Revista Minelor – Mining Revue
ISSN-L 1220-2053 / ISSN 2247-8590
vol. 30, selected papers from the 11th edition of
UNIVERSITARIA SIMPRO / 2024, pp. 164-173

APPROACHING HUMAN ERROR IN INDUSTRIAL SETTINGS: MEMENTO FOR ROMANIAN OCCUPATIONAL HEALTH AND SAFETY PROFESSIONALS

Roland Iosif MORARU[1], Gabriel Bujor BĂBUŢ[2], Mihai POPESCU-STELEA[3]*

[1]University of Petroşani,Petroşani, Romania, rolandmoraru@upet.ro
[2]University of Petroşani, Petroşani, Romania, gabrielbabut@upet.ro
[3]University of Petroşani, Petroşani, Romania, mihaipopescu@upet.ro

DOI: 10.2478/minrv-2024-0054

Abstract: *In recent decades, in addition to numerous work accidents in which tens of thousands of deaths, disabilities and millions of days of temporary inability to work have been recorded, we have unfortunately witnessed some major disasters and accidents due to human errors. Indeed, one of the main identified contributors to the occurrence of these undesirable events stems from latent/active human errors. In this article, we try to develop a selective synthesis of some approaches to human error, different characteristic types, models and methodologies that have been developed to support the minimization of these errors. Relevant aspects of human error are systematized, including applicable systems for effective risk management in order to provide Romanian OSH specialists with tools for deepening/understanding a decisive and - at the same time - insufficiently studied aspect at the national level.*
Keywords: *Occupational Health and Safety (OHS), human error, performance shaping factor, human reliability, taxonomy*

1. Introduction

Although a large percentage of accidents are attributed to human error, the integration of human contribution into the safety of technical systems is often rudimentarily analyzed in industrial engineering [1]. The focus is on reliability, availability, maintenance and especially safety. Technical risks concern the main characteristics of the operational safety of a product, considered in a broad sense (system, equipment, mechanism, organization, procedure) [2]. The safety state of a system can be defined as representing the absence of circumstances that may favor the disruption of the system's operation. Starting from the application of this concept to the preliminary architecture of the system, it is possible to identify events such as failures combined or not with human errors and external risk factors, which can induce unsafe conditions. Until recently, the safety of complex systems was approached in a so-called "positivist" manner, which consists in predicting and controlling risks during the design of the systems. Developed especially by engineers and ergonomists, this approach considers technique as a real phenomenon (the "ontological principle"), having an existence outside the subject who observes and realizes it (the "objectivity principle"), having a determined functioning and laws of success that are their own ("principle of the wired universe") being able to lead to the optimal solution ("principle of unique optimum") [3].

It is considered that the reliability of a system can be built by acting on the technology, the work environment of the operators and on the definition of the procedures to be followed. Man is often identified as the "weak link", an element that reduces the overall reliability of the system, as "a black box capable of unpredictable and irrational behavior, at the origin of mistakes, failures and shortages" [4].

The operator has only a small margin of action or reaction in front of an organizational and technical reality that is external to him, because it was foreseen a priori by those who designed the system. A complementary approach, called "constructivist" was proposed by certain authors [5]. This considers technique

* Corresponding author: Roland Iosif Moraru, University of Petroşani, Petroşani, Romania, contact details: University Street, No. 20, Petroșani, Hunedoara County, Romania, Tel.: +40-723-62-41-05 rolandmoraru@upet.ro

as a construction ("principle of the constructed universe"), encompassing the subject who tries to master it or is content to observe it, by means of the representation it makes ("principles of representability and projectivity"), having a complex functioning, which cannot be broken down into simple independent elements and can only lead to more or less satisfactory solutions ("the principle of intelligent action"). This approach capitalizes on the role of operators in the reliability and safety of systems, not limiting their action to a simple follow-up of predetermined procedures, but seeking to benefit as much as possible from their intelligence and their own ability to react to new situations [6].

Based on a "safety culture" and on the development of the spirit of initiative within organizations, at the antipode of the quasi-military discipline required of operators until then, this approach gives the central role to the individual and is part of the "organizational communication" sphere [7].

Contrary to the positivist conception, the constructivist approach considers that safety is, above all, a social and organizational construction, which is the product of the symbolic representations that the operators build together, in action. From this perspective, the safety conditions reside, in particular, in the organizational and human variables. This ability of the organization to fix dysfunctions would be mostly related to a clear definition of everyone's role and a strong personal responsibility [8].

From the perspective of this approach, safety is considered a "dynamic non-event". Thus defined, safety becomes a problem of interaction, elaboration and management of the representations that will give meaning to the situations experienced by the operators. Risk management is only partially the result of the application of some principles established at the level of theory. Risk management is a continuous process of learning from past experiences, one's own or others [9].

