornal Nacional, 2019).

According to the Minas Gerais Public Prosecutor's Office, internal documents from the Córrego de Feijão mine indicate that the dam was part of a group of 10 dams that were more prone to rupture and were in an area of attention. The document indicated that the Company had estimated the number of deaths in the event of a rupture and the costs that the company would have if that were to happen were estimated at \$ 1.5 billion. Vale acted in accordance with the legislation and based on the reports of stability that had been provided by the companies hired by the company. "The report of stability that is elaborated by national and international experts highly qualified in the subject represent the cornerstone of the entire mining system in Brazil, Vale and the world," said the company's CEO.

The Labour Ministry (MPT) announced that it will carry out an evaluation of the tragedy in Brumadinho (MG) to determine the labour responsibilities involved in the mine tailings dam failure at the Córrego do Feijão Mine, operated by the mining company Vale. Through a note, he said that he will integrate an institutional task force. The objective is to improve labour safety standards and to adopt procedures to reduce the risk of new work tragedy in the mining area.

4.8 United Nations Organization

The author of the report on Human Rights and Toxic Substances from the UN, the person of the United Nations Special, reiterates that the Brumadinho tragedy should be investigated as a crime. This disaster requires responsibility for the episode being investigated. It also emphasizes that Brazil should have implemented measures to prevent the collapse of deadly and catastrophic dams after the Samarco disaster of 2015, in reference to the Mariana disaster.

In the perception of the UN author of the report, the Brazilian authorities should have increased environmental control. But unfortunately, they ignored UN warnings and they disrespected the human rights of workers and residents of the local community. This episode denotes a continuing effort in Brazil to weaken protections for communities and workers dealing with hazardous substances and waste. It shows a disrespect for the rights of communities and workers, stresses the interviewee.

The interviewee also emphasized the Brazilian position that was termed a concern for the events associated with the Brumadinho Dam. "It is particularly worrisome that environmental experts and members of the local community have expressed concern about the potential for disruption of the tailings dam," and that Brazil has ignored such warnings, says the UN author of the report. "Brazil should have ensured effective monitoring of the dam, including robust records of toxicity and other properties of the material being disposed of, implemented early warning systems to prevent loss of life and contamination in case the dam breaks," he said. "Neither the government nor Vale seems to have learned from their mistakes and taken the necessary preventative measures after the Samarco disaster," criticized the author of the report.

According to the United Nations, in July 2018, five UN Special authors of the report and a Working Group of the Human Rights Council expressed concern to the Brazilian government about the environmental situation of mining in the country. They feared that Brazil had not taken adequate measures to provide an effective solution to the disregard that resulted in the Samarco disaster, owned by the same company. In response, the government did not indicate what practical measures were being taken to prevent recurrence of a tragedy such as that hit Mariana that year. To the BBC Brazil, the UN reported that the Brazilian government ignored visiting requests made by the special authors of reporters.

Journalistic evidence indicates that "The mining industry seems insensitive to calls for greater sustainability," says the author of the report. Table 3 presents the categories of the primary tensions from the tragedy.

Table 3. Emerging tensions in Brumadinho's case

Actors	Economic Tensions	Social Tensions	Environmental Tensions	Cultural Tensions	Institutional Tensions
Victims	*	*			*
Employees		*			
Community		*			
Vale	*	*	*		*
Outsourced		*			
Rescue team		*			
Shareholders	*				
Government	*	*	*		*
Public Ministry and Federal Police	*	*	*		*
United Nations Organization	*	*	*	*	*

Different tensions emerged from the actors directly involved in the Brumadinho tragedy. The excerpts from the speeches presented in section 4 highlight these anxieties, disruptions, losses, and feelings of despair experienced by actors directly impacted by the tragedy and the predominant focus of mainstream business on the economic pillar, as also stated by Brix-Asala et al. (2018). It is noted that the economic tensions are the predominant ones, reiterated most often by the actors analysed. Above all, because in the capitalist system the economic perspective is sovereign and often subjugates the other dimensions of sustainability to less valued levels, generating trade-offs and paradoxes, considered typologies of tensions in the perception of Van der Byl and Slawinski (2015). Vale's way of dealing with paradoxical tensions is by providing technical, information, data access and technical support, and victim support. However, discourse does not always align with organizational practices. There were several complaints from people who felt unattended. In economic terms, the mining sector remains critical for millions of people around the world. It is a sector that

generates many profits for a few. The majority of those involved, the employees, are the ones most affected by the environmental impacts; those who reside in the surroundings absorb more liabilities than gains from the mining sector.

