Risk Map Elaboration in Safety Technological Educational: Teaching Prevention Tool

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Abstract

The risks within school area deserve attention because it is an important place for the formation of citizenship and the intellectual development. One must be concerned about the way in which school spaces are used by the Educational Institution community. For instance, verifying whether the environment is well-ventilated and provides adequate furniture in the workspaces. Does an educational institution that is concerned with disseminating sustainability, also investing in the health and safety of its environments in order to be more secure? This article seeks to identify potential risks (environmental, behavioral and accidents), by elaborating Occupational Risks Map. Methodologically, this

research is classified as qualitative, exploratory, by documentary research. This case study identifies risks in Brazilian Technological Education Institution, CEFET/RJ, Chemistry laboratory, by collecting its data. Bearing in mind that the main function of the Risk Map is to signal places where greater safety is needed, alerting students and staff about risk points they should avoid. This study was able to identify different occupational risks. It is demonstrated that the educational institution has been investing in health and safety in their environment. Therefore, students, professors and community are safe in their daily routines, thus preventing potential risks.

Keywords
Occupational Risks, Safety, Risk Map, Control Procedures, CEFET/RJ.

1. Introduction
The working environment is the space where people frequently perform their work activities. The balance of this environment depends on the healthiness of the space and the absence of agents that affect the safety and physical and psychological health of the worker (Almeida Jr.; Mendes, 2017). However, some of the most common problems that compromise the health and work environment of workers are: inadequate installations, absence of thermal insulation, presence of particles of chemicals and dust, noise and vibrations excessive conditions, poor sanitary conditions, poor lighting and ventilation, lack of adequate Personal Protective Equipment (PPE), among other factors.

Therefore, it is necessary to seek a healthy and safe work environment, which is a fundamental right of the Brazilian employee, as it improves the level of productivity, in addition to reducing the organization's costs with fines and labor processes, as well as requests for sickness benefits and disability pensions (Labor Guide, 2019). Laboratories are important places for personnel training and scientific research in universities. They play an increasingly important role in universities, and its safety issues cannot be ignored (Zhang, 2020).

The school environment also deserves attention because it is an important place for the formation of citizenship and the intellectual development of people. In this sense, it is necessary to reflect on the way in which school spaces are used by the teaching institution community. If the environment is advantageous for learning, with ventilated, lighted classrooms and adequate furniture in the workspaces for administrators (Nascimento, 2014), it demonstrates that the educational institution is investing in the health and safety of its students and servers, as well as being concerned with the environments where they study/work.

Methodologically, the article, which is the result of a basic research project, is characterized as a qualitative research, as it portrays the reality of the subjects existing in the environment (Lakatos and Marconi, 2003). It is classified, in terms of objectives, as an exploratory research, as it provides information that increases the reader's familiarity with the project's subject (Gil, 2017).

And with regard to research procedures, it is identified as documentary, from the survey of Regulatory Norms, of the Ministry of Labor and Economy, for the preparation of risk maps, and it is also a bibliographic search. It is a case study (Diehl and Tatim, 2004) for performing the identification of risk factors and proposing preventive and risk control measures in one of the IE environments, which is a Chemistry laboratory, through information collected by the checklist (Figure 3) for the elaboration of the Risk Map.

1.1 Objectives
Thus, this article seeks to recognize the occupational risks (environmental, behavioral and accidents) present in one of the Federal Network for Professional Scientific and Technological Education (RFEPCT) school environments in order to stimulate the creation of a Risk Map, and to raise the control and prevention measures to minimize the risks, which are guided by the Regulatory Norms of the Brazilian Ministry of Labor and Economy.

2. Characterization of Risk Control Measures
It is essential to know the concept of risk in this work, which means the possibility of the occurrence of an event that can cause damage to an organization. (Portal Educação, 2019) These damages can be human, such as accidents involving workers, property, financial, image, among others.

In this case, the existence of the probability that a worker will suffer some damage, as a result of his professional activities, is called occupational or behavioral risk, that is, it is an accident to which the worker in his environment or because of the occupation, is exposed. This risk is classified according to its nature: physical, chemical, biological, ergonomic and accident, and environmental risks include physical, chemical and biological risks. (Nr12semsegredos, 2019)

Regulatory Norm No. 05 defines a classification by color for each type of risk to facilitate the elaboration of the so-called Occupational Risk Map: the green color defines physical risks, the red color is for chemical risks, the brown color covers biological risks, the yellow color reveals ergonomic risks and the blue color is associated with accidents or mechanics risks.

