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Revista Brasileira de Ciência, Tecnologia e Inovação

DOI: https://doi.org/10.18554/rbcti.v9i1.6840

Research paper

# *Analysis of TELEVALE's wireless sound alert system: technological innovation approach applied to self-rescue zones of dams*

## Análise do sistema de alerta sonoro sem fio da empresa TELEVALE: uma abordagem em inovação tecnológica aplicada a zonas de auto salvamento em barragens

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**ABSTRACT:** The growing number of plants located close to habitable zones has currently opened room for the need of containing risks and their factors, since they can be the cause of ruptures in dams and put the population living close to downstream areas in danger due to likely environmental hazards. The aim of the present study is to assess the installation of a high-power sound alert system developed to announce emergency evacuation of populations living close to Rio do Peixe plant's dams. In order to do so, Rio do Peixe plant sent data from maps of theSelf-Rescue Zone (ZAS) and they were collected over the field research. Subsequently, Remote Stations were installed in strategic spots set by the Plant. This procedure was followed by open-field simulations to validate the sound-pressure level in 70 dB, at least. Based on the results, SNE-T is effective, safe and reliable, if one bears in mind that all three measurements reached levels higher than 70 dB. These values meet the requirements by the National Policy for Dam Safety. It is important reporting that the researcher and TELEVALE were awarded, in 2022, with the National Innovation Award for SNE-T's success. This award was endorsed for the technical, acoustic and technological aspects,as well as for the low SNE-T's production and implementation cost, since it was 100% nationally developed. The herein analyzed innovative emergency alert system technology is reliable, effective and safe, in addition to being financially viable.

**Keywords**: Sound Alert. Self-rescue. Emergency Notification.

***RESUMO:*** *Na atualidade, com o crescente número de usinas localizadas próximas a zonas habitáveis, há a necessidade de se conhecer os fatores que podem desencadear na ruptura de suas barragens. Em adição é importante que se tenha sistemas sonoros que avisam a população, frente a um possível desastre ambiental, próximas às áreas a jusante. Frente a isto, este estudo teve como objetivo avaliar a implementação de um sistema de alerta sonoros de alta potência, desenvolvido para notificação emergencial de evacuação em massa da população de moradores próximos a barragens da Usina do Rio do Peixe. Para tanto, na pesquisa de campo, inicialmente a Usina Rio do Peixe enviou dados sob a forma de mapeamento prévio da Zona de Auto Salvamento (ZAS). Posteriormente, foram instaladas as Estações Remotas em pontos estratégicos definidos pela Usina, seguidas das simulações a campo aberto, para validar o nível de pressão sonora de no mínimo de 70 dB. Os resultados apontam que o SNE-T é eficaz, seguro e confiável, considerando que todas as três medições foram acima de 70 dB, atendendo as exigências da Política Nacional de Segurança de Barragens. Importante relatar que pelo sucesso do SNE-T, infere-se que a tecnologia inovadora do sistema de alerta emergencial, analisado nesta pesquisa, é confiável, eficaz e seguro, além de ser financeiramente viável.*

***Palavras-chave****: Alerta Sonoro. Auto salvamento. Notificação Emergencial.*

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## INTRODUCTION

Mining plants have acknowledged the importance of high-quality standards to build tailing dams in Brazil. This is the reason why mining companies have invested in technological innovation to ensure their surroundings' safety through effective sound emissions in self-rescue and mass evacuation zones. In order to do so, several companies have developed sound alert systems, most notably Tele Comunicações do Vale do Rio Grande LTDA - TELEVALE, which recently developed, an innovative and award-winning sound alert system that was also validated and made available. This system is featured as wireless technology developed with 100% national components.

Before developing TELEVALE's Emergency Notification System (briefly referred to as SNE-T), the current study assumed that "structures designed to store mining tailings are getting larger and larger" (Guedes; Schneider, 2018). A previous survey carried out by this company was justified by the increased potential risks posed to populations living downstream dams' river, such as families living around Rio do Peixe Plant (Nova Lima - MG), where SNE- T was installed and validated.

