

**MINISTRY OF EDUCATION
IOSUD UNIVERSITY OF PETROȘANI
DOCTORAL SCHOOL
DOCTORAL FIELD: INDUSTRIAL ENGINEERING**



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DOCTORAL THESIS

-SUMMARY -

**Scientific supervisor
Professor, Ph. D. Habil. Eng. MORARU ROLAND IOSIF**

- 2024-

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***EMPIRICAL RESEARCH ON THE ASSESSMENT OF SAFETY
CULTURE IN THE CONSTRUCTION INDUSTRY***

**Scientific supervisor
Professor, Ph. D. Habil. Eng. MORARU ROLAND IOSIF**

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**PETROȘANI
- 2024 -**

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1. KEYWORDS

For a better understanding of the following exposition, it is necessary to enumerate some notions specific to the field addressed: *safety culture, construction industry, facilitators, barriers, security performance, DELPHI technique, structured interviews, perception questionnaire.*

2. THE IMPORTANCE, CURRENTNESS AND PURPOSE OF DOCTORAL RESEARCH

This doctoral research work represents the "final version, but subject to numerous and constructive improvements" of a constant effort of analysis/synthesis/documentary study/theoretical and empirical/experimental research, stemming from the author's constant concern and dedication to the identification of methods/techniques /applicable solutions in the national socio-economic context for increasing the safety levels of workers who carry out their activity in major industrial branches of the national economy. Conceived, designed and operationalized starting primarily from the experience generated by the knowledge and practical skills of the author, intertwined with a solid level of knowledge of the subject addressed, as a result of "targeted" bibliographic and bibliometric research, through an extensive documentary study carried out from the specialized literature applicable to the field, of systematic and coherent studies of a theoretical/applicative nature carried out during the 3 years of doctoral internship and 2 years of master's studies, the research aimed at an extremely ambitious objective, which can be considered as a first achievement on national level.

The actuality, necessity and importance of the theme result from the fact that unwanted events occurring at the workplace constitute a significant global problem, and, in particular, the construction industry is over-represented in the statistics on workplace losses due to work accidents, occupational diseases, as well as the implicit costs associated with non-safety.

Statistics compiled at the level of the European Union place our country in fifth place in the number of fatal accidents at work with 3 fatal accidents per 100,000 employees. The most fatal accidents at work were recorded in: Cyprus 4.45 deaths caused by accidents at work per 100,000 persons employed, followed by Bulgaria with 3.68 deaths, Italy with 3.39 deaths and Lithuania with 3.17 deaths per 100,000 employees, while countries such as the Netherlands, Sweden, Germany or Greece have less than 1 fatal accident per 100,000 workers. The same source also states that 67.8% of fatal accidents during working hours and 48.5% of serious accidents in the EU occurred in economic sectors such as: construction, industry, transport and storage, agriculture, forestry and fishing. 22.15% of fatal accidents at work in the EU in 2019 occurred in the construction sector, while the industrial sector held a 16.5% share in the ranking. Also, the average incidence rate for serious accidents at work for men is 4.9 higher than that recorded for women. One explanation for this difference is the nature of the work performed.

The main objective of the PhD thesis is to evaluate the safety culture in Romanian construction companies, with the aim of understanding how theory and practice can be integrated to improve the safety culture and related economic results in the construction industry. The research undertaken comprises systematic studies of safety culture in the construction industry, the factors that influence the relationship between safety culture and behavior investigated and examines differences in the perception of safety culture across the organization.

I set out to answer some essential questions to deepen the topic: Is occupational health and safety important? For whom and in what way? How does it present itself within organizations and, respectively, within the specific context of the construction industry? What are the key pieces in the equation and how can we best apply them to continuously improve the work environment in a systematic and unified way? By summing up the answers to this series of questions, I appreciate that I have managed to set a favorable framework for the in-depth understanding of all the implications of the OSH culture in the construction industry. This thesis aims to review research in the field of OSH culture, to separate and classify different approaches and theories. Special

attention is given to the ideal theoretical model to be used in practice, because, regardless of its level of simplicity, it is the basis of any research undertaken.

