

Influence of Innovation and Work Environment on Performance with Work Discipline as Mediator

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Abstract

This study aims to analyze the influence of technological innovation and work environment on employee performance at Tugu Perfect Farmers Group (KTGA), Division 1 PNDA Djuanda Sawit Lestari, with work discipline as an intervening variable. Technological innovation is expected to enhance efficiency and productivity, while a conducive work environment fosters employee motivation and job satisfaction. This research employs a quantitative approach, utilizing path analysis with SmartPLS 3, to examine the relationships between variables based on data collected from 63 employees through a structured questionnaire. The results indicate that technological innovation has a significant and positive impact on employee performance, both directly and indirectly through improved work discipline. Similarly, the work environment has a positive impact on performance, with work discipline serving as a significant mediator. The novelty of this study lies in its integrated examination of work discipline as a mediating variable in the agricultural and plantation sector. This area has remained underexplored in previous research. The findings underscore the importance of integrating technological advancements with a supportive work environment and strong work discipline to enhance performance outcomes. Practically, this study provides actionable insights for human resource management, particularly for plantation-based companies, to develop strategic interventions that focus on employee adaptability, discipline, and motivation. It contributes to the literature by emphasizing the role of organizational culture and behavioral factors in enhancing employee performance through digital transformation and workplace improvement.

Keywords: Employee Performance; Technological Innovation; Work Discipline; Work Environment.

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I. Introduction

In the digital era, technological advances drive improved organizational performance, including in the agriculture and plantation sectors (Wuli, 2023). Automation, data-driven systems, and digital monitoring have transformed traditional work practices. However, many organizations still struggle to implement technology due to limited human resources and inadequate infrastructure readiness. Employees who are accustomed to old methods often struggle to adapt. This has an impact on their performance and discipline. Additionally, team communication, managerial support, and workplace safety also impact motivation and productivity. This challenge is closely related to the Tugu Sempurna Farmers Group (KTGA), which emphasizes the importance of innovation and discipline to improve work results. Moreover, the role of human resources is increasingly central to organizational success. Organizations must develop and optimize their workforce to remain competitive and resilient in the face of internal and external challenges. Human resources with high capabilities and adaptability are very important in achieving company goals in a dynamic environment (Ariyanti et al., 2024; Situmorang, 2023). Therefore, this study examines the impact of technological innovation and the work environment on employee performance, with work discipline serving as a mediating factor.

The palm oil plantation industry in Indonesia plays a crucial role in the country's economy, contributing significantly to its Gross Domestic Product (GDP) and providing livelihoods for numerous workers. However, the industry also faces several challenges, especially in efforts to increase productivity and quality sustainably. The Tugu Sempurna Farmers Group (KTGA) Division 1 PNDA Djuanda Sawit Lestari is one of the farmer groups in this sector that focuses on optimizing plantation yields by improving employee performance. Figure 1 shows data on the palm oil plantation industry in Indonesia (Limanseto, 2021).

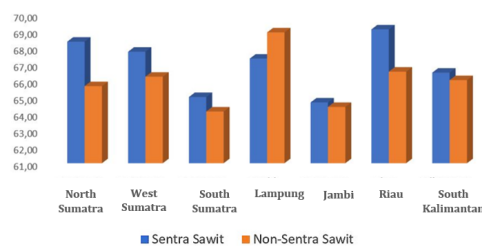


Figure 1. Data on the palm oil plantation industry in Indonesia

Figure 1 presents data related to the palm oil plantation industry in Indonesia, which indicates that this sector is experiencing rapid growth and showing positive performance. In general, performance can be understood as a person's success in carrying out a job. Good performance is one that aligns with established procedures or standards. Performance is the result of a person's work, the overall results of which can be proven concretely and measurably. Performance that can be assessed and measured objectively will increase employee motivation to work better (Asri & Moderin, 2024; Vallennia et al., 2020). In the case of KTGA, when employees feel that their work results are measured objectively and clearly, they will be more motivated to improve their performance. Employee performance is usually influenced by several factors, one of which is innovation (Putra, 2019).

