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METHODS OF ASSESSING HUMAN RELIABILITY WITHIN ORGANIZATIONAL BUSINESS

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ABSTRACT

This paper research human reliability methods which are used in the practice of business management. These methods must have the purpose of estimating the probability of human error. Through the paper, various literature of other authors was researched, which list potential methods for estimating the probability of human error. It is important to note that, in addition to other databases, the Web of Science (WoS) and Scopus databases were also used. The results of the research showed that there are methods for analyzing human reliability that can easily estimate the probability of human error in order to reduce it through the implementation of various measures. These are methods for analyzing human reliability, abbreviated HRA. They are divided into quantitative methods of the first generation - THERP and HEARTH, and qualitative methods of the second generation - ATHEANA and CREAM. These methods describe complex mechanisms that are associated with human error in work through specific models. In this way, human errors in management within various processes are detected, after which action can be taken to reduce them. At the same time, it is important to note that the fewer errors there are during production, the lower costs will be.

Keywords: *costs; human errors; management; methods; reliability*

1. INTRODUCTION

Human reliability refers to the probability of successful human work in certain time frames and environmental conditions. Human error increases costs and negatively affects health and safety. Likewise, it negatively affects the quality of products and processes and, consequently, the competitive advantage that company can have on the market. The organization's goal is to reduce human error in order to improve its operations. To manage human error and consequently workforce reliability, there is a need to identify its causes and understand the mechanism by which errors are repeated. The mental and physical condition of the workers is essential for performing the function of their work task in a certain organization. What is known is that certain human conditions affect human error in work. In most cases, these are stress, repetitive work, fatigue and a bad working environment. We found the above through a review of various literature, and we will explain below.

Stress can occur in an organization due to many reasons such as control over work, management style of managers etc. Stress in limited amounts is beneficial for the organization and employees as well. Stress in excessive amounts can cause harmful effects on the body, mind and psychology of employees (Panigrahi, 2017). Repetitive work refers to work that involves constantly performing the same or repetitive operations. Repetitive operations consist of events that are similar in length, amount of power required, or physical action involved. This type of work often slows down productivity and motivation and makes employees dissatisfied (Tyosuojelu, n.d.). Fatigue is a state of mental and/or physical exhaustion that reduces a person's ability to perform work safely and efficiently. Fatigue is manifested by temporary mental and physiological changes and deterioration of work ability. It is usually characterized by reduced attention, drowsiness, poor coordination of movements, weakened visual acuity and the like. Burnout and exhaustion occur as a result of extraordinary demands on the person and when the employee cannot adequately handle what the organization expects from him and under what conditions (Globočnik Žunac, 2022). All of the above, which we know according to the author's statements, has a bad effect on the business of the organization. There are other factors that can achive a bad effect on business, such as poor competence of employees, etc. In order to reduce the above to a minimum, certain methods of assessing human reliability are needed, therefore the aim of this paper is to present certain methods of assessing human reliability in human work. We want to base ourselves on a certain group of methods that can help with such problems. The research problem is to investigate human reliability methods for detecting and reducing human errors in organizational operations. The hypothesis of the work is the existence of a group of quality methods of assessing human reliability that minimize human errors in work.

2. METHODS

One research method was used in the paper, which was based on the study of the literature of various authors and experts related to this field of research. Different bases of papers and professional literature were used, among them Web of Science (WOS) and Scopus. In order for the research process itself to be of the highest quality, it is guided by

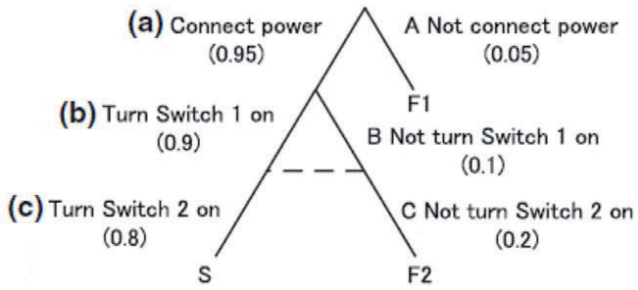
default keywords. With this method, we obtained results that correspond to the topic and goal of this paper. This kind of research gave us the appropriate data that we can present in the research results below.

