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SUMMARY OF Ph.D. THESIS

RESEARCH ON MINIMIZING OCCUPATIONAL ELECTRICAL RISKS

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CHAPTER 5: EXPERIMENTAL RESEARCH ON THE WORKERS′ PERCEPTION OF OSHMS PERFORMANCE WITHIN AN ELECTRICAL ORGANIZATION

1. Research Topic. Timeliness, Necessity, Importance

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The evolution of the statistical indicators regarding the collective work accidents produced in Romania in the last two decades according to the records of the National Institute of Statistics, section 35 - Production and supply of electricity at national level, indicates that there is a decrease in the number of accidents. However, the number of accidents caused by electrical risks continues to remain unacceptably high, with all the associated human, economic and social consequences, which highlights the **importance of the present research** topic.

Existing, applied and validated approaches regarding occupational safety and health management focus on management functions, national and international guidelines, quality standards and principles, with a view to define, describe and ensure the conditions for the implementation of occupational safety and health management systems. These approaches may be a necessary and useful step in the synergetic approach to effectively manage the workers safety and health*;* but these may not be comprehensive enough to properly address all the complex aspects associated with the management of occupational risks of an electrical nature in the complex context of current challenges arising from major changes in the dynamic reality of emerging work environments. **Increasingly topical**, it is necessary to identify, develop and implement a new pragmatic approach, realistic and adapted to the conditions, but at the same time systemic of OSH management, with applicability in the area of electrical risks.

The need for such an approach to electrical risks can facilitate the development of a systemic model of occupational safety and health management in the context of attempting to interpret events as a whole and ″to see″ them, including technical failures and human error as ″products,″ of system operation, and, in this sense, to analyze the consequences of the chain of events (accidents / incidents / occupational diseases / breakdowns / major accidents / property damage, etc), as a result of the operation of the systems. The ultimate purpose of such a research approach is to maintain the risk in an acceptable field in the operations of any economic enterprise, regardless of the internal, external and risk management context in which it is located.

The reasons synthetically presented supra, spell out and support the topicality, the necessity, the importance and the opportunity of the scientific research of the present doctoral thesis, as well as the minimization of occupational electrical risks.

2. Objectives of the Doctoral Research

The general objective (GO) of the doctoral thesis is meant to evaluate the technical, organizational and other options that can be used in the future in industrial companies in Romania, in order to understand how theory and practice can be integrated to improve prevention of electrical risks and related economic results.

The intended result is the adaptation and application of a methodology to analyze electrical risks in medium and high voltage installations, to develop a set of tools for risk and safety level assessment, with a view to minimize occupational electrical risks and develop a systemic management of OSH model and its application in a company supplying and distributing electricity.

In order to achieve the general objective, the following **specific objectives (SO)** have been set:

O.S. 1. *Analysis of the national and international legislative context, as well as of the current state of the managerial strategies for minimizing electrical risks;*

O.S. 2. *Systematization of a typology of electrical risks associated with various categories of specific basic activities and realization of a documentary synthesis on the available technical means of prevention and protection;*

O.S. 3. *Analysis of the literature on OSH management systems applicable in organizations in the electrical field, in order to generate a quasi-exhaustive review of the most relevant and current sources in specialized literature on the characteristics, benefits and limitations of management systems, the necessary elements for the efficient management of OSH regarding OSH best practices, models and frameworks of OSH management system by various professional and standardization associations;*

O.S. 4. *Carrying out an electrical risk analysis based on an audit aimed at establishing the initial situation of the industrial unit in the case study, from the point of view of the OSH, to serve as a reference point for measuring and monitoring the performance of the management system;*

O.S. 5. *Adaptation and application of a methodology for the analysis of electrical risks in organizations, which allows the investigation of the work system by taking into account the dynamics of development and the existing interconditions between the components of the system;*

O.S.6. *Development and application of a research methodology, tools / questionnaires for conducting a statistical study on the workers´/ managers´perception of how to achieve and implicitly obtain the effectiveness of OSH management system operation in the field of conveyance and distribution of electricity.*

O.S. 7. *Theoretical and methodological substantiation of a systemic OSH management model that optimizes the maintenance of electrical risks within an acceptable interval in the operations of an organization, from the primary perspective of worker safety and health, to ensure an increased preventive potential, in the sense that, if all subsystems and connections involved in the model are present within the organization and working correctly / efficiently, the probability of producing malfunctions is to be lower than in the opposite case.*

3. The Structure of the Doctoral Thesis

The doctoral thesis comprises 7 chapters incorporating 213 pages, a number of 173 pages allocated to the proper scientific research and 21 pages to the 8 appendices, 106 figures, 48 tables, and 181 bibliographical references.

