



# The Influence of Multi-Actor Collaboration between Universities on the Formulation of Waste Management Policies

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## ARTICLE INFORMATION

Received: January 02, 2026  
Revised: March 26, 2026  
Available online: March 31, 2026

## KEYWORDS

Waste Management; Higher Education; Multi-Actors; Policy Formulation.

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## A B S T R A C T

This study aims to examine the influence of university collaboration, particularly lecturer research within a multi-actor network, on the formulation of waste management policies in Tasikmalaya City. Despite the existence of Regional Regulation No. 7 of 2012 and Mayoral Regulation No. 22 of 2019, waste management remains suboptimal due to low community participation, limited facilities, weak inter-agency coordination, and budget constraints. This study employs a mixed-method approach, combining a quantitative survey of lecturers from seven universities with in-depth interviews and observations. Quantitative data were analyzed using simple linear regression, while qualitative data were examined through triangulation and member checking. The findings reveal that most universities lack a specific research roadmap on waste management, resulting in limited contributions to policy formulation. Although research and publication training has been implemented, it has not yet focused on environmental policy advocacy. Regression results indicate that policy formulation has a positive and significant effect on multi-actor collaboration ( $p < 0.05$ ), while communication and coordination show positive but insignificant effects. The model explains 62.05% of the variance in collaboration outcomes. This study concludes that clear, directed, and inclusive policy formulation plays a more critical role than communication alone and recommends strengthening university engagement in evidence-based policymaking.

## INTRODUCTION

Waste management policies in Tasikmalaya City have been formulated based on waste types and processes, but their implementation has not been effective in addressing the problem comprehensively. Some of the issues include a lack of communication between implementers, low community participation in waste sorting, and limited facilities [1], [2], [3], [4]. A collaborative approach involving all stakeholders, including universities, has been proven to promote more sustainable solutions. Collective action and collaborative governance can be used to understand the ongoing waste issue [5], [6]. Tasikmalaya City experiences obstacles in waste management, including communication issues and socialization of government policies that are still rarely known by the wider community, coordination between agencies that is not optimal, there are no strict sanctions for those who throw garbage carelessly, lack of human resources and budget, and suboptimal guidance and supervision [7], [8], [9].

In line with the mission of higher education institutions to have a broad impact on society, known as an impactful campus, the implementation of education plays a strategic role in addressing public policy challenges. According to Chou et al. (2017), the education sector can play a multi-level, multi-actor, and multi-issue role. This means that collaboration between higher education institutions and other actors such as local governments, business actors, and the community can contribute to the formulation of policy solutions to various complex cross-sectoral problems [10], [11]. However, the extent to which universities, with their scientific, research, and community service capacities, are truly and substantially involved in the process of formulating waste management

policies remains a major question. This provides a crucial foundation for this research, which explores the concrete role of universities in multi-actor collaboration and their influence on waste management policies in Tasikmalaya City.

This research draws on the theory of collaborative governance, which explains that the process of formulating public policy is increasingly complex and requires the involvement of various actors across sectors, not just government elements. Within this framework, collaboration between public institutions and non-state actors, including universities, is crucial for creating participatory, responsive, and implementable policies. Collaborative governance emphasizes the importance of face-to-face dialogue, trust-building, shared understanding, and interdependence among the actors involved [12].

Furthermore, this research develops William N. Dunn's theory in his book, *Public Policy Analysis*, which explains that policy formulation is a crucial stage in the public policy cycle, where policy alternatives are formulated through a process of information exchange, rational argumentation, and consideration of various values espoused by actors. Policy formulation is not only technocratic but also political, as it involves negotiations between different interests. In this context, universities can play a strategic role through the contribution of scientific data, academic studies, and technical capacity to develop evidence-based policy alternatives [13], [14], [15], [16], [17].

Universities can become "knowledge hubs" that facilitate stakeholders in contextual and sustainable waste management. Previous research indicates that community-based waste management education must involve stakeholders to achieve

long-term effectiveness. For example, community-based zero-waste management involves strategic collaboration between student communities, environmental experts, landowners, and local media in providing sustainable education [18].

