National University of Science and Technology POLITEHNICA of Bucharest

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Marian Ghe. COSAC

PhD THESIS

Cercetări privind îmbunătățirea securității în muncă și la incendiu în clădiri civile și industriale

Research on improving work and fire safety în civil and industrial buildings

DOCTORAL COMMISSION

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- 2023 -

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Introduction

PhD THESIS GOAL

The main goal of the doctoral research was determined in accordance with the data and conclusions drawn from the analysis of the current state, as well as the research & development directions on improving occupational and fire safety in civil and industrial buildings, respectively: *reduction of exposure to risks specific to the „Occupational health and safety", including fire risk, within organizations that carry out activities in civil and industrial buildings*.

In the conditions of current real estate development, the fire safety of buildings, their users and the environment still remains a fundamental problem of the society with incidents whose investigation has not been completed by the authorities.

The recent coronavirus pandemic has provided us with the respite and the opportunity to meditate on some themes of our daily existence, among them, that of fire safety. The last decades have marked the entry into the Romanian specialized market of numerous modern materials, systems and technologies - doubled by new technical elements that can ensure fire safety. From the analysis of a set of data carried out in the previous period, the following conclusions result:

a) effectiveness of fire safety depends on the combination of the human-technique binomial;

b) fire surveillance focused only on improving technical solutions, the protection of the human factor being neglected.

The development of the technique led to the emergence of some principles in firefighting (thermofoam systems, aerosol extinguishing, inert gas extinguishing, etc.), and their application placed on the secondary plan the attempts to increase the efficiency and the performance of the human factor. The previously shown aspects can be argued and explained as follows:

a) the compliance with fire safety regulations only ensures the legal framework of operation based on a minimum accepted level, but does not imply the performance of real fire protection solutions. The motivation is determined by the fact that fire protection includes three main directions: structural, technical and organizational;

b) the specific conditions in the internal environment are characterized by: reluctant mentality to invest, insufficient amounts allocated for fire safety, low level of staff education, during the exploitation period;

c) the analysis of fire protection efficiency is reflected by the logic of „defense in depth", all done so that a „fire does not occur".

In relation to what has been presented, actions are required for:

a) the transition from the normative stage to that of fire safety engineering;

b) recalibrating the weights of the three directions, focused on the operational ones (focused on the human factor).

In the legislative context created after 1990 in our country, and in particular, with the establishment of the quality system in constructions, standardization was given new tasks, particularly important for ensuring the essential requirement of fire safety, detailed as follows:

a) certification of the quality of substances, materials, equipment, devices and machinery used in fire extinguishing installations;

b) assimilation of some international standards (EN, ISO);

c) revision of some product standards (materials, equipment, machines, etc.) used in firefighting, corresponding to the technical progress and performances achieved in this field;

d) revision of some standards of fundamental prescriptions for calculation and design, of fire extinguishing installations (with water/special substances).

Knowledge of the standards and their application is important because the benefits of their application are multiple (improvement of quality performance and reliability of the offered products or services, health and safety of the working environment for employees, access to the international market, cost reduction and compliance with the legislation in force). In the field of occupational health and safety, the SR ISO 45001-2018 standard is used, and on a previous date, ASRO adopted a series of standards from the European level that aim at safety signs (SR EN ISO 7010:2020/A2: 2022 and SR EN ISO 7010:2020/A3:2022, amendments to SR EN ISO7010:2020 standard), smoke control and fire extinguishing installations (SR EN 14972-10:2022, versions of SR EN 12101 standard) and fire resistance tests for technical installations used in buildings (SR EN 1366-11+A1:2022 and SR EN 1366-3:2022, parts of EN 1366 standard).

Regarding the design process of a building, the standard aspect is represented by fire safety.

Building's fire safety design is a process of planning and designing building structures and fire safety systems.

The design's objectives to the fundamental requirement are: saving users, property and limiting damage, protecting response teams, preventing building collapse and fire propagation within and from one building to another. These objectives constitute a priority task of the authorities, as well as administrators, building owners, etc. These objectives determine the importance of fire safety in the category of civil and industrial buildings.

Distinct from the above, the activities carried out by workers in buildings involve their exposure to risks that can cause accidents, unwanted occupational diseases that occur over time and result in physical, emotional and mental injury or even death; thus risk reduction measures are applied.

From the considerations shown, it can be concluded that the current research work derives from the fact that the central element in the realization of an effective management system of the risk of occupational injury and illness and the application of technical-organizational measures in buildings for fire protection (achieved by fulfilling the essential requirement of fire safety) is the risk assessment/audit, respectively the quantitative and qualitative assessment of a building's fire safety.

The doctoral program consisted of preparing, presenting and defending of examinations and scientific reports, deepening the study, proposing and developing work methods and techniques for the application of measures to improve the safety of workers and performing a synthesis of the principles of application of fire safety engineering, focused on the passive fire protection of metal and wooden structures related to buildings.

The construction of a metal structure building requires a documented process, where passive fire protection is the first measure required to ensure fire resistance. In the case of wooden structures, due to the vulnerability of wood to fire - which causes the building to fall into an unfavorable degree of fire resistance - it is required to improve the fire behavior through the fireproofing process.

I also carried out/participated in the creation and publication of scientific papers, as well as the elaboration of this PhD thesis on the research activity aimed at occupational and fire safety, examined in civil and industrial buildings.

This research paper represents the final stage of an extensive approach of analysis and synthesis - thought and practiced within the author's professional activity, carried out in the specialized literature applicable to the field of occupational safety and health and related activities.

The importance of the research topic results from the fact that occupational and fire safety is essential in the construction of a building, as it ensures the protection of human life, property and compliance with legal requirements.

THESIS STRUCTURE

The PhD thesis includes 9 chapters and contains 178 pages.

Chapter 1, entitled „General aspects on the current state of occupational safety and health. Specific and related terminology. Technical and legal regulations specific to the field of occupational safety and health and for related activities. OSH concept" is dedicated to the presentation of a history regarding the legislative framework related to labor protection in Romania, the terms used in this field of activity and related activity and the OSH concept.

Chapter 2, entitled „Current state on fire safety in civil and industrial buildings" is dedicated to the presentation of information on fires, statistical data, constructive elements of buildings, fire safety engineering, comparative national-European situation regarding fire safety requirements.

Chapter 3, entitled „Conclusions on the current state of research on occupational and fire safety in civil and industrial buildings" presents aspects regarding the activities carried out in the work process, the importance of evaluation in an organization, some elements for improvement measures for this field of activity.

Chapter 4, entitled „Research & development directions, main goal and methodology" includes the provided information regarding two research directions (in OSH field and fire risk analysis field), the methodological research framework related to the two fields of activity regarding compliance with the regulations in force adapted to EU requirements.

Chapter 5, entitled „Research and contributions on improving safety and health of staff working in civil and industrial buildings", describes the presentation of two risk assessment case studies for a fire safety drill.

Chapter 6, entitled „Research in the field of analysis of resistance structures exposed to fire. Fire risk identification, assessment and control", includes a novelty element on preventing the fire spread in environmental protection conditions by using PDCA cycle (Case Study) and analysis of a fire scene, respectively fire protection, resistance elements of a building.

Chapter 7, entitled „Research and contributions on improving fire safety in civil and industrial buildings" includes original research on several simulations and description of experimental analyzes performed by the author. Also, experimental tests carried out in a built space are presented, information regarding the values of temperature, humidity and water flow, respectively the influence of water temperature on fire suppression. Within the chapter, a bibliographic research was carried out in which the bibliographic elements were studied and selected based on a number of keywords, entered in the Access™ program with the possibility of sorting, depending on the type of bibliographic resource, the year, no. of pages and title.

Chapter 8, entitled „Research and contributions on fireproofing of wood and textile combustible materials used in construction" includes an experimental study on the fireproofing effectiveness (performed by the author), the use of combustible materials in construction structures and other presented elements.

Chapter 9 is reserved for presenting the final conclusions resulting from the conclusions related to each chapter and listing the new elements inserted in the contents of the research paper.

DURATION OF THE RESEARCH PROGRAM

The individual research program ran for five years.

During these years I deepened the study on the current state, research on the field of fire safety, bibliographic study related to the various existing methods and procedures, elaboration of case studies on the fireproofing effectiveness and proposal of solutions in case of fire, ANOVA statistical analysis and use of a numerical modeling program.

During the doctoral program, I was a scholarship holder in the SMART project - „Preparation of PhD students and postdoctoral researchers in order to acquire applied research skills", held in the Politehnica University of Bucharest (1.10.2022 - 30.09.2023).

PREREQUISITES REQUIRED TO ACHIEVE THE PROPOSED GOALS

To ensure the fulfillment of the proposed goals, I allocated time for:

- knowledge of the current state in the research area
- knowledge of the requirements of the standards
- identifying the activities requires to achieve the proposed goals
- development of an individual research program

Individual research within doctoral school included elements of secondary (desk) and primary (field) research.

The list of consulted bibliographic sources, numbering 230, is presented at the end of the thesis and includes: specialized literature books, standards and websites.

Chapter 1. General aspects on the current state of occupational safety and health.

In this chapter I have described aspects related to the historical evolution of labor protection at the national level, in which I have highlighted the legal acts that include national norms and regulations for occupational safety and health, terms used within organizations (regarding the activities aimed at this field) and the OSH concept, a notion implemented at the organization level that ensures optimal conditions for the development of work processes and secure and safe workplaces for workers. Considering this description, it is found that compared to other disciplines, the occupational safety activity allows: the identification of negative results included in a work process and the research of the events are analyzed on the cause-effect principle. Regarding the theoretical prerequisites related to the mentioned field, they have no correspondence in the content of other disciplines, which is why the current trends related to the applicable legislative field can be grouped and argued as follows:

a) treating this field as a state problem and the scientific character for this discipline;
b) presence of bodies controlling and guiding the activity at national level for the application of conditional measures regarding compliance with general prevention rules..

The structure of the national legislation, shown in Fig. 1, was built to delimit different levels of regulation and highlight the fact that it is based on the employer's own instructions (tertiary legislation).

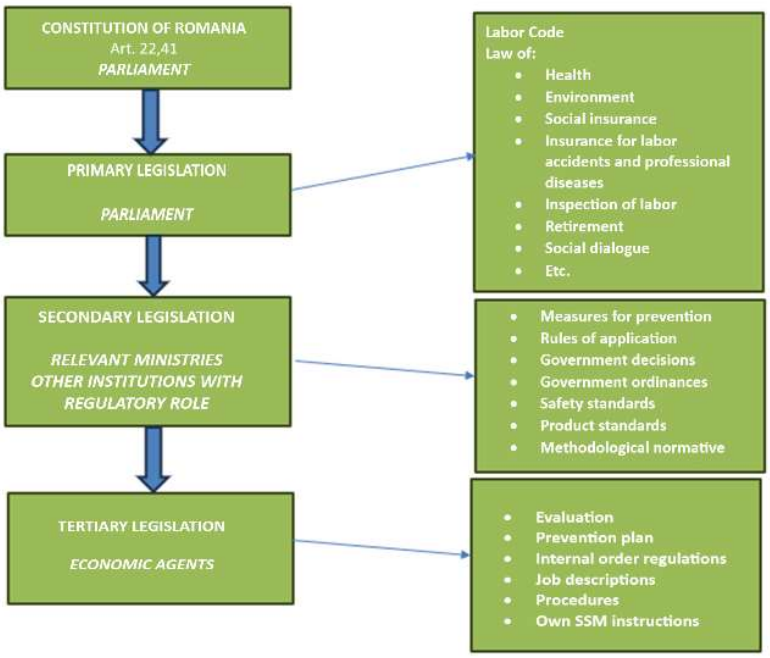

Fig. 1. Structure of national legislation in the field of occupational safety and health

The step required to ensure the minimum conditions of occupational safety and health imposed by the regulations in force, involve an organizational effort and a sustained financial effort.

The knowledge and accurate assessment of occupational risks at each workplace is the main objective of work to prevent occupational injury and illness.

The approach to occupational health and safety offers opportunities to improve the organization's efficiency, as well as to protect workers, a situation motivated by the following aspects:

a) low levels of absence and staff turnover at work;
b) continuity in carrying out the activity, by avoiding events and interruptions in the work process.

According to the data provided and presented in the contents of this chapter, I consider the importance of this activity within an organization necessary, therefore the following benefits can be listed:

a) maximizing workers' productivity;
b) improving the employees' attachment in relation to the organization's activity and the degree to which the organization's values contribute to maintain the employees' health;
c) improving motivation levels, reducing insurance contributions and potential exposure to criminal or civil litigation.

