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IMPROVING THE PERFORMANCE OF TESTING LABORATORY EMPLOYEES OF XYZ CENTER BASED ON THEIR RELATIONSHIP WITH MENTAL WORKLOAD

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ABSTRACT

Balai XYZ is one of the government agencies engaged in services, one of which is material testing. Based on performance value data, about 30% of technicians have less good value. The suspected factor is the pressure in work so that the mental workload increases. Therefore, it is necessary to measure the mental workload using Subjective Workload Dominance method. The measurement results show that many technicians have a heavy mental workload, especially on D and F. In addition, there is a significant negative relationship between workload and performance value. Proposed performance improvements include SOP improvements for D and F assignments, rejuvenation of test kits and assistive devices, as well as improvements to machine tool work instructions.

Keywords

Mental Workload, Performance, Subjective Workload Dominance (SWORD), Suggestions on Improving Employee Performance.

INTRODUCTION

1.1. Introduction

The key to a company's success is not only technological excellence and the availability of funds, but the human sector is also the main key to the success of a company. Companies need to manage human resources as well as possible, because superior human resources will have good performance.

XYZ Hall is one of the agencies engaged in services. One of the services provided is standardization in the field of testing. Based on performance value data, it is recorded that around 30% of all Testing Laboratory technicians have poor scores or below 80. The poor performance is thought to be caused by high mental workload, including technicians who are under pressure due to unsupportive working conditions. Therefore, it is necessary to measure the mental workload of Testing Laboratory employees and correlate it with employee performance values which are the basis for designing proposals for improving employee performance.

1.2. Problem Identification

Robbins (2001) states that good performance is determined by the factors of *Ability* (A), *Motivation* (M) and *Opportunity* (O). The poor performance of technicians is thought to be due to unsupportive working conditions, resulting in increased mental workload. One indicator is that there is still work that is not completed on time. Increased mental workload can lead to *human error* and can endanger workers. Therefore, it is necessary to measure the mental workload of Testing Laboratory employees and correlate it with employee performance values to produce proposals for improving employee performance.

Mental workload in this study will be measured by subjective measurement method.

Subjective Workload Dominance (SWORD). After that, the relationship will be seen with the value of employee performance using the correlation test so that proposals for improving employee performance are obtained.

LITERATURE STUDY

1.3. Ergonomics

Sutalaksana (1979) states that ergonomics is a science that studies human nature, abilities, and limitations to design a work system so that people can live and work on that system well, namely achieving the desired goals through the job, effectively, safely and comfortably.

1.4. Mental Workload

Workload according to de Waard (1996) is a measure or proportion of human capacity to meet demands so as to produce reactions in the form of certain *performance*. Workload analysis is a stage of the process of analyzing the time used by an incumbent in completing a job given to him carried out under normal conditions and situations (Zekben, 2017).

1.5. Factors Affecting Mental Workload

Workload is influenced by 2 factors, namely external factors and internal factors. Factors that affect mental workload according to Tarwaka (2004), namely:

1. External factors, which are loads that come from outside the worker's body, such as;

a. Physical tasks, such as work stations, layout, workplace, tools and facilities, working conditions, work attitudes, and psychological tasks, such as job complexity, level of difficulty, job responsibilities.

b. Work organization, such as length of working time, rest time, work shifts, night work, wage system, organizational structure model, delegation of duties and authority.

c. The work environment is physical work environment, chemical work environment, biological work environment and psychological work environment.

2. Internal Factors

Internal factors are factors that come from within the body itself as a result of external workload reactions. Internal factors include somatic factors (gender, age, body size, nutritional status, and health conditions) and psychological factors (motivation, perception, belief, desire and satisfaction).

1.6. *Subjective Workload Dominance* (SWORD)

Geddie (2001) stated that the *Subjective Workload Dominance* (SWORD) method was developed by Vidulich in 1989 from the AHP (*Analytic Hierarchy Process*) method developed by Saaty in 1980 to evaluate any dimension. Stanton (2005) states the stages of measuring mental workload with the SWORD method are as follows:

1. Specifies the task being analyzed
2. Create a SWORD rating sheet
3. Collecting raw assessment data
4. Make a *judgment matrix*
5. Evaluation of matrix consistency

The Subjective Workload Dominance (SWORD) method is a development method of the *Analytic Hierarchy Process* (AHP) method so it is necessary to test the consistency index. Padmowati (2009)

states that the level of consistency of AHP method user entries must be completed with the calculation of the *Consistency Index*. After obtaining the consistency index, the results are compared with the *Random Consistency Index* (RI) for each n objects. Table 1 shows the RI value for each n objects ($2 \leq n \leq 10$).