The social challenges of job creation, decent work, and adequate pay are tensions that also emerge from the mining sector. There are social programs and projects that are developed that serve specific communities. They are targets of widespread disclosure in sustainability reports and in the media. But there is still a long journey to humanize procedures and to provide a decent life for all actors in the mining sector. The task is especially difficult for those who live around the tailings plants, because they are impacted by environmental liabilities directly and instantaneously.

Although environmental tensions have not been cited as often as social tensions, the impacts are enormous. Many of them are difficult to reverse, and their impacts on the income of the surrounding river dwellers and even on the region's agriculture are substantial. Contaminated soil, water and decontamination practices are long term. Social tensions are often associated with conflicts of interest between different actors, especially between the company and the affected. The company and the supervisory entities, and the company and the entities claiming significant changes are often in conflict. In this way these challenges generate societal and firm-level tensions. Above all, because social and environmental sustainability generates great pressure for many industries in Brazil, behavioral changes are required. Especially important is the objective to adopt terms of conduct and to adjust to the forest code and the federal constitution of Brazil.

Cultural tensions are associated with routines, beliefs, and traditions of the affected communities that have been lost and can no longer be rescued. Culture traditions are linked to the territory, the region, the peoples, and the organizational system of those who lived there. This intangible asset is not recoverable. Institutional tensions are associated with the regulatory framework and the Brazilian supervisory system. Such tensions are complex, exemplary but in practice contradictory structures; they are vulnerable to self-declaration and can be circumvented by lengthy, complex court proceedings that take many years to try.

Another evidence mapped is that since 2016 Vale has implemented an integrated risk management system. In this system, there is the overlap of geotechnical teams, one operational and one corporate ("matrix"). This structure may have

generated internal tensions as security management and risk management overlap in different ways. This overlap can lead to trade-offs to be managed, as noted by Hahn et al. (2014). In contrast, some relevant aspects to minimize risks may be simply neglected.

The economic tensions involved concern the trade-offs of investments in risk management and preventive measures that could have prevented the accident, since the 2019 collapse was so similar to what occurred with the Samarco accident in 2015 as described by Ribeiro and Toledo Junior (2017). Such tensions involve expectations or demands of an actor so that other actors invest or spend financial resources with sustainable technologies, processes, and practices. The other actors analysed, especially the UN, understand that there are asymmetries, injustices, and positions that have made Brumadinho's operations unfeasible for some time and have not been respected or managed quickly. These practices lead to questioning and doubt that a company of this size, with such social, environmental, and economic impact in the territorial contexts in which it is inserted, deserves to be listed in the ranking of the most sustainable in the world. Not surprisingly, in February 2019 Vale was excluded from ISE, the index that brings together companies with more sustainable practices in the Brazilian market. The exclusion occurred 13 days after the breakdown of the Brumadinho / MG mining dam. This fact points to the question of the level of vulnerability, fragility, and superficiality of the sustainable practices adopted even by exemplary companies and leaders. How sustainable were the practices that allowed such a great tragedy to ensue over the region of Brumadinho?

New ecological forms and modernizing theories, assert Tura, Keränen, and Patala (2018), can be incorporated. But irreparable losses, non-compensable losses exist. The plurality of values of the different actors heard in the process, and the level impacted by these actors, had different weights and impacts for each of them. Vale has had immense economic losses from the accident, but the employees have lost their lives, families have lost their income provider, educator, father/mother/child, family structure, residences, personal property. Investors have suffered losses as the stock price swings. The government had to explain itself by showing the rigor of compliance with regulatory measures. But it is a fact that the environmental dimension had an impact of difficult and long remediation. There is no authentic fix or solution for the social collapse for anyone who has been effectively plagued by the mud dam.

Painful voices have manifested that call for justice and for definitive solutions to avoid future similar accidents. This demand for change is a key element, since the Mariana accident that occurred in November of 2015 showed that the controversy, the discourse, the commitment is assumed momentarily. Palliative solutions were adopted, but actual posture and commitment were not enough to reduce risk and or to manage risk efficiently. This shows that employees play an important role in managing operations when they claim, charge, enforce, and oversee processes (Kelliher& McAdam, 2019).

