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Human Error and Organizational Management

Alecxandrina DEACONU
alex.deaconu@yahoo.com
Academy of Economic Study Bucharest
Lavinia RAŞCĂ
laviniar@asebuss.ro
EXEC-Edu ASEBUSS Bucharest

Abstract
The concern for performance is a topic that raises interest in the business environment but also in other areas that – even if they seem distant from this world – are aware of, interested in or conditioned by the economy development. As individual performance is very much influenced by the human resource, we chose to analyze in this paper the mechanisms that generate – consciously or not –human error nowadays.Moreover, the extremely tense Romanian context, where failure is rather a rule than an exception, made us investigate the phenomenon of generating a human error and the ways to diminish its effects.

Key words: human error, performance, management, information processing, organizational culture.

JEL Code: M12

1. Introduction

The knowledge we use nowadays to analyze human error derives, almost entirely, from the organizations that carry out risk operations and threaten with the occurrence of catastrophic events. In this regard, the most generous fields are nuclear energy, chemistry and aviation. However, these are not the only ones.

The work of Alfie Kohn[37] has brought about shocking revelations regarding a new field in which human error has significant effects: *the medical field.* According to the information provided, more and more hospitalized patients die annually as a result of human errors. Even if figures can be contested on the account that death is rather caused by the gravity of the illness than by error, the phenomenon cannot be ignored, especially if we add to the already existent figures the cases when patients die outside the hospital. It is difficult to have a real image as long as the fear of blame and the reward granted to those who deny this reality make the organizations develop a culture of guilt.

For a good part of the XXth century, the main trend in many organizations, especially in the USA, was to associate human error with the environment, with its factors, with the activity, with the organizational design, leading even if to the denial of human involvement. Such a vision, however, is not realistic.

The opinion we sustain in this paper is that human error has roots in the processes based on memory. Thus, the same memory that helps man to adapt, have abstract reasoning, create, and draw conclusions, has a decisive role in processing information and in generating undesirable

[37] Kohn Alfie - Management mistake in Healthcare, Cambridge University Press, Cambridge, 2005.

or wrong behaviour. In other words, man is physiologically speaking predisposed to error. The contextual details and especially their connection with the human nature play also their part to the predisposition to error. Moreover, they increase the complexity of the phenomenon and can often diminish dangerously the aspects of human contribution that should be known and understood in order to implement successfully the requirements of error management.

We are greatly concerned with *managerial errors*. Thus can be explained our attempt to clarify the notion of human imperfection and human error, the generic model of information processing, the relation between the level of human performance and predisposition to errors – these being only some of the topics we deal with below.

2. Defining human error

The suspicion of a human error arises generally when different actions are made or omitted, which are later regarded as generating undesirable consequences (even if the undesirable consequences do not involve the occurrence of human error). The term *error* excludes the cases when there was an intention to affect negatively the result of the action. The errors are associated with the prioritary actions that we want to carry out and in this case two situations can exist:

- if, for any reason, the actions carried out do not come out as they were planned, any undesirable consequence derived from these actions will be due to an error emerged from an undesirable action.
- if the actions develop as they were planned but they did not attain their purpose, any undesirable effect prevented by these actions will be associated with errors emerged from desired but wrong actions.

In any of these situations the mutual element consists of the emergence of *undesirable* or *unfavourable events*. Human error includes also actions whose undesirable effects can emerge much later or can occur after the interpolation of more actions and/or people. Maybe we should also discuss the fact that there are actions that, even if they do not have undesirable effects, can lead to undesirable results and consequently these situations should be considered errors. Under these circumstances, we will accept the idea that what makes the difference between accidents and events with apparent negative visibility of the results is only *the chance*. Sabotage acts, even if they can lead to unfavourable consequences, are not actions that fail the expectances, and that is why they do not represent human error. The same way, the breaking on purpose of the procedures, even if very important, is excluded from the definitions of human error when the actions followed the plan.

This distinction has revealed the need to understand the role of the error – and even the need to encourage the errors – in adaptation and creativity and in gaining knowledge and skills associated with the acquired knowledge.

The lack of consensus in reaching a satisfying definition of human error disturbs so much that can weaken the efforts to identify, control and eliminate the errors from various activity fields and from different activities. Thus can be explained the fact that certain authors abandoned completely the term of human error in favour of the term of *erroneous action*[38], which they consider *an action that does not succeed in producing the expected result, leading this way to an undesirable consequence*.