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Table 1. Normalized Consistency Index Table

Calculate CR:

$$CR = \frac{CI}{RI} \tag{1}$$

If CR <= 0.10 (10%) then the degree of consistency is satisfactory. If CR > 0.10 then there is inconsistency when setting the comparison scale of a pair of criteria.

If this happens, it is certain that the solution resulting from the AHP method becomes meaningless to the user.

6. Calculate rankings based on geometric mean

The geometric mean is usually used for data that has different *quality/weight* among them. Generally, these data have minimum and maximum limit values. The following is the geometric mean formula.

(2) $$G(x_1, \ldots, x_n) = \sqrt[n]{x_1 \cdots x_n}$$

7. Evaluation

1.7. Performance

Robbins (2001) states performance as a function of the interaction between ability or *Ability (*A), motivation or *Motivation* (M) and opportunity or *Opportunity* (O), namely performance = P (A x M x O), meaning: performance is a function of ability, motivation and opportunity.

1.8. Relationship between Mental Workload and Performance

Mental workload is closely related to performance, because it will have an impact on the results of work productivity so there must be suitability. A person's suitability for a job will depend on the rigors of the job and the person's work capacity, thus affecting their performance. The relationship between workload and performance can be seen in Figure 1.

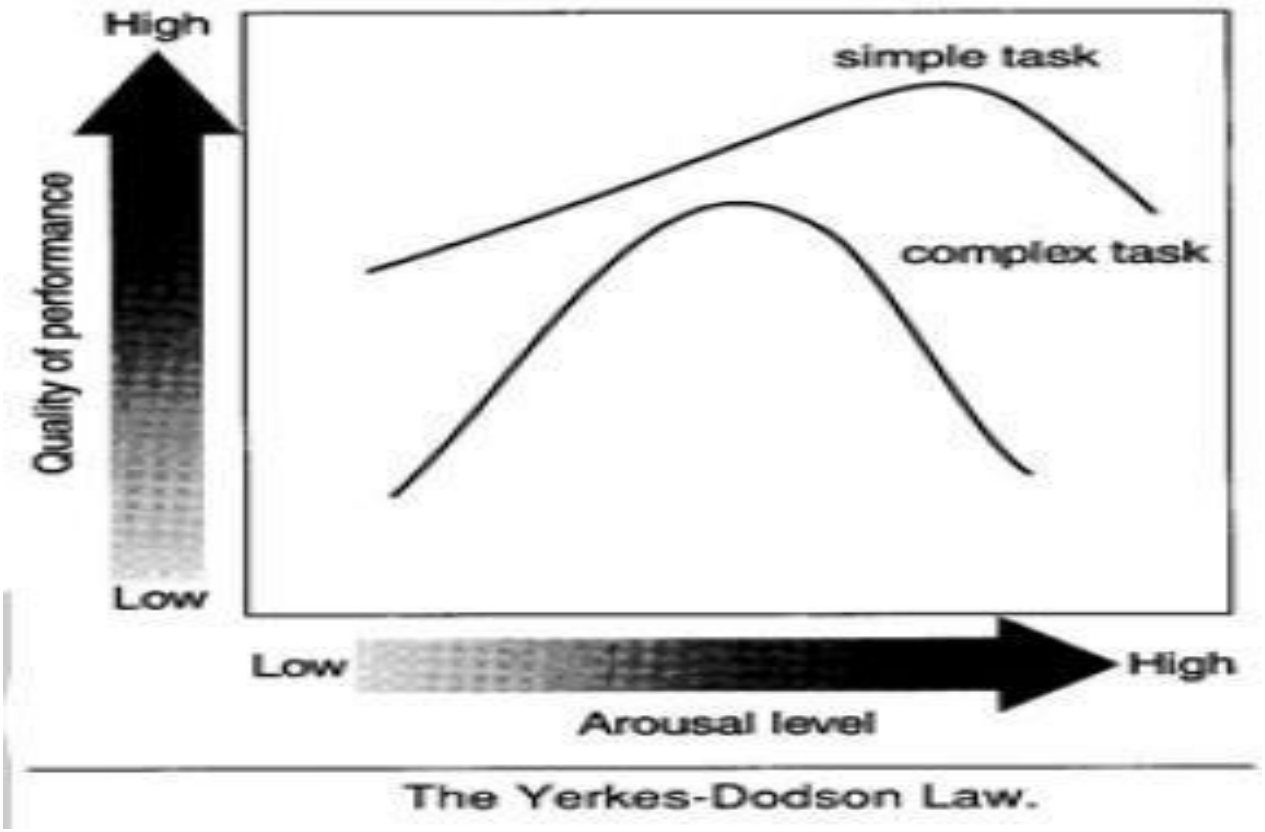


Figure 1. Relationship between workload and performance

1.9. Correlation

The steps to test the significance of the correlation coefficient are as follows:

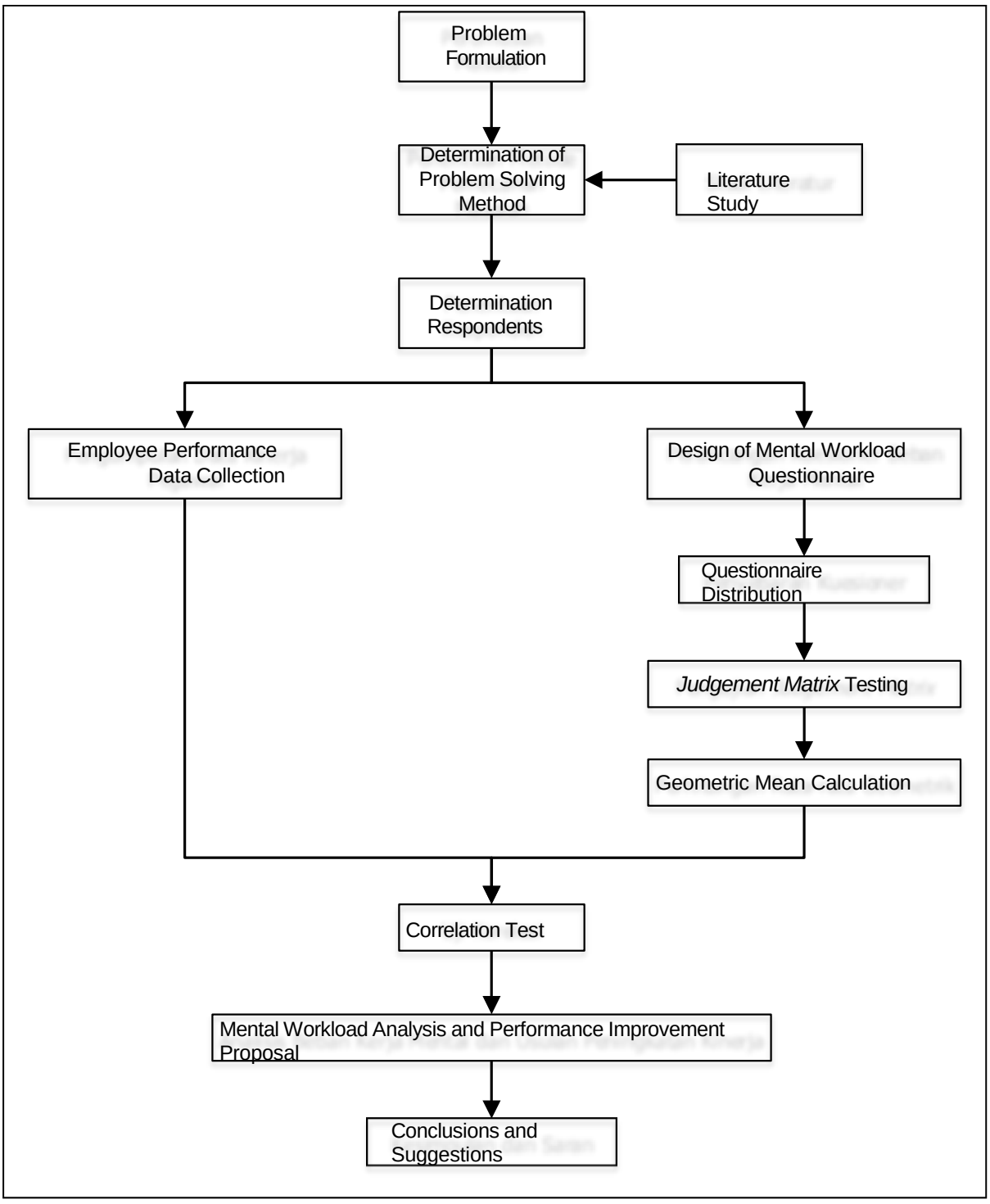
1. Determining the Hypothesis
2. Determine *Significant Level* $\alpha = 0.05$, dk = n-2
3. Determining Testing Criteria

