

Analysis of Factors Determining Competence in Vocational Teacher Candidates: A SEM Approach

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ABSTRACT

Efforts to improve the competence of prospective vocational teachers require educational management that effectively integrates institutional factors and learning quality. This study aims to analyze the determinant factors influencing the competency formation of prospective vocational teacher candidates in higher education. A quantitative survey design was employed involving 278 respondents, consisting of 73 lecturers and 205 alumni selected through purposive sampling. Data were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) to test a structural model involving six latent variables, 58 indicators, and 32 hypotheses. The results show that graduate competence can be explained by the proposed model with an R^2 value of 71.90%. Social adaptation skills, character and exemplary behavior, motivation, and goal achievement emerged as dominant indicators of competency formation, while understanding of current technology showed the lowest contribution. The findings also indicate that learning quality plays a central mediating role in transforming institutional factors, including managerial leadership, academic culture, academic atmosphere, and lecturer competence, into graduate competence. This study contributes to the development of an integrated model of vocational teacher competency formation and provides practical implications for Teacher Education Institution leaders in strengthening leadership practices, lecturer development, and learning quality improvement.

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Introduction

Higher education plays a strategic role in supporting national development through human resource development (Szczepanska-Woszczyzna et al., 2024). In the field of Technical Vocational Education and Training (TVET), educators are provided through vocational teacher education programs organized by Teacher Education Institutions (TEIs). TEIs are key to the success of TVET, because the quality of vocational learning is largely determined by the competence of the teachers

produced (Ji, 2022; Widaningsih et al., 2025). Prospective vocational teachers are expected to have pedagogical, professional, social, and personal competencies (Wahyudi & Arifin, 2023). This is so that teachers are able to deliver learning in accordance with the needs of the times (Njenga, 2024). Therefore, to produce quality vocational education, it must be prepared through vocational teacher education programs organized by TEIs.

The implementation of vocational teacher education programs at TEIs still faces various challenges. Several studies show that the competencies of vocational teacher education graduates have not been applied in competency-based vocational learning (Ana et al., 2022). This is influenced by various factors, such as suboptimal managerial leadership, an academic culture that has not been fully internalized, an academic atmosphere that does not adequately support the learning process of teacher candidates, and limited lecturer competence (Thamodharan & Ghani, 2023). In addition, the learning process still does not emphasize learning for good teacher candidates (Askerud & Adler, 2022).

Previous studies have identified several factors that cause the suboptimal development of vocational teacher candidates' competencies. These include (1) an irrelevant curriculum (Nidhom et al., 2025), (2) limited learning facilities and infrastructure (Habibi et al., 2024), a lack of lecturer competency updates (Dionne et al., 2024), and weak government policy support for the teacher education system (Çolak Çakir & Cansoy, 2025). Based on these findings, it can be concluded that the development of vocational teacher candidates' competencies cannot be separated from the TEI institutional system and environment. Thus, efforts to improve the quality of vocational teacher education require fundamental changes in several of these aspects.

To improve the competencies of vocational teachers, TEIs need to reform institutional factors. Institutional leaders play a role in determining policies that support the improvement of lecturer competencies, as well as shaping academic culture and atmosphere. The academic culture of vocational teacher education must be characterized by collaboration, collegiality, and scientific reflection. This will have an impact on the creation of a positive learning environment. On the other hand, the competencies of lecturers at TEIs play a direct role in designing and implementing learning in the process of developing the competencies of prospective vocational teachers.

However, empirical evidence suggests that institutional factors do not always exert a direct influence on graduate competencies. The effects of managerial leadership, academic culture, and academic climate tend to operate indirectly through learning quality as the primary mechanism of competency formation. (Hair & Alamer, 2022) emphasize that in Partial Least Squares–Structural

Equation Modeling (PLS-SEM) models in educational research, relationships among variables are complex and frequently mediated by learning processes. This indicates that learning quality serves as a critical link between institutional governance in TEIs and the achievement of prospective vocational teachers' competencies.

Although numerous studies have examined factors influencing teacher competency development, empirical research that comprehensively models the interactions among managerial leadership, academic culture, academic climate, lecturers' competencies, and learning quality within a single integrated analytical framework remains limited, particularly in the context of vocational teacher education. Most existing studies examine these relationships in a fragmented manner and do not adequately explain indirect mechanisms of influence. Therefore, data-driven quantitative research is needed to capture the systemic dynamics of vocational teacher education more holistically.

