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The Influence of Physical Work Environment on Work Stress in Educational Staff of the Faculty of Engineering, UNS Surakarta

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ABSTRACT : In office ergonomics, work environment is one of the factors that need to be considered carefully. Physical work environment is one of the importance dimensions in an office. Office workers need a decent physical work environment so they can feel comfortable and safe when working. The physical work environment can influence the psychological condition of office workers which is closely related to work stress that will affect their performance. The aim of this research is to find the influence of physical work environment variables on office worker work stress. The data consisted of 46 samples collected from distributing questionnaires to educational staff who are office workers at the Faculty of Engineering, Sebelas Maret University (UNS), Surakarta. The data was processed using multiple linear regression in SPSS software and the results showed that 3 variables in the form of room color, work chairs and work area design had a significant effect on office workers work stress.

Keywords – Physical Work Environment, Work Stress, Multiple Linear Regression

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1. Introduction

Office is a place where information is processed and distributed to parties involved in it [1]. An office should comply with workplace regulations relating to workplace provisions (health, safety and welfare). Even though offices are generally considered safe, there are still health risks that may occur, such as injury and stress for workers [2]. An office ergonomics approach is needed to support the activities of office workers so they feel safe, comfortable and healthy while working. The focus of office ergonomics is on the well-being of office workers and the adjustment of office components to meet worker needs and comfort[3].

In office ergonomics, working environmental conditions are one of the factors that need to be considered carefully. One dimension of the work environment that needs to be considered in an office is the physical work environment. The physical work environment is an important factor that can influence worker performance. The physical work environment includes all elements around workers that can affect their ability to perform assigned tasks and is influenced by several factors such as chemical, biological, physiological, mental and socio-economic aspects[4]. A healthy and comfortable work environment can increase worker motivation and productivity. Meanwhile, a poor physical work environment can increase workers' vulnerability to disease, stress and poor performance[5]. Therefore, companies must pay attention to the physical work environment and take the necessary actions to maintain a healthy and safe work environment for workers. The physical work environment is something in the form of space, physical layout, noise, equipment in the workplace, and materials in the workplace to improve worker performance[6].

Deshpande [7] stated that physical work environment factors related to worker work stress are body posture, work desk, work area design, humidity, health, lighting, noise and working hours. Kristanti [8] stated that indicators of the physical work environment which are closely related to office worker work stress are humidity, temperature, air circulation, color scheme, lighting, odors, decoration, noise and security. Putra & Saraswati [9] stated that lighting, air temperature, noise, color arrangement, space for movement, and security are factors in the physical work environment that are related to worker work stress.
One of the offices that requires good physical work environment facilities to support the work of its workers is the office in the area of the Faculty of Engineering, Sebelas Maret University, Surakarta, which has 72 educational staff with 53 of them working in the office section.
In the initial interview, there were several complaints from education staff regarding the air temperature being less than cool, tables that were less comfortable to use, work chairs that did not suit your posture so that it made you sore when working, as well as poor arrangement of items and dividers which made the space feel cramped. and makes movement less comfortable.
Based on existing problems, this research aims to analyze physical work environment factors that influence work stress, and provide improvement solutions for the physical work environment in offices.

2. METHODOLOGY

2.1 Sample

This research was conducted at the offices of the Faculty of Engineering, Sebelas Maret University, Surakarta. Primary research data was obtained from interviews with several respondents to find out their complaints about the physical work environment where they work for initial research data, as well as questionnaires filled out by respondents who work as educational staff at the Faculty of Engineering, Sebelas Maret University, Surakarta. Meanwhile, secondary research data in the form of organizational structure and employee data was obtained from the website and personnel documents of Faculty of Engineering, Sebelas Maret University, Surakarta. The amount of research samples for the questionnaire refers to Sevilla, et.al [10] with the following formula:

$$n = \frac{N}{1 + ne^2}$$

n = The amount of sample size
N = The amount of population
e = Error tolerance limit

With a sample size of 52, a population of 52, and an error tolerance limit of 0.05, the total sample obtained was 46 people.

