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Qualitative Analysis of Risk for Safety Belt Testing Equipment

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Abstract
Organizations of all types and sizes face a number of risks that may affect the achievement of their goals. These goals can relate to a range of organization activities, from strategic initiatives to operations, processes, and projects. Risk assessment provides decision-makers and responsible parties with a better understanding of the risks that could affect the achievement of the objectives. The paper presents the main method to be used in risk assessment, namely risk analysis. It provides a basis for deciding on the most appropriate approach to be used to address the risks.

Keywords
risk, safety, standards, risk management, risk assessment methods-technique

1. Introduction

In any area of economic, social or political activity, there is the problem of the risk that may arise, with consequences that cannot always be predicted or anticipated.

Risk assessment and modeling is a complex activity, involving multidisciplinary approaches from different branches of science, namely knowledge from the economic, technological, sociological or political domains. The results of the risk assessment have a decisive influence on the decisions and the success of the strategies adopted at the macro and microeconomic level.

The stages of the risk management process as presented in the literature are: setting objectives, identifying risks, risk analysis, risk assessment, establishing and implementing an appropriate risk response strategy (risk treatment), communication and consultation, and monitoring or review.

Risk analysis consists of determining the consequences and their probabilities for identified risk events, considering the presence (or not) and the effectiveness of any existing controls. The consequences and their probabilities are then combined to determine the level of risk [1].

Two major categories are distinguished in the risk analysis process: qualitative risk analysis and quantitative risk analysis. The results of the qualitative risk analysis are less accurate, they are more indicative than precise. If these results are not satisfactory, risk management also provides a quantitative analysis showing results in numerical form as a result of the calculations made.

2. Model of Qualitative Analysis of Risk for Safety Belt Testing Equipment

Qualitative analysis is an important step in the risk management process, which involves the following steps (Figure 1):

- the choice of risk and probability scales;
- establishment of the risk reference matrix;
- determining the risk score and the risk matrix;
- the ranking of risks.

Qualitative risk analysis process is shown in Figure 1.

Qualitative risk analysis includes several techniques: scenario technique and probability-impact matrix technique [2].

The technique of scenarios involves the formation of a group of informed people, specialists in the field, who are required to apply their knowledge and imagination to describe one or more possible ways of carrying out an event from a situation concrete.

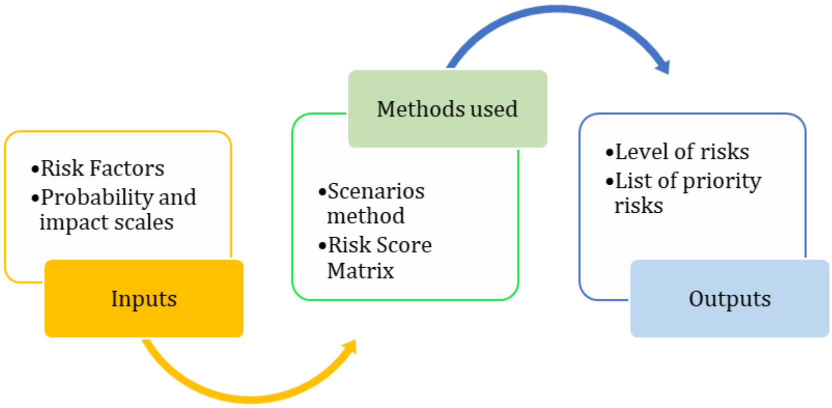

Fig. 1. Qualitative risk analysis process

Probability-impact matrix technique is a technique that combines the two components of the risk thus presenting an overall image.

2.1. Identification of risk factors

As a result of the assessment of the existing situation, factors that may influence the likelihood and impact of the risk, respectively, can contribute to increased risks of obtaining invalid safety belt tests have been identified (Table 1).