The occupational health and safety system of an organization consists of the external factors, the prevention activities of the organization, the internal reactions of the organization's members and the benefits resulting from the activities within the system (represented in Fig. 2). An important element of the occupational safety and health system is the way the organization implements occupational safety requirements [16, 25].

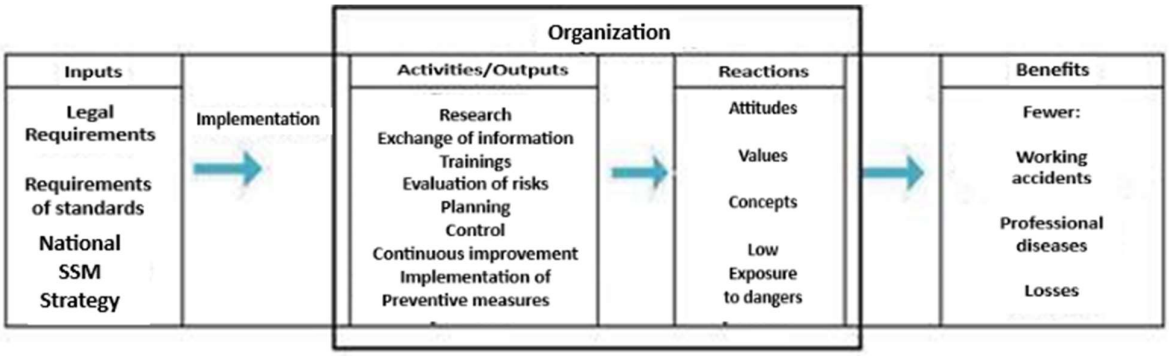

Fig. 2. OHS system of an organization [25]

In order to improve the workers' occupational safety, I consider that it is necessary to present the following recommendations:

a) supplementing the regulatory principles provided in the normative acts with instruments regarding the application of economic incentives;

b) developing the dimensions of communication at the organization level within the OSH communication plans to improve their general perception. The atmosphere of communication with the superior allows workers to express their concerns about undesirable events regarding the risks identified in the workplace and to communicate openly in order to propose alternative prevention means. The role of communication is important in the promotion and continuous maintenance of occupational safety, motivated by the fact that it can generate additional opportunities to remedy the reported issues.

Chapter 2. Current state on fire safety in civil and industrial buildings

In this chapter, I presented aspects regarding the particularities of fires in civil and industrial buildings, statistical data on the number of deaths per county, within the period 2012-2022, the combustion process and conditions in the burning process, the fire protection of a building, the fire protection equipment and installations and the fire safety engineering.

The required conditions for carrying out the combustion process are shown in Fig. 3 below:

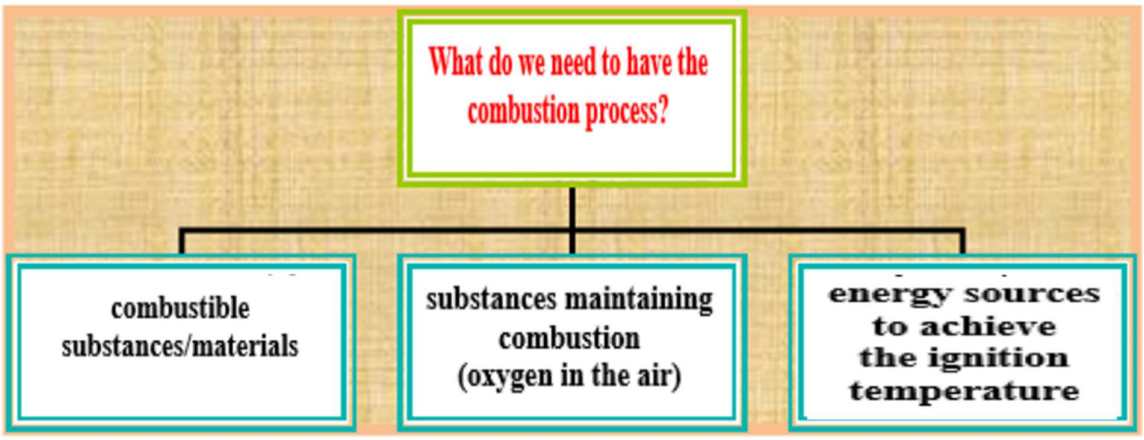

Fig. 3. Conditions in the combustion process

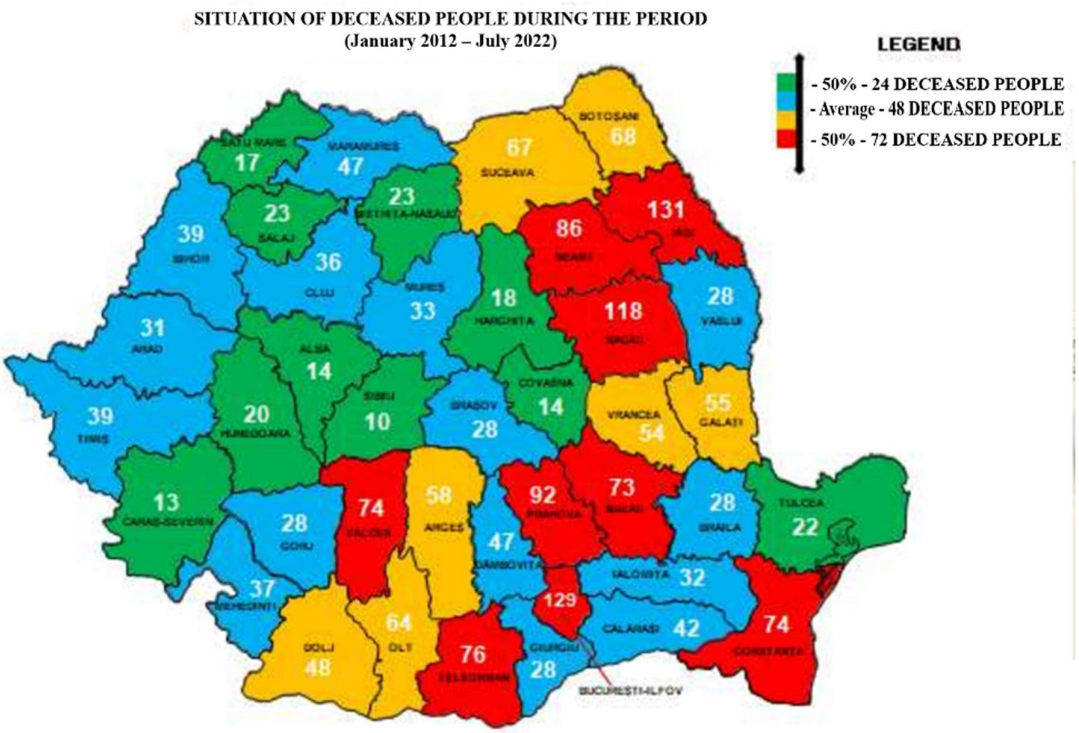

Fig. 4. Situation of the number of deaths registered between January 2012 and July 2022, per county

The analysis of the statistical data, according to different grouping criteria, led to a series of useful observations for the prevention communication activity.

While about 80.8% of the deceased persons had no disability, for about 19.2% various disabilities were reported (Fig. 5):

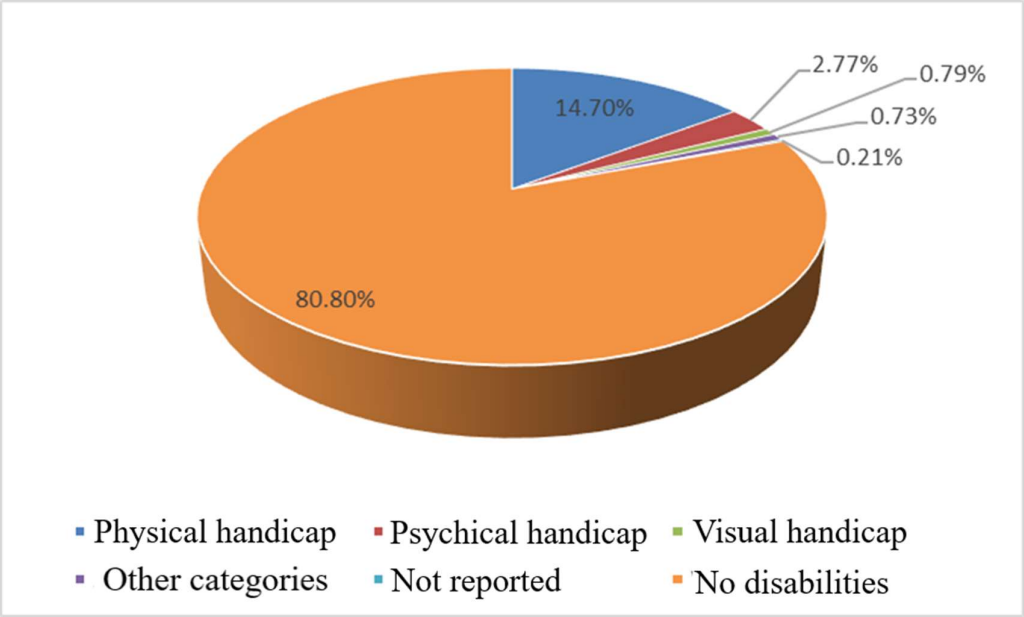

Fig. 5. Situation of the number of deaths according to the disabilities of the victims

The distribution pr months of the year indicates that the most deaths were recorded in: January – 17.31%, February – 14.66%, December – 11.76%, March – 11.30% and November – 9.52%. The numerical and percentage situation, per month, is described in Fig. 6.

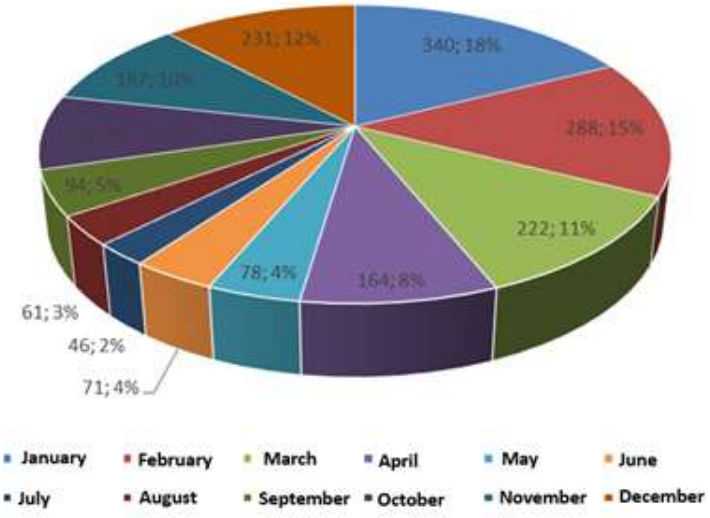

Fig. 6. Situation of the number of deaths per month, by numbers and percentage

Considering the adult/child age groups, the share of children in the total number of deaths is 3.86%. The analysis according to residence shows that approximately 72% of the children came from rural areas, while the rest lived in urban areas (Fig. 7, Fig. 8):

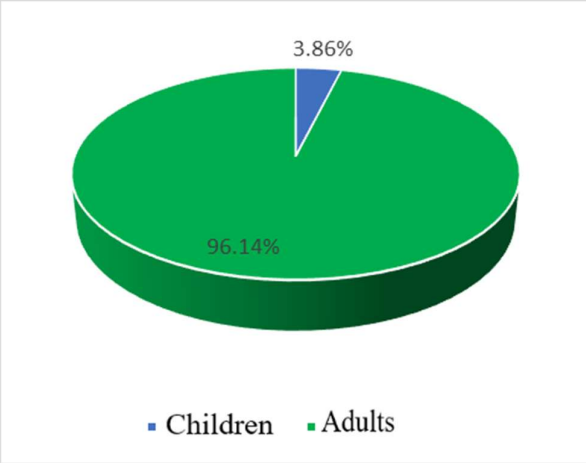

Fig. 7. Fire victims by age groups

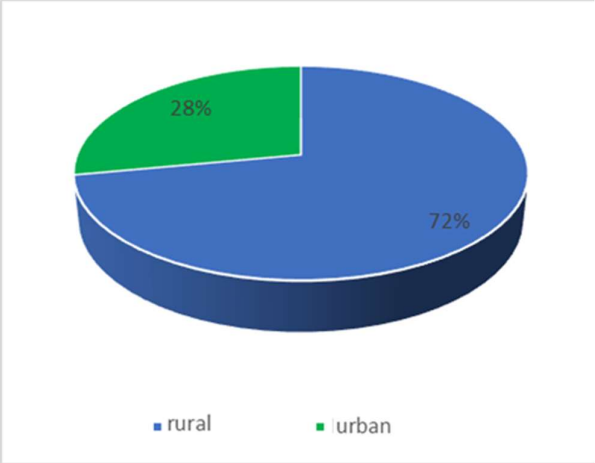

Fig. 8. Distribution of child victims by place of residence

The following are also represented and indicated in the figures and tables: the constructive elements of the resistance structure of a building, the fire protection of a building, the list of buildings of strategic importance in Romania and the fire extinguishing effect of a building.

