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OCCUPATIONAL RISK MANAGEMENT IN THE DESIGN AND MANUFACTURE OF WORK EQUIPMENT USING SR ISO 31000 STANDARD

Anca-Elena ANTONOV, Georgeta BUICĂ, Constantin BEIU, Remus DOBRA

Abstract: *Ensuring occupational health and safety within a company is a key condition for managing management at the highest level, and the integration of risk management into the integrated management of the organization, its structure, operations and processes must be adapted to achieve the established objectives and according to the internal and external context to which it is applied. The implementation of risk management at a company's level can be carried out at the strategic, operational, program or project level. The process of designing and manufacturing work equipment represents an organizational factor that can constitute a source of risk, which can lead to the occurrence of events with a high degree of uncertainty regarding the creation of new products.*
Keywords: *risk, management, safety, work equipment, strategy, SME.*

1. INTRODUCTION

The risk management guidelines defined by the SR ISO 31000 standard [1] represent a crucial step in managing the integrated management of a company, including those of small or medium-sized enterprises (SMEs).

The structure, operations, and processes are managed at the company management level, taking into account the objectives established according to the internal and external context to which they are applied.

Risk management must be integrated into the company's management and decision-making processes.

Implementing an occupational health and safety management system (OHS) at the company level is a key condition for managing management at the highest level, and risk management can be implemented at the company level as well, at the strategic, operational, and program or project levels.

In the process of designing and manufacturing products for professional use, risks may arise that lead to events that must be controlled.

The actions established at the company level to help the interested parties understand the risk are carried out through communication and consultation to help the interested parties manage them.

The identification of risks related to the development projects of products for professional use is also valid for common products. Risk factors related to the company's vulnerabilities and capabilities and changes in the internal and external context may lead to events with a high degree of uncertainty regarding the creation of new products.

To understand the risks that the company may face in developing a project, the systems intended to manage these risks must be identified in relation to the objectives related to the design and manufacture of work equipment.

These risk management systems must be highly effective in the development of a project through correct implementation and operation at the company level.

The publication of the SR ISO 31000 standard in June 2018 is the start of the initiation period for implementing risk management at the company level [1].

Key elements of risk management implementation regarding the design and manufacture of work equipment using the SR ISO 31000 standard at the manufacturing company level indicate the success of implementing an occupational health and safety management system.

Addressing OHS management about ensuring the use of safe work equipment by workers necessitates identifying organisational risk factors specific to the development of a project, in this case, a product intended for professional use.

The research carried out by the research team within a project financed by European funds aimed to identify the risks related to new digital technologies, which require the adoption of new measures limited to protecting and safety products in use.

2. THE ROLE OF RISK MANAGEMENT IN THE INTEGRATED MANAGEMENT OF THE COMPANY

To avoid losses and achieve company objectives, it is necessary to implement a risk management system that utilises specific analytical and operational methods and means to identify, prioritise, and adopt necessary measures to mitigate risks.

The examination and evaluation of the environment from which threats originate, correlated with internal factors that include vulnerabilities, as well as identified external ones, must be taken into account in the implementation of risk management at the company level.

In this regard, action must be taken on the internal elements of the system to identify and eliminate vulnerabilities that generate risks.

The mandatory stages of identifying and prioritizing risks must be identified through a mechanism that considers the identification of risks generated by external threats and internal vulnerabilities. After analysing and prioritizing risks, a plan of adequate countermeasures must be established and implemented in the context of internal and external restrictions to streamline and make them effective.

Top management should ensure that the responsibilities, accountability, and authorities for relevant risk management roles are assigned and communicated at all company levels. The SR ISO 31000 standard is one of the essential tools in understanding and implementing the legislative and technical provisions [2] relating to OSH.

Top management should ensure that the necessary and appropriate resources are allocated for implementing risk management. These include, but are not limited to, personnel, skills, experience, competence, processes, methods, tools, specific procedures, information and knowledge management systems, and professional development and training needs.

In this regard, in order to develop specific tools for implementing and improving a risk management system at the company level, the organization must take into account the provisions of the SR EN ISO 45001 standard, published in November 2024, with amendment A1 published in October 2024 [3], regarding: OHS policies and objectives at the organization's management level, defining the processes implemented within the organization taking into account the legal provisions and identified risks, identifying risks and people associated with the organization's activities, defining risk management processes, organizational and technical risk mitigation measures, increasing awareness at the organization level regarding OHS risk management and ensuring workers to take an active role in OHS issues [3, 4].