The complexity of the network of actors in the mining sector is also to be considered. There are levels of power, of decision-making, of engagement and commitment. The cohesion of this network of actors can strengthen premises for sustainable actions and preventive measures. That's what the local community wants and demands right now. We must also consider the diversified needs of different actors and the level of demand and cohesion with their values, principles, and environmental awareness.

The varying expectations of the different actors often produces misalignment, which makes the process of managing a mining complex hostile, uncertain, obscure, and unsatisfactory for some of those actors. Moreover, fragile regulatory compliance may be another element that contributes to environmental and labor accidents to take on dimensions as great as the case of Brumadinho.

It is well-known that the articulation between company, civil society, and government is fraught with difficulties. Governance is a key factor and partnerships of various stakeholders can help. The role of mining companies and partnerships with companies the size of Vale, one of the largest global mining enterprise, are essential in improving the results of economic and social development of mining. Low socioeconomic performance, environmental impacts, and precarious governance are felt more intensely in regions plagued by occupation by the mining sector (IBRAM, 2013).

The search for superior sustainability promotes sustainability innovations in products and services (Briz-Asala et al., 2018). This is what happened in Brazil, where a call was made of all the protagonists of entrepreneurship, be it startups, incubated companies or acting companies, to unite the tragedy to find technological solutions and innovations that could be useful for the rescue of bodies and to mitigate the

environmental impacts caused by the tragedy. This shows a sense of humanity, of belonging, of commitment to the well-being of the nation. Above all, a sense of urgency to find plausible solutions to an immeasurable tragedy emerged.

Structural stresses are also evident. They concern growth and the need for control (Tura, Keränen, and Patala, 2018). Multiple actors need to have networking, a need for transparency and clear communication between the parties, and a need to have harmony in decision-making and a sense of commitment to the preservation of our common good. There have been gaps in these supra-cited elements and that results in an overwhelming tragedy.

4.9 Discussion of the results

Evidence from the research indicates that the government has, in a sense, sought to delegitimize environmentalists, workers and communities who try to defend their rights against the mining industry. Advocacy was sometimes interpreted as a supposed economic threat. The government's lack of freedom of expression and association, does not value the essential contribution that non-governmental organizations, environmentalists, workers, and communities have for sustainable development and human rights. This fact demonstrates points of tension that align with the premises of Hahn et al. (2014).

The decision to build the administrative center and refectory of Vale below the reject dam is simply irrational. That site was clearly a place with imminent risk and with real chances of causing a tragedy. Three years after the Samarco tragedy did not motivate the government or company to take enough preventive measures. Although there are documents, speeches and reports on the existence of control practices for the tailings dam, the risk management assumptions were not followed in full. No alarm was issued for people to evacuate in time, nor was there a plan B for a situation of outcropping of risks that would minimize the impacts of an tragedy. This lack of planning shows another paradox, which aligns with the words of Smith and Lewis (2011).

The myriad cases of impunity associated with environmental tragedies can also be factors that encourage companies to take high risks. Little or no responsibility is attributed to decision makers, implementers of growth strategies, and to the expansion

of mining companies. This lack of rigor in law enforcement, the absence of blame and punishment for those responsible, legitimizes a process of disengagement away from strong and legitimate sustainable practices (Saraiva & Ferreira, 2018).

The past history of the mining industry signals events of human rights abuses from the inherent risks and conflicts it creates. The toxic legacy of mining projects impacts human rights to life, health, safe work, safe water, food, and a healthy environment (Medeiros, Silveira, & Oliveira, 2018). Legal guidelines and federal oversight bodies need to ensure that laws, policies, and practices respect the rights of communities and workers who face such grave risks from the work of these extractive industries (Cosenza et al., 2018).

