
A DATA-DRIVEN EVALUATION FRAMEWORK FOR ACADEMIC PROMOTION RECOMMENDATION USING STATISTICAL VALIDATION AND REGRESSION ANALYSIS

Joni Maulindar^{1*}, Jawahir Che Mustapha², Singgih Purnomo³

Universiti Kuala Lumpur Malaysia¹, Universiti Kuala Lumpur Malaysia², Universitas Duta Bangsa
Surakarta

*Correspondence Email: maulindar.joni@s.unikl.edu.my

ABSTRACT

The academic promotion process in higher education continues to face challenges related to subjectivity, limited transparency, and inconsistencies in evaluating lecturers' performance. This study develops and evaluates a data-driven framework for academic promotion assessment by integrating multidimensional academic performance indicators with statistical validation and multiple linear regression analysis. A quantitative approach was employed using data collected through a five-point Likert-scale questionnaire from 168 respondents. The research instrument was initially assessed for validity and reliability, followed by classical assumption tests and multiple linear regression analysis to examine the relationships between academic performance indicators and Academic Promotion (AP). The results confirmed that all measurement items were valid and that all constructs demonstrated acceptable internal consistency, with Cronbach's Alpha coefficients exceeding 0.60. The regression model also satisfied the assumptions of normality, absence of multicollinearity, and homoscedasticity. The overall regression model was statistically significant ($F = 3.840$, $p = 0.001$), indicating that the predictors were collectively associated with Academic Promotion. At the individual level, Technological Works (Y6) was the only predictor with a statistically significant positive coefficient ($\beta = 0.157$, $p = 0.007$), whereas Educational Activities, Scientific Publications, Training, Community Service, Committee Involvement, and Scientific Participation were not statistically significant at the 5% level. These findings highlight the distinctive role of technology-oriented and innovation-related outputs in academic promotion while demonstrating the potential of a statistically validated, data-driven framework to support

	<i>more transparent, consistent, and evidence-based academic promotion assessment in higher education institutions.</i>
KEYWORDS	Academic Promotion, Data-Driven Framework, Decision Support, Multiple Linear Regression, Higher Education
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INTRODUCTION

Academic promotion is a strategic mechanism within higher education institutions that plays a crucial role in determining lecturers' career advancement while maintaining institutional quality and competitiveness(Hart & Rodgers, 2024)(Mohamed Hashim et al., 2022). The evaluation of academic promotion is generally based on lecturers' performance in teaching, research, community service, and other institutional contributions(Do et al., 2024). However, in practice, the promotion process continues to face several challenges, particularly those related to subjective assessments, limited transparency, and inconsistencies in the application of evaluation criteria(Širok & Milas, 2026). These issues may lead to unfair decision-making and reduce lecturers' confidence in the existing promotion system.

The complexity of academic promotion evaluation has increased as lecturers' performance has become increasingly multidimensional(Varouchas et al., 2018)(Thanassoulis et al., 2017)(Abo-Khalil, 2024). Academic activities extend beyond teaching to include scientific publications, technological innovations, community training programs, community service publications, committee participation, and involvement in scientific forums(Papavasileiou et al., 2025)(AlQhtani, 2025). Each dimension is represented by different indicators with varying levels of contribution, making it difficult to establish an objective and standardized evaluation system(Velazquez et al., 2025). In many cases, promotion decisions still rely on subjective judgments or individual interpretations of existing criteria, which may introduce bias into the evaluation process(Cook et al., 2024).

With the rapid advancement of information technology and the growing demand for accountable governance in higher education, data-driven approaches have been increasingly adopted to support decision-making processes(Komljenovic et al., 2025). These approaches enable systematic evaluations through the analysis of measurable and verifiable quantitative data. Consequently, data-driven models have the potential to improve objectivity, transparency, and consistency in academic promotion decisions(Addas et al., 2025)(Zeide, 2017). In this context, statistical techniques play a vital role in ensuring that the developed model possesses high validity and reliability.