Research at the level of culture in general and organizational culture specifically, is an area of interest for industrial engineering, risk management, sociology, and work/organizational psychology. That is precisely why, in the doctoral thesis, the emphasis was placed on the practical application of the concepts that are developed by these traditional fields. An important premise from which we started, associated with these practices, is that a set of organizational cultures can only be described with a limited number of parameters. Such parameters are defined on a case-by-case basis and will have associated values following the questionnaire-based study conducted within the organization. These are aimed at describing the actual situation, the diagnosis carried out based on the interpretation of the results and – in the last resort – the intervention/ continuous improvement.

3. OBJECTIVES OF THE DOCTORAL THESIS

The aim of the PhD thesis is to explore the safety culture in construction companies in the country, with the aim of understanding how the theory and practice of the safety culture can be integrated to improve the results regarding safety and health at work, as well as economic performances general within the construction industry, taking into account as much as possible and within the limits of the available data the essential aspects related to safety and health at work: the causes of accidents, the costs of accidents, stress, the regulations of safety and health at work, the factors of specific worker health and safety climate. At the same time, through the research activity specific to this endeavor, it is also desired to develop sets of tools and guidelines for improving safety performance.

Table 1 indicates how each specific research objective addresses the overall research objectives.

The general objectives of the doctoral research program aimed:

1. Obtaining a realistic and at the same time scientific perspective on the way in which the safety culture is understood in theory, compared to the way in which it is applied in practice;
2. Exploring the differences between the modes of perception of the safety culture throughout the organization by various categories of personnel;
3. Examining the relationship between safety culture and security behavior, and investigating additional factors influencing this relationship;
4. Translating the research results into applicable recommendations for improving the occupational health and safety culture and related results within the construction industry in the country.

These fixed objectives are to be achieved through the empirical case studies carried out, each of them addressing one or more of the previously established and mentioned objectives, being also correlated with specific objectives according to Table 1.

The *specific objectives* of the research program are:

- ⇒ *Specific research objective 1* - analysis of how the safety culture is understood and described by managers in the organization;
- ⇒ *Specific research objective 2* – analysis of key enablers and barriers to safety culture;
- ⇒ *Specific research objective 3* – determination of intra-organizational differences between the perception of safety culture and security behavior and their analysis;
- ⇒ *Specific research objective 4*: - determination and description of additional factors that influence safety behavior and related results;
- ⇒ *Specific research objective 5*: - establishing concrete and viable measures to encourage the development of the desired safety behaviors and how to implement them.

Table 1. The general objectives and their correlation with the specific objectives of the research

General research objectives		Specific research objectives				
		OS 1	OS 2	OS 3	OS 4	OS 5
1	Obtaining a realistic and at the same time scientific perspective on how safety culture is understood in theory, versus how it is applied in practice	X	X			
2	Exploring differences in perceptions of safety culture across the organization by various categories of staff			X		
3	Examining the relationship between security culture and safety behavior, and investigating additional factors that influence this relationship				X	X
4	Translating the research results into applicable recommendations for improving the occupational health and safety culture and related results within the construction industry in the country				X	X

4. STRUCTURE AND BRIEF DESCRIPTION OF THE THESIS CONTENT

From a structural point of view, the thesis contains the lists of figures (in number of 63 graphic representations), tables (in number of 111) and acronyms used, an introductory chapter with a specific theme and 6 content chapters, to which is added a final chapter of final conclusions and personal contributions, totaling a number of 310 pages, of which 10 pages represent the "Bibliography", which has a number of 285 bibliographic references. The detailed explanation of the results obtained in the case studies is included in a number of 5 annexes, spread over 74 pages. Also included as an appendix is the exhaustive list of articles/scientific papers published/disseminated during the doctoral internship.

