THE "UNI.ATT" METHOD, METHOD FOR ASSESSING THE RISK OF ACCIDENTS FROM THE USE OF MACHINES AND EQUIPMENT

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ABSTRACT

he Legislative Decree 81/08 in title III chapter I defines work equipment as "any machine, appliance, tool or plant, understood as the set of machines, equipment and components necessary for the implementation of a production process, intended to be used during work". From this definition we can perceive how meaningful the use of equipment in production processes is and how there is a considerable diversification of the same in terms of categories and types. Each work equipment, depending on the characteristics and methods of use, can be a source of danger, both for the health and safety of exposed workers.
In the national scientific literature, there are no validated methods that allow you to calculate, with objective criteria, the accident risk related to the use of equipment in the workplace.
For this reason, the Prevention and Protection Service of the Federico II University of Naples has developed an assessment method called "UNI.ATT", through which it is possible to perform the calculation of the accident risk in an automated manner.

INTRODUCTION

For the development of the method, the following regulatory sources were taken into consideration:

1. The EC directive 42/2006 "machinery directive";
2. UNI EN ISO 12100;
3. UNI EN ISO 14121;
4. Legislative Decree 81/08.

To allow the automated qualitative and quantitative estimation of the risk, an application in Excel format was developed.
The methodology and application include:

- **the census** of all the equipment used with the relative technical specifications which allows to identify for each of them the category and the technical / documentary conformity required by current legislation, also to plan any adaptation / decommissioning interventions;
- **the identification of the dangers**, that is, the recognition of any danger associated with the use of the equipment;
- **the risk estimate**, using the following algorithm, of each identified hazard:

$$R = D \times P$$

$$R_{ATT.} = D_{GRAVITA'} \times P$$

$$P = ESP. + ACC. + EV.$$

- where "**D" (Damage)** is the severity of the repercussions that the event can cause, while **"P" (Probability)** is a function of the sum of the variables of:
  - **"ESP." (Exposure):** indicates the possibility of accessing the danger area and the degree of complexity of the operations performed in the use of the equipment.
  - "**ACC." (Occurrence):** the safety and ergonomic conditions of the workplace
  - "**EV." (Avoidability):** in relation to compliance with the obligations under Article 71 of Legislative Decree 81/08.

Based on the combination of these parameters, different levels of risk have been envisaged for the planning of appropriate prevention and protection measures.

Premise

The work equipment differs in use and types and are an integral part of the company's production processes.
The reality of use differs from commonly used equipment such as: drills, saws, screwdrivers, etc ..., up to the use of sophisticated machines such as machine tools, which are almost completely automated.
Each type involves exposure to risks, depending on the type of machine, for the operator who uses it manually or through remote devices.
It is therefore essential to prevent the risk of accidents deriving from the equipment, both for the operators who use it and for the operators who are in the work area where the machine operates.
To do this, an adequate risk assessment is required to allow for proper use and proper management.
The objectives of this work are the following:

- Propose a method for assessing the risks associated with the use of equipment in the various work situations, based on the current regulatory framework;
- Support the risk assessors (Employer and Head of

the prevention and protection service) through a linear methodological path;
- Estimate the risk qualitatively and quantitatively.

MATERIALS AND METHODS

To estimate the risk qualitatively and quantitatively, three tools have been developed:
- An algorithm developed to identify and evaluate the safety risks deriving from the presence of work equipment;
- A census table to collect preliminary information about the equipment provided within a facility / company and establish their degree of compliance;
- An application created on an Excel sheet that allows the automated calculation of the algorithm.