Innovation is the creation of something new, an idea or tool that has never existed before, and is expected to be something interesting and useful. Someone who continuously innovates can be considered an innovator (Vallennia et al., 2020). A common phenomenon in innovation is the gap between the potential benefits of new technology and the actual results achieved in the field. Employees accustomed to traditional methods may struggle to adapt to new technology. This is due to a lack of adequate skills or training, which prevents technology from being used optimally. In addition to innovation, the work environment also affects performance. In the workplace, employees frequently encounter various challenges in their field. The physical conditions of the work environment, such as high temperatures, difficult terrain, and direct exposure to extreme weather, cause employees to feel uncomfortable and stressed. An unproductive work environment can have a detrimental impact on employee motivation and well-being, potentially leading to reduced productivity and performance. Work discipline is considered an intervening variable. Work discipline in the plantation sector is often a challenge because the nature of the work requires high commitment and punctuality in carrying out tasks. The phenomenon of work

discipline, characterized by high absenteeism and lateness, is often attributed to the distance between the employee's residence and the workplace.

In addition to highlighting the phenomena that occur in the field, this study also identifies a research gap. The results of the study indicate that the work environment affects employee performance (Hanafi & Zulkifli, 2018; Lestary & Chaniago, 2018; Rahayu & Rushadiyati, 2021). This finding is different from several previous studies, which stated that the work environment does not have a significant effect on performance (Sabilalo et al., 2020). Additionally, this study presents intervening variables as a novel element that distinguishes it from previous studies. This study aims to determine the effect of technological innovation and work environment on employee performance, by considering work discipline as an intervening variable. It is expected that the results of this study can provide input for the Tugu Sempurna Farmers Group (KTGA) Division 1 PNDA Djuanda Sawit Lestari in developing more effective strategies to improve employee performance. The implications of this study are expected to provide a foundation for companies in the plantation sector to enhance the factors that impact employee performance, ultimately achieving optimal productivity in the long term.

II. Method

This research employs a quantitative approach with an associative methodology. The data collection technique involved distributing questionnaires using a Likert scale with a value range of 1 to 5. The sample in this study employed a saturated sampling technique, encompassing the entire population of employees at Tugu Sempurna Farmers Group (KTGA) Division 1, comprising 63 individuals. Data processing was carried out using SmartPLS software. Before conducting the main analysis, a research instrument test was performed to assess validity and reliability. The validity test uses the Average Variance Extracted (AVE) indicator, where an AVE value above 0.50 indicates adequate convergent validity (Hair et al., 2010). While the reliability test was carried out using Composite Reliability (CR) and Cronbach's Alpha, with a value of more than 0.70 indicating that the instrument has acceptable internal consistency. Furthermore, the evaluation of the structural model includes several stages, namely: collinearity test using the Variance Inflation Factor (VIF) with a value of less than 5, testing the significance of the path coefficient using the bootstrapping method with a t-statistic value > 1.96 , calculating the effect size (f^2), and assessing the predictive relevance (Q^2) to assess the accuracy and predictive ability of the model. Moderating variables are analyzed through interaction effect analysis, and the overall suitability of the model is evaluated using the Standardized Root Mean Square Residual (SRMR), with a value of ≤ 0.08 indicating a good level of model suitability. Hypothesis testing is carried out at a significance level of 5% ($\alpha = 0.05$), where a hypothesis is declared accepted if the t-statistic value is greater than 1.96 and the p value is less than 0.05 (Sugiyono, 2019).

III. Results and Discussion

1. Descriptive Analysis

To better understand the characteristics of the respondents involved in this study, a descriptive analysis was conducted. The demographic details, including gender, age, education level, and years of service, are presented in Table 1 below.

Table 1. Descriptive Analysis of Respondents

No	Category	Description	Frequency	Percentage (%)
1	Gender	Male	49	77.78
		Female	14	22.22
2	Age	20–30 Years	22	34.92
		31–40 Years	34	53.97
		41–50 Years	5	7.94
		>51 Years	2	3.17
3	Education Level	High School/Equivalent	28	44.44

Continued on next page

Table 1—Continuation

No	Category	Description	Frequency	Percentage (%)
4	Years of Service	Associate Degree (D3)	2	3.17
		Bachelor’s Degree (S1)	31	49.21
		Master’s Degree (S2)	2	3.17
		1–5 Years	21	33.33
		6–9 Years	38	60.32
		>10 Years	4	6.35