Universities play a strategic role in providing guidance, input, and outreach to communities on environmental issues through active involvement in community service activities and community service programs. Universities are a group of actors with high influence but low dependency, enabling them to become important drivers in developing collaborative strategies and behavioral change [19], [20].

The research findings indicate that universities have successfully implemented sustainable environmental management, making this paper relevant for further study in the context of waste management policy formulation in Tasikmalaya City. However, the sustainability of programs implemented by university actors still requires a real contribution to sustainable development [21].

This research integrates Ansell's Perspective, which integrates public policy outcomes as part of a dialogue between state and non-state actors through a process of dialogue, building trust, commitment, and shared understanding. In this research, collaborative governance serves as a conceptual and analytical reference, with the involvement of various actors, especially the role of universities. Furthermore, the research also adopts the concept of policy formulation through a systematic process involving problem structuring, forecasting, recommendations, and legitimacy. This conceptual framework is analyzed through waste management policies and the extent to which universities operationalize policies as alternative solutions in a multi-actor context. Integrating theory and empirical phenomena will be the goal in forming evidence-based and effective policies [12], [22]

Solving the waste problem requires time and the collective effort of all parties, as it is a complex issue, and waste has persisted throughout human civilization. Waste management must be implemented from upstream to downstream, with all parties involved in every process. If left unused, waste piles in landfills will eventually pile up and require new landfill space, in line with the ever-increasing population growth [23].

In the waste management process, waste is defined as the solid waste of daily human activities and/or natural processes. Therefore, waste management is a systematic, comprehensive, and continuous activity that encompasses waste reduction and handling. Waste management encompasses not only technical aspects, such as management, financing, regulation, and community involvement [24].

The diagram above can be part of an evidence-based policy that serves as the basis for policy formulation. The vast amount of waste accumulated in each sub-district requires concrete steps to be taken for sustainable management. Article 3, Paragraph 1 of Tasikmalaya Mayoral Regulation Number 22 of 2019 regulates the policy direction for waste reduction and management, but its implementation has not been effective. This is reflected in the minimal waste management budget, which in 2024 was only IDR 15.7 billion, a figure disproportionate to the volume of waste that must be handled in 69 sub-districts. Furthermore, limited facilities, such as the availability of only 28 trucks, most of which are unusable, indicate low fiscal capacity and innovation in waste management. In such conditions, the role of universities becomes very strategic. Campus involvement in collaborative work across actors can fill the gap left by budget constraints and weak government innovation, through contributions to applied research, affordable and adaptive waste management technology, and data-driven advocacy. Therefore, it is important to examine the extent to which university collaboration within a multi-actor network can influence the formulation of waste management policies in Tasikmalaya City in a more participatory and sustainable manner. Classical issues such as lack of communication between implementers, limited facilities, and low community participation in waste sorting indicate a gap between policy and the reality of its implementation. Amid this complexity, multi-actor collaboration is becoming an increasingly encouraged approach in public policy governance, including on environmental issues.

Various reports indicate limited local government capacity, including budgetary constraints, infrastructure, and the legislative's suboptimal oversight role. Furthermore, the release of hazardous methane gas and the contamination of leachate into the water sources of communities surrounding the landfill demonstrate that the existing management system is insufficiently responsive to the complexities of the problems. One clear example of this system's failure is the condition of the Ciangir Final Disposal Site (TPA), the sole waste disposal site in Tasikmalaya City. Operating since 2002, the Ciangir TPA is now experiencing overcapacity. Of the total daily waste generation of approximately 321.91 tons in 2021, only 192.91 tons were transported to the landfill. As a result, more than 120 tons of waste remains unmanaged each day. In addition to creating piles of illegal waste, this situation also seriously pollutes the surrounding water, soil, and air. Leachate from the mountains of waste even flows into rivers, damaging fish ponds and wells in several surrounding villages.