Chapter 1, entitled ***Analysis of the National and International Legislative Context and the Current State of Management Strategies for Minimizing Electrical Risks***, is assigned to the presentation of national and international standards on risk assessment, national legislation on occupational safety and health, national strategic objectives with a view to occupational safety and health, national and international energy strategies, management strategies of risk minimization, risk analysis methods from the perspective of risk management. The results of this analysis carried out in Chapter 1, were a preliminary step in substantiating the general contextual framework for conducting research, in order to detail the study on the systemic operational management model of OSH designed to minimize electrical risks within an organization in the field of electricity.

Chapter 2, named ***Documentary Synthesis on the Types of Manifestations Forms and Means of Prevention-Protection against Electrical Risk***, focuses on the coherent and synthetic structuring of the types of electrical risks associated with various categories of the specific basic activities. The statistical data regarding work accidents produced at national and international level are presented selectively; a comparative analysis was performed regarding the activities carried out by the operative personnel within a non-retechnologized station compared to a re-technologized one. A classification was also made of the equipment and means of protection employed in the electrical installations, as well as of the measures and technical solutions applied in order to minimize the electrical risks at the present day stage. All these issues dealt with in Chapter 2, provided information on the typology of electrical risks, as well as the general means of prevention-

protection to be adopted, providing a comprehensive view of the situation and a clear reporting system on the area of certainty of the research field.

Chapter 3 – ***Analysis of the Specialized Literature regarding OSH Management Sytems Applicable in Organizations in the Electrical Field –*** aims to present the characteristics of organizations and management systems, the main advantages of approaching occupational safety and health management systems in a holistic manner. The limitations of the standards based OSH management system have been identified, the key elements of best practices for effective OSH management highlighted, and methods for analyzing OSH management practices summarized. The analysis carried out in this chapter generated a set of carefully organised knowledge that supported the development (in chapter 6) of a systemic operational management model of OSH for minimization of electrical risks. This chapter summarizes the main results, the information and the preliminary conclusions drawn from the analysis of the literature on OSH management systems, as well as methods for evaluating OSH management practices.

Chapter 4, named ***Experimental Research regarding Electrical Risk Analysis***, is elaborately structured, representing one of the major original contributions of the research. Within this chapter, a methodology for the analysis of electrical risks in medium and high voltage installations has been proposed and applied. A logical sequencing of the stages regarding the proposed methodology has been performed, the priority areas for assessing compliance with security requirements defined and structured on the components of the investigated work system – ENS module, a set of tools for assessing risks used for quantification, an assessment of the level of security and quantification of the risk has also been carried out in a real organization, generically reffered to as ″electrical risk.″

Given the capacity / potential for improvement detected, the next stage of the research is logically directed to the human and managerial components involved in these activities. It has been considered imperative to develop a statistical study on the perceptions of workers / managers on how to achieve and implicitly obtain the effectiveness of the occupational safety and health system.

As a result, **Chapter 5**, entitled ***Experimental Research on the Workers′ Perception of O.S.H.M.S. Performance within an Electrical Organization***, the object of the research was a company that carries out its activity in the field of conveyance and distribution of electricity. A combined approach, based on diverse methods was adopted, benefiting from the richness of the qualitative data and the level of extension of perceptions following a structured quantitative survey. The carried out research involved an extensive case study on OSH management practices within the organization. Based on the results of the specialized literature reviewed, the research was realized in two parts. In the former, the line management representatives within the organization were interviewed in order to collect information about the priorities and practices of the organization regarding OSH management.

In the latter, a questionnaire was administered to collect the **employees′** opinions and perceptions regarding the management practices of OSH and the functioning of the organization. The responses to the questionaire have been analyzed using descriptive statistics and appropriate parametric tests, which were applied in order to test the statistical significance of the results. An important level of 90% has been set for parametric tests. Based on the above, the analysis of the information that forms the research database was enhanced, using the IBM SPSS (Statistical Package for the Social Sciences) software, one of the most efficient and frequently used statistical data processing programs.

Chapter 6, named ***Systemic Operational Management Model of OSH for Minimizing Electrical Risks***, is an original, innovative suggestion, a direct consequence of the preliminary conclusions highlighted after interpreting the results of the empirical research in **Chapters 5** and **6**. The model developed is a dynamic system, which aims to maintain the electrical risk in the acceptable field in a coherent manner, for all operations of an organization in the electrical field. The model can be applied proactively in the case of a new system, as well as reactive in the case of an existing one.

In **Chapter 7**, entitled ***Final Conclusions and Personal contributions. The limits of the Study and Directions for Further Development of the Research***, the main relevant conclusions are summarized, highlighting the author′s original contribution to the research topic. The inherent limitations of the research study are formulated, along with the perspectives for further research and the potential future directions of development of the present doctoral thesis.

