Civil Engineering

Challenges and perspectives in the implementation of the Fire Protection System in Federal institutions of higher education in Brazil

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Abstract

Federal higher education institutions in Brazil have particularities in terms of construction, geographical location, use of buildings, organizational structures and allocation of budgetary resources. These characteristics make managing the Fire Protection System a significant challenge, requiring an even higher level of attention and commitment. This article aims to present data describing the current context of Fire Protection and Fire Fighting System management at Federal higher education institutions in Brazil (Federal universities and institutes). The data collection was a survey, in which 87 employees, representing 69 institutions, occupying the positions of Occupational Safety Engineer or Technician took part. Among the results, the following stand out: 51% of the institutions do not have a Fire Protection System Management Plan and 32% are in the process of creating one. All institutions inspect and maintain fire extinguishers; only a minority monitor other equipment. Operational routines are weakened by a lack of management (35%), financial resources (31%) and technical staff to carry out the service (24%). Only 9% of the institutions have a Fire Department Inspection Certificate for all their buildings and 5% have an active fire department in all their buildings. Only 9% of institutions have a Fire Department Inspection Certificate for all buildings and 5% have an active fire department in all buildings. The management of the Fire Protection System in Federal higher education institutions in Brazil faces significant challenges, including a lack of management plans, insufficient control of devices and limited resources, resulting in low compliance with fire safety regulations.

Keywords: fire, safety, prevention, protection, security system.

1. Introduction

The field of Fire Safety is relatively recent in terms of academic development, with its beginnings in the last quarter of the 20th century (Negrisolo, 2019). Brazilian legislation on fire protection and firefighting is constantly changing, often in response to past disasters, such as the fires at the Great "North American" Circus in Rio de Janeiro in 1961, Edifício Andraus in 1972, Joelma in 1975 in São Paulo and the tragedy at Boate Kiss in 2013 in Rio Grande do Sul, which resulted in the enactment of Law n. 13.425/2017, known as the "Kiss Law", which establishes general parameters for fire protection in Brazil (Borges, 2017, Rodrigues, Rodrigues, and Silva Filho, 2017).

In Brazil, fire protection measures must comply with Federal, State and Municipal laws and decrees, Brazilian standards and technical instructions of the Military Fire Brigade of each state. There is also the "National Model of Fire and Emergency Safety Regulations", established by Ordinance No. 108 (SENASP, 2019), which provides for a series of measures, but it is up to each unit of the federation to impose its own fire protection rules.

Fire safety laws and technical standards complement each other, with the laws being mandatory, having sanctions in the event of non-compliance, and the technical standards representing the state-of-art on a given subject, non-compliance with which can lead to a greater or lesser degree of intent and/or guilt. The consequences mainly affect structures, and despite decreasing occurrences and fatalities, the effect of these events is still significant (Duarte, 2018; Rodrigues, Rodrigues, and Silva Filho, 2017; Lima *et al*., 2021).

The main objectives of fire safety measures are to avoid exposing people to risks and vulnerabilities and to prevent the loss of life and property, both of which are relevant but have different values. From the point of view of saving lives, it is not a priority to put out the fire; buildings with MSCI favor the rescue and escape of victims. From the point of view of property, it is necessary to extinguish the fire; buildings with MSCI will help contain and extinguish the fire. Adopting administrative measures, such as drawing up a Fire Safety

Management Plan, which includes training, operational routines, and preventive maintenance, can form an efficient safety policy (Negrisolo, 2019; Nascimento, Oliveira, and Minichiello, 2022).

Inspections and maintenance of the Fire Protection and Fighting System are administrative resources that can ensure that, in the event of a fire, the equipment is ready for use and thus hinder the spread of the fire, facilitate extinguishing, and help the building occupants escape. Establishing an inspection, testing and maintenance program is a prerequisite for successful prevention work.

Periodic inspections and maintenance must include devices known as Active Protective Measures, whose equipment includes emergency lighting, fire detection and alarm, fire extinguishers, fire hydrants and sprinklers, among others, all governed by specific standards and technical instructions that establish rules and guidelines for their maintenance and proper use (Negrisolo, 2019; Hassanain, Al-Harogi, and Ibrahim, 2022).