   H0 is rejected if t count > t table or t count ≤ t table H0 is accepted if t table ≤ t count ≤ t table.

4. Draw conclusions about the acceptance or rejection of Ho.

2. RESEARCH METHODOLOGY

The research methodology chapter explains the stages carried out in the research. The stages of the research can be seen in Figure 2.



Flowchart of Research Methodology

3. DATA COLLECTION AND PROCESSING

4.1 Employee Performance Data Collection

Data on the performance value of Testing Laboratory technicians is obtained from the XYZ Center. The performance value is obtained from the average work productivity value from June to December. Performance value data can be seen in Table 2.

Table 2. Employee performance score data

Technician-	1	2	3	4	5	6	7	8	9	10	11
formance Value	78.00	75.78	93.40	82.70	77.20	85.00	96.03	90.00	97.50	89.25	55.68
Technician-	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	
formance Value	89.25	96.00	85.00	63.68	80.00	72.03	68.48	90.00	76.00	78.00	

4.2 Mental Workload Questionnaire Data Collection

Mental workload data collection is obtained from mental workload questionnaires that have been filled out by technicians. An example of the mental workload questionnaire data of the 21st technician can be seen in Figure 3.

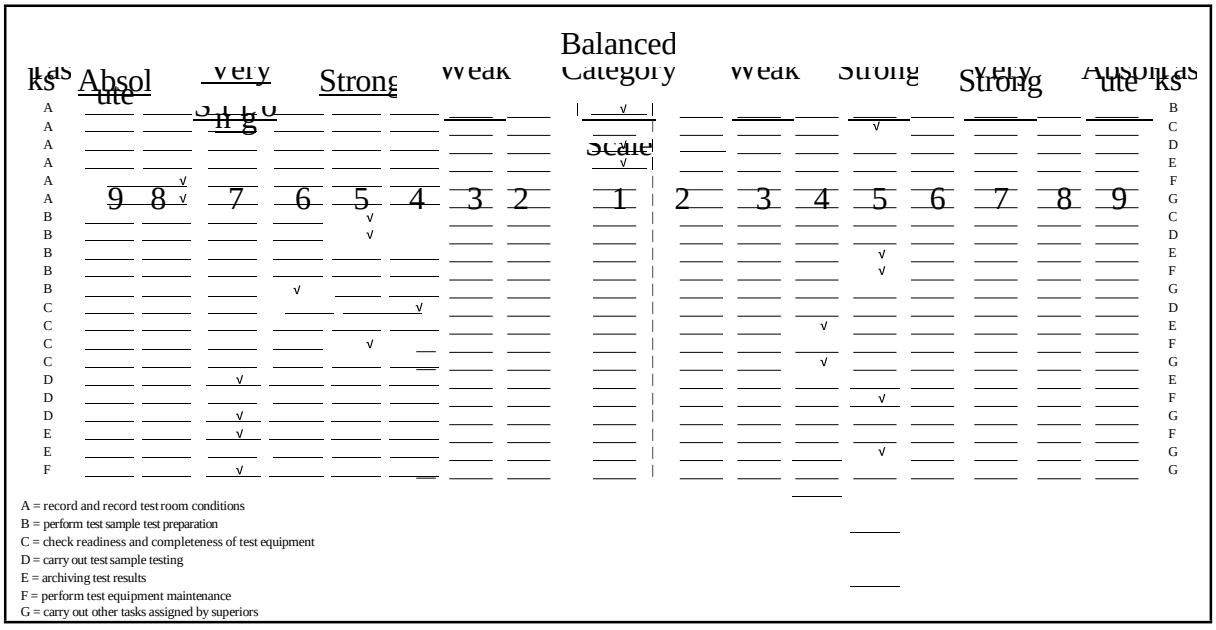


Figure 3. Example of the 21st Technician Mental Workload Questionnaire

4.3 *Judgement Matrix* Testing

To process data using the SWORD method, it is necessary to test the *judgment matrix*. The aim is to determine the consistency of respondents in filling out the questionnaire. The results of testing the *judgment matrix* using formula 1 can be seen in Table 3.