4. Complexity and Novelty of the Research

The degree of complexity, is derived from the very importance of the national and international legislative context, the nature of the systems and risks addressed along with the dynamics of the evolution of the scientific research in the field of OSH. Knowledge has been used from several fields (industrial engineering, electrical engineering, occupational safety and health, mathematical statistics, informatics, management), with a view to giving the doctoral thesis a pronounced multidisciplinary and interdisciplinary character. The overall goal is the adaptation and application of an electrical risk analysis methodology, the design and implementation of the perception survey and statistical processing of the collected data, the theoretical and methodological substantiation of the OSH sytemic management model.

The degree of novelty of this doctoral thesis stems from the fact that at the beginning of the study, the author did not have predefined / pre-established opinions about the emerging framework and the development of the research. Rather, the study was planned in a way that allowed the selected and applied methods, along with the collected data, to define the nature of the relationships between the elements, parameters and significant factors. Thus, the present thesis can be considered more an exploratory study rather than a confirmatory one.

5. Personal Contributions

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

A.1. The main objective of the doctoral thesis is to evaluate the technical, organizational and other options that can be used in the future in industrial companies in Romania, in order to understand how theory and practice can be integrated in order to improve the prevention of electrical risks and related economic results. Moreover, the thesis has led primarily to a ***documentary study of the specialized literature*** **by** focusing on the provisions of existing national and international legislation, as well as managerial strategies to minimize electrical risks **(Chapter 1)**.

A.2. ***Carrying out an in-depth and relevant research on the evolution of statistical indicators*** on work accidents produced in Romannia between 1996-2017, as well as on the evolution of statistical indicators on collective work accidents produced in Romania betwen 1996-2015; in this approach, a strong emphasis has been put on consulting certain statistical databases in the field **(Chapter 2, § 2.2)**.

A.3. ***The documentary synthesis regarding the types of manifestations and the means of prevention – protection of electrical risk***, made in Chapter 2, § 2.3 and §2.5, offers a coherent image of the investigated aspects, in order to substantiate the ways of refining the experimental research of the associated risk levels, electrical hazards in industrial organizations in Romania.

A.4. ***The analysis of the specialized literature on OSH management systems applicable in organizations in the electrical field*** (Chapter 3) generated a quasi-exhaustive review of the most relevant and current souces in the literature in the field on the characteristics, benefits and limitations of management systems, the elements necessary for the efficient management of OSH with a view to the best OSH practices, the models and frameworks of the OSH management system by various professional

and standardization associations, at the same time as the evaluation methods for achieving OSH performance.

A.5. In this context of the bibliographic research, we have documented that the integration systems reviewed enable the efficient implementation of the OSH management, not only as a legal and social obligation, by having multiple strengths for industrial organizations but also ensuring the integration of the OSH management in the management of the company.

A.6. We have pointed out that, while the translatability of safety culture instruments throughout the industry is common but debatable, **the unique nature of electrical risks requires a personalized approach oriented to safety and security culture programs**, as in the case of oil and gas extraction and other complex socio-technical systems worldwide.

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

B.1. Identification, based on the analyzes performed and the case studies developed, the difficulties and problems in the field of occupational safety and health relevant for the specific aspects related to occupational electrical risks and accordingly the establishment of the general research goal of this doctoral thesis.

B.2. Highlighting the specific objectives and clearly establishing the directions of action with a view to achieving the intermediate objectives circumscribed to the topic of this doctoral thesis on the basis of carefully selected criteria.

B.3. Two approaches to assessing the overall performance of OSH have been identified, namely the system audit and the perception survey. This latter approach promotes employees′ participation in OSH activities and the feedback to the OSH performance within an organization.

B.4. Identifying the possibility of developing the case study regarding the application of the SMMOSH model within a large national industrial company in the field of electricity supply and distribution, in order to illustrate its own characteristics and particularities.

C. From the point of view of theoretical research:

The significant theoretical contributions included in the doctoral thesis are the following:

C.1. Dedicated and targeted synthesis of national legislation on occupational safety and health, presentation of national and international standards on risk assessment, highlighted national strategic objectives on risk assessment, national and international energy strategies, and managerial strategies in order to minimize risks and risk analysis methods from the perspective of risk management.

C.2. Structuring in a concentrated and coherent manner, capable of becoming a guidebook for good practices, the types of electrical risks associated with various categories of specific basic activities.

C.3. Classification of equipment and means of protection used in electrical installations, as well as a structured inventory of the main measures and technical solutions applicable and implemented in order to minimize electrical risks in industrial activities and processes.

C.4. Presentation of the evolution of statistical indicators regarding work accidents produced in Romania between 1996-2017, as well as of the evolution of statistical indicators regarding collective work accidents produced in Romania in 1996-2015.

