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Technology Adoption, Leadership, and Employee Performance in Higher Education: The Mediating Role of Productivity and the Moderating Role of Age

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Abstract: This study aims to analyze the influence of technology adoption and leadership on employee productivity and performance, and examine the role of age as a moderating variable and productivity as a mediating variable in a higher education environment. The study used a quantitative approach with an explanatory design. The study respondents were 410 permanent employees consisting of 258 lecturers and 152 educational staff. Data collection was conducted through an online questionnaire and analyzed using Structural Equation Modeling based on Partial Least Squares (SEM-PLS) with the help of SmartPLS. The results showed that technology adoption had a positive and significant effect on employee productivity and performance. Leadership has a significant effect on productivity, but had a negative and significant effect on employee performance. Furthermore, productivity had a positive and significant effect on employee performance. Moderation tests showed that age significantly strengthened the effect of technology adoption on productivity, but did not moderate the effect of leadership on productivity or the relationship between technology adoption and leadership on employee performance. Mediation tests showed that productivity significantly mediated the effect of technology adoption and leadership on employee performance. These findings confirm that performance optimization in higher education needs to be directed at the effective use of technology, increasing productivity, strengthening digital competencies, and implementing leadership that is adaptive to organizational and employee characteristics.

Keyword: Technology Adoption, Leadership, Employee Productivity, Age, Performance.

INTRODUCTION

Employee performance is a crucial indicator of organizational success, including universities, which rely on the quality of lecturers and educational staff to provide academic and administrative services. In an increasingly digitalized work environment, performance is

influenced not only by individual capabilities but also by the organization's ability to utilize technology and the role of leadership in guiding change. Studies show that digital leadership can improve employee performance, including through digital transformation processes that strengthen the organization's and employees' ability to adapt to change (Qiao et al. 2024).

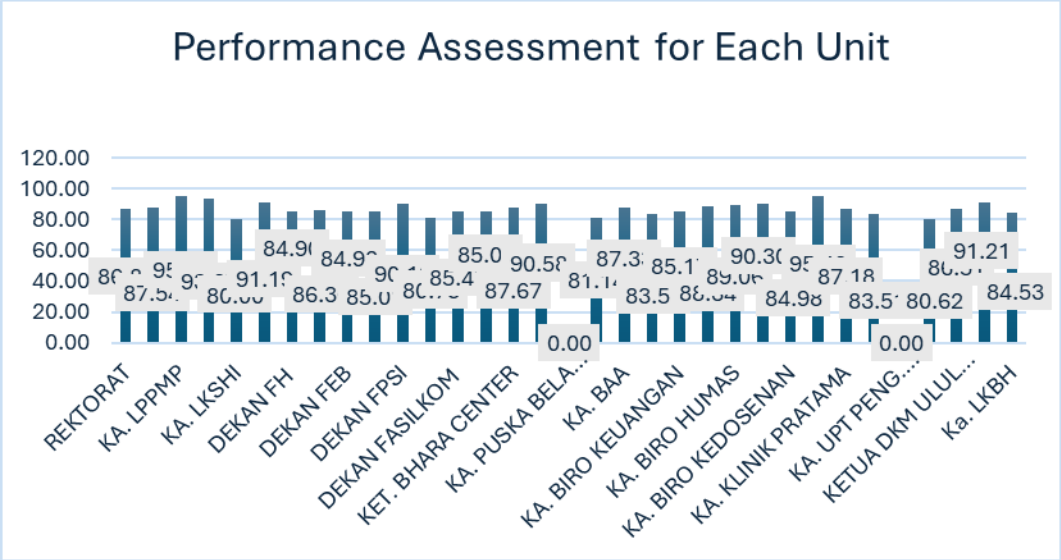


Figure 1. Performance Assessment

A study at one Indonesian university under the auspices of the Indonesian National Police Foundation (Foundation of the Indonesian National Police) showed that most work units received performance ratings ranging from "Very Good" to "Excellent." While this represents a positive achievement, this situation raises questions about whether the assessment scores fully represent actual employee performance and productivity. This phenomenon provides a basis for identifying factors that drive performance and the mechanisms that explain these achievements. Several studies have emphasized that performance assessments that focus too much on output without considering process and input can lead to performance bias (Murphy & Cleveland, 1995). On the other hand, uniform and overly high ratings often reflect problems in standard setting or systemic pressure to demonstrate positive results, rather than objective work realities (DeNisi & Pritchard, 2006).