Despite the existence of regulations, several obstacles hinder the creation of truly fire-safe buildings. These include the lack of a National Fire and Panic Safety Code, the lack of inclusion of safety measures in municipal building codes, the absence of a national fire prevention policy, flexible deadlines, a lack of efficient inspection and a shortage of qualified professionals (Nascimento, Oliveira, and Minichiello, 2022). Another obstacle is that the training of architects and engineers has paid little attention to a fire protection system in buildings, which has led to projects with poor fire risk control (Seito *et al.*, 2008). The results of non-compliance with fire protection requirements are tragedies, loss of life and property, damage to the environment and not being held accountable.

The Instituto Sprinkler Brasil (ISB, 2021) daily monitors the news about so-called "structural fires" in Brazil and points out an evolution of fire cases from 2012 to 2021. Fires were analyzed by region in Brazil and by occupation. Of the segments analyzed by the ISB, Commerce had the highest percentage of fires with 25% and 2,519 occurrences, the lowest rate was Accommodation Services with 1.8% and 181 occurrences, while the Education and Physical Culture block accounted for 5.8% and 590 records.

Federal higher education institutions have their own characteristics in terms of construction, region, occupation, organizational arrangements, and budget allocations, which make managing a fire protection system challenging, demanding even more attention and commitment from the entity. Therefore, this article aims to present data describing the current context of the management of a fire protection and fire-fighting system for Federal educational institutions (Federal universities and institutes) in Brazil.

2. Method

This is a quantitative, descriptive and cross-sectional study, whose data collection procedure was a survey to describe the current context of the management of a fire protection and firefighting system at Federal higher education institutions in Brazil. The survey was conducted virtually using a MicrosoftForms® form.

Approximately 250 active civil servants from Federal higher education institutions in Brazil were invited to take part in the study. They were either occupational safety engineers or safety technicians and over 18 years of age. Therefore, the professionals who collaborated with the study work in different regions of Brazil. Participants were recruited via a WhatsApp® group and institutional email.

A questionnaire was drawn up on "Management of the Fire Protection and Fighting System" (MFPFS) with 17 objective items on: MFPFS Management Plan; Inspection and maintenance of equipment; Record systems used for inspection and maintenance; Fire Department Inspection Certificate; Fire Brigade.

The results were analyzed using descriptive tests (mean, standard deviation and frequency) using Excel software.

This study was submitted to the Research Ethics Committee of the Federal University of the Triângulo Mineiro (CAAE 67946423.9.0000.5154).

3. Results and discussion

The Fire Protection and Combat System management tool investigated the situation of higher education institutions in terms of the administrative, material and human resources adopted for fire prevention.

Brazil has 102 Federal higher education institutions, 62 of which are universities and 40 technological institutes. The Northeast and Southeast also have 29 entities (28%), while the North and South have 17 entities each, resulting in 17%, and the Central-west has 10 entities, equivalent to 10% of the country's institutions (Figure 1).

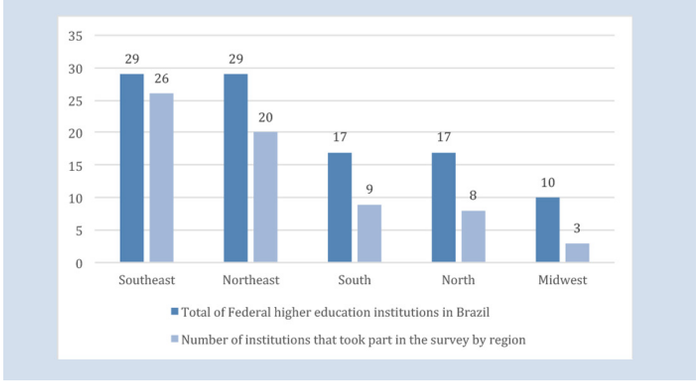

Figure 1 - Quantity of Federal higher education institutions in Brazil by region and number of institutions by region that took part in the survey

A total of 87 federal civil servants took part in the study and 66 higher education institutions were represented, as some institutions have more than one professional working with fire protection, including engineers and occupational safety technicians (Figure 2).

Of the 66 institutions involved (Figure 1 and 2), 20 were from the Northeast (30%), 26 from the Southeast (39%), 8 from the North (12%), 9 from the South (14%) and 3 from the Midwest (5%).