The main chapters of the SR ISO 31000 standard are presented in Table 1.

Table 1

Structure of the SR ISO 31000 standard

Chapter	Title
1	Scope
2	Normative references
3	Terms and definitions
4	Principles
5	Organizational framework
6	Process

In chapter 4, the SR ISO 31000 standard refers to the following principles:

- integration into all activities of the organization;

- structuring and systematization in order to obtain consistent and comparable results;
- proportional and adequate adaptation of the organizational framework and process to the external and internal context of the organization regarding its objectives;
- involvement of stakeholders through awareness;
- access of stakeholders to relevant information;
- influence of human and cultural factors;
- continuous improvement through learning and experience.

In chapter 5, the SR ISO 31000 standard refers to:

- The highest-level management assumed in order to manage risks in the activities and in the integrated management of the company;
- Designing and developing the organizational framework for risk management at the company level;
- Implementation of the organizational framework for risk management, which requires the commitment and awareness of stakeholders in order to correctly and successfully integrate risk management into all organizational activities;
- Assessment of the effectiveness of the organizational framework for risk management by measuring its effectiveness and determining its suitability for achieving the organization's objectives;
- Continuous, appropriate and practical improvement of the organizational framework for risk management, as well as how the risk management process is integrated within the organization [1].

In Chapter 6, the SR ISO 31000 standard refers to the systematic application of policies, procedures, and practices to the activities of communication and consultation, establishing the context and assessing, treating, monitoring, analysing, recording and reporting risk within the risk management process, as an integral part of the company's management processes [1].

When designing the organizational framework for resource management, the resources allocated by the organization must be considered, considering the capabilities and constraints of existing resources.

3. USE OF INFORMATION AND KNOWLEDGE MANAGEMENT TOOLS

Analytical and operational methods and means are employed to identify, prioritise, and adopt appropriate measures to mitigate losses and achieve company objectives, thereby enhancing risk management within the framework of integrated management ([1], [11]).

An organisational tool used for risk management is represented by information and knowledge systems developed for integration into the organisation's structure, operations, and processes related to the design and manufacture of safe products intended for use by workers in sectors of the national economy with a high level of occupational accidents and/or disease.

Within the scope of the project Partnership for the Transfer of Knowledge and the Development of Research in the Assessment and Prevention of occupational risks leading to Disasters (PROC), ID/Code SMIS 2014+: POC P_40_182/111954 ([5], [7],[8]), six knowledge maps were created, on the following research themes: the genesis of dangers, risks and occupational risks; risk management; risk assessment; vulnerability analysis; knowledge of industrial disasters; knowledge on ecological disasters.

A knowledge map of risk management is schematically presented in Figure 1 [6].

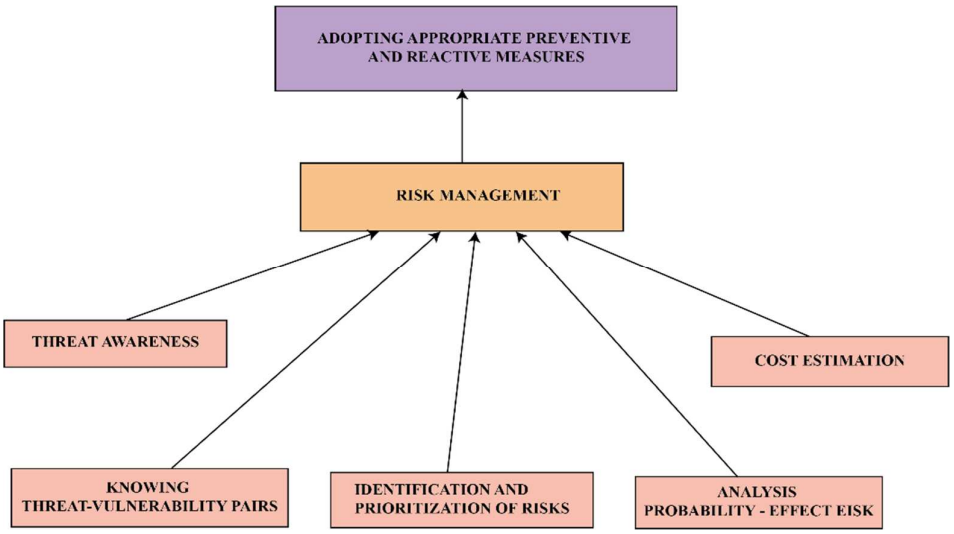

Fig.1. Risk Management

The risk management map is oriented on two distinct axes: a vertical axis that includes the specific stages of risk management and a horizontal axis that focuses on risk analysis.