In this constructivist approach, risk control is, above all, the ability of operators to anticipate and recover from abnormal situations. It presupposes an ability of the actors to understand the environment in which they are, starting from their own experiences; the perceived meaning of the various stimuli that reach them is the product of cognitive operations and not the result of a previously existing meaning independent of them. The constructivist approach also emphasizes the performance of the actors involved and the place of communication in everyday interactions; it considers communication as an integral part of an organizational structuring process.

2. HFACS: Human Factors Analysis and Classification System

HFACS, the Human Factors Analysis and Classification System is a general human error framework originally developed and tested within the US military as a tool for investigating and analyzing the human causes of aviation accidents. Based on Reason's model of latent and active failures, HFACS addresses human error at all levels of the system, including flight crew status and organizational factors [10].

Let's examine the accident investigation and prevention process separately for the mechanical and human components involved. Figure 1 illustrates the current process of investigating and preventing accidents caused by human factors [11].

This example begins with the occurrence of a flight crew error during flight operations that leads to an accident/incident. An investigation of human performance is then to determine the nature and causes of such errors. Of course, unlike the tangible and quantifiable evidence surrounding mechanical / electrical / hydraulic / technical failures in general, the evidence and causes of human error are generally qualitative and elusive. Additionally, human factors investigative and analytical techniques are often less refined and sophisticated than those used to analyze mechanical and engineering concerns. As such, determining the human factors that caused the accident is a "poor" practice at best; and as a result, the information entered in the database associated with the human factor should be rare, vague and insufficiently clearly defined. As a result, when traditional data analyzes are performed to determine common human factors problems in accidents, the interpretation of the findings and the subsequent identification of important safety issues are of limited practical use. Since its initial development, however, HFACS has been used by other military organizations (eg, the U.S. Army, Air Force, and Canadian Defense Force) as an adjunct to pre-existing accident investigation and analysis systems. By 2010 alone, the HFACS framework had been applied to more than 1,000 military aviation accidents, generating objective, data-driven response strategies while increasing both the quantity and quality of human factors information collected during accident investigations.

vol. 30, selected papers from the 11th edition of
UNIVERSITARIA SIMPRO / 2024, pp. 164-173

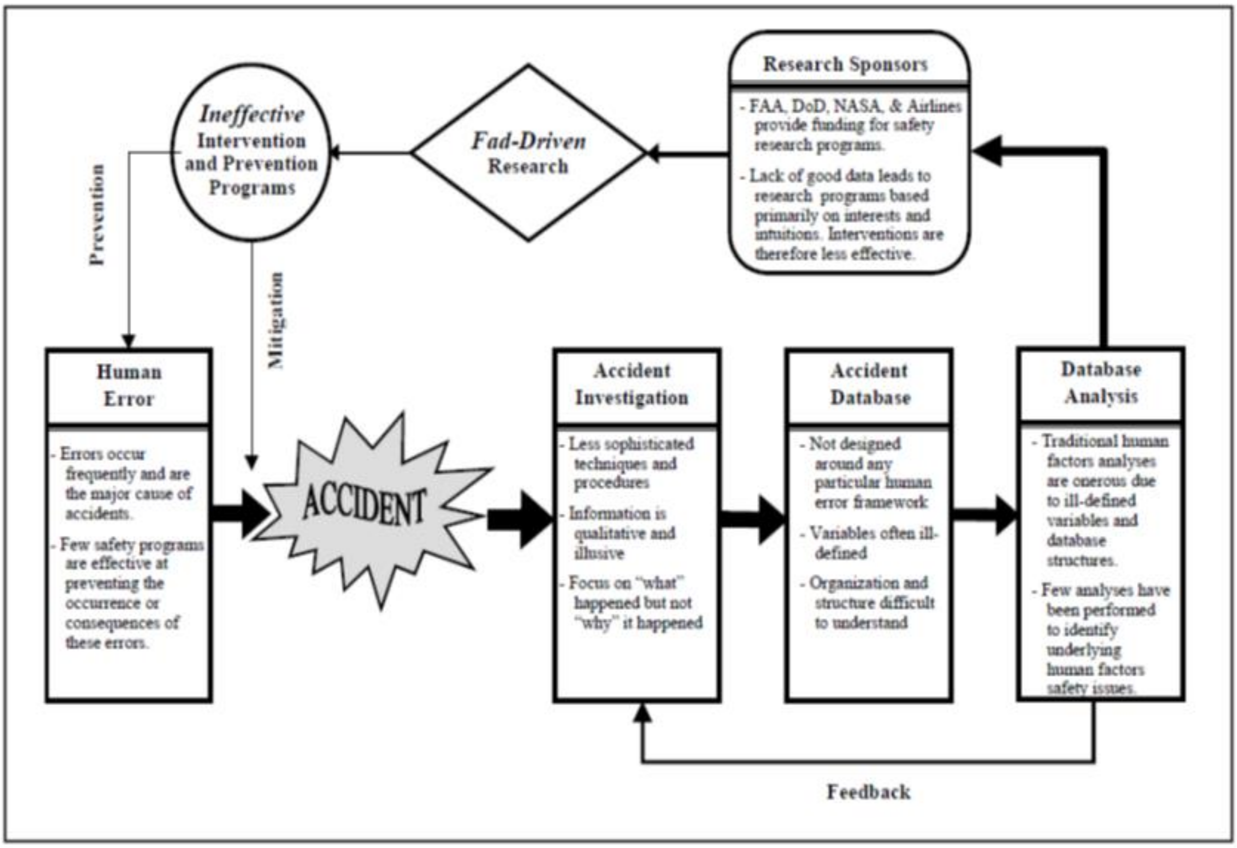

Fig. 1. The overall process for investigating and preventing aviation accidents involving human error (adapted from Shappell, S., Wiegmann, D., 2000) [11]