Theories and practices in technological innovations used in Brazil were sought to design, produce and test a sound alert system in compliance with the plant's demands. Field research was carried out to validate the scope of SNE-T alert's high acoustic power after simulations, based on assessing and analyzing all the components developed by TELEVALE by considering the guidelines in the National Dam Safety Policy (PNSB).

An innovative proposal was herein introduced in compliance with Federal Law 12.334, from September 20, 2010 (amended by Law 14.066/2020) to address the applicability of a sound alert system that uses solar generator to power up SNE-T, in addition to wireless components operated by radio frequency. Like any national policy, the aim of PNSB is to consolidate safety standards to broaden opportunities for self-rescue and mass evacuation by regulating actions and quality standards (Lima, 2020) through innovative and efficient technological devices.

Given the pressing need of preventing environmental hazards resulting from dam ruptures in mining companies, the present proposition is to analyze an open field sound warning system to bring up the discussion on how technological innovations can help self-rescuing procedures in the vicinities of mining plants. It is important not only to simulate, but, most of all, to validate an acoustic warning system whose sound power contributes to the self-rescuing of as many people as possible, to avoid losing lives, mainly after the accidents in Mariana (2015) and Brumadinho (2019), since safety is as necessary as profitability.

After these preliminary considerations, the aim of the present study was to assess the installation of a high-powered acoustic warning system designed to announce emergency mass evacuation of populations living near the Rio do Peixe Power Station dams.

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## THEORETICAL REFERENCE

Currently, mining has urban and economic impact on job positions' generation and on taxation rates. They contribute to regional development through mining, but they also bring along the possibility of disasters that significantly change the daily life of cities by increasing the risk of mass death cases, mainly in population's living downstream rivers (Franco; Santos; Moura, 2021). Contemporary technological innovations can help improving populations' safety and enable effective self-rescuing, which are extremely important strategies for technological updates and to produce new sound warning devices. The present research combines safety, technology and innovation as theoretical and practical framework based on technical design to validate of new self-rescuing innovation patents.

### Safety and technology

As far as the downstream population is concerned, potential risks have always been around mining companies, but vulnerability to dam ruptures has increased due to exponential increase in productivity. The risks posed by dams are not only associated with breaches, but also with the fast and uncontained tailing flow. From this perspective, effective self-rescuing strategies are more evident when dams use reliable sound warning systems with wide-range local reach (Brito; Costa, 2021). The aim of the safety sector is to develop new technologies to enable self-rescue and to prevent the risk of having tailing reaching the population by means of validated and efficient technological systems aimed at promptly enabling the mass evacuation of residents living close to plants' entrances.

Different computerized technologies have been widely used to simulate, test and validate the whole long-range sound wave propagation process right after a dam failure as attempt to minimize or eliminate the consequences of it. Similarly, safety technologies based on numerical simulation allow reproducing a hypothetical situation to test their technical-technological accuracy (Bastos *et al.,* 2022). Decibel meters can be used to measure equipment power and its territorial reach in different self-rescuing zones as one of the main safety and warning measures for the population.

Security, and its technologies, must be part of the "national culture of disaster prevention by stimulating behaviors capable of establishing measures to prevent disasters in risky areas" (Rocha, 2017, p. 28). Security technologies are essential and add strategic value to Emergency Action Plans (PAE) if one takes into consideration sound alert systems as part of a list of equipment capable of protecting citizens in risky areas.

Thus, alert systems installed in SBAs need to have information routines at continuous stable operations that can be easily activated. It must be so, to ensure that the whole population is warned, mainly that living in downstream areas. In addition, a validated technology must take into account risk–area edges to rule out margin of error and to prevent false alarms. It is achieved by maintenance routines aimed at ensuring the system's full operation (CODEVASF, 2021).

Studies by Meirelles (2018, p. 32) on the safety of emergency warning systems in risky areas show that:

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> It is important to notice that, according to an in-depth search, five patents were found [and they] have something to do with using the Internet of Things to monitor and warn risky areas. However, it was noticed that patents did not describe in detail the used radio-frequency technologies or the old technologies still in place.

