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ERGONOMICS ASPECTS AND WORKLOAD ON THE OPERATORS IN THE ELECTRIC POWER CONTROL AND OPERATION CENTERS: MULTI-CASE STUDIES IN PORTUGAL AND BRAZIL

Miguel Otávio Melo[1]
Luiz Bueno da Silva[2]
Francisco dos Santos Rebelo[3]

ABSTRACT: The operation of the electricity sector has resulted in more sophisticated equipment and requires more attention from operators. This results in increased cognitive load and environments more conducive to error, which can cause failures that result in significant economic losses, physical damage, or threats to human life. This research aims to evaluate the workload of the operators in two Electric Power Control and Operation Centers, using the NASA-TLX method in a multicase studies in Portugal and in the Northeast Brazil. There will be benefits to the electricity sector with new information on those activities contributing to a reduction of human error operation and better system quality.

Keywords: Ergonomics in electric power control centers. Workload. Human factors.

[1]Dr., Professor Production Engineering, Federal University of Paraíba, UFPB, PE, Brasil. E-mail: mobcmelo@ct.ufpb.br
[2]Dr., Professor Production Engineering, Federal University of Paraíba, UFPB, PE, Brasil. E-mail: bueno@ct.ufpb.br
[3]Dr., Professor Ergonomics, University of Lisbon, Lisbon, Portugal. E-mail: frebelo@fmh.ulisboa.pt

1 INTRODUCTION

Institutional changes currently underway in the global energy sector are intended to establish a free market in energy by increasing the efficiency of the sector by allowing competition and raise funds for expansion. In this market, as in any other, participants and agents seek to improve its strategic position by obtaining competitive advantages over its competitors to allow their survival and growth in the system of free competition.

The technicians in the industry are at the center of this process, which is charged with more efficiency and productivity. Being in the center, as a component for determining the success of any company, one of the major challenges that organizations increasingly face is related to the health and well-being of this work, especially those directly related to operation of the system.

With technological advancement, tasks performed by humans are more complex, and work environments become increasingly automated. Similar to the systems developed for other industrial sectors, the automation of the electricity sector has resulted in more sophisticated equipment and requires more attention from operators, bringing the monitor and operating a growing set of equipment. This results in increased workload with emphasis on cognitive and environments more conducive to error. Electrical systems can be categorized as critical systems where failure can result in significant economic losses, physical damage, or threats to human life (LIMA, 2006).

By observing the activity of an operator, Operation Centers and Control checks that it performs an intense activity in a complex, specialized, and dangerous situation. They have the basic item, the prevention of incidents and errors that disrupt the operation of the electrical system, or when this is not possible, they attempt to make the process of returning to normal, which is called recovery. They have to do it by mobilizing knowledge and reasoning for which they received training, which, from the point of view of existing rules, are adequate. However, there are some factors that need to be improved because there are still accidents and incidents caused mainly by fatigue, lack of concentration, or inadequate human-computer interface (HCI) (WU et al., 2005).

Changes in operator behavior alter the workload factor, even if the task requirements remain the same. Many studies on workload have been recently made (MIYAKE 2009, LAN et al. 2010). Some tasks have been done specific to the railroad industry (PICKUP, 2005, 2010; BAULK, 2009; DORRIAN, 2011); and others have been applied to, for example, aviation and nautical sectors (CASNER, 2009; GOULD, 2009).

The activities of the operators of Electric Power Operation and Control Centers can become extremely complex because the worker is subject to a high degree of uncertainty and manipulates numerous variables. There are several areas in which there is a need for a center control operation such as railways, subways, air traffic, road traffic, boat traffic. In these centers there is always the need for an operator able to handle various types of data and information, usually responding to several requests efficiently and in a short time (DARBYet al., 2006; GROTJEN et al., 2006; WALKER et al., 2010).

Thus, the operating environment of an electric power installation includes the employee to perform his activity to maintain the quality parameters of electric energy within the normal range. The development of tasks, which require more complex elaboration processes, refers to the activities of control and diagnostics. Thus, the electric utility workers are placed at a critical juncture, among which, the room operators' Operation and Control, which is complex and where human error can cause serious risks and losses (MAY, 2008).