The problems regarding the definition of human error can be partially overcome if we reveal the models able to establish connections between the human psychological processes and the

[38] Hollnagel, Cognitive Reliability and Error Analysis Method (CREAM), Elsevier Science (1993)

manifestation of unfavourable effects in various activity fields. The attempts to modeling are not very numerous. Analyzing some of them allows us to retain certain useful aspects[39]:

- Human error is connected to human imperfection, as it is influenced by the fundamental sensors, by the cognitive capacity and by the nervous characteristics of the individual;
- Human error is connected to context, that is to the situation variables;
- Human error is seen as an interaction between human imperfection and context. This is probably the most intuitive way the specialists explain the causality of human error.
- The description of the elements that determine human imperfection and the context components allows us to perceive the interactive complexity during their action.
- It is possible to appear barriers able to prevent the spread of the errors and to affect even the context.

There are multiple facets of human imperfection and they all can contribute to human error. For example, personality characteristics that show predispositions to confidence, diligence and perseverance could influence the possibility to make errors and the nature of their expression at the levels of performance based on rules and knowledge, especially under pressure. An extreme confidence can lead to risk-taking behaviour, this being a leading factor in many accidents.

Sleep alteration and tiredness are forms of human imperfection and their signs are often seen as contextual factors. In fact, in the marine and commercial industries, these conditions are often attributed to the rules of the regulation companies or agencies. The effects of tiredness can lead to the depreciation of the results of the performer perceived even as unskilled performer (can generate a degradation of the link of interconnected abilities, starting with decision making, reasoning, memory, reaction time and vigilance. NASA, which asks the pilots to report anonymously the problems they deal with, specified that almost 20% of the incidents registered in its Aviation Safety Reporting System are due to tiredness.

Another facet of human imperfection with serious implications for human error is the *situation of ignorance*, which depends upon the mental model of the immediate environment. As in the case of tiredness, the situation of *ignorance* represents an aspect of human imperfection that can hardly be influenced by the contextual factors.

Understanding the importance of different types of information from the environment leads to the need of *temporary ignorance.* Thus, many potential factors that are connected both to human imperfection and to context can influence the *contextual ignorance*. Knowledge or experience should allow a better general assessment of the situation, especially when there is a big volume of work and time constraints. Thus, it is possible to know all the elements of a problem, the relations between them and to identify some solutions difficult to imagine by those unfamiliar with the problem.

Last but not least, numerous affective factors can corrupt human information – can affect capacities and thus lead man to error. The personal crises can generate distractions and emotional information, can lead to replacing relevant information with *pieces of information*. The same way, the human tendency towards panic and fear reactions can deteriorate the activities of processing information, an extremely dangerous thing for human performance.

Human actions appear in different contexts and that is why a relevant description of them can be carried out only by taking into account the details of the context that accompanied and produced them). The way human predisposition to error is materialized in making certain errors and the expression of these possible errors are tightly connected to the context of the

[39] Dekker, The field guide to understanding error, London, 2005.

tasks. Although the concept of context is often considered objective, it is not easy to be defined, leading to a series of frequent alternative expressions, such as: *scenario, situation, situational context, contextual details, contextual characteristics, contextual functionalities, contextual factors and working context*.

The developers of advanced counting applications often specify the necessity to offer functionalities sensitive and receptive to various usage contexts. Taking into account a definition of the context in the field of information application (that involves a good knowledge of the circumstances), *context* is defined as any information that can be used to characterize the situation of a person, of a place, of an object, as well as the dynamic interaction between these entities.

Many quantitative approaches regarding the estimation of human errors use context related concepts. For example, some of these approaches use *factors that shape performance (PSFs-performance-shaping factors)* either to modify the estimated probability for an activity that was wrongly done, or as a basis for estimating human error. Any environmental, individual, organizational or task related factor, which can influence human performance, can be considered in general PSF. Thus, the factors that model performance seem related to the contextual factors. In any case, these approaches that highlight the probabilities in opposition with error possibilities, take over the side effects of PSFs on human performance to the detriment of the interactive effects. On the other side, tightly connected to the concept of context, there is the interactive complexity between contextual factors. A socio-technical method to quantify human error, known as STAHR, is maybe more compatible with the concept of context which it approaches through the perspective of performance-shaping factors. This method uses a hierarchical network of diagrams of influence to represent the effects of the direct influences on human errors, such as pressure and the education quality, but also the effects of the less direct influences, such as the organizational or political aspects, which project their influences through the more direct factors.

