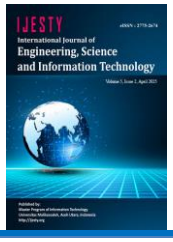
International Journal of Engineering, Science and Information Technology
Volume 5 No. 2 (2025) pp. 47-55
ISSN 2775-2674 (online)
Website: http://ijesty.org/index.php/ijesty
DOI: https://doi.org/10.52088/ijesty.v5i2.780
Research Paper, Short Communication, Review, Technical Paper



Analysis of the Influence of Work Shifts on Employee Workload Using the NASA-TLX Methods

Daffa Firmansyah, Cut Ita Erliana, Muhammad Sayuti*

Departement of Industrial Engineering, Faculty of Engeneering, Universitas Malikussaleh, Aceh, Indonesia

**Corresponding author E-mail: sayuti_m@unimal.ac.id*

The manuscript was received on 18 June 2024, revised on 1 October 2024, and accepted on 2 February 2025, date of publication 2 April 2025

Abstract

The workload workers face can influence their performance and productivity physically and subjectively. Physical workload includes factors such as environmental temperature, noise, and lighting, which affect the worker's health, while subjective workload encompasses time pressure, effort, and stress experienced by the worker. One form of workload that can impact employees is the shift work system, which often leads to physical and psychological fatigue if not correctly managed. This Company, which implements a shift work system in its rubber processing factory, faces employee productivity and health challenges. This study aims to evaluate employees' workload using the NASA-TLX method, which measures six workload dimensions: Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, and Frustration Level. The results of this study are expected to provide insights into the factors affecting employees' workload and offer recommendations for improving the work system to enhance productivity and team member well-being within the Company.

Keywords: *Workload, Ergonomics, Nasa-Tlx, Work Shift, Workload Analysis.*

1. Introduction

The workload is one factor affecting worker productivity and physical and psychological well-being. The workload can manifest physically, such as uncomfortable environmental temperatures, noise, or inadequate lighting, which impact the worker's body condition, such as heart rate, body temperature, and oxygen consumption levels[1][2][3].

This study was conducted at a company engaged in rubber plantation and processing latex into semi-finished products known as Crumb Rubber. The Company has a plantation area of 18,914.43 Ha, where they are directly involved in planting, maintenance, and harvesting processes. This Company has a crumb rubber processing factory covering approximately 290 m², which consists of five units: DM Factory, DX Factory, FM Factory (Fomm Material), and NB 1 and NB 2. In general, the crumb rubber processing in all factories is similar, except for the NB 1 and NB 2 factories, which specialize in latex or liquid rubber processing. To meet the daily production target of around 318 MT or 53 MT for the FM Factory, the Company requires an adequate supply of raw materials. The raw material sources come from two suppliers: 80% from smallholder plantations and 20% from company-owned plantations[4][5] [6].

Interviews with several employees working on a shift system revealed that they experience physical complaints, such as pain in the neck, waist, shoulders, and back. Additionally, the environmental conditions at night present a unique challenge, where cold temperatures exacerbate sleepiness while working. Employees also experience changes in their sleep patterns every week, possibly due to the weekly shift rotations[7][8]. Therefore, the relationship between shift work and workload is influenced by several factors, including shift schedules, types of work, and environmental conditions[9][10] [11].

This study aims to measure team member workload using the NASA-TLX method, which identifies six critical dimensions: Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, and Frustration Level. Using this method is expected to gain a deeper understanding of the workload experienced by employees and provide recommendations for improvements that can enhance work comfort and productivity while reducing the negative impacts on worker health[12][13][14].

2. Research Methods

This study was conducted at the Company in June 2024. The research method for measuring the workload of workers began with collecting primary data (observations, interviews, questionnaires, documentation) and secondary data. Based on the observations and data collection, the data was then processed using the NASA-TLX method, along with data normality testing and ANOVA[15][16].