The present study aims to analyze and identify the determinant factors shaping the competencies of prospective vocational teachers using a PLS-SEM approach. This study focuses on examining both direct and indirect relationships among institutional and learning-related variables to clarify the role of learning quality as the primary mechanism of competency formation. The findings are expected to contribute theoretically to the development of an integrated model of vocational teacher competency formation and provide practical implications for TEI leaders, lecturers, and policymakers in improving learning quality and sustaining vocational teacher competency development.

Method

Research Design

This study uses a quantitative approach with survey design. The aim is to analyze the factors that influence the formation of vocational teacher candidates' competencies. A quantitative approach was chosen because it allows for data collection and analysis of complex relationships between latent variables. The data were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM), as this method can accommodate research models with many constructs and indicators. In addition, PLS-SEM can be used to test causal relationships for data that are not fully normally distributed and moderate sample sizes (Hair et al., 2020).

Participant

The target population in this study were lecturers and alumni of vocational teacher education who were involved in the education process of prospective vocational teachers. This population was selected because both groups had a direct role in the implementation and evaluation of vocational teacher education programs. The lecturer respondents were selected from universities that offer accredited vocational teacher education study programs. Meanwhile, the alumni respondents were selected from graduates of vocational teacher education programs who had completed their education and/or were working as vocational teachers.

The research sample consisted of 278 respondents, including 73 lecturers and 205 alumni, and was determined using purposive sampling. The criteria for lecturer respondents were: (1) teaching in a vocational education study program, (2) coming from an accredited public or private university, and (3) having experience in the learning process and academic management. Meanwhile, the criteria for alumni respondents included: (1) being a graduate of a vocational teacher education program, and (2) having completed the entire teacher education process. The sample size met the minimum recommendation for PLS-SEM analysis, which is five to ten times the number of structural paths leading to the endogenous construct, and was therefore considered adequate to support the validity and reliability of the research findings (Hair et al., 2020).

Purposive sampling was applied by identifying respondents who were directly involved in or had completed vocational teacher education programs. Lecturer respondents were recruited from accredited vocational teacher education study programs and were required to have experience in teaching, curriculum implementation, or academic management. Alumni respondents were selected from graduates who had completed all stages of vocational teacher education and had sufficient experience to evaluate the relevance of institutional support, academic atmosphere, learning quality, and graduate competence. The invitation to participate was distributed through institutional networks, study program contacts, and alumni communication channels. Only respondents who met the inclusion criteria and completed all questionnaire items were included in the final analysis. This procedure was used to ensure that the respondents had relevant knowledge and experience regarding the competency formation process in vocational teacher education.

Data Collection and Measurement

Data collection in this study was conducted using questionnaires as the main instrument, which were distributed online via Google Forms to lecturers and alumni of vocational teacher education programs. This technique was chosen to reach many respondents and a diverse geographical

distribution. The research instrument to measure the respondents' level of agreement with each indicator was compiled using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The indicators were developed based on relevant previous literature reviews and were developed into an instrument consisting of six main dimensions with a total of 58 statements, as presented in Table 1. In addition, several items were adjusted based on field observations and discussions with stakeholders to ensure their suitability to the context of vocational teacher education in Indonesia.

Table 1. Dimensions of Competence in Vocational Teacher Candidates

Variable	Indicator	Construct	Reference
Managerial Leadership (KEP)	Leader's Strength & Conviction	KPII1	(Heikka et al., 2019; Pitoyo & Sawitri, 2017)
	Emphasis on Goal Achievement	KPII2	
	Enthusiasm for Development Plans	KPIM1	
	Motivation by Vision-Mission	KPIM2	
	Fostering Creativity & Innovation	KPIS1	
	Proposing New Work Methods	KPIS2	
	Understanding Individual Needs	KPIC1	
	Staff Competency Development	KPIC2	
Graduate Competence (KOL)	Mastery of Student Characteristics	KLKE1	(Jafar et al., 2020; Misbah et al., 2022; Wahyudi & Arifin, 2023)
	Mastery of Curriculum Development	KLKE2	
	Use of Learning Technology	KLKE3	
	Application of Teaching Strategies	KLKE4	
	Mastery of Current Issues	KLKR1	
	Ability to Teach Theory	KLKR2	
	Ability to Teach Practice	KLKR3	
	Good Interpersonal Skills	KLKK1	
	Critical Thinking Skills	KLKK2	
	Continuous Self-Development	KLKK3	
	Teamwork and Collaboration Skills	KLKS1	
	Collaboration with Other Parties	KLKS2	
	Student Mentoring Skills	KLKS3	