The following constructive elements shown in Fig. 9 [7], [123] are the basis of a resistance structure.

The information contained in this chapter determines the importance of fire safety in buildings, a fact argued by the design objectives to the fundamental requirement: saving users, property and limiting damage, protecting intervention teams, preventing the collapse of the building and the fire propagation inside and from a building to another building etc.

The fire safety strategy is based on prevention. The fire initiation and development depends on certain factors: the nature and distribution of thermal loads, air intake, performance of the building envelope and smoke control. To improve fire safety, recommendations are needed on the compatibility between extinguishing agents and the combustible environment, extinguishing efficiency and user safety.

The development of the technique led to the emergence of some principles in the firefighting (thermofoam systems, aerosol extinguishing, inert gas extinguishing, etc.), and their application placed on the secondary plan the attempts to increase the efficiency and the performance of the human factor. The previously presented aspects can be argued and explained as follows:

a) the compliance with fire safety regulations only ensures the legal framework of operation based on a minimum accepted level, but does not imply the performance of real fire protection solutions. The motivation is determined by the fact that fire protection includes three main directions: structural, technical and organizational;
b) the specific conditions in the internal environment are characterized by: reluctant mentality to invest, insufficient amounts allocated for fire safety, low level of staff education, during the exploitation period;

c) the analysis of fire protection efficiency is reflected by the logic of „defense in depth", all done so that a „fire does not occur".

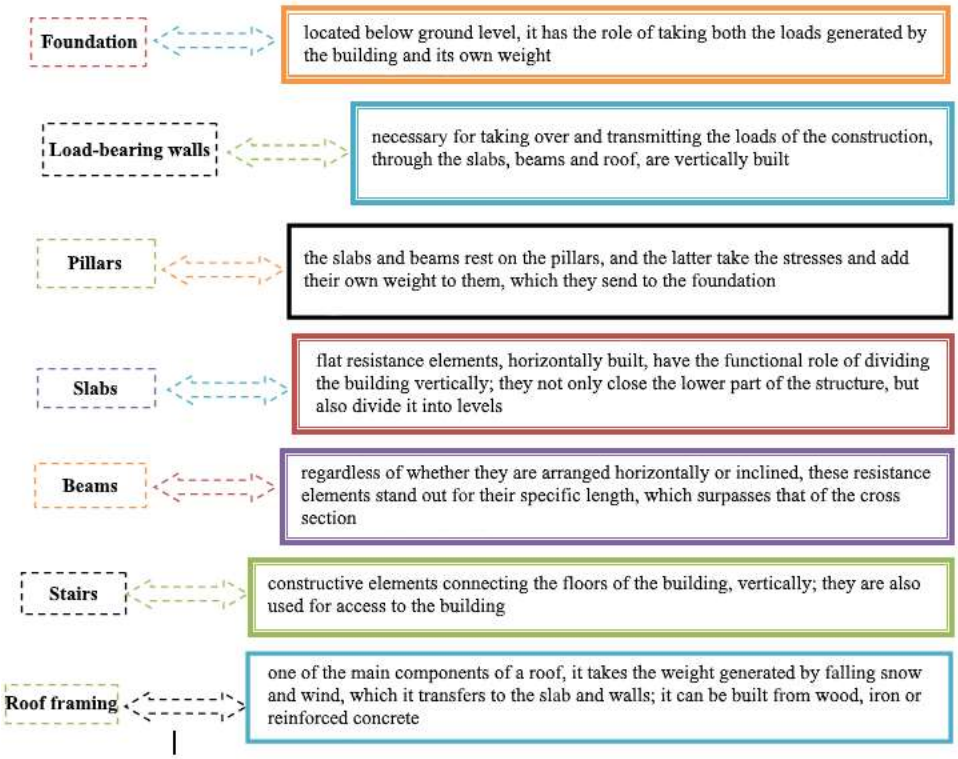

Fig. 9. Constructive elements of the resistance structure

Objective of Fire Safety Engineering is presented in Fig. 10[92]:

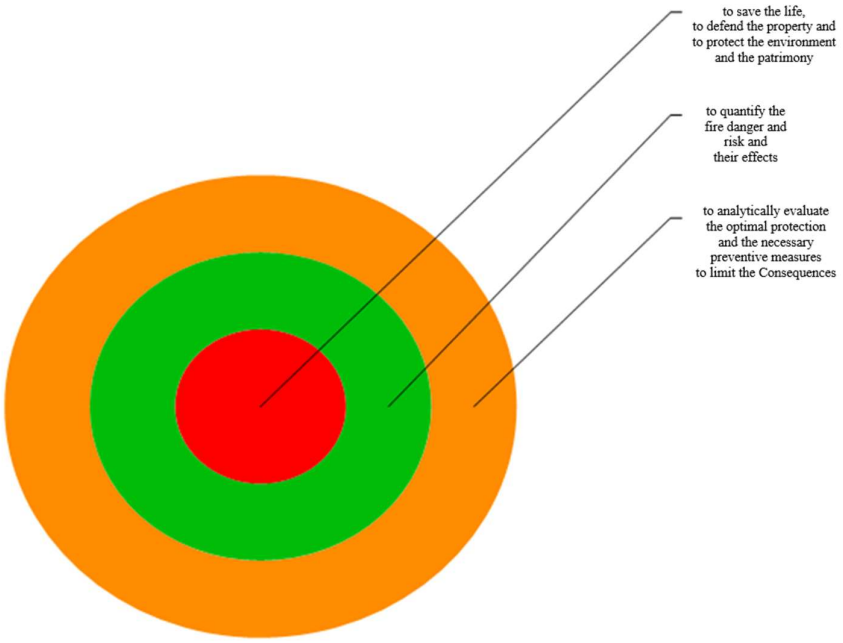

Fig. 10. Purpose of Fire Safety Engineering [4], [92]

Chapter 3. Conclusions on the current state of research on occupational and fire safety in civil and industrial buildings

From the analysis of the current state of research & development regarding occupational and fire safety in civil and industrial buildings, the following conclusions can be drawn:

• The starting point in the optimization of occupational injury and illness prevention activity is considered risk assessment. The elements considered necessary are:

a) the detail level shall permanently observe the seriousness and probability of professional risks (dangers identified in different activities, findings on site, etc.);
b) the archiving of documents (reports and files) regarding the confirmation of evidence related to the implementation of own instructions within the organization;
c) mandatory assessments for each component of the work system (see §1.2).

• Legislation in the OSH field includes provisions regarding the obligation of risk assessment by organizations and aims at preventive measures (see § 1.2).

• The OSH system of an organization is particularly complex, it includes external factors, prevention activities, organizational behavior, etc. (see § 1.2).

• The factors that can favor the occurrence and development of a fire are: existence of combustible substances or materials, presence of substances that maintain combustion (oxygen in the air), existence of energy sources that can produce the ignition temperature (see § 2.1).

• The analysis of the statistical data regarding the number of deaths registered between January 2012 and July 2022 reveals an uneven and random distribution of the values per months of the year (see § 2.1).

• In the category of buildings and especially inside them, various human activities are carried out (which involve the existence of people and material goods), which can cause a fire to occur (see § 2.1).

• Fire is an unfortunate event in the life of a building and its users, always causing losses. In tall buildings, the most victims are usually found on the top floors, intoxicated by smoke and hot gases (see § 2.1).

• Fire safety is an essential requirement related to the quality of buildings, which refers to the set of measures regarding the safety of users in the event of a fire (see § 2.2).

• In the fire risk assessment, there is a differentiation between ordinary buildings and those with a height regime, determined by the structure on the floors, the concentration of occupants and combustible materials, the probability that an uncontrolled fire will develop towards the upper floors, the difficulty of access for intervention teams at the scene of the event, the heavy evacuation of the occupants of the building (see § 2.2).

• From the aspect of fire safety, the design and execution of the building require the stability of the load-bearing elements and the limitation of the phenomenon of fire and smoke propagation (see § 2.3).

• Passive protection is an important part of any fire safety strategy, being designed for the purpose of protecting lives and reducing the financial impact of damages produced by restricting the spread of smoke, respectively fire, with the help of fire-resistant components that are part of the building structure (see § 2.3)

Chapter 4. Research & development directions, main goal and methodology

Based on the findings from the current state analysis, the following research & development directions on improving occupational and fire safety in civil and industrial buildings are deemed to be current:

- identification of events that generate risks in civil and industrial buildings;
- compliance with legal requirements and other requirements in the activity field;
- identification of risks provided for in the applicable normative acts, in force, by using statistical methods;
- systematic study of bibliographic resources related to the research topic;
- capitalization of tools specific to PDCA cycle regarding fire risk reduction;
- study of the fire behavior of combustible materials subjected to different fireproofing treatments.

Research & development main goal

Taking into account the data and conclusions drawn from the current state analysis, as well as the research & development directions on improving occupational and fire safety in civil and industrial buildings, it is established as the main goal of the doctoral research: *reduction of exposure to risks specific to the field of „Occupational health and safety", including fire risk, in organizations that carry out activities in civil and industrial buildings*.

Corresponding to the mentioned main goal, the following specific goals are defined:

a. use of Kinney occupational injury and disease risk assessment methodology;
b. application of ANOVA statistical method for the evaluation and objectification of the neuropsychological demands of workers carrying out activities in civil buildings;
c. development of a bibliographic analysis method, with the help of a supporting IT application;
d. use of PDCA cycle regarding the prevention of the fire propagation phenomenon;
e. carrying out an experimental study on the use of hot water to create water mist;
f. experimental determination regarding the fireproofing effectiveness of the combustible material.

Research & development methodology

The research-development methodology is designed as a reference system for the actions that will be taken to achieve the main goal of the doctoral work, as well as future developments.

The methodological benchmarks are as follows:

I. Investigation

In order to achieve the goals proposed for the doctoral research approach, we have collected a consistent documentation base, which includes reference works for the field of the PhD thesis, respectively the basic and related field related to OSH activity. To achieve the proposed goals, we consulted and analyzed bibliographic references consisting of courses, monographs, magazines, national and European legislation and jurisprudence, materials developed by different entities or institutions.

II. Establishing the research methodology

a. Study of bibliographic resources;

b. Application of the methodological framework regarding the identification of occupational injury and illness risks in civil buildings intended for offices;

c. Interpretation of the results regarding the assessment of events generated by risks at workplace;

d. Justification for the determination of the risk factor in office buildings;

e. Choice of ANOVA dispersion method - unifactorial for the assessment of the level of socio-professional stress, dissatisfaction and subjective overwork;

f. Data collection method: survey based on questionnaire;

g. Participation of employees in filling out COHEN questionnaire, Holmes Rahe questionnaire, general questionnaire, filling out questionnaires and the sheet form relating to risk factors;

h. Processing the collected data, according to ANOVA methodology;

i. Interpretation of results;

j. Analysis of the conclusions of health reports within the organization;

k. Evaluation and objectification of the neuropsychological demands of the staff were carried out on a sample of employees: the estimation of some personality characteristics mainly aimed at the ability of professional adaption/ non-adaptation through LUSCHER test; assessment during visual perception through DA test – PRAGUE; assessment of the ability to maintain focused and distributed attention on precise execution, through CCA – KRAEPELIN test;

l. Analysis of the requirements and available data for the structured bibliographic study;

m. Realization of the database. Implementation within the database management system used. Popularity of the database;

n. Capitalization of the database to extract the necessary information for the bibliographic study;

o. Delimitation of the general considerations and the conceptual framework regarding PDCA tools;

p. Setting up a scenario regarding the importance of standardizing the relationship of citizens with public institutions in order to prevent the fire spreads;

q. Carrying out the experimental study on the use of hot water to create water mist: formulating a problem, proposing a hypothesis, carrying out a controlled experiment to test the validity of the hypothesis, interpreting the results.

r. Fire tests in accredited laboratories, for various fireproofing products. Interpretation of results.

III. Research tools

The tools used in the research are statistical calculation formulas, spreadsheet tools (Microsoft ® Excel™), S.G.B.D. (Microsoft® Access™), Pyrosim specialized program.