The risk management map presents the principles on which risk management is based, the possible options for dealing with risks, and the specific responsibilities in this regard.

The map introduces the ALARP principle (As Low as Reasonably Possible) and the notion of Integrated Risk Management under the conditions of integrating the entire issue into Total Quality Management (TQM).

The development of a specific ontology aims to define the main classes of terms corresponding to the OHS field applicable at the enterprise level, in order to ensure the safety and health of workers, the environment, and the means of production, taking into account the conceptual elements of OHS.

The creation of an appropriate ontology is challenging and uses the following information: Primary classes of the terms within the OSH field at the enterprise level: o about the OSH the targeted factor is the safety of the employees that work; o about Occupational Health the targeted factor is the health of some people who are working; o about OSH environment protection is the most relevant aspect; o regarding the OSH goods defined as means of production might lead to harming the humans working; them; The most critical OSH is built around the following factors: participation, risk, hazards; The most essential elements that can define a concept referring to the OSH could be: rules, protocols, procedures, norms; A second problem in building the knowledge database (but also creating specific ontology) is to differentiate the database that is addressed to knowledge that may be produced, as a result of what is already known (assuming the fact that the information becomes model for knowledge) and not what is already known and existing.

The idea behind the final product that could arise from collecting all the information through chip technology is the following: in case of an industrial domain, occupational safety and health is about the standards of value and value quantity (or “the risk”).

In defining the ontology related to OSH, the following steps were considered:

- Step 1: Construction of the ontology by defining and understanding the environment ontology, data classification and application of semantic similarity for the existing ontology.
- Step 2: Refinement of the ontology, which requires supervision of the entire process and recording previous experiences in a knowledge base through human intervention by experts in the field.

Within the research studies carried out by research teams, some specific ontology models in the field of OSH were developed related to the risks identified at the level of beneficiary organizations.

As a result of the operational study carried out within the framework of the subsidiary research contract, the specific categories of a specific ontology model were defined:

- The beneficiary organization/company, which also includes aspects related to the means of production;
- Worker;
- Environment is defined mainly as the working environment.

Regarding the ontology specific to the OSH domain, within the category relating to the beneficiary organization/company, the following are defined:

- Class 1 – Identification and analysis of specific occupational risks;
- Class 2 – Risk and security assessment;
- Class 3 – Risk elimination/reduction (mitigation) solutions and implementation.

Each class is defined by subclasses, which are defined by types of activities.

The class relating to the identification and analysis of specific occupational risks is defined by the subclasses regarding:

- Identification of the area(s) subject to the assessment;
- Establishment of the appropriate risk assessment and analysis procedure;

The subclass relating to the identification of the area(s) subject to the assessment is, in turn, defined by a series of activities structured by type: identification and establishment of the risk checklist, establishment of the risk analysis map and, respectively, establishment of the risk list and prevention measures plans.

The subclass relating to the establishment of the appropriate risk assessment and analysis procedure is, in turn, defined by a series of activities structured by type: the establishment of management plans regarding technical and organisational measures to adopt the necessary corrections based on the assessment carried out.

The class relating to the assessment of risks and the level of safety is defined by the subclasses regarding:

- Assessment of the level of safety;
- Establishment of strengths and weaknesses;
- Establishment of specific/punctual prevention and protection plans.

Regarding the ontology specific to the OHS domain, within the category related to the worker, the following classes are defined:

- Training;
- Work tools (methods, procedures of good practices);
- Behavioural analysis;
- Work equipment and means of protection,
- Personal protective equipment.
- The class related to Training is defined by the following subclasses regarding:
- General OH&S training;
- Specific OH&S training;
- Technical Training (includes Training on work methods and technologies);
- Emergency training;
- Practical Training.

The behavioural analysis class is defined by the subclasses regarding:

- Identification and analysis of education and training needs in the field of OSH;
- Identification and establishment of weak points for improving Training in the field of OSH;
- Identification of situations that determine the need for behavioural analysis of the worker/operator;
- Identification of the thematic directions that require establishing professional meetings in an organized worker/management framework.