This issue reflects not only technical issues but also weak synergy among stakeholders in the formulation and implementation of waste management policies. In this regard, the government, the Regional People's Representative Council (DPRD), NGOs, and civil society have each played their respective roles, but systematic, coordinated collaboration has yet to be established. Universities, as strategic actors, have yet to significantly participate in this cross-sectoral collaboration. Yet, university contributions through research, outreach, technology development, and policy advocacy are crucial for developing sustainable, evidence-based waste management solutions.

This research is motivated by the problem of waste management in Tasikmalaya City continues to be a serious challenge that affects environmental aspects, health, and urban governance. Despite the issuance of Regional Regulation



Source: BPS Tasikmalaya City

Number 7 of 2012 concerning Waste Management and Mayoral Regulation Number 22 of 2019, the implementation of these policies has not shown optimal results. To date, waste management in Tasikmalaya City is still dominated by the collect-transport-dispose system and open dumping, which has caused the Ciangir Landfill to experience overloading, water and air pollution, and complaints from the surrounding community.

This research have some research questions:

1. To what extent does university collaboration in multi-actor collaboration influence waste management policy formulation in Tasikmalaya City?
2. What are the forms, processes, and challenges of university collaboration with other actors (government, local parliament, NGOs, and the community) in supporting waste management policy formulation?
3. What factors support and hinder the effectiveness of university collaboration in the policy formulation process?

## METHOD

This study uses a mixed methods approach, combining quantitative and qualitative research methods. In addition to answering the formulated research questions, the use of mixed methods provides a more comprehensive and in-depth picture than relying solely on quantitative or qualitative approaches [25]. A quantitative approach will be used to measure the influence of multi-actor university collaboration on waste management policy formulation in Tasikmalaya City and identify supporting and inhibiting factors. A qualitative approach is also needed in this research to provide in-depth data on the processes, forms, processes, and actual contributions of universities in supporting waste management policies.

The population in this study is all active lecturers in seven universities in Tasikmalaya City that have study programs related to environmental issues and public policy, namely Siliwangi University (UNSWIL), Health Polytechnic (Ministry of Health Tasikmalaya), Muhammadiyah University of Tasikmalaya (UMTAS), Tasikmalaya University of Struggle (UNPER), College of Administrative Sciences (STIA), BTH, and Indonesia University of Education (UPI Tasikmalaya). The estimated number of lecturers is around 425 people, with a focus on the departments of Environmental Engineering, Political Science, Public Administration, Management, and Public Health. Purposive sampling technique was used to select relevant lecturers according to their experience and involvement in waste management policy collaboration. Researchers adjusted to the relevant study programs so that they would take all of the universities.

Data collection in this study was conducted through the distribution of questionnaires to lecturers from universities with relevant study programs in Tasikmalaya City. The questionnaire focused on questions about perceptions, experiences, and the impact of collaboration in universities in addressing waste issues. Qualitative data collection was conducted through in-depth interviews with lecturers active in environmental research and policy. Several other stakeholders were also recommended for this data collection, such as the Regional People's Representative Council (DPRD) and NGOs.

Researchers also conducted documentation and observations to observe the collaboration process.

In this study, which used a mixed methods approach, validity tests were conducted separately for each type of data, namely quantitative and qualitative. For quantitative data, instrument validity was tested using construct validity with the Pearson Product Moment correlation technique, which measures the extent to which items in the questionnaire correlate significantly with the total score. An item is declared valid if the calculated  $r$ -value is greater than the table  $r$ -value at a significance level of 5%. In addition, a reliability test was also conducted using Cronbach's Alpha to determine the internal consistency of the instrument, where an  $\alpha$  value  $\geq 0.70$  indicates that the instrument is reliable. Meanwhile, for qualitative data, data validity was tested through source triangulation and member checking techniques. Source triangulation was carried out by comparing information from various informants (e.g., lecturers, government officials, NGOs), while member checking was carried out by confirming the results of interview interpretations with informants to ensure that the data and meaning captured by the researcher corresponded to what was intended by the informant. Furthermore, an audit trail was also conducted to ensure transparency in the data analysis process, where the entire process, from transcription and coding to theme extraction, was systematically recorded. By applying validity tests to each approach, the integrity of the data in this study can be maintained so that the analysis results can be trusted and scientifically accounted for.