IV. Presentation of results and conclusions

It is highlighted that the identification of these events, as well as the study on well-founded scientific bases (statistical methods) of the neuropsychological demands at the workplace, together with the appropriate application of PDCA in order to prevent the fire spread, of devices for preventing the fire risk based on water mist and wood protection are essential factors that contribute to improving work safety and user safety in the event of a fire. Occupational safety, respectively fire prevention measures, will always remain a topical issue for all factors involved in the work process.

The (PDCA) cycle Plan-Do-Check-Act on fire prevention is adapted according to Fig. 11. [224]:

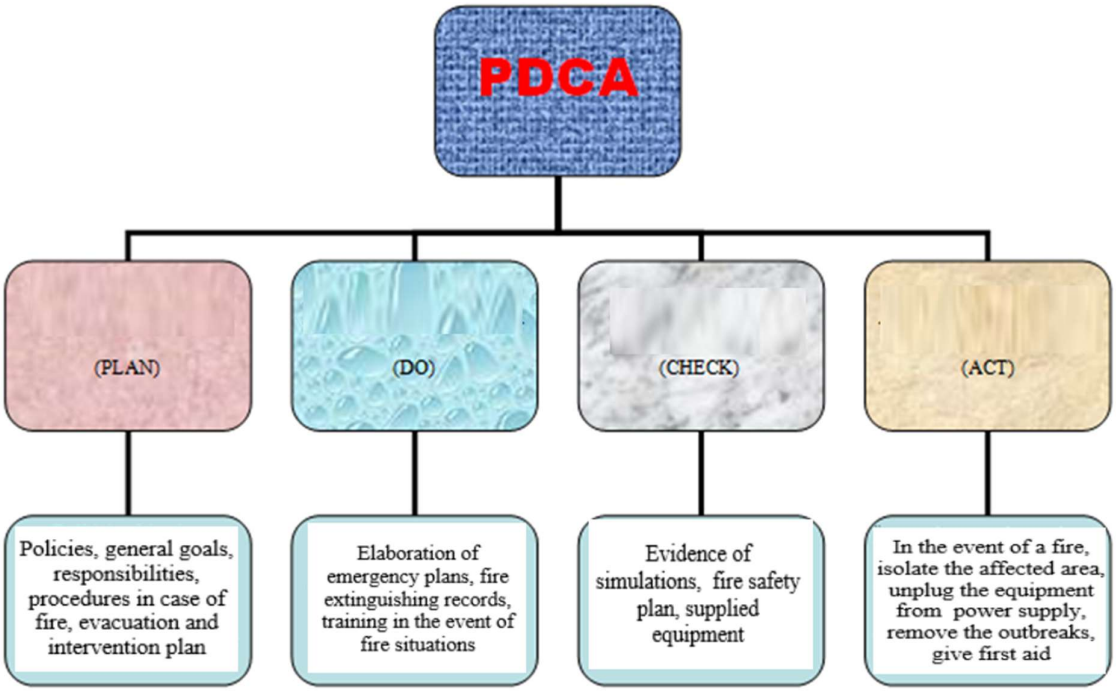

Fig. 11. PDCA for fires [224]

Chapter 5. Research and contributions on improving safety and health of staff working in civil and industrial buildings

The use of the work procedure allowed the assessment of occupational injury and disease risks related to the activities carried out at the woekplace for the job of jurist, employed at a public institution. The public institution is located in a civil office building.

For the assessment, the Kinney method was used in conjunction with the method of assessing the risks of occupational injury and illness at workplace, developed by specialists of „Alexandru Darabont" INCDPM (National Institute of Research-Development on Labor Protection) and approved by the MMSSF (Ministry of Labor, Social Solidarity and Family) in 1993. From the INCDPM assessment method, to identify the risk factors of occupational injury and illness, the annexes with the risk factors specific to each element of the work system, the assessment sheet adapted according to Kinney method and the prevention measures sheet were used.

In order to identify and evaluate the job specific risks for the position of Jurist - employed at a public institution, the job duties from the job description, presented in the subchapter, were analyzed.

13 risk factors were identified, out of which 5 risk factors specific to the performer, 2 risk factors specific to the workload, 4 risk factors specific to the means of production and 2 risk factors specific to the work environment.

For each risk factor, the risk level was calculated as the product of severity, probability and frequency of its manifestation. The values of these parameters were established according to the tables in the Kinney evaluation method. Two risk factors specific to the performer have a value of 7.5 and a risk factor specific to the means of production, are the risk factors with the lowest risk level, which means that in the contents of table no. 4 of the Kinney method there are acceptable risk factors, for which no preventive measures are required.

The identified risk factors are illustrated comparatively, depending on their value in the graphic represented in Fig. 12.

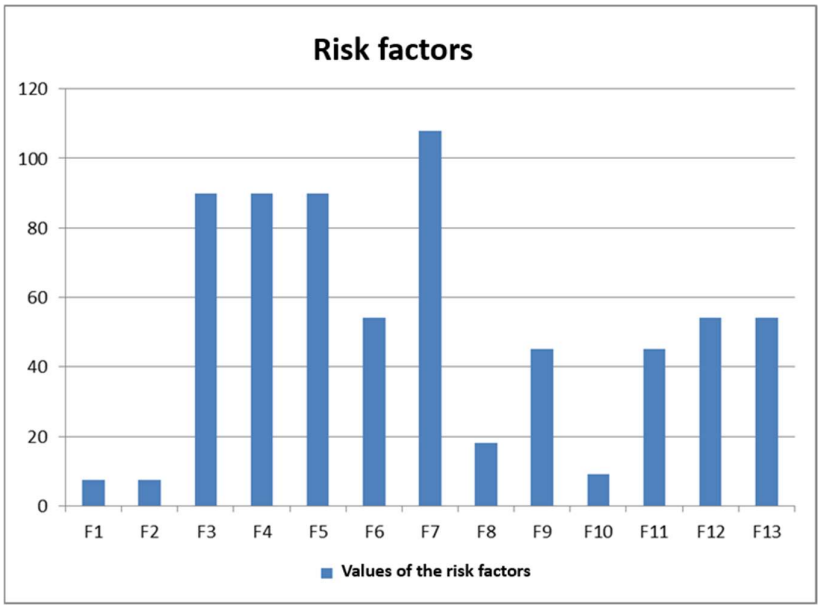

Fig. 12. Risk factors

The highest risk level has the value of 108 and is for the risk factor „Static effort determined by the position at the computer without observing the ergonomic norms (spinal damage, eye conditions)" specific to the work force. According to the risk classification, it is a significant risk, as are the other risks for which preventive measures have been proposed.

The resulting risk level actually reflects the situation determined by the intrinsic risk factors that characterize a certain element of the work system involved in an activity.

What should be highlighted is the fact that, for the prioritization and adoption of preventive measures, all identified risk factors should be taken into account, with priority given to the risk factors with the highest risk level.

For them, the preventive measures proposed in the paper or other measures should be adopted if they are considered to be effective.

The risk factors specific to the performer represent 38.46% of the total, the risk factors specific to the means of production represent 30.77% of the total, the risk factors specific to the workload and the work environment represent each 15.38 of the total. This distribution of risk factors on the elements of the work system are presented comparatively in the graphic of Fig. 13.

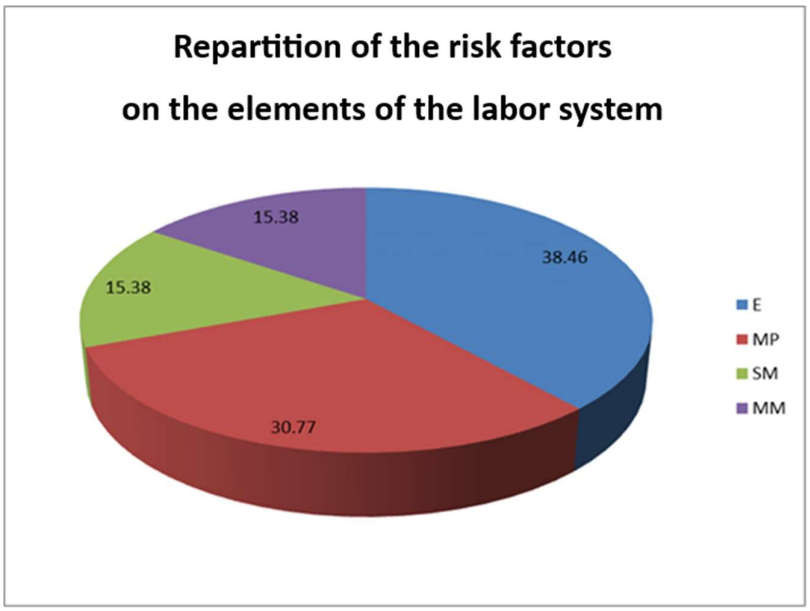

Fig. 13. Distribution of risk factors on the elements of the work system

Legend: Performer –E; Means of production – MP; Work load - SM; Work environment- MM

It therefore shows that most of the identified risk factors are specific to the performer.

The conclusion that is imposed refers to the peeformer's responsibility in carrying out the activities, the responsibility of those who organize and lead this activity, as well as the responsibility of the person who carries out the activity of prevention and protection, regarding the elaboration of their own security instructions for each type of activity, displaying them at the workplaces, the appropriate training of the operation staff and the testing of the knowledge transmitted during the training.

Considering the identified risk factors, specific to the elements of the work system and taking into account the risk level corresponding to each risk factor, a series of preventive measures were proposed.

Evaluation and objectification of neuropsychological demands for staff working in civil buildings; Case Study

As part of the research activity, a sensory overload study was carried out, by evaluating a number of employees who carry out activities in office spaces.

The conceptual framework regarding the analysis of sensory overload is indicated in Fig. 14.

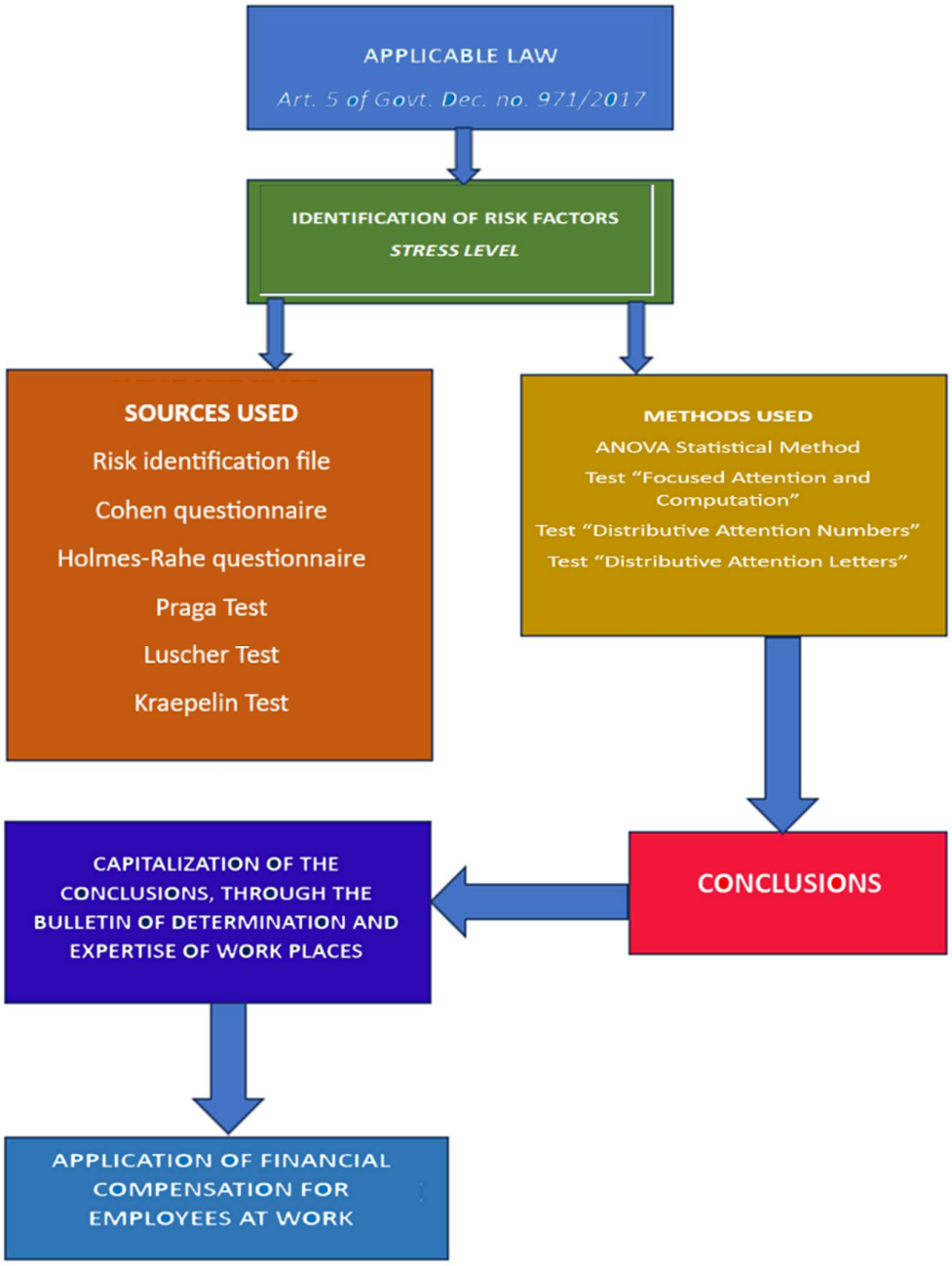

Fig. 14. Conceptual framework regarding the analysis of sensory overload

The data were processed using the ANOVA - unifactorial dispersion method [160, 161].

