

THE ROLE OF GREEN INNOVATION LEADERSHIP IN IMPROVING THE QUALITY OF VOCATIONAL HIGH SCHOOL GRADUATES: POLICY AS MODERATOR AND COMPETENCY AS MEDIATOR

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Abstract

This study aims to analyze the role of Green Innovational leadership in improving the quality of vocational high school graduates, which is mediated by competence and moderated by school policies. The population studied was Vocational High Schools in East Java, Indonesia. Researchers used simple random sampling techniques in sampling, with 935 respondents as the research sample. Data collection was done through a google form link linked to a social media account. The data analysis technique used is SEM-PLS. The results showed that Green Innovational leadership proved to have a positive and significant effect on the quality of graduates, indicating that environmentally oriented leadership has an important role in improving the quality of graduates. Individual competence also has a positive and significant effect on the quality of graduates, indicating that the higher the competence, the better the quality of graduates produced. However, the effect of Green Innovational leadership on graduate quality is not direct and significant, but rather influences through competence as a significant mediating variable. Meanwhile, policy is not proven to moderate the relationship between Green Innovational leadership and graduate quality, which indicates that the existence of policy is not strong enough to strengthen or weaken the relationship. The novelty of this research contributes to the development of the concept of leadership in vocational education by applying competency variables as mediators and policies as moderators.

Keywords: Green Innovational Leadership; Graduate Quality; Vocational High School

Introduction

Education as a fundamental instrument of sustainable development has a strategic role in shaping the mindset and character of the younger generation to have high ecological awareness and be able to become agents of change in maintaining environmental balance (Imran et al., 2024). The government in Indonesia has initiated the Adiwiyata Program as a concrete step in instilling awareness and concern for the environment in the educational environment. This program aims to form schools that have a culture of environmental care by focusing on four main pillars, namely: implementation of environmentally friendly policies, integration of environmental materials in learning, active involvement of all school members in environment-based activities, and management of school facilities that support sustainability principles. The implementation of this program is in line with the fourth goal of the Sustainable Development Goals (SDGs), namely Quality Education, which emphasizes the importance of inclusive and quality education and encourages sustainable learning, including in terms of ecological awareness (Rahmawati et al., 2024). However, although the Adiwiyata Program has a strong foundation and objectives, its implementation in many schools, especially at the Vocational High School level, is still faced with various obstacles. These challenges include weak commitment from schools and policymakers, low involvement of teachers and students in environmental programs, and limited human and financial resources (Lindayani, 2019). Without the support of effective leadership, the transformation of environmentally friendly culture and behavior in schools will be difficult to realize.

Acton's (2022) research highlighted the challenges faced by neighborhood teacher leaders in Ontario, Canada, including a school culture resistant to change, constraining school

structures, and a lack of support from the principal. This study emphasized the importance of the principal's role in supporting teacher leadership to overcome these barriers. Dunlop et al. (2022) identified barriers to education for environmental sustainability in the UK, such as a lack of policy support, limited resources, and a lack of training for teachers. This study also emphasized the importance of active participation of students and teachers in environmental education. In addition, it is supported by Parry and Metzger's (2023) research, which revealed that teachers in various countries face challenges in implementing education for sustainability, including overcrowded curricula, lack of training, and limited time and resources. This research highlights the need for institutional support and adequate training for teachers.

Adiwiyata Vocational High School is an educational unit that has been recognized by the government as a school that has successfully implemented the principles of environmental conservation in all aspects of its management. The Adiwiyata concept emphasizes the importance of a school culture that cares for and cultivates the environment. In this context, school leaders play an important role as agents of change who can shape an organizational culture that supports sustainable and environmentally friendly learning (Mogali and Newton, 2020). Environment-based Green Innovational leadership is closely related to this. Green Innovational leadership is a leadership style that combines the principles of transformational leadership, such as inspiration, motivation, intellectual stimulation, and individualized attention, with an orientation towards sustainability and environmental preservation (Umar et al., 2025). Leaders with this style not only mobilize school members to achieve academic goals but also raise awareness and active participation in protecting the environment, instill green values, and integrate sustainability principles in the curriculum and school culture. Leaders who apply green leadership are expected to influence all elements of the school, from teachers, education personnel, to students (Kusi et al., 2021).