In the context of digital transformation, technology adoption has the potential to increase work process efficiency and productivity. However, the presence of technology does not automatically result in higher performance, as its benefits depend on employees' ability to use the technology and organizational support. Therefore, productivity is seen as an important mechanism explaining how technology adoption translates into employee performance. Furthermore, leadership that emphasizes technological adaptability, support for innovation, policy flexibility, and information transparency can create a work environment that supports improved employee performance (Shafariah et al., 2024).

The effectiveness of this relationship can also be influenced by age, an individual characteristic. Age differences are related to experience, readiness to adapt, and technology acceptance patterns. A systematic review of 51 studies demonstrated age-based differences in various determinants of technology adoption in the workplace and confirmed that age can act as a moderating factor in the relationship between technological characteristics and technology use behavior (Fazi, Zaniboni, & Wang, 2025).

Although research on technology adoption, leadership, productivity, and employee performance has expanded, an important research gap remains in understanding how these factors operate jointly, particularly among permanent employees in Indonesian higher

education institutions. Specifically, further empirical investigation is needed to examine an integrated framework in which technology adoption and leadership serve as antecedents of employee performance, productivity mediates the relationships between these antecedents and performance, and age moderates the relationship between technology adoption and productivity. Addressing this gap, this study develops a model entitled *"Driving Employee Performance through Technology Adoption and Leadership: The Mediating Role of Productivity and the Moderating Effect of Age."*

The novelty of this study lies in the simultaneous integration and empirical testing of these relationships within a single research framework and a specific institutional context that remains insufficiently examined. Rather than examining the direct effects of technology adoption and leadership on employee performance in isolation, this study investigates the mediating role of productivity in both relationships and examines whether the relationship between technology adoption and productivity varies according to employee age. By integrating these direct, mediating, and moderating relationships, this study seeks to advance understanding of the mechanisms through which technology adoption and leadership are associated with employee performance in an increasingly digitalized higher education environment. From a practical perspective, the findings are expected to inform higher education administrators in designing more effective technology adoption initiatives, strengthening leadership practices, and enhancing employee productivity while accounting for age-related differences among permanent staff.

Overall, this study contributes an integrated analytical framework for examining employee performance in Indonesian higher education and provides an empirical basis for further research on the interaction between technological, leadership, and demographic factors in organizational settings.

METHOD

This study employed a quantitative explanatory design to examine the relationships among technology adoption, leadership, productivity, employee performance, and age. The research was conducted at a private higher education institution in Indonesia. Technology adoption and leadership were modeled as exogenous variables, productivity as a mediator, employee performance as the endogenous variable, and age as a moderator of the relationship between technology adoption and productivity.

The population comprised 410 permanent employees, including 258 lecturers and 152 educational staff. A census sampling approach was adopted by inviting all eligible employees to participate. Of the 410 employees, [number] questionnaires were returned, of which [number] valid responses were included in the analysis, yielding a response rate of [percentage]%. Data were collected through an online questionnaire during [data-collection period]. Measurement items were adapted from established instruments, using a [five-point/seven-point] Likert scale. The original sources, adaptation procedures, and ethical approval or informed-consent arrangements were documented as applicable.