Statistical analyzes were carried out for all the questionnaires, which can be found in the thesis, according to the example related to the Cohen questionnaire detailed below:

The scores corresponding to the COHEN questionnaire are presented in Table 5.6.

For the variable X_i we calculate **mean (M), dispersion (D), mean standard deviation (σ), coefficient of variation (v):**

Mean:

$$M = \frac{199}{15} = 13{,}26$$

Parameter m_2

$$m_2 = \frac{3237}{15} = 215{,}8$$

Dispersion $D = 215{,}8 - 13{,}26^2 = 215{,}8 - 175{,}82 = 39{,}98$

Mean standard deviation

$$\sigma = \sqrt{39{,}98} = 6.32$$

Coefficient of variation

$$v = \frac{6.32}{13.73} * 100 = 46.03\%$$

Conclusion: the population is inhomogeneous, because *v* is higher than 35%.

Unifactorial dispersion analysis can be found in the thesis for all questionnaires, according to the example – general questionnaire (Table 1):

Table 1. Observation matrix

Group no.	**Val**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
I		10	8	26	3	21	16	20	18	n_1=8	x_1 mean=15,25
II		11	13	4	13	10	16	16	0	n_2=7	x_2 mean=11,85

$$M = 13{,}66$$

$$SPT = 15 * D = 558{,}15$$

$$SPD = 8 * (15{,}25 - 13{,}66)^2 + 7 * (11{,}85 - 13{,}66)^2 = 43{,}1575$$

$$SPI = SPT - SPD = 558{,}15 - 43{,}15 = 515{,}0$$

$$MPD = \frac{43{,}1575}{(2-1)} = 43{,}1575$$

$$MPI = \frac{515}{(15-2)} = 39{,}6153$$

$$MPT = \frac{558{,}15}{(15-1)} = 39{,}8678$$

Results are centralized in Table 2.

Table 2. Dispersion characteristics

Dispersion components	**Sum of deviations squares**	**Number of freedom degrees**	**Dispersion estimates**
Between groups	43,15	1	43,15
Within groups	515	13	39,6153
Total	558,15	14	39,8678

$$F_{calculated} = \frac{43{,}1575}{39{,}6153} = 1{,}0894 < F_{table} = F_{0{,}05;(1,13)} = 4{,}67.$$

In this case, the stress does not influence the studied population.

e) Unifactorial dispersion analysis – general questionnaire (Table 3):

Table 3. Observation matrix

Group no.	**Val**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
I		12	13	23	7	26	26	22	25	k1=8	x1 mean=19,25
II		20	22	9	28	16	23	21	0	k2=7	x2 mean=19,85

$M = 19{,}53$

$SPT = 15 * D = 15 * 40{,}38 = 605{,}7$

$SPD = 8 * (19{,}25 - 19{,}53)^2 + 7 * (19{,}87 - 19{,}33)^2 = 63{,}5292$

$SPI = 605{,}7 - 63{,}5292 = 542{,}1708$

$$MPD = \frac{63{,}5292}{(2-1)} = 63{,}5292$$

$$MPI = \frac{542{,}1708}{(15-2)} = 41{,}7054$$

$$MPT = \frac{605{,}7}{(15-1)} = 43{,}2642$$

$$F_{calculated} = \frac{63{,}5292}{43{,}2642} = 1{,}4684 < F_{table}.$$

The centralized data for the three questionnaires are indicated in Table 4 and presented in Fig. 15.

Table 4. Stress level %

Questionnaire	Relative frequencies	Slight	Moderate	Strong	$F_{calculated} < 4,67$
1 Cohen		66,66	20	13,33	0,72
2 Holmes Rahe		60	33,33	6,66	2,30
3 General		80	13,33	6,66	4,73

$\alpha = 0,05$ significant threshold

Namely $p = 0,95$ confidence coefficient$1 - \alpha$.

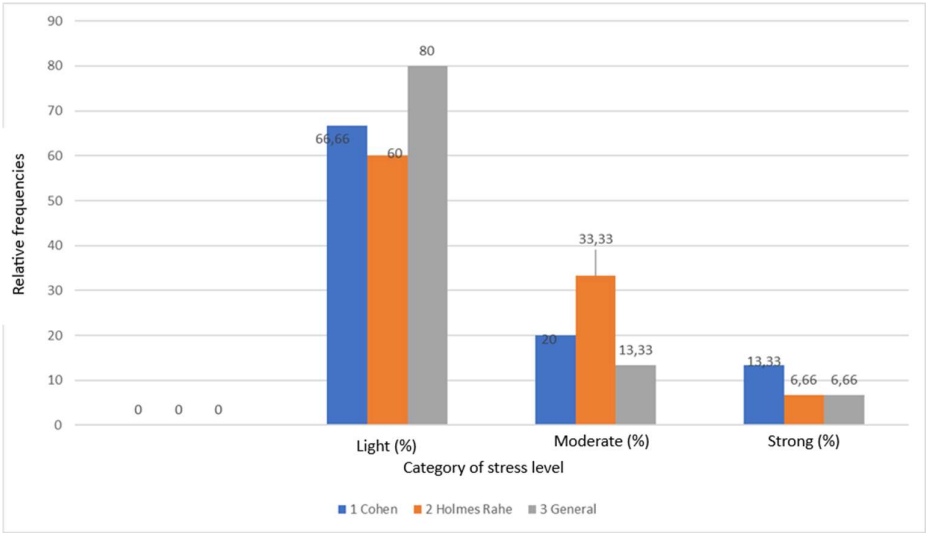

Fig. 15. Stress level – relative frequencies

The critical region $F_{calculat} > F_{tabelat}$ not being complied with, in the three populations to which separate questionnaires were applied, means that stress does not influence them.

The following results from the analyzed study and based on the histogram:

- Coefficient of variation $v < 35\%$, shows that the population is homogeneous, representative indicators
- Cohen questionnaire 1, $v = 46,03\%$, shows that the population is not homogeneous.
- Holmes Rahe questionnaire 2, $v = 30,53\%$, arată ca populația este omogenă, indicatorii reprezentativi.
- General questionnaire 3, $v = 38,5\ \%$, shows that the population is almost homogeneous.

The results of LUSCHER, KRAEPELIN and PRAGUE tests are indicated in Table 5.23 of the thesis.

The tests were completed by 16 employees (expert, engineer, economist, jurist, senior advisor, head of legal service, assistant advisor, senior advisor, general manager). LUSCHER tests (16 determinations), DA – PRAGUE (16 determinations, 2 assessments) and CCA – KRAEPELIN (16 determinations, 2 assessments).

In this sub-chapter, the application of the tests for the assessment of a number of 16 workers confirms that the values recorded in the normal work schedule, at different times, highlight a lower level of concentrated attention, a fact confirmed at the second assessment (1:30 p.m.) compared to the first assessment (9.00 a.m.).

Taking into account the aspects presented in this chapter, I consider the following conclusions necessary:

a) The estimation of some personality characteristics (respectively, professional adaptation/non-adaptation) suggests some adaptation deficiencies.

b) The assessment of the ability to maintain the degree of mobility and the recording of the concentration level during visual perception and sustained attention, revealed a decrease in the number of cases with correct answers to the images viewed, suggesting a relatively low level of the concentration degree during perception in a relatively complex environment.

c) The assessment of the ability to maintain focused and distributed attention in the presence of multiple visual stimuli with the possibility of multiple-choice reactions revealed a decrease in the number of cases with correct responses to the images viewed, suggesting the existence of difficulties in responding to different stimuli which changes in a relatively short period of time.

d) The assessment of socio-professional stress level through the recording scale, using the ANOVA - unifactorial method, suggested a relatively average stress at work, dissatisfaction, stressful conditions and lack of rest.

e) The results recorded in the Job Determination and Expertise Report highlighted the presence of risk factors (identified by applying the statistical method) in the performance of activities carried out by employees during working hours. This aspect constitutes a unique instrument that determined the application of compensation measures, in the form of an increase, in accordance with the applicable legislation and, in this case, the institution’s expenses were void.

Chapter 6. Research in the field of analysis of resistance structures exposed to fire. Fire risk identification, assessment and control

We appreciate that applying the PDCA cycle to the fire prevention process brings undeniable benefits for the actors involved. The fact that citizens promptly notify the emergency service of the occurrence of a fire contributes to minimizing the intervention time of the specialized structure. Correspondingly, the risks to the integrity of the human being and the production of material damage are reduced. From this point of view, it is recommended to develop the monitoring of citizens' relationship with IGSU (General Inspectorate for Emergency Situations) and similar/subordinate institutions, by expanding the indicators that characterize this relationship (for example, the number of calls to the emergency service versus the number of events, by event categories, by risk categories, etc.) and their uniform application at national level. Also, through the transparency at the action level shown by IGSU, citizens' confidence in the promptness and professionalism of the intervention crews and support structures increases.

Scenario/Case Study: The importance of standardizing the citizens' relationship with public institutions in order to prevent the fire spread by using the PDCA cycle regulated by the ISO 14001 standard

Both citizens and public institutions hold the main roles when discussing about society. These two elements are equally active in the development of society, but also responsible for their actions. In this form, we want to present the scenario as a case study through which the involvement of citizens in the actions of public institutions is the central pillar on which the prevention and keeping fires under control, in Romania, is supported.

On the one hand, the scenario will look at how to implement the PDCA cycle in order to prevent and extinguish fires, so that the environment is not affected.

On the other hand, the information channels will be watched, through which public institutions comply with the principle of transparency and make aware of the current situation regarding the fire spread both at local and national level, all this by observing the PDCA cycle.

The case study, carried out through the scenario's lens, puts the General Inspectorate for Emergency Situations in the foreground. Thus, in order to better understand this delimitation, the main objective of IGSU aims to make the actions of prevention and management of emergency situations more efficient, in order to keep the risks under control and ensure the normality of the life of human communities. In order to achieve the objective, the multitude of prevention and intervention activities for fire extinguishing or other types of natural or anthropogenic calamities is highlighted [112]. Thus, the activity of the General Inspectorate's representatives is vast, covering an area of calamities and events that can affect a considerable number of individuals, but also have a long-term impact on the environment. The way in which this scenario is approached is qualitative research [113], because it aims to answer the question „Why is it relevant to monitor the citizens' relationship with public institutions in order to prevent the fire spread by using the PDCA cycle?", as well as the interpretation method based on the information provided by the analysis in this sense.

Starting from this question, which represents the central core of qualitative research, it can be emphasized that citizens are the main engine of society and the main beneficiaries of public services. Events that can disrupt both the environment and the well-being of citizens create for public institutions a mission for the fulfillment of which it is necessary to respond with and for citizens. Thus, informing and involving citizens both in the decision-making process, as well as prevention

and combat actions are vital. Analyzing the steps of the General Inspectorate for Emergency Situations in order to certify specific activities, it can be noted that the quality management system is certified according to ISO 9001:2015 [114]. As mentioned in the conceptual framework, the structures of the certifications are similar, thus there is the possibility of expansion on several ISO branches. From this threshold, the case study can be developed through the PDCA cycle's lens, following the measures applied by IGSU, thus creating a scenario to prevent the fire spread, complying with the quality management and that regulated by ISO 14001.

The scenario we will present highlights the problem of fires and uncontrolled burning that produce emergency situations requiring an operative, integrated and effective response to limit and remove the consequences on the population, material and cultural values and/or economic activities [115].