Although numerous studies have investigated academic promotion systems, most have primarily focused on qualitative approaches or have not comprehensively integrated statistical analyses into the evaluation process(Ncube & Ngulube, 2024)(Abdolalipour et al., 2024)(Bui et al., 2024). Furthermore, previous studies generally have not developed a framework capable of integrating multiple dimensions of academic performance into a single structured and measurable model(Adewale et al., 2025)(Wang et al., 2025). These limitations indicate a research gap in the development of statistically validated, data-driven academic promotion models.

To address this gap, this study proposes the development of a data-driven Academic Promotion Recommendation framework by integrating multiple lecturer

performance indicators, including teaching activities, scientific publications, technological works, training activities, community service publications, committee membership, and participation in scientific activities. Each variable is operationalized into quantifiable indicators, enabling the evaluation process to be conducted systematically and objectively.

An essential step in developing the proposed model was the preparation of a data collection instrument capable of producing valid and reliable measurements. A structured questionnaire employing a five-point Likert scale was designed to capture lecturers' perceptions and levels of engagement with the selected academic performance indicators. Instrument validity was examined using the Pearson product-moment correlation test, whereas internal consistency was evaluated through Cronbach's Alpha. These procedures ensured that each questionnaire item measured the intended construct accurately and consistently before the subsequent statistical analyses were performed.

Following the instrument evaluation, multiple linear regression analysis was performed to determine the effects of the independent variables on the dependent variable representing academic promotion. This analytical approach was used to identify which academic performance indicators significantly contributed to promotion decisions. Prior to interpreting the regression results, the model was evaluated by testing the classical regression assumptions, including normality, multicollinearity, and heteroscedasticity. Compliance with these assumptions indicates that the regression model provides statistically reliable, unbiased, and appropriate estimates for supporting evidence-based decision-making.

The proposed framework was empirically evaluated using data collected from lecturers who had either applied for or successfully obtained academic promotion. Data were gathered through the validated questionnaire and distributed extensively via digital platforms. With an adequate number of respondents, the collected data provide a representative understanding of the factors influencing academic promotion. Statistical analyses were then systematically performed to evaluate the model's performance and identify variables that significantly contribute to promotion decisions.

The main contribution of this research is the establishment of a data-driven framework for academic promotion that combines multidimensional performance indicators with rigorous statistical validation. By integrating these components, the proposed framework offers a more objective and transparent approach to evaluating lecturers' academic performance while strengthening the reliability of promotion decisions. Furthermore, the framework provides an evidence-based basis for promoting fairness, accountability, and consistency in academic promotion practices, thereby supporting the implementation of a more systematic promotion system within higher education institutions.

This research was conducted to establish and validate a data-driven academic promotion recommendation framework by incorporating multidimensional lecturer performance indicators with statistical validation procedures and multiple linear regression analysis. The study focuses on evaluating the validity and reliability of the proposed measurement instrument while investigating the influence of key performance variables on academic promotion. In addition, classical assumption testing was performed to ensure that the regression model satisfied the required statistical assumptions before interpretation. The resulting framework is expected to provide a reliable and systematic basis for supporting transparent, objective, and evidence-based academic promotion decisions within higher education institutions.

RESEARCH METHOD

This research adopted a quantitative methodology to establish and validate a data-driven academic promotion recommendation model using statistical analysis. The study was carried out through a structured sequence of research activities, including the identification of relevant variables, the development of the research instrument, data collection, and subsequent analysis using appropriate inferential statistical methods.

Variable Identification and Indicators

The variables in this study consist of independent and dependent variables. The independent variables include teaching activities (X1), scientific publications (Y1), technological works (Y6), community training activities (Z3), community service publications (Z6), committee membership (N1), and participation in scholarly activities (N6). The dependent variable is academic promotion (AP). Each variable was operationalized into measurable indicators and assessed quantitatively using a five-point Likert scale.

Research Instrument Design

A structured five-point Likert-scale questionnaire was developed to assess respondents' perceptions of the identified academic performance indicators. To ensure the quality of the measurement instrument, validity and reliability assessments were completed prior to data collection, confirming that the questionnaire was capable of generating accurate and consistent responses for further statistical analysis.

