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ASSESSMENT OF THE HUMAN RELIABILITY OF OPERATORS IN A WINE PRODUCING COMPANY, THROUGH INTEGRAL RISK INDEX

Technology

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ABSTRACT

The human reliability assessment for prevention and management of technological risks is very important, yet not well enough explored area. Most of the difficulties, when assessing a worker are related with the diverse expressions of human behavior, and their effect on different risk zones of the technological processes. The following study is aiming to assess how the human behavior of operators in vine producing company influence the execution of their work duties, by using a data from a test system and a mathematical model for risk assessment through integral risk index.

KEYWORDS:

Human reliability, Human error, Integral risk index

The following study is based on the application of the mathematical model for assessment of the integral risk index and human reliability of employees of a vine production company in Burgas region, Bulgaria. For gathering of the data, needed for the research is used a test system, developed also to evaluate the correlation between the theoretical model for the assessment of human reliability and the accuracy of its factors and their constituents and range [1].

There were examined eleven people working at different jobs positions in a factory for initial winemaking, located in Burgas region, Bulgaria. Amongst them were: Manager Plant, Main plant Technologist, Engineers food industry, Operators on fermentation equipment of alcohol and Locksmith mechanics. The applied test system of study is shaped as a questionnaire of 80 questions, grouped into five groups according to the chosen in the mathematical model for integral risk index five basic factors. It was used the five point scale response from maximum to minimum: yes; rather yes; yes and no; rather not; no. Every employee filled the questionnaire in person. The test system includes the following information groups: General information; Professional characteristics; Personal characteristics; Working environment; Physical condition and Collective/Team behavior.

1. Experiment: We chose the largest group of assessed employees, with similar working duties and environment, working in the same working positions. These are five people, working as Operators on fermentation equipment of alcohol. Three of them are man and two of them are women. The obtained results will be converted to a numeric scale at the range from 0 to 1, where the lower values indicate low risk and high human reliability and high values - high risk and low human reliability. In the present study would be shared the results of two cases – Case 1 a woman and Case 2 a man. A detailed list of the basic and component factors values would be given for case 1.

1.1. Integral risk index R_{int} and human reliability assessment calculation. Human reliability (HR) is defined on the base of the integral risk index - Rint (Rint [0, 1]) on the following formula:

$$HR = 1 - R_{int}$$

From the formula is obvious that the lower risk indicator is the higher human reliability is.

1.2 Human reliability, estimated by R_{int}-table 1.

Table 1. Human reliability, estimated by Rint

Value of R_{int}	Quality level of R_{int}	Value of Human reliability	Human reliability assessment
[0-0,20)	Very low risk	(0,8-1,00]	Very high
[0,20-0,37)	Low risk	(0,63-0,80]	High
[0,37-0,63)	Medium risk	(0,37-0,63]	Medium
[0,63-0,80)	High risk	(0,20-0,37]	Low
[0,80-1,00]	Very high risk	[0-0,20]	Very low

2. Operator on fermentation equipment of alcohol working position description: Collects the grape and participates directly in the general activities of the work in the press equipment division. Prepares yeast from the selected yeasts in a continuous and discontinuous processes. Supervises the process of fermentation of grapes. Monitors and participates in the implementation of all operations related to the receipt and storage of wines - cooling, racking, blending, refining, sulfating, centrifugation, and filtration. Directly involved in the production of wine materials for boiling of grape must and grape concentrate. Involved in handling, cleaning and disinfection of wine vessels and equipment. The working position requires work in day shift, eight hours per day, five days a week. The work duties allow micro breaks for relaxation, if needed. The work is collective, not isolated.

2.1. Work's characteristics The work can be characterized with neuro-psychological tension and slight to moderate body loading. Working standing posture is accompanied by bending, squatting and standing, descending, climbing, and twisting the body. Working movements involve flexor and extensor muscle groups in the forearms, shoulder and elbow joints. Loaded are muscles of the neck, back and waist [2].

3. Case1: Operators on fermentation equipment of alcohol – a woman with working experience of 10 years. She has engineering university education, which in her opinion exceeds the knowledge, needed to execute her working duties. She gains additional skills for the working positions by reading specialized literature, when needed (rarely), but she thinks that the theory is less needed than practice. From her personal characteristics is seen that she tends to be nervous.