In the *first chapter*, called "**Objectives and the conceptual - methodological framework of the research**", the conceptual and methodological benchmarks of the systemic approach to safety and health at work are presented synthetically, in correlation with the elements justifying the opportunity, importance and topicality of the research. Several safety culture models have been proposed, and the most relevant of them have been discussed in chapter 2 as part of the literature review. On this basis, I specified the specific objectives and structured the logical scheme regarding the progress of the phases/stages of the research, a representation that allows easy visualization and understanding of the concept and the evolutionary structure of the scientific approach undertaken, in direct correlation with the objectives proposed at the beginning of the internship.

Chapter 2, entitled "**Analysis of the current state of knowledge in the field of safety culture and health at work**", presents a critical synthesis regarding the sources, causal models and objectives of research related to safety culture and climate. Special attention is given to the presentation of a theoretical model in a single approach, because it is believed that such a model, no matter how simple, should be the beginning of any scientific approach. Understanding the contributions of the most productive and influential researchers and their impact on the development of the theory and practice of safety climate research represented the foundation on which I developed the research methodology presented in chapter 4 of the thesis.

Starting from this synthesis, *chapter 3*, entitled "**Analysis of the evolutions and statistics of work accidents in the construction industry**" proposed to set the framework of the research through the descriptive analysis of the nature and particularities of the construction industry on a national and European level, of the statistics of work accidents occurring in the last 10 years in this field of the national economy. It is concluded that a simple approach by complying with legal requirements in the field of construction does not fully cover the needs of organizing activities specific to the safety and health of workers.

In *chapter 4* called "**Development of safety culture evaluation tools in the construction industry**" the strategy and methodological framework of the applied research development is presented. Safety culture is investigated as a dependent variable, where descriptions and content of

culture are investigated alongside facilitators and barriers that enable or oppose safety culture, respectively. As an original contribution to the specialized literature and knowledge in the field at the national level, the facilitators and obstacles to the development and maintenance of the safety culture are explored from the perspective of both safety managers and construction workers. For this purpose, specific instruments were developed to investigate the safety culture and climate in the construction industry.

Chapter 5 entitled "*Empirical research on the perception of safety culture in the construction industry*" details the analysis of the results obtained in the first case study that addresses the specific factors of the perception of safety culture in relation to four target groups: managers/engineers, OSH managers, supervisors/foremen and workers. Three questionnaires were used as tools, an interview to which people from the first three target groups answered and a simplified questionnaire each for the managerial level made up of the first two target groups mentioned previously and for the execution level made up of people from the target groups represented by supervisors/foremen and workers.

The results from the second case study of the doctoral research are contained in **Chapter 6** whose title "*Exploratory research of the determinants of safety performance in the investigated organizations*" refers directly to the topic addressed, namely safety performance as an exponent of the safety culture. The tools used were, as in the previous case, an interview questionnaire answered by the same people as in case study number 1 and a simplified questionnaire applied to all participating people. The differences of opinion in this study were quite evident both between the respondents within the companies compared to those within the company and in the case of the respondents from the managerial level compared to those from the execution level, the general perception being that within the companies and at the execution level safety performance is often understood and limited to being viewed as mere compliance with specific legislation.

The conclusions, proposals, own contributions and future research directions are summarized in the last chapter of the thesis, highlighting the most important aspects identified following the stages of the research. In the last part of the chapter, I highlighted a series of main research directions that could be addressed in the future and that could bring more understanding and knowledge regarding the factors that influence organizational performance in terms of safety and occupational health culture.

5. PERSONAL CONTRIBUTIONS

The conceptual, methodological and experimental/applicative researches synthesized in this doctoral thesis have allowed the development of work/research tools and solutions potentially applicable in industry, with a certain originality, capable of supporting managers, OSH managers, supervisors and workers in optimizing safety results associated with routine and non-routine activities carried out in the activities of national organizations in the field.

