Revista ARACÊ
ISSN: 2358-2472

SUBJECTIVITY IN DAM RISK MANAGEMENT: THE IMPACT OF THE TRAINING OF CIVIL DEFENSE AGENTS

https://doi.org/10.56238/arev7n3-134

Submitted on: 02/14/2025 **Publication date:** 03/14/2025

Armando Hideo Momose[1], Alexandre Luís Belchior dos Santos[2], Samir Batista Fernandes[3], Paulo Gustavo Von Krüger[4], Marcelo Luciano Vieira[5] and Victoria Clem Belchior dos Santos[6]

ABSTRACT

The collapses of mining tailings dams in Mariana (2015) and Brumadinho (2019) highlighted structural weaknesses in risk management and safety governance in Brazil. These disasters exposed flaws in regulatory oversight, corporate hierarchy, and the role of Civil Defense agents in disaster prevention and response. This study investigates how the lack of technical training of Civil Defense agents influences the greater or lesser presence of subjectivity in decision-making in dam safety management. The research adopts a qualitative approach through documentary analysis, considering official reports, regulatory frameworks and academic studies. To rank the factors that impact the subjectivity of these agents, the GUT Matrix (Severity, Urgency and Tendency) was used. The results indicate that inadequate training, hierarchical corporate structures and the lack of clear protocols significantly compromise risk governance. In addition, the absence of structured training

[1] Master in Civil Defense and Security
Fluminense Federal University
E-mail: eng.momose@gmail.com
ORCID: https://orcid.org/0009-0001-9293-4243
LATTES: http://lattes.cnpq.br/1598928153993802
[2] Doctor in Educational Sciences
Inter-American College of Social Sciences - FICS
E-mail: abelchior.prof@gmail.com
ORCID: https://orcid.org/0000-0002-5314-3553
LATTES: https://lattes.cnpq.br/2105122714361920
[3] PhD student in Environmental Engineering
State University of Rio de Janeiro
E-mail: samirfernandes@usp.br
ORCID: https://orcid.org/0000-0001-9976-5318
LATTES: http://lattes.cnpq.br/3392029367010292
[4] Doctor in Structural Engineering
Federal University of Minas Gerais
E-mail: paulovonkruger@gmail.com
ORCID: https://orcid.org/0000-0003-3628-911X
LATTES: http://lattes.cnpq.br/1865214323026005
[5] Doctor of Science
ICICT/FIOCRUZ
E-mail: mlucianopuc@gmail.com
ORCID: https://orcid.org/0000-0003-4319-715X
LATTES: https://lattes.cnpq.br/6800572094521227
[6] Master's student in Defense and Civil Security
Fluminense Federal University
E-mail: vitoriaclem@gmail.com
ORCID: https://orcid.org/0009-0009-6599-8936
LATTES: http://lattes.cnpq.br/7662877604282209

Revista ARACÊ
ISSN: 2358-2472

limits the ability of agents to interpret technical reports, question business practices, and implement effective preventive measures. Although technical training is not the only determining factor for efficient management, the study highlights its importance in reducing vulnerabilities and increasing objectivity in decisions. The findings highlight the need for ongoing training, independent audits, and improvement of regulatory standards. The study also recommends greater involvement of local communities in safety protocols to ensure transparency and accountability. These measures are essential to prevent future disasters and strengthen dam safety governance in Brazil.

Keywords: Civil Defense. Risk management. Dam safety. Mining disasters. Support for decision-making.

Revista ARACÊ
ISSN: 2358-2472

INTRODUCTION

The disasters that occurred in Mariana (2015) and Brumadinho (2019) represent milestones in the history of dam safety in Brazil. In both cases, the rupture of mining tailings dams resulted in irreversible environmental impacts, hundreds of deaths, and incalculable social and economic damage (ANA, 2023; ANM, 2020; BRAZIL, 2019). Tragedies are failures in the management of risks associated with dam safety, evidencing regulatory and operational weaknesses, problems in inspection and the performance of Civil Defense agents (Momose, 2025).

The complexity of dam safety management involves multiple actors, including mining companies, regulatory agencies, and municipal Civil Defenses. According to Momose (2025), although there are studies on dam safety, there are still few studies that directly relate the organizational hierarchy of mining companies, inspection failures, and the training of Civil Defense agents. In addition, the organizational hierarchy of mining companies, characterized by highly centralized decision-making processes, often limits transparency and makes it difficult to identify responsibilities. In addition, the outsourcing of inspection, combined with asymmetric power relations between entrepreneurs and inspection agencies, creates an environment conducive to increased operational risks.