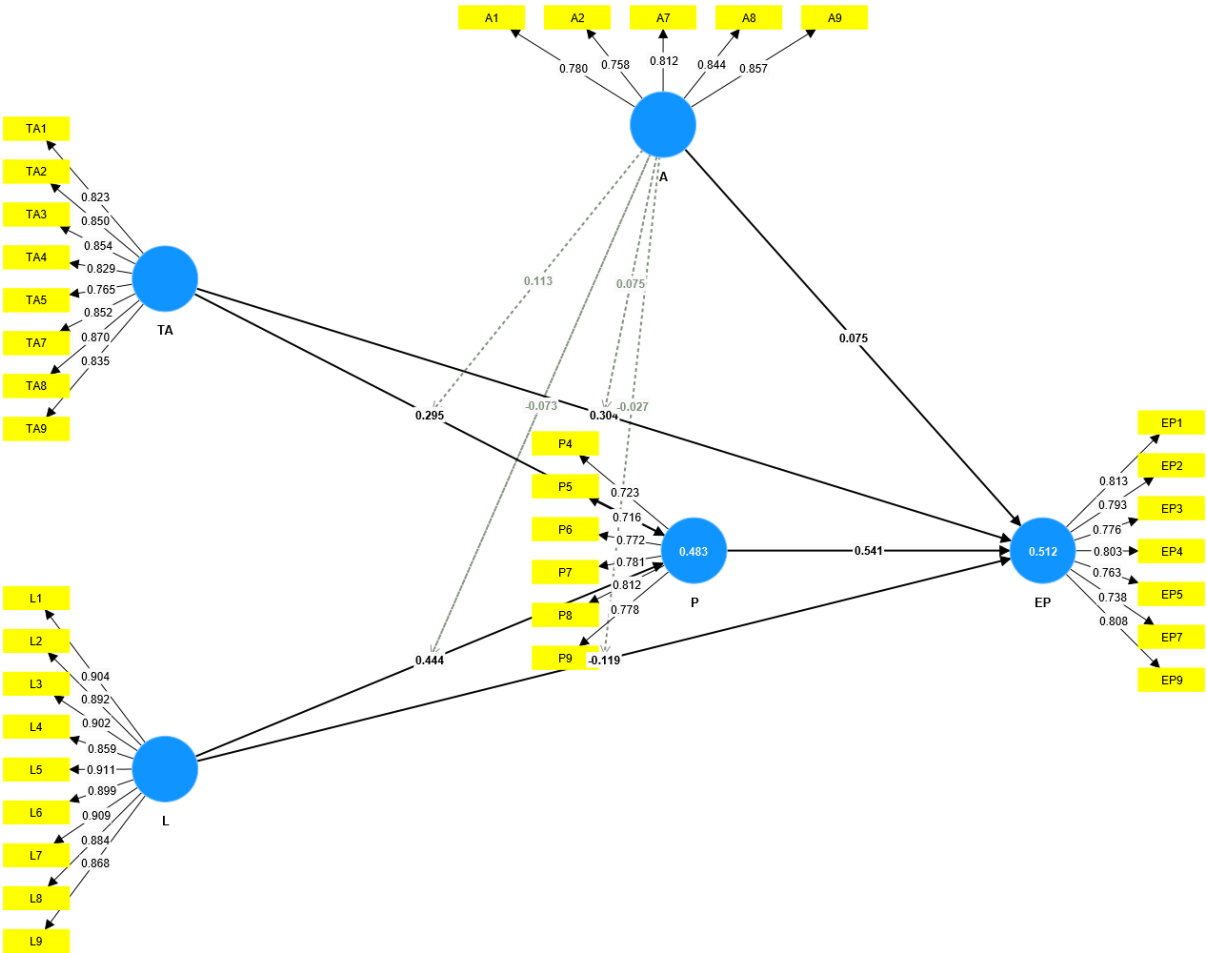
Data were analyzed using SmartPLS 4.0 and partial least squares structural equation modeling (PLS-SEM). The measurement model was assessed for indicator reliability, internal consistency, convergent validity, and discriminant validity using indicator loadings, Cronbach's alpha, composite reliability, average variance extracted (AVE), and the heterotrait–monotrait ratio (HTMT). The structural model was evaluated using path coefficients, (R^2), adjusted (R^2). and predictive measures where applicable. Direct, indirect, and moderating effects were assessed using bootstrapping with [number] resamples. Statistical significance was determined using [two-tailed/one-tailed] tests at the 5% significance level, with ($p < 0.05$) as the significance criterion.

