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Evaluation of Ergonomics and Mental Workload: A Case Study in Education Personnel

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Abstract.
The mental workload and ergonomic aspects in the world of work have often not been considered. Although in past literature it has been stated that mental workload and ergonomic aspects have a direct impact on worker productivity. The main objective of this research is to evaluate the ergonomics aspect and measure the mental workload of the UNISBA Faculty of Engineering education staff. The method used in this study is an ergonomics evaluation questionnaire (ergonomic checklist) and a mental workload questionnaire (Nasa-TLX). The stages carried out include problem formulation, preliminary study by observing the research object, literature study, preparing questionnaires, distributing questionnaires, data processing, and analysis. The results showed that there was educational staff who were included in the category of having a very high mental workload and needed attention to ergonomic aspects, especially related to buildings (ventilation) and work organization (attention to pregnant and lactating women).

Keywords: Ergonomics, Mental Workload, work organization

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1. INTRODUCTION

The educational staff at a university plays an important role in supporting the smooth process of education administration. The COVID-19 pandemic has changed the order of lectures, which were originally conducted offline, turned into online. These changes have an impact on increasing the number of administrative work regarding the lecture process. In addition, the workplace, namely the Dean's Building, which is a new building, does not meet the Occupational Health and Safety requirements so it still needs some improvements. In addition, the workload of the education staff at the UNISBA Faculty of Engineering is quite high. This condition has an impact on the performance produced by the education staff.

Indonesian law that concerning work safety (Article 3 paragraph 1) contains several safety requirements that must be met. It is intended to prevent and reduce accidents;

prevent and control the incidence of occupational diseases, both physical and psychological, poisoning, infection, transmission; obtain harmony between the workforce, work tools, environment, ways and processes of work [1]. One way that can be done to meet occupational safety and health is the application of ergonomics and mental workload aspects in the workplace environment.

Ergonomics is a systematic study that studies people in the workplace to improve work situations, working conditions, and tasks performed [2]. It is a multidisciplinary discipline for systems development in which people play an important role by using scientific principles, methods, and data and focusing on people as the most important component of technological systems [3]. In other words, ergonomics focuses on matters related to the interaction

between the person and the machine and the design of the interface between the two [4]. There are several lists of questions that can be used to examine ergonomic matters. The list of questions is summarized in an ergonomic checklist to provide simple and low-cost solutions to improve working conditions. Thus the ergonomic checklist can be a powerful tool for detecting and estimating work-related risk factors by considering the risk score for each item [5].

Alsuraykh et al. [6], explained that mental workload is the relationship between the demands placed on individuals and their capacity to cope. The subjective method of measuring workload has proven to be very relevant for monitoring mental workload, one of the subjective methods is the NASA-TLX. Data collection on the NASA-TLX method is carried out through filling out questionnaires by respondents. In the questionnaire, the concept of workload will be obtained from various aspects, including physical demands. Therefore, the NASA-TLX method is known as a multidimensional method [7]. Nasa-TLX is the most widely used tool for measuring mental workload and is associated with its pedigree, and simplicity of application and interpretation [8].

The results of preliminary observations show that the performance of the education staff at the UNISBA Faculty of Engineering has not been optimal and the work system has not paid attention to ergonomic aspects. On the other hand, it is realized that education personnel has an important role in the continuity of the teaching and learning process. Thus, an in-depth research is needed on the evaluation of mental workload and the application of ergonomic aspects. The results of the research will be the basis for improvement as an effort to improve the performance of education personnel. The research was carried out using the NASA-TLX questionnaire and an ergonomic checklist.

2. RESEARCH METHODS

This research on the work environment was conducted by direct observation (observation) on 24 educational staff of the Faculty of Engineering, Islamic University of Bandung. In addition, questionnaires and interviews were distributed to each respondent. This is done as an effort to collect primary data needed for the evaluation of ergonomic aspects. The preparation of the questionnaire used in this study refers to the Nasa TLX method. There are 6 indicators are considered in the Nasa TLX questionnaire, namely mental demand, physical demand, temporal demand, performance, effort, and frustration level.