HFACS describes human error at each of four levels of "failure":

i. unsafe acts of operators (e.g. flight crew),
ii. preconditions for unsafe actions,
iii. unsafe surveillance/monitoring and
iv. organizational influences.

A brief description of each causal category follows (Figure 2). The HFACS framework bridges the gap between theory and practice, offering safety professionals a theoretically grounded tool for identifying and classifying the human causes of aviation accidents, but also of other categories of unwanted events that operates industrial technical systems. Because the system focuses on both latent and active failures and their interrelationships, it makes it easier to identify the root causes of human error [12].

3. Analyzing the probability of human error and human reliability (HEP & HRA)

For decades there have been methods that allow quantifying, for a given task, the probability of human error (HEP, Human Error Probability), using the relationship (1):

HEP= No. of observed errors/No of. Possibilities of error occurrence (1)

The role of these methods is to guide the evaluator in the process of estimating the probability of the occurrence of human error, and the percentage of errors is calculated starting from the databases that contain type errors and from the reasoning of experts. The first analytical approach to human reliability is based on breaking down the workload into elementary steps. The THERP (Technique for Human Error Rate Prediction) method proposed by Swain [13] and then developed in collaboration with Guttman [14] is presented as an example. The method for estimating the probability of occurrence of human error THERP includes, in essence, the following stages (Fig. 2):

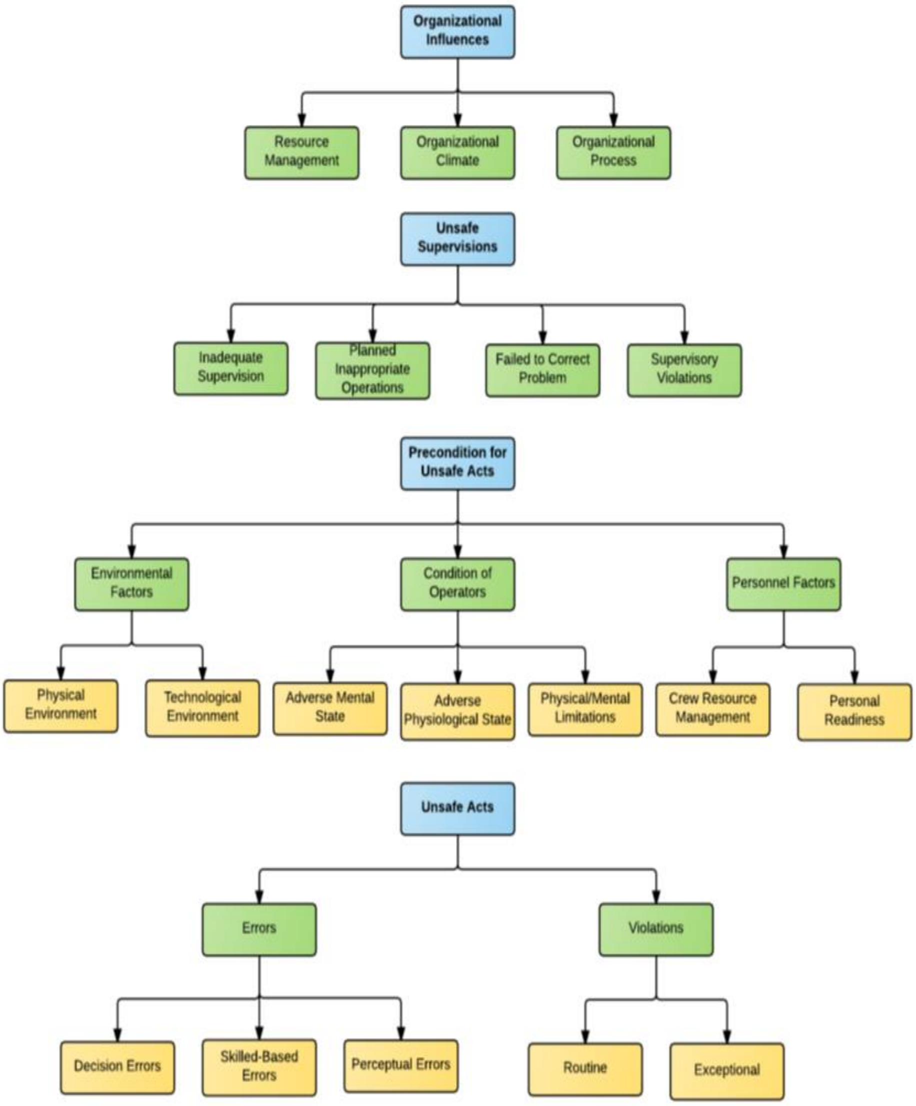

Fig. 2. General description of the human factors analysis and classification system (HFACS) (adapted from Shappell, S., Wiegmann, D., 2000) [11]

