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The Influence of Music Tempo on Employee Productivity in Fabrication using the Cognitive Failure

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Abstract

This study aims to determine the effect of music tempo on work productivity and the level of cognitive failure among employees in the fabrication division of PT. Adi Joyo Kusumo. Music is used as an intervention to address boredom and stress caused by monotonous work. This research employs the Cognitive Failure Questionnaire (CFQ) method distributed to 12 employees, and observations were made on production quantities over seven days under three conditions: without music, fast tempo music, and slow tempo music. The results indicate that fast tempo music yields the highest productivity level with a total production of 26 units, followed by the no music condition (23 units) and slow tempo music (21 units). Validity tests show that all CFQ items are valid, and reliability tests yield a Cronbach's Alpha value of 0.921, indicating reliability. ANOVA tests show a significance value of 0.000 ($p < 0.05$) and an F value of 17.078, indicating a significant effect of music tempo on cognitive failure levels. Although fast tempo music can enhance work performance, the noise level reached 89 dB, disturbing other divisions. This study concludes that fast tempo music can be used as a productivity enhancement strategy, provided that noise levels are controlled to avoid negative impacts on other work environments.

Introduction

Productivity is a key performance indicator in the industrial sector and a primary concern in human resource management (Gagarinskaia et al., 2019; Sun, 2025; Tieber et al., 2019). One of the challenges faced by manufacturing companies is maintaining consistent employee performance, especially in divisions with repetitive and monotonous workloads such as fabrication. This condition can lead to stress, boredom, and decreased concentration, ultimately negatively impacting productivity (Cleary et al., 2016). PT. Adi Joyo Kusumo, a company engaged in construction and manufacturing traffic equipment, experiences fluctuations in production levels believed to be caused by work-related stress in the fabrication environment.

Survey results indicate that 10 out of 11 fabrication employees experience stress while working. To address this issue, Abrams (2010) and DeNora & Wigram (2010) said, one approach used is music therapy, which involves playing music during work processes. Rickard et al. (2005) and Franco et al. (2014) said that, Music is believed to stimulate emotions, improve mood, and influence cognitive performance. Music tempo, measured in beats per minute (BPM), is an important variable as it affects the rhythm speed and the level of stimulation provided. Fast tempo music can increase energy and work speed, while slow tempo music can create a calm atmosphere and enhance concentration (Setiadi & Yuliati, 2025; Avandra & Mayar, 2023; Handayani et al., 2025).

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However, music played at excessively high volumes can become a source of noise, disturbing other employees and even exceeding the comfort threshold (85 dB). This study aims to analyze the effect of music tempo on work productivity and cognitive failure levels among employees in the fabrication division at PT. Adi Joyo Kusumo. To measure cognitive failure levels, the Cognitive Failure Questionnaire (CFQ) method is used, which is a psychological instrument to identify simple errors such as concentration disturbances and forgetting work procedures (Goodhew & Edwards, 2025; Wagle et al., 1999). Additionally, this research also considers the impact of noise on other divisions located around the fabrication area. The results of this study are expected to contribute to the development of productivity enhancement strategies based on ergonomic and psychological workplace approaches, as well as provide input regarding the effective and non-disruptive application of music in industrial work environments.

Cognitive Ergonomics

Cognitive Ergonomics (CE) is a field of science that explores and elaborates on how tasks, jobs, and environments or systems can be designed to interact or synergize with human cognitive abilities (Jati & Amalia, 2024). According Hutabarat in Jati & Amalia (2024) Cognitive ergonomics is a part of ergonomics that examines human mental activities. Essentially, humans are not just passive receptors of stimuli; they actively process and filter the information they receive, converting it into specific structures and classifications. Experiences through visualization, memory, and problem-solving are all terms that describe phases of cognition (Wang et al., 2013).

Productivity

According Chen Lin in Thalibana (2022), productivity is the relationship between the output produced and the input required to produce that output. According to Husein Umar in Thalibana (2022) productivity means the comparison between the results achieved (output) and the total resources used (input). Human resource productivity can also be influenced by many factors, including compensation, work environment, and work stress (Riyadi, 2019; HR et al., 2022; Trang, 2016; Anjanarko et al., 2022). Indicators of work productivity include ability, improving desired outcomes, work enthusiasm, personal development, quality, and efficiency (Sufriadi, 2024; Abdelwahed & Doghan, 2023; Westover et al., 2010). According to Agus in (Safitri, 2019) there are five dimensions used to measure work productivity: Quality of Work, Quantity of Work, Timeliness, Work Enthusiasm, and Work Discipline.

