2009 International Nuclear Atlantic Conference - INAC 2009
Rio de Janeiro,RJ, Brazil, September 27 to October 2, 2009
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
***ISBN:* 978-85-99141-03-8**

THE DECISION-MAKING PROCESS DURING ACCIDENTS OR INCIDENTS IN THE OPERATIONAL NUCLEAR AREA

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ABSTRACT

This study reflects on one of the human behavior mediating factors that face nuclear facility operators during their decision-making process. It includes some mental processes used to determine the best course of action, based on intuitive and creative decisions, within a specific set of rational conditions which depend much more on perception about threats than on theoretical knowledge. A fast and efficient decision, in an unstable and on-going changing scenario/environment, is extremely complex. The decision-making process goes beyond the purely rational level and many times is influenced by intuition. The importance of the decision-making process leads the study to also review human factors. The methodology used in this paper is based on cognitive aspects which are focused essentially on studies such as: decision process models, decision types and human rationality limits (time) versus individual decisions. Lastly, it makes assessments on how reason, emotion and being under stress relate to the decision-making process.

1. INTRODUCTION

This study is based on the results obtained from Martins MSc. Dissertation [1] which dealt with human factors focusing human failures. This motivated the further study of one of the human behavior mediation factors in the Decision-Making (DM) process caused by the conditions in which the reactor operators work.

This study is intended to be not only a reflection but also as a tool to minimize accidents and incidents in nuclear facilities, which is also the concern of regulatory authorities.

As pointed out by Simon [2], the decision process generically contains two elements: (1) the action at the moment and (2) the description of a future. The action has an imperative quality, and selects the state of future things in detriment of others and guides a behavior addressed to the choice of an option. This author says “both the decision task and the execution task integrally permeate an organization, the former being, in fact, intimately linked to the latter”.

Therefore we can say that a decision involves action processes to be taken in response to some problem to be solved, for some necessity to be satisfied or for some objective to be

achieved. It considers the various influences suffered by the decision maker during the process or indeed by other factors inherent in the mind and human condition, as well as other aspects such as the decision process model, decision types, individual style and the context in which the decisions are taken.

Faced with a context of uncertainties and rapid changes, we seek mechanisms that assist us to adapt to and even somehow anticipate the changes, so that the action and the execution of this process bring us the best result.

> *"Nevertheless, does not the fact of knowing more and more about life make our hand hesitate? The more we know, the more we doubt. The decision is nothing - it lasts only an instant - and the hesitation is everything - it lasts much longer" [3].*

2. METHODOLOGY

Every study that touches on cognitive aspects, and that is aimed at accidents and incidents, is based on at least two pillars, these being qualitative / quantitative studies, through questionnaires and interviews. They seek worker information of his adherence to tasks and offer an analysis of his performance, a very relevant factor to the objective of the study which is aimed at "decision-making".

Another method is the informal talk that brings answers or very significant information to the objective and also bibliographical research to give a theoretical foundation to the proposed study, where cognitive aspects such as memory, attention, perception, interest and motivation, attitude, emotional state, stress, among others should be considered.

In the context study in which decisions are made, there is basically only one model. Afterwards comes all the information analysis, so that these finally contribute to minimize errors and consequently accidents.

2.1. Decision process models

The concern to know what happens in the human mind at the decision moment, has given rise to decision process models, such as: rational, quantitative, limited rationality.

In the rational and quantitative processes, some factors are important if we previously consider the peculiarity of an accident or incident in which the operator is faced with a situation which confronts time with the action. In this situation there are basic conditions to be fulfilled, such as: if the choice options are given, if the associated consequences are known and if the decision maker has classified the possible sets of consequences. But it is known that these models tend to fail when one ignores the behavioral and subjective factors that are inserted in the decision process.

The cognitive aspects that are involved in the decision process, bearing in mind the human rationality limits, are considered in the limited rationality model.

Explained by Simon [2]:

"Real behavior does not achieve objective rationality, for at least three different aspects":

(1)Rationality requires complete and anticipated knowledge of the resultant consequences of each option. In practice, however, the consequence knowledge is always fragmentary.

(2)Considering that these consequences belong to the future, the imagination must supply the lack of experience by assigning them values, although these can only be anticipated in an imperfect manner.

(3)The rationality presupposes one option among all the possible alternative behaviors. In real behavior, however, only a fraction of all these possible options are taken into consideration.

When confronted with accidents or incidents we face the limitation of time and knowledge limitation, so that the individual is unable to find an optimum decision and then one has to be content with the satisfactory decision in detriment to the optimum.

There are various decision process models, and it is important to know them to detect other ways of this process, other different decision logics for comparison with the applied model.

Another vision of the decision process that must be considered of great value to this study is reason, intuition and disorder. Studies reveal that the rational decision model is not always something linear, unalterable, and that decision makers fit their rationality according to each situation. This is because they consider the existence of cognitive limits in the rational model, where the option selection, or better, the cycles pass through several stages and these frequently repeat themselves taking different paths. Furthermore, the complexity of the problem itself and the conflict existing within it, influence the decision path.