Table 3. *Judgement Matrix* Testing Results

Technician	CI	RI	CR	Conclusion
1	0.122	1.320	0.093	consistent
2	0.124		0.094	consistent
3	0.129		0.098	consistent
4	0.124		0.094	consistent
5	0.119		0.090	consistent
6	0.120		0.091	consistent
7	0.128		0.097	consistent
8	0.060		0.045	consistent
9	0.096		0.073	consistent
10	0.066		0.050	consistent
11	0.130		0.099	consistent
12	0.611		0.463	inconsistent
13	0.286		0.216	inconsistent
14	0.075		0.057	consistent
15	0.063		0.048	consistent
16	0.119		0.090	consistent
17	0.121		0.091	consistent
18	0.122		0.093	consistent
19	0.124		0.094	consistent
20	0.126		0.095	consistent
21	1.559		1.181	inconsistent

Consistency Ratio (CR) shows the level of consistency of technicians in filling out the questionnaire. If CR is less than or equal to 0.1, it means consistent while if CR is more than 0.1, it means inconsistent. The results of data processing show that 18 technicians are consistent and 3 technicians are inconsistent in filling out the questionnaire. Inconsistent data is not processed to the next stage.

4.4 Geometric Mean Calculation

The results of the *judgment matrix* test show that 18 technicians are consistent and 3 technicians are inconsistent. The geometric mean calculation is carried out for 18 consistent technicians. A

recapitulation of the geometric mean calculation can be seen in Table 4.

Table 4. Recapitulation of Geometric Mean Calculation

Tasks	Geometric Mean																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	0.361	0.310	0.343	0.320	0.230	0.315	0.375	0.305	0.472	0.315	0.244	0.348	0.297	0.202	0.304	0.374	0.310	0.281
B	1.292	1.188	1.188	1.104	0.923	1.111	0.906	1.177	0.906	1.177	0.965	1.177	1.177	1.706	1.188	1.219	1.188	1.150
C	1.931	1.150	1.150	1.263	0.505	1.270	1.036	1.669	1.346	1.669	1.219	1.426	1.669	1.669	1.150	1.931	1.150	1.086
D	2.549	2.863	2.863	2.863	3.130	1.883	2.216	2.578	2.583	2.578	1.610	2.686	2.578	2.147	2.926	2.549	2.863	3.221
E	0.631	0.313	0.279	0.313	1.000	0.346	0.367	0.296	0.410	0.313	0.270	0.332	0.313	2.095	0.313	0.518	0.313	0.308
F	1.026	4.865	4.948	4.618	3.837	1.346	3.497	1.902	1.426	1.739	1.238	1.739	1.842	0.476	4.865	1.279	4.865	5.332
G	0.673	0.540	0.540	0.540	0.777	2.564	0.540	1.150	1.150	1.150	6.466	1.104	1.150	0.816	0.540	0.673	0.540	0.540
Average	1.209	1.604	1.616	1.575	1.486	1.262	1.277	1.295	1.185	1.277	1.716	1.259	1.289	1.301	1.612	1.220	1.604	1.702
Total	8.463	11.230	11.310	11.022	10.402	8.835	8.937	9.076	8.294	8.940	12.012	8.811	9.026	9.105	11.287	8.543	11.230	11.917

The geometric mean shows the perception of each technician's workload for each task. For example, technician 1 stated that the workload of task A was 0.466 and the average workload of all tasks was 1.185. Table 5 shows that technician 9 has the smallest perceived mental workload of 1.185 and technician 11 has the largest perceived mental workload of 1.716. After the geometric mean is obtained, then determine the workload *rank* for each technician which can be seen in Table 5.