NASA-TLX is a method that combines subjective assessments of six workload dimensions: mental demand, physical demand, temporal demand, own performance, effort, and frustration level. The data processing using the NASA-TLX method follows these steps[17][18]:

1. Weighting: Respondents are asked to choose one indicator that they feel is more dominant in causing workload about the task.
2. Rating: Respondents are asked to provide ratings for the six workload indicators.
3. Calculating the Product is obtained by multiplying the rating by the factor weight for each descriptor. Thus, six indicator products are produced (MD, PD, TD, OP, EF, FR).
4. Produk = rating x bobot kerja
5. Calculating Weight Workload (WWL) is obtained by adding the six product values.
6. Skor $=\sum \frac{Bobot+Rating}{15} =$
7. Interpretation of Scores states that the mental workload score obtained is used to determine the group or level of workload.

2.1. Data Normality

The data normality test is used to determine whether the data that has been collected through previous measurements is normally distributed. The results of this normality test affect subsequent statistical testing: data is considered normal if sig > α (0.05). If the data is normally distributed, the next step is parametric statistics, namely the Repeated Measures Anova test. Conversely, if the data is not normally distributed, the Friedman test is used[19][20].

2.2. Repeated Measures Anova

In this study, the Repeated Measures Anova test was applied to evaluate the effect of work shifts on team member workload (Weight + Rating) / 15n in a production plant, using SPSS IBM Statistic 25 statistical software. After completing the Repeated Measures ANOVA analysis, the next step was to conduct a Post Hoc Test to identify specific differences between groups, after the analysis of variance (ANOVA) showed a significant difference[21][22].

3. Results and Discussion

The results of this research data collection involved 51 respondents who were employees of the Production factory, the 51 people were divided into 3 Shifts who did different jobs on 3 different work shifts. The Paired Comparison data from the distribution of team member questionnaires can be seen in Tables 2, 3, and 4. Employees in the production factory have several types of jobs that can be seen in Table 1.

Table 1. Production Job Data

Name Job	Job Type Number	Number of Employees
Mandor	Control	2 employees
Wet Process	Loading materials, cutting, cleaning and controlling	6 employees
Dry Process	Fill the crumb rubber into the trolley and insert the trolley filled with crumb into the dryer.	3 employees
Finishing Product	weighing, pressing, checking for white spot contamination and sampling, re-weighing, metal detection, packaging.	6 employees

In processing the research data, respondents were required to fill out the NASA-TLX questionnaire. From the questionnaire, it was obtained by multiplying the rating by the factor weight for each workload dimension. Furthermore, the Weighted Workload (WWL) value was calculated by adding up the six product values. After the WWL value was obtained, the next step was to find the average by dividing the WWL value by the total weight, which was fifteen. After obtaining the average value, the classification of the workload experienced by employees could be determined.

Table 2. Pairwise Comparison Data of Morning Shift Employees

No.	Team Member Name	work	Workload Dimensions						Total
			MD	PD	TD	OP	EF	FR	
1.	Ariansyah	Foreman	3	2	2	3	2	3	15
2.	Indra	Foreman	3	3	3	1	3	2	15
3.	Sudarno	Wet Proses	3	3	3	2	2	2	15
4.	Hans	Wet Proses	1	3	3	3	3	2	15
5.	Poniren	Wet Proses	3	2	3	2	2	3	15
6.	Sumarno	Wet Proses	3	3	2	2	3	2	15
7.	A. Muhid	Wet Proses	3	2	2	3	2	3	15
8.	Miskamto	Wet Proses	3	3	2	2	3	2	15
9.	Candra	Dry Proses	3	3	3	2	2	2	15
10.	Rahmadi	Dry Proses	4	1	2	3	2	3	15
11.	Samsul	Dry Proses	3	2	2	3	3	2	15
12.	Indra Hidayah	Finishing	3	2	2	3	3	2	15
13.	Rahman	Finishing	2	3	2	2	2	4	15
14.	Parsal	Finishing	1	4	2	3	3	2	15
15.	Adi. S	Finishing	2	3	1	4	3	2	15
16.	Rurman	Finishing	3	2	1	4	2	3	15
17.	Edo	Finishing	3	2	3	2	3	2	15