1. Defining system failures due to human errors whose probability is to be estimated;
2. Identification, listing and analysis of all operator tasks and their relationships with system functions;
3. Estimating the probability of the occurrence of errors;
4. Determining the consequences of human errors on the system;
5. Proposing measures to reduce the probability of system failure to an acceptable level.

The first stage allows getting to know the system and understanding its way of functioning. In order to achieve the mentioned objectives, a systematic analysis of the defects is carried out (by applying the AMDE method) and then a descriptive and causal analysis of their chaining, by AAD. In the second stage, the analysis of work tasks is completed by a list of elementary actions. The third stage is dedicated to the presentation, in chronological order, of the elementary actions in the form of an event tree of the type represented in figure 3. Each action is associated with three states, namely: success, failure and recovery. These states are represented by branches that each have associated a probability value obtained from the databases. For each action, the error probability P(E) is determined with the relation (2):

$$P(E) = P_1 \cdot K \cdot P_2 \tag{2}$$

where:

P1 is the basic probability;
K - correction coefficient depending on the stress level of the operator;
P2 - the probability that the error will not be recovered.

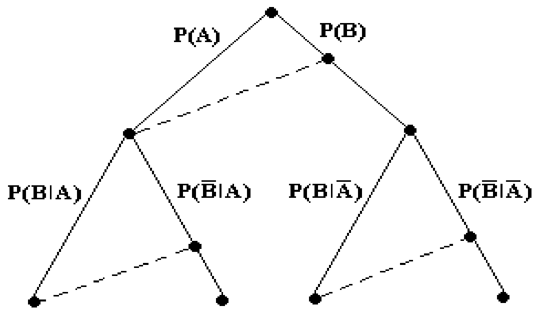

Fig. 3. The human reliability tree

The accuracy of the evaluation can be increased if the PSF (Performance Shaping Factor) performance modeling factors are taken into account, as in the case of the SLIM (Success Likelihood Index Methodology) method. The SLIM method was developed by Embrey [15]. It includes the definition of situations and work tasks and proposes the quantification of the probability of human error by taking into account the PSF values that influence the analyzed work tasks [16].

The success probability of the task P(S) is determined using relations (3) and (4):

$$\mathrm{LogP(S)} = a \cdot \mathrm{SLI} + b \tag{3}$$

with

$$\mathrm{SLI} = \sum_{k=1}^{n} \mathrm{PSF}_k \cdot w_k \tag{4}$$

where:

n is the number of performance shaping factors;

PSFk - the influence of the performance factor;

wk - weight of performance factor "k";

a, b - constants whose values are set by experts based on the probabilities of errors evaluated for known work tasks (during a phase called "calibration").

Another pioneering method that can be used to quantify human error is the MAFERGO method (Méthodologie d’Analyse de la Fiabilité et ERGonomie Opérationnelle) which allows the study and analysis of operational reliability by combining ergonomic aspects with those related to technical reliability. The method involves going through the following steps [17]:

1. Structural and functional analysis: aims to describe the normal operation of the system/installation. The technical point of view describes the technological system and process, and the ergonomic point of view includes the description of the prescribed tasks.
2. Operational analysis: the objective of this stage is to ascertain the operational realities. The actual operation of the installation is analyzed and the level of availability is identified. At this stage, the ergonomic analysis refers to the activities of the operators and their degree of occupation.
3. Identification of malfunctions: going through this stage allows the listing of malfunctions, based on AMDE-type methods. The consequences of the dysfunctions on the activity of the operations are highlighted through the ergonomic analysis.
4. Causal analysis of malfunctions: it consists in establishing a causal graph of the scenarios of malfunctions, a graph that highlights the relationships between technical, human and organizational events.
5. Proposing improvement measures: its objective is to propose improvement measures that are validated by simulation, repeating the previous stages.

The joint study of technical and human aspects is the main original component of the MAFERGO methodology, a methodology that allows taking into account the real operating situations of a system. Quantifying human reliability remains a controversial topic. Moreover, there is a difference between the results obtained by using different methods existing worldwide, but also between the results obtained by different evaluators who apply the same method. Considering the previously mentioned aspects, it can be concluded that the qualitative approach is more pertinent. Moreover, this approach is predicted by Vanderhaegen, who proposes an original method of analyzing human reliability, APPRECIH [18].