The automated equipment currently performs more mechanical and repetitive activities, whereas humans perform activities in dynamic contexts, requiring rapid adaptation and flexibility for effective performance. This adaptation to circumstances that change constantly because of the variability of processes and the supervisory role of workers requires complex skills and cognitive abilities. Some studies about methods to prevent problems associated with the work of the operator control systems and automated processes were conducted recently (PERSSON et al., 2001).

In this scenario, the incorporation of the cognitive component in the analysis of the work has become a necessity so that we can satisfactorily answer the complex skills involved in the operation of modern work systems. In this aspect, the health worker considers the work as much as a space where there is domination and submission worker by capital as well as a space of resistance, pivot (OLIVEIRA, 2009).

The main objective of this paper is to evaluate human factors and workload on the operators in the centers of operation and control of electric energy and analyze whether there are differences in workload in two countries of different continents Brazil and Portugal.

1.1 General Considerations

The introduction of new technologies is requiring operators to solve problems of an intellectual nature, even those who might be regarded as less qualified. This means that many of the tasks depend more on reasoning than the layout and physical engagement. The problem is that the routines are also automated and that it could not be included in the programs is something unexpected, exceptional and so something new and that was not the object of reflection that accompanies the act of designing. Thus, the operator is not required to blindly follow rules of thumb, but he thinks that he is so clever as to be able to solve routine problems (VIDAL, 2008).

A starting point of the study is directly related to the performance of the work environment of the operators. In this environment, the factors to be considered include the following: lighting, humidity, temperature, vibration, and noise. In observing these factors, the effect that they cause in carrying out the activities shall also be analyzed, with the stresses exerted by time and the complexity of the equipment operated (LIMA, 2006).

The second point refers to the type of task operators, whose basic item, the prevention of incidents that disturb the normal progress of the process or production step where they work or where this is not possible; try to make return to normal process, the so-called recovery.

They have to do it by mobilizing knowledge and reasoning for which they received training, which, from the point of view of the existing rules, are adequate; however, there are some factors that need to be improved because there are still accidents and incidents caused mainly by high workload that may lead to fatigue and decreased attention and concentration.

Figure 1 shows a typical operating room control and power where there are individual monitors and bottom frames and monitors and monitors overall system. In general, there is a complex information system where the operator is at the center of decisions between different monitors and tables and diagrams that occupies your entire field of vision.

Figure 1 – Room of Electric Power Control and Operations Center
Source: ONS, 2014.

Salles (2008) examines several aspects of these technical power sectors and discusses the aspects of cognitive ergonomics and its contribution in the areas of reasoning, comprehension, and memory, among others.

1.2 Cognitive Ergonomics and Human-Machine Interfaces (HMI)

The engineering of human-machine interfaces (HMI) applies in the context of computerized tasks, where the cognitive processes of the activities are preponderances and is a study area of interdisciplinary and multidisciplinary character that casre about the adaptation of computing systems to its user.

Many researches in this subject were realized been recently made (CAÑAS et al., 2008; ANTOLI et al., 2002; QUESADA et al., 2003; FAJARDO et al., 2004; SAMERÓN et al., 2007; CARVALHO, 2008). These studies and research are increasingly being enhanced because of the complexity of technology, and the development of models for the use and operation becomes simpler (PETERSEN, 2004).

We emphasize the research use of virtual reality in these studies on ergonomics and HMI (ROBERT et al., 2008, 2000; DUARTE, 2010; VIEIRA, 2010; REBELO, 2010, 2012; VILAR 2013).

In the design of an interactive software development, knowledge about human characteristics in information processing are just as important as the understanding of the physiology of the hand and arm in the construction of a hand tool. The goal is to understand the capabilities and limitations of human beings to learn to harness them as best as possible in interface design. An appropriate methodology for this analysis of cognitive interaction can be based on the “principle of mutual dependence” (CAÑAS et al, 2004). This principle states the following:

- The interface functions are great ones that fit human cognitive functions involved in the task.
- The human cognitive functions that are involved in the task depend on the features of the interface.
- The modification, substitution, or the introduction of a new function interface requires adapting human cognitive functions.
- Development, for example, learning, or limitation (elderly users) of human cognitive functions involve limitations on the functions of the interface.

In the specific case of human-computer interface in the electric systems planning and operation task a large amount of multivariate data must be taken into account. As an example of simple information on loadflows, there are a potentially large number of dependent variables, such as flows in transmission lines, bars, generators, reactive power, and data transformers and generators. With systems containing many bars, the biggest challenge is to present these data in a fast and intuitive manner (WIEGMANN et al*.,* 2006, 2005).