Validity Test

Construct validity was evaluated using the Pearson product-moment correlation coefficient to determine the degree of association between the score of each questionnaire item and the overall instrument score. This analysis was performed to verify whether every item adequately represented the construct being measured. The Pearson correlation coefficient was computed using the following equation:

$$r = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2] [N \sum Y^2 - (\sum Y)^2]}}$$

where:

(r) = Pearson correlation coefficient

(N) = number of respondents

(X) = individual item score

(Y) = total score

An item is considered valid if $r_{calculated} > r_{table}$

Reliability Test

The internal consistency of the research instrument was evaluated using Cronbach's Alpha coefficient. This reliability analysis was performed to determine whether the questionnaire items produced consistent measurements of the intended constructs. Cronbach's Alpha was calculated using the following equation:

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2} \right)$$

where:

α = reliability coefficient

k = number of items

σ_1^2 = variance of each item

σ_t^2 = total variance

The instrument is considered reliable if the value of $\alpha > 0.6$.

Data Collection

Data collection was carried out between June and August 2024 using an online questionnaire administered through Google Forms. The participants consisted of lecturers who had previously applied for academic promotion or were actively undergoing the promotion process during the study period. Respondents were recruited using a snowball sampling technique, resulting in a final sample of 168 lecturers.

Classical Assumption Tests

Before conducting the regression analysis, classical assumption tests were performed as follows:

- Normality Test: The Kolmogorov–Smirnov test was used to assess data normality. The data were considered normally distributed if the significance value was greater than 0.05.
- Multicollinearity Test: Multicollinearity was assessed using the Tolerance value (> 0.1) and Variance Inflation Factor (VIF) (< 10).
- Heteroscedasticity Test: Heteroscedasticity was assessed based on the significance value, with a value greater than 0.05 indicating the absence of heteroscedasticity.

Multiple Linear Regression Analysis

To examine the effects of the independent variables on academic promotion, a multiple linear regression model was employed using the following equation:

$$AP = \beta_0 + \beta_1 X_1 + \beta_2 Y_1 + \beta_3 Y_6 + \beta_4 Z_3 + \beta_5 Z_6 + \beta_7 N_6 + \varepsilon$$

where:

AP = academic promotion

β_0 = constant

$\beta_1 - \beta_7$ = regression coefficients

ε = error term

The model was evaluated using the F-test (ANOVA) to determine the simultaneous significance of the independent variables and the t-test to assess the partial effect of each independent variable.

Research Flowchart

The research procedure adopted in this study is illustrated in the following flowchart. Figure 1 outlines the sequence of research activities undertaken in this study. The process starts with defining the research variables and performance indicators, followed by questionnaire development and instrument validation through validity and reliability testing. Once the survey data had been collected, classical assumption tests were performed to ensure that the dataset met the requirements for multiple linear regression analysis. The resulting regression model was then assessed to identify the significant determinants of academic promotion and to evaluate its statistical performance. Based on the validated model, a data-driven recommendation framework was established to support transparent and evidence-based academic promotion decisions.

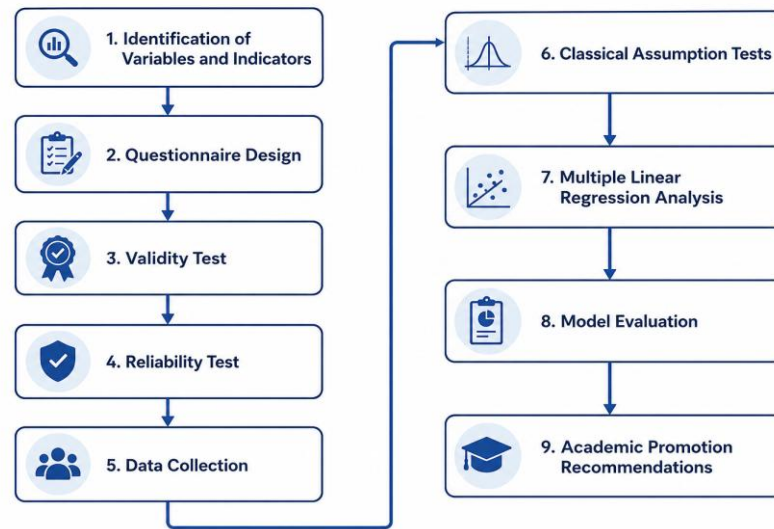


Figure 1. Research Flowchart for Developing the Data-Driven Academic Promotion Recommendation Framework