Data Analysis

Data were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) due to its ability to estimate complex models and simultaneously test causal relationships among variables (Daryono et al., 2024). The measurement model was evaluated by assessing convergent validity through average variance extracted (AVE) and factor loadings, discriminant validity using the Fornell–Larcker criterion, and construct reliability through Cronbach's Alpha, rho_A, and Composite Reliability (Al-Fraihat et al., 2020; Hair & Alamer, 2022). After the measurement model satisfied the

required criteria, the structural model was assessed using path analysis to examine both direct and indirect effects among variables, along with R² and effect size analyses to evaluate the strength of the relationships in the model (Hair et al., 2021; Sarstedt et al., 2020).

Result and Discussion

Result

A. Measurement Model Analysis

The purpose of the measurement model evaluation is to ensure that the constructs used in the research model are measured accurately and reliably by the selected indicators. This involves testing convergent validity to ensure that the indicators are consistent in measuring the same construct (using factor loading and AVE), as well as testing internal consistency reliability to ensure that the indicators have good consistency. This evaluation is important to ensure that the data collected is reliable and the constructs in the model are valid. Figure 1 is Fornell-Larcker criterion is a technique used to evaluate discriminant validity in PLS-SEM models.

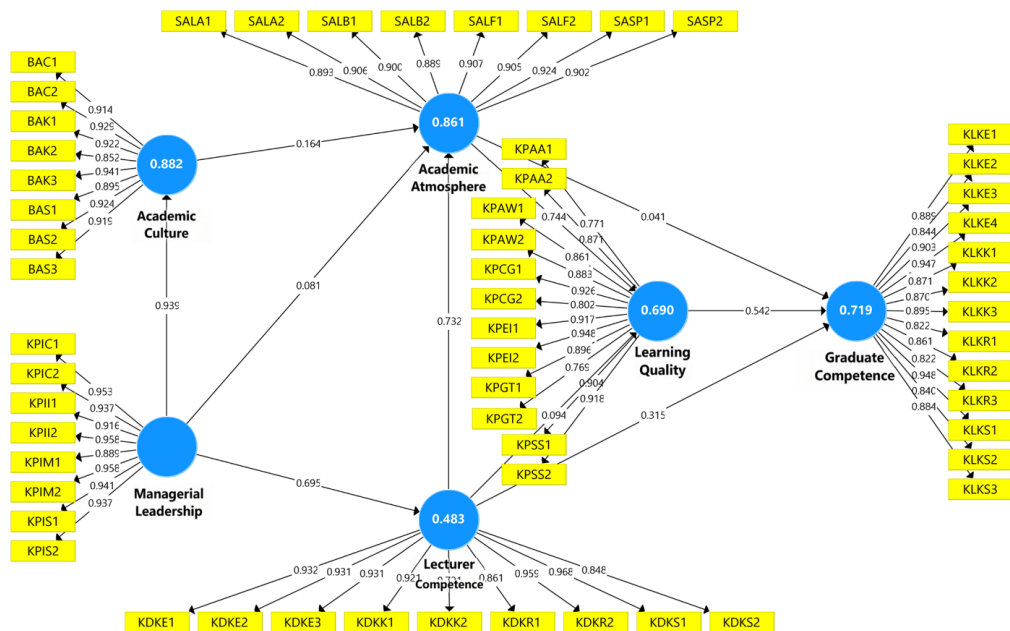


Fig 1: Results of the measurement model

The Fornell-Larcker table shows that the correlation value between latent variables is compared to the square root of the AVE of the variable itself. If the square root of the AVE of a variable is greater than the correlation with other variables, then the discriminant validity is met. In Table 3, we can see that the diagonal value (for example, BUA = 0.939) is higher than the correlation with other

variables in the column, indicating that each construct better explains its own indicator variable than other variables. This indicates that discriminant validity has been met. Discriminant validity was assessed using the Fornell–Larcker criterion. As shown in Table 2, the square root of the *average* variance extracted (AVE) for each construct exceeds its correlations with other constructs, indicating that each construct is empirically distinct.