The next stage according to the PDCA cycle is to develop the necessary solutions and implement the whole process as a pilot program [116]. First of all, it should be mentioned that in order to plan at national level, a legal basis is needed to develop communication with society. Public communication within the scenario is ensured on the principle of a single voice. In relation to the chosen scenario, the development program is to raise awareness and notify the population vis-à-vis the risks of using flammable substances and products, as well as the need to become aware of the situations in the area through the RO-alert system, as well as to notify the authorities in a timely manner. In this respect, the General Inspectorate for Emergency Situations provides daily updates vis-à-vis the involvement of citizens in relation to the requests received regarding uncontrolled fires on the institution's website. At the same time, the website www.fiipregatit.ro offers an action guide for any citizen to act in order to extinguish a fire. In addition, the information is delivered in an accessible and easy-to-understand form, and the presentation of scenarios is aimed at prevention (before the fire), in order to reduce the fire spread (during the event) and the resilience development (action after the event).

Going into the evaluation phase, which involves checking, analyzing and testing the efficiency of the solutions, as well as the impact it has at the moment, we will follow the dynamics of the calls made by citizens to the emergency services in the last warm season, which is also dangerous from the point of view of fires, with statistical analysis in the period August 8-12, 2023. Thus, starting from the data collected, it can be seen that there is a continuity in reports regarding uncontrolled fires.

This threshold results in an average of 47.2 uncontrolled burnings observed in the analyzed week and at least as many calls to the emergency service 112 (Fig. 16). It can be appreciated that citizens do not remain indifferent and act accordingly by reporting, whenever appropriate, the existence of such a danger or event.

It can be observed that at this point of the analysis a pilot project is not necessary, because the action at institutional level is prompt, the communication with the civil society is active, the transparency both at decision-making and at action level is present, and the citizens can access the information as notification and education, as well as contacting emergency services. All this while complying with quality and ecosystem.

The final step for action can only be outlined in this discussion, as the piloting of the citizen engagement program was quickly transformed into an action in its own right. The transition from „to do" to „to act„ is done only through a „check", and when it comes to emergency situations aimed at the fire spread, citizens and state institutions need to make a common front.

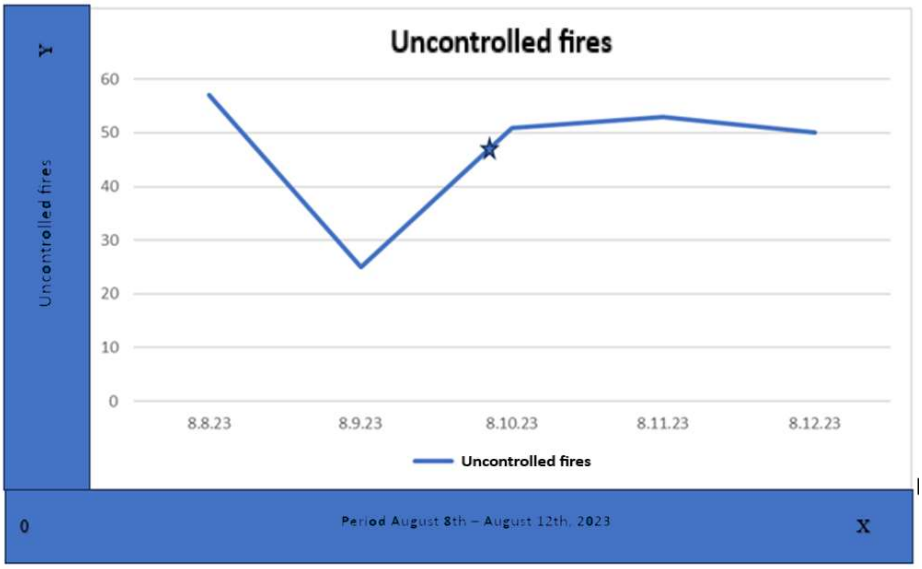

Fig. 16. Uncontrolled burnings

Through this scenario, represented in Fig. 17, we wanted to present the legal ground that facilitated the implementation of prevention and citizen involvement actions. Subsequently, the resources that were the basis of the standardization of the relationship between citizens and the emergency service were observed, and as a form of verification, the information was transposed based on the principle of transparency in order to have an overall picture. All this, building an integrated system, well implemented with the possibility of continuous development by complying with the PDCA cycle and last but not least complying with quality and ecosystem.

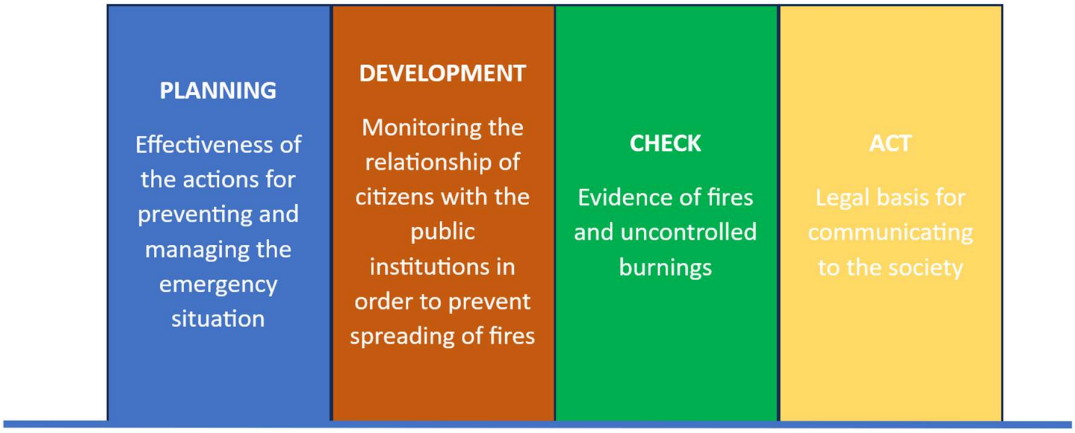

Fig. 17. Standardizing the relationship of citizens with public institutions – PDCA approach

Since the risks associated with fires increase significantly in certain situations (when it is not an isolated incident, but several uncontrollable fires that cannot be tackled simultaneously), the planning and use of the resources of the intervention structures is crucially influenced by the information received and its quality (process where citizen involvement can be a major advantage).

It is recommended to extend the application of the PDCA cycle for monitoring quality management systems within organizations in the field of emergency management, as well as at the level of structures with attributions in this regard from other categories of entities.

Chapter 7. Research and contributions on improving fire safety in civil and industrial buildings

Through the tests that are the subject of this chapter, the method of using hot water to create water mist is proposed. It starts from the premise that the warm water mist will cool the firebox in a shorter time than the cold water mist. Considering that it is about a building, the faster the extinguishing takes place, the smaller the amount of water used will be and implicitly the collateral losses will decrease. The amount of water that must be pumped to height will also be reduced. Also, if the combustion will be suppressed earlier in the case of hot water mist, then the temperature values in the firebox will be lower and the damage will be much lower in value compared to the classic water mist situation.

Necessary steps for conducting the experimental study. Method of using hot water to create water mist.

Since 1997, the Montreal Protocol has imposed the identification of fire extinguishing substances with a low pollution percentage, instead of products called halons, which are effective in extinguishing but have a high degree of pollution.

Later, alternatives were sought, i.e. new, cheap and non-polluting elements, one of which was water mist - specialized works highlighted the good extinguishing qualities of water mist.

Sprayed water in the form of mist cools and suppresses the outbreak more quickly compared to sprinkler systems, and material losses are greatly reduced [119].

For the application of the experiment, a space of size 2.2 x 2.2 x 1.85 was used, according to the indications presented in Fig. 18 and Fig. 19.

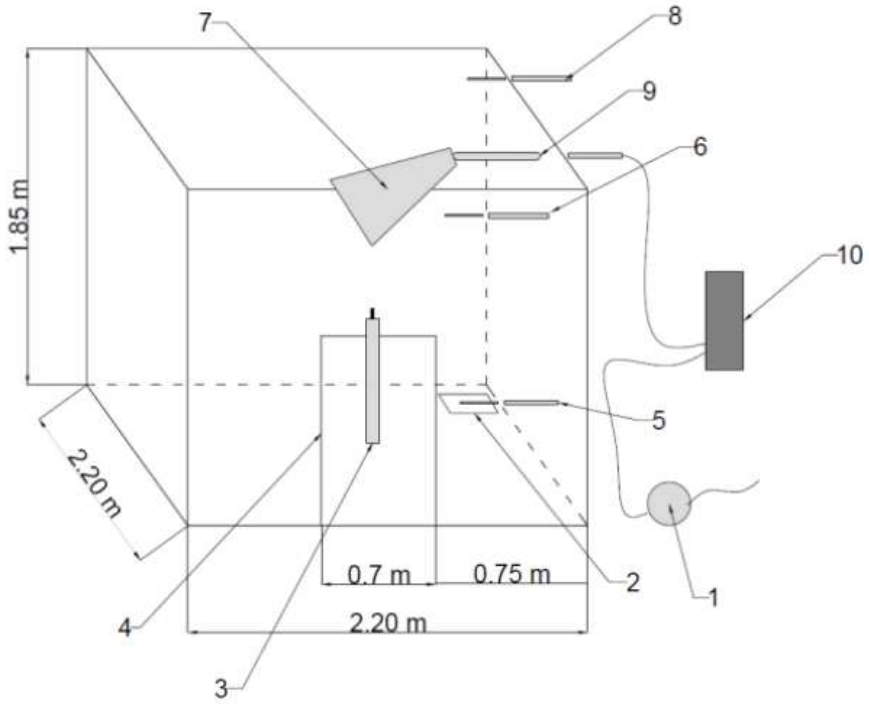

Fig. 18. Scheme regarding the sizes of the space for testing and positioning of used equipment

Legend: 1 – Flow meter resistant to high temperatures; 2 – Ethanol outbreak; 3 – Hygrometer probe; 4 – Height opening; 5, 6 – Probe with thermocouple placed in the flame, h =0.2 m, respectively h =1 m; 7 – Jet to water mist; 8 – Probe with thermocouple at ceiling height; 9 – Water mist discharge nozzle at the enclosure; 10 – Device for raising the water pressure to 120 bar.

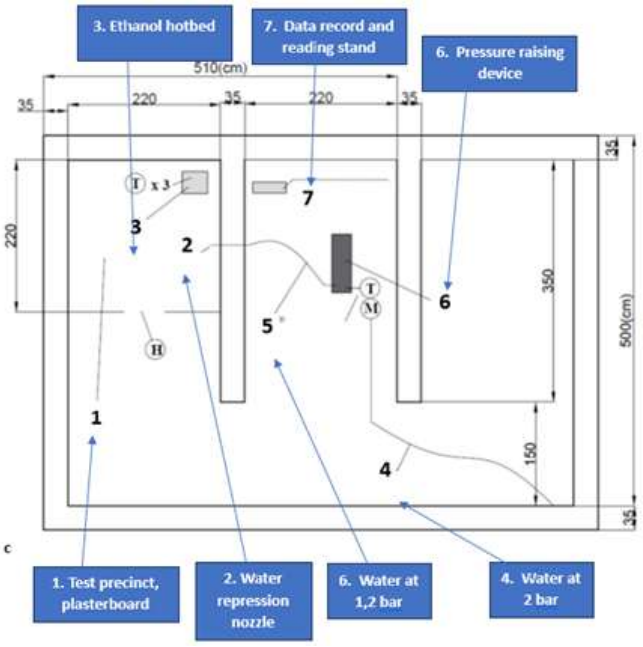

Fig. 19. Scheme regarding the location of the test enclosure and equipment

Application of proposed procedure

Several simulations were carried out on the computer with the Pyrosim program until a run was obtained in which the temperatures are similar to the practical tests, but only in the time range of 60-90 seconds after ignition.

Part of the material base used in the tests was made by own forces, and the devices used for data collection and recording were obtained from the experimental base to which the author has access,

The results of the three tests can also be compared from the point of view of images. Thus, halfway through the discharge, i.e. approximately 30 seconds later, images were taken for each test. Three images (Fig. 20, Fig. 21, Fig. 22) were chosen, taken during the experiment, which suggestively show the increase in the amount of droplets transformed into vapors, with the increase of the inlet temperature.

As we are talking about practical tests, the greater their number, the more the average of the temperature values will give a value close to the truth. Thus, for each of the three temperatures (15, 30, 40 °C), five tests were performed and recorded.

Some single tests were also presented in the chapter, one for each mist temperature used for suppression. Following the tests, some clarifications and observations were made regarding some specific elements.