Consequently, I can summarize the main original contributions that resulted from completing the doctoral internship and the elaboration of this thesis as follows:

A. From the perspective of bibliographic research and analysis of the current state of the topic addressed:

A.1. The main objective of the PhD thesis is to evaluate the technical, organizational and other options that can be exploited in the future in industrial companies in the field of constructions in Romania, with the aim of understanding how theory and practice can be integrated to maximize the level of occupational safety, led primarily to the realization of a *documentary study from the specialized literature*.

A.2. The *bibliographic research* carried out confirmed that in the last three decades, empirical research on safety climate and culture has developed considerably, but unfortunately the theory has

not gone through a similar progress. Between 1980 and 2018, approximately 494 studies on safety climate or culture were prepared by 1,373 authors and co-authors, approximately 25% of which were published as of 2016. The period 2002–2010 was witness a new growth of academic interest in the safety climate. The period 2011–2018 has seen a constant increase in the number of published articles, in 2017 alone being approximately 61, which is almost equal to the total number of articles published in the period 1980–2007 (28 years since the emergence of the concept). Just to put things into perspective, from 1980 to 2018, the number of publications grew at an annual growth rate of nearly 11%. We have highlighted the fact that if, on a national level, the scientific approach to the topic of safety culture is - at best - sporadic and unsystematic, most of the research on safety culture has been carried out by authors who come from or are affiliated with organizations from USA, UK, Israel, China and Norway. Most of the research has also been published in journals originating from Western countries that are culturally homogenous.

A.3. I have proven that most researchers have defined either safety climate or safety culture in their publications, as well as the objective of their exploration. Emphasis on either perceptions, beliefs, or attitudes, as well as one or another of the aggregates (eg, "molar," "group," "summary") suggests a self-administered questionnaire research paradigm.

A.4. I have identified with certainty that the missing element in many publications on safety culture is an explicit theoretical model outlining how safety culture is considered to be embedded in the overall practices and system structure of an organization; In general, we highlighted two types of models: (1) *normative or prescriptive models*, which aim to describe and specify the safety climate or culture itself; and (2) *descriptive or empirical models*, which attempt to summarize findings from one or more organizations under study.

A.5. A significant contribution derives from the identification of the fact that safety management researchers have also reflected on security culture, the concept of safety culture stimulating the interest of researchers from many related fields in recent decades, such as organizational psychology and social systems security engineering -complex techniques.

A.6. It has been proven that organizations with an *optimal level of safety culture* have employees with positive attitudinal patterns towards security practice. These organizations have mechanisms for providing security information, measuring security performance and organizing people to learn how to work safely .

A.7. Certainly, we have made it clear that most research efforts to date have focused on empirical issues surrounding security climate although it is possible to identify the theoretical development of the concepts within the security culture literature. Also, the terms security culture and security climate have been used interchangeably in the literature.

A.8. The bibliographic sources accessed and studied confirmed that, in the context of organizational behavior, motivation is often mentioned as a factor that has a critical influence on performance. A number of studies have investigated motivation in a security context. Safety motivation is a key construct, suggesting that it is one of the mediating factors between security culture and security behavior components. Subsequent research has also tested safety motivation as mediating support for an indirect climate–behavior relationship.

B. From the perspective of establishing the research objectives of the doctoral thesis:

B.1. I have identified, based on the analyzes carried out and the case studies designed - and subsequently materialized - the *current challenges* in the field of safety and health at work relevant

to the specific aspects associated with the occupational risks specific to the construction industry and we have consequently defined the general objective and the specific research objectives.

B.2. I specified the specific objectives and clearly established the action vectors in order to achieve the intermediate objectives circumscribed by the thesis theme, based on carefully selected criteria.

B.3. I answered some essential questions to deepen the topic: *Is health and safety at work important? For whom and in what way? How does it present itself within organizations and, respectively, within the specific context of the construction industry? What are the key pieces in the equation and how can we best apply them to continuously improve the work environment in a systematic and unified way?* By summing up the answers to this series of questions, I appreciate that I have managed to set a favorable framework for the in-depth understanding of all the implications of the OSH culture in the construction industry. The present thesis also aimed to review the research in the field of OSH culture, to separate and classify different approaches and theories. Special attention was paid to the optimal theoretical model to use in practice, because, regardless of its level of simplicity, it is the basis of any research undertaken.