In order to guarantee job security to the organization's employees, in view of the risks related to each occupation, measures must be adopted to control and reduce risks, some with higher priority and others with less. This list of priorities is known as Hierarchy in Risk Control (HRC) or Hierarchy of Control Measures (Brasil, 2019), which is also provided for in the new Regulatory Standard no 01 (NR-01) shown on Figure 1.

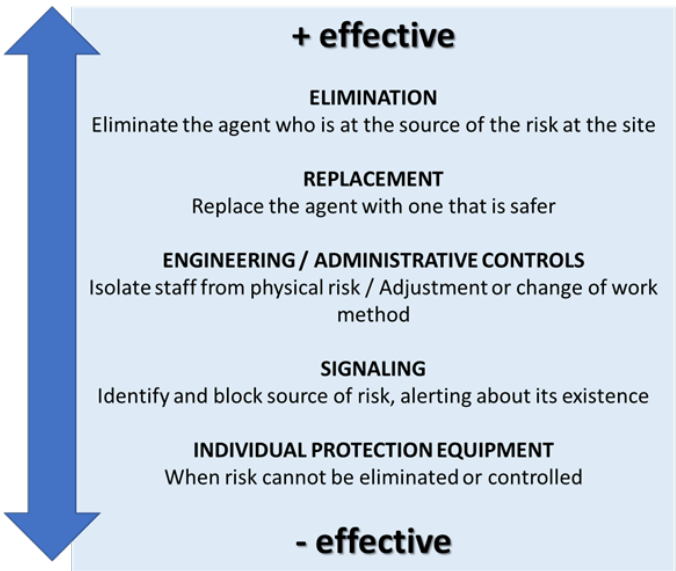

Figure 1. Control Risks Hierarchy
Source: Authors.

The measures can also be viewed, according to their position in the hierarchy (FLORES, 2016), which are:

- Source: contaminant' source;
- Environment or trajectory: route between origin and worker; and
- Individual or Worker: the receiver.

For each of these three phases, the following measures are observed (BFA, 2018):

- *Elimination Measure* (Source): provides for the elimination of the dangerous condition that puts the worker at risk. For example, eliminate manual handling of a dangerous tool by mechanical handling. In fact, the best action to be taken in terms of effectiveness.

- *Substitution or Minimization Measure* (Source): replace the hazardous risk agent with a less aggressive one, or reduce the process energy, or better, the risk (through force, amperage, temperature, etc.).

- *Engineering Control Measure* (Environment): occurs from the change in the structure of the professional's workplace, in order to distance the dangerous condition of workers. For example: implantation of ventilation systems, enclosure, etc. It is important that there is constant maintenance to ensure the effectiveness of the measures.

- *Administrative Control Measure* (Environment and Individual): it is related to training / qualification and teachings to people to perform the work. For example: Horizontal and vertical signs, warning signs and alarms, as well as access permissions, etc.

- *Signaling Measure* (Environment): isolates the worker from risks in the environment. For example: the separation of cyclists, pedestrians and vehicles on public roads in the city. In this way, it separates the energies, avoiding accidents.

When all of the above measures are not sufficient to ensure the health and safety of the worker, it is the company's duty to provide personal protective equipment (PPE) for the worker. PPE is any device or product for individual use used by the worker when there is a risk that was not 100% eliminated by previous measures (Flores, 2016).

Another classification that can be found for control measures are Prevention Controls and Recovery Control. Since the Prevention ones avoid the possibility of the dangerous situation reaching the worker and avoiding the manifestation. Recovery measures are the measures that act on the consequence, after the unwanted event has already happened. (Secaf, 2019)

The adoption of security measures in an educational institution is important, considering that the majority of individuals in the environment are adolescents and people who demand protection. According to Nascimento (2014), "educating students to learn accident prevention measures, contributes to the formation of a safety culture".

2.1 Risk Maps

The Occupational Risk Map is a representation of the health risks identified in each of the various workplaces within an organization and aims to gather data for generating diagnoses and disseminating information among workers, as well as encouraging their participation in the activities of prevention.

The mandatory requirement for the elaboration of the Environmental Risk Map was effectively given by the Ordinance of the National Department of Safety and Health of the Worker no 5, of 08/17/1992, of the Ministry of Labor, which altered the NR-09 on the Prevention of Environmental Risks.

The Risk Map is visualized through a graphic representation of the recognition of the five types of occupational risks present in the workplace, in order to raise awareness among workers. Therefore, the importance of occupational risks being properly identified and classified. In this article, we seek to build the Risk Map in a participatory manner, having as a basic principle the development of the Map as a prevention and information tool for all of the educational institution.