In what concerns the class: Work tools (methods, procedures of good practices), the subclasses have been defined regarding:

- Definition of work tools (methods, good practices);
- Legislative and technical regulations issued by national authorities;
- Prescriptions on the design and making of work equipment and protection systems, including PPE;
- Case studies (examples);
- Guidelines on standardization;
- Checklists for verifying compliance with legal requirements relating to ensuring safety and health at work;

The class to work equipment and means of protection was established on the basis of the following sub-classes:

- Legislative and technical regulations issued by national and European authorities;
- Identification and setting of technical standards of occupational safety and health in the field of design and production of product prototypes to avoid occupational risks and achieve the protection of the human being during the performance of industrial activities;
- Definition of safety requirements for product prototypes;
- Development of procedures and tools for assessing and testing product prototypes;
- Product-prototyping experimentation protocols development and testing;
- Validation, implementation, and testing processes.

The subclass related to the Development and testing of product prototype experimentation procedures is defined by a series of activities structured by type: testing of product prototype experimentation procedures, testing of the product prototype evaluation, and testing method.

The subclass related to the validation, implementation, and testing of procedures is defined by a series of activities structured by type: Validation, implementation, and testing of procedures, as well as Validation of prototype experimentation procedures.

Regarding the ontology specific to the OHS domain, within the category relating to the beneficiary organization/company, the following are defined:

- Class 1– Identification and analysis of specific occupational risks;
- Class 2– Risk and security assessment;
- Class 3– Risk elimination/reduction (mitigation) solutions and implementation.

Each class is defined by its subclasses, which in turn is defined by the types of activities they perform.

The class relating to the identification and analysis of specific occupational risks is defined by the subclasses regarding:

- identification of the area(s) that is/are the subject of the assessment;
- establishment of the appropriate risk assessment and analysis procedure;

The subclass relating to the identification of the area(s) that is/are the subject of the assessment is, in turn, defined by a series of activities structured by type: identification and establishment of the risk checklist, establishment of the risk analysis map and establishment of the risk list and prevention measures plans.

The subclass relating to the establishment of the appropriate risk assessment and analysis procedure is, in turn, defined by a series of activities structured by type: establishing management plans regarding technical and organisational measures to adopt the necessary corrections based on the assessment carried out.

The class relating to the assessment of risks and the level of security is defined by the subclasses regarding:

- assessment of the level of security;
- establishing strengths and weaknesses;

Establishing specific and punctual prevention and protection plans.

Within the ontology specific to the OHS domain, the class relating to solutions for eliminating/reducing (mitigating) risks and implementing the subclasses regarding:

- Structural protection (buildings);
- Intrinsic protection (ways to prevent accidents and occupational diseases through technical prevention measures, namely by acting on the shape, location, assembly method, operating principle or construction of an installation, tool, equipment, device or machine, without adding elements specially designed to achieve occupational safety and health);
- Collective protection (ways of preventing accidents and occupational diseases through measures that mitigate the risks identified at the workplace, through technical and/or organizational prevention measures ([6], [9]);
- Individual protection;
- Emergency services/occupational medicine.

The intrinsic protection subclass is defined by a series of activities structured by type:

- Identification and establishment of new work,
- Methods and procedures; identification,

Selection and use of safe work equipment and, Respectively, specific training on the use and,

- Maintenance of work equipment, including the establishment of specific work instructions.

Regarding the ontology specific to the OHS field, within the category relating to the worker, the following classes are defined relating to:

- Training;
- Work tools (methods, procedures of good practices);
- Behavioural analysis;
- Technical work equipment and technical means of protection,
- Individual protective equipment.

The training class is defined by the following subclasses relating to:

- General OHS training;
- Specific OHS training
- Technical training (includes training on work methods and technologies);
- Emergency training;
- Practical training.

The class related to behavioural analysis is defined by the subclasses regarding:

- Identification and analysis of education and training needs in the field of OHS;
- Identification and establishment of weak points for improving training in the field of OHS;
- Identification of situations that determine the need for behavioural analysis of the worker/operator;
- Identification of the thematic directions that require the establishment of professional meetings held within an organised worker-management framework.