B.4. The *main objective* of the PhD thesis was to evaluate the safety culture in Romanian construction companies, with the aim of understanding how theory and practice can be integrated to improve the safety culture and related economic results in the construction industry. The research undertaken comprises systematic studies of safety culture in the construction industry, the factors that influence the relationship between safety culture and behavior investigated and examines differences in the perception of safety culture across the organization. In a global way, the obtained results will generate important perspectives on how the security culture can be theoretically systematized, compared to how it is applied in practice, and lead to a series of recommendations that can guide the development of future safety culture interventions in the construction industry, with possibilities of expansion/generalization in other industrial branches.

B.5. The context of the research was represented by the *various challenges that have a direct impact on the organization of specific OSH activities and implicitly on the safety culture and climate*. These aspects were followed throughout the research and analyzed accordingly.

C. From the point of view of theoretical research, both conceptual and methodological:

C.1. I paid special attention to presenting a theoretical model in one approach, because I believed that *such a model, no matter how simple, should be the beginning of any scientific approach*. A solid theoretical framework, including safety culture, climate, performance outcomes, and predictive factors that contribute to complex internal relationships also guides the research approach. This theoretical framework was balanced by including industry-specific views on culture, as perceived and expressed by employees and managers of the investigated organizations..

C.2. I have identified an important assumption associated with current practices in the field, related to the fact that *a large group of organizational cultures can be described with a limited number of dimensions*. Such dimensions are typically sought through organization-wide questionnaire-based surveys with the ultimate goal of description or diagnosis and possibly intervention. Other approaches and viewpoints were also explored. We have analyzed the various definitions formulated for safety climate and safety culture, clearly documenting the fact that unfortunately few authors have proposed a theoretical model that can be tested.

C.3. The *logic of the research* was based on a basic theoretical framework derived from the documentary study carried out from the specialized literature, regarding the undesirable events occurring at the workplaces in the construction industry and approaches based on the safety culture

at the workplace. The related theoretical models of security culture were synthesized, systematized and structured, along with the relationship between safety culture and the safety performance of economic organizations.

C.4. We highlighted that while the translatability of safety culture tools across the industry is common but debatable, the unique nature of risks in the construction industry requires a tailored and targeted approach to safety management and safety culture programs, as carried out worldwide in the nuclear, oil and natural gas industry and in other complex socio-technical systems.

C.5. Proposal for defining the safety culture:

Safety culture: state of fact felt at the organizational and personal level through the prism of existing beliefs, values, perceptions and norms in order to develop attitudes and behaviors related to security that ultimately lead to the well-being of everyone and the organization.

C.6. As a result of the research and as a tool that can be used later in other applied studies, I propose the customization and application of the original developed methodology, by expanding its use in other industrial branches, based on questionnaires with a larger number of both open and closed questions. For this purpose, I propose a simplified framework questionnaire that aims to analyze the perception of safety culture and safety performance at the level of organizations and that includes items related to the themes, aspects and factors summarized in table 7.1 within the thesis.

D. From the point of view of practical and applied contributions:

D.1. I made a conclusive description of the nature and particularities of the construction industry (Chapter 3, § 3.1), in correlation with the statistics of work accidents (§ 3.2.1 and 3.2.2), and the evolution of legislative and managerial measures specific to this field (§ 3.2. 3 and 3.2.4).

D.2. I carried out an in-depth and relevant research on the evolution of statistical indicators regarding work accidents in the construction industry in Romania in the period 2014-2023, as well as the evolution of statistical indicators regarding collective work accidents in the European Union in the period 2013-2021, in this approach placing great emphasis on consulting certain statistical databases in the field (Chapter 3, § 3.2).