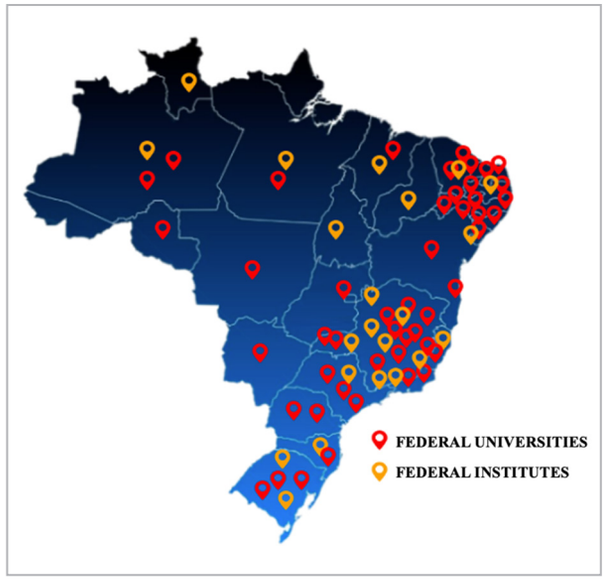

Figure 2 - Overview map of the distribution of Federal educational institutions in Brazil by region that participated in the study.

The Fire Protection and Combat System Management is an integral part of the Fire Emergency Plan. It is an administrative tool that straddles the theoretical realm of standards, legislation and protocols, as well as the practical realm of implementation, inspections, and maintenance. Theoretical, because it consists of drawing up a firefighting project, certification with the Fire Department Inspection Certificate (*Auto de Vistoria do Corpo de Bombeiros - AVCB*), drawing up standard operating procedures, registering and controlling all related equipment. Practical, since it refers to the installation and post-implementation of equipment, inspection routines, periodic maintenance, replacement of damaged or discontinued parts, training, adaptation of installed equipment, among other things. All the necessary Fire Safety Measures, specific to each site, must be covered in the Emergency Plan. Therefore, management covers system maintenance and emergency response management (Seito *et al.*, 2008).

By asking about the existence of a Fire Protection and Fire Fighting System Management Plan (FPFFSMP) (Figure 3), the aim was to investigate the reality of the institutions in terms of the control and maintenance of the firefighting system, measures that should be listed in the plan, and to identify the entities that invest in promoting preventive firefighting actions. The results showed 44 organizations that "do not have" a FPFFSMP (51%), 28 organizations whose plan is "in the making" (32%), and 15 organizations that "do have a FPFFSMP " (17%). The high percentage of institutions that do not have a Fire Protection and Fighting System Management Plan suggests a lack of priority in the control and maintenance of this system, leaving it weakened in the face of emergency situations.

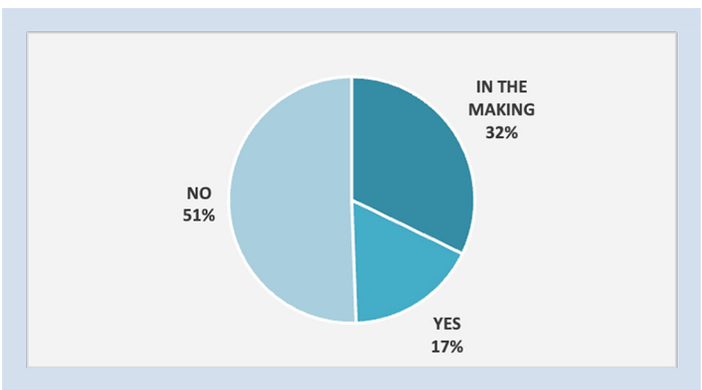

Figure 3 - Existence of a Fire Protection and Fire Fighting System Management Plan in Federal Educational Institutions in Brazil

Based on this identification, questions were asked about the implementation of the FPFFSMP in the higher education institutions. Of the participating entities (Figure 4), 45 replied that they were "not" implementing it (52%), 29 replied that they were "yes" implementing it (33%) and 13 replied that it was "not applicable" (15%).