2.2 Data Collection

Data was collected by distributing questionnaires either directly with printed questionnaires or via social media with Google forms. Question points for the questionnaire were obtained from previous research regarding physical work environment variables and work stress. The first part of the questionnaire is about the characteristics of the respondents, the second part is about physical work environment variables in the form of lighting, air temperature, room color, work chairs, work desks and work area design. Meanwhile, the third part is about work stress. Each question item has 5-point Likert scale such as (1) strongly disagree, (2) disagree, (3) not sure, (4) agree, (5) strongly agree. The data obtained was processed with multiple linear regression using SPSS software.

2.3 Conceptual Framework

The conceptual framework in this research is shown in Figure 1 where the independent variables are lighting, air temperature, room color, work chairs, work desks, and work area design. The dependent variable is work stress.

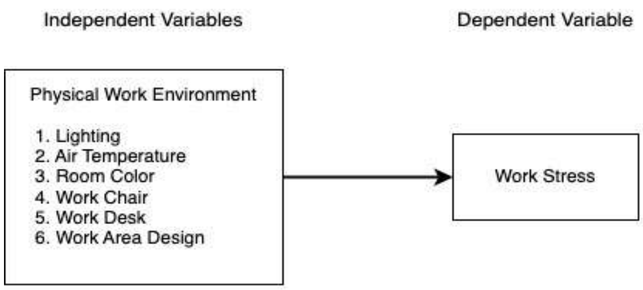

Figure 1 Conceptual Framework

3. RESULT AND DISCUSSION

The data collection process was carried out by distributing printed questionnaires directly or via social media using Google Form to educational staff at the Faculty of Engineering, Sebelas Maret University, Surakarta with a total of 46 respondents.

3.1 Respondent Characteristics

Respondent characteristics are divided into gender, age, and work experience at the Faculty of Engineering, Sebelas Maret University, Surakarta. The characteristics and responses of respondents who have filled out the questionnaire can be seen in Table 1.

Table 1 Respondent Characteristics

Characteristics	Frequency	Percentage
Gender		
Female	16	34.8%
Male	30	65.2%
Age		
20 - 30 years old	2	4.3%
31 - 40 years old	7	15.2%
41 – 50 years old	25	54.3%
>50 years old	12	26.1%
Work Experience		
<5 years	3	6.5%
5 - 10 years	4	8.7%
11 – 15 years	9	19.6%
>15 years	30	65.2%

Based on table 1, it was found that there were 30 male respondents or 65.2%, while there were 16 female respondents or 34.8%. In addition, the educational staff of the UNS Faculty of Engineering were dominated by staff with an age range of 41-50 years with 25 people or 54.3%, while the most respondents who had worked at the UNS Faculty of Engineering for more than 15 years were 30 people or 65.2%.

3.2 Data Quality Test

There are 2 stages in testing the quality of data obtained from the questionnaire before being processed using the multiple linear regression method, which are validity testing and reliability testing.

3.2.1 Validity Test

Validity test is used to measure the validity of each indicator question of each variable in the questionnaire data. A questionnaire statement is declared valid if r count > r table or significant value < 0.05, and the questionnaire question is declared invalid if r count < r table or significant value > 0.05. With 46 respondents and a significance of 5% (0.05), the r table is 0.2907. The results of processing the validity test of the questionnaire questions are shown in Table 2.