Table 3. Pairwise Comparison Data of Morning Shift Employees

No.	Team Member Name	work	Workload Dimensions						Total
			MD	PD	TD	OP	EF	FR	
1.	Pandar Tarigan	Foreman	3	4	1	2	3	2	15
2.	Suprianto	Foreman	3	2	3	2	3	2	15
3.	Tukiman	Wet Proses	4	2	1	3	3	2	15
4.	Zulkifli S	Wet Proses	4	4	2	2	1	2	15
5.	Theo Panjaitan	Wet Proses	3	2	3	2	2	3	15
6.	M. Reza	Wet Proses	3	4	2	4	1	1	15
7.	Teguh Damanik	Wet Proses	3	2	3	3	2	2	15
8.	Tukiran	Wet Proses	4	3	4	1	2	1	15
9.	Rafli	Dry Proses	3	2	1	4	2	3	15
10.	Aswin Damanik	Dry Proses	4	1	3	2	3	2	15
11.	Irvan Darma	Dry Proses	2	3	2	3	2	3	15
12.	Sujadi Leo	Finishing	2	2	1	3	3	4	15
13.	Mislan	Finishing	2	2	2	3	4	2	15
14.	Muhammad Arifi	Finishing	2	4	3	2	3	1	15
15.	M. Saladi	Finishing	2	3	2	3	3	2	15
16.	Dwi Syahputra	Finishing	3	1	4	3	1	3	15
17.	Bima Purnama	Finishing	2	2	2	3	3	3	15

Table 4. Pairwise Comparison Data of Morning Shift Employees

No.	Team Member Name	work	Workload Dimensions						Total
			MD	PD	TD	OP	EF	FR	
1.	Herbet	Foreman	2	3	3	3	2	2	15
2.	Surianto	Foreman	2	3	2	3	1	4	15
3.	Edi Supono	Wet Proses	3	2	2	3	1	4	15
4.	Sugianto. P	Wet Proses	3	2	2	2	3	3	15
5.	Cahyadi. S	Wet Proses	2	4	2	2	2	3	15
6.	Arif Lesmana	Wet Proses	1	1	3	3	3	4	15
7.	Wanda	Wet Proses	3	2	2	2	3	3	15
8.	Dani Muliono	Wet Proses	3	2	2	3	4	1	15
9.	Jogi Vito	Dry Proses	2	3	2	3	2	3	15
10.	Ridwan	Dry Proses	2	2	3	3	3	2	15
11.	Turino	Dry Proses	2	3	4	1	3	2	15
12.	Parman	Finishing	3	2	3	2	2	3	15
13.	Jainudin. P	Finishing	2	2	3	2	3	3	15
14.	Alfin Rahman	Finishing	2	3	2	3	3	2	15
15.	Rianal	Finishing	2	3	3	3	2	2	15
16.	Andre Nasution	Finishing	3	2	2	1	3	4	15
17.	Wawan Setiawan	Finishing	3	2	4	1	3	2	15

After completing the paired comparison data, all respondents also gave ratings to the existing dimensions of team members' mental workload to continue calculating the product value for each workload dimension and WWL value for each worker and questions representing each workload indicator by a team member named Ariansyah as an example in table 6 as follows:

Table 5. Mental Workload Indicator Scale Description

No.	Workload Category	Value Range
1.	Low	0% - 40%
2.	Medium	41% - 70%
3.	High	71% - 100%

After all respondents with a total of 51 employees have completed the paired comparison and rating questionnaires, the product value calculation will be carried out on each workload dimension and the WWL value for each team member in tables 7 to 9 as follows:

Table 6. Questions for Rating Representatives of Each Indicator on Employees Ariansyah

Indicator	Question	Rating
Mental Demands (MD)	How much concentration, calculation, remembering information and decision making are needed in doing the job?	70
Physical Demands (PD)	How much mental and physical work did it take to complete this job?	60
Temporal Demands (TD)	How much pressure do you feel regarding the time to complete this work?	65
Performance (OP)	What level of success is needed to achieve production targets?	70
Effort (EF)	How much effort did you put in to achieve your current level of work performance?	70
Frustrations (FR)	How much anxiety, pressure and stress do you feel in completing this work?	70