Each organization needs to prepare its Risk Map, so that it can properly manage its risks. And currently, by the new NR-01, either by the work regime, which is verified in the organization, single legal or hired worker, the identification and classification of risks, and, therefore, the indication and implementation of preventive measures are necessary (item 1.5.3.2). In this sense, the elaboration of the Risk Map is a mandatory document for the proper risk management (NR-05) and is required in all countries where the Internal Accident Prevention Commission (CIPA) is present and its absence can cause in high value fines.

Legenda		
Grupo de Risco	Descrição	Intensidade dos Riscos
Riscos Físicos	Ruídos, vibrações, radiações ionizantes, radiações não ionizantes, frio, calor, pressões anormais, umidade.	Risco Grande
Riscos Químicos	Poeiras, fumos, névoas, neblinas, gases, vapores, substâncias, compostos ou produtos químicos.	
Riscos Biológicos	Vírus, bactérias, protozoários, fungos, parasitas, bacilos.	Risco Médio
Riscos Ergonômicos	Esforço físico intenso, levantamento e transporte manual de peso, exigência de postura inadequada, controle rígido de produtividade, imposição de ritmos excessivos, trabalho em turno e noturno, jornadas de trabalho prolongadas, monotonia e repetitividade, outras situações causadoras de stress físico e/ou psíquico.	
Riscos de Acidentes	Arranjo físico inadequado, máquinas e equipamentos sem proteção, ferramentas inadequadas ou defeituosas, iluminação inadequada, eletricidade, probabilidade de incêndio ou explosão, armazenamento inadequado, animais peçonhentos, outras situações de risco que poderão contribuir para a ocorrência de acidentes.	Risco Pequeno

Figure 2. Caption of CEFET/RJ Chemistry Laboratory Risk Map
Source: Worker Health and Safety Section (2019)

The Risk Map must be clearly displayed in all sectors analyzed, so that employees can easily see it, considering that its main function is to signal the places where greater safety care is needed, alerting anyone who enters the area of the points where you should be more careful or even avoid. It also has a legend (Figure 2), which identifies the groups of risks identified in susceptible places in the analyzed environment and which are positioned in the form of circles, whose sizes indicate the degree or intensity of the risks:

- small circle to slight risk
- medium circle to medium risk
- large circle to high risk

Likewise, each circle receives a color related to the type of risk related to a specific point in the analyzed environment. In addition, the number of workers exposed to such risk should be placed within the colored circle.

Therefore, it must be developed with the participation of employees (servers and outsourced workers) who operate / work in the location / environment. In the same way that the Map instructs its team, drawing attention to aspects that are sometimes overlooked. This facilitates the work of the members of the Internal Accident Prevention Commission in the inspections that must be conducted regularly.

3. Safety in Education Institutions

A university laboratory is a serious workplace that needs to be studied (Langerman, 2009), and it is expected to be the main place for the implementation of inquiry practice (Sedghpor et al, 2013). Therefore, its safety must be prioritized (Shariff and Narazahar, 2012). But only a few scholars paid attention to the risk and conduct research on the safety risk (Zhang et al, 2020).

Laboratories of different disciplines and majors have their own contents and requirements of safety management, but generally speaking, laboratory safety management has the characteristics of diversity, complexity, comprehensiveness and service (Jingqi and Shuyan, 2016). Thus, colleges and universities should accurately grasp the characteristics and dangers of safe experiment in the process of building emergency system for safety production emergencies (Zhou and Li, 2019).

Some scholars supported laboratory hazard identification and risk management by implementing a chemical health risk assessment project, bowtie method, or developing a laboratory at-risk behavior and improvement system (Shariff and Narazahar, 2012; Abbas et al, 2017; Mulcahy et al, 2017).

Yang et al (2019) developed a study where a total of 219 scientific publications on university laboratory safety were identified and screened from the database of Web of Science, covering 44 countries or regions, 254 research institutions, 575 authors, 126 publication sources, and 70 subject categories. The results indicate that university laboratory safety is a highly multidisciplinary research field. However, it is still a young discipline and belongs to the minority research field when compared with other safety domains.

Academic and research laboratories within universities contain a diverse array of hazards, and the risks associated with these hazards can be significant if not properly managed. The misperception that university labs are “low risks” and “inherently safer” remains within and outside academia, in part, due to a lack of hazard awareness (Olewski and Snakard, 2017).