Qualified Vocational High School graduates are expected not only to be able to enter the professional world of work but also to become environmentally conscious individuals who can become agents of change in society (Altuntas and Barut, 2023). The quality of Adiwiyata Vocational High School graduates in this case includes technical abilities in the field of expertise, work skills, work attitudes, and awareness of sustainability and environmental care. Competency development that is carried out not only focuses on technical or vocational skills, but also on the formation of social competencies, pro-environmental attitudes, and understanding of the importance of sustainability in work and daily life (Muaddab, 2024). Inspiring and visionary leadership will promote meaningful and relevant learning, which will strengthen students' competencies. When school leaders can create a supportive learning environment, empower teachers, facilitate environment-based learning innovations, and build collaborations with communities and industries that care about sustainability, student competencies will improve. With strong competencies, Adiwiyata Vocational High School graduates will be better prepared to compete in the world of work and become actors of sustainable development. One of the things that plays an important role in this is the policies made by school leaders (Musyoki et al., 2021). One of the factors that determines this success is the policies made by school leaders.

Policy implementation that integrates environmental education holistically in the learning process, character building, ecological school management, and sustainable evaluation systems will optimize the correlation between transformational leadership and educational outcomes. Conversely, superficial institutional policies without substantive implementation of Adiwiyata values will hinder the effectiveness of leadership in realizing sustainable transformation (Alhazemi, 2024). Thus, a comprehensive understanding of the dynamics of the interaction of leadership, competence, and policy formulation is fundamental

in optimizing the overall quality of graduates. Sustainability-oriented policies will strengthen the implementation of green leadership in developing students' superior competencies (Suprpto et al., 2024). Therefore, this study aims to analyze the role of Green Innovational leadership in improving the quality of vocational high school graduates, which is mediated by competence and moderated by school policies. This research novelty contributes to the development of the concept of ecocentric leadership in vocational education by applying competency variables as mediators and policies as moderators using Structural Equation Modeling - Partial Least Squares (SEM-PLS).

Methods

In this study, the population studied was Vocational High Schools in East Java, Indonesia, taking into account factors such as gender, skill competency/major, and green leadership program implementation. This focus aims to understand the role of green leadership in improving the quality of Vocational High School education through environment-based education management. The researcher used a simple random sampling technique in sampling, where there were 935 respondents in the research sample. Data collection was done through a google form link linked to a social media account. In ensuring that there is no double recording of a respondent, it will be equipped with open and closed questions related to demographic characteristics. The data analysis technique used is Structural Equation Modeling - Partial Least Squares (SEM-PLS) to analyze the research model. The following is the model in this study.

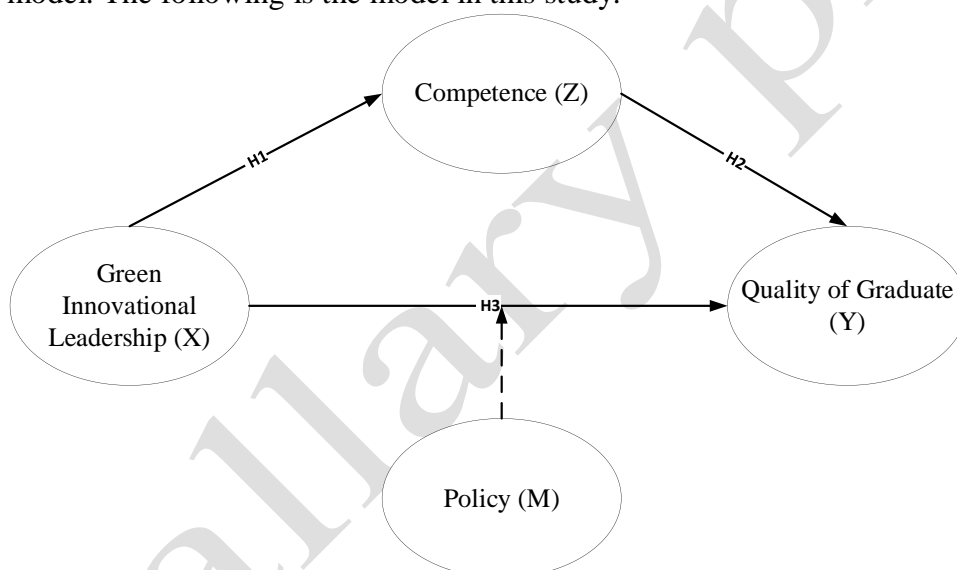


Figure 1. Research Model

Based on Figure 1 the hypothesis in this study is as follows:

- Hypothesis 1 : Green Innovational Leadership (X) has a significant effect on Competence (Z)
- Hypothesis 2 : Competence (Z) has a significant effect on Quality of Graduates (Y)
- Hypothesis 3: Green Innovational Leadership (X) has a significant effect on the Quality of Graduates (Y).
- Hypothesis 4: Green Innovational Leadership (X) has a significant effect on the Quality of Graduates (Y) mediated by Competence (Z).
- Hypothesis 5: Green Innovational Leadership (X) has a significant effect on the Quality of Graduates (Y) moderated by Policy (M).