Regarding the class relating to work tools (methods, procedures of good practices), the subclasses were defined as:

- Definition of work tools (methods, good practices);
- Legislative and technical regulations issued by national authorities;
- Requirements regarding the design, manufacture and use of work equipment and means of protection, including PPE;
- Case studies (examples);
- Guidelines regarding standardization;
- Checklists for verifying compliance with legal requirements regarding ensuring safety and health at work;
- The class relating to technical work equipment and technical means of protection was defined by the subclasses regarding:
- Legislative and technical regulations issued by national and European authorities;
- Identification and establishment of technical safety conditions regarding the design and production of product prototypes intended to prevent occupational risks;
- Development of safety requirements for product prototypes;
- Development of methods for evaluating and testing product prototypes ([5],10]);
- Development and testing of product prototype experimentation procedures;
- Validation, implementation and testing of procedures.

The Subclass relating to the development and testing of product prototype experimentation procedures is defined by a series of activities structured by type:

- Testing of product prototype experimentation
- Procedures; testing of the method for evaluating and testing product prototypes ([5],[7]).

The subclass relating to the validation, implementation, and testing of procedures is defined by a series of activities structured by type: validation, implementation, and testing of procedures, and validation of prototype experimentation procedures.

Regarding the ontology specific to the OHS domain, within the categories relating to personal protective equipment and the environment, mainly classified as a work environment, the subclasses and specific classes were defined.

The research project developed focused on the activities defined in the class related to work equipment and protective equipment, as well as the structured subclasses, particularly those dealing with the specific aspects defined by the product prototypes developed by the beneficiary organization for the creation of new industrial products aimed at preventing occupational risks in electrical installations.

Within the research project implemented with the beneficiary organization, product prototype experimentation procedures were developed, and the product prototype evaluation and testing

method was tested [7] to validate both at the leader and partner levels.

The research activities were carried out to conceive, design and develop a cause-consequence structure for the risks identified in electrical installations, as well as to carry out on this basis a draft of prevention measures development of a specific ontology based on research studies on the assessment of occupational risks in electrical installations, in order to ensure the safety and health of workers and the technical analysis of the compliance status of the work equipment used in this sector of activity [6].

The establishment of the list of requirements and the functional framework served as the basis for the design and concept of the decision support system for preventing risks associated with disasters and for protecting people in electrical installations.

The development of the knowledge base encompassed the knowledge elements necessary for testing product prototypes, the "zero series", and the upgraded product for "series production", intended to prevent occupational risks and ensure the protection of individuals carrying out activities in electrical installations.

The logic diagrams used to represent domain-specific knowledge regarding the design and development of new products intended to prevent occupational risks and ensure the protection of people carrying out activities in electrical installations served as a representation model.

The functional logic diagrams were developed for the case studies and covered the prototype, "zero series", and the upgraded product for the purpose of experimentation phases in "series production".

The functional logic schemes were the basis for the development of the functional model of the expert decision support system/product regarding:

- Identification of professional risks to design and create product prototypes intended to prevent occupational risks.
- Establishment of technical conditions/requirements for occupational safety and health regarding the design and creation of product prototypes intended to prevent occupational risks
- Evaluation and testing of product prototypes aimed at preventing occupational risks.

The decision support system/product, which identifies professional risks for designing and creating product prototypes aimed at preventing occupational risks, is an integral part of the research study. It also includes the developed logic schemes.

Figure 2 shows the scheme regarding the overall structure for the risks generated by product prototypes – Knowledge Builder application (screenshot).