Table 6. Workload *Rank* for Each Technician

Tasks	Workload *Rank* for Each Technician																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	7	7	6	6	7	7	6	6	6	6	7	6	7	7	7	7	7	7
B	3	3	3	4	4	5	4	4	5	4	5	4	4	3	3	4	3	3
C	2	4	4	3	6	4	3	3	3	3	4	3	3	4	4	2	4	4
D	1	2	2	2	2	2	2	1	1	1	2	1	1	1	2	1	2	2
E	6	6	7	7	3	6	7	7	7	7	6	7	6	2	6	6	6	6
F	4	1	1	1	1	3	1	2	2	2	3	2	2	6	1	3	1	1
G	5	5	5	5	5	1	5	5	4	5	1	5	5	5	5	5	5	5

Table 6 shows the workload rank of each technician for each task. The number 1 means the greatest workload (largest geometric mean value), while the number 7 means the least workload (smallest geometric mean). For example, technician 1 states that task D has the greatest workload and task A has the least workload.

4.5 Correlation Test

The correlation test results show that there is a significant relationship between workload and performance scores. The correlation coefficient (r) between the two variables is - 0.693. The categorization interval for the strength of the correlation relationship according to Sugiyono (2007) falls into the strong category (0.60-0.799). The negative value indicates that the mental workload and performance variables in this study are negatively related, meaning that in the perception of heavy mental workload, the higher the mental workload, the lower the employee performance, and vice versa.

4. ANALYSIS

4.1. Analysis of *Judgement Matrix* Testing Results

Consistency Ratio shows the level of consistency of respondents in filling out the mental workload questionnaire with the SWORD (*Subjective Workload Dominance*) method. This test is carried out to ensure that the data taken is feasible to be used as input in research. If CR is less than or equal to 0.1, it means consistent, while if CR is more than 0.1, it means inconsistent. The results of data processing show that 18 technicians are consistent and 3 technicians are inconsistent in filling

out the questionnaire. Inconsistent data is not processed to the next stage. Inconsistency can occur due to the number of categories being compared, namely 7 tasks so that technicians experience confusion when filling out the questionnaire.

4.2. Technician Analysis Based on Geometric Mean

The geometric mean shows the perceived workload of each technician for each task. Technician 9 has the smallest average workload of 1.185 and technician 11 has the largest average workload of 1.716. This shows that technicians

The testing laboratory as a whole has a high perceived mental workload as it is above 1. In addition, the geometric mean determines the workload rank of each technician for each task. Overall, technicians stated that task D (conducting tests) had the largest average workload of 3.215 and task A (recording and recording test room conditions) had the smallest average workload of 0.401.

4.3. Correlation Test Analysis

The results of SPSS calculations show that there is a significant relationship between workload and performance scores. The correlation coefficient (r) between the two variables is -0.693. This shows that the strength of the relationship between workload and performance value of testing laboratory technicians is strong. The negative value indicates that the mental workload and performance variables in this study are negatively related. This means that the higher the mental workload, the lower the employee performance, and vice versa. This result illustrates part of The Dodson Law theory where the relationship between workload and performance is described by an inverted U-shaped curve, namely on the right side of the letter U because in this study the technician's mental workload is above 1 so it does not discuss on the left side (below 1). Because workload has a strong correlation with work value, the analysis will discuss the tasks that are considered to have a heavy workload, namely tasks D and D.