This method studies the consequences of human fallibility and allows the analysis of human activity according to the context of the work load. If for technical components it is possible to take into account almost

vol. 30, selected papers from the 11th edition of
UNIVERSITARIA SIMPRO / 2024, pp. 164-173

all modes of operation and failure, in the case of human factors this is not possible, because the human operator is considered a reactive agent (reacting) to the states of the system. Deviant behaviors, in this case violations or violations of prescriptions, are not taken into account in this type of approach. Human reliability analysis methods allow determining the probability of error or success, being based on the analysis of human work. As a result, they represent the potential tools for analyzing human errors in the work system. The conventional approach to risk analysis is probabilistic, generally aiming to evaluate the probability of the occurrence of dysfunctions at the level of the components of the work system. Probability values are obtained from available databases that are often created by component designers and builders. The data is obtained through laborious tests, in which a very large number of identical components are requested many times. Such data banks are practically not constituted for human errors. As previously mentioned, the few available information come, in particular, from the field of the nuclear industry and are mainly obtained through simulations. Effectively, data banks are extremely rare and are specific to certain industrial fields, and the application in other fields is delicate and requires adaptations. For this reason, obtaining the values of the probabilities of the occurrence of human errors results, most frequently, from estimates made through the reasoning of experts guided by certain methods.

In the field of human reliability analysis, the probability of human error is the subfield that deals with human performance in a sense of empirical data. Human reliability analysis basically talks about three vectors which are: human action identification, human activity modeling and HEP –Human Error Probabilities [19].

That said, HEP is defined as the calculated probability that a work task will be performed incorrectly/nonconformingly within a well-known time period and in a sense of relative frequency. Moreover, the methods and techniques used in calculating probabilities related to human performance must be as close to accurate as possible, where miscalculation or underestimation would lead to dangerous failures. Numerous methods are available to perform a probabilistic assessment of human error, of which we only mention here:

i. Human Error Rate Prediction (THERP) technique
ii. Human Error Evaluation and Reduction Technique (HEART)
iii. Standardized Site, Risk, Human Reliability Analysis (SPAR-H)
iv. Technique for Retrospective and Predictive Analysis of Cognitive Error (TRACEr)
v. Absolute Probability Judgment (APJ)
vi. Success Likelihood Index Method (SLIM)
vii.Paired Comparison (PC)
viii. Systemic Human Action Reliability Procedure (SHARP)
ix. Onboard Operation Human Reliability Analysis (SOHRA)
x. Cognitive Reliability and Error Analysis Method (CREAM))

In addition, in human error assessment, not all techniques deal with error probability calculation, as some of the methods are concerned with identifying the most repeated errors. In the context of HEP calculation, which results in a systematic quantification of human error, parameters such as performance modeling factors (PSFs) must be defined in advance. Determining the modeling factors is related to the error modes where the expert described some error modes that would help in the selection of PSFs. PSFs are defined as the effect of general human operations, which leaders/managers can list according to specific maintenance activities and the environment in which operators and technicians work [19]. The identification of PSFs is a part of the HEP calculation; in some methods such as THERP, the performance modeling factors are identified in the form of dependency patterns, and in the SLIM method, the PSFs are combined into a single-valued index/index. It is also important to mention that the variables that can control the quality of PSFs so that the modeling factors are considered a global and integrated aspect of the characteristics of an operator/technician, the work environment, the vision of the organization and the nature of the task that could influence human performance. Furthermore, in human reliability analysis, research has identified different terminologies related to HRA, such as Time Cantered HRA, where operators in maintenance departments are required to work for a longer period of time without stopping/pausing or setting up new equipment. Also in simplification efforts, a HEP calculation equation is demonstrated by and Böllhoff, et al. [20], as having the following form:

$$\text{HEP} = \text{Number of perceived errors}/\text{Number of possibilities for errors to occur} \tag{5}$$

Quantitative approaches are concerned with assigning numerical values to the probabilities of human error, and qualitative approaches are usually concerned with classifications of failure modes to analyze an application or activity where human error occurs repetitively.

vol. 30, selected papers from the 11th edition of
UNIVERSITARIA SIMPRO / 2024, pp. 164-173

4. General model of the work system and factors shaping performance

In recent years, researchers in the field have offered several ways to identify human errors and their different classifications. Several taxonomies are presented in the specialized literature by Böllhoff, et al. [20] (Figure 4).