Next, the total of all workload aspect values is added up to obtain the WWL value. The final value is calculated by dividing the WWL (Weighted Workload) value by 15, which is the sum of the combinations of the six pairs of mental workload aspects of shift employees. The first step in calculating the recapitulation of the NASA-TLX WWL value is to add up the

total value of each load, which is obtained from the multiplication of the rating and weight. After recapitulating the data from the pairwise comparison results, and recapitulating the data from the rating of the team member workload dimensions. Next, a recapitulation of the product value calculation for each workload dimension is carried out as well as the WWL value for each worker which can be seen in tables 10-12, as explained in the calculation example below:

WWL = MD + PD + TD + OP + EF + FR

MD = rating x bobot OP = rating x bobot

PD = rating x bobot EF = rating x bobot

TD = rating x bobot FR = rating x bobot

Skor Nasa-TLX = $\frac{WWL}{15}$

Contoh Perhitungan :

Responden Ariansyah

MD = Rating x Bobot
= 70 x 3
= 210

TD = Rating x Bobot
= 65 x 2
=130

EF = Rating x Bobot
= 70 x 2
=140

PD = Rating x Bobot
= 60 x 2
=120

OP = Rating x Bobot
= 70 x 2
=210

FR = Rating x Bobot
= 70 x 3
=210

WWL = MD + PD + TD + OP + EF + FR
= 210 + 120 + 130 + 210 + 140 + 210
= 1020

Nilai WWL = $\frac{\text{WWL}}{15} = \frac{1020}{15} = 68$

Table 7. Data Recapitulation Calculates Morning Shift Employee Workload

No.	Team Member Name	Workload Dimensions						Total	Value WWL
		MD	PD	TD	OP	EF	FR		
1.	Ariansyah	210	120	130	210	140	210	1020	68
2.	Indra	165	180	195	70	210	130	950	63,33
3.	Sudarno	225	210	210	170	150	140	1105	73
4.	Hans	60	225	240	210	195	140	1070	71,33
5.	Poniren	195	190	210	160	170	210	1135	75,66
6.	Sumarno	210	210	140	160	140	140	1000	66,66
7.	A. Muhid	210	160	160	225	160	225	1140	76
8.	Miskamto	210	195	140	160	255	130	1090	72,66
9.	Candra	225	240	225	150	160	120	1120	74,66
10.	Rahmadi	320	70	120	195	160	180	1045	69,66
11.	Samsul	225	150	160	240	240	130	1145	76,33
12.	Indra Hidayah	240	150	150	240	255	120	1155	77
13.	Rahman	160	240	160	160	160	240	1120	74,66
14.	Parsal	70	300	140	240	240	110	1100	73,33
15.	Adi. S	140	240	80	280	240	120	1100	73,33
16.	Rurman	240	140	75	340	160	210	1165	77,66
17.	Edo	210	140	255	140	240	120	1105	73,66
				Average					73,5

Table 8. Data Recapitulation Calculates the Workload of Evening Shift Employees

No.	Team Member Name	Workload Dimensions						Total	Value
		MD	PD	TD	OP	EF	FR		WWL
1.	Pandar Tarigan	180	280	70	140	195	120	985	65,66
2.	Suprianto	195	140	240	140	210	110	1035	69
3.	Tukiman	280	140	65	210	210	100	1005	67
4.	Zulkifli S	280	260	110	120	80	120	970	64,66
5.	Theo Panjaitan	210	130	195	140	160	165	1000	66,66
6.	M. Reza	210	320	140	280	80	60	1090	72,66
7.	Teguh Damanik	180	140	240	210	140	160	1070	71,33
8.	Tukiran	300	210	260	80	140	65	1055	70,33
9.	Rafli	210	120	55	300	140	165	990	66
10.	Aswin Damanik	220	70	180	150	210	130	960	64
11.	Irvan Darma	120	210	120	180	120	165	915	61
12.	Sujadi Leo	120	140	70	225	210	220	985	65,66
13.	Mislan	130	140	170	210	340	150	1140	76
14.	M. Arifi	140	320	195	110	210	75	1050	70
15.	M. Saladi	140	210	120	210	240	90	1010	67,33
16.	Dwi Syahputra	180	80	280	210	80	165	995	66,33
17.	Bima Purnama	140	140	160	225	225	210	1100	73,33
				Average					67,57