Researchers used quantitative data analyzed through simple linear regression to determine the influence of university collaboration on policy formulation, while qualitative data was processed using triangulation techniques. Integration will be used to compare and connect statistical results, including those that demonstrate a significant quantitative influence, with qualitative findings that explain how that influence translates into real-world practice. Therefore, this data analysis will be useful in providing policy recommendations based not only on numbers but also on experiences and dynamics in the field.

## RESULTS AND DISCUSSION

### Institutional Constraints and Limited University Engagement in Policy Formulation.

Based on the results of research through in-depth interviews with the Head of Higher Education Institutions/LPPM at each Higher Education Institution that was a respondent to the research, the following results were obtained:

1. The leadership of universities/LPPM at each university in Tasikmalaya City does not specifically facilitate or bridge the gap between their university lecturers in conducting research or community service related to waste management issues or problems in Tasikmalaya City.
2. The leadership of universities/LPPM at each university in Tasikmalaya City has a research roadmap or institutional research agenda tailored to the disciplines of each study program and the expertise of the lecturers at their university. Therefore, they do not have a research roadmap or institutional research agenda that specifically supports the direction of environmental governance policy in Tasikmalaya City.

3. The selection mechanism for research and community service proposals implemented by the Higher Education Research and Empowerment Society (LPPM) at each university in Tasikmalaya City does not consider public policy issues related to waste management; instead, the selection mechanism focuses on the academic disciplines of each study program.
4. Higher Education Research and Empowerment Society (LPPM) at each university in Tasikmalaya City has conducted various training sessions/workshops for lecturers, but these sessions do not provide specific material on public policy advocacy in the field of environmental/waste management. The training sessions/workshops generally focus on improving lecturers' abilities to conduct research, publish, and develop high-quality proposals to compete for research/community service grants.
5. The Institute at each university in Tasikmalaya City does not yet have a structured mechanism to ensure that the results of lecturers' research/community service are utilized by the government. Currently, lecturers' research/community service results are only required to be published in national/international journals or in the media.
6. The leadership of universities at each university in Tasikmalaya City has been involved by the Tasikmalaya City Government in various activities, but not activities that specifically address the formulation of environmental governance policies.
7. The leadership of universities/LPPMs at each university in Tasikmalaya City acknowledged that the direction of research/community service at their universities has focused on the disciplines within their respective study programs, thus hindering active collaboration with the government on waste management issues.

The results of the interviews above indicate that the issue of waste management in Tasikmalaya City has not been a primary focus of research or community service for universities. Research and community service carried out by universities in Tasikmalaya City have so far focused on the disciplines of each study program and the expertise of lecturers, this has hampered the role of universities in collaborating with the government to address the problem of waste management in Tasikmalaya City. This condition is certainly not entirely the fault of universities, as higher education institutions, universities have an obligation to direct, ensure, research/community service carried out by lecturers is in accordance/linear with the disciplines of study programs/expertise of lecturers, which will be related to the need for promotion of lecturers' academic positions, as part of improving the quality of Human Resources (HR) of lecturers at universities.

However, in the future, the Leaders of Higher Education Institutions/LPPM must be brave to implement breakthroughs in the field of research/community service, namely by adjusting the needs of the community or issues that are currently hot in the community, of course without forgetting the discipline of study programs/expertise of lecturers. The presence of Higher Education Institutions should not only be useful for providing

education to students but must provide broader benefits to the community, if the obstacle is caused by the factor of the absence of study programs related to environmental governance, the Higher Education Institution can collaborate with other Universities to carry out research/community service in order to answer problems that exist in the community.