In these systems, an interface with the operator who seems confused can result in misinterpretation and induce errors during decision making. Therefore, these systems require quality, safety, adaptability to different users and levels of experience, and training facility associated with their learning and use (VIEIRA et al. 2010b).

May (2008), in turn, underscores the complexity of HMI in operation centers and control for the following reasons:

- Demand for sustainable energy production, leading to an increase of the amount of variable sources of energy generation with low predictability (such as wind);
- Greater integration and increase in the size of the national and regional networks;
- Increased level of automation involving distributed measurements and automatic decisions;

- Increased complexity of coordination arising from the implementation of optimal power flow, based on the electricity markets
- Increased demand for power grids resilient in the form of permanent "micro-networks" or "islanding" that can help protect networks over voltage instabilities. Other complications include the state maintenance of transmission and distribution and the lack of qualified control room operators and updated training and procedures.

The information associated with energy systems has generally been shown using a three dimensional (3D) display interface often consisting of either a diagram or a line list of tabs as shown in Figure 2.

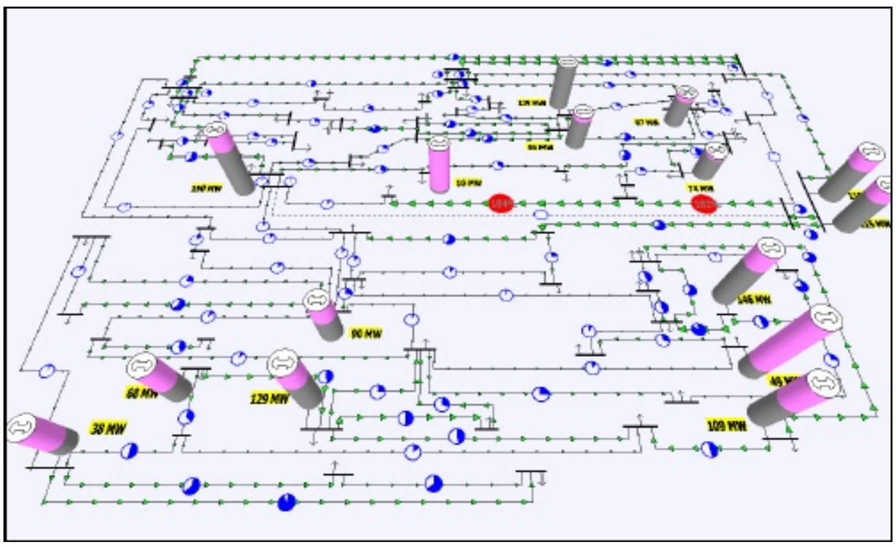

Figure 2 – Electric load flow diagram unifilar 3D displayed on a monitor screen in a Operating Room
Source: WIEGMANN et al., 2006.

In this diagram, the black bars signify electrical substations, lines are power transmission lines, and circles are larger power generations. The smaller circles in blue with internal insertion inform the electrical system load, turn arrows indicate the direction of the flow of electrical power. Pink and gray cylinders represent the power generation.

1.3 The Workload—Mental and Physical

Workloads have an external component, related to environmental conditions in which the worker lives, and an internal component, associated with experiences and tensions relating to labor organizations. It is inversely proportional to the experience of the operator, the more inexperienced is the worker, the greater the workload arising from the interaction operator. A task load also relates to the general conditions of the operator during the performance of physical and mostly mental tasks.

Dadashi (2013) investigated the potential of a semi-automated surveillance system to reduce operator workload of closed circuit televisions (CCTV) on a rail system. In this research, we developed an automated system that provides different levels of trust information system for operators, significantly reducing its workload. Ku et al. (2010) examines the aspects of fatigue and health of workers in the rail systems that are related to organizational systems.

The concept of mental burden is related to cognitive ergonomics, which deals with this branch-related cognitive task (MURATA, 2005). Several studies address this research topic at the University of Granada; Cañas et al. (2010, 2009) and Di Stasi (2010), examined the correlation between the time aspects of the task.

Quesada et al. (2000, 2001) analyzed the mental aspects and defined models relating them to working memory. Moreover, the concept using the relation between the cognitive and mental load is cognitive architecture, which refers to the description of the different elements that constitute the cognitive system and their relationships.