RESULT AND DISCUSSION

Table 1. Demografi of Respondent

Profile	Classification	Number	Percentage
Gender	Male	224	55%
	Female	186	45%
Age	20 – 30	57	14%
	31 – 40	133	33%
	41 – 50	108	26%
	> 51	112	27%
Years of service	0 – 5	132	32%
	6 – 10	177	43%
	11 – 15	44	11%
	>16	57	14%
Level of Education	Diploma	6	2%
	Bachelor's	100	24%
	Master's	170	41%
	Doktoral	134	33%

Validity and Reliability



Figur 2. Structural Equation Model (SEM) Results

Table 2. Validity & Reliability Test Result

Constuct	Cronbach's Alpha	Composite Reliability (Rho_A)	Composite Reliability (Rho_C)	Average Variance Extracted (AVE)
Age (A)	0.869	0.869	0.905	0.658
Employee Performance (EP)	0.896	0.899	0.918	0.617
Leadership (L)	0.968	0.968	0.972	0.796
Productivity (P)	0.857	0.860	0.894	0.584
Technology Adoption (TA)	0.938	0.941	0.949	0.698

Results of processed data (2026)

Table 2 HTMT Test Result

Constuct	Age (A)	Employee Performance (EP)	Leadership (L)	Productivity (P)
Employee Performance (EP)	0.424			
Leadership (L)	0.333	0.371		
Productivity (P)	0.471	0.744	0.655	
Technology Adoption (TA)	0.375	0.585	0.419	0.559

Results of processed data (2026)

The discriminant validity of the measurement model was assessed using the heterotrait-monotrait ratio (HTMT). As presented in Table 1, all HTMT values ranged from 0.624 to 0.836, which were below the recommended threshold of 0.85. These findings indicate that discriminant validity was established, suggesting that the constructs were empirically distinct from one another.

Table 3 Structural Model Evaluation

	R-Sequare Adjusted	Prediction Model
Productivity (P)	0.477	Moderat
Employee Performance (EP)	0.505	Moderat

Source: SmartPLS Data Processing, 2026

The R-square Adjusted value for the Productivity variable is 0.477, indicating that the predictor variables used in the research are able to explain 47.7% of changes or variations in employee productivity. Meanwhile, 52.3% of other variations in productivity are related to factors outside the construct analyzed in this research. Based on the R-square Adjusted interpretation criteria, this value is included in the moderate category. Thus, the research model has a sufficient level of explanatory power regarding employee productivity. For the Employee Performance variable, an Adjusted R-square value of 0.505 was obtained. These results indicate that the constructs in the model can explain 50.5% of the variation in employee performance. Meanwhile, 49.5% of the variation in employee performance is explained by other factors not included in the research model. The R-square Adjusted value is in the moderate category, indicating that the model has fairly good explanatory power in predicting employee performance.

Direct Effect Hypothesis Testing

Table 4. Path Coefficients (Direct Effects)

No	Relationship Between Variables	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Description
1.	Tochnology Adoption on Productivity TA -> P	0.295	0.298	0.054	5.430	0.000	Supported
2.	Leadership on Productivity L -> P	0.444	0.440	0.059	7.578	0.000	Supported
3.	Tochnology Adoption of Employee Performance TA -> EP	0.304	0.306	0.074	4.110	0.000	Supported
4.	Leadership on Employee Performance L -> EP	-0.119	-0.110	0.076	1.571	0.116	Not Supported
5.	Productivity in Employee Performance P -> EP	0.541	0.536	0.089	6.078	0.000	Supported

