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ORIGINAL

THE EFFECT OF NOISE, WORKLOAD, AND WORKING HOURS ON WORK PRODUCTIVITY THROUGH WORK FATIGUE AMONG EMPLOYEES OF PT. MARUKI INTERNATIONAL INDONESIA IN 2025

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ABSTRACT

Background: Noise, workload, and working hours are important factors that can trigger fatigue, which ultimately contributes to work productivity levels. **Objective:** This study aims to analyze the effect of noise, workload, and working hours on work productivity through work fatigue among workers at PT. Maruki International Indonesia. **Methods:** This quantitative study used a *cross-sectional* design with SMART-PLX-based *path analysis*. **Results:** The results showed that noise did not significantly affect work fatigue (p=0.834) or work productivity (p=0.342), and work fatigue as a mediator was not significant (p=0.844). physical workload significantly affects work fatigue (p=0.018) and does not affect work productivity (p=0.369), and work fatigue as a mediator is significant (p=0.041), mental workload does not significantly affect work fatigue (p=0.977) and affects work productivity (p=0.010), and work fatigue as a mediator is not significant (p=0.977), length of service significantly affects work fatigue (p=0.016) and does not affect work productivity (p=0.213), and work fatigue as a mediator is significant (p=0.042). **Conclusion:** Physical workload, mental workload, and length of service are important factors that affect work productivity, both directly and through fatigue as an intervening variable, while noise is not proven to have a significant effect on fatigue or work productivity.

KEYWORDS: Noise, Workload and Work Duration, Fatigue, Productivity

1. INTRODUCTION

Sharing resources is necessary to run a business, including capital, materials, and equipment. In addition, companies also need human resources, namely employees. Organizations expect employees to perform well, with the ability to achieve planned performance targets. Manufacturing is an important indicator of technological progress, because large-scale manufacturing can increase economies of scale. Companies need to maintain and improve employee performance to achieve their goals. Low business productivity is a major problem that must be addressed by businesses because it can affect the quality and quantity of products (Rosento et al., 2021). One cause of a poor working environment is noise. 250 million workers worldwide are exposed to noise, and hearing impairment due to noise is the most common occupational disease in Europe. In the United States, approximately 30 million workers are exposed to dangerous noise levels in the workplace. Industries such as construction, agriculture, mining, manufacturing, transportation, and the military are particularly at risk. Industrial environments are difficult to regulate. Furthermore, companies must implement sustainable and effective hearing protection programs that meet OSHA standards (NIOSH, 2019). Workload has a significant impact on employee productivity. This occurs because the workload assigned is often not in line with the skills or experience possessed by employees. A high workload in a company can reduce productivity, especially when the facilities and infrastructure available are inadequate to support employees in carrying out their duties. In addition to noise and workload, length of service is also an element that affects employee productivity (Asnora, 2020). Length of service refers to the length of time an employee has been employed, which allows them to gain work experience so that they can complete their work more quickly. However, on the other hand, long periods of service in certain types of work can cause workers to become monotonous, bored, and tired. In performing work, physical capacity is described as the activity of the body's muscles contracting alternately. When muscles are tense for a long time, blood flow is disrupted, thereby inhibiting the supply of blood and glucose. This causes the metabolism to be unable to immediately eliminate waste. This condition causes fatigue (Nensi L, 2024). Fatigue can reduce work performance by disrupting concentration and prolonging the time needed to complete tasks. Loss of productivity occurs when a worker fails to complete their tasks according to the set target value. Every workplace and type of work can cause fatigue in workers. This can lead to decreased performance and increased work error rates, thereby increasing the risk of workplace accidents in the industry (BPJS Ketenagakerjaan, 2021). According to Suma'mur, monotonous work performed over long periods of time can cause chronic fatigue. Fatigue occurs when the workload exceeds 30–40% of a person's working capacity and can be triggered by continuous statistical activities. The International Labor Organization (ILO) noted that in 2018 there were more than