At this point, we have an interface of cognitive and psychic. It can be assumed, for example, that automated reasoning produces a mental burden smaller than the arguments or nonautomated troubleshooting. However, this may not be true if the executors of this task have an automated training and education far above the requirements of the task (PERSSON et al., 2001).

What we try to emphasize is that the use of subjective methods to assess mental workload gives researchers a basis for comparison between different moments in the execution of the same task or between different tasks. On this basis, one can make a series of investigations, including transposing to psychic barrier and organizational aspects.

1.4 Evaluation Models of Engineering Ergonomics and Workload

There are several methods for assessing engineering ergonomic work with emphasis on the cognitive function and workload. Various methods include the following: NASA TLX, VACP method, MRQ, and SWAT (dimension-based instrument).

The NASA-TLX used in this research is a method of a multidimensional measure of mental workload, arising from an overall score ranging from 1 to 20 in relation to workload guided the weighted average of ratings of six subscales.

These six factors involve the following: levels of achievement, effort, and frustration, which have strong influence on the individual characteristics of the operators; and the mental demand (MD), physical requirements (PR), and temporal requirements (TR), which are determined by the work situation.

The level of achievement (LA) refers to the satisfaction with the performance of the personnel who carries out the task. The level of effort (LE) is in terms of how much you have to work physically and mentally to achieve a good performance. The level of frustration (LF) is the factor that inhibits the completion of work, such as insecurity, irritation, lack of stimulation, and setbacks. The mental demand (MD) involves mental activity required for the completion of work, the physical requirement (PR) corresponds to the physical activity required for execution of the work and the time requirement on the level of imposed pressure to achieve the same, as shown in Table 1 (NASA, 2008; DINIZ, 2003).

Factors considered	Low Limit Level 1	High Limit Level 20
Mental Demand	Tasks considered easy, simple, goals achieved without difficulties	Tasks difficult, complex, requiring much mental effort to achieve the goal
Physical Requirement	Light, slow, easily accomplished tasks	Heavy, quick, strong, and lively tasks
Temporal Requirement	Slow and relaxed pace, with low pressure to the termination of activities	Fast and furious pace, with lots of pressure for completing the activities
Level of Effort	You become no satisfied and almost no one notices your work	You feel very happy and are praised when it reaches the goals
Level of Achievement	For the task to be performed successfully, surface concentration, muscle strength light weight, and simple reasoning are required (lack of skills)	Deep concentration, muscle strength, intense, complex reasoning, and great skill are needed
Level of Frustration	You feel safe, happy, and relaxed when you run the task	You feel insecure, discouraged, angry, and bothered with the task

Table 1 – Factors considered in the NASA-TLX Method
Source: Diniz (2003).

The VACP method (visual, auditory, cognitive, and psychomotor) is an early attempt at a simple tool for measuring diagnostic workload; when combined with network modeling tasks, it can be used to assess load job and task demands according to a list, with one of the four standard dimensions.

Levels were assessed dimensionally to create ranking intervals that could be used in simulated constructions. A method has been proposed; a simple sum with a threshold value of any of the dimensions could be achieved before operator overloading would occur (CAIN, 2004).

The method is to attempt to assess the cause of the workload through the multiple resources questionnaire. This MRQ method correlates well with others.

The SWAT method is a widely used technique (CAIN, 2004). Multidimensional assessment or multi-scale techniques often have procedures to create an aggregate ranking of the overall workload and SWAT proposes an aggregation procedure, which has a solid base metrology.

2 METHODS AND MODELS

The research used a sample of operator control center electricity with 27 operators in Portugal and was compared with a sample of 27 operators in North Eastern Brazil. This total sample of 54 operators corresponds to approximately 20% of all operators of the selected region of Brazil and Portugal.

Questionnaires were given to evaluate the NASA-TLX method, to obtain information on the following variables: MD (mental demand), RP (Requirement Physics), TR (Temporal Requirement), LA (Level of Achievement), LE (Level of Effort) and LF (Level of Frustration). The scale corresponds to the first minimum value and the maximum index 20. Technical measures of central tendency and box-plot graphs were used to evaluate the data collected for possible differences between the search parameters. Correlations were used to analyze the associations between variables. Regression models and single were constructed to identify linear relationships between variables. Finally, we analyzed the reliability of the models and comparisons were performed between the model parameters as well as the percentage of influence of independent variables on the dependent variable MD (Mental Demand).