RESULTS AND DISCUSSION

Validity Test Results

The validity test was conducted using Pearson's correlation to ensure that each questionnaire item accurately measures the intended variable. The formula used is as follows:

$$r = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2] [N \sum Y^2 - (\sum Y)^2]}}$$

Based on the test results involving 43 respondents ($N = 43$) in the initial validation stage, the critical correlation coefficient ($r_{tabel} = 0.304$). All items for the research variables had calculated correlation coefficients ($r_{calculated}$) greater than the critical value (r_{table}), indicating that all questionnaire items were valid.

Table 1. Summary of Validity Test Results

Variable	Range of $r_{calculated}$	r_{table}	Interpretation
X1 (Educational Activities)	0.813–0.866	0.304	Valid
Y1 (Scientific Publications)	0.519–0.879	0.304	Valid
Y6 (Technological Works)	0.474–0.770	0.304	Valid
Z3 (Training)	0.515–0.966	0.304	Valid
Z6 (Community Service)	0.862–0.897	0.304	Valid
N1 (Committee Involvement)	0.604–0.909	0.304	Valid
N6 (Scientific Participation)	0.670–0.909	0.304	Valid
AP (Academic Promotion)	0.901–0.904	0.304	Valid

Reliability Test Results

The internal consistency of the research instrument was evaluated using Cronbach's Alpha coefficient. This analysis was performed to determine whether the questionnaire

items consistently measured the intended constructs. The Cronbach's Alpha coefficient was computed using the following formula:

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2} \right)$$

The instrument was considered reliable if the Cronbach's Alpha coefficient was greater than ($\alpha > 0.6$).

Table 2. Reliability Test Results

Variable	Cronbach's Alpha	Interpretation
X1	0.782	Reliable
Y1	0.749	Reliable
Y6	0.601	Reliable
Z3	0.884	Reliable
Z6	0.706	Reliable
N1	0.728	Reliable
N6	0.778	Reliable
AP	0.773	Reliable

Classical Assumption Test Results

Normality Test

The normality assumption was evaluated using the Kolmogorov–Smirnov test. The analysis produced a significance value of **0.064**, exceeding the established threshold of **0.05** (**0.064 > 0.05**). These findings indicate that the regression residuals followed a normal distribution, confirming that the normality assumption was satisfied.

Multicollinearity Test

The regression model was evaluated for multicollinearity to ensure that the independent variables were not highly correlated with one another. The following criteria were applied to determine whether multicollinearity was absent:

1. Tolerance > 0.10
2. Variance Inflation Factor (VIF) < 10

Table 3. Multicollinearity Test Results

Variable	Tolerance	VIF	Interpretation
X1	0.835	1.198	No multicollinearity
Y1	0.850	1.176	No multicollinearity
Y6	0.833	1.201	No multicollinearity
Z3	0.834	1.199	No multicollinearity
Z6	0.863	1.159	No multicollinearity
N1	0.943	1.061	No multicollinearity
N6	0.666	1.502	No multicollinearity

Heteroscedasticity Test

The heteroscedasticity test results showed that all variables had significance values greater than 0.05 ($p > 0.05$). Therefore, no heteroscedasticity was detected, indicating that the regression model satisfied the homoscedasticity assumption.

Multiple Linear Regression Analysis Results

The multiple linear regression model used in this study is expressed as follows:

$$AP = \beta_0 + \beta_1 X1 + \beta_2 Y1 + \beta_3 Y6 + \beta_4 Z3 + \beta_5 Z6 + \beta_7 N6 + \varepsilon$$

Simultaneous Test (ANOVA)

Table 4. ANOVA Test Results

Source	F	Sig.
Regression	3.840	0.001

The ANOVA test results showed an F-value of 3.840 with a significance value of 0.001. Since the significance value was less than 0.05 ($p < 0.05$), the regression model was statistically significant. This indicates that the independent variables simultaneously had a significant effect on academic promotion (AP).