1.8 million work-related deaths in the Asia-Pacific region, with Asia accounting for about two-thirds of the total work- related deaths worldwide. In Indonesia, data from the Social Security Administration Agency (BPJS Ketenagakerjaan) shows that in 2021 there were 234,270 cases of work accidents. This figure represents an increase of 5.65% compared to 2020, which recorded 221,740 cases. Findings in the field show that workers in high-risk processing industries are prone to work fatigue. This is due to their heavy workload, where they have a great responsibility to maintain smooth production processes. Workers are required to follow strict schedules and meet predetermined production targets, which can ultimately cause physical and mental fatigue. Unsupportive working conditions, such as disturbances, high temperatures, and exposure to dust, are also factors that trigger stress and increase fatigue. Based on these observations, the researchers identified this issue as the focus of their final research project, entitled "The Effect of Noise, Workload, and Working Hours on Work Productivity through Fatigue among Workers at PT. Maruki International Indonesia."

2. Research Method

This study used a quantitative design with a *cross-sectional* approach to production workers at PT. Maruki International Indonesia during the period of May-July 2025. The independent variables consisted of noise, workload, and working hours, while the dependent variable consisted of work productivity with work fatigue as the mediator. Noise was measured using a sound level meter, physical workload using a pulse oximeter, mental workload using the NASA-TLX questionnaire, glucose using an autocheck, fatigue using a reaction timer, and work productivity using a questionnaire. The data was then processed using SPSS to analyze univariate and bivariate data. Path analysis based on SMART-PLS was then used to examine direct effects and mediating functions.

3. Research Results

Respondent characteristics

Table 1: (a) Frequency Distribution of Respondent Characteristics based on Age and Gender

CHARACTERISTICS RESPONDENTS	FREQUENCY (N)	PERCENTAGE (%)
AGE (YEARS)		
18–25	9	7.5
26–35	18	15.0
36–45	44	36.7
46–55	40	33.3
56–65 YEARS	9	7.5

Table 1: (b) Frequency Distribution of Respondent Characteristics based on Age and Gender

CHARACTERISTICS RESPONDENTS	FREQUENCY (N)	PERCENTAGE (%)
TOTAL	120	100%
GENDER		
MALE – FEMALE	82	73.3
	32	26.7
TOTAL	**120**	**100**

Source: Primary Data, 2025

The results of the age distribution of the 120 respondents show that the largest group is in the 36–45 age range, with 44 people (36.7%). Next is the 46–55 age range, with 40 people (33.3%), followed by the 26–35 age range, with 18 people (15%). The age groups with the smallest numbers were 18–25 years and 56–65 years, with 9 people (7.5%) each. Meanwhile, the distribution based on the gender of workers at PT. Maruki International Indonesia was dominated by men with 82 people (73.3%), while female workers numbered 32 people (26.7%).

Table 2: Bivariate Analysis of the Effect of Noise, Physical Workload, Mental Workload, Length of Service, and Glucose on Work Fatigue

VARIABLE		FATIGUE				TOTAL		*P-VALUE*
		WEIGHT		MILD				
		n	%	n	%	n	%	
NOISE	Does not meet requirements	62	68.1	29	31.9	91	100	0.793
	Qualified	19	65.5	10	34.5	29	100	
	Total					120		
PHYSICAL WORKLOAD	Heavy	28	87.5	4	12.5	32	100	0.005
	Mild	53	60.2	35	39.8	88	100	
	Total					120		
MENTAL WORKLOAD	Heavy	44	69.8	19	30.2	63	100	0.758
	Light	28	66.7	14	33.3	42	100	
	Moderate	9	60.0	86	30	15	100	
	Total					120		
LENGTH OF SERVICE	Duration	70	70.7	29	29.3	99	100	0.103
	New	11	52.4	10	47.6	21	100	
	Total					120		
GLUCOSE	Abnormal	27	90.0	3	10.0	30	100	0.002
	Normal	54	60.0	36	40.0	90	100	
	Total					120		

Source: Primary Data

Table 2 is based on the results of bivariate analysis, which shows that

the noise variable obtained a p-value of 0.793, indicating no significance in relation to work fatigue. The physical workload variable showed a p-value of 0.005, which means it is significantly related to work fatigue. The mental workload variable showed a p-value of 0.758, indicating no significance in relation to work fatigue. The variable of length of service obtained a p-value of 0.103, indicating no significance in relation to work fatigue. Meanwhile, glucose obtained a p-value of 0.002, indicating a significant relationship with work fatigue.