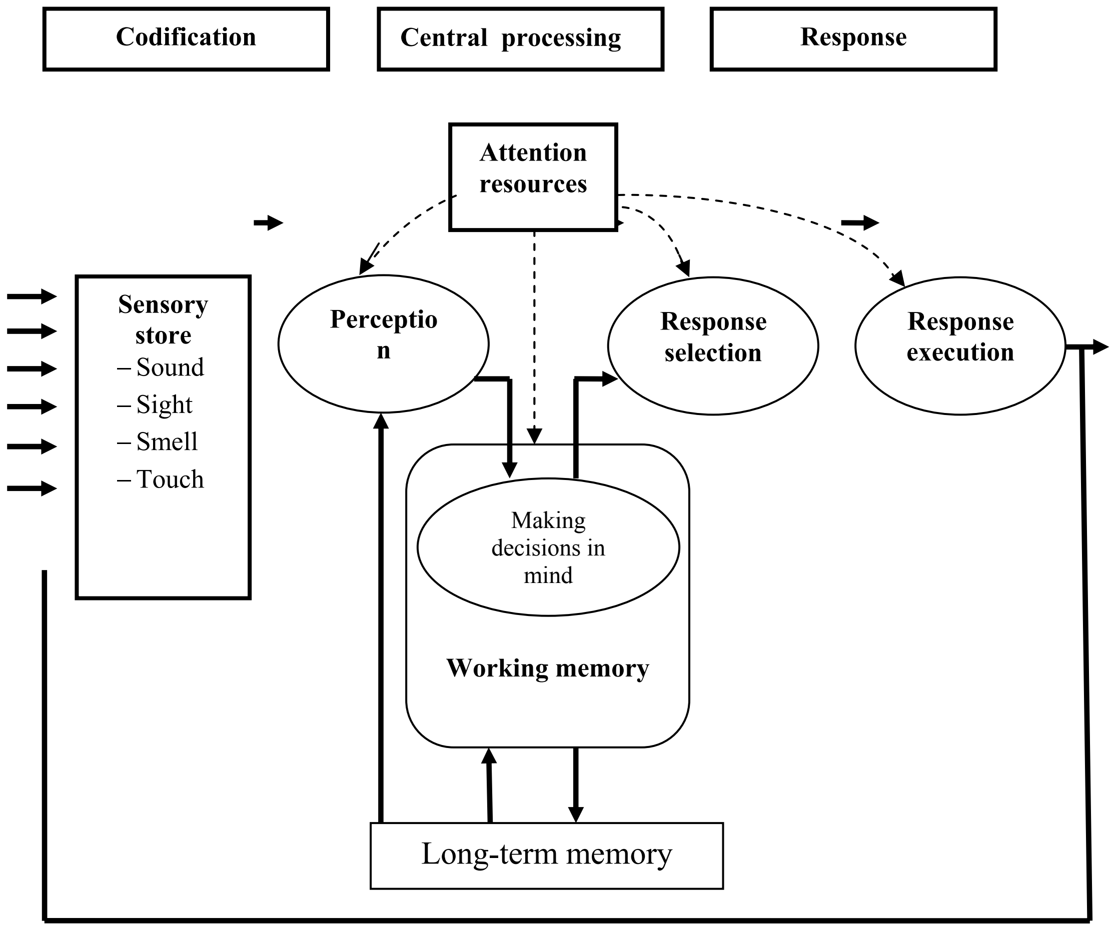
From the perspective of the human factor, error is the result of a discrepancy between the required tasks and the human physical and mental capacities. It is possible that this perspective allow only general anticipations of human error, which are based only on external characteristics.

The socio-technical perspectives regarding human error involve the potential impact on the policies of management and organizational culture, shaping the context where people act. These factors of contextual "importance" are capable of certain and considerable influences on the image of working places, operation procedures, training programmes and communication protocols and can generate overcharges of the tasks by imposing certain conflictual or changing performance goals that create thus a pressure on the individual.

3. Human information processing

Many human errors derive from the fundamental limitations existent in the sensory, cognitive and motor processes. These limitations are better understood if we take into account the *generic model of human information processing*, model that describes the existence of various resources of processing for managing the flow and the changes of information (Figure 1).