D.3. The conclusions of the applied research quickly highlight ***the contribution in the field of the diagnosis of the safety culture in the construction industry***, they being explained in a precise and systematic manner. The innovative elements that prove full involvement in this endeavor are those related to the definition of the security culture through the prism of associating the knowledge from the specialized literature with the results and experiences specific to the context created by the participating organizations, as well as the outline of a process for improving the safety culture safety starting from the PDCA concept - Deming's Cycle. Also, the entire research design and development approach (concept, way of structuring, sampling of participating organizations and socio-professional categories, developed tools and their way of putting into practice, the particularities of the engineering analysis of the results obtained, etc.) can be appreciated as a significant scientific contribution in the approach dedicated to minimizing the occupational risks associated with a major industrial field. I have highlighted a series of main research directions that could be addressed in the future and that could bring more understanding and knowledge regarding the factors that influence organizational performance in terms of occupational safety and health culture.

D.4. In analyzing the relationship between safety culture and safety behavior, a number of additional factors were investigated in terms of the extent and nature of their influence on the traditional relationship.

D.5. I carried out, in the time interval, August 2023-June 2024, *two case studies* that explored the organizational safety culture and clarified the experience of the safety culture at different levels of some construction companies operating in the country. The two studies followed a sequential process, with the mention that the results of the case studies were corroborated with the scientific documentation and that obtained from the organizations under analysis.

D.6. I developed the *logical scheme of the sequential development of the research stages*, the survey questionnaires regarding the perception of the safety culture, the centralizing tables of the results, we performed the analysis and interpretation of the data obtained by applying the interview questionnaires. The raw data obtained from the questionnaires were processed using data analysis programs such as SPSS and EXCEL. The opportunity and availability of using these tools was necessary due to the volume and complexity of the data obtained. For a quantitative analysis as conclusive as possible in relation to the answers received from the respondents, the mean, median, standard deviation and indices of asymmetry and skewness were used as descriptive statistical parameters..

D.7. I applied the *technique of content analysis* to examine the comments written in the last section of the questionnaires. Based on this method, meaning units that have the same central meaning in the comment section were organized from most common to least common. Content analysis enabled replicable and valid inferences to be made by defining and coding textual materials. Through a systematic examination of data such as documents, oral communication and graphics, qualitative data were translated into quantitative data.

D.8. The application of the tools was carried out, in both case studies, depending on the availability of people from the target groups, in the following variants:

- listed and delivered personally by the author of the thesis or a predetermined person at the level of the organization;
- online by e-mail, the relationship being made by the staff of the target groups with the author of the thesis or a pre-established person at the level of the organization.

The data were collected both in listed format and in online format, being later used both independently and in conjunction between the two case studies, in order to obtain the most conclusive results for achieving the objectives of the doctoral thesis.

D.9. In the *first case study* I addressed the factors specific to the perception of safety culture in relation to four target groups: *managers/engineers, OSH managers, supervisors/foremen and workers*. Three questionnaires were used as tools, an interview to which people from the first three target groups answered and a simplified questionnaire each for the managerial level made up of the first two target groups mentioned previously and for the execution level made up of people from the target groups represented by supervisors/foremen and workers. This case study involved the use of both semi-structured interview technique and open-ended questionnaires for all categories of staff at all organizational levels. Through the simplified questionnaires we identified the factors of the safety culture, the barriers to the safety culture and the facilitators of its improvement. The study provided a foundation for the research program by gaining an in-depth understanding of how safety culture was perceived and understood by those in the construction organizations under investigation.

D.10. The obtained results were further used to substantiate and update the tools used in the second case study, in which I resorted to *a safety culture-behavior model to measure the perception* of how safety performance was evaluated within the organization, the way workers were motivated to behave in safe conditions and a series of safe behavior measures highlighted both at the level of workers and at the level of organizational management factors and workplaces.

D.11. In order to evaluate the supervisors' attitude related to OSH, six relevant aspects were established in this regard, regarding the attitude towards the opinions of subordinates, attention to the needs of subordinates, understanding the importance of employees' interests, appreciation of the superior level of task performance, recognition of the improvement of the quality of the work performed and the way of reaction to the work results of the employees. The analysis of these factors by the supervisors proved at the same time an evaluation of their own attitude towards the issues presented, but following the face-to-face discussions it emerged that they also took into account the attitude of their direct bosses as a weight in their answers, where it was the case.