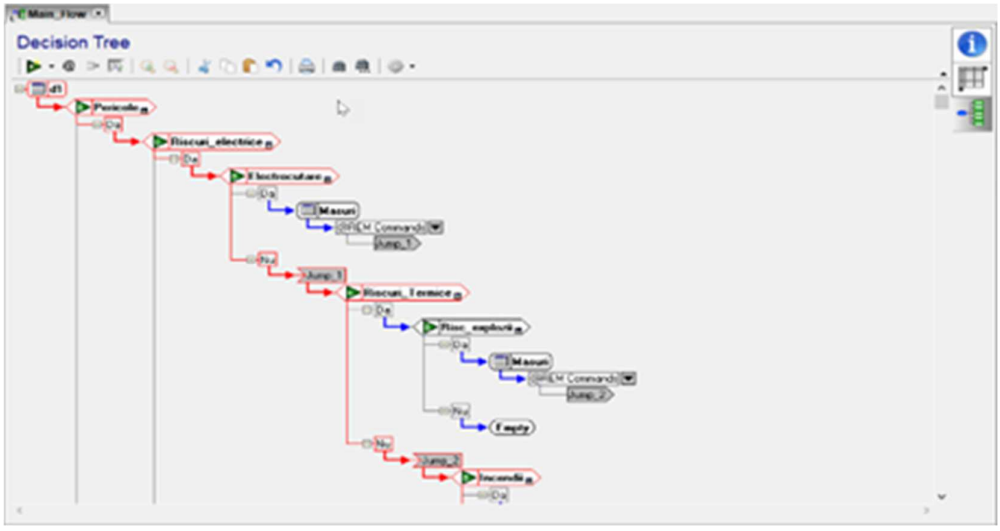

Fig.2 Overall structure for risks generated by product prototypes – Knowledge Builder application (screenshot)

The overall structure for the risks generated by the tested product was developed through the Knowledge Builder application, where the tree type is branched for all identified occupational risks ([5], [10]).

Within the research project, a decision support system/product for identifying occupational risks in electrical installations was developed to establish the technical conditions and requirements for occupational safety and health related to the design and realisation of product prototypes intended to prevent occupational risks, which also included developed logic schemes.

The functional logic schemes were developed to meet the technical conditions and requirements for occupational safety and health related to the design and realisation of five product prototypes developed and experimented with during the experimental research.

Figure 3 presents the logic scheme related to the requirements applicable to the product prototype - Bipolar phase correspondence indicator, for use in electrical installations with a nominal voltage of 6-35 kV – Knowledge Builder application (screenshot) [5].

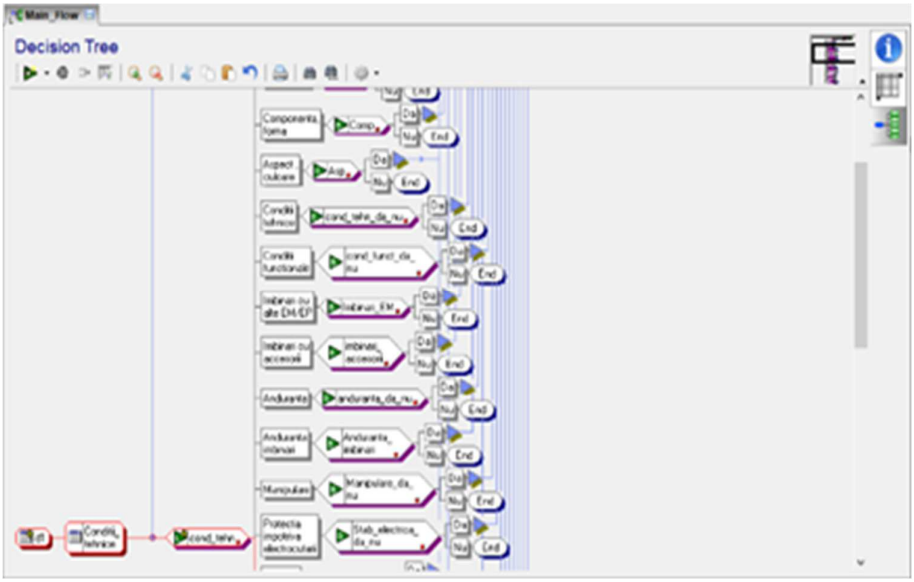

Fig 3 Logic diagram regarding the requirements applicable to the product prototype - Bipolar phase correspondence indicator, for use in electrical installations with nominal voltage 6-35 kV – Knowledge Builder application (screenshot) ([5], [7])

The logic diagram regarding the requirements applicable to the product prototype was developed through the Knowledge Builder application, where a tree type was created for the 5 case studies and product prototypes.

The decision support system/product for evaluating and testing product prototypes, intended to prevent occupational risks and ensure the protection of persons carrying out activities in electrical installations, is an integral part of the research study. It also includes the developed logic diagrams.

Figure 4 shows the diagram regarding the overall structure of the product prototype checks - Bipolar phase correspondence indicator, for use in electrical installations with a nominal voltage of 6 - 35 kV - Knowledge Builder application (Screenshot) ([5], [7]).