Algorithm

The analysis of the Accident Risk of work equipment assumes that the equipment made available to the workforce actually complies with regulatory obligations. **
For each equipment that meets this requirement, the Excel sheet called UNI.ATT. Is compiled, through which it is possible to obtain the risk value for each hazard relating to the equipment in question.
Once the hazards have been identified and selected, the Risk is calculated for each of them, by entering the appropriate values in each specific box of the automated calculation line.
The formula identified was obtained by taking references from the technical standard UNI EN 12000, about the risk indices taken as a reference, and from Title III of Legislative Decree 81/08.
The formula used then looks like this:

$$R = D \times P$$

$$R_{ATT.} = D_{GRAVITA'} \times P$$

$$P = ESP. + ACC. + EV.$$

In which the basic indices of the formula are **Damage and Probability (R = D * P)**. The damage is configured as the quantitative **variable of Severity**, that is, the degree of injury that the event can cause. The probability instead is divided in turn into three elements added together which are: **Exposure, Occurrence and Avoidability**

Harm

Damage (Severity) is the factor that affects the final risk estimate the most and is the only value that does not allow action to be taken to lower its level. It must be established considering the maximum degree of injury with reference to the identified danger. The score goes from 1 to 4, and each value is corresponding to:
1. MILD: injuries that can be treated with first aid measures;
2. MODERATE: reversible injuries requiring medical attention;
3. SERIOUS: irreversible injuries with partially disabling outcomes;
4. VERY SERIOUS: injuries that can cause death or severe permanent disability.

Probability

• Exposition

The first index that collaborates in determining the probability is given by the exposure to the risk factor. The value of the Exposure varies according to the methods of interaction with the equipment, i.e. the possibility of accessing the danger area or not and the degree of complexity of the operations performed during the work phases.
In the new generation equipment, especially in virtue of the new regulations, great attention is paid to the confinement of danger zones.
The possible values are 3:

1. NEGLIGIBLE: confined equipment and prohibition of access to the danger area;
2. SPORADIC: occasional access to the danger area and execution of simple operations (start-up / shutdown, loading / unloading of materials, etc.);
3. CONSTANT: constant / frequent access to the danger area or execution of complex operations.

• Happening

The Incident is envisaged as the safety and ergonomic conditions of the workplace where the equipment is located, is nothing more than the detailed configuration of Article 71, paragraph 6, of Legislative Decree 81/08: “The employer takes the necessary measures to ensure that the workplace and the position of workers during the use of the equipment have safety requirements and comply with the principles of ergonomics”.

The values attributable to the **event range from 0 to 3** (fig. 14) and are divided as follows:

1. RARE: suitable environmental conditions and low physical work load;
2. POSSIBLE (1): suitable environmental conditions and high physical work load;
3. POSSIBLE (2): poor environmental conditions and low physical work load;
4. LIKELY: poor environmental conditions and high physical workload.

Environmental conditions include all factors indicating the **healthiness of the workplace**, which may in some way affect the concentration and well-being of exposed workers. The environmental conditions are to be considered suitable when each of the following parameters satisfies the minimum requirements of the reference standards:
1. Microclimate: temperature and humidity of the air suitable for the body during the working time;
2. Lighting: natural or artificial, which guarantees good visibility at the workstation;
3. Flooring: kept in good condition, with non-slip bottom or one that prevents slipping or falls;
4. Spaces: respect for physical encumbrance spaces and range of motion;
5. Noise: absence of background noises that could compromise the operator’s concentration.

The physical workload reflects the principles of ergonomics applied to the workstation, and considers:

NUMERICAL VALUE	RISK LEVEL	MEASURES OF PREVENTION AND PROTECTION
2 - 4	NEGLIGIBLE	Maintenance of the conditions and measures of prevention and protection or identification of adaptation interventions to be planned.
5 - 12	LOW	Control over the maintenance of safety conditions, verification of any system deficiencies or review of prevention and protection measures.
13 - 24	MEDIUM	Implementation, in a short time, of prevention and protection measures and improvement of system conditions and / or continuous supervision.
≥ 25	HIGH	Immediate implementation of prevention and protection measures and improvement of system conditions.

Tab. 1- *Levels of risk*

1. Energy consumption: energy consumed during the performance of the activity;
2. Times and rhythms of work: n. of actions required during working time;
3. Posture: no obligation to assume a fixed posture.

A low physical workload requires that all the parameters considered are compliant following the analysis of the work cycle.