Results

SEM-PLS analysis is used to analyze the relationship between quantitative variables, both latent (not directly measured) and manifest (directly measured). SEM-PLS tests the relationship model between variables simultaneously and produces estimated path coefficients, which allow researchers to test the strength and direction of influence between variables in the model (Wong., 2019). SEM-PLS can be used to examine the relationship between green leadership policies, teacher attitudes, education quality, and learning outcomes in vocational high schools. SEM-PLS is a statistical method consisting of two main components, namely the outer model and inner model (Hair et al., 2021). Figure 2 shows the results of the SEM-PLS analysis, consisting of outer loading and inner model.

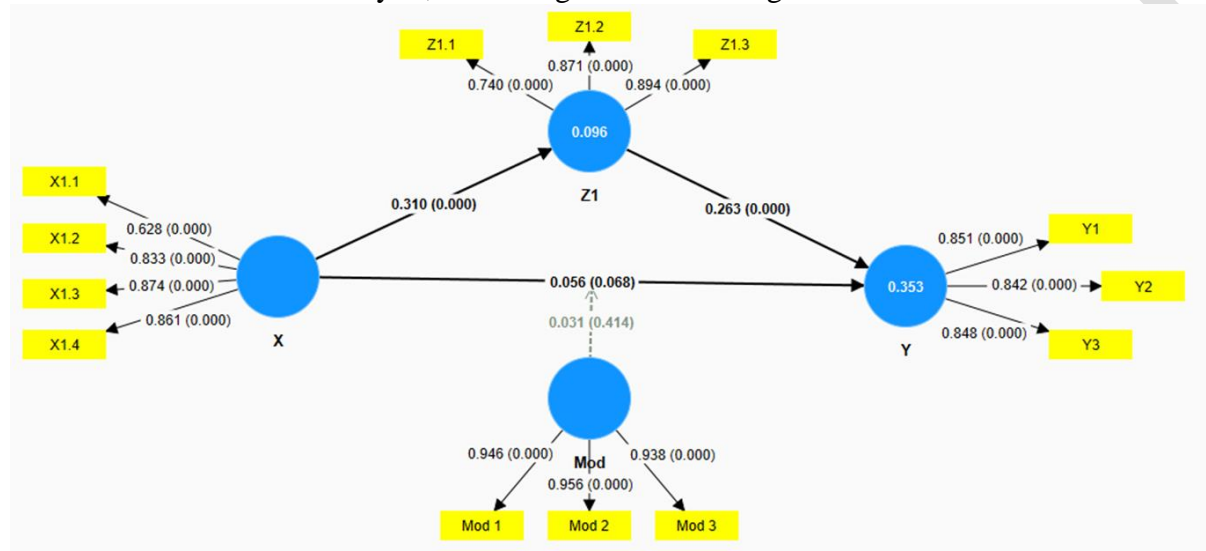


Figure 2. SEM-PLS Analysis Results

Outer Model

The outer model aims to explain the relationship between latent variables (constructs that cannot be measured directly) and their indicators (measured variables). At this stage, researchers verify the validity and reliability of indicators, both through reflective and formative models, to ensure that the indicators used can truly represent the measured constructs. The outer loading coefficient shows how strongly the indicator reflects the latent variable, with a minimum recommended value of ≥ 0.5 . The indicator is declared significant as a variable measure if the P-value < 0.05 (Hair et al., 2021). The measurement model obtained in the SEM-PLS analysis is as follows.