Source: SmartPLS Data Processed, 2026

Direct Effect Hypothesis Testing

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4.	Leadership on Employee Performance L -> EP	-0.119	-0.110	0.076	1.571	0.116	Not Supported
5.	Productivity in Employee Performance P -> EP	0.541	0.536	0.089	6.078	0.000	Supported

Source: SmartPLS Data Processed, 2026

Testing of The Mediation Effect

Table 6. Path Coefficients (Indirect Effects/Mediation)

No.	Mediating Role	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Description
1.	Productivity Mediates the Effect of Technology Adoption on Employee PerformanceTA -> P -> EP	0.160	0.159	0.034	4.683	0.000	Supported
2.	Productivity Mediates the Effect of Leadership on Employee Performance L -> P -> EP	0.240	0.234	0.040	5.975	0.000	Supported

Source: SmartPLS Data Processed, 2026

Results

Based on the test results, technology adoption has a positive and significant effect on employee performance (p-value = 0.000 < 0.05); therefore, the hypothesis is accepted. Conversely, leadership does not have a significant effect on employee performance (p-value = 0.116 > 0.05), meaning this hypothesis is not supported. Meanwhile, productivity has a positive and significant effect on employee performance (p-value = 0.000 < 0.05).

In the moderation analysis, age was found to strengthen the relationship between technology adoption and productivity (p-value = 0.031 < 0.05). However, age does not moderate the relationship between leadership and productivity (p-value = 0.204), technology adoption and performance (p-value = 0.100), or leadership and performance (p-value = 0.613). Thus, age acts as a selective moderator within the research model.

Furthermore, the mediation analysis indicates that productivity significantly mediates the effect of technology adoption on employee performance (p-value = 0.000). Since the direct effect of technology adoption on performance is also significant, productivity functions as a partial mediator. Productivity also significantly mediates the relationship between leadership and employee performance (p-value = 0.000), even though the direct effect of leadership on performance is not significant. These findings suggest that the influence of leadership on performance occurs primarily through the enhancement of productivity.

Discussion

The research results show that technology adoption has a positive and significant impact on employee productivity. This finding suggests that the more optimally technology is used in carrying out work, the higher the resulting productivity. Technology helps speed up work processes, improve accuracy, and facilitate access and coordination of information. This finding aligns with the Technology Acceptance Model (TAM) (Davis, 1989) and UTAUT (Venkatesh et al., 2003), which explain that perceived benefits and performance expectations drive technology use, thereby increasing work effectiveness. Thus, technology not only functions as a work support tool but also becomes a resource that can increase productivity when supported by user competence and appropriateness to job requirements.

Leadership was also shown to have a positive and significant impact on productivity but did not have a significant direct effect on employee performance. This pattern suggests that leadership plays a more visible role in creating conditions that enable employees to work productively rather than directly resulting in improved performance. Leadership through direction, motivation, coordination, and empowerment can increase productivity, which in turn contributes to performance. These findings align with the transformational leadership perspectives of Bass (1985) and Yukl (2013), which position motivation, work behavior, and work processes as important mechanisms in generating organizational outcomes. Therefore, leadership effectiveness in the context of higher education needs to be understood not only in terms of its direct relationship to performance, but also in terms of its ability to build a work environment that supports productivity.

Furthermore, technology adoption has been shown to have a positive and significant impact on employee performance. This finding indicates that technology use provides direct benefits to work effectiveness, efficiency, and quality. These results support the TAM and UTAUT models, and reinforce the Resource-Based View (Barney, 1991) and Task-Technology Fit (Goodhue & Thompson, 1995) perspectives, which emphasize that technology can be a strategic resource when it is integrated with work processes and aligns with task requirements. Therefore, the success of digital transformation is determined not only by the availability of technology, but also by the ability of the organization and employees to utilize it effectively.