In addition to the courage to make breakthroughs in the field of research/community service, the future Leadership of Higher Education/LPPM must be able to facilitate and ensure that the results of lecturers' research/community service are utilized by the government to become the basis for making policies to address various problems faced by the community, especially waste management problems. This can be achieved through effective inter-institutional communication through the Leadership of Higher Education with the Government and the signing of a collaboration to use the results of lecturers' research/community service as study material/input in policy making, so that the results of lecturers' research/community service are not only published in journals but will have a greater impact on society because they are utilized by the government.

#### Determinants of Collaboration Success: Evidence from Regressions Analysis

This study confirms that the intensity of collaboration between institutions is very important in urban waste management. Our findings on the distribution of respondents by institution show the dominant role of several universities in Tasikmalaya. We distributed questionnaires to universities in Tasikmalaya City, including: Siliwangi University (UNSIL); Muhammadiyah University of Tasikmalaya (UMTAS); Perjuangan University (UNPER); College of Administrative Sciences (STIA); Health Polytechnic (POLTEKKES); Indonesian Education University (UPI) Tasikmalaya; Bakti Tunas Husada University (BTH); and Galunggung Law College (STHG). This is in line with research that addresses the same problem by showing that collaborative strategies between institutions (government-private-community-academia) can increase the effectiveness of waste management.

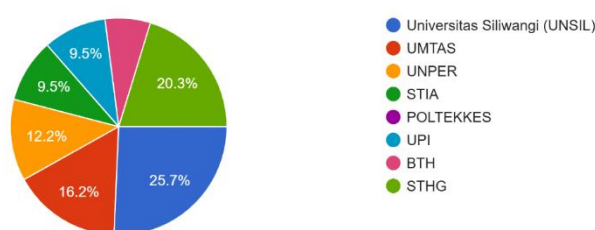


Figure 1. Research Respondents

Based on the results of data processing on 74 respondents, an overview of the distribution of origin of institutions involved in the study on the Influence of Multi-Actor University Collaboration on Waste Management Policy Formulation in Tasikmalaya City was obtained. The data shows that the majority of respondents came from Siliwangi University (UNSIL) with a percentage of 25.7%, followed by Galunggung Law College (STHG) with 20.3%. These two institutions dominated the number of respondents, thus reflecting the significant role of UNSIL and STHG in the context of university collaboration in the Tasikmalaya region. Furthermore, significant contributions also came from Muhammadiyah

University of Tasikmalaya (UMTAS) with 16.2%, and Perjuangan University (UNPER) with 12.2%. Meanwhile, the College of Administrative Sciences (STIA) and the Indonesian University of Education (UPI) each contributed the same amount, namely 9.5% of the total respondents. Meanwhile, BTH contributed a smaller amount, namely 6.8%.

Overall, this distribution demonstrates variation in involvement across universities, with UNSIL and STHG emerging as the institutions with the most participation. This also illustrates that the formulation of waste management policies in Tasikmalaya City does not involve a single higher education institution, but rather represents the result of contributions from a diverse range of universities, although the intensity of participation varies from institution to institution.

Table 1. T-test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.905557	2.585150	1.510766	0.1353
X1	0.123001	0.115391	1.065948	0.2901
X2	0.696862	0.102080	6.826646	0.0000

Based on the results of the regression analysis, it can be explained that the constant variable (C) has a coefficient value of 3.905 with a probability value of 0.135 ( $>0.05$ ). This indicates that although the constant provides an initial or baseline value for the model, it does not statistically significantly influence the collaboration outcome. In other words, the presence of the constant in this model only serves as a baseline value without providing strong meaning in explaining the impact of collaboration.

For variable X1, namely communication and collaborative coordination, the estimation results show a coefficient value of 0.123 with a probability of 0.290 ( $> 0.05$ ). A positive coefficient indicates that increased communication and collaborative coordination tend to be followed by increased collaboration outcomes. However, because the probability value is greater than 0.05, the effect is not statistically significant. This means that, although communication and collaborative coordination remain positive, in the context of this study, these factors are not strong enough to explain significant changes in collaboration outcomes.