In this context, the technical training of Civil Defense agents is a pillar in the management of dam safety risks, consequently the absence of specific education can compromise the ability of these professionals to interpret technical reports, question protocols or make reasoned decisions. Thus, the hypothesis raised is that the lack of technical training of Civil Defense agents directly compromises the effectiveness of preventive actions, response to dam disasters and community protection.

Based on this problem, this study sought to answer the following central question: How does the lack of technical training of Civil Defense agents compromise the safety risk management of mining dams in the iron quadrangle of Minas Gerais?

The relevance of this study was to foster the improvement of a safety culture that goes beyond compliance with regulations, which includes the continuous training of the professionals involved and involves the community potentially affected by a dam failure. In addition, the research, in theory, has the potential to contribute to the debate on the restructuring of training programs for Civil Defense agents, considering the complexity of the challenges faced in disaster risk management.

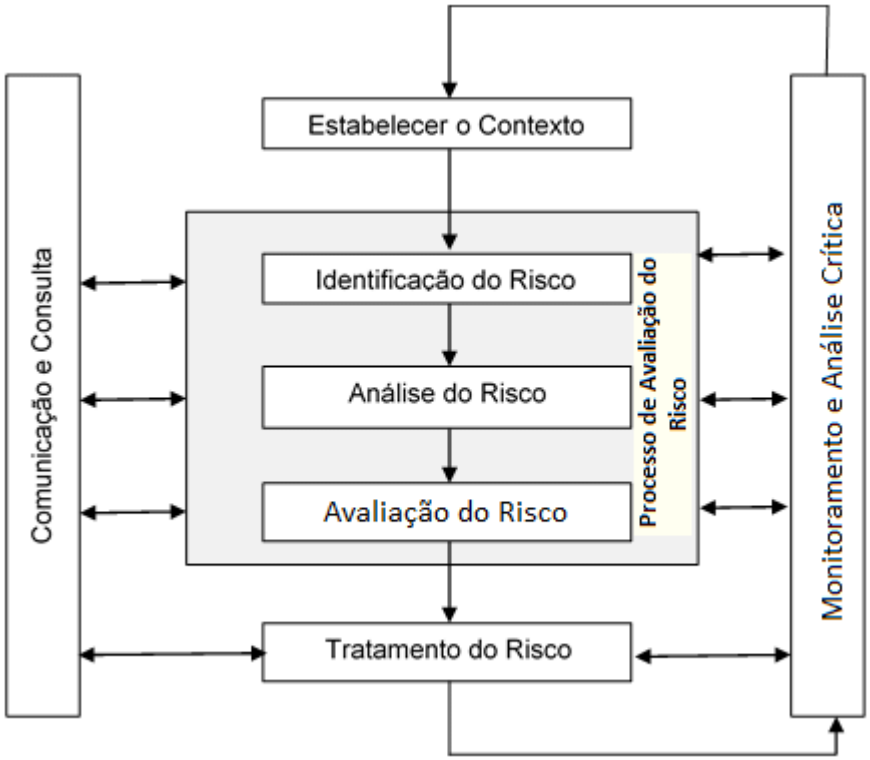
Revista ARACÊ
ISSN: 2358-2472

This article is structured as follows: after this introduction, the theoretical framework presents concepts and studies on the formation of Civil Defense, the organizational hierarchy of mining companies and dam safety. Next, the materials and methods section describes the approach used in the research. The results and discussions analyze the main findings of the study, and, finally, the conclusion summarizes the contributions of the research and suggests directions for future studies.

THEORETICAL FRAMEWORK

Risk management in dam safety is a multidisciplinary field recommended in guidelines of the *International Commission on Large Dams* (ICOLD) or in the ISO 31,000 standard for risk management that combines engineering, public policies and disaster response.

Figure 1 - ISO 31000 risk management process and framework



Source: ABNT (2009)

In Brazil, the legislation that regulates this activity includes the National Dam Safety Policy through Federal Law No. 12,334 of 2010, which establishes guidelines for monitoring, inspection, and risk classification (ANM, 2020). However, in Sampaio's study (2016) The implementation of these guidelines faces challenges, especially in the

Revista ARACÊ
ISSN: 2358-2472

inspection of the entrepreneur's self-declaration on the safety conditions of the dams and later the technical capacity of the agencies responsible for verifying the veracity and technical relevance of the information provided.