It should be noticed that the most updated warning devices work through components that are microcontrolled by computers and applications whose functionality is preferably activated by radio frequency by means of wireless technology. In addition, these devices are capable of emitting signals through radio frequency microchips to send out real-time warnings. Therefore, it is of utmost importance to theoretically address technological innovations in notification systems to analyze TELEVALE's SNE-T.

## Technological innovation in emergency notification systems

When it comes to technological innovation, social-urban organization modes have been followed by broad demographic and societal restructuring, including exploiting mineral reservoirs near cities, since they often lead to the construction of tailing dams. As for technological advances: "We live in a time when science no longer only studies and unveils, but also creates, empirical objects and produces theories that support them as phenomena" (Baumgarten; Guivant, 2021, p. 7). It is worth recalling that scientific culture and its theoretical contributions often analyze technologies beyond the technical-industrial dimension (empirical objects), but also as public utility (phenomenon), such as the case of emergency notification systems aimed at self-rescuing.

Accordingly, the technologies installed in ZAS are validated on a scientific basis for emergency notification to be effective in mass evacuation (with prior simulation), mainly by digitally mapping sirens' strategic positioning on remote towers. As a rule, emergency notifications are emitted by sirens with high acoustic performance whose signal range depends on their strategic location. These audible warnings are activated when a disaster is imminent. However, they must meet the necessary conditions for immediate population evacuation and establish a state of readiness (CODEVASF, 2021).

Sound warning sirens must be powerful enough to notify many people when an emergency is underway in order to provide timely self-rescuing. In this case, the technological project must be operationally consistent with the SBA to ensure its full effectiveness (BARROS, 2018). Mapping technologies have enabled TELEVALE to deploy its Remote Stations based on using carefully positioned sirens to widen warning's reach to sites beyond risky areas. When it comes to digital mapping to place sound warning towers in risky zones, Campolina; Rodrigues; Silva (2021, p. 128) state:

> This mapping is one of the strategies used by mining companies to minimize possible resistance when they arrive in a given territory to convince local communities that the company cares about society and the environment. The impacts of mining - far from being only concentrated around the installed mining complex - can cover extensive

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territories and, even at different intensities, subject thousands of people to vulnerability situations.

Thus, it is paramount that every technological innovation is assessed to reduce failures. It is so, because, in a real dam failure situation, the whole self-rescuing zone needs to clearly hear the warnings emitted by the emergency notification system.

These (wired or wireless) systems are computerized and based on functions and commands aimed at being activated from long distances. These same systems can enable mining companies to manage warning devices controlled by computerized operational routines (Miguel, 2021). In addition, these innovative technologies allow using devices integrated to a broader risk management model.

The herein referenced literature highlights the importance of both incentive policies and award events for bold technologically advanced products that extrapolate technical limits, mainly wireless products, to bring the discussion into the theoretical-practical context of technological innovation.

These innovations are conceived as means to overcome the foreign profile of technological products whenever national technologies achieve scientific accuracy excellence, as well as cost-effectiveness. These features make them attractive for large-scale production and marketing.

## MATERIALS AND METHODS

Field study analysis and discussion applied to the collected data allowed running simulations and tests to prove the effectiveness and functionality of a mass-evacuation sound warning system installed in the Self-Rescue Zone (SRZ) of Rio de Peixe Hydroelectric Power Plant, in Nova Lima City (MG). Simultaneoulsy, the effectiveness and consistency of TELEVALE Emergency Notification System (SNE-T) as innovative technology - which was patented as technical solution- was validated to make emergency notifications to the population based on sound pressure of 70 decibels, minimum, to meet guidelines in the National Dam Safety Policy.

### Open field research: plant, SAZ and technical specificities

Previous topographical and technical- technological elements were collected by professionals from Rio de Peixe Power Plant to prepare initial studies and projects aimed at developing a technological solution for mass population evacuation in risky areas in case of a likely dam failure, based on delimiting the self-recuing zones. Plotting maps was essential to set the strategic location of seven Remote Stations forming SNE-T in order collect preliminary information and data.