3 RESULTS

The results show Table 2 and 3 the general data and comparative statistical analysis of the available data sample corresponding to 54 operators and six variables: MD, RP, TR, LA, LE, and LF.

Brazil Results					
MD		RP		TR	
Min	1,00	Min	1,00	Min	1,00
1st Qu.	16,50	1st Qu.	8,00	1st Qu.	14,50
Median	19,00	Median	11,00	Median	16,00
Mean	17,67	Mean	10,03	Mean	15,85
3rd Qu.	20,00	3rd Qu.	13,00	3rd Qu.	19,00
Max	20,00	Max	20,00	Max	20,00
LE		LA		LF	
Min	1,00	Min	3,00	Min	1,00
1st Qu.	14,50	1st Qu.	16,00	1st Qu.	4,50
Median	16,00	Median	17,00	Median	10,00
Mean	15,85	Mean	16,48	Mean	8,667
3rd Qu.	19,00	3rd Qu.	19,00	3rd Qu.	15,50
Max	20,00	Max	20,00	Max	18,00

Table 2 – Results of NASA-TLX method variables (Brazil)
Source: Own Elaboration.

PORTUGAL RESULTS					
MD		RP		TR	
Min	6,00	Min	1,00	Min	4,00
1st Qu.	11,50	1st Qu.	2,00	1st Qu.	13,50
Median	15,00	Median	3,00	Median	17,00
Mean	14,37	Mean	5,185	Mean	15,33
3rd Qu.	18,00	3rd Qu.	5,00	3rd Qu.	19,00
Max	20,00	Max	20,00	Max	20,00
LE		LA		LF	
Min	5,00	Min	7,00	Min	1,00
1st Qu.	10,50	1st Qu.	13,50	1st Qu.	5,00
Median	14,00	Median	15,00	Median	9,00
Mean	13,37	Mean	14,81	Mean	9,00
3rd Qu.	15,50	3rd Qu.	17,00	3rd Qu.	12,00
Max	20,00	Max	19,00	Max	18,00

Table 3- Results of NASA-TLX method variables (Portugal)
Source: Own Elaboration.

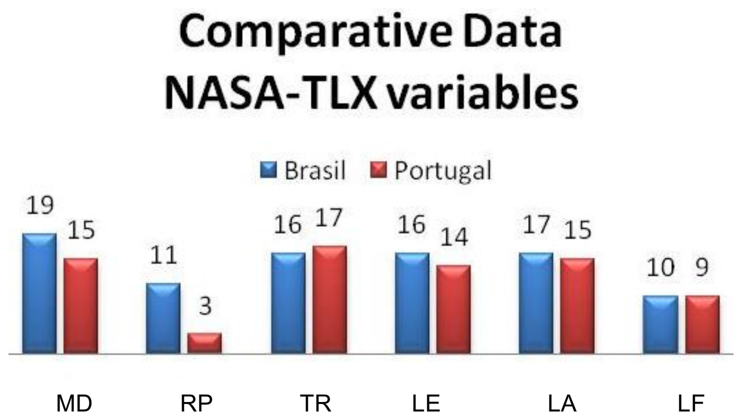

Figure 3 – Comparative data between Brazil and Portugal of NASA-TLX variables (MD, RP, TR, LE, LA, LF)
Source: Own Elaboration.

In analyzing the data in Tables 2 and 3 and Figure 3 the following comments were observed:

• The measures of MD are high, which feature a type of difficult and complex work task, requiring much mental effort to achieve the goal. Median values are higher by 25% in Brazil (MD = 19) than in Portugal (MD = 15). The distribution shows the percentile value of 75% of the sample with maximum scale value of MD = 20 in Brazil and MD = 18 in Portugal.

• As for RP, the values has a difference of data between Brazil and Portugal, RP = 11 and RP = 3, respectively.

• Regarding TR, the median values of TR = 16 in Brazil and TR = 17 in Portugal also demonstrate high rates. This is confirmed by the distribution by quartile, the third quartile since the samples have a score of TR = 19 in both countries. Thus, the type of work features a high TR, which is a fast and frantic pace, with much pressure up to the end of the activities.

• The LE binds the physical and mental demands, and the study has a median LE of 16 in Brazil and 14 in Portugal. It is observed that 25% of the samples have scores up to 14, so a quarter of the samples had moderate scores. However, the MD was observed to show high values, whereas the RP, showed low values in Brazil (RP = 11) and Portugal (RP = 3), and it can be concluded that the activity has a moderate LE.