Table 2. Convergent Validity: Factor Loading and AVE

Variables	Construct	Convergent Validity		Variables	Construct	Convergent Validity	
		FL	AVE			FL	AVE
Managerial Leadership (KEP)	KPII1	0.916	0.877	Learning Quality (KUP)	KDKK1	0.861	0.764
	KPII2	0.958			KDKK2	0.959	
	KPIM1	0.889			KDKS1	0.968	
	KPIM2	0.958			KDKS2	0.848	
	KPIS1	0.941			KPGT1	0.896	
	KPIS2	0.937			KPGT2	0.769	
	KPIC1	0.953			KPEI1	0.917	
	KPIC2	0.937			KPEI2	0.948	
Academic Culture (BUA)	BAK1	0.922	0.833	Graduate Competence (KOL)	KPAW1	0.861	0.770
	BAK2	0.852			KPAW2	0.883	
	BAK3	0.941			KPAA1	0.771	
	BAC1	0.914			KPAA2	0.871	
	BAC2	0.929			KPCG1	0.926	
	BAS1	0.895			KPCG2	0.802	
	BAS2	0.924			KPSS1	0.904	
	BAS3	0.919			KPSS2	0.918	
Academic Atmosphere (SUA)	SALF1	0.907	0.816	Lecturer Competence (KOD)	KLKE1	0.889	0.770
	SALF2	0.905			KLKE2	0.844	
	SALB1	0.900			KLKE3	0.903	
	SALB2	0.889			KLKE4	0.947	
	SALA1	0.893			KLKR1	0.822	
	SALA2	0.906			KLKR2	0.861	
	SASP1	0.924			KLKR3	0.822	
	SASP2	0.902			KLKK1	0.871	
Lecturer Competence (KOD)	KDKE1	0.932	0.810	KLKK2	0.870	0.770	
	KDKE2	0.931		KLKK3	0.895		
	KDKE3	0.931		KLKS1	0.948		
	KDKR1	0.921		KLKS2	0.840		
	KDKR2	0.721		KLKS3	0.884		

For example, the diagonal value for academic culture (BUA = 0.939) is higher than its correlations with all other variables in the model. These results confirm that each construct explains its own indicators better than it explains those of other constructs, thereby satisfying the requirement for discriminant validity. Table 3 presents the discriminant validity results based on the Fornell–Larcker criterion.

Table 3. Discriminant validity based on the Fornell–Larcker criterion.

Variables	BUA	KEP	KOD	KOL	KUP	SUA
Academic Culture (BUA)	0.939					
Managerial Leadership (KEP)	0.912	0.936				
Lecturer Competence (KOD)	0.775	0.695	0.915			
Graduate Competence (KOL)	0.669	0.620	0.772	0.878		
Learning Quality (KUP)	0.733	0.705	0.774	0.820	0.874	
Academic Atmosphere (SUA)	0.806	0.743	0.900	0.779	0.830	0.903

The findings indicate that all constructs meet the discriminant validity requirement because the square root of the Average Variance Extracted (AVE), shown in bold on the diagonal values, is higher than the correlations between constructs in the same row and column. For example, the AVE value of Academic Culture (BUA) is 0.939, which is greater than its correlations with other variables, while Managerial Leadership (KEP), Lecturer Competence (KOD), Graduate Competence (KOL), Learning Quality (KUP), and Academic Atmosphere (SUA) also demonstrate higher diagonal values compared to inter-construct correlations. These results confirm that each construct is empirically distinct and capable of measuring its respective concept accurately within the structural model.

B. Structural Model Analysis (Inner Model)

The R^2 value illustrates the proportion of variance in the endogenous (dependent) variables that can be explained by the exogenous (independent) variables. For instance, Academic Culture (BUA) has an R^2 value of 0.882, which signifies that 88.2% of the variance in this variable is accounted for by the model. Generally, R^2 values are classified as low, medium, or high depending on the context of the study. Meanwhile, the f^2 (effect size) indicates the magnitude of an exogenous variable's influence on an endogenous variable. As an example, the Academic Atmosphere (SUA) variable exerts an effect size of 0.293 on the Graduate Competence (KOL) variable, indicating that SUA has a medium influence on KOL. The f^2 values are interpreted as 0.02 (small), 0.15 (medium), and 0.35 (large).

From a practical perspective, the R^2 and effect size results indicate that TEI managers should not

interpret institutional leadership merely as administrative control, but as a strategic mechanism for improving learning quality. The strong explanatory power of the model suggests that graduate competence can be strengthened when leaders consistently align institutional vision, lecturer development, academic culture, and assessment practices. Therefore, managerial leadership needs to be translated into concrete actions, such as regular evaluation of learning quality, structured lecturer capacity-building programs, and curriculum review based on graduate competency needs. The effect of learning quality on graduate competence also implies that institutional improvement will have limited impact unless it is directly connected to classroom practices, assessment clarity, student autonomy, and problem-solving skill development.