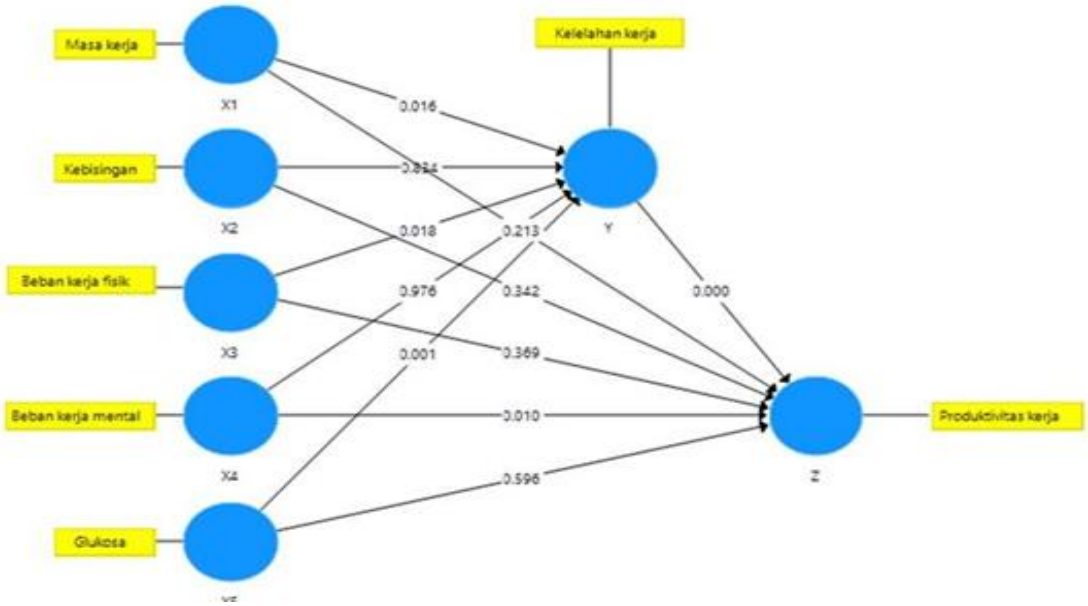

Figure 1: Path Analysis

There are 7 hypotheses that can be investigated in terms of direct influence. The following table presents the results of the direct influence analysis between variables:

Table 3: (a) Bivariate Analysis of the Influence of Noise, Physical Workload, Mental

VARIABLE		PRODUCTIVITY				TOTAL		*P-VALUE*
		POOR		GOOD				
		n	%	n	%	n	%	
NOISE	Does not meet requirements	54	59.3	37	40.7	91	100	0.553
	Qualified	19	65.5	10	34.5	29	100	
	Total					120		
PHYSICAL WORKLOAD	Heavy	25	78.1	7	21.9	32	100	0.019
	Mild	148	54.5	40	45.5	88	100	
	Total					120		
MENTAL WORKLOAD	Heavy	46	73.0	17	27.0	63	100	0.016
	Light	20	47.6	22	54.4	42	100	
	Moderate	7	46.7	8	53.8	15	100	

Table 3: (b) Bivariate Analysis of the Influence of Noise, Physical Workload, Mental