Thus, it can be seen how the amount of water in the case of using water mist at 15 °C, to significantly reduce the temperature in the burning space, is only about 6 liters. In the case of sprinklers, the amount of water used for the same effect would be at least 10 times higher.

Fig. 20. Image after 30 seconds of pumping water into the enclosure at water temperature for suppression of 15 °C

Fig. 21. Image after 30 seconds of pumping water into the enclosure at water temperature for suppression of 30 °C

Fig. 22. Image after 30 seconds of pumping water into the enclosure at water temperature for suppression of 40 °C

From the analysis of the performed experiment, the following results can be listed:

– For optimal suppression in all three points located on the height, it is preferable to choose water mist at a temperature of 30 °C.

– If a decrease in temperature is wanted in the central area of the space, „at the wall", it is advisable to use cold water (15 °C);

– For optimal results in the outbreak, both 40 °C and 30 °C water mist can be used. 30 °C water mist implies a decrease of 19.6 °C compared to the cold water situation (15 °C), so it is about 7.33 % more efficient;

– To reduce the temperature on the ceiling, it is advisable to use cold water at 15 °C for extinguishing.

Given that firefighters use water mist on some of their vehicles and accessories, methods of improvement have been proposed by directing the temperature of the water that is to generate the mist. Similarly, recommendations and proposals were made for fixed water mist suppression systems.

The reason for studying these hot water mist suppression phenomena and problems is very simple: there are currently a lot of water mist systems installed in the world; the results of this research can recommend some optimal pump inlet water temperatures for suppression and extinguishing; therefore, it would be enough to complete these installations with a heating element and thus obtain better results with minimal financial effort.

Within the development of a **fire safety drill**, following the conclusions found, technical-organizational measures and recommendations are required.

Taking into account the protective measures adopted in the technical documentation developed and implemented through the execution works, the fire safety requirement of the analyzed building layout is deemed to be met, as it falls within the admissible performance levels provided by the applicable technical regulations.

Method of bibliographic analysis of the current state of research on fire safety of buildings

Using the ACCESS™ program for bibliographic references and keywords

To properly conduct a research, a rigorous assessment of the current state of knowledge in the field is required. This situation requires the design and creation of a procedure for analyzing and organizing bibliographic elements. Thus, a database with 230 bibliographic references (with the structure of Fig. 23) was implemented, used by the author to identify the current state of research in the field and to highlight the real sources of information taken from other specialists.

The study of the bibliography was carried out on three main topics:

- Vertically developed structures. Their fire safety.
- Computer programs for simulating fires and other related specialized situations.
- Using water to extinguish fires. Water mist used in fixed fire extinguishing installations located including in tall buildings.

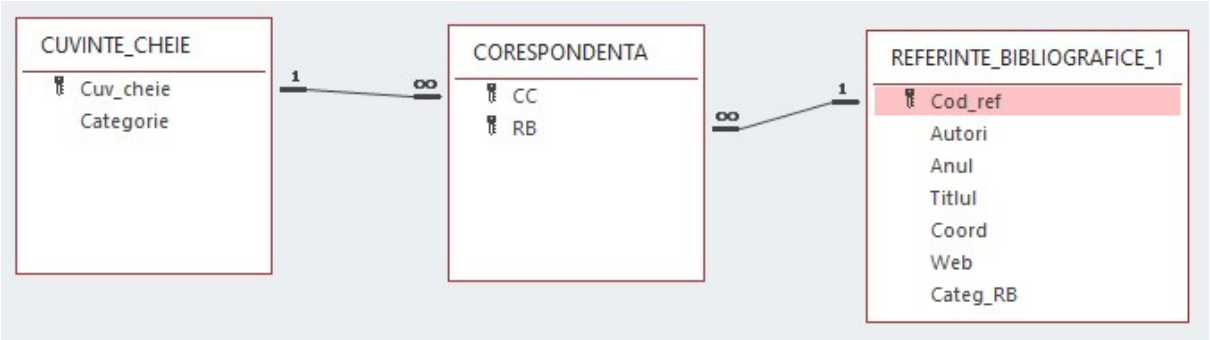

Fig. 23. Database used for bibliography management and classification. Physical data model implemented in Microsoft ®ACCESS™

At each of the paragraphs above, a bibliographic research was carried out that included the following sources: Politehnica University of Bucharest library, University of Bucharest library, Politehnica University of Bucharest virtual library with access to databases and articles on the Internet, Faculty of Firefighters library, the author's personal library.

The bibliography elements were then entered into the Microsoft ® AccessTM program, which is part of the Office package. Sorting can be done according to any of the attributes of the „BIBLIOGRAPHIC_REFERENCES" table, but we consider it particularly useful to sort according to: type (category) of the bibliographic element; year of appearance; number of pages; title; first author's name (surname).

Each bibliographic element corresponds to one or more keywords, and a keyword can be associated with one or more bibliographic references. As can be seen in Fig. 7.8, this *many-to-many* correlation, present through two *one-to-many* correlations, is complied with. The „CORRESPONDENCE" table allows loading of correlations between bibliographic elements and keywords. All correlations can be verified visually by means of query requests.

Example

In order to check all bibliographic elements that have attached (assigned) the general keyword „Sprinklers and drains", it is defined a query request that displays these references (Fig. 24):

Cuvant cheie	Autori	Anul	Titlul
Sprinklere şi drencere	McGrattan, K.B., Hamins, A., Stroup, D.W.	1998	International Fire Sprinkler; Smoke and Heat; Draft Curtain Fire Test Project - Large Scale Experiments and Model Development
Sprinklere şi drencere	Kim, A	2002	Overview of recent progress in fire suppression technology
Sprinklere şi drencere	Grimwood, P.	2003	Operational aspects of high-rise firefighting 2
Sprinklere şi drencere	Carino, N. J. Starnes, M.A. et al	2005	Passive fire protection at WTC
Sprinklere şi drencere	***	2005	Life Safety Laws: Sprinklers in High-Rise Buildings
Sprinklere şi drencere	***	2006	SR EN 12101. Sisteme pentru controlul fumului şi gazelor fierbinţi
Sprinklere şi drencere	***	2007	Ordinul Ministrului Administraţiei şi Internelor nr. 163 din 28 februarie 2007 pentru aprobarea Normelor generale de apărare împotriva incendiilor

Fig. 24. Query for bibliographic references - screenshot Microsoft ®ACCESS™

The database structure also allows obtaining summary data on the collected bibliographic resources: number of resources per classification category; number of resources per classification categories and keywords etc.

A database has been created that aims to store the relevant bibliographic references that characterize the state of knowledge in the field and to allow their finding, classification, grouping.

Chapter 8. Research on fireproofing of wood materials with flame retardants

Fireproofing is part of the group of special protections applied to prevent degradation and collapse caused by the existence of aggressive agents inside and outside the building, for example: ignition sources, biological, chemical, geo-climate factors, pollutants, etc. without neglecting the importance of the contribution of the anthropic factor. [221]

Cercetări experimentale privind ignifugarea

Based on the data in Table 8.2, the mass loss, related to softwood, hardwood and wood derivatives, was graphically represented, shown in Fig. 25.

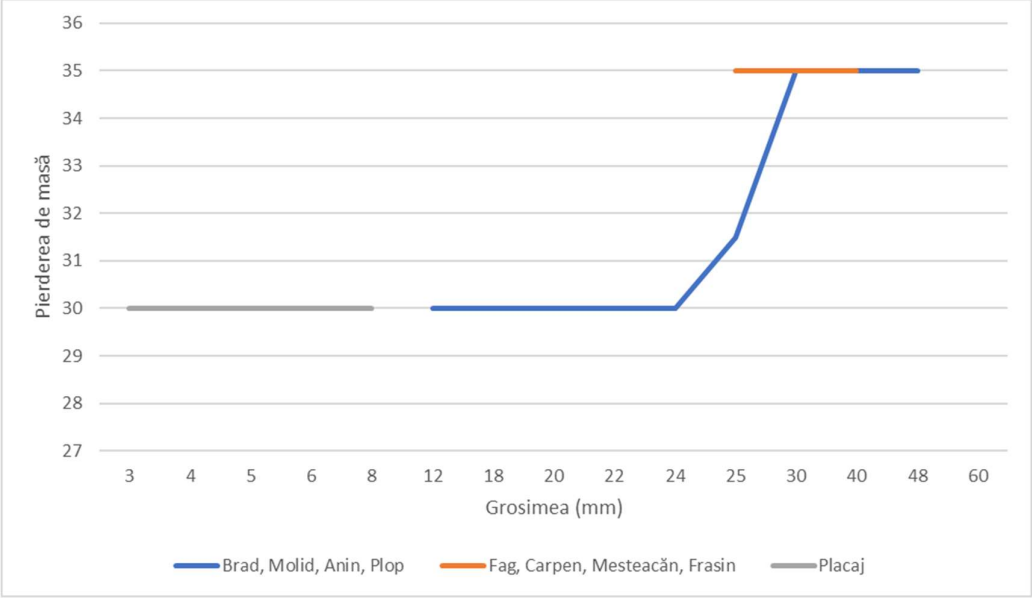

Fig. 25. Mass loss depending on the thickness of the wood material

The calculated mass loss is kept at a constant level relative to different thicknesses of the wood material (hardwood and wood derivatives). For softwood, mass loss registers increasing values relative to different thicknesses of the material.

Experiment performed using the IGNISOL product

The experiment was carried out according to the standard [228].

The first stage in the experience is the configuration of the SBI-type apparatus, located in a test enclosure, of the samples used, as well as of the laboratory conditions.

The next step was to use a multi-function device to fire test the wood. This device includes a software component for automatic data processing of the test operation.

The results of data processing are provided by the software in graphic and table form, simultaneously offered to the user. The results of the experiment, in graphic form, are indicated in Fig. 26. and Fig. 27. Also, the images taken during the experiment are presented in Appendix 5.

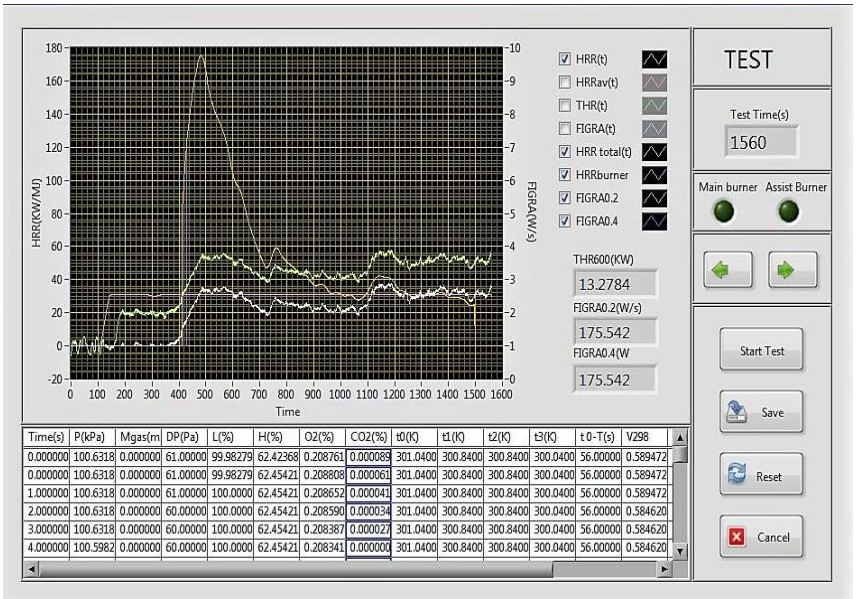

Fig. 26. Results of the experiment, in graphic form, for sample 1

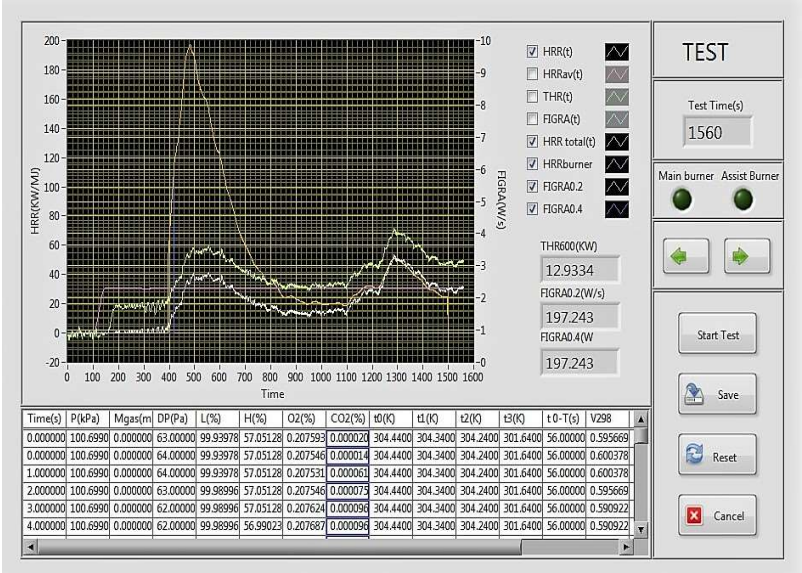

Fig. 27. Results of the experiment, in graphic form, for sample 2

The results of applying the methods for the three samples are shown in Table 8.5 of the thesis.