D.12. In the *second case study*, I assessed from the perspective of driving factors at both organizational and workplace levels, how and why staff are motivated to be safe and what could affect both positively how negative this fact is and how safety behaviors can be encouraged in workplaces. During the interviews, held between November 2023 and January 2024, after applying the tools used in case study number 1, the people from the target groups made up of managers/engineers of the companies and the company, the people from the OSH services and the supervisors answered the questions about to the aspects considered essential in the analysis of safety performance at the level of organizations included in the related interview questionnaire, described in chapter 4. The second part of this study, by means of a simplified questionnaire answered by the participants from all four target groups, being represented both organizational levels, management and execution, followed the analysis of the level of safety performance through the level of development of some factors considered also relevant, such as: *alignment and integration of safety as a value, training at all levels, improvement of leadership safety in construction sites, management commitment, worker empowerment and involvement, ensuring accountability at all levels, improving communication.*

D.13. To complete the description of safety performance factors at the level of organizations participating in the doctoral study, we developed the aspects related to *the alignment and integration of safety as a value, training at all levels, improving safety leadership in construction sites, management commitment, empowerment and involvement of workers, ensuring accountability at all levels and improving communication* through the answers given by all participants to the simplified questionnaire drawn up for this purpose. We thus obtained a more complete view of this aspect from the people within the four target groups established at the beginning of the doctoral research who expressed their agreement or disagreement with the situations described by each item answering with marks between 1 and 5, on a scale 5-point Likert. The results were centralized in Annex 5 and analyzed from a statistical point of view, relative to the same 4 criteria mentioned in Chapter 6, also using for this the same statistical indicators such as: the average of the answers, the median, the index of asymmetry - skewness and the index of vaulting – kurtosis, theoretically detailed in Chapter 4 .

D.14. Based on the PDCA concept, I propose a process for the implementation and continuous improvement of the safety culture in an industrial organization whose operational structure is represented in the thesis.

D. 15. I propose the analysis of the opportunity to include the field of OSH in the mandatory curricula of some study programs starting at least from the technological high school level and undergraduate and master's university studies, in the engineering fields (especially those of production, mechanics, energy, mining, oil-gas and related to them) and management considering the fact that future managers or engineers/specialists will have responsibilities in the field of OSH established by specific national legislation.

E. From the point of view of disseminating the results:

During the doctoral research work and the preliminary documentation carried out, I published as first author and co-author a number of 15 articles and scientific papers, as follows:

- 1 article published in the indexed journal Web of Science - WoS (ISI);
- 2 scientific papers published in the volumes of scientific events indexed Web of Science- WoS (ISI) Proceedings;
- 5 articles published in specialist journals indexed by BDI;
- 3 scientific works published in the volumes of International Conferences indexed by BDI;
- 2 scientific works published in the volumes of international conferences with ISBN;
- 1 book chapter, in published volume with ISBN.

6. Limits of the study and future research perspectives

6.1. Limits of research

Although the tools applied, the analysis of the obtained results and the interpretations within the doctoral thesis were carried out on the basis of a rigorous interpretation, it is natural to admit that due to objectively restricted resources and time constraints, the research process itself was inherently affected by limitations in terms of regarding the research design and - in particular - the scope of the study. The main limits of the research can be summarized - in my opinion - in the following manner:

LC.1. Approaching for the first time on a national level the research topic proposed in the doctoral thesis, correlated with the objective of making a diagnosis of the safety culture in organizations in the construction industry, it is natural ***to aggregate individual data at the level of an organizational group or unit to ask whether the combined data actually correspond*** to an existing attitude object at that level. Moreover, as previously discussed, at each particular level of aggregation the problem of commonality arises - a certain amount of homogeneity of opinion is necessary in order to be able to talk about common attitudes or assumptions.