Table 9. Data Recapitulation Calculates the Workload of Evening Shift Employees

No.	Team Member Name	Workload Dimensions						Total	Value
		MD	PD	TD	OP	EF	FR		WWL
1.	Herbet	150	240	210	195	140	150	1085	72,33
2.	Surianto	140	195	140	210	80	300	1065	71
3.	Edi Supono	180	140	140	240	70	200	970	64,66
4.	Sugianto. P	210	160	140	120	180	210	1020	68
5.	Cahyadi. S	140	320	120	140	140	240	1100	73,33
6.	Arif Lesmana	80	65	210	240	195	280	1070	71,33
7.	Wanda	195	100	120	140	195	210	960	64
8.	Dani Muliono	210	120	110	195	280	70	985	65,66
9.	Jogi Vito	120	195	150	210	120	150	945	63
10.	Ridwan	120	140	195	210	180	140	985	65,66
11.	Turino	150	240	280	65	210	140	1085	72,33
12.	Parman	210	130	210	110	140	180	980	65,33
13.	Jainudin. P	150	140	210	130	210	180	1020	68
14.	Alfin Rahman	160	210	140	225	240	140	1115	74,33
15.	Rianal	140	210	180	210	160	140	1040	69,33
16.	Andre Nasution	210	120	140	70	255	240	1035	69
17.	Wawan Setiawan	210	140	280	70	225	150	1075	71,66
				Average					67,16

The analysis of the dimensions of workload, namely physical, mental, emotional, social, environmental, and time, shows that each shift has its characteristics and challenges in the production plant. The calculation results obtained the highest level of workload experienced by workers in each shift, as well as the work shift indicator graph, which can be seen in Table 10 below:

Table 10. workload level scores and interpretation

No.	Team Member Name	Work Shift		
		Morning Shift		
		Workload Level		
1.	Rurman	Score		Average
		77,66	High	73,5
		Afternoon Shift		
		Workload Level		
2.	Mislan	Score		Average
		76	Medium	67,57
		Night Shift		
		Workload Level		
3.	Alfin Rahman	Score		Average
		74,33	Medium	67,16

3.1. Data Normality Test

This data normality test is conducted to determine whether the data collected through Nasa-TLX follows a normal distribution. The results of this data normality have a significant effect on further analysis. If the data is normally distributed, then the next test will use parametric statistics, namely Repeated Meansures Anova. The calculation of the normality test for the mental workload score was carried out using SPSS 25 statistical software, and the results can be seen in Table 11.

Table 11. Team member Normality Date Testing

Category	Statistics	Decision
Morning Shift	039 > 0,05	Normal
Afternoon Shift	200 > 0,05	Normal
Night Shift	111 > 0,05	Normal

So the results of the normality test of the data displayed in the table, the data distribution is considered normal if there is no significant difference, which is indicated by the p-value> 0.05 at a significance level (alpha) of 5%. In the table, the significant value of Kolmogorov Smirnov chooses because the number of respondents using more than 50. When the subject can be categorized as normal because the p-value is greater than alpha (0.05), namely the morning shift 039> 0.05, the afternoon shift 200> 0.05, and the night shift 111> 0.05.

3.2. Repeated Measures Anova Test

Repeated Meansures Anova test This method is applied to more than three paired groups. This test aims to analyze the impact of work shifts on the mental workload of employees in a production plant. Before drawing conclusions, it is important to analyze the test results using SPSS 25 software. After the analysis, the results obtained will be presented in Table 12.

Table 12. Anova Test of Employee Data

Category	Sig	Decision
Shift	002	Significant

The ANOVA test determines whether the means of the three samples are comparable or different. The following is the information used to make decisions in the ANOVA test:

- If the significance value (Sig) > 0.05, it is concluded that there is no real difference.
- If the significance value (Sig) > 0.05, it can be concluded that there is a real difference.