Corporate governance refers to the set of rules, practices, and processes by which an organization is directed and controlled. In the context of mining companies, this model includes the company's hierarchical structure, decision-making mechanisms, and relationships between shareholders, managers, and stakeholders (Sampaio, 2016)

Conflicts of interest occur when there is overlap between an organization's objectives and the regulatory responsibilities of supervisory bodies or third-party audits. In high-risk sectors such as mining, the lack of independence between auditing and enforcement can compromise the transparency of safety reporting (Barbosa; Filgueira; Da Silva, 2023).

Power distance is a dimension of organizational culture identified by Hofstede (1984) and updated with the latest version through the studies of Minkov and Kaasa (2022). This dimension measures the degree of acceptance of hierarchical inequality within a society or organization. In companies with a high power gap, decisions are centralized at the top levels and there is little room for questioning by subordinates (Hofstede, 1984). In the mining sector, the organizational hierarchy is highly verticalized, which can hinder communication between different operational levels and impact the implementation of dam safety measures (Sampaio, 2016).

Uncertainty aversion is another dimension of organizational culture that refers to the degree of discomfort of a society or company in the face of ambiguous or unknown situations (Hofstede, 1984). Organizations with a high aversion to uncertainty tend to rely heavily on regulations and formal audits to minimize risk, rather than adopting more flexible and proactive approaches.

In the case of dam safety, this characteristic is manifested in the prioritization of external audits and formal compliance with standards, without necessarily encouraging an organizational culture focused on innovation in inspection and disaster prevention (Barbosa; Filgueira; Da Silva, 2023).

Barbosa, Filgueira e Silva (2023) point out that in the case of the Mariana – MG collapse, the set of actors involved in the disaster had a direct or indirect relationship, either through actions and/or omissions to materialize the adverse event. The authors list the "consultants, responsible for the construction and operation of the dam, the managers

Revista ARACÊ
ISSN: 2358-2472

of the mining company, the bodies responsible for supervising the mining activity, among others" as the group of people related to the disaster (Barbosa; Filgueira; Da Silva, 2023, p.2047).

THE TRAINING OF CIVIL DEFENSE AGENTS AND THEIR INFLUENCE ON DAM SAFETY MANAGEMENT

In addition to the organizational management of dam safety management, another relevant factor is the qualification of Civil Defense agents, which represents a relevant aspect in disaster risk management (Momose, 2025). However, in Brazil, this training process is characterized by asymmetries, reflected in the heterogeneity of training between states and/or municipalities, due to the lack of a consolidated national standard (Marchezini *et al.*, 2021). The training gap limits the ability of agents to interpret technical reports, perform geotechnical analysis, and proactively intervene in the prevention of adverse events (Marchezini *et al.*, 2021).

The data collected in the report of the Elos project, which was a survey aimed at diagnosing the Municipal capacity in Civil Protection and Defense, indicate that a fraction of the municipal Civil Defenses declare themselves insufficiently qualified to act in the different phases of a disaster: 43% before, 40% during and 41% after the occurrence of the event (Marchezini *et al.*, 2021).. Notably, the Midwest and Northeast regions have the lowest qualification rates, while the South and Southeast regions register better perceptions of preparedness (Marchezini *et al.*, 2021).

In the context of the research carried out at the time of the Elos project, it was detected that training occurs informally, through accumulated experience and the exchange of information between professionals in the area, and formally, through training promoted by state and federal agencies, academic institutions, and research centers (Marchezini et al., 2021). However, most of the courses offered are introductory, aimed at those entering the function, without a progressive training path that contemplates different levels of specialization and the complexities inherent to dam inspection (Momose, 2025).

Regarding technical skills, 44% of the municipal Civil Defenses reported little training to promote the inspection of risk areas, 42% reported challenges in mobilizing and training volunteers, and 35% showed lack of knowledge regarding the use of the Civil Defense Payment Card – CPDC (Marchezini *et al.*, 2021). In addition, 61% of the municipalities do not use early warning systems, and 54% do not have records of populations in risk areas,

Revista ARACÊ
ISSN: 2358-2472

presenting vulnerabilities in operational processes (Marchezini *et al.*, 2021). The lack of training is also reflected in the low dissemination of training with local communities. Only 9% of the municipal Civil Defenses promote courses aimed at the Community Centers for Civil Protection and Defense – NUPDECs. (Marchezini *et al.*, 2021).