Table 2 Validity Test

Variable	Indicator	r Count	r Table	Significance	α	Result
Lighting	X1.1	0.872	0.2907	<0.001	0.05	Valid
	X1.2	0.720	0.2907	<0.001	0.05	Valid
	X1.3	0.578	0.2907	<0.001	0.05	Valid
	X1.4	0.802	0.2907	<0.001	0.05	Valid
	X1.5	0.769	0.2907	<0.001	0.05	Valid
	X1.6	0.641	0.2907	<0.001	0.05	Valid
Air Temperature	X2.1	0.849	0.2907	<0.001	0.05	Valid
	X2.2	0.849	0.2907	<0.001	0.05	Valid
Room Color	X3.1	0.781	0.2907	<0.001	0.05	Valid
	X3.2	0.854	0.2907	<0.001	0.05	Valid
	X3.3	0.783	0.2907	<0.001	0.05	Valid
Work Chair	X4.1	0.532	0.2907	<0.001	0.05	Valid
	X4.2	0.601	0.2907	<0.001	0.05	Valid
	X4.3	0.680	0.2907	<0.001	0.05	Valid
	X4.4	0.473	0.2907	<0.001	0.05	Valid
	X4.5	0.844	0.2907	<0.001	0.05	Valid
	X4.6	0.684	0.2907	<0.001	0.05	Valid
	X4.7	0.860	0.2907	<0.001	0.05	Valid
	X4.8	0.730	0.2907	<0.001	0.05	Valid
	X4.9	0.867	0.2907	<0.001	0.05	Valid
	X4.10	0.655	0.2907	<0.001	0.05	Valid
	X4.11	0.580	0.2907	<0.001	0.05	Valid
Work Desk	X5.1	0.747	0.2907	<0.001	0.05	Valid
	X5.2	0.526	0.2907	<0.001	0.05	Valid
	X5.3	0.719	0.2907	<0.001	0.05	Valid
	X5.4	0.743	0.2907	<0.001	0.05	Valid
	X5.5	0.674	0.2907	<0.001	0.05	Valid
	X5.6	0.700	0.2907	<0.001	0.05	Valid
	X5.7	0.465	0.2907	0.001	0.05	Valid
	X5.8	0.756	0.2907	<0.001	0.05	Valid
	X5.9	0.765	0.2907	<0.001	0.05	Valid
Work Area Design	X6.1	0.889	0.2907	<0.001	0.05	Valid
	X6.2	0.758	0.2907	<0.001	0.05	Valid
	X6.3	0.870	0.2907	<0.001	0.05	Valid
	X6.4	0.837	0.2907	<0.001	0.05	Valid
	X6.5	0.719	0.2907	<0.001	0.05	Valid
	X6.6	0.787	0.2907	<0.001	0.05	Valid
Work Stress	Y1	0.485	0.2907	<0.001	0.05	Valid
	Y2	0.734	0.2907	<0.001	0.05	Valid

Variable	Indicator	r Count	r Table	Significance	α	Result
	Y3	0.790	0.2907	<0.001	0.05	Valid
	Y4	0.860	0.2907	<0.001	0.05	Valid
	Y5	0.740	0.2907	<0.001	0.05	Valid
	Y6	0.777	0.2907	<0.001	0.05	Valid
	Y7	0.824	0.2907	<0.001	0.05	Valid
	Y8	0.839	0.2907	<0.001	0.05	Valid
	Y9	0.804	0.2907	<0.001	0.05	Valid
	Y10	0.621	0.2907	<0.001	0.05	Valid
	Y11	0.511	0.2907	<0.001	0.05	Valid
	Y12	0.480	0.2907	<0.001	0.05	Valid
	Y13	0.536	0.2907	<0.001	0.05	Valid
	Y14	0.522	0.2907	<0.001	0.05	Valid
	Y15	0.453	0.2907	0.002	0.05	Valid
	Y16	0.383	0.2907	0.009	0.05	Valid
	Y17	0.556	0.2907	<0.001	0.05	Valid
	Y18	0.535	0.2907	<0.001	0.05	Valid

In the validity test results, all statement items have a calculated r value > r table or a significant value < 0.05, so it can be stated that all statement items are valid.

3.2.2 Reliability Test

To measure the consistency of research variables, reliability test is used. When respondents answer of the questions asked are consistent or stable over time, then the variables in the research can be said as reliable. In the reliability test, the parameter used is the Cronbach's alpha value. If the Cronbach's alpha value is > 0.60, then the variable stated as reliable. The results of the research data reliability test are shown in Table 3.

Table 3 Reliability Test

Variable	Cronbach's alpha	Standard	Result
Lighting (X1)	0.811	0.60	Reliable
Air Temperature (X2)	0.612	0.60	Reliable
Room Color (X3)	0.728	0.60	Reliable
Work Chair (X4)	0.888	0.60	Reliable
Work Desk (X5)	0.852	0.60	Reliable
Work Area Design (X6)	0.883	0.60	Reliable
Work Stress (Y)	0.916	0.60	Reliable

Based on the table 3, the result of reliability test showed that all of independent variables and dependent variables have Cronbach's alpha value > 0.60 therefore it can be stated that all of these variables are reliable.