Based on the descriptive analysis of 63 respondents, the majority are male (77.78%), while female respondents make up 22.22%. In terms of age, the largest group falls within the 31–40-year range (53.97%), followed by the 20–30-year range (34.92%). Meanwhile, respondents aged 41–50 years and above 51 years account for only 7.94% and 3.17%, respectively. Regarding educational background, most respondents hold a Bachelor’s Degree (S1) at 49.21%, followed by high school graduates (44.44%), while Associate degree (D3) and Master’s degree (S2) holders each represent 3.17%. In terms of work experience, the majority of respondents have been working for 6–9 years (60.32%), while 33.33% have worked for 1–5 years, and only 6.35% have been employed for more than 10 years. Overall, these findings indicate that most respondents are male, within a productive age range (31–40 years), hold a high level of education (S1), and possess considerable work experience (6–9 years).

2. Validity and Reliability Test

To assess the measurement model, validity and reliability tests were conducted using SmartPLS 3. The outer model path diagram shown below illustrates the relationships between the indicators and their respective constructs.

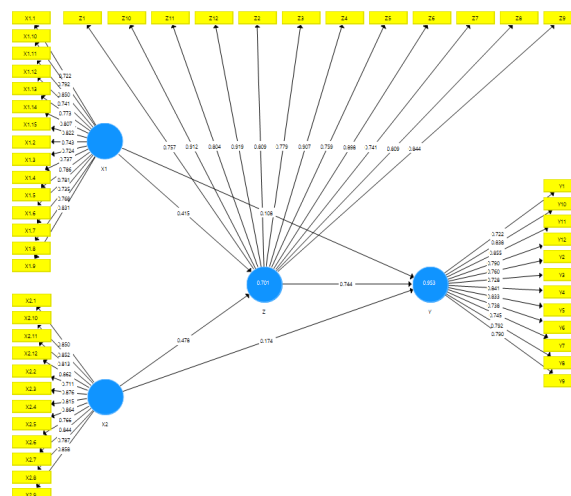


Figure 2. Path Diagram of the Outer Model

The diagram in Figure 2 shows the standardized outer loading for each indicator. All loading values are above the recommended threshold of 0.7, indicating strong indicator reliability. Furthermore, the diagram supports the overall construct validity of the measurement model.

2.1. Convergent Validity Test

To assess the validity of each indicator used in the study, a convergent validity test was conducted using the outer loading values generated through Smart PLS 3 analysis. Table 2 below presents the outer loading results for each indicator in each construct.

Table 2. Outer Loadings Results

	X1	X2	Y	Z
X1.1	0.722			
X1.10	0.792			
X1.11	0.850			
X1.12	0.741			
X1.13	0.773			
X1.14	0.807			
X1.15	0.822			
X1.2	0.743			
X1.3	0.724			
X1.4	0.737			
X1.5	0.786			
X1.6	0.781			
X1.7	0.735			
X1.8	0.768			
X1.9	0.831			
X2.1		0.850		
X2.10		0.852		
X2.11		0.813		
X2.12		0.862		
X2.2		0.711		
X2.3		0.876		
X2.4		0.815		
X2.5		0.864		
X2.6		0.766		
X2.7		0.844		
X2.8		0.787		
X2.9		0.858		
Y1			0.722	
Y10			0.838	
Y11			0.855	
Y12			0.790	
Y2			0.760	
Y3			0.728	
Y4			0.841	
Y5			0.833	
Y6			0.738	
Y7			0.745	
Y8			0.792	
Y9			0.790	
Z1				0.757
Z10				0.912
Z11				0.804
Z12				0.919
Z2				0.809
Z3				0.779
Z4				0.907
Z5				0.759
Z6				0.898
Z7				0.741
Z8				0.809
Z9				0.844

The data processing results using Smart PLS indicate that all indicators within each variable (X1, X2, Y, and Z) have outer loading values above 0.7. This suggests that all indicators meet the convergent validity criteria, meaning they strongly correlate with their respective constructs. The outer loading value above 0.7 confirms that the indicator provides a significant contribution to the measurement of the construct. Since all indicators in this study meet this criterion, the indicators can be used for further analysis without any necessary modification (Hair et al., 2010).

2.2. Average Variance Extracted (AVE) Test

To assess convergent validity, the Average Variance Extracted (AVE) values of each construct were examined. An AVE value greater than 0.5 indicates that the construct explains more than half of the variance of its indicators, which confirms acceptable convergent validity. The results are presented in Table 3.