The survey also identified the main obstacles to the expansion of training, among which the high costs (31%) stand out, particularly in the North and Northeast regions; the scarcity of courses (27%); and insufficient personnel (25%), a particularly limiting factor in the South and Southeast (Marchezini *et al.*, 2021).

Subjectivity in the decision-making process emerges as another limitation, since the lack of technical training restricts the ability of agents to contest reports from outsourced companies and to base their decisions on scientific criteria (Momose, 2025).

Given the risk management model established by ISO 31000, Hofstede's organizational theories (1984) Regarding the influence of culture on decision-making, the legislation relevant to risk management in dams and the characteristics of the training of protection and civil defense professionals, it is possible to integrate these topics for a deeper understanding of the practices that can improve the effectiveness of dam safety management. In the next section, the materials and methods used to conduct this research will be presented.

METHODOLOGY

This study adopted an explanatory approach, based on documentary analysis and descriptive qualitative research (Gil, 2019). The research seeks to understand how the training of Civil Defense agents influences the management of dam safety risks, analyzing technical documents, institutional reports and case studies related to the disasters of Mariana in 2015 and Brumadinho in 2019.

The research used documentary analysis, considering different data sources: Official documentation, Federal and State Laws (MG), regulations of the National Mining Agency – ANM, technical and academic studies on the training of Civil Defense agents and their influence on risk management, studies on organizational hierarchy and dam inspection.

The research is explanatory, as it analyzed the relationship between the technical training of Civil Defense agents and their ability to act in dam risk management. As mentioned earlier, it has a descriptive qualitative character, since it is based on the

Revista ARACÊ
ISSN: 2358-2472

interpretation of technical documents and official reports to describe power dynamics, institutional failures, and impacts on oversight (Bardin, 2011)

In addition, the technical reports were reviewed and official documents on Mariana and Brumadinho were compared. Comparison between the management failures identified in each disaster. Identification of recurring patterns in the performance of Civil Defense and inspection agencies.

The documents and studies were analyzed based on content analysis, which according to Bardin (2011) is a widely used method for interpreting qualitative data. Official and academic documents published between the years 2010 and 2024 were selected, as it was intended to use the legal framework of the National Dam Safety Policy in 2010, the studies after the Mariana disaster passing through Brumadinho and the legal changes until the research cutoff in 2024. Selection criteria included relevance to the topic, credibility of the source, and freshness of the content.

The documents were categorized into three main axes. After the elaboration of the theoretical framework, the technical training of Civil Defense agents was grouped as an axis due to the influence of Brazilian legislation in the execution of Civil Protection and Defense policies. The second axis was the organizational hierarchy and its influence on decision-making from the perspective of Brazilian culture and Hofstede's theory. Finally, dam safety risk management, especially from the perspective of ISO 31,000.

In this way, the data were compiled, seeking to identify patterns, gaps and relationships between the themes until the elaboration of an influencing factor that dialogued with all axes. This qualitative analysis proved to be interesting because, in the results section, a table is presented containing the factors considered pertinent and an analysis, through the Matrix of Influence on Decision Making (GUT Matrix) tool, in which criteria that influence decision making in dam safety risk management were hierarchized. It should be noted that the criteria for search, analysis, sample, inclusion, exclusion, limitations, etc., follow the classification made by Momose (2025).

RESULTS AND DISCUSSION

Theoretical teaching during the training of civil defense agents is a pillar in their professional career. Even if the professional has experience at the beginning of his career, he must be properly trained at the beginning of his career, especially for risk management

Revista ARACÊ
ISSN: 2358-2472

in dam safety, which is the core of this study. This understanding indicates that the objective of the research was achieved and that the hypothesis proved to be valid.

The civil defense agent, when starting his career backed by a consolidated theoretical base, will have more elements to make his decision objective and based on the lessons learned as a student. Over the years and the accumulation of experiences, it will give new meaning to its theoretical bases from the lived experience. Therefore, theoretical training at the base potentially contributes to the reduction of disaster risks and reduces subjectivity in decision-making.