LC.2. When working with questionnaires, the researcher faces several phenomena such as ambiguity, poly-interpretability, lack of clarity of long sentences, etc., which threatens the validity of the results. Obviously, providing answers to questions that target the entire organization requires a strong cognitive effort. Respondents are expected to replace abstract references with their personal substitutions. I conclude that ***this issue has so far not received the attention it deserves***. Further research is needed to shed more light on this problem, the severity of its consequences and to identify possible solutions.

LC.3. An analysis involving the following personnel categories was carried out within the research study: management, OSH management, supervisors/foremen and workers, in order to evaluate the differences in perception due to the difference between positions/posts within the hierarchy of the investigated companies. The sample size of the sub-groups in the survey results was quite different, which in turn could affect the validity of the parametric tests adopted to test the statistical significance of the survey results. To ensure a compatible number of data from different sub-groups available, sampling could be planned in a more strategic way. For example, the number of questionnaires for target respondents in each sub-group could be predetermined before the survey and ***the sample size for each sub-group could be increased to reduce sampling error***.

LC.4. Empirical research has shown clear signs of association between the degree of participation in OSH activities and the degree of perception of safety culture. ***This topic may be useful/profitable for verification in future studies***. If the relationship proves to be positive, it will mean that organizations in the construction industry could increase employees' awareness of safety culture by promoting their participation in OSH activities.

LC.5. Experimental research measured/assessed employee perception *only at one point in time*. Since the perception can change over time, due to the changes regarding the situations in the field of OSH, it is desirable that the methodological tools/questionnaires developed are applied with a certain periodicity to monitor the evolution of the perceptions regarding the security culture, thus increasing the significance of the results obtained.

6.2. Future research directions

From the perspective of deepening knowledge in the addressed research field, personal contributions, corroborated with the limits highlighted above, allow me to formulate the following potential research directions aimed at deepening/developing future studies in this area of knowledge:

DC.1. The employees' opinions and perception of the OSH performance of the investigated organizations were measured in the survey by means of the questionnaire, using a rating scale in relation to the specific elements or aspects of OSH. As mentioned in the literature review, the *reliability of the questionnaire and the rating scale could be improved by an external validation* through a larger scale pilot testing.

DC.2. An interesting perspective can result from conducting studies of *a larger scale in terms of the number of participating organizations*, directed separately both at companies with a maximum of 100-150 employees and only at large companies, in which the analysis criteria are age, level of education and construction experience to do a separate analysis for the two forms of organization and then compare the results, which are much more conclusive for all four target groups: managers, OSH managers, supervisors and workers. In a company study, a comparison of the results achieved in different workplaces could also be developed, here the local leadership style could be correlated with group cohesion and OSH results.

DC.3. The explicit approach of a study on the *impact of digitization/artificial intelligence on safety culture* in the construction industry, from the perspective that it should not completely replace human interactions at the workplace and face-to-face training, as for example in the case of replacing the practical component of periodic training with visual training/awareness materials.

DC.4. To illustrate the *potential of the methodological tools developed in the PhD thesis as investigative tools*, it is desirable to deepen the relationship between employee participation in OSH activities and the evaluation of OSH perception. If such a relationship could be established, it could imply that the perception rating could be changed by promoting participation in OSH activities.

DC.5. Considering the sharp increase in the share of migrant workers in the construction industry, future research should be directed towards a study of foreign workers, through the prism of cultural differences related to regions and countries of origin. The validation of safety culture as a robust indicator of the results of organizations in the construction industry will need to be completed, further, by testing its relationships with antecedents, moderators and mediators, as well as with other organizational "constructs".

DC.6. The exploration of safety culture, as it manifests in industrial organizations, and the empirical investigation of the relationship between safety culture and safety performance can be focused on identifying mediating factors that can be the focus of future interventions integrated into a vision global optimization of safety, to coordinate prevention and intervention efforts in a targeted and efficient manner, applicable in other fields of industrial activity.

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