F. The graph of tasks D and F can be seen in Figure 4.

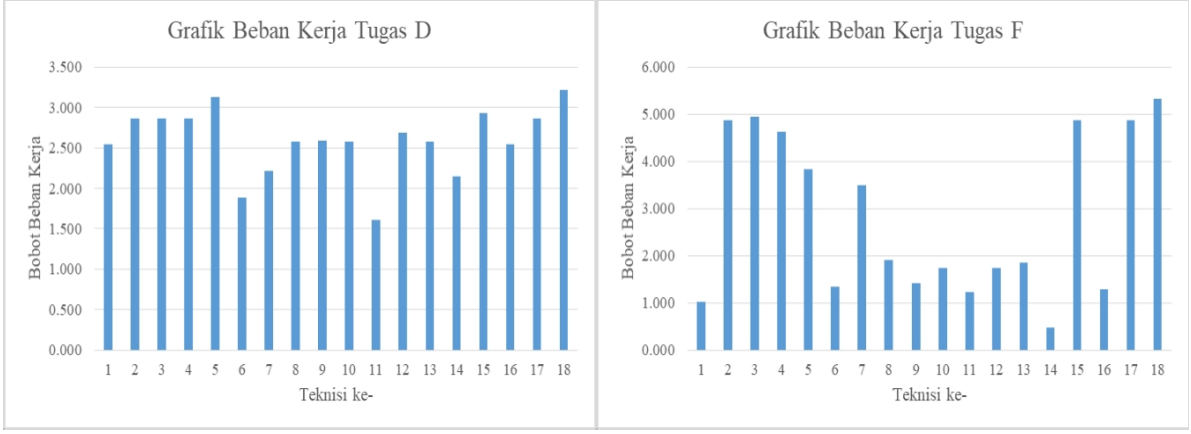


Figure 4: Task D and F Workload Chart

Task D has the highest workload according to employee perceptions because the work requires *skills* and *knowledge*, starting from determining the test that matches the test sample, determining the appropriate tool and conducting the test on the testing machine. Task D requires a high level of focus, memory and concentration to minimize errors. The tests carried out for 1 test sample have many parameters, namely more than 10, so employees have a perception of heavy workload because it takes a long time. If there is a queue, employees must work overtime to complete the test. In addition, some test machines and auxiliary tools are damaged so that technicians perform more difficult tests on damaged machines. Task D needs to be improved, including SOPs that are easy to apply and the need for **skill** transfer between technicians so that the load is more evenly distributed, and *upgrading* machines and tools that have been damaged is needed to make it easier to do testing.

Task F has a large workload according to employee perceptions as seen from the number of employees who have a mental workload number of more than 1, because task F requires a mental workload of more than 1.

diligence to maintain old or damaged machines. Test equipment maintenance consists of calibration, cleaning test equipment, applying oil and replacing *spare parts*. Maintenance takes a long time because there are many machines and tools, especially for machines that require more maintenance. It is necessary to rejuvenate auxiliary equipment and test machines to support the smooth running of testing. Task F needs to be improved including making SOPs that are easy to apply and the need for **skill** transfer between technicians so that the load is more evenly distributed.

4.4. Proposed Performance Improvement

Based on the research results, there are several suggestions for improving technician performance as listed in Table 6.

Table 6. Proposed Performance Improvement

No.	Problem	Proposal
1	Technician 14 has a mental workload score that is quite far from his peers for task B (preparing test samples) and task E (filing test results). Technician 14 felt the workload was heavy for creating work instructions and archiving test results. This is because technician 14 has only worked for 1 year, so he is still inexperienced in creating work instructions that require more *knowledge*.	Apprentice task B and task E to a more advanced friend
2	The perception of workload on task C has a wide range of loads, it can be seen from the graph that the mental workload figures between technicians are uneven, starting from technician 5 who has the smallest workload to technician 1 who has the largest workload.	Skill transfer between technicians is required so that all technicians can perform C tasks.
3	The overall workload perception of task D has too wide a range from technician 11 who has the smallest workload perception of 1.61 to technician 18 who has the largest workload perception of 3.221. Most technicians feel that Task D has a heavy workload according to the ranking grouping.	There is an improvement in work SOPs. In addition, skill transfer between technicians is required so that all technicians can perform D tasks.

4	The overall workload perception of task F has a wide range from technician 7 who has the least workload perception to technician 18 who has the most workload perception. Most technicians perceived Task F as having a heavy workload according to the ranking groupings.	There is an improvement in work SOPs. In addition, skill transfer between technicians is required so that all technicians can perform F tasks.
5	There are some test equipment and tools that are damaged and too old, which interferes with the testing process.	*Upgrading* defective test equipment and auxiliary tools or old.
6	Some technicians are less able to understand the tool's work instructions on the automated machines that hindered the testing process.	Revise work instructions tool

5. CONCLUSIONS

The results showed that there was a strong negative relationship between the mental workload of testing laboratory employees and employee performance, as indicated by the correlation coefficient (r) of -0.693. Testing laboratory technicians as a whole have a high perception of mental workload because it is above number 1. Overall, technicians stated that task D (conducting tests) had the largest average workload of 3.215, followed by task F (performing test equipment maintenance) which had a workload of 2.759, while task A (recording and recording test room conditions) had the smallest average workload of 0.401. Proposals for performance improvement are based on heavy mental workload, the proposals needed are SOP improvements for tasks D and F whose workload is considered heavy by technicians, rejuvenating test equipment and tools that are damaged or old for the smooth running of the testing process, and improving tool work instructions for automatic machines so that they can be understood by all technicians.

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