Table 1. SEM-PLS Measurement Model Results

Variables	Indicator	Indicator Loading	P-value	Conclusion
Green Innovative Leadership (X)	X1	0.628	0.000	Significant
	X2	0.833	0.000	Significant
	X3	0.874	0.000	Significant
	X4	0.861	0.000	Significant
Competence (Z)	Z1	0.740	0.000	Significant
	Z2	0.871	0.000	Significant
	Z3	0.894	0.000	Significant

Variables	Indicator	Indicator Loading	P-value	Conclusion
Policy (M)	M1	0.946	0.000	Significant
	M2	0.956	0.000	Significant
	M3	0.938	0.000	Significant
Quality of Graduates (Y)	Y1	0.851	0.000	Significant
	Y2	0.842	0.000	Significant
	Y3	0.848	0.000	Significant

- The measurement model of the Green Innovational Leadership (X) variable is as follows:

$$X = 0.628X_1 + 0.833X_2 + 0.874X_3 + 0.861X_4$$
- The Competence (Z) variable measurement model is as follows:

$$Z = 0.740Z_1 + 0.871Z_2 + 0.894Z_3$$
- The Policy (M) variable measurement model is as follows:

$$M = 0.946M_1 + 0.956M_2 + 0.938M_3$$
- The measurement model of the Quality of Graduates (Y) variable is as follows:

$$Y = 0.851Y_1 + 0.842Y_2 + 0.848Y_3$$

Based on the measurement model test results presented in Table 1, all indicators of each variable have indicator loading values above 0.5 and a p-value of 0.000, which shows significance at the 5% level. This indicates that each indicator significantly reflects the Green Innovational Leadership (X), Competence (Z), Policy (M), and Quality of Graduates (Y) variables. This high indicator loading value indicates that convergent validity has been met, meaning that these indicators can measure constructs consistently and accurately. Thus, it can be concluded that all indicators on the construct are worth maintaining in the model, because they have met the validity and reliability criteria in the Structural Equation Modeling (SEM) reflective model.

The indicator with the highest loading value also indicates the most dominant indicator in representing the variable. In the Green Innovational Leadership variable (X), the most dominant indicator is Encouraging employees to achieve goals to preserve the environment (X3), with a loading value of 0.874, which reflects the environmentally oriented transformative leadership dimension most strongly. In the Competence (Z) variable, the most dominant indicator is Students involved in data-driven green technology projects (Z), which has a loading value of 0.894, which is the strongest representation of individual competence. Furthermore, the Policy (M) variable has the most dominant indicator on Technology used in schools supports energy efficiency and emission reduction (M2) with a loading value of 0.956, which indicates the strength of the indicator in measuring policies that support sustainability. While in the Quality of Graduates (Y) variable, the strongest indicator is Vocational high school graduates have competencies that are needed by the needs of the green industry (Y1) at 0.851, which is the main measure in assessing the quality of graduates.

Inner Model

The inner model in SEM-PLS is used to analyze and test the relationship between latent variables in the model. This model represents the direction and strength of influence between constructs through paths based on research hypotheses. There is a significant influence between one variable on another if the p-value <0.05 (Hair et al., 2021). In SEM, two

influences are known, namely the direct effect and the indirect effect. The results of the SEM-PLS analysis for the inner model are presented in Table 2.

Table 2. SEM-PLS Inner Model Results

No .	Variable Relationship				Coefficient Path	P-value	Description	
Direct Influence								
1	Green Innovationa l Leadership (X)	→		Competenc e (Z)	0.310	0.000	Significant	
2	Competenc e (Z)	→		Quality of Graduates (Y)	0.263	0.000	Significant	
3	Green Innovationa l Leadership (X)	→		Quality of Graduates (Y)	0.056	0.068	Not Significant	
Mediating Influence: Competence (Z)								
4	Green Innovationa l Leadership (X)	→	Competenc e (Z)	→	Quality of Graduates (Y)	0,082	0,000	Significant
Moderating Effect: Policy (M)								
5	Green Innovationa l Leadership* Policy (X*M)	→		Quality of Graduates (Y)	0.031	0.414	Not Significant	

Table 2 shows that:

1. The test of the direct effect of Green Innovational Leadership (X) on Competence (Z) obtained a structural coefficient of 0.310 and a p-value of 0.000. Because the p-value is < 0.05, and the coefficient is positive, it indicates that there is a significant and positive influence. That is, if Green Innovational Leadership (X) increases, then Competence (Z) will also increase, and vice versa. Then, **hypothesis 1 is accepted**.
2. Based on the results of the direct effect test, the structural coefficient is 0.263 with a p-value of 0.000 for the relationship between Competence (Z) on Quality of Graduates (Y). Because the p-value < 0.05 and the coefficient is positive, it can be concluded that there is a significant and positive influence. Thus, an increase in Competence (Z) will be followed by an increase in Quality of Graduates (Y), and vice versa. Then, **hypothesis 2 is accepted**.
3. The effect of Green Innovational Leadership (X) on Quality of Graduates (Y) obtained a structural coefficient of 0.056 and a p-value of 0.068. Because the p-value > 0.05, it means that there is an insignificant effect of the Green Innovational Leadership (X) variable on the Quality of Graduates (Y). This indicates that the high Green