C. Path Analysis and Hypothesis Testing

Path analysis and hypothesis testing are utilized to examine the direct and mediation effects among variables within the model concerning the formative factors of prospective vocational teacher candidates' competencies. This process involves testing the statistical significance of each path coefficient to ensure that the presumed influence between variables is statistically valid (Ashraf & Ahmed, 2022; Rodriguez-Delgado et al., 2022). Furthermore, mediation analysis is specifically aimed at evaluating whether the relationship between two variables is mediated by a third variable. This analysis is crucial for uncovering the complex mechanisms within the model and providing a more profound understanding of the dynamics of the relationships between variables that shown on table 4.

Table 4. Results of Path Analysis and Hypothesis Testing

Hyp.	Path	β -values (+)/(-)	T-statistics (>1.96)	p-values (<0.05)	Decision
H-DIR1	KEP → BUA	0.939	83.214	0	Accepted
H-DIR2	KEP → SUA	0.081	3.426	0.001	Accepted
H-DIR3	KEP → KOD	0.695	29.59	0	Accepted
H-IND21	KEP → KOD → SUA → KUP	0.379	12.178	0	Accepted
H-IND22	KEP → BUA → SUA → KUP	0.114	2.778	0.006	Accepted

The path analysis results show that the factors that shape the competence of prospective vocational teachers have varying degrees of influence. The most significant direct influence was found in path H-DIR1 (KEP → BUA) with a β -value of 0.939, indicating that the Managerial Leadership variable is the main and most fundamental predictor of the Academic Culture variable. Meanwhile, hypothesis H-DIR9 (SUA → KOL) was rejected because the path coefficient was weak

and statistically insignificant. In terms of indirect effects, the most significant mediation path was Hypothesis H-IND5 (KOD → SUA → KUP) with a β -value of 0.544. This shows that the Lecturer Competence variable has a very strong mediating role in influencing Learning Quality through Academic Atmosphere. Meanwhile, the weakest and insignificant indirect effect was found in the H-IND9 path (KEP → SUA → KOL), with a β -value of 0.003; therefore, this hypothesis was rejected.

Overall, the results of testing the hypotheses show that not all pathways have a significant influence in the model of vocational teacher candidate competency formation. The results of testing hypotheses H-DIR1 and H-DIR5 have very significant values. This indicates that the variables of Managerial Leadership directly and Lecturer Competence indirectly through Academic Atmosphere are the most crucial determinants in the formation of vocational teacher competencies. On the other hand, rejected hypotheses such as H-DIR9 and H-IND7 show that there are several paths tested that do not have a statistical effect in this study.

Discussion

Based on the results of data analysis, this study shows that the formation of vocational teacher candidates' competencies is influenced by factors such as managerial leadership, academic culture, academic atmosphere, lecturer competencies, and learning quality. These findings confirm that one of the factors influencing graduate competency is institutional factors. This is in line with (Hair et al., 2020), who stated that in the PLS-SEM education model, the influence of exogenous variables is generally indirect and mediated by the learning process. The findings of this study are also consistent with (Morales et al., 2025) and (Misbah et al., 2022), who emphasize the importance of synergy between the educational process and the institutional environment in the success of the teacher education system. Thus, the results of this study place the quality of learning as the main mechanism that transforms institutional policies and environments into the competence of prospective vocational teachers.

The dimension of institutional managerial leadership emerges as the initial foundation in developing the academic system of vocational teacher education institutions at TEIs. Managerial leadership does not have a direct relationship with graduate competencies but must go through other factors as mediators. Visionary and supportive leadership figures have been proven capable of shaping academic culture and creating a conducive academic atmosphere in shaping graduate competencies. This can be seen from the acceptance of the H-IND11 hypothesis, which reflects the influence of leadership in shaping these two aspects. This finding is in line with (Purcell et al., 2019),

who state that educational leadership acts as a driver of institutional change in achieving its vision and mission. This is also reinforced by the research of (Louis et al., 2016), which shows that managerial leadership does not directly impact graduate competencies. This indicates that the role of TEI leadership is more dominant as an initial lever that works through the formation of academic culture and atmosphere as well as faculty development.