VARIABLE		PRODUCTIVITY				TOTAL		*P-VALUE*
		POOR		GOOD				
	Total					120		
LENGTH OF SERVICE	Duration	60	60.0	39	39.4	99	100	0.912
	New	13	61.8	8	38.1	21	100	
	Total					120		
GLUCOSE	Abnormal	70	70.7	29	29.3	90	100	0.235
	Normal	11	52.4	10	47.6	30	100	
	Total					120		
FATIGUE	Abnormal	27	90.0	3	10.0	30	100	0.002
	Normal	54	60.0	36	40.0	90	100	
	Total					120		

Source: Primary Data

Table 3 is based on the results of bivariate analysis, which shows that the noise variable obtained a p-value of 0.553, indicating no significance in terms of productivity. The physical workload variable shows p=0.019, which means it is significantly related to productivity. The mental workload variable shows a p-value of 0.016, indicating a significant relationship with work productivity. The working time variable obtained a p-value of 0.912, indicating no significance in terms of productivity. The glucose variable with a p-value of 0.235 shows a significant effect on work fatigue, while the work fatigue variable has a p-value of 0.002, indicating a significant effect on work productivity.

Table 4: (a) Multivariate Analysis of the Direct Effect of Independent Variables on Dependent and Intervening Variables

HYPOTHESIS	ORIGINAL SAMPLE	SAMPLE MEAN	STANDARD DEVIATION	T STATISTICS	P VALUES
NOISE -> PRODUCTIVITY	0.091	0.094	0.095	0.951	0.342
NOISE -> FATIGUE	0.016	0.015	0.078	0.210	0.834
PHYSICAL WORKLOAD -> PRODUCTIVITY	-0.084	-0.077	0.094	0.899	0.369
PHYSICAL WORKLOAD → FATIGUE	0.180	0.178	0.076	2.376	0.018
MENTAL WORKLOAD -> PRODUCTIVITY	-0.221	-0.223	0.086	2.584	0.010
MENTAL WORKLOAD -> FATIGUE	0.003	0.007	0.086	0.03	0.976
WORK EXPERIENCE-> PRODUCTIVITY	0.106	0.109	0.085	1.247	0.213

Table 4: (b) Multivariate Analysis of the Direct Effect of Independent Variables on Dependent and Intervening Variables

HYPOTHESIS	ORIGINAL SAMPLE	SAMPLE MEAN	STANDARD DEVIATION	T STATISTICS	P VALUES
WORK EXPERIENCE-> FATIGUE	0.234	0.237	0.097	2.412	0.016
GLUCOSE -> PRODUCTIVITY	-0.043	-0.050	0.081	0.530	0.596
GLUCOSE → FATIGUE	-0.235	-0.234	0.068	3.474	0.001
FATIGUE-> PRODUCTIVITY	-0.434	-0.444	0.090	4.844	0.000

Source: Primary Data

Table 4 based on the results of multivariate analysis, the variables of disturbance (p=0.342), physical workload (p=0.369), and glucose (p=0.596) were not proven to have a significant direct effect on productivity. Conversely, the variables of mental workload (p=0.010) and fatigue (p=0.000) showed a significant effect on work productivity. Meanwhile, analysis of fatigue, the disturbance variable (p=0.834), and mental workload (p=0.976) showed no significant effect. However, the variables of physical workload (p=0.018), length of service (p=0.016), and glucose (p=0.001) were proven to have a significant effect on work fatigue.

Table 5: Multivariate Analysis of the Indirect Influence of Independent Variables on Dependent Variables and Intervening Variables

HYPOTHESIS	ORIGINAL SAMPLE	SAMPLE MEAN	STANDARD DEVIATION	T STATISTICS	P VALUES
Noise -> Fatigue -> Productivity	-0.007	-0.006	0.036	0.197	0.844
Physical Workload → Fatigue → Productivity	-0.078	-0.079	0.038	2.046	0.041
Mental Workload -> Fatigue -> Productivity	-0.001	-0.003	0.039	0.029	0.977
Working Hours -> Fatigue -> Productivity	-0.102	-0.106	0.050	2.036	0.042
Glucose → Fatigue →	0.102	0.104	0.038	2.701	0.007

Source: Primary Data

Based on Table 5 of the multivariate analysis results, the variables of disturbance (p=0.844) and mental workload (p=0.977) did not have a significant indirect effect on productivity through work fatigue. Conversely, the variables of physical workload (p=0.041), length of service (p=0.042), and glucose (p=0.007) showed a significant indirect effect on work productivity through fatigue.