SNE-T was analyzed in two main components based on the aforementioned on-site demarcation, namely: local operation center (LOC) and Remote Stations (RS). LOC can be described as technological device installed in safe areas (outside risky zones). Yet, it can emit emergency warnings to RSs, through a wireless technology triggered by radio frequencies. It has emergency buttons that transmit pre- recorded messages to the RS when they are pressed. RSs are concrete poles equipped with a siren sound system and microcontrollers, including a photovoltaic system and batteries that are remotely activated

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by radio frequency. This sound system can transmit sound warnings over long distances through sirens that have high acoustic performance.

These two basic components are controlled by a software developed at TELEVALE to establish computerized communication. They send a radio frequency signal to the RSs (Figure 1) by the sirens' angular and altimetric positioning through a quite audible sound range. It is important noticing that sound pressure emissions measured by decibel meters were carried out on site in order to validate the technical solution installed near risk y zones.

**Figure 1.** Remote Alert Stations.

The simulations and tests identified the relevance of setting the most accurate coordinates possible at the time to install the stations/sirens. They must be integrated to the present research's analysis and validation parameters, and show the technological innovations added to SNE-T. Simulations were carried out in SNE-T tests by using a set of emissions, measurements and decibel alert analysis to prove TELEVALE system's scope, safety and reliability, as described below.

## Data validation and processing: technological analysis criteria

The previously described ZAS composition was of paramount importance to carry out tests with SNE-T components and prepared simulations and tests. Simulations of a new product in open field studies are essential to predict consistencies and inconsistencies. This process includes determining fixed spots, in the case of the current study: strategic spots. Tests allowed simulating and identifying RS power and siren's acoustic dispersion based on the following variables:

- Coordinates sent by the client of 07 available points
- Height of Remote Station sirens from the ground: 8 meters.
- Angle of the horns heading towards ZAS

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- Dominant frequency of the warning tone: 2,000 Hz
- Siren sensitivity: 120 decibels at 1m distance
- Room temperature: 25ºC
- Terrain topology: According to Google Earth maps
- Air humidity: 30%
- Mean listener height from the ground: 1.50 meters
- Atmospheric pressure: 1020 hPa.

These variables were calibrated in the propagation software provided by TELEVALE 'SoundVale'. This procedure aimed at measuring SNE-T effectiveness based on the RS deployment coordinates at fixed spots. Data were collected at these fixed spots to validate the entire system. It was done because of sirens' ability to concentrate sound pressure to prevent acoustic dispersion from reaching unwanted areas far from risky zones. Sirens' correct direction, which is essential for open-environment acoustic systems, was essential for sound propagation, so that it was possible to provide sound power able to cover the whole SBA. Data collection was based on following methodological procedures to get to research results:

- The system was audibly activated by the emergency button in COL in order to automatically trigger SNE-T's general warning, in all seven RSs;
- An audio test was run with siren tone close to 2,000Hz;
- The system was activated three times, each activation lasted 1 minute and 30 seconds;
- The research team moved to five defined coordinates for data collection purposes;
- Three sound pressures were collected by decibel meters at each selected spot;
- Measurements were recorded in spreadsheet on the researcher's mobile device;
- Data were collected by the researcher after three system activations;
- The researcher gathered all the collected information in a chart to show the results, which enabled plotting comparative graph of the five spots;
- At least two measurements at sound pressure higher than 70 decibels were considered for validation;
- Mean decibels measured at the selected spots were drawn up to analyze system effectiveness.

It is important to notice that measurements and validations in the current study are susceptible to external weather variations such as wind, air resistivity, atmospheric pressure, temperature, humidity, among other factors interfering with data measurements. No external variables capable of compromising the performed simulations were identified. Measurements provided valuable information and data to compose the research through simulations carried out with SNE-T and to prove system effectiveness in the open field.