The mud invaded the reservoir of the Rio Manso. The damage to fauna and flora is irreparable for the next hundred years. The legal contours were facilitated by recommending the expansion of the Vale mine in Brumadinho for a period of 10 years. That is, a license was granted for new operations of the Brumadinho Dam, registered in the minutes of the Environmental Police Council of Minas Gerais. This action was criticized by environmentalists, whose voices were neglected. The positioning of the National Forum of Civil Society in watershed management requesting the suspension of licensing in December 2018 signals a sensible thought of these leaders. However, the Environmental Policy Council of Minas Gerais confirmed the recommendation of the operations of the Brumadinho Dam, and the document was signed by representatives of the Brazilian Mining Institute and the Mineral Industry Union. This flawed recommendation proves that the precepts of the miners' representatives were those that gained greater coalition and prevailed.

The national plan for the prevention, preparation, and rapid response to environmental emergencies with hazardous chemicals is fragile. This means that the decrees of IBAMA, the National Mining Agency and the National Policy on Dam Safety, were met. The assumptions, practices, conduct, and standards adopted were very fragile and inefficient for a dam rupture situation and to avoid the impacts as shown (Keovilignavong, 2019). This view is in line with Tura, Keränen, and Patala (2018) who stress how organizational decisions aimed at improving collective well-being can also lead to tensions and conflicts.

The expertise of a socially (Pactwa & Woźniak, 2018) and regionally restricted system may have been insufficient to deal with the sea of mud and chemical waste

that over whelmed the region. Whereas there is much technical knowledge and organizational learning embedded in the mining industry, the sustainable manufacturing process involves its own practices (Garetti & Taisch, 2012) and environmental practices (Muñoz-Pascual, Curado, Galende, 2019).

However, the capabilities of the production system (Egbunike et al., 2019), the economic potentialities of job creation, income, social inclusion cannot be neglected. Vale has promoted radical changes in the contexts in which it operates. It has contributed to the growth and progress of families, villages, communities, and the whole environment of enterprises. On the other side, a number of normative principles of environmental governance, as currently codified in international environmental agreements, can contribute to improve the rigors of management risks (Henckens et al., 2018). Lastly, environmental stewardship is the keystone to sustainability in mining and industry (Zvarivadza, 2018) and the necessity for future disaster risk management (Stephan, Norf and Fekete, 2017).

4.10 Lessons Learned



The main lessons learned from the case:

- Brazil has a fragile regulatory framework for the mining sector: although we have exemplary legislation, there are many loopholes that can be endorsed by attorneys that guarantee bail, fines, and release of those who cause environmental tragedies. Punishments take a long time to occur when they do occur.
- Self-declaration of environmental risks: this is a fault of the Brazilian dam inspection system. Self-declared technical reports mean that the project does not always have the security assured in the documentation.
- Entrepreneur empowerment: Although there are 23 supervisory agents in Brazil, the regulatory structure empowers the entrepreneur, making him the protagonist of the process, given the economic contribution of the enterprise.
- Lobbies of entrepreneurs and dam managers clearly pressure regulatory agents to approve milder legal measures for the sector.
- High-risk generator dam construction system: The upstream dam construction system using the sludge itself to construct the containment barrier is low cost, faster to

license, but it is less safe. The two dams that broke adopted the same construction system.

Therefore, it is necessary to rethink these aforementioned aspects in order to circumvent the associated risks, to implement tighter governance, to enact more effective punishments, and to be more agile and capable of punishing in an exemplary way those involved with tragedies of such magnitude.

At the same time, there need for regulatory progress and entrepreneurs' commitment to effective risk management and safety around the dams. In this sense, it is appropriate to follow the referrals made by England Church in 2019 (Anglo American Sustainability Report, 2018), containing a set of relevant practices to minimize the risks of tragedies, such as:

- Investors meet monthly to compile risk management suggestions based on safety indicators;
- Establish a public forum for suggestions from communities affected locally by environmental tragedies
- Allow a better understanding of the social and financial risk scale associated with the failure of the tailings storage facilities (TSF);
- Help identify the actions needed to make best practices in TSF management to an acceptable minimum standard, including input from TSF experts and industry leading companies;
- Define the roles of investors, companies, and other stakeholders in reducing security risks associated with TSF;
- Map a precise scale of risks and manage them accurately;
- Identify which company has responsibilities for which facilities;
- Create common public reporting standards to communicate to relevant stakeholders the current status of ventures, risks, risk management practices adopted and investments in security around the venture;
- Create tailings safety initiatives stored in tailings dam structures;
- Develop plans for direct communication with communities that may be affected by the collapse of tailings plants;
- Take measures to prevent risks and failures, especially preventive and corrective measures;
- Operationalise stakeholder capitalism rather than shareholder capitalism;