Based on the results of the ANOVA analysis conducted, it can be concluded that the average of the three shifts in the production plant is significantly "DIFFERENT" or "NOT THE SAME". Thus, there are significant differences identified between the three shifts analyzed. We can apply the Post Hoc Test or follow-up test in Table 12 below:

Table 13. Uji Post Hoc Test

Working Conditions Comparison (Shift)	Test Statistics	Decision
Shift 1 compared to *Shift* 2	003 < 0,05	Significant
Shift 2 compared to *Shift* 3	003 < 0,05	Significant
Shift 3 compared to *Shift* 1	002 < 0,05	Significant

Based on the results of the calculations and tests that have been carried out, it can be concluded that the conditions in each shift affect the workload felt by employees. This analysis is based on the Repeated Measures ANOVA statistical test followed by the Post Hoc Test for each work shift, which is explained as follows :

1. The comparison between the conditions of morning shift 1 and afternoon shift 2 shows a value of 0.03 < 0.05, so it can be concluded that there is a significant difference between the two conditions.
2. The comparison between the 2 pm shift and 3 pm shift conditions shows a value of 0.03 < 0.05, which indicates a significant difference between the two conditions.
3. The comparison between the 3-night shift and 1-morning shift conditions shows a value of 0.02 > 0.05, so it can be concluded that there is no significant difference between the two conditions.

According to the results of statistical tests, there is a significant influence between the three shifts. This is due to data showing that, on average, fifty-one employees have worked for more than one year. In the production plant, there is an evident influence of the work shift system implemented by the Company, and the tasks given are adjusted to the conditions of each shift.

3.3. Suggested Improvements

From the research results, the proposed improvements for company production employees are as follows:

Table 14. Recommendations for Improvement Proposals

No.	Problem	Repair Basis	Suggested Improvements
1.	On average, morning shift employees get the highest workload dimension, namely performance (OP).	This high performance shows a balance of work, fair rewards and adequate support to maintain optimal performance.	Job rotation can reduce boredom and provide variety in work, which increases job satisfaction and performance.
2.	On average, evening shift employees have the highest workload dimension, namely mental needs (MD).	Break complex tasks into more straightforward, structured parts to reduce the need for high concentration levels.	Division of work according to team member capacity and skills. Avoid piling up the burden on one individual and rotate tasks if necessary.
3.	On average, night shift employees have the highest workload, namely frustration (FR).	Provide training to increase team members' motivation to complete tasks more quickly and efficiently.	To reduce physical and mental fatigue, create a comfortable working environment, such as adequate lighting, controlled temperature, and good rest areas.

4. Conclusion

Based on the results of data analysis obtained from the research that has been conducted, it is necessary to pay attention to the recommendations for improvements that need to be considered, including:

1. The results of measuring the workload felt by employees at the PT. ABC production plant based on the Nasa-TLX method obtained an average score of the morning shift workload of 73.5 which can be categorized as a high mental workload, then in the afternoon shift the average workload score was 67.57 which can be categorized as a moderate mental workload, while in the night shift the average workload score was 67.16 which can be categorized as a moderate mental workload.
2. Based on the Repeated Measures ANOVA statistical test results conducted by processing data from fifty-one (51) employees and the average results of team member workload at the DX Factory production plant of PT. Bridgestone Sumatera Rubber Estate through the Post Hoc Test showed that the comparison between Shift 1, Shift 2 and Shift 3 obtained a value of less than <0.05 which indicated a significant difference between the three work shifts. Therefore, Morning, Afternoon and Night Shifts have different impacts on employees. Night shifts or rotations can disrupt the body's biological rhythm, causing sleep disturbances, fatigue and reducing concentration. Morning and afternoon shifts are usually more in line with the body's natural rhythm, but regular or long shifts still affect stamina and productivity.

3. Recommendations for improvement that can be submitted based on the analysis and calculation of team member workload in the factory are job rotation every month, equal division of work, and creating a comfortable environment. These steps are expected to minimize team member workload and improve their performance.

References

[1] M. Dahlan and S. Nengsih, "Beban Kerja Psikologis Perawat Pasien Covid-19: Metode NASA-TLX," *J. Kesehat.*, vol. 13, no. 3, pp. 516–521, 2022, doi: 10.26630/jk.v13i3.3112.