Thus, the purpose of analyzing the degree to which the lack of academic training of civil defense professionals impacts subjectivity in the decision-making process regarding dam safety, compromising efficiency in the management of community protection, was achieved. This is because the objectivity in the training of these agents, aimed at Civil Protection and Defense, constitutes an opportunity, although with some limitations, in the management of risks associated with dams.

It was understood that the training of the civil defense agent is an instrument for the work, allowing him to reflect in greater depth on the challenges he faces. This is because the complexity involved in the operation of a dam company requires a highly qualified professional to understand the particularities of management. In addition, this complexity goes beyond the technical functioning of the dam, extending to the authority vacuums present in the high-risk operations of these corporations, which have large revenues and often opt for management models that tolerate disaster risks, as long as the financial objectives are achieved.

The complex organization of these corporations conceals a hierarchy that widens the distance of power, seeking, in theory, to ensure political autonomy to the detriment of technical aspects. As a consequence, there is an increase in the probability of failures, since the business management model favors the maximization of profits. Instead of offering effective support, the legislation makes it possible to hire third-party companies to certify safety, as in the case of Brumadinho, where the company in charge of the inspection was of German origin, and those responsible for the failures never suffered any type of penalty. It should be noted that so far, the analysis is still practically focused on the operational dimension, which, to a large extent, corroborates the idea of reducing subjectivity in the decision-making process. However, we are not disregarding the decision here as an imminently human and, above all, discretionary act of the manager. On the

Revista ARACÊ
ISSN: 2358-2472

contrary, both the operational dimension and the political dimension were highlighted. Because in a crisis, it is necessary that both those who are supporting and those who are deciding never lose this vision, which can certainly expand the possibilities for educational agencies in this scenario.

In addition, within the scope of operations and training, there is the possibility of civil defense agents being recruited to act as consultants for companies, assisting in the preparation of the community, coordinating evacuation simulations and preparing evacuation plans, even without the proper technical qualification, but still holding authority for inspection.

The influence of the status of the local civil defense manager can compromise the effectiveness of contesting the leadership, even in the face of the identification of irregularities. The risk of omission or alignment with the interests of dam companies becomes even more worrying if the civil defense agent does not have a specialized qualification or does not have qualified professionals for dam safety management.

This does not mean that other factors do not influence management, but the absence of adequate education in the training of civil defense agents represents a serious failure in the management of disaster risk in dams. It is in this context that the concept of subjectivity in management is reinforced here. It is worrying that a civil defense agent is assigned to work in an environment that presents multiple layers of complexity related to dams without prior technical qualification or that at least has a specialist professional on his team.

The Mariana and Brumadinho disasters exposed systemic institutional failures, highlighting the need to reformulate security policies and improve inspection mechanisms. The analysis of these events allowed us to understand how deficiencies in dam safety management and the lack of participation of the local community intensify the risks and, consequently, the impacts of disasters. It is essential to analyze how these factors interact within the specific scenario of the mining industry in Brazil, characterized by an unequal power relationship between companies, the State and affected populations.

The comparison between the Mariana and Brumadinho disasters revealed patterns and distinctions in dam risk management and in the response of the responsible agencies. Both disasters exposed failures in enforcement and the implementation of safety practices.

In the case of Mariana, the deficiencies in communication and the lack of efficient coordination between the Civil Defense and the company responsible amplified the impacts

Revista ARACÊ
ISSN: 2358-2472

of the disaster. The lack of a structured response plan, combined with the lack of training in emergency protocols and communication for the agents involved, further aggravated the situation. In Brumadinho, the location of the dam, close to densely populated areas, added to the inefficiency of the warning systems, resulted in a tragedy of even greater proportions, with a higher number of fatalities.

The comparative analysis also highlighted the role of organizational culture and management practices in the ability to respond to emergencies. The high power gap and the aversion to uncertainty present in the companies involved made it difficult for local communities to actively participate and prevented the adoption of more effective preventive measures.

The lack of transparency and the concentration of decisions have intensified poor risk management. These disasters highlight the urgency of a more integrated and collaborative approach that engages local communities and ensures transparency at all stages of dam management. It is critical to ensure that all stakeholders, including potentially impacted populations, are properly informed and have the possibility to actively participate in decisions that may directly affect their lives and well-being.