Partial Test (Variable Significance)

Table 5. Partial Test Results

Variable	Coefficient	Sig.	Interpretation
X1	0.029	0.602	Not Significant
Y1	0.015	0.739	Not Significant
Y6	0.157	0.007	Significant
Z3	0.076	0.084	Not Significant
Z6	0.035	0.635	Not Significant
N1	0.088	0.099	Not Significant
N6	0.167	0.195	Not Significant

As reported in Table 5, the partial regression analysis identified Technological Works (Y6) as the only predictor with a statistically significant positive influence on Academic Promotion (AP). The estimated regression coefficient ($\beta = 0.157$) and the corresponding significance value ($p = 0.007$) demonstrate that higher levels of Technological Works are associated with improved academic promotion outcomes after accounting for the influence of the remaining explanatory variables.

In contrast, Educational Activities (X1), Scientific Publications (Y1), Training (Z3), Community Service (Z6), Committee Involvement (N1), and Scientific Participation (N6) had significance values greater than 0.05, indicating that these variables did not have statistically significant individual effects on Academic Promotion in the regression model.

Empirical Research Model

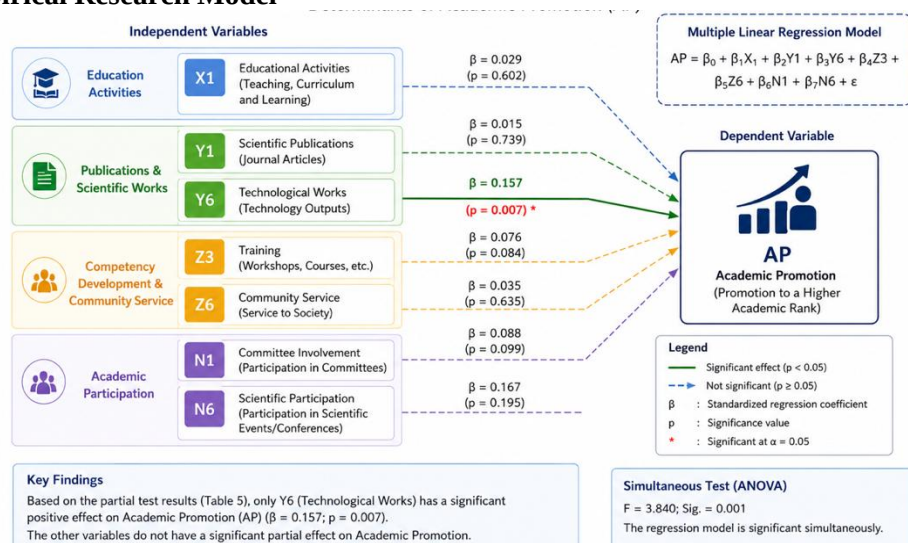


Figure 2. Visualization of the Research Model

Figure 2 illustrates the multiple linear regression model used to examine the factors associated with Academic Promotion (AP). The model includes seven independent variables: Educational Activities (X1), Scientific Publications (Y1), Technological Works (Y6), Training (Z3), Community Service (Z6), Committee Involvement (N1), and Scientific Participation (N6).

The partial regression results indicate that Technological Works (Y6) is the only variable with a statistically significant positive effect on Academic Promotion, with a regression coefficient of $\beta = 0.157$ and a significance value of $p = 0.007$ ($p < 0.05$). This finding suggests that greater involvement or achievement in technological works is positively associated with academic promotion when the other variables in the model are held constant.

In contrast, Educational Activities (X1; $\beta = 0.029$, $p = 0.602$), Scientific Publications (Y1; $\beta = 0.015$, $p = 0.739$), Training (Z3; $\beta = 0.076$, $p = 0.084$), Community Service (Z6; $\beta = 0.035$, $p = 0.635$), Committee Involvement (N1; $\beta = 0.088$, $p = 0.099$), and Scientific Participation (N6; $\beta = 0.167$, $p = 0.195$) do not show statistically significant individual effects on Academic Promotion at the 5% significance level.

Nevertheless, the simultaneous ANOVA test shows that the overall regression model is statistically significant ($F = 3.840$, $p = 0.001$). This result indicates that the independent variables, when considered collectively, significantly explain variation in Academic Promotion, even though most predictors are not statistically significant individually. Furthermore, the model satisfies the classical regression assumptions, including normality, absence of multicollinearity, and homoscedasticity, supporting the validity of the regression analysis.