3.1. Basic and component factors values (Table 2) Table 2. Basic and component factors values for case 1

Basic Factors	Component factors		Qualitative assessment of the factor				
	Title	Weight	Current value	Minimum value	Maximum value	Case 1 data and notes	Normalized value
Working environment							
	Ergonomics	0,30	0,40	0	1	The work requires many physical actions	0,40

	Work organization	0,25	0,50	0	1	Average level of taking decisions	0,50
	Aggressiveness of the environment	0,25	0,50	0	1	Average level	0,50
	Danger substances	0,20	0,10	0	1	Minimum amount	0,10
		1				Aggregated value of the basic factor	0,39
Physical state							
	Psychological health	0,5	0,7	0	1	Nervous	0,70
	Physical health	0,5	0,5	0	1	Average physical state. Physical power is not required for the working position	0,50
		1				Aggregated value of the basic factor	0,60
Behavior in the team							
	The importance of the team for the work	0,5	50	0	100	Average importance	0,50
	Acceptance of the person in the team	0,5	100	0	100	She would not ask for help, from a colleague if needed	1
		1				Aggregated value of the basic factor	0,75
Personal characteristics	*The notes are taken from The big five project personality test,' available online at: http://www.outofservice.com/bigfive/?score-bigfive [3-5]*						
	Risk of Openness	0,20	12	0	100	Prefer traditional experiences	0,12
	Risk of Conscientiousness	0,20	46	0	100	At the average	0,46
	Risk of extraversion	0,20	31	0	100	Shy and away from social situations	0,31
	Neurotism	0,20	60	0	100	Tends to be anxious or nervous	0,60
	Risk of agreeableness	0,20	10	0	100	Easy criticize others	0,10
		1				Aggregated value of the basic factor	0,32
Professional characteristics							
	Qualification	0,40	0,20	0	1	Engineering university education	0,20
	Experience	0,30	0,50	0	1	10 years of working experience	0,50
	Skills	0,30	0,80	0	1	Not interested in gaining skills (only with literature)	0,80
		1				Aggregated value of the basic factor	0,47

3.2. Integral risk index for case 1 (table 3) Table 3. Integral risk index for case 1

First level title	Integral assessment	Results	Integral assessment
	Human reliability		
Basic factors	5		0,45	
№	Basic factor's title	Weight of the basic factor	Number of factors from the second level	Aggregated current value	Weighted value
1	Professional characteristics	0,33	3	0,47	0,16
2	Personal characteristics	0,27	5	0,32	0,08
3	Environment	0,20	4	0,39	0,08
4	Behavior	0,13	2	0,60	0,08
5	Physical state	0,07	2	0,75	0,05
		1			

2.3. Recognition of the level of the integral risk index for case 1 (Table 4)

Table 4. Recognition of Integral risk index level

Level	Very low	Low	Average	High	Quite high
			0,45		

2.4. Human reliability assessment through integral risk index R_{int} for case 1. Tables 1÷4

HR=1 - R_{int}
HR=1 - 0, 45

HR= 0,55 - medium level of human reliability

3. Case 2: Operators on fermentation equipment of alcohol 2 – a man with working experience of 20 years. He has no university degree, but he graduated from a profiled school for technical education, according his opinion his education is sufficient for his job. He has no additional qualification, but thinks that it would have quite positive impact on the work of the team. Open hearted, calm and ready to ask for help if needed. He finds the team very important.

3.1. Integral risk index for case 2 (table 5)

Table 5. Integral risk index for case 2

First level title		Integral assessment		*Results*	Integral assessment
		Human reliability			
Basic factors	5			0,37	Weighted value
№	Basic factor's title	Weight of the basic factor	Number of factors from the second level	Aggregated current value	
1	Professional characteristics	0,33	3	0,32	0,11
2	Personal characteristics	0,27	5	0,48	0,13
3	Environment	0,20	4	0,39	0,08
4	Behavior	0,13	2	0,30	0,04
5	Physical state	0,07	2	0,20	0,01
		1			

3.2. Recognition of the level of the integral risk index for case 1 (Table 6)

Table 6. Recognition of Integral risk index level

Level	Very low	Low risk	Average	High	Quite high
		0,37			

3.3. Human reliability assessment through the integral risk index R_{int} for case 2 Tables 5÷6

HR=1 - R_{int}
HR=1 - 0, 37
HR= 0,63 - high level of human reliability

Results

The operator in Case 2 has better integral risk index and higher level of human reliability than the operator in Case 1. If we compare the two

results we would see, that Case 2 does not have the educational background of Case 1, but has more open and socially oriented personal profile and blends better in the working team, contributing to the common execution of the work duties. He also finds the team very important for the job and is not afraid to ask for help. There is also a positive influence of the longer working experience, which is more practical than theoretical. Case 2 is the person, who would work better and would be more efficient in the working team, than Case 1.

The developed mathematical model for the determination of integral risk index enables a risk expert to improve the human reliability levels by focusing on specific criteria (basic factors), namely: Professional characteristic, Personal characteristics, Working environment, Physical state and Behavior. The model gives, accurate profile of the weak and strong points in these factors expressions in the assessed people. That is very important for every organization no matter of its overall risk level. The results are especially important for jobs, which require teamwork, balanced and productive working environment. Due to its numeric expression the developed mathematical model allows simple comparison, which make it objective and easily applicable.

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