This finding suggests that communication and coordination alone do not automatically guarantee successful collaboration without the support of other, more fundamental factors. Meanwhile, variable X2, the formulation of waste management policies, showed different results. The coefficient of X2 was 0.696 with a probability value of 0.000 ( $<0.05$ ). This indicates that waste management policy formulation has a positive and significant effect on collaboration outcomes. This means that every improvement in the quality of policy formulation leads to a significant improvement in collaboration outcomes. With a coefficient value greater than X1, the policy formulation variable can be considered the dominant factor in determining the success of multi-actor collaboration in waste management in Tasikmalaya City. This finding indicates that a clear, focused policy development process that accommodates the interests of all stakeholders is key to achieving optimal collaboration impacts.

Overall, the results of this study indicate that in the context of multi-actor collaboration, communication and coordination are indeed important, but these roles are not significant enough

if they are not accompanied by concrete and implementable policy formulation. Policy formulation and collaborative governance must be supported by transformational leadership to build stakeholder trust and participation [26]. The formulation of a sound waste management policy is a determining factor because it can provide a clear legal basis, direction, and mechanism for all parties involved in the collaboration. Thus, the success of collaboration in Tasikmalaya City is determined more by how the policy is formulated, rather than solely relying on the intensity of communication and coordination between actors.

Table 2. F-Tests

R-squared	0.620554	Mean dependent var	28.41892
Adjusted R-squared	0.609866	S.D. dependent var	6.733695
S.E. of regression	4.205915	Akaike info criterion	5.750557
Sum squared resid	1255.970	Schwarz criterion	5.843965
Log likelihood	-209.7706	Hannan-Quinn criter.	5.787818
F-statistic	58.05752	Durbin-Watson stat	1.585744
Prob(F-statistic)	0.000000		

The results of the model feasibility test show that the R-squared value is 0.6205 or approximately 62.05%. This means that the independent variables used in the model, namely communication and collaborative coordinator (X1) and waste management policy formulation (X2), are able to explain the variation of the dependent variable, namely the results or impact of collaboration, by 62.05%. Meanwhile, the remaining 37.95% is explained by other variables outside this research model. The Adjusted R-squared value of 0.6098 confirms that the regression model is quite good, because after adjusting for the number of variables, it still shows a high ability to explain the relationship between variables.

The F-statistic value of 58.05752 with a probability of 0.0000 ( $<0.05$ ) indicates that the overall regression model is significant. This means that the independent variables used in this study, namely collaborative communication/coordination and policy formulation, jointly influence the collaboration outcome. Therefore, the model can be considered suitable for analyzing the inter-variable interactions.

The Standard Error of Regression (SE of regression) value of 4.2059 indicates the average deviation of the predicted results from the observed values. The smaller the value, the better the model's predictions. In this case, although there is still some deviation, this value is relatively reasonable for social research.

Furthermore, the Durbin-Watson result of 1.5857 indicates that there are no serious autocorrelation issues in the model, as the value is close to 2. This means that the regression model can be said to adequately meet the assumption of residual independence.

Overall, these results indicate that the regression model used is adequate, with waste management policy formulation and collaborative communication/coordination simultaneously making a significant contribution to explaining variations in collaboration impacts. This demonstrates that the success of multi-actor collaboration in Tasikmalaya City is indeed influenced by the synergy established between actors, particularly through clear policy formulation, while communication and coordination serve more as supporting factors that are not yet significant enough individually.

Table 3. Multikolinieralitas

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	6.682998	27.95645	NA
X1	0.013315	53.22096	2.000860
X2	0.010420	40.77395	2.000860

The table above presents the results of a multicollinearity test using the Variance Inflation Factor (VIF) value. This test aims to determine whether there is a strong relationship between the independent variables that could affect the validity of the regression model.