The Mariana and Brumadinho disasters underscore the urgent need for profound transformations in the organizational culture of mining companies. Safety must be placed as a priority, above financial interests, and negligence in the maintenance and inspection of dams cannot be admitted. The analysis also indicates that, while in Mariana there was a certain degree of omission on the part of the regulatory authorities, in Brumadinho the tragedy was enhanced by the lack of preventive actions, even in the face of constant alerts and previously expressed concerns about the stability of the dam. As the disasters occurred in both Brumadinho and Mariana, there remains a continuous alert that similar events may be repeated in other areas of the iron quadrangle.

Faced with this complexity in dam management, a civil defense manager is not able to intervene and it is important to return to this point. Their decisions tend to be based on their beliefs and aligned with their interests. An additional layer of complexity lies in the condition of the status of the local civil defense manager. Depending on the municipality, many are sworn in as coordinators, directors or superintendents, which in the municipality's hierarchy places them below other managers, further increasing the distance from decision-making power.

Revista ARACÊ
ISSN: 2358-2472

It is essential to emphasize and reinforce that this relationship of distancing in power can hinder the administration and compromise the effectiveness of civil defense actions at the municipal level. It should be noted that the receptivity of businessmen about security issues is directly related to the hierarchical position of the civil defense manager: the lower his position in the command structure, the lower his capacity for influence and authority about the entrepreneurs. This hierarchical dynamic limits the impact of interventions and weakens the ability to implement essential changes to ensure dam safety and population protection.

It can be understood that companies operating in high-risk sectors, such as mining, are structured in highly vertical hierarchies. These organizations have a diversity of protocols and decision-making processes that follow a centralized logic.

In failure situations, as occurred in Brumadinho, this hierarchical structure makes it difficult to identify a single person responsible for the incident. In practice, when questions are directed to the upper echelons, such as senior management, the commonly presented answer is that there was no direct knowledge about the problem, as the guidelines were issued so that the protocols were followed. Similarly, when asking lower operational levels, such as local managers, the justification often points to compliance with established orders and norms, alleging ignorance of critical issues or lack of authority to bring about change.

It is in this context that the subjectivity of the civil defense agent becomes a critical factor. A professional without adequate training may have difficulties understanding the complexity of this hierarchical structure. He will hardly realize that, above the local operations manager, there is a much more political and intricate decision-making system, composed of multiple administrative levels that act in a way that is disconnected from the operational routine. It is important to say that we are not denying the political dimension of the decision-making process, but what is being problematized is the need for decision-making anchored in evidence, and these constitute a crucial subsidy for a better-founded and more assertive decision-making.

The agent may not recognize that this structure, deliberately or not, sometimes omits failures or manages risks by prioritizing maximizing profits over safety.

This lack of understanding limits the ability of the civil defense agent to question the processes efficiently. For him, the performance of simulated training, the triggering of alarms and the presentation of compliance reports by third-party companies may seem like sufficient evidence that security is being managed properly.

Revista ARACÊ
ISSN: 2358-2472

To face this complexity and enable more objective decision-making in dam risk management, the GUT Matrix (Severity, Urgency and Trend) was used as a tool to prioritize the factors that influence the subjectivity of civil defense agents. This approach made it possible to classify problems according to their impact and the need for intervention, facilitating the definition of strategic actions.

Table 1 represented in a hierarchical manner the factors that influence the subjectivity of civil defense agents, ranking them according to their degree of severity, urgency and tendency to worsen. This systematization allowed us to prioritize corrective actions and define strategies to mitigate the negative influence of these factors on dam safety.

When analyzing the results of the GUT Matrix, it is clear that the factors with the highest score, such as resources, inadequate training, hierarchical organizational culture, and lack of clear protocols, require immediate intervention. This reinforces the need for managers with prior knowledge to ensure more objective risk management.

However, without the necessary knowledge to discern the complexity behind these actions, he will not realize that many of these practices may be only superficial, used to comply with regulatory requirements, without actually ensuring the safety of the dams and the protection of the community.

This limitation highlights the need for more in-depth and technical training for civil defense agents. Only with a solid understanding of the organizational dynamics and the risks involved will it be possible for these professionals to act effectively in the inspection and protection of communities.