Music Tempo

Music is an art form that expresses human thoughts and feelings through beautiful sounds with specific concepts and techniques. Music is created by individuals with certain talents to express ideas that can arise spontaneously or through planning (Andaryani, 2019). Music can be described as a sequence of notes accompanied by beats, with the speed of music referred to as tempo. Tempo itself is the speed of a song's beat and has a specific measurement known as BPM (Beats Per Minute), indicating the number of beats per minute (Aryanto & Megananda, 2019).

Noise

Noise is sound that can disturb human hearing. According to Salter in Balirante et al. (2020) the number of sound sources increases regularly in the surrounding environment, and when the sound becomes undesirable, it is referred to as noise. The noise level is a measure of sound energy expressed in decibels (dB). Based on the Decree of the Minister of Environment No. KEP.48/MENLH/11/1996, dated November 25, 1996, regarding the standard noise levels for area or activity purposes, the following table can be referenced:

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Tabel 1. Noise Quality Standards

No.	Area/Activity Purpose	Noise Level dB(A)
1.	Residential and Settlement	55
2.	Trade and Services	70
3.	Offices and Trade	65
4.	Green Open Spaces	50
5.	Industry	70
6.	Airports	75
7.	Government and Public Facilities	60
8.	Recreation	70
9.	Hospitals or Similar	55
10.	Schools or Similar	55
11.	Places of Worship or Similar	55

Source: Balirante et al., 2020

Cognitive Failure Questionerre (CFQ)

According to Desrianty in Sari (2019), the Cognitive Failure Questionnaire method is a measurement tool in the form of a questionnaire to assess the level of cognitive failure. Cognitive ergonomics here seeks to delve into the mental processes present in humans during activities that significantly influence cognitive and mental aspects. CFQ also aims to assess individuals' tendencies to make cognitive errors, both simple and complex, during daily activities. By using this method, researchers can gain a clearer picture of an individual's cognitive behavior patterns and the extent to which these failures affect productivity and quality of life. Respondents will choose answers based on a Likert scale of 0 - 4, and the scores will be assigned values from 0 - 100. After the scores are determined, they will be analyzed based on three levels of cognitive failure categories from CFQ, as follows:

Tabel 2. Cognitive Failure Categories of the CFQ

Score	Cognitive Failure Category
1-35	Low
36-59	Medium
60-80	High

Source : Septiani et al., 2023

Fishbone Diagram

The Fishbone Analysis (or Ishikawa) is a structured approach that allows for a more detailed analysis in finding the causes of problems, discrepancies, and existing gaps. This method divides problems into causes and effects, consisting of several factors: machines, management, materials, manpower, environment, measurement, and methods (Hidayat & Saefulloh, 2022). This diagram is also often referred to as a Cause-and-Effect Diagram. It was first applied to manufacturing problems, but over time its application has expanded to more universal issues (Budianto, 2021; Stavropoulos et al., 2018).

Data Validity Test

The validity test is conducted by comparing the calculated r value (Pearson correlation) with the r table value. The calculated r value will be used as a benchmark to determine whether the questionnaire items used to support the research are valid or not. The criteria for validity testing

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are as follows: (1) If r calculated > r table, then the research instrument is considered valid; (2) If r calculated < t table, then the research instrument is considered invalid.

Thus, the hypotheses for this research are as follows:

H_0 : The research instrument is not valid, so it cannot proceed to the next test.

H_1 : The research instrument is valid and can proceed to the next test.

Data Reliability Test

The reliability test is conducted by comparing the Cronbach's alpha value with the significance level used. The significance level can be 0.5, 0.6, or 0.7 depending on the research needs. The criteria for reliability testing are as follows: (1) If the Cronbach's alpha value > significance level, then the instrument is considered reliable; (2) If the Cronbach's alpha value < significance level, then the instrument is considered unreliable.

Thus, the hypotheses for this research are:

H_0 : The research instrument is not reliable.

H_1 : The research instrument is reliable.