Several provisions in the processing of the Nasa-TLX questionnaire, namely **Weighting, Rating. The weights and ratings** for each indicator are multiplied and then added up and divided by 15, the total results of the questionnaire are compared with the standard [9]. Referring to the explanation of Hart and Staveland [9] regarding the Nasa-TLX theory quoted from it can be seen that the workload score obtained can be interpreted as follows: Low (0 -9), Medium (10- 29), Somewhat High (30-49), High (50-79) and Very High (80-100) [10].

Ergonomic Checklist Ergonomics is a branch of science that studies human capabilities and limitations, and the application of ergonomics is intended to improve human interactions with products, systems, and the environment [11]. The ergonomic checklist is a list of questions that can be used for examination and data collection in research on ergonomics. In the Ergonomic Checklist, there are 132 inspection items, each inspection item can be used in its entirety or selected only a few items that are relevant to the observed workplace conditions [12].

3. RESULTS

Table 1 shows the profile of respondents in the form of gender, age, last education, and work experience.

From Table 1 it can be seen that 33.3% of respondents' ages are in the range of 26-30 years, 62.2% of respondents are male and 41.7% of respondents are educated at the Senior High School / Vocational School level.

4. Mental Workload Measurement (Nasa-TLX)

Table 1: Profile of Respondents.

Characteristics of Respondents		Total	Percentage (%)
Gender	Male	15	62.5 %
	Female	9	37.5 %
Age	20 – 25	2	8.3 %
	26 – 30	8	33.3 %
	31 – 35	5	20.9%
	36 – 40	2	8.3 %
	41 – 45	1	4.2 %
	46 - 50	2	8.3 %
	51 – 55	4	16.7 %

Table 1

Last Education	Senior High School / Vocational School	10	41.7 %
	D1	2	8.3 %
	D3	2	8.3 %
	Bachelor Degree	9	37.5 %
	Postgraduate	1	4.2 %
Work Experience	< 5 years	7	29 %
	5-10 years	11	45.8 %
	> 10 years	6	25 %

4.1. Weighting

The weighting is done by the respondent by choosing one of two options which are a sub-scale of the mental workload dimension.

4.2. Rating

Rating is done by circling the value from 0 to 100 on each factor that represents the working conditions.

4.3. Product Value Calculation

The calculation of the product value is done by multiplying the rating by the weight factor for each descriptor. An example of calculating product value is as follows:

Product Value of Respondent 1 (Non-Laboratory) = (4x75); (0x50) ; (3x65) ; (1x10) ; (5x95) ; (2x90)

4.4. Calculation of Weighted Workload (WWL)

WWL calculation is done by calculating the total number of multiplication results between rating and weight.

Examples of calculations are as follows and the results of the recapitulation of calculations can be seen in Table 2.

WWL Respondent 1 (Non-Labor) = (4x75) + (0x50) + (3x65) + (1x10) + (5x95) + (2x90) = 1160

4.5. Calculation of Average WWL

The calculation of the average WWL is done by dividing the WWL by the total weight (15). An example of calculating the average WWL is as follows and the results of the recapitulation of calculations can be seen in Table 2.

Average Respondent 1 =1160/15 = 77.3

4.6. Score Interpretation

The last stage is score interpretation. Score interpretation is carried out on the final score obtained. The workload experienced by the education staff at the UNISBA Faculty of Engineering can be known after interpreting the score whether it is low, high, and others. The results of score interpretation can be seen in Table 2.

TABLE 2: Score interpretation.

No. Res	WWL	Average WWL	Category
1	1160	77,3	High
2	990	66,0	High
...			
23	880	58,7	High
24	925	61,7	High

Results Interpretation of mental workload scores for education personnel shows that 4 people have a very high category, 16 people have a high category, 3 people have a rather high category and 1 person has a medium category.

5. Ergonomic Checklist

The ergonomic Checklist is a list of questions to check workplace conditions from an ergonomic aspect and in total 132 checklists can be used for troubleshooting and finding the best solution. There are 9 assessment aspects in the ergonomics checklist used in this research. Table 3 shows the details of the complete number of ergonomic checklist questions and details of the number of questions used in this study.

TABLE 3: Ergonomic checklist.