The Centered VIF values for variables X1 (Communication and Collaborative Coordinator) and X2 (Waste Management Policy Formulation) are each 2.000860. This value is still well below the commonly used threshold of 10, thus concluding that there are no serious multicollinearity issues between the two independent variables. Thus, variables X1 and X2 can stand alone in the model without distorting each other's influence on the dependent variable (collaboration outcomes).

Meanwhile, the Uncentered VIF values do appear quite high, at 53.22096 for X1 and 40.77395 for X2. However, these values were not used as the primary reference because in regression with a constant (intercept) entered, the relevant value is the Centered VIF. Therefore, the test results still indicate that the regression model does not experience disruptive multicollinearity.

Overall, these results strengthen the validity of the regression model used in the study. Collaborative communication and coordination (X1) and waste management policy formulation (X2) can be analyzed together without bias caused by excessively high linear relationships between the independent variables. Therefore, the interpretation of the influence of each variable on the collaboration outcome is reliable.

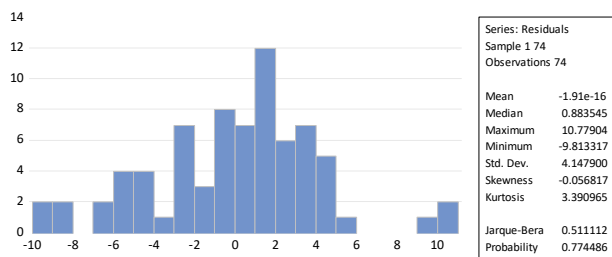


Figure 2. Normalitas Tests

The results of the residual normality test indicate that the residual distribution in the regression model tends to be symmetrically distributed around zero. The mean residual value is close to zero  $(-1.91 \times 10^{-16})$ , and the median value is 0.883, indicating that the residuals are not far from the center.

The skewness value of -0.0568 indicates that the residual distribution is relatively symmetrical, as it is very close to zero. Meanwhile, the kurtosis value of 3.3909 is close to 3, the kurtosis value for a normal distribution. This indicates that the residual distribution is neither too sharp nor too flat, but resembles a normal distribution.

Furthermore, the Jarque-Bera test result of 0.511 with a probability value of 0.774 ( $>0.05$ ) indicates that the residuals in

the model are normally distributed. Thus, the assumption of residual normality is met.

Overall, these results demonstrate that the regression model used in this study meets the classical assumption of normality. This means the model is suitable for estimation, and the analysis results are reliable because there are no serious deviations from the assumption of a normal distribution.

Table 4. Autocorrelation Test

F-statistic	3.094492	Prob. F(2,69)	0.0516
Obs*R-squared	6.091115	Prob. Chi-Square(2)	0.0476

The table above displays the results of the autocorrelation test using the Breusch-Godfrey Serial Correlation LM Test. This test is used to determine whether there is a correlation between residuals in a regression model, particularly in time series data.

The test results show an F-statistic of 3.094 with a probability of 0.0516. This probability value is slightly greater than 0.05, so at the 5% significance level, it can be concluded that there is no significant autocorrelation. However, because the value is very close to the 0.05 threshold, this condition can be considered to be in the 'nearly significant' or autocorrelation-prone area.

Furthermore, the Obs\*R-squared value of 6.091 with a Chi-square probability of 0.0476 ( $<0.05$ ) indicates that the Chi-square test indicates autocorrelation. In other words, although the F-test yields a nearly insignificant result, the Chi-square test actually indicates the presence of an autocorrelation problem at the 5% level.

Overall, these results suggest that the regression model exhibits weak autocorrelation. This means that residuals from one period may be related to residuals from the previous period. This condition requires attention because autocorrelation can affect the accuracy of standard errors, ultimately impacting the significance test of the regression coefficients.

Table 5. Heteroscedasticity Test

F-statistic	5.361703	Prob. F(2,71)	0.0068
Obs*R-squared	9.709973	Prob. Chi-Square(2)	0.0078
Scaled explained SS	10.12626	Prob. Chi-Square(2)	0.0063

The table shows the results of the heteroscedasticity test using the Breusch-Pagan-Godfrey method. This test is used to detect whether a regression model contains heteroscedasticity, a condition in which the variance of the error (residual) is not constant across all observations.