Anova One-Way

One-way ANOVA is a type of parametric statistical test aimed at determining whether there are differences in means among more than two sample groups. The term "one-way" means that the source of variation analyzed occurs in one direction, namely between treatments (between groups). The purpose of one-way ANOVA is to compare more than two means. The usefulness of one-way ANOVA is to test the ability to generalize. If the means between two groups are proven not to differ, then the two sample groups can be generalized (the sample data is considered representative of the population) (Prabowo et al., 2022). (1) If the Sig value > 0.05, then the data is normally distributed; (2) If the Sig value < 0.05, then the data is not normally distributed.

Thus, the hypotheses for this research are:

H_0 : The average variable has no effect.

H_1 : The average variable has an effect.

Methods

This research was conducted at PT. Adi Joyo Kusumo, a construction implementation company located in Sidoarjo Regency, East Java. The research was carried out during September 2024 until the entire data collection and analysis process was completed. This research is quantitative with a quasi-experimental approach to determine the effect of music tempo on productivity and cognitive failure of employees in the fabrication division. Data were collected through three main methods: direct observation of daily production quantities, distribution of the Cognitive Failure Questionnaire (CFQ), and measurement of noise levels using a decibel meter. The research was conducted under three different conditions: without music, fast tempo music (≥110 BPM), and slow tempo music (≤80 BPM). Each condition was applied for several days in rotation to obtain representative data. The population in this study is all employees of PT. Adi Joyo Kusumo, with a purposive sample of 12 individuals from the fabrication division. Data analysis was performed using validity and reliability tests on the CFQ instrument, as well as one-way ANOVA statistical tests to examine the significance of differences in cognitive failure levels among treatments. Validity was determined based on Pearson Correlation values, and reliability was measured using Cronbach's Alpha values. This research also considers noise

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factors in the work environment to assess the impact of music on other divisions not directly involved in the research.

Results and Discussion

Based on observations over seven working days under three different conditions: without music, fast tempo music, and slow tempo music, data on daily performance scores show variations based on the influence of the type of music played. The following is a recap of production data:

Tabel 3. Production data Recap

Day	Without Music	Fast Tempo	Slow Tempo
1	3	2	4
2	3	3	4
3	3	3	3
4	4	4	3
5	3	4	3
6	4	5	2
7	3	5	2
Total	**23**	**26**	**21**

From Table 3, it shows that fast tempo music has the most positive influence on employee performance, with a total production of 26 box units and experiencing performance improvement each day. The no music condition produced 23 box units, while slow tempo music showed a decrease in productivity with only 21 box units. Although fast tempo is effective in increasing productivity, the noise level (89 dB) exceeds the ideal comfort threshold for work. Noise levels exceeding the ideal comfort threshold can potentially trigger cognitive failure. Therefore, a test was conducted using the Cognitive Failure Questionnaire (CFQ) method. The respondents used as research samples for filling out the cognitive failure questionnaire were 12 employees from the fabrication division at PT. Adi Joyo Kusumo.

Tabel 4. Cognitive Failure Questionerre (CFQ) Recap

Respondent	Score	Percentage (%)
1	10	16.67%
2	25	41,67%
3	30	50.00%
4	18	30.00%
5	10	16.67%
6	3	5.00%
7	30	50.00%
8	12	20.00%
9	34	56.67%
10	19	31.67%
11	18	30.00%
12	9	15.00%

Next, a validity test was conducted on the CFQ questionnaire to determine whether the items used are valid for supporting the research. The hypothesis for this test is as follows:

H0: The research instrument is not valid, so it cannot proceed to the next test.

H1: The research instrument is valid and can proceed to the next test.

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The following table presents the results of the validity test for the CFQ questionnaire:

Tabel 5. CFQ Questionerre Validity Test Results

No	Statement	R_{table}	$R_{calculated}$	Decision
1	Have you ever forgotten the tools or materials being used during the production process?	0,576	0,644	Valid
2	Have you ever forgotten the work sequence established in the fabrication SOP?	0,576	0,736	Valid
3	Have you ever not heard instructions from your supervisor while focusing on your work?	0,576	0,618	Valid
4	Have you ever forgotten to check the quality of the production results?	0,576	0,626	Valid
5	Have you ever accidentally discarded or moved components that were still needed?	0,576	0,778	Valid
6	Have you ever forgotten to wear personal protective equipment (PPE) before entering the work area?	0,576	0,638	Valid
7	Have you forgotten to turn off machines or equipment after use?	0,576	0,666	Valid
8	Do you often make mistakes in reading technical drawings or work instructions?	0,576	0,607	Valid
9	Have you forgotten the work schedule or shifts that apply?	0,576	0,592	Valid
10	Do you often forget the names of colleagues even though you frequently work together in a team?	0,576	0,590	Valid
11	Do you often forget the procedures for operating machines even though you frequently use them in daily work?	0,576	0,852	Valid
12	Have you ever forgotten the deadline for completing production?	0,576	0,692	Valid
13	Have you ever stored tools in the wrong place, making them hard to find again?	0,576	0,734	Valid
14	Have you ever left the work area and realized that a procedure was missed?	0,576	0,847	Valid
15	Have you ever felt you lost documents/tools, but they were actually in a location you already checked?	0,576	0,787	Valid