In contrast to technology adoption, leadership does not demonstrate a significant direct influence on performance. These findings indicate that leadership does not always result in direct performance improvements and that its effectiveness can be influenced by the organizational context, job characteristics, and the level of employee autonomy. In higher education environments characterized by professionalism and relative autonomy, leadership influence likely operates more through intermediary processes, particularly productivity. The Self-Determination Theory perspective (Deci & Ryan, 1985) also explains that an overly controlling leadership approach can reduce individual autonomy and intrinsic motivation.

Productivity was subsequently shown to have a positive and significant effect on employee performance. These findings demonstrate that the ability to produce output effectively and efficiently is a critical component in achieving performance. These results align with Campbell's (1990) performance theory, Goal-Setting Theory (Locke & Latham, 1990), and AMO Theory (Appelbaum et al., 2000). Therefore, improving performance requires not only leadership and technology but also productivity improvements through effective work systems, clear targets, and employee competency development.

In terms of moderating relationships, age has been shown to strengthen the influence of technology adoption on productivity. These findings suggest that the relationship between technology and productivity varies according to employee age. Differences in experience, adaptability, and utilization of technology may be one reason why the benefits of technology on productivity are not entirely uniform. This finding is consistent with UTAUT and Task-Technology Fit, which emphasize the importance of user characteristics, enabling conditions, and technology-to-task fit. However, age did not moderate the relationship between leadership and productivity or any other relationship in the model. Thus, age acts as a selective moderator, not a factor that generally changes the overall relationship between variables.

The mediation results show that productivity significantly mediates the effect of technology adoption on employee performance. Because the direct effect of technology adoption on performance also remains significant, the pattern suggests partial mediation. This means that technology improves performance through two channels, namely directly and through increasing productivity. These findings strengthen the Task-Technology Fit perspective that technology will provide benefits when it fits work needs, and show that the benefits of technology do not stop with system use but are translated through increasing the efficiency and effectiveness of work processes.

Meanwhile, productivity significantly mediates the relationship between leadership and performance, while the direct effect of leadership on performance is not significant. These findings indicate that productivity is the main mechanism that translates leadership influence into performance. Leaders can improve performance not primarily through direct influence, but by creating conditions that encourage productivity through clear direction, coordination, motivation, and empowerment. These findings strengthen the view that the relationship between leadership and performance needs to be understood through intervening mechanisms, while also demonstrating the importance of productivity as an explanatory mechanism in the context of higher education organizations.

Overall, the research findings position productivity as a key mechanism in explaining the relationship between technology adoption, leadership, and employee performance. Technology adoption plays a role through direct channels as well as through productivity, while leadership primarily contributes to performance through increased productivity. At the same time, age functions as a selective moderator of the relationship between technology adoption and productivity. These findings imply that improving employee performance in higher education requires an integrated approach through strengthening digital

transformation, empowering leadership development, increasing productivity, and developing competencies that take into account employee characteristics.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

This study shows that technology adoption has a positive and significant effect on employee productivity and performance, underscoring the importance of digital transformation in improving work effectiveness and efficiency. Conversely, leadership has a positive but insignificant effect on productivity, and a negative but significant effect on employee performance, indicating that leadership effectiveness is highly dependent on the appropriateness of leadership style to the organizational context and employee characteristics. Furthermore, productivity has a positive and significant effect on employee performance and is proven to be an important mechanism in bridging the influence of technology adoption and leadership on performance.

Moderation analysis results indicate that age significantly strengthens the relationship between technology adoption and productivity. However, age was not found to moderate the relationships between leadership and productivity, technology adoption and employee performance, or leadership and employee performance.

Limitations

These findings suggest that the role of age as a moderating factor is specific, particularly regarding the relationship between technology utilization and productivity. Furthermore, productivity was found to partially mediate the impact of technology adoption and leadership on employee performance.

Recommendations

Overall, this study confirms that enhancing employee performance in higher education institutions requires supporting productivity optimization as a strategic mechanism achieved through digital competency development, the implementation of effective work systems, and adaptive leadership practices.

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