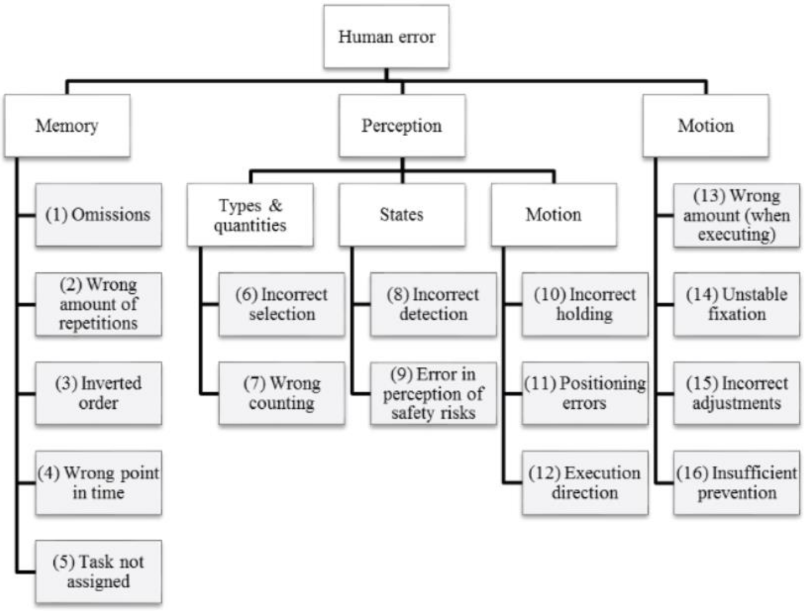

Fig. 4. Classification of human errors (adapted from Böllhoff et al., 2016) [20]

Figure 5 highlights the fact that human factors appear especially in the phases of design, construction, operation and maintenance. People's workstations are shaped by design engineers, the employer and the operator himself. The designer is not necessarily located only at the manufacturer, because the operating company (ie the employer) often sets the requirements very closely, through specifications, etc. [21]

Therefore, the designer neither estimates the deviations from the user's perception of risk at the time of operation nor takes into account his own error. However, systematic errors must be controlled by requirements determined by Safety Integrity Levels (SIL) and by new safety management systems [22].

Risk assessment and control processes still vary in many European countries. During harmonization there is a chance to integrate human input into system safety and performance to establish not only technical interoperability but also human interoperability.

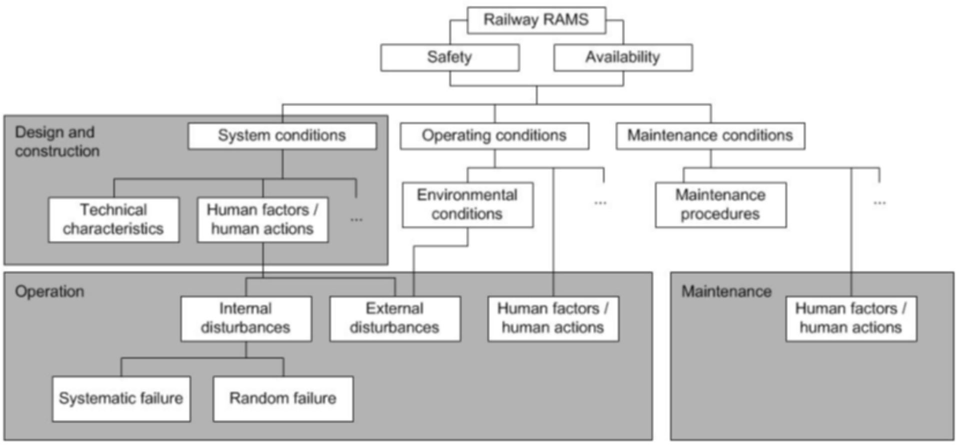

Fig. 5. Human factors in the system safety life cycle

Quantitative risk analyzes are required. So, a frequently used, but not sufficient, way to assess the human contribution to reliability is to integrate human error into classical risk analysis techniques. By using this approach, there is a risk of limiting the human operator to a single error-prone brick in a complex construct. The work systems model defines the core of the system as an interaction of a human operator, his task, and his tools (see center of Figure 6). The set variables are physical, personal and organizational factors, i.e. performance shaping factors.

vol. 30, selected papers from the 11th edition of
UNIVERSITARIA SIMPRO / 2024, pp. 164-173

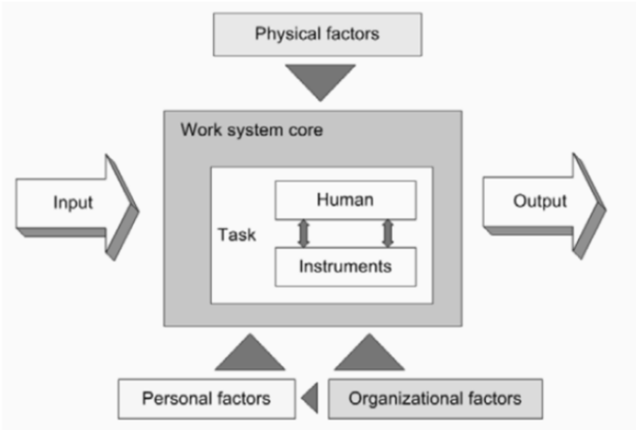

Fig. 6. General model of work system and factors shaping performance

A zoom on human reaction in these surroundings has been added to the core of the work system to account for the high mental demand of today's systems [23].