Table 1. Risk Factors

R_i	Risk Factors
R1	Improper use of equipment
R2	Use of equipment by unauthorized personnel
R3	Performing incorrect tests
R4	Failure to follow the instructions for use of the equipment
R5	Overload of equipment
R6	Fatigue
R7	Unergonomic working position
R8	Use of uncalibrated equipment
R9	Noise
R10	Low reliability degree
R11	Hard to exploit
R12	Improper temperature
R13	High humidity
R14	Positioning of equipment in too small space
R15	Positioning of equipment in a poorly illuminated space
R16	Incomplete working method
R17	Failure to observe the order of operations
R18	Application of improper force on the material

2.2. Determination of probability and impact scales

Risk analysis by means of probability and impact helps to identify those risk factors that have a high score and to adopt the appropriate treatment which may be acceptance, mitigation or elimination [3].

The probability scale of risk (Table 2) can be made up of two categories of values, namely:

- ordinal values, respectively very low (almost impossible), low (unlikely), medium (possible), high (probable) and very high (almost safe);
- cardinal values, in which case the above ratings are assigned probability scores, respectively 1, 2, 3, 4 and 5, in which 1 is the score for a risk that has a very low probability of occurrence, and 5 is the score of a risk that has high probability of occurrence.

Table 2. Probability scale of risk

Qualitative assessment of probability	Quantitative assessment of probability	Probability score
Very high (very probable)	Once in 3 months	5
High (probable)	Once in 6 months	4
Medium	Once a year	3
Low (unlikely)	Once in 3 years	2
Very low (very unlikely)	More than 3 years	1

The risk impact scale (Table 3) reflects the severity of the damage, in case of risk occurrence and may be:

-ordinary, with impact values: very low, low, moderate, high, very high;

-cardinal, with the values of impact scores 1, 2, 5, 10 and 20, in which the value of 1 represents the score for a very low impact and 20 for a very high impact.

Table 3. Risk Impact Scale

Qualitative impact assessment	Quantitative impact assessment	Impact score
Very high	Number of invalid tests greater than 20%	20
High	Number of invalid tests between 5 and 20%	10
Moderate	Number of invalid tests between 5 and 20%	5
Low	Number of invalid tests between 1 and 5%	2
Very low	No invalid tests lower 1%	1

2.3. Setting the risk reference matrix

The risk reference matrix is constructed by combining the probability and impact scales of the risk presented in Tables 1 and 2. The risk matrix can be represented both in an ordinal form (the matrix of the risk level) and in a cardinal form (the matrix of risk score) [4].

The risk score (SR) is a criterion by which the risks can be ranked and calculated as the product between the score probability of occurrence of the respective risk (SP) and the score of its impact (SI), according to the relationship 1:

$$SR = SP \times SI. \tag{1}$$

The classification of risks is made by the values of the scores obtained (Table 4).

Table 4. Risk classification

SR value	Risk level	Color
$50 \le SR \le 100$	5 – Very high risk	Red
$25 \le SR \le 40$	4 – High risk	Orange
$10 \le SR \le 20$	3 – Medium risk	Yellow
$5 \le SR \le 8$	2 – Low risk	Light Green
$1 \le SR \le 4$	1 – Very low risk	Green

Five levels are used for risk factor scores, number correlated with probability scale and risk impact levels. For safety belt test equipment, the risks fall into four levels (Table 5).

To assess risk factors, the risk score matrix is ordered by decreasing values of the risk score.

Thus, a risk prioritization is obtained, used in the risk management documentation, which allows the necessary treatment to be established for each risk.

They are thus clearly highlighted, both the risks above the horizontal right called 'critical level' requiring treatments such as avoidance or mitigation, and the risks below the critical level that can be accepted (Figure 2).

Table 5. Levels of risk scores

R_i	Probability score	Impact Score/Severity	Risk score	Risk score
R1	1	20	20	3
R2	1	20	20	3
R3	3	10	30	4
R4	1	20	20	3
R5	1	20	20	3
R6	2	20	40	4
R7	3	5	15	3
R8	1	20	20	3
R9	2	2	4	1
R10	3	5	15	3
R11	2	5	10	3
R12	3	10	30	4
R13	3	10	30	4
R14	2	20	40	4
R15	1	20	20	3
R16	2	10	40	4
R17	3	5	15	3
R18	3	10	30	4