Innovational Leadership (X) does not affect the Quality of Graduates (Y). Then, **hypothesis 3 is rejected.**

4. The indirect effect (mediation) between Green Innovational Leadership (X) on Quality of Graduates (Y) through Competence (Z), obtained an indirect effect coefficient of 0.082 with a p-value of 0.000, where the value is less than alpha 5% (0.05). So, it can be concluded that there is a significant influence of Green Innovational Leadership (X) on Quality of Graduates (Y) through Competence (Z). In other words, the Competence (Z) variable is the mediating variable of Green Innovational Leadership (X) on Quality of Graduates (Y). Thus, **hypothesis 4 is accepted.**
5. The effect of Green Innovational Leadership (X) on Quality of Graduates (Y) with Moderation Policy (M) is known to have a path coefficient of 0.031 with a p-value of 0.414. Thus, it can be said that Policy (M) is not a moderator of Green Innovational Leadership (X) on Quality of Graduates (Y). This can be interpreted that the moderation Policy (M) cannot strengthen the influence of Green Innovational Leadership (X) on Quality of Graduates (Y). Thus, **hypothesis 5 is rejected.**

Discussion

This study shows that Green Innovational Leadership (X) has a positive and significant effect on Competence (Z), meaning that the first hypothesis is accepted. This is in line with the findings by Perez et al. (2023), which states that Green Innovational leadership encourages pro-environmental behavior through green human resource management, which in turn increases employee competence in implementing sustainable practices. Research by Perez et al. (2023) emphasized that Green Innovational leadership creates a work environment that supports learning and innovation, which then increases individual competence. In addition, Zhao and Huang (2022) showed that in the era of Industrial Revolution 4.0, leaders who adopt Green Innovational leadership can facilitate the development of technological competencies and adaptive capabilities of employees to the dynamics of industrial change. With the ability to inspire, provide a clear vision, and encourage active participation of employees in green activities, Green Innovational leadership forms an organizational culture that supports the improvement of human resource capacity.

The second hypothesis of this study found that Competence (Z) has a positive and significant influence on Quality of Graduates (Y). This means that the higher the competence possessed by individuals, the higher the possibility of producing quality graduates. The competencies in question include cognitive, technical, and work attitude aspects that are relevant to the demands of the world of work and industry. These results are supported by research by Indah and Liestyowati (2023), which emphasizes the importance of technological competence in improving green performance and institutional competitiveness. In the context of higher education, this shows that the development of student competencies, both in the form of hard skills and soft skills, plays a crucial role in determining the quality of graduates who are ready to use and relevant to the needs of the labor market. Thus, improving competencies through various educational interventions, such as industry-based curriculum, practicum training, and involvement in research projects, will directly contribute to improving the quality of graduates. Higher education must play an active role in creating a learning environment that enables the development of competencies as a whole. Sunardi and Hasanuddin (2019), in the context of vocational education, also showed that student competencies play a vital role in determining graduates' job readiness. They found that the integration of project-based curriculum and industrial internships significantly improved student competencies and had a positive impact on the quality of graduates. Therefore, higher

education programs should emphasize the development of practical skills, communication abilities, and critical thinking as part of the strategy to improve the quality of graduates.

The results of research on the third hypothesis show that Green Innovational Leadership (X) has no significant effect on Quality of Graduates (Y). This result confirms that although Green Innovational leadership plays an important role in shaping organizational culture and sustainability values, its effect on graduate quality output is not direct. This is consistent with the research of Ding and Hahn (2023), which states that Green Innovational leadership is more likely to influence graduate variables through indirect pathways, such as increased green creativity and employee involvement in sustainable innovation. Research by Sobaih et al. (2022) also shows that the impact of Green Innovational leadership on organizational outcomes is not direct, but rather mediated by innovation and organizational learning. So, in the context of education, Green Innovational leadership must be implemented in conjunction with student capacity building strategies to produce a real impact on the quality of graduates. Green Innovational leadership from the leaders of educational institutions may only have a real impact on the quality of graduates if it is accompanied by an increase in individual capacity and competence through learning processes and practical experience. In other words, Green Innovational leadership has a catalytic role in building an environment conducive to learning and self-development, but it does not guarantee improved graduate quality without support in the aspects of competence and active learning.