• The distribution shows that, with respect to LA, the sample has a high median score of LA = 17 in Brazil and LA = 15 in Portugal. Thus, the LA can be considered relatively high.

• In terms of LF, 50% of the samples have a low score of 10.09. These data showed low values with respect to this variable and, therefore, provides an indication that the operators feel safe and secure when performing the task. Figures 4 and 5 show the box plot representations of data in Portugal and Brazil of three NASA-TLX variables: MD, TR and LE.

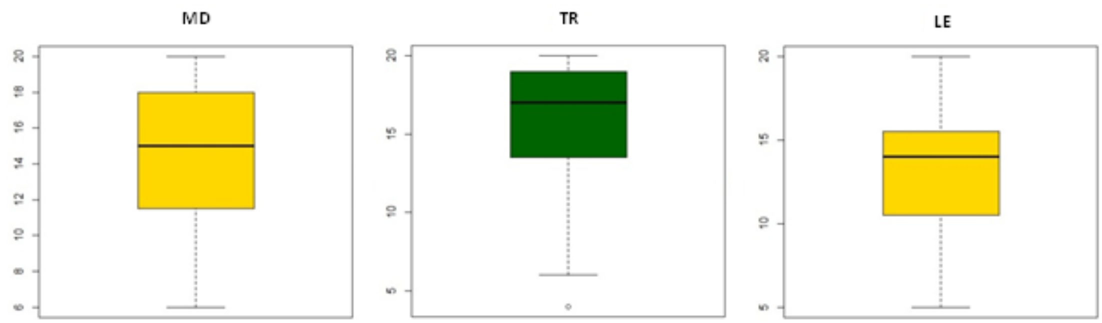

Figura 4 - Boxplot Graphs of Portugal of variables MD, TR and LE
Source: Own Elaboration.

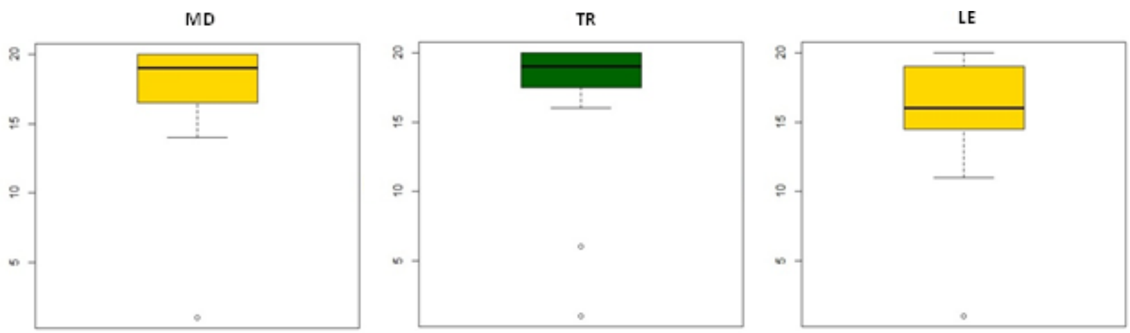

Figure 5 - Boxplot Graphs of Brazil of variables MD, TR and LE
Source: Own Elaboration.

Analyzing the boxplot of Figures 4 and 5 has the following results: The NASA-TLX variables MD and LE in Brazil are higher and more concentrated than those from Portugal. In variable TR, the values were close in both countries. However, the levels of Mental Demand (MD) are well dispersed in Portugal, ranging from 12 to 18, compared with Brazil, ranging from 18 to 20.

The linear correlation between the six variables, considering the data for both countries was analyzed. The results are as follows (Table 4 and 5)

	Portugal (PT)					
	MD	**RP**	**TR**	**LE**	**LA**	**LF**
MD	1	0,073	**0,789**	**0,771**	0,441	-0,010
RP	-	1	-0,011	0,125	-0,105	-0,283
TR	-	-	1	0,564	0,460	-0,047
LE	-	-	-	1	0,300	0,248
LA	-	-	-	-	1	-0,317
LF	-	-	-	-	-	1

Table 4 –Correlation Coefficients of the NASA-TLX variables (Portugal)
Source: Own Elaboration.