3.3 Classical Assumption Test

The classical assumption test is used to analyze the validity assumptions of the regression equation used to predict. The following are the results of the classical assumption test in regression:

3.3.1 Normality Test

The normality test is used to ensure that the regression model of the analyzed confounding variables or residuals is normally distributed as a prerequisite for analysis. The Kolmogorov-Smirnov (K-S) non-parametric statistical test is used to test normality. If the significance value is > 0.05, then the data is normally distributed. The results of this normality test are shown in Table 4.

Table 4 Normality Test Result

One-Sample Kolmogorov-Smirnov Test			
			Unstandardized Residual
N			46
Normal Parameters[a,b]	Mean		.0000000
	Std. Deviation		9.74037149
Most Extreme Differences	Absolute		.100
	Positive		.100
	Negative		-.058
Test Statistic			.100
Asymp. Sig. (2-tailed)[c]			.200[d]
Monte Carlo Sig. (2-tailed)[e]	Sig.		.298
	99% Confidence Interval	Lower Bound	.286
		Upper Bound	.310
a. Test distribution is Normal.			
b. Calculated from data.			
c. Lilliefors Significance Correction.			
d. This is a lower bound of the true significance.			
e. Lilliefors' method based on 10000 Monte Carlo samples with starting seed 926214481.			

The Kolmogorov-Smirnov normality test results table shows that the significant value is 0.200 > 0.05, so the data is normally distributed.

3.3.2 Multicollinearity Test

Multicollinearity test is used to test the presence of correlation of independent variables. In the assumption of multicollinearity, independent variables must be free from symptoms of multicollinearity. To test the presence or absence of multicollinearity, use the VIF (Variance Inflation Factor) tolerance value parameter. If the tolerance value is > 0.10 or the VIF value < 10, then there are no symptoms of multicollinearity. The results of the multicollinearity test are shown in Table 5 below.

Table 5 Multicollinearity Test Result

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	Total Lighting	.595	1.681
	Total Air Temperature	.651	1.536
	Total Room Color	.633	1.579
	Total Work Chair	.877	1.140
	Total Work Desk	.510	1.960
	Total Work Area Design	.385	2.596
a. Dependent Variable: Total Work Stress			

The multicollinearity test results table shows that all variables have a tolerance value > 0.10 or a VIF value < 10, so it can be concluded that there are no symptoms of multicollinearity or the variables pass the multicollinearity test.

3.3.3 Heteroscedasticity Test

This heteroscedasticity assumption test is a test on regression to ensure that the variance of the residuals is not different for one observation with another observation. The heteroscedasticity test is used to test whether there is inequality of variance of the residuals between observations. If the residual variance between observations remains the same, then it can be called homoscedasticity, but if it is different, it can be called heteroscedasticity. Regression is said to be good if it is homoscedasticity. In this test, if the significant value is > 0.05, then it passes the heteroscedasticity test. However, if the significant value is < 0.05, then it does not pass the heteroscedasticity test. The results of the heteroscedasticity test are shown in Table 6.

Table 6 Heteroscedasticity Test Result

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-9.423	7.900		-1.193	.240
	Total Lighting	.171	.306	.102	.560	.579
	Total Air Temperature	.591	.723	.142	.818	.418
	Total Room Color	-.055	.577	-.017	-.095	.925
	Total Work Chair	-.186	.103	-.269	-1.804	.079
	Total Work Desk	.475	.239	.389	1.986	.054
	Total Work Area Design	-.052	.367	-.032	-.143	.887
a. Dependent Variable: ABS_RES						

The table of heteroscedasticity test results shows that all variables have a significant value > 0.05, so it can be stated that there are no symptoms of heteroscedasticity or they pass the heteroscedasticity test.

3.4 Multiple Linear Regression Equation

This multiple linear regression analysis is used to analyze the influence of the relationship between dependent variables and two or more independent variables, as well as to predict the value of the dependent variable based on the increase or decrease in the value of the independent variable. Table 7 shows the constant coefficient values of the independent variables.