Figure 5 shows the structuring of the categories of security checks defined within the scheme relating to the overall structure of the checks of the prototype product -

Bipolar phase correspondence indicator, for use in electrical installations with nominal voltage 6 - 35 kV - Knowledge Builder application (Screenshot) ([5], [7])

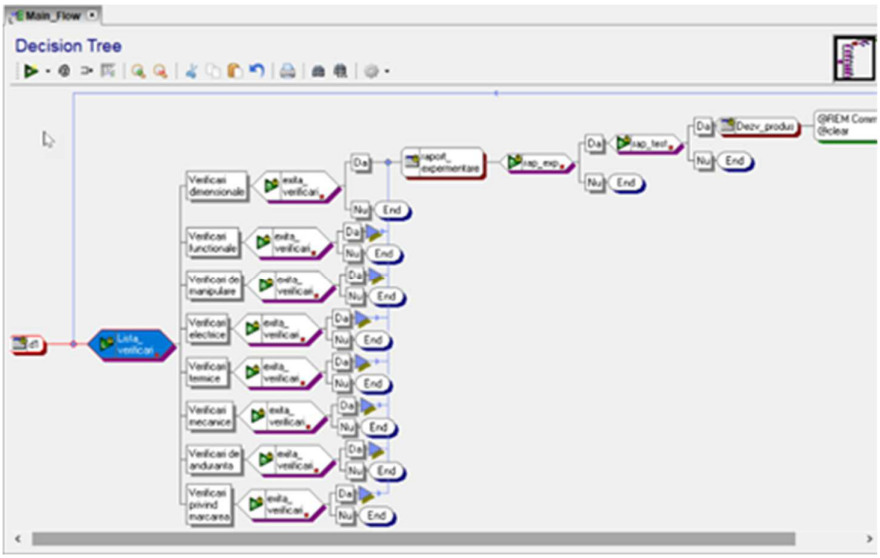

Fig.4 Overall structure of product prototype verifications - Bipolar phase correspondence indicator, for use in electrical installations with nominal voltage 6 - 35 kV - Knowledge Builder application (screenshot) ([5], [7])

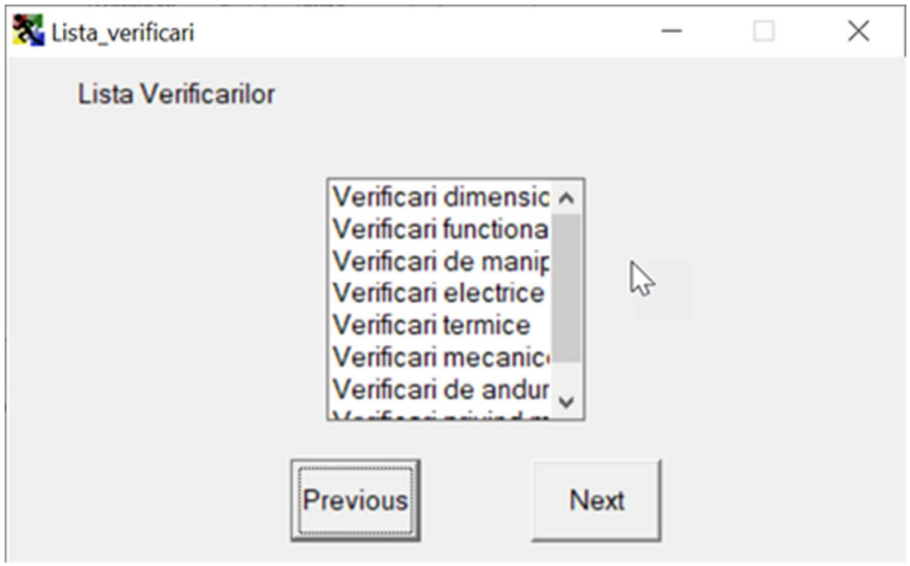

Fig.5 Overall structure of product prototype verifications - Bipolar phase correspondence indicator, for use in electrical installations with nominal voltage 6 - 35 kV - Knowledge Builder application (screenshot) ([5], [7])

The decision support system/product for product experimentation and testing – SQTEST, developed within the industrial research project [5]- allowed for the functional analysis of the decision support system/product [10] for the verification of the five developed products. tested and upgraded within the experimental research. The developed functional logic schemes and the decision support system/product enabled the transfer of knowledge within the beneficiary organization. Following the studies carried out within the project, which were registered with OSIM, two patent applications were filed for two products.