Table 3. AVE Test Results

Variable	AVE
Technological Innovation (X1)	0,601
Work Environment (X2)	0,682
Employee Performance (Y)	0,62
Work Discipline (Z)	0,69

2.3. Discriminant Validity Test

To evaluate discriminant validity, cross-loading values were examined for each indicator. Discriminant validity is established when an indicator's loading on its associated construct is higher than its loading on other constructs. Table 4 presents the results of the cross-loading analysis for all indicators in this study.

Table 4. Cross-Loading Results

	X1	X2	Y	Z
X1.1	0.722	0.471	0.626	0.627
X1.10	0.792	0.715	0.652	0.616
X1.11	0.850	0.590	0.624	0.631
X1.12	0.741	0.595	0.553	0.455
X1.13	0.773	0.583	0.559	0.464
X1.14	0.807	0.537	0.574	0.576
X1.15	0.822	0.729	0.688	0.661
X1.2	0.743	0.571	0.736	0.726
X1.3	0.724	0.403	0.621	0.641
X1.4	0.737	0.766	0.841	0.815
X1.5	0.786	0.579	0.588	0.582
X1.6	0.781	0.455	0.570	0.562
X1.7	0.735	0.536	0.523	0.431
X1.8	0.768	0.557	0.564	0.478
X1.9	0.831	0.580	0.586	0.520
X2.1	0.722	0.850	0.705	0.667
X2.10	0.545	0.852	0.629	0.566
X2.11	0.560	0.813	0.706	0.753
X2.12	0.576	0.862	0.667	0.573
X2.2	0.582	0.711	0.666	0.669
X2.3	0.647	0.876	0.731	0.689
X2.4	0.595	0.815	0.692	0.597
X2.5	0.685	0.864	0.766	0.712
X2.6	0.807	0.766	0.747	0.677
X2.7	0.511	0.844	0.647	0.555
X2.8	0.552	0.787	0.661	0.675
X2.9	0.652	0.858	0.709	0.655
Y1	0.641	0.564	0.722	0.742
Y10	0.700	0.759	0.838	0.804
Y11	0.675	0.684	0.855	0.892
Y12	0.673	0.769	0.790	0.696
Y2	0.611	0.591	0.760	0.765
Y3	0.548	0.500	0.728	0.766
Y4	0.700	0.765	0.841	0.788

Continued on next page

Table 4—Continuation

	X1	X2	Y	Z
Y5	0.649	0.679	0.833	0.840
Y6	0.616	0.568	0.738	0.717
Y7	0.550	0.641	0.745	0.647
Y8	0.662	0.737	0.792	0.711
Y9	0.681	0.704	0.790	0.718
Z1	0.631	0.599	0.719	0.757
Z10	0.700	0.718	0.883	0.912
Z11	0.639	0.739	0.820	0.804
Z12	0.658	0.722	0.876	0.919
Z2	0.645	0.639	0.787	0.809
Z3	0.530	0.580	0.706	0.779
Z4	0.713	0.713	0.872	0.907
Z5	0.603	0.581	0.763	0.759
Z6	0.695	0.714	0.848	0.898
Z7	0.636	0.624	0.731	0.741
Z8	0.651	0.657	0.796	0.809
Z9	0.615	0.570	0.784	0.844

The cross-loading values in Table 4 demonstrate the correlation between indicators and their respective constructs. Key indicators such as X1.10 (0.792), X2.11 (0.813), Y10 (0.838), and Z12 (0.919) have higher loading factor values within their respective constructs compared to other constructs. This indicates that these indicators strongly correlate with their respective variables and do not significantly overlap with other constructs, thereby meeting the criteria for good discriminant validity. Furthermore, the study also meets the HTMT (Heterotrait-Monotrait Ratio) criterion and the square root of AVE (Average Variance Extracted), ensuring that each construct is distinct from the others.

2.4. Reliability Test (Composite Reliability Test)

To ensure the internal consistency of the constructs, reliability was tested using Cronbach's Alpha, rho_A, and Composite Reliability (CR). A Composite Reliability value above 0.70 indicates that the indicators consistently measure the latent construct. Table 5 displays the reliability results of each variable used in this study.