In this study, a variable is considered valid if the Pearson Correlation value (as r calculated) is greater than the r table value (0.576; df = 12 - 2 = 10; two-tailed with a significance level = 5%/2 = 0.025). Based on the validity test results, all questions in each item in Table 5 have r calculated values greater than r table, meaning that the decision H1 is accepted, and the data is declared valid and suitable for use in the research. If the questionnaire items are declared valid, the next step is to conduct a reliability test. The hypothesis for this research is:

H_0 : The research instrument is not reliable

H_1 : The research instrument is reliable.

This test is conducted to measure a questionnaire that serves as a tool for this research. A questionnaire is considered reliable if respondents' answers to the presented questions are

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consistent or stable over time. This test uses a significance level of 0.025, with df = 10, and employs Cronbach's alpha technique. The output results from the reliability test using SPSS software are as follows:

Tabel 6. Overall Reliability Test

Reliability Statistics			
Cronbach's alpha	**N of Items**	**Condition**	**Information**
0,921	15	>0,60	Reliabel

Based on Table 6, it shows that the variable has been declared reliable because it has a Cronbach's alpha value above 0.60, which is 0.921.

Table 7. Test Results One Way ANOVA Cognitive Failure Questionerre

ANOVA					
Results					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2596.030	1	2596.030	17.078	.000
Within Groups	3800.267	25	152.011		
Total	6396.296	26			

After conducting the One-Way ANOVA test, H0 will be accepted if the significance value is greater than 0.05. In Figure 1, the significance value (Sig.) is obtained at 0.000, which is less than the significance level $\alpha = 0.05$. This indicates that there is a statistically significant difference between the treatment groups, namely the conditions without music, fast tempo music, and slow tempo music on the level of cognitive failure (Cognitive Failure) of employees in the fabrication division. The calculated F value of 17.078 indicates that the variation between groups is much greater than the variation within groups.

Therefore, it can be concluded that music tempo has a significant effect on the level of cognitive failure. This means that changes in the type of music played during work processes have a real impact on concentration and cognitive errors experienced by employees while working in the fabrication environment. The percentage calculation of cognitive failure is conducted to determine the extent of cognitive failure levels among fabrication employees at PT. Adi Joyo Kusumo. According to Bridger et al. (2013), there are three levels of cognitive failure assessment in the CFQ as follows:

Percentage 1-35% : Low Cognitive Failure

Percentage 36-60% : Medium Cognitive Failure

Percentage 61-95% : High Cognitive Failure

Tabel 8. Cognitive Failure Percentage

Respondent	**Score**	**Percentage (%)**	**Category**
1	10	16.67%	Low
2	25	41,67%	Medium
3	30	50.00%	Medium
4	18	30.00%	Low
5	10	16.67%	Low
6	3	5.00%	Low
7	30	50.00%	Medium
8	12	20.00%	Low
9	34	56.67%	Medium

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10	19	31.67%	Low
11	18	30.00%	Low
12	9	15.00%	Low

The calculation of the cognitive failure level percentage among employees in the fabrication division at PT. Adi Joyo Kusumo is as follows:

Low Category

$$\%\ Cognitive\ Failure\ Level\ = \frac{\text{Number of Respondents in Low Category}}{\text{Total Respondents}} x100\%$$

$$= \frac{8}{12} x100\%$$

$$= 67\%$$

Medium Category

$$\%Cognitive\ Failure\ Level\ = \frac{\text{Number of Respondents in Medium Category}}{\text{Total Respondents}} x100\%$$

$$= \frac{4}{12} x100\%$$

$$= 33\%$$

Tabel 9. Cognitive Failure Level Recap

Category	Number	Percentage (%)
Low	8	67%
Medium	4	33%
High	0	0
Total	**12**	**100%**

Based on Table 9 using the Cognitive Failure Questionnaire (CFQ), it is known that the majority of respondents are in the low cognitive failure category, with 8 individuals or 67%. Meanwhile, 4 respondents or 33% fall into the medium category, and no respondents fall into the high category. If employees in the fabrication division show cognitive failure levels in the medium to high category, improvements to the work system implemented at PT. Adi Joyo Kusumo need to be proposed.