The fourth hypothesis in this study shows that Competence (Z) becomes a significant mediating variable in the relationship between Green Innovational Leadership (X) and Quality of Graduates (Y). This means that Green Innovational leadership can improve the quality of graduates indirectly by increasing individual competence. This is reinforced by research by Ding and Hahn (2023), which shows that Green Innovational leadership can drive individual performance outcomes by mediating variables such as involvement in the creative process and innovation capacity. In the context of education, transformational leadership that focuses on green values can foster motivation and enthusiasm for learning, which in turn improves competence and subsequently contributes to the quality of graduates. These findings suggest the importance of learning program design that combines inspirational leadership with student competency development strategies. Strategies such as mentoring, collaborative learning, and integration of industry practices are essential to ensure that the influence of Green Innovational leadership can be translated into quality educational outcomes. Begum et al. (2020) also pointed out that the influence of transformational leadership on organizational success is often mediated by individual qualities such as skills and competencies. Thus, competency mediation in this context becomes a crucial pathway to achieve better graduate quality. These findings point to the importance of learning program design that combines inspirational leadership with student competency development strategies. Strategies such as mentoring, collaborative learning, and integration of industrial practice are essential to ensure that the influence of Green Innovational leadership can be translated into quality educational outputs.

This research on the fifth hypothesis shows that Policy (M) does not moderate the relationship between Green Innovational Leadership (X) and Quality of Graduates (Y). This means that although institutional policies are available, their existence is not strong enough to strengthen or weaken the influence of Green Innovational leadership on the quality of graduates. Research by Saini et al. (2025) shows that Green Innovational leadership directly affects environmental stewardship through the mediation mechanism of digital transformation readiness, with the main moderating factors being the adoption of environmentally friendly technology and tacit knowledge. This indicates that the influence of Green Innovational leadership on organizational graduates is more influenced by internal

factors such as technological capabilities and knowledge, not external factors such as regulations or policies. Another study by Sanusi et al. (2023) highlighted that Green Innovational leadership influences employee green behavior through value alignment and green identity, without mentioning the role of policy as a moderating variable. This finding is reinforced by the research of Apostu et al. (2024), who found that government regulations play a moderating role in the relationship between green learning and sustainable project success, not in the direct relationship between Green Innovational leadership and education graduates. These empirical data are consistent with the results of structural analysis in the academic context, which show that the contribution of Green Innovational leadership to students' green creativity (as a proxy for graduate quality) is more determined by intrinsic motivation and direct transformational leadership practices.

Conclusion

Based on the results of data analysis and hypothesis testing that has been carried out, several results can be concluded as follows:

The most dominant indicator in the Green Innovational leadership variable is encouraging employees to achieve the goal of preserving the environment, which reflects the main dimension in green leadership. In the competence variable, the most dominant indicator is students involved in data-based green technology projects, which is the strongest representation of individual competence. Furthermore, the policy variable has the most dominant indicator on the technology used in schools supporting energy efficiency and emission reduction, which signifies the strength of the indicator in measuring policies that support sustainability. While in the quality of graduates variable, the strongest indicator is that vocational high school graduates have competencies that match the needs of the green industry, which is the main measure in assessing the quality of graduates.

Green Innovational leadership has a positive and significant effect on the quality of graduates, so the first hypothesis of this study is accepted. This shows that environmentally oriented transformational leadership has a real contribution to improving the quality of graduates. The second hypothesis of this study found that the higher the competence possessed by individuals, the higher the possibility of producing quality graduates. It is proven that the competence variable has a positive and significant influence on the quality of graduates. The third hypothesis shows that Green Innovational Leadership has no significant effect on the Quality of Graduates. This result confirms that although Green Innovational leadership plays an important role in shaping organizational culture and sustainability values, its influence on the quality of graduates output is not direct. This is corroborated by the fourth hypothesis, which shows that Green Innovational leadership can improve the quality of graduates indirectly by increasing individual competence through the competence variable. This study shows that competence is a significant mediating variable in the relationship between Green Innovational leadership and the quality of graduates. The fifth hypothesis shows that policy does not moderate the relationship between Green Innovational leadership and the quality of graduates. This means that although institutional policies are available, their existence is not strong enough to strengthen or weaken the influence of Green Innovational leadership on the quality of graduates.

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