[2] Kartika Herdianty, P. Purwatiningsih, and Ratih Setyo Rini, "Pengaruh Disiplin Kerja dan Motivasi Kerja terhadap Kinerja Karyawan pada PT XYZ," *J. Manaj. Kreat. dan Inov.*, vol. 2, no. 3, pp. 92–106, 2024, doi: 10.59581/jmki-widyakarya.v2i3.3753.

[3] Akbar Dani Al-Ihsan, "Pengaruh Shift Kerja dan Beban Kerja Terhadap Kelelahan Kerja di RSUD Blambang Banyuwangi," *Skripsi*, pp. 10–11, 2023.

[4] E. Yuniarsih, R. Tiarani, R. Fariyanda, E. Y. A. Raki, and F. Damayanti, "Pengaruh Gaya Hidup dan Mental Accounting Terhadap Pengelolaan Keuangan Mahasiswa Penerima KIP Kuliah (Studi Kasus: Mahasiswa FEB UNTAN)," *J. Audit dan Akunt. Fak. Ekon. Univ. Tanjunpura*, vol. 13, no. 1, pp. 111–137, 2024, doi: 10.26418/jaakfe.v13i1.81912.

[5] I. M. Batubara, A. O. Aritonang, L. H. Batubara, and S. Salianto, "Pengaruh Shift Kerja Terhadap Stress Kerja pada 5 Orang Karyawan PT. Asam Jawa Kota Pinang," *El-Mujtama J. Pengabdi. Masy.*, vol. 4, no. 2, pp. 822–828, 2023, doi: 10.47467/elmujtama.v4i2.4409.

[6] R. Mirsa, M. Muhammad, F. Fidyati, E. Saputra, and M. Rumiza, "Space Transformation in Residential House Small Entrepreneurs Banana Sale," *Int. J. Eng. Sci. Inf. Technol.*, vol. 1, no. 4, 2021, doi: 10.52088/ijesty.v1i4.167.

[7] S. Hartini, I. A. G. Suka, I. M. S. Depari, S. L. Okta, and T. L. B. Kaban, "Shift, Beban Pasien dan Interaksi Internal dalam Kaitannya dengan Kelelahan Kerja Petugas Laboratorium," *J. Penelit. Kesehat. "SUARA FORIKES" (Journal Heal. Res. "Forikes Voice")*, vol. 15, no. 2, p. 209, 2024, doi: 10.33846/sf15207.

[8] N. Istikhomah, S. Rohaetin, and B. Barbara, "Pengaruh pembelajaran ekonomi terhadap minat berinvestasi siswa SMA Negeri 1 Pangkalan Bun : Analisis regresi linear The influence of economic education on investment interest among students at SMA Negeri 1," *J. Environ. Manag.*, vol. 5, no. 1, pp. 18–25, 2024.

[9] A. M. Nurdin, R. Rusindiyanto, and J. A. Saifudin, "Analisis Faktor Lingkungan Kerja Fisik Dan Penentuan Waktu Istirahat Kerja Di Pt. Xyz," *Juminten*, vol. 1, no. 6, pp. 37–48, 2020, doi: 10.33005/juminten.v1i6.179.

[10] T. S. Pramono, "Analisis Faktor-Faktor Yang Berpengaruh Pada Produktivitas Kerja Karyawan," *J. Ilmu Manaj. Terap.*, vol. 1, no. 6, pp. 580–589, 2020, doi: 10.31933/jimt.v1i6.216.

[11] M. M. Rahman Redoy Akanda and M. A. Hossain, "Smart-devices in Human Behavior Manipula-tion: Process diagram with exploratory assessment," *Int. J. Eng. Sci. Inf. Technol.*, vol. 1, no. 3, 2021, doi: 10.52088/ijesty.v1i3.88.

[12] D. Andriani, A. Handayani, and K. A. Kusuma, "The Influence Of Workload, Employee Engagement And Job Satisfaction On Employee Performance," *Manag. Stud. Entrep. J.*, vol. 4, no. 6, pp. 9752–9762, 2023.