Some colleges and universities have not yet established a safety management network from the school leaders to the grass-roots laboratories. Lack of clear responsibility implementation for all aspects of laboratory safety management has resulted in the confusion of multidimensional cross-management, unclear responsibilities and powers, poor coordination and untimely emergency disposal (Xiaofeng and Xinghuo, 2012).

4. Case Study

The concept of professional education was consolidated in the Law of Guidelines and Basis, the process of integration of schools in the federal network is consolidated through Law No. 11,892/2008, establishing the Federal Network for Professional Scientific and Technological Education (RFEPCT) and created the Federal Institutes of Education, Science and Technology. From its institution, a reflection is opened about the expression ‘Federal Education System’ that originates in the Federal Constitution of 1988, in which it is stated that ‘the Union, the states and the municipalities will organize in collaboration with their systems education’.

The Federal Center for Technological Education Celso Suckow da Fonseca (Cefet/RJ), which is part of RFEPCT, linked to the Ministry of Education. It presents itself as a multicampi system composed of 8 campuses, and in the case study, the Maracanã campus was selected, a unit that has about 70% of the enrolled students, be it undergraduate, graduate and technical professional education courses. medium level and 56% of servers across Cefet/RJ (Cefet/RJ, 2019). This headquarters campus comprises 11 blocks and six pavilions, totaling 72 classrooms, 166 laboratories and workshops, nine auditoriums, a library, two video libraries, a sports complex with courts, gymnasium, swimming pool and athletics track, among other nature spaces educational. (Cefet/RJ, 2018)

In this case study, one of the educational institution environments, which the authors study and work on, will have its Risk Map developed and analyzed. The Chemistry laboratory is where the Occupational Risk Map will be carried out and is located on Maracanã campus. In this laboratory, students observe chemical experiments, which pose risks, and

are performed by technicians and Chemistry teachers, who are well trained to deal with predictable situations in a laboratory.

Professionals and students should be aware of the Risk Map for this type of environment as a general model of the possible risks that present themselves in an Educational Institution, from the most common to the specific ones. For the environment to offer greater security, the risk control measures that must be used must be recognized.

4.1 Methodology procedures

Considering that the Occupational Risk Map is the photo of the floor plan/layout of the workplace or the environment and that each area of the environment must be broken down by color, with specifications on the existing risks, it is necessary to study the place in a thus, to arrive at a diagnosis about the dangers of each sector/environment. Therefore, it is an instrument of guidance for employees and care for the safety and health of the community.

Based on the work coordinated by the Worker's Health and Safety Section, which is part of the Cefet/RJ Worker's Health and Safety Division, the step-by-step development of Chemistry Lab Occupational Risk Map was prepared. The educational institution procedures (Figure 4), which are currently used by students in high school and higher education classes in practical Chemistry classes are (SSST, 2019):

1) Knowing the work process in the place to be analyzed, from an interview with the consent (Authorization Term for Conducting Research) of the Chemistry laboratory coordinator and with the two laboratory technicians about the activities of each worker, the description of the workplace, the equipment on site and the presence of fire extinguishers in the workplace.

2) Making a graphic representation of the layout of the studied environment, using programs such as Paint Brush or Office Word.

3) Identifying the risks existing in the analyzed place, based on the information collected by the checklist (Figure 3) for the preparation of the Risk Map with two laboratory technicians. The checklist was developed by the Health and Safety Section of the Educational Institution and points out the situations that contribute to the risk, verifying the presence or absence of materials / instruments and situations of fire protection or other risks (Sesst, 2019).