C.5. Carrying out a comparative analysis of the activities undertaken by the operative staff within a non-technologized power station compared to a re-technologized one, in order to emphasize the significance of the technical / work equipment component **(Chapter 2, § 2.4)**.

C.6. Presentation of the characteristics of organizations and management systems, highlighting the main advantages of approaching occupational safety and health management systems. In short, we have proved the need in Romania not only for a **systemic** approach, but also a **contextual** one **(Chapter 3, § 3.7)**.

C.7. Design and development of a complete and complex set of risk assessment tools, subsequently applied and validated in order to estimate, quantify and evaluate the level of safety and risk assessment of an electrical nature within a representative industrial organization at national level **(Chapter 4)**.

C.8. Proposing a methodology for analysis risks of electrical nature in medium and high voltage installations and performing a logical sequencing of the stages regarding the suggested methodology, defining priority areas for assessing compliance with safety requirements, structured on the components of the investigated work system – ENS Module **(Chapter 4, § 4.1)**.

C.9. Establishing the methodology, tools / questionnaires for conducting the statistical study on the perceptions of workers / managers as to how to achieve the effectiveness of the OSH management system within an organization that operates in the field of electricity conveyance and distribution. The tools developed and the structure of the research stages are reproducible and these can be used for similar studies and research in other types of industrial organizations and, by their minimal adaptation, they will be able to analyze the perceptions on the management of other relevant risk categories **(Chapter 5, § 5.1)**.

C.10. The in-depth analysis of the information that forms the research database (answers to administered questionnaires) was done using IBM SPSS (Statistical Package for the Social Sciences) software, one of the most efficient and frequently used statistical data processing programs **(Chapter 5, § 5.2)**.

C.11. The systemic approach, in line with the provisions of ISO 31000: 2018 standard on principles, general framework and risk management process, was capitalized in order to develop a systemic model of occupational safety and health management (SMMOSH) dedicated to industrial organizations in the field of electricity, with certain potential for generalization in other types of industrial organizations.

C.12. The theoretical development of the OSH systemic management model generates the organizational framework meant to maintain the electrical risk in the acceptable field in a coherent manner, for all operations of an organization in the electrical field, regardless of the internal, external, and risk management context in which it is located.

D. In terms of practical and applied contributions:

The practical and applied contributions consist of the folowing:

D.1. Application and adaptation of a methodology for the analysis of electrical risks in medium and high voltage installations within the investigated organization **(Chapter 4, § 4.1)**.

D.2. Design and development of a set of specific risk assessment tools used for the quantification, and evaluation of the level of risk security.

D.3. Carrying out an electrical risk analysis based on a conformity assessment audit, aiming at establishing the initial situation of the industrial unit in the case study, from the point of view of the OSH, in order to serve as a point of reference for measuring and monitoring the system performance management. Implemented during the operation of the S.M.M.O.S.H., the audit or conformity assessment had the role of evaluating the degree of compliance with the provisions of the legislation and of qualitatively determining the efficiency of the elements of the S.M.M.O.S.H., within the organization in the case study conveying and distributing electricity **(Chapter 4, § 4.2)**.

D.4. Conducting a case study on OSH management practices within an organization in the electrical field, through a combined approach, based on diverse methods, benefiting from the rich qualitative data and the level of extension of perceptions obtained from conducting a structured quantitative survey **(Chapter 5)**.

D.5. Conceiving a checklist, with questions regarding issues related to the key elements in the research, in order to facilitate a semi-structured interview with the representatives of the line management **(Appendix 5)**.

D.6. Development and implementation of a questionnaire in order to collect the opinions and perceptions of employees regarding the management practices of the OSH and the functioning of the organization in the electrical field **(Appendix 6)**.

D.7. Carrying out a statistical study on the perceptions of workers / managers as to how to achieve and, implicitly, obtain the effectiveness the occupational safety and health system, by using the IBM SPSS (Statistical Package for the Social Sciences) software - **(Chapter 5, § 5.2)**.

D.8. Development of a systemic management model for occupational safety and health (SMMOSH) and its application in an industrial company in the field of electricity supply and distribution **(Chapter 6)**.

E. From the point of view of disseminating the results

During the doctoral internship and the previous documentation I have published (8 articles and scientific papers as first author and co-author) the following (details in **Appendix 8**):

- 1 article published in journals indexed Web of Science - WoS (ISI);
- 3 scientific papers published in the volumes of scientific events indexed Web of Science-WoS (ISI) Proceedings;
- 1 scientific paper published in BDI indexed specialized journals;

- 1 paper published in the volumes of International Conferences Proceedings held in the country;
- 2 book chapters printed by publishing houses abroad.

KEY WORDS: electrical risk, occupational safety and health, management systems, prevention, protection

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