Table 1 - Influence Matrix on Decision Making with GUT

Influencing Factor	Degree of Impact	Possible Solutions	(G)	(U)	(T)	GUT
Inadequate training	High	Mandatory technical training for agents	5	5	5	125
Hierarchical organizational culture	High	Greater decentralization and active participation of agents	5	4	5	100
Lack of clear protocols	High	Elaboration and implementation of redundant protocols	4	4	5	80
Lack of communication between agencies	Medium	Real-time information integration and sharing	5	4	4	80

Revista ARACÊ
ISSN: 2358-2472

Power distance between agents and managers	Medium	*Skin in the game*	4	5	4	80
Insufficient financial resources	Medium	*Barbell strategy*	4	4	4	64
Reliance on external expertise	Low	Creation of internal nuclei of permanent specialists	3	3	4	36
Political influence on the decision	Low	Support of technical criteria in decision making	3	3	3	27

Source: Momose (2025)

However, this study does not advocate the complete elimination of subjectivity in favor of absolute objectivity as the sole basis for decision-making. The central proposal is that the reflection of a problem can only emerge from a continuous learning process, either through theoretical training or through accumulated practical experience.

This study does not reduce decision-making to the strictly technical field, but recognizes that subjective decisions may involve political dimensions and must be based on technical criteria. The intersection between specialized knowledge and the discretion of the manager is essential to ensure more balanced and informed decisions.

The work highlighted the risks of exposing unqualified professionals to decision-making processes, emphasizing the need for continuous training so that civil defense agents can perform their functions with greater grounding.

The analysis of the Mariana and Brumadinho disasters provides lessons for improving dam safety management in Brazil. Among the main lessons is the need to strengthen inspection and monitoring mechanisms, promote the continuous training of Civil Defense agents, and implement alert and communication systems that effectively involve local communities.

In addition, it is essential to raise the status of municipal civil defense coordinators, with secretary positions, in order to reduce the power gap between the authorities who effectively decide, namely the mayor and entrepreneurs, which in theory contributes to promoting a culture of security that values the active participation of all those involved.

It is also recommended to review the construction practices of dams, prioritizing safer methods that are more appropriate to the geotechnical and climatic conditions of the Iron Quadrangle region, which are not restricted to Mariana and Brumadinho. In addition, mining companies must take a proactive stance towards safety by investing in monitoring technologies and frequent audits of their structures. The creation of independent

Revista ARACÊ
ISSN: 2358-2472

enforcement mechanisms capable of acting impartially is also necessary to ensure that safety standards are met and that failures are corrected before they can result in disasters.

Another important recommendation is the implementation of public policies that encourage the participation of affected communities in the decision-making process. Social inclusion and the democratization of access to information contribute to the construction of a more collaborative security culture. Local communities must be empowered to question, suggest, and actively participate in decisions that impact their safety and well-being. Finally, the experience with these disasters reinforces the importance of learning from the past, to avoid the repetition of similar tragedies, and highlights the need for a continuous and uncompromising commitment to the safety and preservation of human life.

CONCLUSION

The research deepened the understanding that the lack of technical training of Civil Defense agents is a factor to be considered and that it compromises the effectiveness of risk management in dam safety. The absence of technical training in dam safety makes it difficult to interpret technical reports, reduces the autonomy of agents and increases subjectivity in decision-making. As a consequence, there is a structural vulnerability in inspection, which is aggravated by the organizational hierarchy of mining companies, marked by the decentralization of responsibility and the outsourcing of safety audits.

The disasters of Mariana (2015) and Brumadinho (2019) exemplify how institutional and regulatory failures can amplify the impacts of a structural collapse. Both cases highlighted the fragility of inspection mechanisms, the influence of economic interests on security and the lack of planning for emergency response. The comparison between the disasters allowed us to identify recurring patterns, such as the delay in the response of the Civil Defense, the failure in communication between companies and regulatory agencies, and the absence of adequate training for inspection agents.

Based on these findings, some recommendations are essential to improve dam safety management in Brazil:

- Mandatory technical training for Civil Defense agents, ensuring that they have specific knowledge about dam safety, risk auditing and emergency management.
- Review of the inspection structure, reducing dependence on third-party audits and promoting greater transparency in technical reports.

Revista ARACÊ
ISSN: 2358-2472

- Strengthening institutional governance, ensuring the autonomy of supervisory bodies to avoid political and economic pressures.
- Implementation of independent audits, conducted by exempt institutions with no financial ties to mining companies.
- Change in emergency protocols, with more effective evacuation plans, early warning systems and regular training for the community.