Figure 1. The generic model of human information processing



According to this model, the sensory information received by the various receptor cells of the body is registered in a system of sensory stores with a huge storage capacity. Despite this, that information is available only partially for further processing. Through the process of selective attention, subparts of this enormous collection of information are meant for a further processing, known as perception. Here, information can gain significance by comparison with the information from the long-term memory (LTM): it can become a response or can be later processed in a store of the short-term memory (working memory - WM). A great part of our conscious effort is dedicated to the activities connected to the working memory - such as visualization, planning, assessment, conceptualization and decision making - and an important part of this activity of the working memory depends upon the information that can be accessed from LTM. The recurrence of the information in WM makes possible its codification in LTM (If the information is not recurrent, it will disappear rapidly). WM has quite strict limits of capacity as regards the quantity of information that can be maintained active. The controversy is that within WM there are separate store systems for the accommodation of the visual information in an analogous spatial form or of the verbal information in an acoustic form, and there is an attention control system to coordinate these two. Eventually, the results of WM /LTM analysis can lead to a response (e.g. an action or a motor decision), or to reconsideration of the thoughts. It should be mentioned the fact that, even if this sequence of information processing is presented in Figure 1 as a flow from left to right, it can begin from anywhere.

Except for the system of sensory stores and LTM, the processing resources of this model could require attention. Often seen as a mental effort, attention is considered here as an internal source of finite and flexible energy under conscious control, whose intensity can be modulated in time. Although attention can be distributed to the resources of information processing, fundamental attention limits restrain the capacities of these resources. In other words, there is only a limited quantity of information that can bear perceptual codification or WM analysis. Focusing attention on one of these resources will often disadvantage other resources.

Attention can also be concentrated almost exclusively on WM, as it often happens during problem solving or activity planning. The ability to divide attention, on which time division is based, is often noticed at people who learnt to shift rapidly their attention from one task to another. This ability can require knowledge of the temporal requests as well as knowledge regarding the tasks and the possibility that one or more of these become automatic and need thus less attention for their accomplishment. To justify why people succeed, in situations of equal time distribution, in using more efficiently their processing capacities, have been proposed numerous dichotomies within the information processing system: for example, that between visual and auditive modalities and that between early (perceptual) and late (central and the response) processing.

We have mentioned above the long-term memory. LTM has been described as an architecture distributed in parallel that is reconfigured permanently by selective activation and by the inhibition of the interconnected neuronal units. These processes of reconfiguration take place within some distinct modules responsible for various representations of the information, for mental images or for the sentence syntax. During the process of adaptation to new stimuli or thoughts, the complex interactions that appear between the neuronal units lead to generalizations and rules that are so important for human performance. As regards the forms of knowledge stored in LTM, usually we distinguish between the general knowledge we have about the world, called *semantic memory* and knowledge about events, called *episodic memory*.

When elements of the information - such as visual images, sounds and thoughts based on already existent knowledge - are processed in WM at the same time, they become interassociated in LTM. The recovery of this information from the LTM will depend upon the power of the individual elements as well as on the force of the association with other elements. It is assumed that a high frequency and the recent character of the activity contribute to creating more powerful memory connections (more stable), which undergo thus negative exponential alterations.

We can imagine that a great part of our basic knowledge is stored in *semantic networks* that are implemented through architecture distributed in parallel. Other systems of knowledge representation mentioned in the literature regarding the human factors are the mental schemes and models. *Schemes* represent usually organized knowledge regarding a concept or a theme. When the schemes reflect processes or systems for which there are relations between inputs and outputs that man can visualize mentally, and with which he can experiment, the schemes are often called *mental models.* The organization of knowledge in LTM as schemes or mental models is based also on semantic networks.

The restrictions associated with the LTM architecture can favour a better understanding of the human reliability and of the interaction with situational context that can produce errors. For example, the ability to remember both elements of the information and its patterns (e.g. associations) on the basis of partial matches of this information with the memory content is implicit in the case of parallel associative networks. As contexts where people operate often produce what we call *cognitive subspecification*, it is possible that, at a certain moment during information processing, its specification should be incomplete. This thing can be due to the limitations of conceptual processing, WM or LTM limitations or external restrictions. The

LTM organization can overcome these limitations by recovering some elements of the information that match with the input data. Thus it is possible that, by preliminary association with other elements of the information from LTM, a whole regulation should be activated. Unfortunately, this regulation cannot be adapted for particular situations.