		Complete Question			Used Question
No	**Aspect of Assessment**	**Total of Question**	**Nomor of Question**	**Total of Question**	**Nomor of Question**
1	Materials storage and handling	17	1 – 17	8	5,7,8,9,11,12,13,17
2	Tools	14	18 – 31	8	18,19,26,27,28,29,30,31
3	Machine safety	19	32 – 50	8	32,33,35,40,42,43,45,50
4	Workstation design	13	51 - 63	13	51,52,53,54,55,56,57,58,59,60,61,62,63
5	Lighting	9	64 – 72	9	64,65,66,67,68,69,70,71,72
6	Premises	12	73 – 84	11	73,74,76,77,78,79,80,81,82,83,84
7	Hazardous substances and agents	10	85 – 94	1	90
8	Welfare facilities	11	95 – 105	5	95,96,97,98,99
9	Work organization	27	106 - 132	24	106,107,108,109,110,111,112,113,114,115,116,117,118,120,121,122,123,125,127,128,129,130,131,132
	Total	132		87	

Table 4 Shows the recapitulation of the results of distributing the ergonomic checklist to education staff at the UNISBA Faculty of Engineering

Table 4 shows that there are still many aspects that need attention and need to be improved. Of the several things that are known to need improvement, two main priorities need attention, including aspects of the building/place (related to repair and maintenance of ventilation to get better air) and aspects of work organization (especially related to attention to health and safety for pregnant and lactating woman worker).

6. DISCUSSION

The very high mental workload experienced by educational staff in carrying out work is due to a large amount of work that must be done, racing against deadlines, and the number of services that must be provided to students. It is also undeniable that the coronavirus pandemic that has hit since 2019 has increased the workload due to

Table 4: Recapitulation of ergonomic checklist.

No	Aspect of Assessment	Total of Question	Evaluation		Not Available
			Good	Poor	
1	Materials storage and handling	17	3	5	9
2	Tools	14	1	7	6
3	Machine safety	19	1	7	11
4	Workstation design	13	4	9	
5	Lighting	9	4	5	
6	Premises	12	3	8	1
7	Hazardous substances and agents	10		1	9
8	Welfare facilities	11		5	6
9	Work organization	27	4	20	3
	Total	132	20	67	45

changes in the work system where there is a working system that implements an online system and works from home (WFH).

Several ways to control pressure at work include adjusting the workload to the capacity of workers, setting work (working time, etc.), establishing a healthy social environment, managing stress (both individually and organizationally) [13]. Determination of working time for human resources is divided into several things, including time to work, annual leave, education & training, national holidays, etc.

The results of observations of ergonomic aspects through an ergonomic checklist indicate that several things need to be improved, including the ventilation system and the need for a special room for pregnant and lacating women. A ventilation system is necessary because good airflow in the workplace is important for productivity and health. Adequate ventilation can help control hazardous substances and prevent heat [12]. By looking at the condition of the building/workplace of the education staff, things that can be done to pay attention to the ventilation system are to maximize the AC (Air Conditioner) system, explain the importance of ventilation for health and regulate the work system as much as possible so that education personnel can have time to outside the building to breathe natural air.

It is very important to ensure that the health and safety of pregnant and lactating women are taken care of. This is a priority because some education personnel is at the age of having young children. Several concerns can be given to pregnant and lactating mothers, including a) assigning pregnant workers to sedentary tasks that are not physically demanding. Pregnant women are not required to maintain the same working posture all the time. b) provide adequate rest time during the working day for

pregnant women. c) Provide adequate welfare facilities in the workplace that can be used comfortably by pregnant women [12]. In addition, other things that can be done to pay attention to pregnant and lactating women include providing a special room for pregnant and lactating women so that they can rest and carry out the necessary activities comfortably.

7. CONCLUSION

Some things that can be concluded from the results of the study are the existence of educational staff who have a very high mental workload (4 people) and education personnel needs the attention of related parties in terms of air ventilation (to get fresher natural air) and attention more for pregnant and lactating education personnel. The suggestions that can be given are for the relevant parties to provide explanations to the education staff about the importance of ventilation and regulate the work system to be effective in getting fresh air and pay attention to the room and work system for pregnant and lactating education staff.

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