• **Avoidability**

The last parameter that determines the probability index is represented by the Avoidability. **Avoidability** means the obligations under art. 71 and that the employer is required to observe when he makes any type of equipment available to workers. The requirements to be taken into consideration are:

1. Correct installation and intended use in compliance with the instructions provided by the manufacturer;
2. **Suitable maintenance** carried out by skilled workers specifically for this function;
3. Information, education and training of operators;
4. Dissemination of **safety procedures** (assembly; disposal; transport; procurement; etc.);
5. **Periodic control** interventions, according to the methods and frequencies established based on the indications provided by the manufacturer;
6. Availability of **PPE adequate**.

The avoidability index values are 0, 3 and 5 (fig. 15), divided according to the percentage of enforceable obligations met:

1. HIGH: 100% of the feasible requirements met;
2. AVERAGE: 51-99% of the feasible requirements met;
3. LOW: 0-50% of the feasible requirements met.

Once the actual values have been established for each of the components of the formula, a numerical value is obtained for each of the **hazards identified**.
This number value is then associated with a table containing the risk levels, to which the prevention and protection measures correspond as illustrated in the following table (Tab.1)

Application

An automated application (with Office Excel software) has been developed to assess the accident risk associated with the use of equipment, which contains a series of sheets as follows:

- **Instructions**: A practical guide which contains information on how to use the application correctly;
- **Flow chart**: A schematic representation for defining the degree of conformity of the equipment used according to the regulations in force;
- **Census**: A valid tool for collecting preliminary information about the equipment provided within a facility / company. It consists of a table divided into four sections, each of which containing fields to be filled in, with the aim of creating a detailed overview of the status of the equipment.
- **Application UNI.ATT**: the core of the application, characterized by five main elements:
  - **Section summarizing the data of the equipment in question**: This section is used to recognize the machine for which the risk is being assessed (in practice, the data entered in the "equipment census" sheet are taken up);
  - **Hazards identification section**: in which it is possible to select, through a drop-down list, the hazards inherent to the equipment under analysis and add a brief description;
  - **Risk calculation**: the part in which the calculation is carried out with the selection of the indices illustrated above;
  - **Evaluation result**: the cells in which the numerical values of the calculation and their judgment are reported, based on the parameters indicated in table 1;
  - **Note**: section in which it is possible to note the criticalities detected during the evaluation or the possible improvements in reference to the parameters exposure, occurrence and avoidability.

Experimental application of the method

The proposed evaluation method was preliminarily tested in the LaStra laboratory of the Department of Civil, Construction and Environmental Engineering of the Federico II University of Naples. The method was validated (following the principles of ISO 9001)

by extending the application of the method to various private and university realities. In particular, the Botanical Garden was involved (to test the method on agricultural machines), the Department of Industrial Engineering of the University of Naples Federico II (with the presence of laboratories and workshops), an engineering construction company and a construction site. The validation process involved the application of the method on a total of 58 machines.

CONCLUSIONS

The experimental application of the methodology and operational tools made it possible to evaluate the effectiveness of the method: the results obtained reflect the risk situation of the work situations examined. In particular, it was found that, in the presence of hazards with a high level of severity and with structural / organizational deficiencies and prevention and protection measures, the estimated value of the risk is in the MEDIUM / HIGH class, highlighting the need for priority interventions. . On the other hand, for hazards characterized by a mild or moderate level of severity and with some system deficiencies, the MEDIUM risk class has never been exceeded. Finally, a LOW level of risk was found in cases of use of recently built equipment (which comply with the most recent safety regulations) with the presence of optimal working conditions.

In conclusion, the developed algorithm allows you to:

1. Preliminarily identify non-compliant equipment, both from a technical and documentary point of view, in order to guide those responsible for verification / adaptation or possible decommissioning;
2. Identify all the dangers related to each piece of equipment, through a careful categorization of the same and the possibility of extending the evaluation process;
3. Identify the deficiencies related to the intrinsic characteristics of the equipment, the methods of use, the work environment (eg background noise, lighting, work load, etc.), the specific prevention and protection measures (eg. PPE , training, etc.);
4. Support the assessor in identifying appropriate prevention and protection measures according to the estimated risk level and the variables taken into consideration during the assessment.

Ultimately, considering the experiments already carried out in different types of work activities, it is assumed that, with the necessary precautions and / or adaptations, the method can be extended to any working reality in which there are equipment or work machines.

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