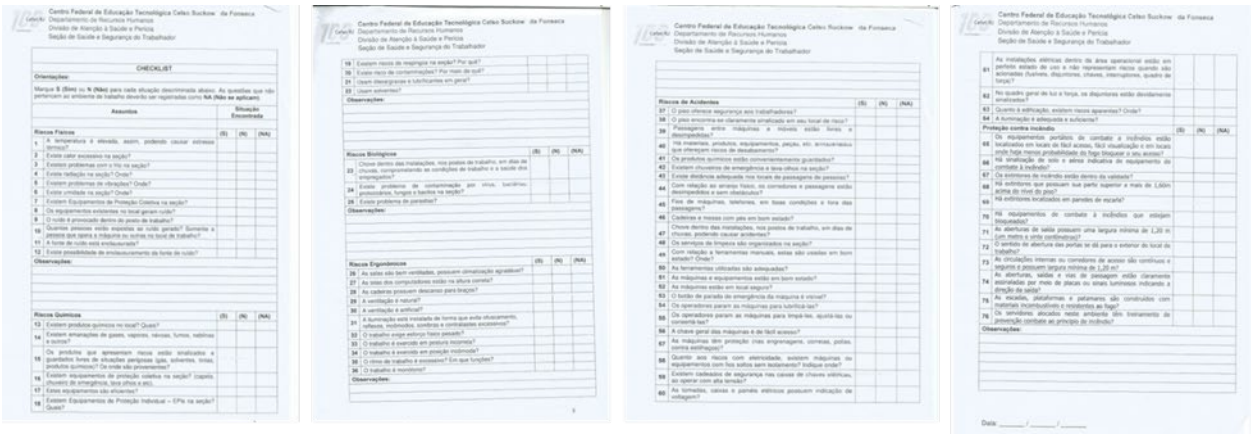

Figure 3. Checklist on risks in the laboratory environment
Source: Cefet/RJ

4) Being aware of the environmental surveys already carried out at the site and indicate the points where there is a risk of accidents in the designed environment, specifying the number of workers exposed to the risk and the agents, for example: chemical, physical, ergonomic, biological or accidents.

5) Identifying the existing preventive measures and their effectiveness, among them: collective protection measures, work organization, individual protection and hygiene and comfort.

6) Discovering the most common complaints among employees exposed to the same risks, professional illnesses already diagnosed and the most frequent causes of absence from work.

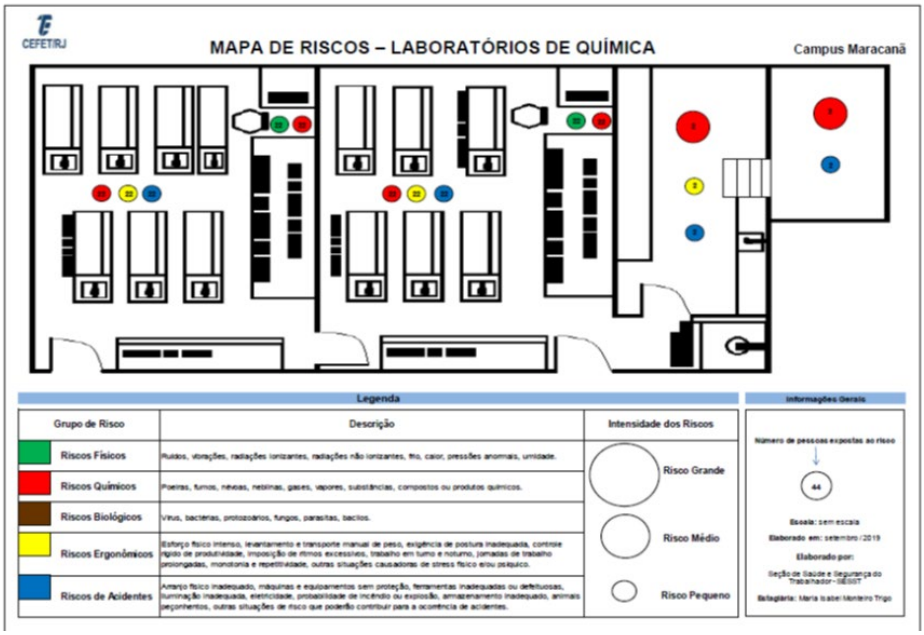

Figure 4. Chemical Laboratory Risk Map

This Risk Map (Figure 4) presents four of the five types of occupational risks present in the chemistry laboratory and aims to gather data for generating diagnosis and disseminating information, as well as encouraging the participation of those most exposed to prevention activities. The results of this analysis are presented in the next session.

5. Results and Discussion

There are two circles with medium intensity of chemical risk (red), which are located in two rooms: the reagent preparation and the reagent storage rooms. This is due to the large amount of chemical agents present, whether in liquid or gaseous forms. In these spaces, there are circles with a low intensity of accident risks (blue), which can be associated with: floors without signs, wires that are not in good condition, taken without voltage indication etc. Another risk that exists in the reagent preparation room is the ergonomic risk (yellow) that has a small intensity due to the few situations that can cause physical or / and mental stress. In these areas, there are usually few people exposed to risks, as seen in Figure 4, who are the chemistry technicians.