3. RESULTS

Through the previously mentioned research method, we obtained satisfactory data that we can present further. When we entered terms related to the assessment of human reliability in the paper, the most mentioned methods were THERP, HEARTH, ATHEANA and CREAM. Through research, we discovered that they are the most important methods in this context. There are also other methods that we discovered through literature research, namely (abbreviations) ASEP, AIPA, APJ, CAHR, CARA, CES, CESA, CM, CODA, COGENT, COSIMO, DNE, DREAMS, FACE, HCR, HORAAM, HRMS, INTENT, JHEDI, MAPPS, MERMOS, NARA, OATS, OHPRA, PC, PHRA, SHARP, SLIM-MAUD, SPAR-H, STAHR and TESEO. Below we will explain the most important methods.

THERP (Technique for Human Error Rate Prediction) method is about the level of dependence between two HFEs that are evaluated discretely taking into account their spatio-temporal relationship, functional relevance, stress, and similarity among employees. HFE (human failure events) is the basic probability event of the risk model of the entire system, which represents the event that is carried out in most cases of employees (working personnel). (Kim, et al., 2023.) The THERP method consists of a human reliability event tree that can describe all possible causes and consequences of human error in the work process. The method is designed so that after each branch of the event tree has been assigned a probability of occurrence, the probability of success or failure in the operation process can be derived (Yang & Liu, 2017.). In THERP, a human task is modeled using a binary event tree as shown in Figure 1, which shows an example task consisting of three steps: (1) connecting power to the equipment, (2) turning on switch 1, and (3) turning on switch 2. Each branching node corresponds to an elementary unit of the task, and the left and right branches, respectively, show the successful and unsuccessful paths of the task. One of the shortcomings of the first generation HRA is its limited power to describe human performance situations. It is therefore only applicable to tasks that are well defined as standard operating procedures. Tasks that require complex cognitive judgment processes are beyond the scope of first-generation HRAs. Each branch corresponds to an elementary unit of the task, and the left and right branches respectively show the successful and unsuccessful paths of the task (Ebrary, n.d.). This method is known as the best HRA approach of the first generation whose focus is on quantifying the probability of human errors and operational human errors without too much consideration of the causes and reasons of visible human behavior, which achieves good results of human reliability assessment (Purba & Tjahyani, 2016.).

Figure 1. THERP event tree with probabilities



Source: (Ebrary, n.d.)

The HEARTH (Human Error Assessment and Reduction Technique) method was developed with technical evaluation and human error reduction to identify human error values and calculate human error probability (HEP). This method uses the experience and knowledge of experts to assign operational use. The HEART method can be defined using two basic parameters, namely EPC and GEP. The GEP parameter indicates the generic value of the error probability that the expert performs by selecting a generic task type (GTT). The GTTs described in the method select the appropriate GTT for the task and assign a generic error probability (GEP) relative to the human error probability value. EPC on the other hand shows performance shaping factors for people and can influence the value of HEP. EPC parameters can refer to any internal human characteristic, management, environment, machine, etc. (Ogmen & Ekmekci, 2022.) This method is quite simple and flexible. It also makes it possible to carry out a cost-benefit analysis and gives suggestions on how to reduce the occurrence of errors, and these advantages were mentioned by (Kirwan, 1994) back in 1994.

ATHEANA (A Technique for Human Error Analysis) treats context that causes errors due to a combination of plant conditions and other influences that can contribute to human error. It depicts error types, error mechanisms, unsafe actions, factors that shape human action performance, and employee mental models using informal rules, as a function of the operational characteristics of the scenario and the operational behavior of the process variables. Using retrospective analysis, ATHEANA enables the analysis of the perspective of human error, i.e. the retrospection of significant events that have already occurred and the prospective analysis that identifies potential errors of employees during plant operation. Also, this method checks the existing vulnerability in the training processes of operators and their qualification tests. ATHEANA enables structured and differentiated analysis by combining knowledge and experience in PSA, engineering, human factors and cognitive psychology. In addition, this method considers plant-specific information and experience derived from significant accident analyses. (Fonseca, et al., 2013.) This approach provides a more comprehensive understanding of the context of the human factor that causes an incident or error. (Purba & Tjahyani, 2016.)