Table 5. Composite Reliability Results

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Technological Innovation	0.952	0.956	0.957	0.601
Work Environment	0.957	0.958	0.963	0.682
Employee Performance	0.944	0.946	0.951	0.620
Work Discipline	0.958	0.961	0.964	0.690

The results indicate that all constructs in this study have composite reliability values above 0.70, confirming a high level of reliability in the measurement model. The highest composite reliability is found in Work Environment (0.963), while the lowest is in Technological Innovation (0.957). Additionally, Cronbach's Alpha and rho_A values exceed 0.90, suggesting that each construct demonstrates strong internal consistency. These findings confirm that the measurement instruments used in the study are reliable and can be used for further structural model analysis (inner model evaluation).

3. Inner Model Evaluation

After evaluating the outer model, the next step is to assess the inner model to determine the relationships between the latent variables. This includes evaluating the path coefficients, R^2 values, and the significance of hypothesized relationships. The path diagram of the inner model is shown in Figure 3 below.

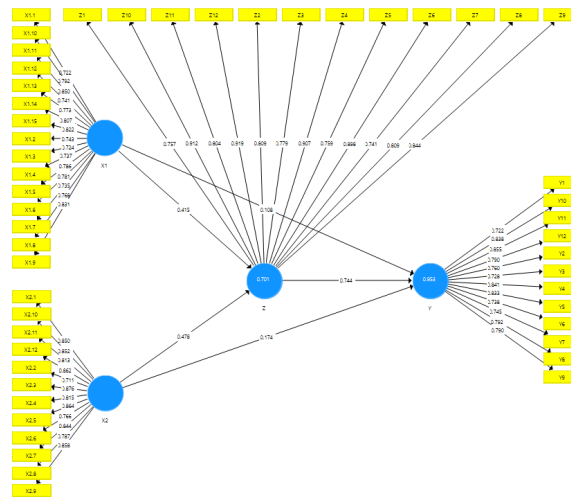


Figure 3. Inner Model Path Diagram

4. Coefficient of Determination

The coefficient of determination (R^2) is used to measure how well the independent variables explain the variance of the dependent variables. A higher R^2 value indicates a better explanatory power of the model. Table 6 presents the R^2 and adjusted R^2 values for the endogenous variables in this study.

Table 6. R-Square Test Results

	R Square	R Square Adjusted
Employee Performance	0.953	0.951
Work Discipline	0.701	0.691

Based on Table 6, the R^2 value for Employee Performance is 0.953, meaning that approximately 95.3% of the variability in Employee Performance can be explained by the variables in the model. Meanwhile, the R^2 value for Work Discipline is 0.701, indicating that approximately 70.1% of the variability in Work Discipline can be explained by the variables in the model. The Adjusted R^2 values also show similar results, suggesting that this model has strong predictive power for both dependent variables.

5. Effect Size (F)

The effect size (f^2) is used to determine the magnitude of the impact that an exogenous variable has on an endogenous variable. According to Cohen’s guidelines, an f^2 value of 0.02 is considered small, 0.15 medium, and 0.35 large. Table 7 presents the f^2 values for each relationship in the structural model of this study.

Table 7. F-Square Test Values

Relationship	F-Square Value	Effect Size
Technological Innovation → Employee Performance	0.086	Small
Technological Innovation → Work Discipline	0.247	Medium
Work Environment → Employee Performance	0.207	Medium
Work Environment → Work Discipline	0.328	Medium
Work Discipline → Employee Performance	3.514	Large

These results indicate that Work Discipline has the strongest influence on Employee Performance, while the other relationships show either small or medium effects.

6. Predictive Relevance (Q^2)

Predictive relevance (Q^2) is used to evaluate how well the model and its parameters reconstruct the observed values. A Q^2 value greater than zero indicates that the model has predictive relevance for a particular endogenous construct. The Q^2 values in this study were obtained using the blindfolding procedure. Table 8 presents the Q^2 values for each endogenous variable.

Table 8. Q-Square Test Values

	$Q^2 (=1-SSE/SSO)$
Employee Performance	0.577
Work Discipline	0.471

Based on the table above, which lists the Q^2 Predict values, the Employee Performance variable shows a value of 0.577, indicating good predictive relevance. Meanwhile, the Work Discipline variable shows a value of 0.471, also indicating good predictive relevance.

7. Hypothesis Testing Results

Hypothesis testing was conducted using the bootstrapping method in SmartPLS 3 to assess the significance of each proposed relationship in the structural model. The results include path coefficients, standard deviations, t-statistics, and p-values. A hypothesis is considered supported if the t-statistic value is greater than 1.96 and the p-value is less than 0.05. Table 9 summarizes the results of hypothesis testing for this study.