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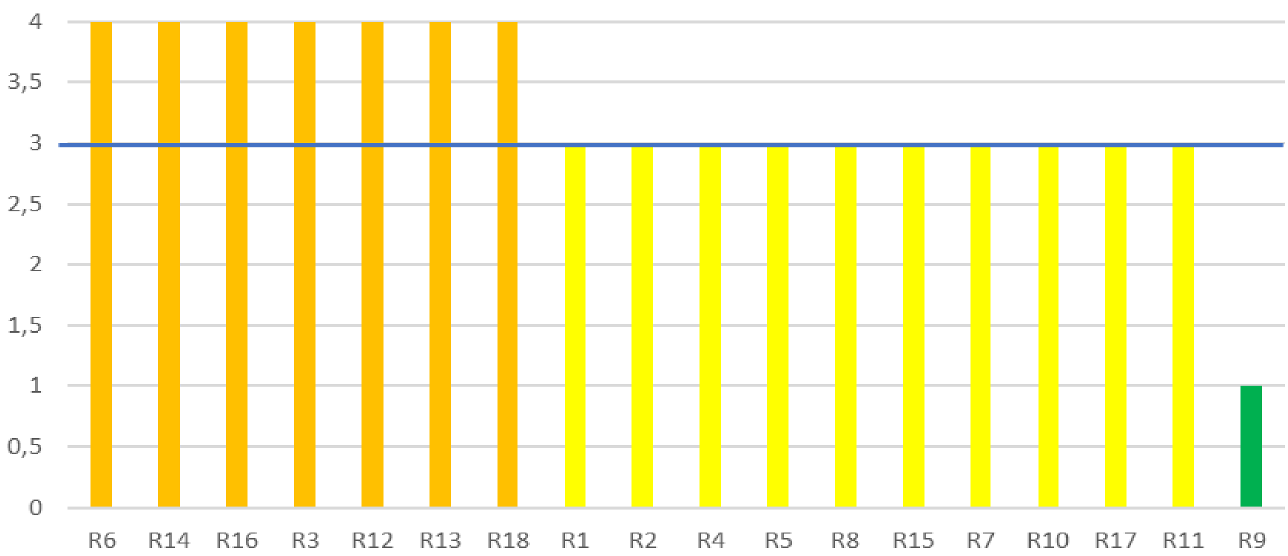

Fig. 2. Risk factors chart

2.4. Risk treatment measures

The main risk treatment measures may be to avoid, mitigate, transfer or accept [5].

For safety belt test equipment, risk mitigation measures are shown in Table 6.

Table 6. Risk treatment measures

Factor determinant	R_i	Effect	Level of importance	Treatment measures
Operator	R1	Risk of injury	Medium	Operator training
	R2	Risk of injury	Medium	Personal Access Authorization
	R3	Invalid test	High	Test repeat
	R4	Risk of injury, equipment failure	Medium	Operator training
	R5	Equipment failure	Medium	Working station protection system
	R6	Risk of injury	High	Existence of breaks in the work programme
	R7	Fatigue	Medium	Evaluation of the ergonomics of the workplace
Machine	R8	Additional costs	Medium	Periodical checking of equipment/recalibration
	R9	Non-compliant working conditions	Very low	Sound protection equipment
	R10	Low productivity	Medium	Replacing components with some more reliable
	R11	Low productivity	Medium	Evaluation and updating of machines
Environment	R12	Failure to comply with the legislation in force	High	Implementation of air-conditioning installations
	R13	Failure to comply with the legislation in force	High	Implementation of air-conditioning installations
	R14	Risk of injury	High	Reorganizing workplace
	R15	Risk of injury	Medium	Installation of lighting fixtures
Method	R16	Invalid test	Medium	Redo test/Redo documentation
	R17	Invalid test	Medium	Operator training
Material	R18	Additional costs	High	Operator training

3. Conclusions

From the example shown above, it can be deduced that the probability-impact matrix is a very useful tool for risk management. This technique is often used in practice, being easy to approach, as well as helping to the management of risk events to establish those who require attention.

The risk treatment process must be followed by a monitoring and review process aimed at identifying changes in the external and internal environment, changes that may entail both the modification of risk factors and the emergence of new risks, situations that claim both a new analysis, evaluation and review of risk priorities, and the review of the treatment to be applied to them.

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