Table 7 Independent Variable Constant Coefficient Value

Coefficients[a]		
Model		Unstandardized Coefficients
		B
1	(Constant)	45.489
	Total Lighting	-.690
	Total Air Temperature	.908
	Total Room Color	2.649
	Total Work Chair	.503
	Total Work Desk	.118
	Total Work Area Design	-1.986
a. Dependent Variable: Total Work Stress		

The general equation for multiple linear regression results is:

Y = 45,489 + (-0,690 X1) + 0,908 X2 + 2,649 X3 + 0,503 X4 + 0,118 X5 + (-1,986 X6)

Y = 45,489 - 0,690 X1 + 0,908 X2 + 2,649 X3 + 0,503 X4 + 0,118 X5 - 1,986 X6

1. The constant coefficient value is 45.489 with a positive value, so it can be interpreted that there is a unidirectional influence between the independent variable and the dependent variable. So, if all independent variables in the form of lighting (X1), air temperature (X2), room color (X3), work chair (X4), work desk (X5), and work area design (X6) have a value of 0% or constant, then the work stress value is 45.5%.
2. The coefficient value of the lighting variable (X1) is -0.690, it means that the lighting variable has a negative value on worker stress so that if the value of other independent variables is constant and the lighting variable increases by 1 unit, then the work stress variable decreases by 0.690 units.
3. The coefficient value of the air temperature variable (X2) is 0.908, it means that the air temperature variable has a positive value on worker stress so that if the other independent variables have constant values and the air temperature variable increases by 1 unit, then the work stress variable increases by 0.908 units.
4. The coefficient value of the room color variable (X3) is 2.649, it means that the room color variable has a positive value on worker stress so that if the other independent variables have constant values and the space color variable increases by 1 unit, then the work stress variable increases by 2.649 units.
5. The coefficient value of the work chair variable (X4) is 0.503, it means that the work chair variable has a positive value on worker stress so that if the value of other independent variables is constant and the work chair variable increases by 1 unit, then the work stress variable increases by 0.503 units.
6. The coefficient value of the work desk variable (X5) is 0.118, means that the work desk variable has a positive value on worker stress so that if the other independent variables have constant values and the work desk variable increases by 1 unit, then the work stress variable increases by 0.118 units.
7. The coefficient value of the work area design variable (X6) is -1.986, it means that the work area design variable has a negative value on worker stress so that if the other independent variables have constant values and the work area design variable increases by 1 unit, then the work stress variable decreases by 1.986 units.

3.5 Hypothesis Test Results

3.5.1 Determination Coefficient Test (R^2) Result

In the determination coefficient test (R^2), used to measure how far the model explains the variation of independent variables. Table 8 shows the results of the determination coefficient test (R^2):

Table 8 Determination Coefficient Test (R^2) Result

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.533a	.284	.174	10.46284
a. Predictors: (Constant), Total Lighting, Total Air Temperature, Total Room Color, Total Work Chair, Total Work Desk, Total Work Area Design				

The Adjusted R square value is 0.174 or 17.4%. The coefficient of determination value shows that the lighting variables (X1), air temperature (X2), room color (X3), work chair (X3), work desk (X4), and work area design (X6) are able to explain the work stress variable (Y) by 17.4%, while the remaining 82.6% is explained by other variables.

3.5.2 F-Test Result

The F-test is used to determine whether independent variables can simultaneously affect the dependent variable. This test identifies whether the estimated regression model is feasible to be used to explain the effect of independent variables on the dependent variable. The provision is if F count > F table or significant < α 0.05, then H0 is rejected, and Ha is accepted. If F count < F table or significant > α 0.05, then Ha is rejected, and H0 is accepted. The results of the F test are shown in table 9.

Table 9 F-Test Result

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1697.350	6	282.892	2.584	.033[b]
	Residual	4269.368	39	109.471		
	Total	5966.717	45			
a. Dependent Variable: Total Work Stress						
b. Predictors: (Constant), Total Lighting, Total Air Temperature, Total Room Color, Total Work Chair, Total Work Desk, Total Work Area Design						

Based on the table, the calculated F value is 2.584 > the F table value of 2.342, and the significant value is 0.033 < 0.05, so H0 is rejected and Ha is accepted, it means that the variables of lighting, air temperature, room color, work chair, work desk, and work area design together have an effect on work stress.