Brazil (BR)						
	MD	RP	TR	LE	LA	LF
MD	1	0,260	**0,738**	**0,804**	-0,078	0,399
RP	-	1	0,175	0,343	0,311	-0,063
TR	-	-	1	0,625	-0,147	0,448
***LE**	-	-	-	1	0,018	0,168
LA	-	-	-	-	1	-0,129
LF	-	-	-	-	-	1

Table 5 – Correlation Coefficients of the NASA-TLX variables (Brazil)
Source: Own Elaboration.

Analyzing the data in Tables 6 and 7 it was concluded that there is a linear correlation between the variables MD-TR (0.789, 0.738) and between variables MD-LE (0.771, 0.804). The simple linear regression analysis between the three variables that were correlated MD-TR and MD-LE are shown in the Figures 6 and 7 according equations 1, 2, 3 and 4 :

MD-TR variables analyses.

Results from Portugal (lower curve):

$$\boxed{MD = \beta_0 + \beta_1 TR \rightarrow MD = 2{,}798 + 0{,}755TR}$$

Multiple R-squared: 0.6222

p-value: 1.017e-06 <0,05

Results from Brazil (upper curve)

$$\boxed{MD = \beta_0 + \beta_1 TR \rightarrow MD = 6{,}322 + 0{,}641TR}$$

Multiple R-squared: 0.5449

p-value: 1.106e-05 <0,05

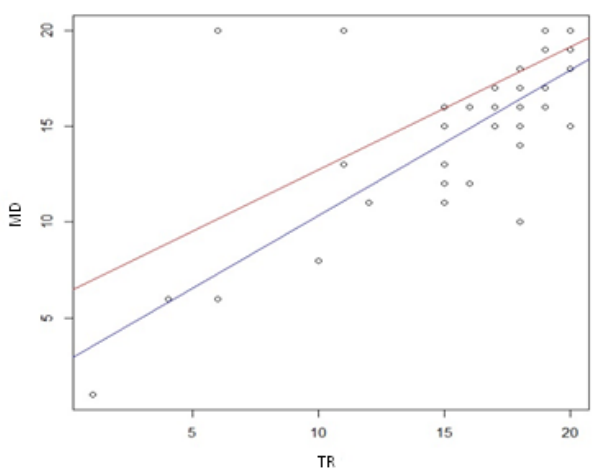

Figure 6- Linear regression curve of TR-MD, upper curve-Brazil; lower curve-Portugal.

Source: Own Elaboration.

MD-LE variable analyses

Results from Portugal (lower curve):

$$\boxed{MD = \beta_0 + \beta_1 LE \rightarrow MD = 3{,}733 + 0{,}796LE} \quad (3)$$

Multiple R-squared: 0.5937

p-value: 2.581e-06 <0,05

Results from Brazil (upper curve)

$$\boxed{MD = \beta_0 + \beta_1 LE \rightarrow MD = 5{,}641 + 0{,}759LE} \quad (4)$$

Multiple R-squared: 0.6458

p-value: 4.474e-07 <0,05

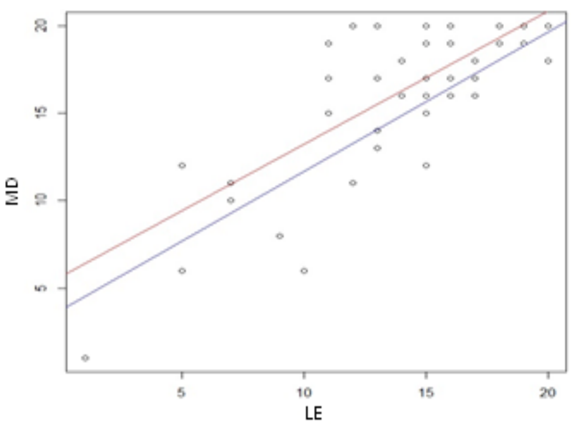

Figure 7- Linear regression curve of MD-LE, upper curve-Brazil; lower curve-Portugal

Source: Own Elaboration.

Were then performed an analysis of multiple linear regression (MLR) that explain the influence TR and LE in the variable MD data in Portugal and Brazil. The gaps between the planes of these models can be observed in Figure 8 according equations 5 and 6.