Experimental research on fireproofing effectiveness

In this sub-chapter we have carried out a synthesis study on values obtained through fire tests in accredited laboratories, for various fireproofing products, before putting the products on the market, with specifications regarding the fire reaction class and wood protection characteristics, conferred by fireproofing.

The experimental values can be found in the Technical Approvals and are presented in Table 8.6 of the thesis. [221]

This subchapter presents a synthesis study that includes the values obtained through fire tests, within accredited laboratories. The results confirm that each fire retardant product based on mass loss falls within the fire reaction class shown in Table 8.6.

Chapter 9. Final conclusions and main contributions

The relevant conclusions regarding the doctoral research and development activity, in relation to its main goal and with the methodological reference elements (see § 4.3.), are the following:

a) The purpose of carrying out the risk assessment is to enable employers to take the necessary measures to protect the workers' safety and health. These measures include: preventing occupational risks, informing and training workers, ensuring the organization and appropriate means for implementing the necessary measures. It is necessary to comply with the two principles of risk assessment: the structuring of the assessment (to ensure that all relevant hazards and risks are approached), respectively the priority identification of the possibility to eliminate such risk. Risk assessment is a detailed check of the workplace to identify those situations that can cause damage, in particular, to workers. A solution to reduce the risk is retrofitting (see § 5.1.).

b) It is very important for the employer to periodically assess the neuropsychological demands that affect the workers, in order to know the real exposure to the specific risk factors of these demands. The application of statistical tools, based on a scientifically based methodology, provides a solid guarantee of the quality of the obtained results. The conducted study revealed that the stress level is above average among the surveyed workers (most of them are subject to a high stress level), the risk of illness is moderate - average, as well as dissatisfaction, stressful conditions and lack of rest (see § § 5.2.).

c) The implementation of the scenario based on PDCA cycle highlighted the resources, including of a legislative nature, which facilitated the implementation of prevention and citizen involvement actions, respectively which were the standardization ground of the relationship between citizens and the emergency service, and as a form of verification the information was transposed based on the transparency principle in order to have an overall picture (see § 6.5.).

d) The experimental study on the use of water mist for fire extinguishing revealed the implications of using water at different temperatures, including the factor that ensures optimal results, and its efficiency was quantified numerically (see § 7.2.).

e) The systematization, the structured organization of bibliographic resources within a database, built according to the specifics of the research, is a useful tool for highlighting the contributions from the specialized literature related to specific aspects. The possibilities of expanding the database structure are only limited by the availability of input data (see § 7.4.).

f) Starting from the factors that affect the wood fire behavior, the importance of carrying out a complete preventive treatment, which raises the level of fire protection of the wood-based material, was highlighted. The qualitative and quantitative characteristics derived from the study underline the need for an analytical approach, by performing similar experiments when changing the fireproofing treatment (see § 8.3.).

g) Technical-organizational measures and recommendations proposed in the development of a fire safety drill.
Taking into account the protective measures adopted through the technical documentation developed and implemented through the execution works, the fire safety requirement of the analyzed building layout is deemed to be met, as it falls within the admissible performance levels provided by the applicable technical regulations.

Personal contributions

I. Practical and applicable contributions

During the period 01.10.2023 - 30.09.2023, within the project „Preparation of PhD students and postdoctoral researchers in order to acquire applied research skills - **SMART**" (MySMIS Code: 153734) I carried out an internship at the Company: **Corporation Situații de Urgență SRL**, with respect the research activity related to the PhD thesis. During the activities, theoretical and practical prerequisites were analyzed for buildings with different destinations in order to apply fire protection measures. The activities carried out included actions regarding:

a) investigation at the scene in case of fires (investigation at the scene);

b) analysis of the place in the event of a fire, the procedure for carrying out the activity and specific rules applied;

c) organizing the intervention for fire extinguishing, limiting and liquidating the effects caused by natural calamities: design, technical-organizational measures;

d) characteristics of fires, organization and conduct of the intervention activity;

e) fire safety, management strategy and scenario development methodology;

f) stages of the process regarding the fireproofing of combustible wood and textile materials used in construction;

g) risk aspects, prevention and protection measures in case of fires generated by certain phenomena;

h) fire extinguishing in buildings with spaces intended for accommodation, rest, recreation and balneotherapy treatment, respectively for fire prevention in hospitals;

i) fire propagation in a building (terminology, statement of principles, limitations, factors, fire performance of construction products, topography, protective measures);

j) fire safety of constructions used in fire risk assessment (performance, definition of terms, determination methods, user requirements, performance criteria: fire reaction, resistance and stability, fire causes, fire stability level, times for evacuation.

II. Main contributions

In the research activity carried out, it is considered that, through this work, a series of personal contributions have been made to raise the knowledge level of the approached subject and to raise the qualitative level of the research by proposing solutions, in order to improve occupational and fire safety. Approaching the theme inserted in the field of research determined the possibility of realizing some new elements personally designed and detailed as follows:

a) Development of a simplified framework model used to assess the risks of occupational injury and illness in a civil building intended for offices, presentation of the methodological framework, respectively a case study, carried out for a workplace.

b) The results recorded in the Job Determination and Expertise Report highlighted the presence of risk factors (identified by applying the statistical method) in the performance of activities carried out by employees during working hours. This aspect constitutes a unique instrument that determined the application of compensation measures, in the form of an increase, in accordance with the applicable legislation and, in this case, the institution's expenses were void.

c) Elaboration of a representative scenario regarding the prevention of fire spreads under environmental protection conditions by using PDCA cycle and observing the applicability of ISO 14001, the importance of strengthening the relationship of citizens with public institutions in order to prevent fire spreads under environmental protection conditions by using PDCA cycle and observing ISO 14001 applicability.

This process expresses the need to approach the environmental management system called ISO 14001 from the perspective of the PDCA cycle (planning, development, check, action), thus developing a practical approach with the role of involving citizens in the process of preventing the fire spread. This approach has the role of creating a common framework where both individuals and competent institutions create a common front and find viable solutions for cooperation in order to prevent emergency situations. In this form, the paper will exemplify the way of planning at an institutional level for fire prevention and awareness of citizens vis-à-vis their impact on the environment, development of a common framework for communication and management of emergency situations, verification of the impact that the plan has in society and action of the parties to improve the plan.

The current context based on climate change, the spread of uncontrolled fires and subsequently man-made fires, positions the presented theme to the attention of the authorities currently. Specifically, at national level, complex missions are carried out every day by firefighting crews that act to extinguish fires, mainly targeting uncontrolled burning (stubs, dry vegetation, waste). From a statistical point of view, in July 2023, in Romania, a number of 3,436 fires were located and liquidated by the intervention teams. In order to outline these statistical data, according to the National Strategy for Prevention of Emergency Situations approved by GD 762/2008, more than 75% is represented by fires in citizens' households. This fact not only presents a perpetual problem that is independent of the institutions' ability to prevent in any way, but this fact emphasizes the need for citizens to be aware of the dangers they expose themselves to, through the fire spread and the risk of spreading and affecting both the citizens and the environment in the long term. In this sense, in order to reduce the number of fires, to reduce the areas affected by fire as well as to stabilize a possible fire that may have an effect on the environment, the process of standardizing the relationship between citizens and public institutions will be pursued, the way of approach and involvement, the results of the process, as well as the gaps that may arise.

d) Carrying out an experimental study on the fireproofing effectiveness of combustible wood materials.

Chapter 8 details aspects related to increasing the fire resistance of combustible wood materials through the chemical protection process known as fireproofing. The combustibility of some materials is due to the chemical composition based on easily flammable organic compounds, which, through prolonged heating or in the presence of an ignition source, form oxides and volatile derivatives with oxygen, in a process with flame emission and toxic combustion gases. Fireproofing is of major importance to ensure a prolonged fire resistance period of construction elements based on combustible materials, being necessary both for the protection of the construction itself and for the protection of material assets and the people inside it. Although fireproofing does not act to fight fires, and even if fireproofed wood catches fire and burns, there are still those beneficial effects due to the fireproofing barrier, quantified in ignition delay times and slowing or stopping of propagation flame, determining the possibility of intervention and rescue in case of fire.

Research on wood fireproofing aims to realistically approach the need to perceive fireproofing as an integrated protection system, among the fire risk assessment factors, for designers, performers and beneficiaries, in the sense of increasing the wood resistance in construction, with properties

improved against aggressive thermal, biological, physical and chemical agents, as the main fire and bio-degradation sources, coming from inside and outside the building.

The contributions of the paper consist in carrying out an experimental study on the fireproofing effectiveness, through a series of laboratory investigations carried out on wood and wood-based products, with various thicknesses, fireproofed with simple fireproofing and full protection products, existing on the market, with notes on the fire reaction class of the wood after fireproofing.

The novelty element of this paper consists in the elaboration of a unitary concept of approach to the wood protection in constructions through fireproofing, formulating the necessity and obligation of fireproofing in an integrated risk prevention system, both to reduce the main fire risk and the additional risks caused by the use of wood, in which we used the principle of analyzing the conditions that favor causes and effects, taking into account the knowledge of wood's classes of use, classes of durability, classes of reactions to fire, and, in general, all the requirements and criteria regarding the realization of maximum functionality with a minimum risk coefficient, with the aim of significantly increasing the duration of exploitation, safety and comfort, in order to ensure the fundamental requirements applicable to constructions and to increase quality, as the main goal.

e) Setting up a bibliographic analysis method regarding the research state related to the topic of the PhD thesis, described in subchapter 7.4 and carried out on 3 main elements: Building structures, their fire Safety, fire simulation computer programs and other related specialized situations.

f) Using a numerical modeling program to improve fire safety (experimental study on the method of using hot water to create water mist).

This PhD thesis, through the studied issues, the particularities of the research methods applied, determined by the purpose of the research and the results obtained, highlights the assessment of exposure to occupational safety and fire risks. Both theoretical and practical research has been carried out. The research results were disseminated to the scientific and professional community, the evidence in this regard being the mentioned publications.

The scientific importance of this PhD thesis is determined by the contributions made by the author to the improvement of the assessment and assurance methods of occupational and fire safety and by the solutions proposed following the interpretation of the results of the risk assessments and the experiments carried out.

The practical importance of this PhD thesis is determined by the applicability, in the organizations' activity, of the assessment methods, as configured by the author, as well as measures to improve occupational and fire safety.

I believe that the PhD thesis is useful for:

a) Students and teaching staff, by making available some assessment methods of occupational and fire safety risks and some experiments, which can be adapted and capitalized according to the theme and contents of the taught/ studied subjects.

b) Researchers interested in topics similar to those approached by the author, who can use the methods and results in their own research;

c) Organizations from the economic-social environment, in any field of activity;

d) Practitioners in the field of OSH and fire safety, for whom I believe that the application of the methods presented in the thesis will bring added value to their professional activities.

Dissemination of research results

Communication and dissemination were carried out as follows:

- **11 Articles published** during the research activity, listed in the thesis.
- **Participation in conferences**/ events organized in research field:

a) National Seminar on Occupational Safety and Health, Poiana Brașov – March 18–19, 2022.

b) The 8th edition of Pria Conference „Fire Safety in Buildings", Bucharest – April 8, 2022.

c) The 14th edition of ARTS National Conference (Fire fall – no fire at all) – Bucharest - September 27, 2022.

d) OHS National Conference, Bucharest - November 14, 2022.

e) OHS National Seminar, edition 029, Poiana Brașov, March 17-18, 2023.

f) IBIMA International Conference (International Business Information Management Association), Granada, Spain, May 30–31, 2022 – online.

g) OHS National Conference, Bucharest, June 14, 2023.

Perspectives

The field of the PhD thesis will remain relevant in the future, and technical progress and development of science will bring both challenges and answers for practitioners, researchers and academic environment. I intend to develop the research described in this PhD thesis, by extending the methods and experiments related to risk assessment, wood fireproofing, use of water mist for fire extinguishing and exploitation of the PDCA advantages in other types of activity within organizations and in other research works.

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