2.2. Decision types

Decisions can be classified as programmed and non-programmed according to Simon [4]:

Programmed decisions – are programmed in that they are routine, repetitive, with established procedures that mean they do not need to be dealt with again when they occur. They require the decision maker to make psychological processes that involve: memory, habits and simple manipulations of things and symbols.

Non-programmed decisions – are new decisions, unstructured and with unusual consequences, where procedures exist to deal with it, and the decision maker performs a judgment exercise. This act depends to a certain extent, on experience, insight and intuition, and according to the difficulty, it is possible that creativity is required.

2.3. Time X Individual decisions

This aspect is related to the human rationality limits, where not everything can be known. Therefore, the decision-making is based on incomplete information regarding possible options and consequences. As a result, the decision maker does not seek the optimum decision; instead he makes the best decision based on information obtained up to that moment and according to his decision-making experience. In other words, the decision maker chooses between those options on hand in function of the available time.

It is important to highlight that this study was focused on individual decision-making.

3. RESULTS

The decision-making process, one of the immediate factors related to human factors, is discussed on the present paper since part of the severe accidents and incidents happen due to human failure. The study of the decision-making process is essential to the minimization of accidents.

Results were based on questionnaires covering variables that involve the performance and engagement of employees, correlated with the safety standards described in an issue by International Atomic Energy Agency (IAEA) [5].

This questionnaire used the methodology of Hayes [6] that offers an evaluation by *Cronbach's Alpha* reliability estimation, using the correlation matrix between the attributes. These results were considered adequate for the first stage of the research and reached good results.

The Likert, cited in Hayes [6] type survey form allowed the evaluation of the degree of agreement and disagreement between the variables, whereas statistically, the average values obtained permitted to classify the installation as partially meeting the Safety Culture.

Qualitative results of this study reveal that the lack of the workers motivation lead to a perception level below the desirable one, thereby influencing directly on the possible necessity of decision-making if considered:

Altered levels of perception determine the behavior in front of the resolution of the problem, even the way to anticipate the problems, making the situation vulnerable to surprises;

As a consequence the low self-esteem, the personal and intuitive abilities which are preponderant factors to determine an action become fragile;

Low motivation leads to an inefficient assimilation of knowledge which influence the behavior on the decision-making process, so in detriment of the situation the level of cognitive control changes passing to act on knowledge level.

4. CONCLUSIONS

This study is not intended to neither express nor exhaustively define what decision-making is, which, by the very nature of its concept, is difficult to define and measure. Many other

variables related to DM are not contemplated by definition, especially the contingency variables, the most complex situations that face the individuals. The intention is that these definitions express DM variables indicators to clarify which concept was adopted to achieve the analysis and interpretation objectives.

Results of this research are focused on a point that corresponds to an individual's mediating factors, which need an intermediary and form the activity base. When the activity becomes altered by the lack of motivation, it enters a process that unfolds alterations in all other directions or factors that influence a human being's behavior and consequently decision-making.

As this is essentially a subjective theme, and in order for this to contribute to minimize accidents and incidents, studies of cognitive aspects are necessary before planning changes. This is because in decision-making process the individuals do not seek an optimum result; instead they choose the best decision based on information, experience and psychological state.

The decision-making process, in front of an initially unstable scenario, sustains itself on rational models, and even on intuitive and creative forms. Fast actions are needed. These actions are taken in short periods of time and leave no time to consult theoretical procedures which could support the options.

Decisions do not always follow procedure requirements. Pressure, physical and emotional state are present and make operators options difficult in the decision-making process. Their actions modify procedures and they act in the knowledge level.

Decision is taken only after the information has passed behind intuition and feelings, therefore, giving a rational appearance. In other words, decision is not rational; instead it is rationalized in parts.

REFERENCES

1. M. P. S. Martins, *Estudo de Fatores Humanos, e observação dos seus aspectos básicos, focados em operadores do reator de pesquisa IEA-R1 objetivando a prevenção de acidentes ocasionados por falhas humanas*. MSc. Dissertation thesis, Instituto de Pesquisas Energéticas e Nucleares (IPEN-CNEN/SP) & Universidade de São Paulo, São Paulo, SP, Brasil, (2008).
2. H. A. Simon, *Comportamento Administrativo: Estudo dos Processos Decisórios nas Organizações Administrativas*. Aliança para o Progresso, Rio de Janeiro, Brasil (1965).
3. B. Jarrosson, *Décider ou ne pas décider? Réflexion sur lês processus de décision*. Máxima, Paris, France, (1994).
4. H. A. Simon, *The new science of management decision*. Prentice-Hall, New Jersey, NJ, USA, (1977).
5. INTERNATIONAL ATOMIC ENERGY AGENCY. *Application of Management Systems for Facilities and Activities Guide*. Safety Standards Series nº GS-G-3.1, Vienna, Austria, (2006).
6. B. E. Hayes, *Medindo a Satisfação do Cliente*; Qualitymark Ed., Rio de Janeiro, Brasil, (1995).