- Strengthen the human rights journey instead of the profit journey at all costs;
- Assume true social responsibility, where companies empower the surroundings of their enterprises, generate autonomy and quality of life for the people who live there, not just risks and losses;
- Corporations deal fairly and ethically with suppliers, support the communities in which they work, empower individuals, generate autonomy, respect people and the environment, adopt sustainable practices;
- Review the unprecedented power of large mining companies to democratize production chains and generate distributed earnings, not to prioritize profit for the entrepreneur and his shareholders;
- Review the business model to make it more sustainable. This also includes the potential for labor exploitation;

Address the root causes of breakdowns, especially the production business model which may be more effective than taking a reactive approach after drastic tragedies

5 FINAL REMARKS



This study sought to analyse how different stakeholders understand the tragedy that occurred with the Brumadinho Dam in Brazil and its emerging tensions. It has noted the presence of multiple glances, different anxieties, different perceptions of the most diverse actors involved in Brumadinho's case. Each has his point of view, his pains, his worries, and his disenchantment with the episode. Multiple tensions arise from this context.

It is notorious that the economic outlook prevails in many moments. But the social dimension was the one that most impacted during the analysed period. In a circumstance of tragedy, the human factor to take a key role but to comfort the pain, to comfort before the dilemmas, to give the strength to carry on. The environmental dimension has also been recalled at various times, especially with regard to water quality and to the variety of fauna and flora lives that were impacted by the tragedies. Relations between government, inspection bodies and Vale, outsourced companies also reverberated intensely.

The tensions are present intensely, causing discomfort for some actors in the network. They are fuses for the promotion of changes and favor a rethinking of processes, practices, and systems of decision making. Thus, the contributions of this study include benefits for multiple actors.

For managers, this study provides insight into how to anticipate, manage, and mitigate potential tensions that may arise in business networks when an interested party decides to implement sustainable practices in a highly polluting industry. For those affected, it seeks to show the complexity of elements associated with tragedy. The subject's gaze shows the tension, the disillusionment, and the narrow perspective of the future that comes upon him. But the look of the network shows that it is possible to use the case as a prerogative to articulate regulatory progress, stricter measures, and greater oversight for the sector. For the community, it shows that tensions and trade-offs should be used to pressure key actors to promote more drastic changes for the sake of the security and progress of municipalities.

Finally, people are more important than entrepreneurs and should be valued as such, protected by labor rights and well-being and with the right to quality of life. Social relations empower people and strengthen them in circumstances of instability. For future studies, it is recommended to adopt the discourse analysis technique to understand the ideological constructions present in the Brumadinho tragedy. A longitudinal study to understand the major events and changes associated with Brumadinho's tragedy is also a recommendation for upcoming research.

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APÊNDIX 1

Table 1 - Specification of the materials analysed for the elaboration of the research

Type of Material	Material Source	Specificati on	Links
Printed/online journalistic reports	Journal Folha de São Paulo	55 different news stories in the Journal	https://search.folha.uol.com.br/?q=acidente+brumadinho&site=todos
Journalistic reports in the Jornal Nacional	Jornal Nacional	15 reports	https://www.youtube.com/watch?v=xSmjaP1cUAK https://www.youtube.com/watch?v=kqnKMQCIqN0 https://www.youtube.com/watch?v=ioyMjZikiW8 https://www.youtube.com/watch?v=JAvYJgnxR7E https://www.youtube.com/watch?v=u2dcQv1KJa8 https://www.youtube.com/watch?v=2XTAY3V1DV4 https://www.youtube.com/watch?v=1cYYwszxDpM https://www.youtube.com/watch?v=4oBujjcuJsc https://www.youtube.com/watch?v=3Uf0TcNVvLM https://www.youtube.com/watch?v=UGWI7M7Dfjl https://www.youtube.com/watch?v=vYSjUSIOQvl https://www.youtube.com/watch?v=1cYYwszxDpM&t=7s https://www.youtube.com/watch?v=Rz1MwiTuccM https://www.youtube.com/watch?v=9pEVcDHakoM