The test results show:

- The F-statistic is 5.3617 with a probability of 0.0068 ( $<0.05$ ), indicating the presence of heteroscedasticity.
- The Obs\*R-squared value is 9.7099 with a Chi-Square probability of 0.0078 ( $<0.05$ ), also supporting the conclusion that the model suffers from heteroscedasticity.
- Similarly, the Scaled Explained SS result of 10.1263 with a probability of 0.0063 ( $<0.05$ ) consistently indicates the presence of heteroscedasticity.

Thus, it can be concluded that the regression model used in this study is indicated to suffer from heteroscedasticity. This means that the residual variance is not constant, which can cause the estimated regression coefficients to be inefficient.

Table 6. Linearity Test

	Value	df	Probability
t-statistic	0.218508	70	0.8277
F-statistic	0.047746	(1, 70)	0.8277
Likelihood ratio	0.050457	1	0.8223

F-test summary:			
	Sum of Sq.	df	Mean Squares
Test SSR	0.856088	1	0.856088
Restricted SSR	1255.970	71	17.68972
Unrestricted SSR	1255.114	70	17.93020

LR test summary:	
	Value
Restricted LogL	-209.7706
Unrestricted LogL	-209.7454

The table above displays the results of the linearity test conducted to determine whether the regression model used was truly linear. Linearity is an important assumption in regression analysis, as the relationship between the independent and dependent variables must be linear.

The test results show:

- The t-statistic is 0.2185 with a probability of 0.8277 ( $> 0.05$ ).
- The F-statistic is 0.0477 with a probability of 0.8277 ( $> 0.05$ ).
- The likelihood ratio is 0.0505 with a probability of 0.8223 ( $> 0.05$ ).

These three results consistently indicate that the probability values are well above 0.05. This means that the regression model does not reject the null hypothesis ( $H_0$ ) stating that the model is linear. Therefore, it can be concluded that the relationship between the independent variables (collaborative communication/coordination and waste management policy formulation) and the dependent variable (collaboration outcomes) is linear.

The calculation summary in the F-test summary section also shows a very small difference in the Sum of Squares Residual (SSR) values between the restricted and unrestricted models, indicating no deviation from linearity. Similarly, in the LR test summary section, the log likelihood values between the restricted (-209.7706) and unrestricted (-209.7454) models are nearly identical, indicating no significant differences in the models and that a linear relationship is appropriate.

Thus, this test confirms that the regression model in this study meets the linearity assumption, allowing the analysis results to be correctly interpreted in accordance with the research objectives.

## CONCLUSION

This study demonstrates that university collaboration within a multi-actor network plays a strategic role in the formulation of waste management policies in Tasikmalaya City. The qualitative findings reveal that most universities do not yet have specific research roadmaps on waste issues, limiting their direct contributions to policymaking. Although training in research and publication has been provided, there is still no concrete effort to strengthen lecturers' capacity in environmental policy advocacy.

Quantitative analysis using simple linear regression confirms that the formulation of waste management policies has a positive and significant effect on the success of multi-actor collaboration ( $p < 0.05$ ). In contrast, communication and coordination, although positive, were not statistically significant. The regression model as a whole is significant, with

an  $R^2$  value of 62.05%, indicating that policy formulation and collaborative communication together explain more than half of the variation in collaboration outcomes. These findings highlight that the clarity, inclusiveness, and direction of policy formulation are the key determinants of collaboration success, outweighing the mere intensity of communication among actors.

Therefore, universities are expected to take bold steps in research and community engagement that align with current societal issues, strengthen networks with government, parliament, NGOs, and civil society, and ensure that research outputs are effectively utilized in policymaking. Such efforts will enhance the role of universities as strategic actors in fostering participatory and sustainable environmental governance.

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