The last most significant method that we obtained through research is CREAM (Cognitive Reliability and Error Analysis Method). It is a second generation method used as one of the HRA techniques used in many industries (Shirali, et al., 2019.). This method can be

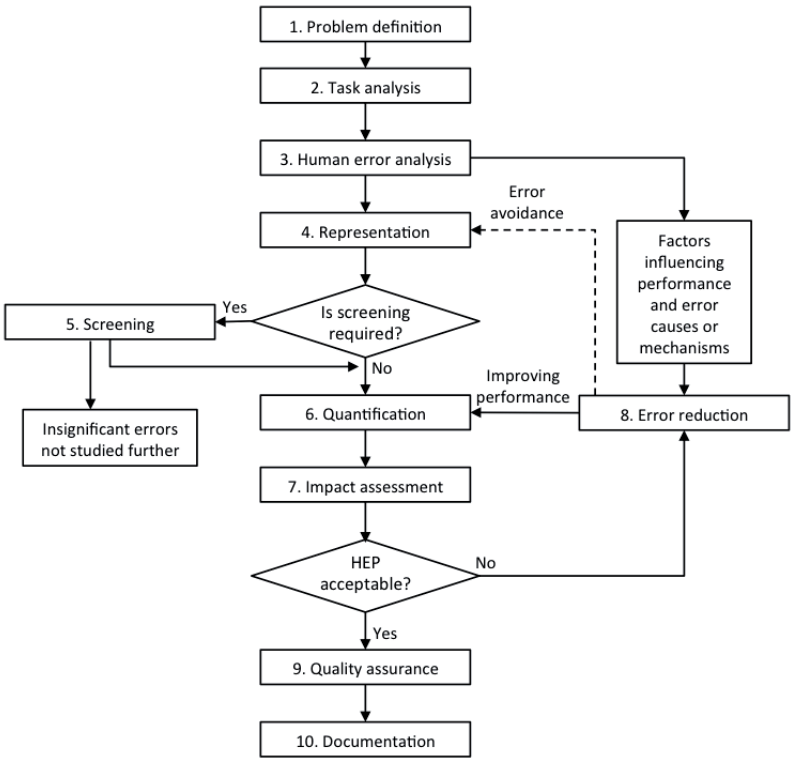
used for retrospective and prospective purposes. Likewise, it can be applied to qualitative and quantitative analysis. The quantitative part consists of a basic and extended method. The basic method is a human error probability quantification process that defines nine conditions. The basic predictive part evaluates CPCs to predict the probability of human error related to contextual control modes with four different failure probability intervals corresponding to the values of the combined CPC results using a mapping in the control mode diagram. CREAM is mainly used as a screening purpose in HRA. It can also be used to identify conditions that may reduce or enhance aspects of human reliability in risk assessment. On the other hand, subsequent and more detailed analyzes of human interactions can be obtained with the extended CREAM method. (Ahn & Kurt, 2020.) The advantages of this method are very concise, well structured, as well as HEP's direct quantification. It provides the HRA framework with nine performance conditions for estimating possible error types and probability intervals which gives it an even better advantage. (Purba & Tjahyani, 2016.)

All of these methods belong to the HRA (Human Reliability Assessment) group of methods that are considered the most useful for reducing human error (Blackett, 2017). All of these methods belong to the HRA (Human Reliability Assessment) group of methods that are considered the most useful for reducing human error.

HRA has several steps listed by (Blackett, 2017), in order: (1) Problem definition: Determining the scope of the HRA, the criteria for achieving the scope, and the constraints within which the HRA must be implemented. Included in this step is determining whether the HRA should be quantitative or qualitative in nature and whether it should focus only on non-routine or urgent tasks or should also consider pre-launch tasks. (2) Task analysis: Description and analysis of the employee's interaction with the plant system and other personnel working in that system, with special emphasis on the tasks/actions that the employee must perform in order to achieve the system's goals. (3) Analysis of human errors: Identification and analysis of human errors that may occur during the execution of the tasks or actions listed in the previous step, which could affect the goals of the system. (4) Data Representation: Development of a model (such as an event tree or fault tree) to show how identified human errors can combine to cause a system goal to fail. The logic of the model can then be used to calculate the overall level of human contribution to risk in the system. (5) Review: Assessing human errors to identify those that should be sent for more detailed analysis. Errors are assigned a highly pessimistic probability to determine whether they have a significant impact on the overall risk level; if not, then they are removed to avoid wasting resources on assessing errors that have no or negligible impact on risk. (6) Quantification: Calculating the human error probability (HEP) for the represented errors and the overall effect of human error on the safety or reliability of the system (based on model logic). (7) Impact assessment: Assessment of whether the calculated risk level for that system is acceptable and which events contribute the most to the risk level. (8) Error reduction: Investigating ways to reduce the level of risk to an acceptable level (if considered too high) through the development of error reduction measures (ERM). This step also includes re-quantification of HEPs according to the changes proposed by ERMs until the risk level is satisfactory. (9) Quality Assurance: System development to ensure effective implementation of all required ERMs and to ensure that all assumptions made during analysis remain valid throughout the life of the system. (10) Documentation: Documentation of analysis results.