3.5.3 T-Test Result

The t-test is used to determine whether each independent variable can affect the dependent variable. The provisions of this t-test are if the calculated t value > t table or significant < α, then H0 is rejected, and Ha is accepted. Likewise, if the calculated t value < t table or significant > α, then Ha is rejected, and H0 is accepted. Table 10 shows the results of the t-test.

Table 10 T-Test Result

Coefficients[a]						
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	45.489	15.961		2.850	.007
	Total Lighting	-.690	.619	-.196	-1.115	.272
	Total Air Temperature	.908	1.460	.104	.622	.538
	Total Room Color	2.649	1.165	.387	2.274	.029
	Total Work Chair	.503	.208	.349	2.413	.021
	Total Work Desk	.118	.483	.046	.245	.808
	Total Work Area Design	-1.986	.741	-.585	-2.680	.011
a. Dependent Variable: Total Work Stress						

Based on Table 10, the partial influence of the independent variables on the dependent variables is as follows:

1. The calculated t value of the lighting variable (X1) is -1.115 < the t table value of 2.015 and the significant value is 0.272 > 0.05, so Ha is rejected and H0 is accepted, it means that the lighting variable does not affect work stress. This is in accordance with research conducted by Makhbul et al. [11] that lighting does not affect worker work stress.
2. The calculated t value of the air temperature variable (X2) is 0.622 < the t table value of 2.015 and the significant value is 0.538 > 0.05, so Ha is rejected and H0 is accepted, it means that the air temperature variable does not affect work stress. This is the same as the results of research conducted by J. F. Thayer et al. [12] regarding the air temperature variable which does not affect worker work stress.
3. The calculated t value of the room color variable (X3) is 2.274 > the t table value of 2.015 and the significant value is 0.029 < 0.05, so H0 is rejected and Ha is accepted, it means that the room color variable has an effect on work stress. This is in line with previous research conducted by Prasetya [13] that the selection of room color has an effect on work stress.

4. The t-value of the work chair variable (X4) is 2.413 > the t-table value of 2.015 and the significant value is 0.021 < 0.05, so H0 is rejected and Ha is accepted, it means that the work chair variable has an effect on work stress. This is in contrast to previous research conducted by Makhbul et al. [11] which stated that work chairs do not have a significant effect on work stress.

5. The calculated t value of the work desk variable (X5) is 0.245 < the t table value, which is 2.015 and the significant value is 0.808 > 0.05, so Ha is rejected and H0 is accepted, it means that the work desk variable does not have an effect on work stress.

6. The calculated t value of the work area design variable (X6) is -2.680 <t table value of 2.015 and the significant value is 0.011 <0.05, so H0 is rejected and Ha is accepted, it means that the work area design variable has an effect on work stress. This is in contrast to research conducted by Makhbul et.al. [11] and J. F. Thayer [12] which state that there is no effect of work area design on work stress.

4 CONCLUSION

In this research about the influence of physical work environment on work stress in educational staff at the Faculty of Engineering, Sebelas Maret University, Surakarta, the physical work environment variables related to work stress are lighting, air temperature, room color, work chair, work desk, and work area design. The results of this research indicate that the six independent variables in the form of lighting (X1), air temperature (X2), room color (X3), work chair (X4), work desk (X5), and work area design (X6), together (stimultaneously) affect the dependent variable of work stress (Y). The results of data processing also show that there are 3 variables that partially affect worker work stress, which are room color, work chair, and work area design. Meanwhile, lighting, room temperature, and work desk do not have a partial effect on worker work stress.

The results of this research can be used by the leaders of the Faculty of Engineering, Sebelas Maret University, Surakarta as a consideration in optimizing physical work environment facilities that are in accordance with worker needs so that workers can work more comfortably and safely. In addition, a survey of the need for physical environment facilities for workers can also be conducted so that the leader can provide facilities according to worker needs.

This research is limited because it only uses 6 independent variables. For further research, more independent variables can be used so that more variables that influence work stress can be identified.

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