Despite the contributions of this study, some limitations should be considered. The document analysis had restrictions on access to internal reports of the mining companies, which could provide more detailed information on operational or strategic failures. In addition, the research focused on the training of Civil Defense agents, but other institutional factors can influence inspection, such as the Brazilian regulatory framework and the role of environmental agencies in dam management.

Therefore, future research can deepen the impact of public policies on dam safety, assess the effectiveness of new post-Brumadinho regulations, and investigate international models of inspection and governance, comparing them with the Brazilian reality. In addition, studies that integrate quantitative analyses, such as statistics on dam failures and correlations with the qualification of inspection agents, can provide even more robust data to support future reforms in the sector.

In view of the recurrence of disasters involving dams, it is urgent to rethink the training of the agents responsible for inspection and strengthen control mechanisms, ensuring that the safety of the population and the environment is an unquestionable priority in risk management in Brazil.

This study sought to articulate the need for adequate training of civil protection and defense professionals, articulating themes, knowledge, duties and essentially both the operational and the strategic dimensions. However, based on the itinerary covered in this study, it is suggested as future studies the possibility of articulating the debate on the curricula of the main training units in the sector, aiming at the construction of an analysis also of the type of information/training that the current teaching units do, and from the in-depth analysis of the curricula, who knows if it would not be possible to think about the possibility of unifying the training?

Revista ARACÊ
ISSN: 2358-2472

REFERENCES

1. ABNT. **Risk management - principles and guidelines**. [*S. l.*]: ABNT, 2009.

2. ANA. **Dam Safety Report 2022**. [*S.l.*]: National Water and Basic Sanitation Agency, 2023.

3. ANM. **RESOLUTION No. 51**: Ministry of Mines and Energy. [*S.l.*]: National Mining Agency, 2020. Available at: https://www.snisb.gov.br/Entenda_Mais/legislacao-aplicada/anm-resolucao-no-51-de-24-de-dezembro-de-2020-1.pdf. element.

4. BARBOSA, S. D. O.; FILGUEIRA, H. J. A.; DA SILVA, T. C. Investigation on the Causes of Mining Tailings Dam Failure: A Case Study of the Fundão Dam, in Mariana, Minas Gerais, Brazil, with the Use of the Constellation Analysis Technique. **Brazilian Journal of Physical Geography**, [*s. l.*], v. 16, n. 4, p. 2047–2068, 2023.

5. BARDIN, L. **Content Analysis**. 1st edition ed. [*S. l.*]: Almedina Brasil, 2011.

6. BRAZIL. **Work Accident Analysis Report**. [*S.l.*]: SEGUR - Occupational Safety and Health Section, 2019. Available at: https://www.gov.br/trabalho-e-emprego/pt-br/assuntos/inspecao-do-trabalho/seguranca-e-saude-no-trabalho/acidentes-de-trabalho-informacoes-1/relatorio_analise_acidentes_brumadinho.pdf. Accessed on: 22 Apr. 2024.

7. GIL, A. C. **Methods and Techniques of Social Research**. 7th edition ed. [*S. l.*]: Atlas, 2019.

8. HOFSTEDE, G. **The cultural relativity of the quality of life concept**. [*S.l.*]: Academy of Management Review, 1984.

9. MARCHEZINI, V. *et al.* **Diagnosis of municipal capacities and needs in Civil Protection and Defense – Brazil**. Brasília, DF: National Center for Monitoring and Alerts of Natural Disasters (CEMADEN), 2021.

10. MINKOV, M.; KAASA, A. Do dimensions of culture exist objectively? A validation of the revised Minkov-Hofstede model of culture with World Values Survey items and scores for 102 countries. **Journal of International Management**, [*s. l.*], v. 28, n. 4, 2022.

11. MOMOSE, A. H. **Strengthening Civil Defense: Reducing subjectivity in dam safety decision-making through education**. 2025. 61 f. Dissertation - Fluminense Federal University, Niterói, 2025.

12. SAMPAIO, J. A. L. The Deficiencies of the Emergency Action Planning for Dams in Brazil. *In*: , 2016. **Brazilian Journal of Law**. [*S. l.: s. n.*], 2016. p. 7–17. Available at: https://seer.imed.edu.br/index.php/revistadedireito/article/view/1313. Accessed on: 30 jan. 2025.