The Fishbone Diagram analysis identifies six main factors causing cognitive failure and decreased work productivity in the fabrication division of PT. Adi Joyo Kusumo, namely: human, method, machine, material, environment, and measurement. The human factor includes stress and boredom due to monotonous work. From the method side, work procedures are inflexible. The machines do not have significant issues, but the lack of safety support systems poses a risk of errors. Materials and an ergonomically inadequate work layout slow down the process (Suhardi et al., 2019; Arezes et al., 2015). The work environment is disturbed by noise from music and machines, affecting concentration. Meanwhile, the lack of routine performance measurement leads to delays in identifying problems. All these factors are interconnected and require integrated handling.

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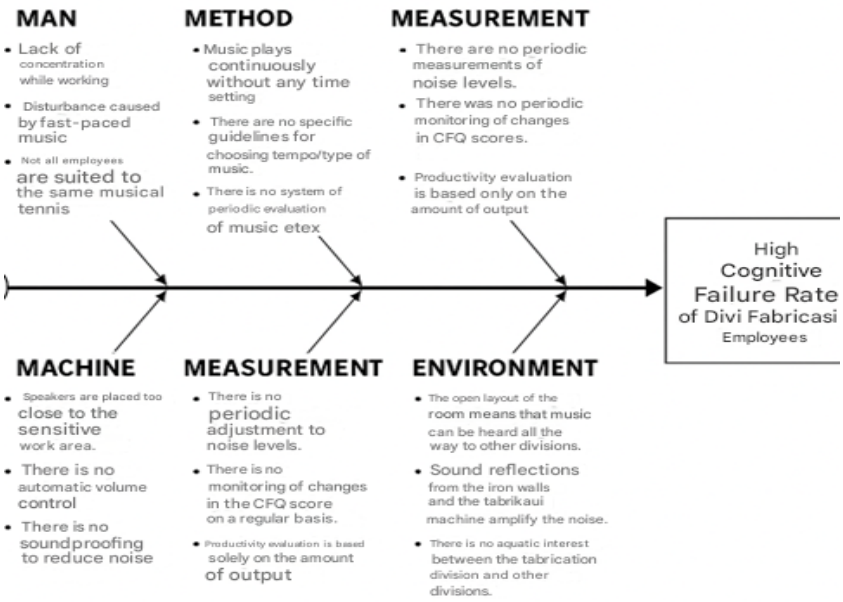

Figure 1. Fishbone Diagram

Conclusion

Based on the objectives of the research conducted at PT. Adi Joyo Kusumo, it can be concluded that music tempo has a significant influence on work productivity and cognitive failure levels of employees, particularly in the fabrication division. The production recap results show that during the seven days of observation, playing fast tempo music resulted in the highest total production of 26 box units, compared to the no music condition of 23 units and slow tempo music of 21 units. This indicates that fast tempo music can optimally enhance employee work performance. However, this increase is also accompanied by potential disturbances due to noise, especially since the decibel level exceeds the comfort threshold for work. Furthermore, the results of the Cognitive Failure Questionnaire indicate that the majority of employees experience cognitive failure at low to medium levels, with the majority of respondents (67%) in the low category. Validity and reliability tests on the CFQ instrument yielded a Pearson Correlation value greater than 0.576 and a Cronbach's Alpha value of 0.921, indicating that the instrument is valid and reliable. Additionally, the one-way ANOVA test supports this research with a significance value of 0.000 ($p < 0.05$) and an F value of 17.078, proving that differences in music tempo statistically affect cognitive failure levels. Based on this analysis, it can be concluded that playing fast tempo music can be a strategy to enhance work productivity while still considering noise limitations to minimize the risk of cognitive disturbances and hearing health issues.

Suggestions

This research also recommends improvements to the work environment and music volume regulation so that the optimal benefits of music usage can be achieved without causing negative impacts on other employees in the surrounding work area.

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