			https://www.youtube.com/watch?v=KXSZT-Swh_0
Press reports on BBC News	BBC News	11 reports	https://www.youtube.com/watch?v=YIN02W40UTE https://www.youtube.com/watch?v=Ly9-WfCRzuU https://www.youtube.com/watch?v=dGpz_-RrzrM https://www.youtube.com/watch?v=TUq8pjOU4U https://www.youtube.com/watch?v=HJYJ-W2YFPo https://www.youtube.com/watch?v=WZEzpLq8oTM https://www.youtube.com/watch?v=SRAHUra_Sl https://www.youtube.com/watch?v=2MNUzQJCqI0 https://www.youtube.com/watch?v=c0PUe5VWf1I https://www.youtube.com/watch?v=GNOxXfxAKGA https://www.youtube.com/watch?v=iYRna8oQwXE
News about the accident of Brumadinho	Site da Vale	84 news	http://www.vale.com/sites/search/pt/Paginas/results.aspx?k=brumadinho&u=http://www.vale.com/brasil/PT/aboutvale/servicos-para-comunidade/minas-gerais/atualizacoes_brumadinho#k=brumadinho
Interviews with survivors	BBC News Jornal Nacional	2 interviews	https://www.youtube.com/watch?v=DDW4-EcdJU8 https://www.youtube.com/watch?v=2MNUzQJCqI0&t=8s

Interviews with lifeguards	BBC News Jornal Nacional	2 interviews	https://g1.globo.com/mg/minas-gerais/noticia/2019/10/05/brumadinho-uma-das-comandantes-dos-bombeiros-conta-detalhes-do-ultimo-resgate.ghtml https://globoplay.globo.com/v/7975142/
Interviews with the President of Vale	BBC News Jornal Nacional	6 interviews	https://www.youtube.com/watch?v=m4ePM554OR4 https://www.youtube.com/watch?v=Z9tm7fOQFBQ https://www.youtube.com/watch?v=XrCzHm72sCE
Interviews with relatives of victims	BBC News Jornal Nacional	4 interviews	https://globoplay.globo.com/v/7963858/ https://globoplay.globo.com/v/7963281/ https://globoplay.globo.com/v/7940255/ https://globoplay.globo.com/v/7919249/
Interviews with subcontractors	BBC News Jornal Nacional	2 interviews	https://globoplay.globo.com/v/7963860/ https://globoplay.globo.com/v/7963841/
Interview with the President of Brazil	BBC News Jornal Nacional	2 interviews	https://g1.globo.com/mg/minas-gerais/post/2019/01/25/bolsonaro-nao-aponta-culpados-por-tragedia-em-brumadinho-mas-diz-algo-esta-sendo-feito-errado.ghtml https://www.youtube.com/watch?v=4P9sWybiyVk
Interview with	BBC News	6 interviews	https://www.youtube.com/watch?v=QjE7NQagi8w https://www.bbc.com/portuguese/brasil-47077083

Brazilian public agencies	Jornal Nacional		https://g1.globo.com/mg/minas-gerais/noticia/2019/01/25/ambientalistas-repercutem-o-rompimento-da-barragem-em-brumadinho.ghtml https://www.otempo.com.br/cidades/documentario-brumadinho-acidente-ou-crime-1.2135992 http://agenciabrasil.ebc.com.br/geral/noticia/2019-01/acidente-em-brumadinho-e-destaque-na-imprensa-internacional http://agenciabrasil.ebc.com.br/politica/noticia/2019-02/plenario-da-camara-debate-tragedia-de-brumadinho https://www1.folha.uol.com.br/cotidiano/2019/02/agencia-determina-fim-de-barragens-como-a-de-brumadinho-ate-2021.shtml
Interviews with the UN	BBC News	1 interview	https://www.youtube.com/watch?v=SRaHIUrA_Sl https://exame.abril.com.br/brasil/onu-pede-investigacao-rapida-e-imparcial-de-tragedia-em-brumadinho/
Technical Reports Description of the plant characteristics	The company's website	5 reports 3 news links	http://www.vale.com/brasil/PT/aboutvale/servicos-para-comunidade/minas-gerais/atualizacoes_brumadinho/Paginas/default.aspx
Vale's Sustainability Report	Site	179 pages	http://www.vale.com/brasil/pt/aboutvale/relatorio-de-sustentabilidade-2018/paginas/default.aspx