The academic culture dimension in this study plays an important role in shaping a conducive academic atmosphere through the values of collaboration, collegiality, and academic independence. This relationship is reinforced by empirical findings in hypothesis H-DIR4, which shows that academic culture has a significant influence on the academic atmosphere. These findings are consistent with the research by (Pedraja-Rejas et al., 2020) and (Lubis & Edward, 2024), which states that academic culture is the foundation for creating a productive learning climate. The results of this study indicate that the dimension of academic culture alone is not sufficient to directly improve graduate competence. Therefore, academic cultural values need to be interpreted into learning strategies that are suitable for developing the competence of prospective vocational teachers.

The dimension of lecturer competence emerges as one of the most decisive dimensions in shaping graduate competence. Lecturers who have good pedagogical, professional, social, and personal competencies can create a positive academic atmosphere while improving the quality of learning. This finding is reinforced by the acceptance of hypothesis H-DIR7, which shows that lecturer competence has a direct effect on graduate competence, as well as hypothesis H-DIR6, which indicates that lecturer competence contributes significantly to improving the quality of learning. These results support (Üstünlüoğlu, 2017) research that lecturer competence is one of the key factors in improving the quality of learning in higher education. Furthermore, these results confirm that lecturers are the main actors in transforming institutional policies into student learning outcomes (Do et al., 2025; Kristiadi et al., 2025). Thus, strengthening lecturer competence is a direct strategy for improving the quality of vocational teacher education graduates.

The academic atmosphere dimension in this study reflects the quality of academic interaction, institutional support, and learning climate. The results of the analysis show that the academic atmosphere has a significant effect on the quality of learning but does not directly affect graduate competence. This can be seen from the acceptance of hypothesis H-DIR8, which has a significant relationship between academic atmosphere and learning quality. This finding is in line with (Ramísio et al., 2019), who emphasize that the academic atmosphere functions as a supporting

condition for learning, not as a direct determinant of competence. The rejection of the direct path hypothesis between the academic atmosphere and graduate competence shows that a good academic climate does not necessarily produce competence without the support of effective learning strategies. Therefore, academic atmosphere is needed to be integrated with appropriate learning quality to have a real impact on the competency development of prospective vocational teachers.

The dimension of learning quality in this study became the main mechanism linking institutional factors with the formation of graduate competencies. Learning that has clear objectives, appropriate methods, fair assessment, and soft skills reinforcement has been proven to contribute directly to the competencies of prospective vocational teachers, as indicated by the acceptance of H-DIR10. In addition, learning quality also acts as the main mediator in various indirect pathways, for example, in the relationship between academic atmosphere and graduate competencies in hypothesis H-IND1. These findings reinforce the theory of constructive alignment (Rajadurai et al., 2025), which states that alignment between learning objectives, processes, and evaluation is the key to successful education. Therefore, improving the quality of learning needs to be the focus in the management of vocational teacher education.

Despite these contributions, this study has several limitations that should be acknowledged. The data were collected using self-reported questionnaires based on a Likert scale; therefore, the responses may be influenced by respondents' subjective perceptions and potential self-reporting bias. Second, although the sample involved lecturers and alumni who were relevant to vocational teacher education, the use of purposive sampling limits the generalizability of the findings to all Teacher Education Institutions. Third, this study focused on institutional and learning-related variables, while other potential factors such as industry partnership quality, teaching practicum experience, and digital pedagogical readiness were not examined in detail. Future studies may combine survey data with interviews, classroom observations, or institutional document analysis to provide a deeper explanation of the competency formation process.

Conclusion

This study confirms that the competence of prospective vocational teacher candidates is shaped through the interaction of managerial leadership, academic culture, academic atmosphere, lecturer competence, and learning quality. Among these factors, learning quality serves as the main mechanism that transforms institutional support into graduate competence. The findings indicate

that institutional improvement in TEIs should not stop at policy formulation, but must be translated into effective learning practices, relevant assessment, and lecturer capacity development.

Based on these findings, TEI leaders should take several immediate actions. First, they need to strengthen managerial leadership by aligning institutional vision, curriculum implementation, lecturer development, and graduate competency targets. Second, TEIs should establish systematic learning quality assurance through regular evaluation of course delivery, assessment relevance, student workload, and the development of problem-solving and analytical skills. Third, lecturer competence should be improved through continuous professional development, particularly in vocational pedagogy, technology integration, and competency-based assessment. These actions are expected to help TEIs produce vocational teacher candidates who are pedagogically, professionally, socially, and personally prepared to respond to changing educational and industrial demands.

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