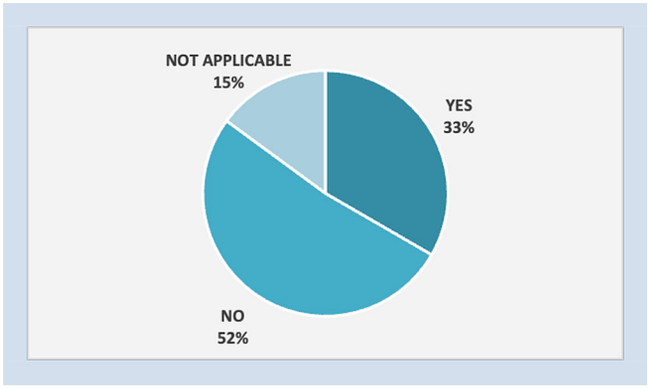

Figure 4 - Implementation of the Fire Protection and Combat System Management Plan in Federal educational institutions in Brazil.

Analyzing the data in Figures 3 and 4, of the 44 institutions that do not have a FPFFSMP, 35 said that the plan was "not" being implemented and 9 said that it was "not applicable". As for the 28 institutions whose plan is being drawn up, 17 responded that "yes" the plan is being implemented, 9 responded that "no" it is not being implemented and 2 said "not applicable". Among the 15 institutions that have a FPFFSMP, 11 replied that "yes", the plan is being implemented, 2 entities replied that "no" it is not being implemented and 2 entities replied that "not applicable".

The FPFFSMP is a guiding document for institutions due to the procedures and targets defined. However, fire prevention practices can be adopted regardless of whether the plan has been created. This is what the survey showed: most institutions whose PGSPCI is currently being drawn up are putting fire prevention safety measures into practice, which demonstrates the dynamism of the institution in solving related problems.

As for the components of the fire protection system, these are governed by standards and technical instructions, which determine the rules on how and when monitoring should be carried out, reviews, the use of appropriate materials, recommended professionals, among others. Table 1 summarizes the frequency of monitoring of fire protection and fire-fighting equipment, according to the standards in force.

Table 1 - Fire Protection and Combat System Inspection and Maintenance Frequency.

INSPECTION AND MAINTENANCE OF THE FIRE PROTECTION AND COMBAT SYSTEM				
EQUIPMENT	**CURRENT STANDARDS**	**FREQUENCY**	**CONTROL**	**ITEM**
Emergency lighting	NBR 10898:2013	Monthly	Check that all luminaires are switched from standby to illumination and are in working order	9.2.1
		Half-yearly	Test the state of charge of the batteries by running the system for at least one hour	9.2.2
Fire detection and alarm	NBR 17240:2010	Manufacturer's recommendation	Check battery operation and measurements	-
		Quarterly	Carry out preventive maintenance according to the script in item 10.5 of the NBR 17240:2010	10.5
Fire extinguishers	NBR 12962:2016	Annual	Perform level II test: complete overhaul of the extinguisher	5.3.7
		Quinquennial	Carry out level III testing: complete overhaul and hydrostatic tests	5.3.8
Hydrants	NBR 13714:2000	Quarterly	Perform visual inspection	C1.1/C.2
		Annual	Leak test; Function test	C1.2 / C1.3/ C.3
Hoses	NBR 12779: 2009	Half-yearly	Perform visual and dimensional inspection	4.1
		Annual	Hydrostatic testing; Repairs	4.1
Fire pumps	NBR 13714:2000	Fortnightly	Operate for 15 minutes	C.2.2 NOTA
		Annual	Leak test; Function test	C1.2 / C1.3/ C.3
Technical fire reserve	NBR 13714:2000	Quarterly	Carry out periodic inspections	C.2
Automatic showers	NBR 10897:2020	According to standard	Maintenance and inspection of all system equipment	TABLE C.3

With regard to the maintenance of the institutions' Fire Protection System equipment (Figure 5), the following figures were obtained: 85 entities monitor fire extinguishers periodically, 41 entities monitor hydrants and accessories, 35 entities monitor emergency lighting, 20 entities monitor fire pumps, 20 entities monitor fire detection and alarm, 19

entities monitor the Atmospheric Discharge Protection System, 16 entities monitor the technical fire reserve, 11 institutions monitor automatic showers and 2 entities replied that they do not monitor the equipment listed. Figure 5 provides information on the inspections or maintenance of the institutions' Fire Protection System equipment.