In the areas where practical laboratory classes take place and there are two teachers and around twenty-two students at the most, there are chemical, physical, ergonomic and accidents risks with low intensity. What stands out most is the chemical risk due to the greater exposure to agents that, on benches or inside chapels, can release vapors, mists and others, leading to possible contamination, if there is the absence of some PPE (lab coat, mask), goggles and safety shoes). As for physical risks, some equipment generates noise such as the exhaust hood and the ceiling fan. Ergonomic risks, on the other hand, can cause physical stress, because the chairs do not have a footrest. Finally, the risks of accidents can be generated due to the poor condition of seats / chairs, sockets that have no voltage indication, apparent risks that are observed on the ceiling, among others. Despite the intensity of the risks in these areas being classified as small, the number of people exposed is relatively large, which requires greater attention from teachers with experiments that present student participation.

Due to the existence of the aforementioned risks, Control Measures must be proposed, which are observed in a given Hierarchy - HRC, if possible, starting with those of greater effectiveness. In the Chemistry Laboratory, the most effective measure to control and reduce risk is the substitution measure, which aims to replace the dangerous risk agent with a less dangerous one. This measure fits in the risk of accidents, when the seats / chairs are replaced by safer ones. Also according to the HRC, the Engineering Control Measure is another measure that occurs from the change in the structure of the place and can be applied to some accident risks, such as: the apparent risk observed in the ceiling and the fan with noise, both should undergo maintenance.

Another important measure is Signaling, which fits the risks of accidents due to the lack of voltage indications in sockets and signs in the general light and power table and on the floors, next to the stairs.

The least effective measure, according to HRC, and by no means the least, is the use of PPE, which are used when there is no way to eliminate or control the risk. The use of PPE is necessary in the presence of chemical and physical risks, as lab coats, masks, glasses, noise mufflers and safety shoes must be used to handle chemical reagents.

As an academic research, this work made it possible to recognize and guide the factors, whether environmental, ergonomic and accidental, that generate risks and to characterize, even if superficial, the risks in a given work environment, through the structuring of the Risk Map in a study environment of an Educational Institution. It was important to understand how people, who answered the checklist, see the risks to which they are exposed.

The mapping will enable the development of more prudent attitudes, based on the control measures identified, some still to be adopted and others already adopted, by the people who are most exposed, in the chemistry laboratory, to the graphically signaled risks. In professional terms, a more in-depth environmental assessment should be carried out in the future through the Environmental Risk Prevention Program (PPRA).

6. Conclusion

It is a fact that there are potential risks present in study environments. Throughout the professional life of the occupational safety technician, he must be prepared to manage risks in order to guarantee his safety and that of his co-workers, as well as the environment in which he finds himself. Work safety applies to all segments / processes / environments. Evidently, each segment has its specific characteristics and risks, and exactly for that reason, each environment needs to be “taken care of”, like the study environments within a Teaching Institution.

In this sense, the project was able to identify the different risks (environmental, behavioral and accidents), based on the elaboration of the Occupational Risks Map of the Chemistry Laboratory of Cefet/RJ. Bearing in mind that, the main function of the Risk Map is to signal the places where greater security is needed, alerting students and servants about the points where they should be more careful or even avoid.

Another objective foreseen and achieved with the development of the project was to raise the necessary control and prevention measures for the selected environment, which in this case, stood out those of Replacement, Engineering Control, Signaling and the use of PPE. It should be considered that, currently, the risk control hierarchy, mentioned in this study, is addressed in the “new” NR-01 that deals with General Provisions and Risk Management, item 1.4.1, letter g, when it comes implementation of preventive measures, in order of priority.

Some Regulatory Norms related to the elaboration of the Risk Map were also addressed, such as NR-05, which says that it is up to CIPA to do it and NR-09, which talks about the Environmental Risk Prevention Program (PPRA) and its objective of preserving the health and integrity of workers. NRs establish minimum protection requirements in the workplace, in order to prevent occupational accidents and diseases, preserving the health and safety of the community of the educational institution in question.

Therefore, considering the importance that Cefet/RJ has been giving, through the development of extension and scientific initiation projects, in the dissemination of sustainability, especially when incorporating social, environmental and economic values and guiding principles of environmental strategies, both in disciplines taught as well as in the management of their physical structures; it is believed that the educational institution can invest in the health and safety of its environments so that they become more harmonious and safe, thus preventing potential risks.

Considering the contributions of this research, how much: (i) the employee / administrative technician will feel more valued and tends to be more motivated at work, and yields more in the performance of the function; (ii) to the teacher, it will lead to a better quality of life, as well as a better condition for transmitting the content to students; (iii) students, more efficient learning and with lower risks; (iv) for the school, better results in school evaluations and reduction in the number of licenses of its professionals.

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