Information processing is extremely important in the decision making. Human limitation in decision making can be caused by various reasons that involve, directly or indirectly, LTM. For example, if the information that man decides to select for WM activity is unclear or incomplete, he will need to interpret it intensively or to integrate it. In addition, any hypothesis generated by the decision maker and related to this will depend a lot on the information obtained from LTM. Moreover, sometimes it is necessary an assessment of the hypotheses taking into account further information. Although any hypothesis that has an appropriate basis can be useful for this action, any possible information that should be assessed in WM needs a recovery process from LTM. Furthermore, the effects associated to each action, the estimations of the probability of these effects and the negative and positive implications of these actions should be also taken from LTM.

4. Levels of human performance and predisposition to errors

The attentive observation of the performance and the prediction of various types of errors force us make the distinction between the three levels of performance:

- *Skills:* The activities carried out at this level are intensively repeated and require less conscious attention. They connect perception directly to action, avoiding WM and favouring highly automatic routines.
- *Rules*: In this case, are used rules that have been established in LTM on the basis of some past experience. When the stored rules are not efficient – as it often happens when new challenging problems emerge – man has to make plans that should involve hypothesis exploration and testing and has to permanently develop the results of these effort in a mental representation or model.
- *Knowledge*. At this level of performance there should be expected many requests for information processing, especially by WM, and the performance is vulnerable to the architectural restrictions of LTM, to the extent that WM is dependent upon LTM in problem solving.

In fact, many significant tasks that people carry out represent a mix of skills, rules and knowledge. Although performance at the level based on skills has as effect a considerable economy of cognitive effort, diminishing the attention resources involves a risk.

Many errors produced at the rule-based level involve an inadequate match either of the external suggestions or of the information generated internally with the conditional components of the rules stored in LTM. In general, the conditional components of rules that have been satisfied frequently or that seem to match closely the dominant conditions have a higher probability to be activated. Anticipating errors at this level of performance requires identifying other rules that could be considered more capable to answer the requests of that task and of the whole process. Thus, can be provided not only detailed knowledge only for the current tasks, but also knowledge of the process through which the person obtained knowledge based on rules.

Yet, the general rules have often higher levels of activation in LTM because they have an elevated probability to be met in contextual conditions that involve a smaller amount of work and high time restrictions.
At the knowledge-based performance, when the required associations or schemes are not available in LTM, the control shifts first of all towards intensive activities. This level of

performance is often associated with high degrees of freedom that characterize a man *moving through the problem space* and suggests a greater register of behavioural responses and appropriate reactions to errors The contextual factors that include characteristics of tasks and personal factors that comprise emotional states, risk attitudes and confidence in the intuitive abilities can play a significant role in shaping the models of the error, making these types of errors more difficult to predict.

At this level of performance we notice the insignificant importance paid to the prominent signals or early data, to tendencies of confirmation, to using representative available resources and researches (especially for estimating the cause-effect relations), underestimation and overestimation of the probability of the events as a response to the observed data), wandering (jumping from an exit to another, often without realizing that the exits have already been visited, without having an essential movement in the problem space) and seclusion (overestimation of several details on other's account, probably more relevant information).

5. Conclusions

The study of human error is a topic that deserved being discussed upon in the view of reaching the essence of the things and becoming more prepared to protect our organization. On the basis of the investigations we carried out, we retained several ways of action, which we synthesize below instead of conclusions:

- *Interactive computer systems* that can constrain the user to correct a prioritary input inadequate for the procedure, can issue warnings on actions that could induce errors and can also use auto-correction algorithms that wait for the user intentions. Unfortunately, each of these methods can be interrupted, according to the context where they are used.
- *Written work procedure*, largely spread but very easily neglected. Most of the procedures for the high-risk operations include warnings, contingencies (information about when and how one should give up when dangerous conditions occur during operations), and other specifications. In order to avoid the recurrence of past incidents, these procedures are continuously updated. That is why they increase in size and complexity up to the point when they can contribute to the overcharge of the information, enhancing the possibility to miss or to mistake important information. The procedures that undermine the impulse of human action usually tend to be broken.
- *People themselves* are quite good at detecting and correcting many errors taking into account their experience. Auto-correction requires that man should attentively invest resources periodically to check if his intentions have been fulfilled and if not, to find appropriate suggestions.
- The transfer of *good practices* in organizations, the preservation of organizational knowledge and experience.
- Developing certain *human competences* capable to detect human errors.
- Developing *managerial competences* in the human error field.
- An *organizational culture* favouring a correct attitude towards error.

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