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## RESULTS AND DISCUSSION

A product developed in partnership with, and support from, TELEVALE was herein introduced as technological innovation. TELEVALE is in Uberaba City - MG it and provided all the necessary materials to implement and execute the computerized technological project. These materials and financial resources allowed bringing this topic for discussion after data collection and system validation at the Plant. It is important for companies in the Brazilian market to try to foster ideas based on innovative projects (BAUMGARTEN; GUIVANT, 2021). TELEVALE played decisive role in sponsoring the development of a national technology in a competitive market to set a link among system design, execution, testing and validation.

### Results

It is important highlighting that the measured parameters showed the system's features/properties at the time to present field study results. These findings pointed out the system's effectiveness and acoustic variation through operational structural tests. Tests and validations have shown that SNE-T is effective based on the set criteria (sound range and acoustic power for self-rescue) and that it can be produced and easily traded in domestic and international markets.

The present study is part of a research project, whose data have been validated and analyzed. Tests were run separately at five strategic spots in relation to the places Remote Stations (RS) were installed in. The analyzed variable was sound pressure. It is worth pointing out that the five spots were set in relation to sound warning system's acoustic range, also known as acoustic potential.

**Table 1.** Acoustic Potential of the ER in Decibels.

| Local | Measurement 01 (dB) | Measurement 02 (dB) | Measurement 03 (dB) | Average (dB) |
|---|---|---|---|---|
| Spot 01 | 86.5 | 82.3 | 71.2 | 80.0 |
| Spot 02 | 83.4 | 81.3 | 82.5 | 82.4 |
| Spot 03 | 86.2 | 80.2 | 80.2 | 82.2 |
| Spot 04 | 80.3 | 78.5 | 79.4 | 79.4 |
| Spot 05 | 87.0 | 73.5 | 80,2 | 80.2 |

The spots (01 to 05) were defined in advance, at Rio do Peixe Plant during the tests to validate the SNE-T system. It was done before taking the three sound pressure measurements, which were followed by parameters described in the National Dam Safety Policy. The discussion was based on the average recorded for the three measurements in comparison to decibel (dB) variations among the five RS installation spots at Rio do Peixe Plant.

Point 02 was more effective than the other points if one has in mind that all strategic spots achieved sound pressure indices higher than 70dB. On the other hand, although Point 04 achieved the lowest validation average in comparison to the other tested spots, values

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remained higher than the 70dB required by PNSB. From this perspective, the means recorded for measurements taken from all SNE-T validation spots, and considering results to range from favorable to very favorable, it is possible stating that values were above the expected ones for technical project conduction. The herein addressed system's technical, acoustic and technological performance is presented below.

Product innovation has gradually become more popular in companies and enterprises due to the evolution of wireless technology and to the increasing reliability of computer systems. The relevance of product innovation in the Brazilian market can be seen in the large demand for national advanced equipment and technologies regulated by safety-related laws, including awarding prizes granted to technological development at national level.

From this perspective, the aim of the present study was to achieve greater technical and technological performance through gradual SNE-T optimization to achieve the highest sound pressure possible to accomplish mass self-rescuing events. According to Azevedo (2021), companies have started to invest in the safety sector they operate in, to improve their performance in a safer way. Thus, security systems' outsourcing (emergency warnings and notifications) is based on professional skills associated with the development of technological resources to ensure a safer environment, and SNET meets this expectation from the technological innovation perspective.

**Table 2.** Technical, acoustic and technological aspects.

| Criteria | Considerations | Ano |
|---|---|---|
| Compliance with the PNSB | Validated: fully compliant | 2022 |
| Exclusively national development | Confirmed: developed according to technical design | 2022 |
| Autonomous, wireless radio frequency operators | Consistent with the technology developed and its purpose | 2022 |
| Powered by a battery-operated solar panel | Validated: cost-effective and favorable performance | 2022 |
| Long-range sirens and performance | Consistent: range above 70dB | 2022 |
| Deployment in remote areas close to ZAS | Confirmed: ideal positioning at strategic points | 2022 |
| Lower production and deployment costs | Confirmed: lower cost than imported products | |
| Protecting and saving lives | Consistent with the purposes of SNE-T | 2022 |

With regards to the analyzed criteria, the emergency notification system (SNE-T) meets the technical and operational self-rescue specificities. Therefore, it contributes to the safety of downstream populations, and it is a great advantage for its production based on national capital. Although imported sound warning systems have been the ones most widely used by most power stations, SNE-T accounts for more affordable production/implementation costs. Moreover, it was validated as ideal if placed at strategic

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collectively predefined spots, i.e. defined along with the present author and Rio do Peixe Power Station managers.