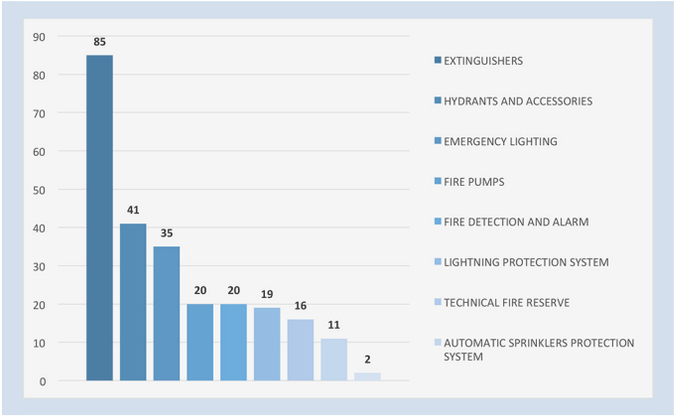

Figure 5 - Fire protection and firefighting devices inspected and/or monitored periodically at Federal educational institutions in Brazil.

Fire extinguishers are monitored in approximately all of the organizations that took part in the survey, while hydrants and accessories are inspected by only half of the institutions that responded. The other equipment undergoes periodic maintenance in only a minority of the organizations. It is important to note that a building's fire and panic safety measures are defined according to the group it belongs to, its height (in meters) and total area in square meters. It can therefore be inferred that the protection system for automatic sprinklers was low, as not all institutions have buildings with characteristics that require such equipment.

Regular inspections and maintenance of the Fire Protection and Fighting System are crucial to ensure that the equipment is ready in the event of a fire, hindering its spread and helping extinguish the fire. The survey revealed that most institutions do not carry out regular maintenance on all the Fire Protection and Firefighting System equipment, which puts the safety of the site in doubt in emergency situations.

In view of this, Figure 6 expresses the reasons for the lack of monitoring and the institutions were able to give more than one reason.

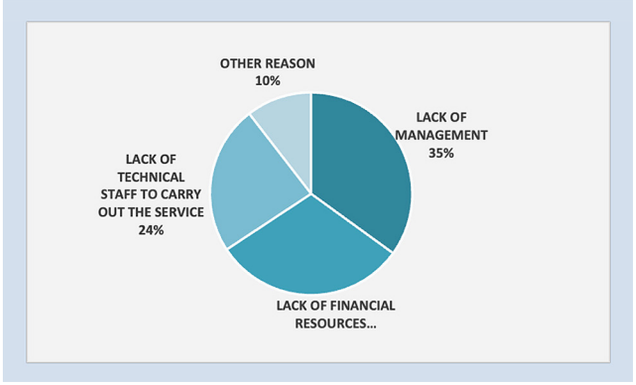

Figure 6 - Reasons for the lack of inspection and/or periodic maintenance of Fire Protection and Firefighting System equipment at Federal educational institutions in Brazil.

Fifty institutions (35%) stated that they do not carry out periodic maintenance due to a lack of management; 44 (31%), due to a lack of financial resources; 34 entities due to a lack of technical staff to carry out the service (24%) and 15 entities stated that they do not carry out periodic maintenance for another reason (10%).

The results confirm that many institutions do not carry out periodic maintenance of fire protection equipment due to lack of management and financial resources. For there to be efficient prevention of Fire Protection and Firefighting System, there are three fundamental axes that must be considered: a preventive firefighting policy, which includes drawing up and implementing the Fire Protection and Firefighting System Management Plan (administrative and material resources); specialized and committed technical staff (human resources); and budget allocation (financial resources). The removal of any of these elements can result in the prevention work not being carried out in full, leaving the system unsafe in some way.

In addition to the Fire Protection and Firefighting System being up and running, another important factor is the licensing of buildings through the Fire Department's Inspection Certificate, which certifies that the building has the fire and panic safety conditions provided for in the legislation.

Figure 7 indicates that 50 institutions do not have Fire Department's Inspection Certificate in all their buildings (58%), 29 have partial in their buildings (33%) and 8 have Fire Department's Inspection Certificate in all their buildings (9%).

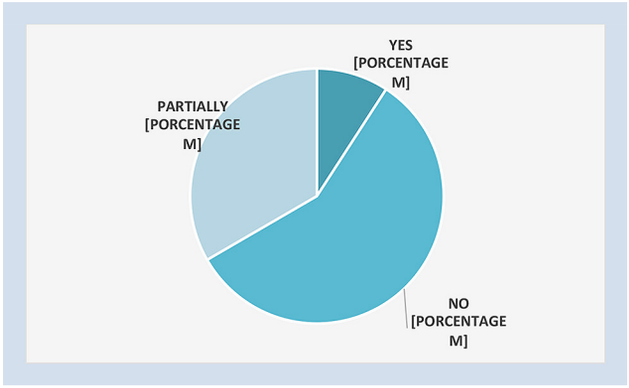

Figure 7 - Status of the Fire Department's Inspection Certificate for all Federal educational institution buildings in Brazil.