These ten steps are also shown in the diagram in Figure 2.

Figure 2. Human Reliability Analysis Process



Source: (Blackett, 2017)

4. DISCUSION

We discovered in this research that there are methods for human errors that can detect them and thus reduce them, which was also our goal. From the total number of methods we found, we singled out a few that are most used in practice, which gives the reader (expert) additional proof of its reliability for practical application. These methods belong to HRA analyses. The mentioned methods obtained from the research can be reduced to a minimum. Through our work, we have confirmed the hypothesis given in the introductory part of the article. In order to confirm the hypothesis, a research method was used that was based on the study of the literature of various authors and experts related to this field of research. We conducted this research because it is weak or not conducted at all. Likewise, the discovered methods are important for every business and logistics process in order to make them better and quality. This was shown by the numerous advantages that we discovered for each of the methods, and they were also mentioned in the research results.

5. CONCLUSION

The research method we used in the paper obtained the required results. They refer to the methods used to assess human reliability in work. HRA analysis methods are mentioned during research. We discovered a total of 35 methods for analyzing and assessing human reliability that fall under the HRA group. We also discovered that 17 of them are in constant use, while we singled out the most significant ones. Among the most important are THERP, HEARTH, ATHEANA and CREAM. Each of these methods has its own advantages that minimize human error. The advantages mentioned are the focus on quantifying the probability of human errors and operational human errors without overmuch consideration of the causes and reasons of observable human behavior, thus achieving good results of human reliability assessment. The next advantage mentioned is the simplicity and flexibility of the method, which at the same time allows carrying out a cost-benefit analysis and gives suggestions on how to reduce the occurrence of errors. Errors are minimized by implementing the suggestions. One method provides a more comprehensive understanding of the human factor context that causes an incident or error, which can also minimize errors. A very concise, well-structured method that provides nine performance conditions for evaluating possible types of errors and probability intervals is cited as one of its advantages, which gives it an even greater advantage for further error reduction. Through the work, we have achieved the goal of researching and presenting certain and most relevant methods of assessing human reliability in human work, and through the aforementioned advantages, we have come to confirm our hypothesis that there are groups of quality methods of human reliability that reduce human errors to a minimum. Further research should go in the direction of investigating the application of such methods in Croatian companies, which would give us insight into such a situation

METODE PROCJENE LJUDSKE POUZDANOSTI UNUTAR ORGANIZACIJSKOG POSLOVANJA

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SAŽETAK

Ovaj rad istražuje koje se sve metode ljudske pouzdanosti koriste u praksi poslovnog upravljanja. Te metode moraju imati svrhu procjeniti vjerojatnost ljudske pogreške. Kroz rad se istraživala različita literatura drugih autora koja navodi potencijalne metode za procjenu vjerojatnosti ljudske pogreške. Važno je napomenuti da su se osim drugih baza koristile i baze Web of Scinece (WoS) i Scopus. Rezultati istraživanja su pokazali da postoje metode za analizu ljudske pouzdanosti koje vrlo lako mogu procjeniti vjerojatnost ljudske pogreške u cilju njihovih smanjenja kroz provođenje različitih mjera. To su metode za analizu ljudske pouzdanosti, HRA. One se dijele na kvantitativne metode prve generacije – THERP i HEARTH, te kvalitativne metode druge generacije – ATHEANA i CREAM. Ove spomenute metode kroz određene modele opisuju složene mehanizme koji se povezuju sa ljudskom pogreškom u radu. Na taj se način detektiraju ljudske pogreške kod upravljanja unutar različitih procesa nakon čega se može djelovati u cilju njihova smanjenja. Pritom je važno napomenuti da što je manje grešaka prilikom neke proizvodnje to će i troškovi biti puno manji.

Ključne riječi: *ljudske pogreške; metode; pouzdanost; troškovi; upravljanje*

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