## Discussion

Prospecting and developing new technologies in contemporary times means achieving operational efficiency, lower financial costs and undertaking safety, including technical and acoustic aspects of sound alert system aimed at emergency warning. According to recent studies, the economic viability of a technical project allows greater investment in advanced technologies and the projects' implementation potential. Therefore, new products can be transferred to the productive- industrial sector (Tironi, 2017). Thus, Scientific and Technological Innovation Institutions (ICTI), such as Federal University of Triangulo Mineiro, stand out as essential agents in scientific and technological development.

Based on Table 1, it was very important to first assess how these spots were transformed into markings for sound emission. It was done by combining measurements, and acoustic and technological studies to understand the effectiveness of five strategic spots generated in geoprocessing application to establish a spatial reference for Remote Stations (RS) installation. This process is explained by the fact that spots' demarcation was carried out in relation to environmental parameters recorded for the plant's surroundings, based on their topology.

Bastos et al (2022) states that topographical components and the volume supported by a dam are analyzed as subsystems of a demarcated environment. This process allows better understanding the association between containment power and spatial dimension to achieve environmental safety. Based on the concept of safety, space has become a technical reference, i.e., a tactical demarcation of the plant's downstream surroundings, because the recorded acoustic pressure has shown that the plant's whole SBA can perceive and recognize the warning signal at minimal margin of error, and it does not interfere with the quality of the emergency warning.

These acoustic demarcations (at the five fixed spots; Table 1) worked as RS placement support among other strategic functions. Their technical-technological validation was carried out to guide emission locations and sound pressures, as well as to define essential criteria (Table 2) that have guided the present acoustic study. These fixed spots were essential to assess TELEVALE's Emergency Notification System consistency, as well as to implement the sound alert system and its effectiveness.

According to Rocha's (2017) research, demarcations are chosen as convergence spots that set an open-environment area located in higher topographic spaces and valleys (prairies/routes). Overall, convergence points for a first measurement are often defined in open field surveys. They proved to be effective for further measurements to be carried out and to corroborate SNE-T effectiveness. In addition, the strategic RS implementation allowed analyzing likely operational inconsistencies. Comparative tests can be carried out depending on the measurement; therefore, sound pressure averages can be gathered to show the system's full efficiency and safety.

Power plants that have dams (which can break) have become more concerned about developing and installing population safety-based technologies in a technological society. Innovation implies not only creating a new product to be inserted in a competitive

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market, but, most of all, offering safety, consistency and reliability in material structure and computerized systems (Franco; Santos; Moura, 2021). When it comes to emergency warning systems based on sound alert, the whole process becomes innovative if a fully national product presenting quality equal to, or even higher than, that of imported products is developed.

Measurements and validations are equally important when the aim is to provide a safe environment for plant–activity conduction based on state-of-the-art technology (Meirelles, 2018). Measurements and their respective validations, and the acoustic range recorded by decibel meters, were part of an innovative process. Measurements, and technical and technological considerations, contributed to decision-making on likely structural changes to SNE-T. That said, the tests have increased the system's reliability regarding population safety close to plants. The present acoustic study has become a benchmark in the safety sector, since it allows verifying that the adopted sound pressures (measured during SNE-T operation) are reliable. This finding explains why the system can be used in self-rescue zones. Acoustic coverage can be identified and validated through testing and validation, as well as technical limitations of on-going projects, given the possible risks posed to the population and to the environment (Oliveira, 2022). Tests and validations based on on-site measurements were essential to analyze SNE-T and to confirm the purpose of TELEVALE's sound alert system, before it was used.