An extended approach to the multiple interdependent determinations that compete for the set of variation states of the performance modeling factors is shown in the generic network of influence in figure 7. Phenomena such as workload, stress and vigilance level will be understood here – somewhat simplified – as passive variables, i.e. dependent variables, and as a subjective human reaction to influencing factors. For example, alertness depends on fatigue (personal factor), work planning (organizational factor) and how human-machine interaction is designed. Rather, influencers offer the chance for changes through redesign. So, a change in the independent variables (causes) results in effects in the man-machine system. Personal factors can be with or without the influence generated by organizational factors. It should be emphasized that PSFs are constant for a working period, while the cognitive response changes with the situation and with the corresponding inputs.

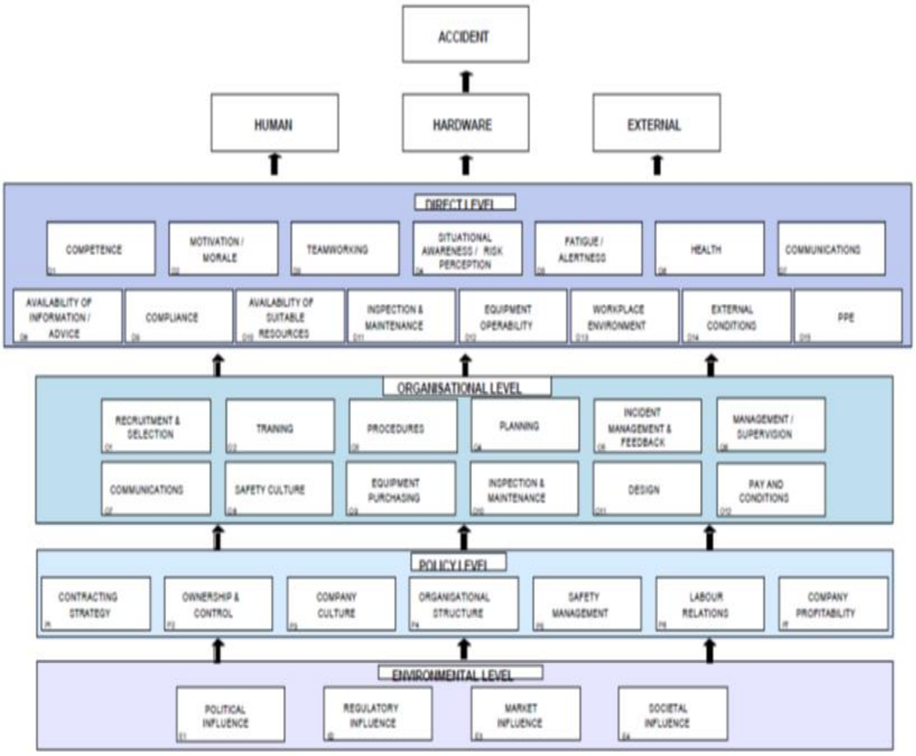

Fig. 7. The generic network of influence on human error

We can consider safety culture as an organizational factor, safety awareness as a permanent attitude of the operator and risk awareness as situation-dependent awareness. High subjective workload, less vigilance, incomplete situational awareness, and reduced risk awareness are examples of error-promoting conditions. So, the diagram provides a practical tool to qualitatively illustrate the performance influences (causes and effects) of a human-machine system.

5. Conclusions

The holistic approach of industrial, technological, financial systems, etc., through the components of their hierarchical, organizational and decision-making structures, is a necessary condition to ensure their proper management. In order to have the expected importance and efficiency, risk management must be an integral part of the general management of the system. This has a specific importance in the management of technological systems, where system failure can be caused by the appearance of dysfunction in hardware, in software, in the organization or at the level of the human factor. The positivist approach to risk control, which consists in predicting and controlling risks during the design of systems, focuses on work equipment, the environment and the work load, and the human being is at the center of the constructivist approach, based on the concept of "safety culture" and on the development of the spirit of initiative within organizations. From the perspective of the systemic approach to professional security, the two approaches appear as complementary, with the task of harmonizing them falling on the practitioners. The corollary of a constructivist approach involves a process of auditing organizations in which not only the practices are systematically examined, but also the way in which the actors involved represent and elaborate them. In this framework, organization and communication, building each other, become emergent realities, forming an indissociable couple. This position, which allows the analysis of the set of elements that are sometimes, artificially, approached in isolation, gives way to a global heuristic for interpreting the phenomena. There are numerous examples of collective errors, occurring especially in stressful situations, during which some actors evade the decision-making act, transferring it to others. At the same time, the culture that this communication develops in the organization is not necessarily beneficial; the critical sense, in the sense of the permanent vigilance of individuals for any dysfunction and openness to novelty, can pale in the face of conformity. The transition from the conception phase to the operation phase is often delicate and sometimes opens real chasms of representation. Thus, the actors of the conception phase sometimes have the tendency to diminish the role of the operators and to consider them, if not as causers of problems, at least as a necessary evil. As for the operators, they do not precisely express their way of proceeding in a context of permanent expectation of a danger (absent most of the time), a stress-generating context. On the other hand, their representation on the system decisively influences the manner of reacting to the unpredictable and imposes constraints when the system is complex. This distance between representation and reality is the cause of many accidents and incidents which, in statistics, are considered to be generated by the human factor.