4. Discussion

4.1 The Effect of Noise on Work Productivity through Work Fatigue

Noise is one of the potential hazards often encountered in the work environment, especially in the industrial sector that utilizes machines to support production activities. Noise can be measured through two main aspects, namely frequency in Hertz (Hz) and intensity in decibels (dB). Frequency describes the number of sound waves that occur every second, while intensity indicates the level of sound exposure received by workers. According to Suma'mur, disturbance is defined as unwanted sounds or noises. The perception of disturbance can vary from person to person, as the assessment of sounds that are considered disturbing is subjective. Research (Dewi et al., 2021) (p=0.864) shows that there is no relationship between noise levels and fatigue that can reduce work productivity in production areas. This is because measurements taken with a sound level meter show that the noise intensity in the workplace does not exceed the threshold value (NAB). The findings at PT. Maruki International Indonesia show that workers who have been working for a long time in a high-noise environment tend to adapt. They are accustomed to the sound of machines or production activities so that noise no longer disturbs their concentration or causes severe fatigue. This study shows that most workers do not feel disturbed by noise in the workplace, even though measurements using a sound level meter show that noise levels in factories 1, 2, and 3 exceed the NAB (threshold limit value). Indirectly, noise is not the main factor that can reduce work productivity through work fatigue; there are other factors.

4.2 The Effect of Physical Workload on Work Productivity through Work Fatigue

Workload is the difference between the workload required and the ability or capacity of employees to complete the work. Because human activities are characterized by mental and physical exertion, each individual has specific limitations to working together. Excessive workload causes excessive energy consumption and a decrease in employee productivity. Conversely, too low a workload causes fatigue and exhaustion, which in turn leads to burnout (Rahmi & Rio, 2020). According to Tarwaka, the theory of work efficiency is a source of job satisfaction, is determined not only by the number of calories burned, but also by the amount of activity, the static load involved, and the thermal pressure of the work environment, which can increase the heart rate. A flexible work environment is associated with reduced stress, fatigue, accidents, injuries, illness, and employee job satisfaction. Workloads that are related to employee abilities can cause a number of problems in the workplace. Stress caused by skill-related workloads can reduce work productivity, and if a person does not have adequate skills for a task, it can cause employees to lose their jobs

(Fathonah, 2023). In the production area of PT Maruki, although most workers perform tasks with a light physical load, such as installing small components, packaging products, and quality checks, the same activities are performed for hours without variation. This causes boredom and physical complaints, which accelerate the onset of fatigue. Workers with heavy physical workloads, such as moving goods between one production area to another, will experience fatigue more quickly. Even with additional workers or tools, if the physical workload remains high, fatigue will still occur and work productivity will decline.

4.3 The Effect of Mental Workload on Work Productivity through Fatigue

Workload can cause fatigue for workers, such as static and dynamic tasks, and can also be caused by mental activities such as the ability to concentrate, think, and maintain responsibility. Mental workload that is not in line with the usual time constraints (deadlines) based on the limitations of workers' mental abilities can cause fatigue for workers, resulting in decreased productivity, which ultimately affects the overall performance of the organization. Mental workload is included in cognitive ergonomics. Mental workload arises from a mismatch between job demands, related to the worker's mentality, and their mental abilities. Some mental workloads that can occur in the workplace include the need for accurate and quick decision-making, related to limited socialization responsibilities due to an isolated workplace, which can cause boredom and fatigue; the need to constantly stay focused and alert for long periods of time; and the existence of monotonous tasks and activities that can worsen the decline in concentration (Nata et al., 2025). This study is not in line with several other studies (Regina et al., 2025) which state that the greater the workload given to workers, the more fatigue they feel, thereby decreasing work productivity. The findings on workers at PT. PLN Nusantara Power Up Tarahan show that the high workload given by the company causes workers to feel fatigue because they do not have enough time to rest. In addition, the demands and pressure make workers feel tired, so that a high workload can cause fatigue in workers, which tends to reduce their productivity.