Data analysis (Tables 01 and 02) has proven that SNE-T is reliable and can be used for downstream populations' safety. According to Silva et al (2018, p. 2), "validation logistics is used as support to organize and deploy fast, agile and effective response actions, always focused on the safety of the people involved" in cases of emergency warning. The people involved in the present case are the assessed plant's employees and its surrounding populations. It is so, because these populations are exposed to natural risks that worry Brazilian managers, mainly the disorderly occupation of downstream areas.

The radio frequency drive (wireless technology), solar panel power supply and strictly national materials are among SNE-T's innovative features. They show the low costs to produce and operate it , since it is electronically computerized. The application is also an essential part TELEVAVLE's software operation in emergency alert systems; therefore, it can be included as innovation patent. In this case, the SNE-T software was passed on to the plant's professionals, so that they could learn how to operate the whole system and get to know its specific features.

It is important adding that SNE-T is promising to optimize plant's safety processes, since it reached sound pressure levels higher than 79dB (the minimum recorded value), although the legal requirement is 70dB. According to Barros (2018), the physical and operational features of a computer system increase information accuracy by providing a competitive edge for companies and enterprises. The present study showed the broad applicability of a national sound alert system that was validated by measurements taken at five strategic spots. This system could be marketed in the security sector.

According to Guedes and Schneider (2018), the main purpose of an emergency warning system installed in an SBA is to help the safe evacuation of people living in risky areas. These systems are activated by means of high-powered acoustic signals emitted in downstream areas. These alerts are emitted as soon as the plant notices the dam has broken. It is important to notice that SNE-T does not monitor dams to send out the warning.

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Professionals in charge of the plant's safety must monitor vulnerabilities and threats to activate radio frequency RSs and enable rescuing residents in risky areas.

Miguel (2021) believes that increasingly accurate technology applications are found in several undertakings and in different businesses to minimize risks, so that people do not lose their lives in inevitable and, almost always, unexpected disasters. Thus, SNE-T was previously validated through three consistent measurements aimed at preventing unexpected failures and inconsistencies to claim for lives that could have been saved in time.

TELEVALE ordered measurements to be carried out to validate SNE-T by making available and authorizing research in the technological innovation field. SNE-T sound pressure proved to be satisfactory and safe, not only for system effectiveness, but to ascertain its reach over long distances and to protect populations living near the dam. It is necessary to adopt appropriate, safety-intensifying corporate practices in the country, based on incentives and awards, to bring up the importance of developing a Brazilian emergency warning system to the discussion.

## CONCLUSIONS

SNE-T technical and technological construction has enabled the present author to gain professional experience and to produce a differential for TELEVALE by seeking answers supported by the innovation of national technological product that was manufactured, tested and validated in Brazil. All the testing and simulations have consolidated the integration between RSs and their operability.

A sound warning system is developed not only out of different materials, but of applications, practices, resources and technologies aimed at warning about imminent threats, so that self-rescuing measures can be activated, and damage and casualties can be reduced. Thus, before carrying out on-site simulations, TELEVALE selected the strategic spots for RS deployment by mapping areas to present a technological system aimed at developing an innovative product: SNE-T.

One of the main purposes of the testing/validation process was to predict the response capacity of sound alerts strategically integrated at previously defined spots. Accordingly, TELEVALE was able to rule out inconsistencies in measurements taken with decibel meters. This process can be seen through data analysis and validation. The three measurements kept the confidence level in the herein analyzed system and, at the same time, they showed that SNE-T is valid as sound warning system for self-rescuing purposes.

New research on emergency warning systems developed with Brazilian components is extremely important to broaden the national technology market based on validated cost-effective innovation. This statement is explained by the fact that the dam's safety sector is essential for disasters, such as those reported in Mariana and Brumadinho, not to cause damage and the loss of so many lives that could have been saved.

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DOI: https://doi.org/10.18554/rbcti.v9i1.6840

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Received on: 2023/05/08
Approved on: 2024/04/14