The high rate of organizations that do not have certification was evident, inferring that obtaining the Fire Department's Inspection Certificate is an obstacle for institutions. There are several factors that can be considered obstacles in this process, including: a lack of specialized professionals with expertise in building licensing procedures; a lack of Fire Protection and Firefighting System management, which implies updating fire-fighting projects and periodic preventive maintenance; constant changes in physical arrangements; and a lack of budget to invest in system updates and maintenance.

Regarding human resources, the fire brigade is a safety measure that consists of an organized group of people trained and qualified to act in prevention, building abandonment, firefighting and first aid, within a pre-established area (IT-12 / CBMMG).

With this in mind, we investigated the existence of an active fire brigade in the buildings required by law (Figure 8). It was found that 60 organizations do not have a fire brigade (69%), 23 organizations have a fire brigade in part of their buildings (26%) and 4 institutions have a fire brigade in all their buildings (5%).

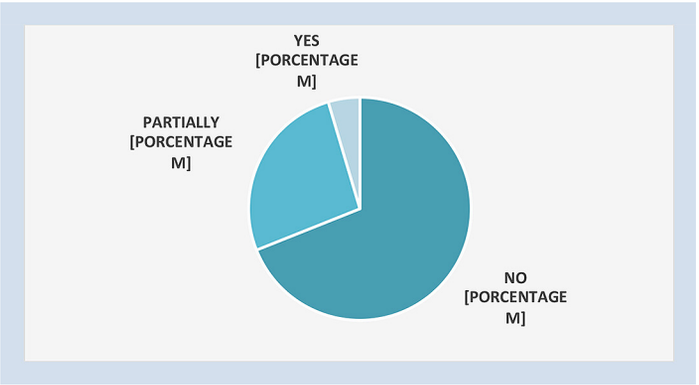

Figure 8 - Existence of an active fire brigade in all the buildings of Federal educational institutions in Brazil.

It is notoriously difficult for many institutions to set up a fire brigade and several factors can contribute to this situation. Some of the possible reasons include financial costs, lack of awareness of its importance, regulatory complexity, lack of training, limited human resources and logistical challenges.

The research revealed that the Federal Educational Institutions Fire Protection System presents itself in a complex scenario, full of difficulties to be overcome. It is necessary to create an efficient fire safety policy to mitigate existing problems, preserving the lives and health of everyone and the institution.

4. Conclusion

This article sought to present the context of the Fire Protection System in Federal institutions of higher education in Brazil. To obtain the results, we investigated: the existence and implementation of the Fire Protection System Management Plan; the periodic maintenance of the equipment belonging to the Fire Protection System, and if not, the reason for the lack of maintenance; obtaining the Fire Department's Inspection Certificate; and the composition of the fire brigade.

Although organizations must comply with fire safety laws and technical standards, the survey revealed that many institutions face difficulties in complying with current legislation. The results showed that most institutions are in a critical situation about fire protection measures, ranging from planning preventive actions and certifications to maintenance and training. The Federal educational institutions are operating in the minimum conditions required, especially regarding Fire Protection System maintenance. The system's vulnerability stems from the absence of a preventive firefighting policy, the lack of specialized technical staff and the lack of budget allocation.

It is worth noting that Brazil does not have a culture of prevention, especially when it comes to fire. Although standards and laws are essential, it is necessary to make society aware of the risks of fire and how to prevent them. This reality could be mitigated if undergraduate architecture and engineering courses addressed this issue, training aware and trained professionals, and through public education campaigns to raise awareness of fire risks and prevention. As a rule, build-

ings comply with the requirements to obtain the Fire Department's Inspection Certificate, when there is an inspection, but disregard periodic maintenance of equipment and human resources, such as training. The results of the survey reflect this reality.

Finally, it should be noted that institutions need to adopt a proactive approach to fire safety, including a commitment to complying with regulations, providing adequate resources, and raising awareness of the importance of prevention. Fire safety is crucial to protecting lives and property, and investing in this area is fundamental to mitigating existing risks.

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