[13] M. Ramadhan, M. Kustiawan, and Fitriana, "Pengaruh Pendapatan Asli Daerah, Pengelolaan Belanja Daerah, Dan Kemandirian Keuangan Daerah Terhadap Kinerja Keuangan Daerah," *J. Syntax Transform.*, vol. 3, no. 06, pp. 832–846, 2022, doi: 10.46799/jst.v3i6.572.

[14] H. P. D. Daeli, T. A. A. Amzul, S. Y. Purnomo, L. Gunawan, A. Prihatni, and L. Gunawan, "Pengaruh Kepemimpinan Transformasional, Budaya Organisasi, Dan Motivasi Kerja Terhadap Kinerja Karyawan Di PerusahaanManufaktur," *J. TADBIR Perad.*, vol. 4, no. 2, pp. 404–419, 2024.

[15] R. Alfianto and F. N. Azizah, "Analisis Beban Kerja Mental Menggunakan Metode NASA-TLX pada Engineering Departement (Studi Kasus PT. Muliaglass Float Division)," *J. Tek. Ind. Terintegrasi*, vol. 7, no. 1, pp. 186–197, 2024, doi: 10.31004/jutin.v7i1.22556.

[16] B. P. Sari and P. Y. Leksono, "Pengaruh Gaya Kepemimpinan, Budaya Organisasi, Dan Motivasi Kerja Terhadap Kepuasan Kerja Karyawan," *Pros. Simp. Nas. Manaj. dan Bisnis*, vol. 3, pp. 937–946, 2024.

[17] N. B. Aranda, A. Sugiyono, and A. Syakhroni, "Analisis Beban Kerja Mental Operator Mesin Cetak Web dengan Target Pekerjaan Menggunakan Metode National Aeronautics and Space Administartion Task Load Index dan Rating Scale Mental Effort di PT. Bawen Mediatama," *J. Appl. Sci. Technol.*, vol. 1, no. 02, p. 38, 2021, doi: 10.30659/jast.1.02.38-48.

[18] E. Worldailmi, A. Prabaswari, and Rojab Bagus Widianto, "Analisis Beban Kerja Mental pada Marketing Menggunakan Metode NASA-TLX (Studi Kasus di Perusahaan XSMK)," *Teknoin*, vol. 28, no. 01, pp. 30–36, 2023, doi: 10.20885/teknoin.vol28.iss1.art4.

[19] Kristian Mangku Setyo Panjaitan, Harsono Teguh S, Achmad Daengs GS, Sugiharto Sugiharto, Bambang Karnain, and Rina Dewi, "Analisis Pengukuran Waktu Kerja Dan Beban Kerja Mental Guna Menentukan Jumlah Tenaga Kerja Yang Optimal Pada PT. Papan Jaya Lumajang," *J. Mhs. Manaj. dan Akunt.*, vol. 2, no. 2, pp. 29–39, 2023, doi: 10.30640/jumma45.v2i2.1528.

[20] G. A. Yudhistira and A. F. Milania, "Pengukuran Beban Kerja Mental Mahasiswa Universitas XYZ Yogyakarta pada saat E-Learning," *Semin. dan Konf. Nas. IDEC 2021*, p. A24.1-A24.6, 2021.

[21] M. Dhafin Putra Naratama and D. Nurkertamanda, "Analisis Perbandingan Beban Kerja Mental Pihak Manajemen Dan Pekerja Proyek Rumah Pompa Menggunakan Metode NASA-TLX Dan Saran Perbaikan (Studi Kasus Proyek Rumah Pompa Pt Waskita Beton Precast, Tbk)," *Ind. Eng. Online J.*, vol. 12, no. 4, 2023.

[22] M. A. Dias, Z. Ismah, and S. Arrazy, "Pengaruh Beban Kerja Mental dan Motivasi Kerja terhadap Kelelahan Kerja pada Pekerja di PKS PTPN IV Bah Jambi," *Heal. Inf. J. Penelit.*, vol. 16, no. 2, p. e1514, 2024, doi: 10.36990/hijp.v16i2.1514.