References

[1] **Cacciabue P.**, 2004
Guide to applying human factors methods - human error and accident management in safety-critical systems, Springer Verlag.

[2] **Chandler F.T., Chang J.Y.H., Mosleh A., Marble J.L., Boring R.L., Gertman D.I.**, 2006
*Human Reliability Analysis Methods: Implementation Guidance for NASA***,** NASA/OSMA Technical Report

[3] **Le Moigne J-L.**, 1990
Epistemologies constructivistes et sciences de l'organisation, in Martinet, A.C., Epistemologies et Sciences De Gestion, Paris: Economica.

[4] **Journe B.**, 1997
Positivisme et constructivisme dans la gestion de surete et de la fiabilite des centrales nucleaires, **Constructivisme et Sciences de gestion, Lille, France.**

[5] **Le Moigne J-L.**, 1990
*La modélisation des systèmes complexes***,** Editions Dunod, Paris, France

[6] **Chang Y.H.J., Mosleh A.**, 2007
*Cognitive modeling and dynamic probabilistic simulation of operating crew response to complex system accidents: Part 1: Overview of the IDAC Model***,** Rel Eng & System Safety, 92(8), pp. 997-1013

[7] **Gort J., Starren A., Zwetsloot G.I.J.M.**, 2006
*Embedding safety in the company's core business - case studies***,** 3rd Working in Safety Conference, Delft, Netherlands

[8] **Hale A., Hovden J.**, 1998
*Occupational Injury: Risk Prevention and Intervention***,** Taylor & Francis, UK.

[9] **Păun A.P., Dura C.C., Mihăilescu S., Moraru R.I., Isac C.A.**, 2020
OHS Disclosures Within Non-Financial Reports: The Romanian Cas, Sustainability, 12, no. 1963

[10] **Reason J.**, 1995
A system approach to organizational error, Ergonomics, 38 (8), pp. 1708-1721

[11] **Shappell S., Wiegmann D.**, 2000
*The Human Factors Analysis and Classification System-HFACS***,** DOT/FAA/AM-00/7 Office of Aviation Medicine, Washington, U.S.A

[12] **Shappell S., Wiegmann D.**, 2001
The Human Factors Analysis and Classification System-HFACS, Human Factors and Aerospace Safety, 1, pp. 59-86

[13] **Swain A.D.**, 1987
Accident Sequence Evaluation Program Human Reliability Analysis Procedure, NUREG/CR-4772, U.S. N.R.C.

[14] **Swain A.D., Guttmann H.E.**, 1983
Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications, NUREG/CR-1278, U.S. N.R.C.

[15] **Embrey D.E., Henderson J.**, 2012
An independent evaluation of the UK process industry association gap analysis tool for addressing the use of an operator as a SIL 1 component in tank overfill protection systems, IChemE Hazards XXIII conference, Stockport, UK

[16] **Embrey D.E., Humphreys P., Rosa E.A., Kirwan B, Rea K.**, 1984
SLIM-MAUD, an approach to assessing human error probabilities using structured expert judgement, USNRC Technical Report, Washington D.C., USA

[17] **Jouffroy D., Demor S., Ciccotelli J.**, 1999
An Approach to Integrate Safety at the Design Stage of Numerically Controlled Woodworking Machines, Integrated Design and Manufacturing in Mechanical Engineering '98. Springer, Dordrecht

[18] **Vanderhaegen F.**, 2020
*Human-error-based design of barriers and analysis of their uses***,** Cognition Technology and Work, 12 (2), pp. 133-142

[19] **Islam T.M., Khan F., Abbassi R., Garaniya V.**, 2017
Human Error Probability Assessment During Maintenance Activities of Marine Systems, Safety and Health at Work, 9. 10.1016/j.shaw.2017.06.008

[20] **Böllhoff J., Metternich J., Frick N., Kruczek M.**, 2016
Evaluation of the Human Error Probability in Cellular Manufacturing, Procedia CIRP 55, pp. 218-223

[21] **Ziębacz I., Moraru R.I.**, 2017
*The quality of human capital and the risk in terms of evolutionary psychology***,** Quality - Access to Success, 18 (S1), pp. 51-56

[22] **Băbuţ G.B., Moraru, R.I.**, 2016
*Occupational risk assessment framework in Romania: an institutional perspective***,** Proc. of the 16th International Multidisciplinary Scientific GeoConference SGEM 2016: 2, pp. 635-642

[23] **Moraru R.I., Băbuţ G.B., Cioca I.L.**, 2012
Operational safety measures in human-machine systems: an overview, Proc. of the 18th Int Conf - The Knowledge-Based Organization: KBO 2012, pp. 86-91, Sibiu, Romania