The research activities carried out within the research project aimed to design a decision system by establishing a list of requirements and a functional framework, developing a product prototype, and developing a prototype schema (functional logic schema) for the prototype. Additionally, the research organisation organization and the beneficiary enterprise developed the SQTEST model. ([5], [10])

The development and customisation of the SQTEST system provide manufacturers with a fundamental tool for designing, manufacturing, experimenting with, and testing work equipment and protective equipment intended to ensure the protection of people carrying out activities in electrical installations [8].

4. CONCLUSION

Within the research project, an ontology specific to the SSM field and an SQTEST management tool were developed, which are necessary for identifying the requirements that products intended for use in electrical installations must meet. The beneficiary company produced five products in various phases of experimentation to test them for the case studies outlined in the research project.

To test the product prototypes, operational procedures were developed, taking into account the stages defined for product development intended for use in electrical installations. The main objective of the research activity was to increase the competitiveness and scientific capacity of the company in the research activity - analysis and prevention of disasters, as a result of technological and knowledge transfer, by implementing a specific management tool for the prevention of risks associated with disasters and the means of protecting people in order to prevent risks in electrical installations. The model developed within the research work can be adapted to suit the specific needs of the organization that designs and produces products intended for professional use, thereby preventing risks in the workplace.

The studies carried out aimed to promote sustainable development through a decision support system developed for assessing and preventing risks that can lead to disasters. For that purpose, an information and knowledge management tool were developed through which:

- The professional risks identified in the case studies were "personalized", which determined the development of action models for the most significant of them;
- New and efficient evaluation methods were developed - allowing the exact identification of the moment when a specific risk becomes "active" and can affect the sustainable development process;
- Specific management procedures were developed, which would offer, through the decision support system, multiple solutions, ordered in terms of efficiency, within the reach of the "risk manager" manager;

"Risk libraries" were developed that contribute directly, as sources of knowledge accessible at the organizational level, to sustainable development and the protection of people involved in industrial activities.

To increase the competitiveness of companies in the market and ensure a high level of security for individuals involved in industrial activities, the developed management tools can be adapted to account for the scope of their activities.

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Managementul riscurilor profesionale privind proiectarea si fabricarea echipamentelor de munca utilizand standardul SR ISO 31000

Abstract: *Asigurarea securității și sănătății în muncă în cadrul unei companii este o condiție cheie necesară pentru gestionarea unui management la cel mai înalt nivel, iar integrarea unui management al riscurilor in managementul integrat al organizației, în structura, operațiunile și procesele acesteia, trebuie adaptat pentru realizarea obiectivelor stabilite și potrivit contextului intern și extern căruia îi este aplicat. Implementarea unui management al riscurilor la nivelul unei companiei se poate realiza la nivel strategic, operational, al programului sau al unui proiect. Procesul de proiectare și fabricare a echipamentelor de muncă reprezintă un factor organizational care poate constitui o sursă de risc, care poate să conducă la producerea unor evenimente cu grad ridicat de incertitudine privind realizarea unor noi produse.*

Anca-Elena ANTONOV, Ph.D, Senior researcher R3, Head of ET Certification, National Research and Development Institute on Occupational Safety – INCDPM "Alexandru Darabont", Ghencea 35A, Bucharest, Romania, Certification Body, anca.antonov@gmail.com, +4021 313 3158, 0722 519 910

Georgeta BUICĂ, Ph.D, Senior researcher R4, Head of Electrical and Mechanical Risks Laboratory, National Research and Development Institute on Occupational Safety – INCDPM "Alexandru Darabont", Ghencea 35A, Bucharest, Romania, Electrical and Mechanical Risks Laboratory, gbuica@protectiamuncii.ro, +4021 313 3158, 0727 277 943

Constantin BEIU, Recognized researcher R2, National Research and Development Institute on Occupational Safety – INCDPM "Alexandru Darabont", Ghencea 35A, Bucharest, Romania, Electrical and Mechanical Risks Laboratory, cbeiu@protectiamuncii.ro, +4021 313 3158, 0745 280 483

Remus DOBRA, Associate professor PhD. Eng, Department of Informatics, Mathematics and Applied Electronics (DIME), University of Alba Iulia, 510009 Alba Iulia, Romania