Table 9. Hypothesis Testing Results

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
X1 ->Y	0.108	0.105	0.054	2.023	0.047
X1 ->Z	0.415	0.476	0.174	2.392	0.020
X2 ->Y	0.174	0.188	0.079	2.198	0.032
X2 ->Z	0.478	0.424	0.181	2.636	0.011
Z ->Y	0.744	0.732	0.083	8.994	0.000
X1 ->Z ->Y	0.309	0.350	0.135	2.284	0.026
X2 ->Z ->Y	0.356	0.308	0.130	2.729	0.008

Hypothesis testing can be classified into two forms, namely direct testing and indirect testing, also known as intervening testing. The first hypothesis shows that innovation has a significant effect on employee performance, with a p-value of 0.047. Furthermore, the second hypothesis also confirms that innovation contributes to increased performance, as indicated by a p-value of 0.020. The application of appropriate innovative technology is considered capable of increasing employee work discipline, which ultimately has a positive impact on improving overall performance (Aldia & Sutarno, 2025; Ramdhona et al., 2022; Widodo et al., 2023). When technological innovation is optimally implemented in a company environment, employees tend to feel more comfortable working and find it easier to complete their tasks. The third hypothesis shows that the work environment has a significant direct effect on employee performance, with a p-value of 0.031. Furthermore, the fourth hypothesis shows that the work environment also has a significant effect on work discipline, with a p-value of 0.011. These findings emphasize the importance of creating a conducive work environment in shaping positive behavior and increasing employee satisfaction (Monica et al., 2024; Nurdin & Djuhartono, 2021; Ramdhona et al., 2022; Santanu & Utami, 2024). Therefore, the role of work discipline as an intervening variable requires special attention

in efforts to improve overall employee performance. The fifth hypothesis indicates that work discipline has a significant impact on employee performance, with a p-value of 0.000. Work discipline is one of the important factors that affect the level of employee performance in an organization. Work discipline reflects the extent to which an employee can comply with the rules, regulations, and work procedures established by the company. Employees with high discipline will demonstrate a regular work attitude, strong responsibility for tasks, and consistency in their work. The positive influence of discipline on performance is reflected in increased productivity, efficiency, and work effectiveness. Disciplined employees tend to complete tasks on time, avoid mistakes due to negligence, and can work with high focus and commitment (Anisa, 2023; Ariesni & Asnur, 2021; Pangarso & Susanti, 2016; Rarung et al., 2021).

Hypothesis testing, indirectly or through intervening variables, is carried out by making work discipline a mediating variable between innovation and performance, as well as between the work environment and performance. The results demonstrate that discipline significantly mediates the effect of both technological innovation and work environment on performance. The results of the study indicate that work discipline significantly mediates the relationship between technological innovation and work environment, influencing performance. Work discipline acts as a mechanism that regulates, enforces, and provides corrections or sanctions for violations of organizational rules, thus encouraging the creation of orderly work behavior and sustainable productivity (Abid & Jamilah, 2025; Karabi & FoEh, 2024; Rachmatan et al., 2024; Yanto et al., 2023; Yuliantini & Suryatiningsih, 2021).

IV. Conclusion

Based on the study's results, it can be concluded that technological innovation and the work environment have a positive impact on employee performance. Work discipline has also been shown to play an important role in improving performance, where employees with high discipline tend to work in a more structured and focused manner, producing more optimal performance. In addition, this study demonstrates that work discipline serves as a significant intervening variable, strengthening the relationship between technological innovation and the work environment on employee performance. However, this study has several limitations, one of which is its limited scope, as it only highlights technological innovation and the work environment as independent variables, without considering other factors that also have the potential to affect employee performance, such as leadership style, organizational culture, and intrinsic motivation. Based on these findings, it is recommended that KTGA management continue to encourage the use of modern technology and create a more conducive work environment to increase employee productivity, which will ultimately have a positive impact on overall organizational performance.

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Declaration

The first author was responsible for the study design, data collection, and analysis, and initial writing of the article. The second, third, and fourth authors contributed to the review, feedback, and revision process to ensure quality and compliance with academic standards. The authors declare no financial conflicts of interest or personal relationships that could have influenced the content of this article.

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