However, findings at PT Maruki show that although the mental workload on employees is quite high due to production targets and tight deadlines, this does not directly reduce employee productivity. This is due to the fact that the majority of employees have been working for more than five years. With considerable work experience, employees have become accustomed to demanding work patterns and have been able to develop adaptation strategies to cope with the pressure of their workload. This adaptation process enables workers to manage the resulting fatigue, thereby maintaining productivity. In other words, despite the high mental workload, productivity at PT Maruki does not decline due to the factors of experience and length of service, which strengthen workers' resilience to work pressure.

4.4 The Effect of Length of Service on Work Productivity through Fatigue

Length of service refers to the duration or length of time a person has worked at a company. Working hours are a factor that contributes to employee fatigue, especially when combined with age. Time has both positive and negative effects. When a person works longer, their ability to complete tasks increases, which has a positive effect. However, on the other hand, employees are more likely to work longer hours, especially in monotonous and tiring jobs (Rusila & Edward, 2022). The results of this study are consistent with previous research (Elia et al., 2020), which found that employees have more experience with longer tenure. Long-term employees are generally more productive than new employees with shorter tenure due to better supervision and work knowledge. However, sitting for too long can cause negative effects, such as fatigue. If fatigue is not managed properly, the high productivity resulting from work experience may decrease in the long term. The results found in the production area at PT Maruki International show that the average length of service of workers exceeds 5 years. This shows that the longer a person works, especially in monotonous and repetitive jobs, the greater the risk of physical and mental fatigue. This condition makes it difficult for workers to maintain their optimal performance. In addition, the average worker in factory 1 is over 50 years old, so fatigue sets in more quickly because their endurance and physical strength have declined. As a result, work productivity declines even though they have considerable work experience.

4.5 The Effect of Glucose on Work Productivity through Fatigue

Energy consumption supports metabolism. Carbohydrates, the main source of energy, are converted into glucose. Glucose plays a role in glycolysis in the cytosol, and pyruvate plays a role in pyruvate dehydrogenase in the mitochondria. Acetyl-CoA enters the citric acid cycle, producing ATP (adenosine triphosphate), the body's cellular energy source. High energy ranges from 80-100% of total energy and is considered high energy because it is less than 80% of total energy (Hapsari & Kartini, 2013). Glucose is a compound that serves as the main source of ATP, both through aerobic and anaerobic pathways. In the anaerobic process, glucose is broken down without oxygen through the mechanism of anaerobic glycolysis or the lactic acid system. Meanwhile, in aerobic conditions, glucose and oxygen are processed through a series of chemical reactions to produce ATP, known as aerobic glycolysis. The aerobic process produces more energy than anaerobic glycolysis. Glucose comes from the breakdown of various types of carbohydrates that are consumed. This compound is stored in the blood as blood glucose and in the form of glycogen in the liver and muscles as an energy reserve. Glucose is a simple carbohydrate that cannot be broken down into smaller saccharides. In the body, glucose is the main form of carbohydrate circulating in the blood and is a source of energy for cells. Glucose is found in fruits, honey, and human blood. In the medical

world, the term blood sugar refers to the level of glucose in the blood, which is strictly controlled because it is the body's main fuel. Normally, blood sugar levels ranges between 4–8 mmol/l (70–150 mg/dl), increases after eating, and is at its lowest in the morning before eating (Khairani et al., 2025).

5. Conclusion

The results indicate that productivity is influenced by physical workload and working hours, which increase fatigue and thus reduce productivity, as well as by glucose, which plays a positive role in maintaining energy and increasing productivity. Meanwhile, noise and mental workload were not found to have an effect through fatigue.

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