Results from Portugal (lower plane):

$$\boxed{MD = \beta_0 + \beta_1 TR + \beta_2 LE \ \rightarrow MD = 0{,}155 + 0{,}497TR + \ 0{,}493LE} \quad (5)$$

Multiple R-squared: 0.7778

p-value: 1.446E-08 <0.05

Results from Brazil (upper plane):

$$\boxed{MD = \beta_0 + \beta_1 TR + \beta_2 LE \ \rightarrow MD = 3{,}314 + 0{,}336TR + \ 0{,}530LE} \quad (6)$$

Multiple R-squared: 0.737

p-value: 1.093E-07 <0.05

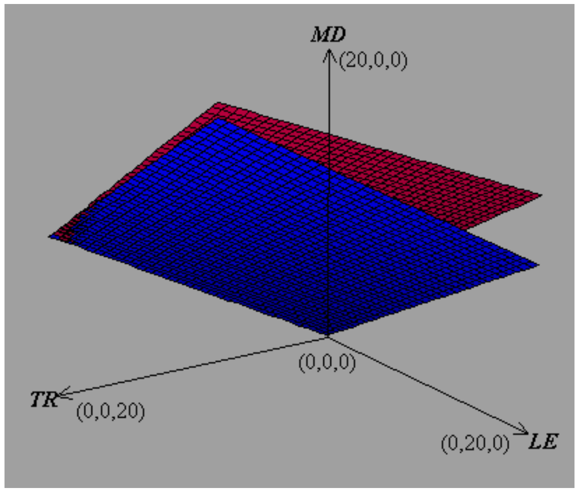

Figure 8- Multiple Linear regression planes of MD-TR-LE, upper plane-Brazil; lower plane-Portugal
Source: Own Elaboration.

The following are the comments regarding statistical analysis:

- The regression models show that the LE and TR have an influence on the MD of the operators in the electric power sector of both countries.
- The LE of operators in Portugal contributes more (62%) for mental load compared with those in Brazil (54%). However, the TR of operators in Brazil is slightly higher (64%) than the operators in Portugal (59%).
- If we take into account the variables LE and TR, both have influences on MD—about 78% in Portugal and 74% in Brazil.

4 CONCLUSIONS

It was observed the following conclusions:

The values for MD are high in both countries, although data in Brazil are higher than 25% for Portugal. These values are very representative of both countries that feature a difficult and complex type of work task, requiring much mental effort to achieve the goal.

The TR rates were also found to be high in both countries. Thus, the type of work of the operators in control centers is characterized by having a fast and frantic pace and with much pressure.

In analyzing the comparative figures of the variable LE for Portugal and Brazil, it appears that the data from latter are higher by about 17%.

With respect to the index level of realization (LA), the sample has a high score. This level characterizes the activity in which the operator feels satisfied with his activity.

In the field of LF, the data show the low values in both Portugal and Brazil and provides an indication that workers perform their activities when they feel safe and secure.

The LE and TR have an influence in the MD of the control operators of the electricity sector in both countries. This influence rate of operators in Portugal is about 78% compared with 74% of those in Brazil.

Taking into account the cognitive aspects that require that operator attention and accuracy are fundamental for the implementation of its activities, it can be concluded that certain levels of requirements in a given time can cause possible errors that may cause harm to the electrical systems.

These results provide support for the preparation of a new working methodology for the operators of the Electric Power Control and Operation Centers and contributing to a reduction of human error operation and better quality system.

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ASPECTOS ERGONÔMICOS E CARGA DE TRABALHO NOS OPERADORES NOS CENTROS DE OPERAÇÃO E CONTROLE DE ENERGIA ELÉTRICA: ESTUDO DE MULTI-CASO IN PORTUGAL E BRASIL

RESUMO: A operação do setor elétrico tem sido feita em equipamentos cada vez mais sofisticados e requer mais atenção dos operadores. Isso tem causado um aumento de carga de trabalho e ambientes mais propícios ao erro cognitivo, o que pode causar falhas que resultam em perdas significativas econômicas, danos físicos ou ameaças à vida humana. Este trabalho tem como objetivo avaliar a carga de trabalho dos operadores em Centros de Operação e Controle de Energia Elétrica, usando o método da NASA-TLX em um estudo multicaso em Portugal e no Nordeste do Brasil. Como conclusão são obtidas informações sobre essas atividades contribuindo para a redução de erros humanos da operação.

Palavras Chave: Ergonomia em Centros de Energia Elétrica. Carga de Trabalho. Fatores Humanos.

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