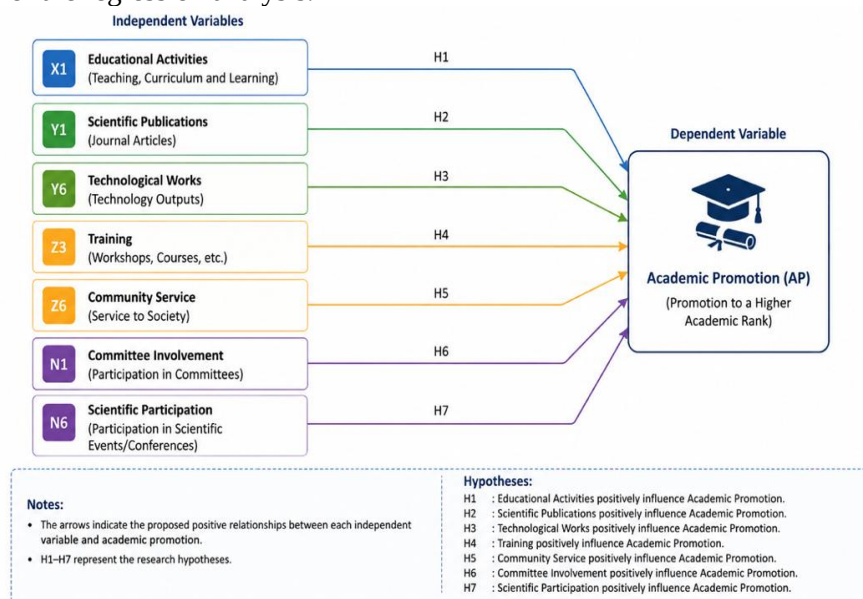


Figure 3. Conceptual Framework of the Research

Figure 3 presents the conceptual framework developed to examine the determinants of Academic Promotion (AP). The framework consists of seven independent variables: Educational Activities (X1), Scientific Publications (Y1), Technological Works (Y6), Training (Z3), Community Service (Z6), Committee Involvement (N1), and Scientific Participation (N6). Academic Promotion (AP) serves as the dependent variable.

The framework proposes that each independent variable may contribute to lecturers' academic promotion. Educational Activities (X1) represent lecturers'

involvement in teaching, curriculum development, and learning-related activities. Scientific Publications (Y1) reflect scholarly outputs, particularly journal publications, while Technological Works (Y6) represent technology-based outputs and innovations. Training (Z3) represents participation in professional development activities, whereas Community Service (Z6) reflects lecturers' contributions to society. Committee Involvement (N1) represents participation in institutional or professional committees, and Scientific Participation (N6) reflects involvement in scientific activities, such as conferences, seminars, and other academic forums.

The arrows from X1, Y1, Y6, Z3, Z6, N1, and N6 toward AP represent the hypothesized relationships between the predictor variables and academic promotion. Accordingly, the conceptual framework provides the basis for examining both the individual and simultaneous contributions of these variables to Academic Promotion using multiple linear regression analysis.

The empirical results subsequently show that, although the overall regression model is statistically significant, Technological Works (Y6) is the only predictor with a statistically significant individual association with Academic Promotion ($\beta = 0.157$, $p = 0.007$). These findings are discussed separately in the Results and Discussion section.

Discussion

The findings of this study indicate that the proposed data-driven Academic Promotion Recommendation Framework demonstrates satisfactory validity and reliability while satisfying the statistical assumptions required for regression analysis. These results indicate that the research instrument consistently measures lecturers' academic performance and provides a robust quantitative foundation for objective decision-making. Furthermore, the findings highlight the value of a data-driven approach in academic promotion assessment by improving transparency, consistency, and evidence-based decision-making while reducing reliance on subjective judgment.

The validity and reliability tests confirmed that all research variables were suitable for further analysis. The indicators adequately represented key dimensions of lecturers' academic performance, including educational activities, scientific publications, technological works, training, community service, committee involvement, and scientific participation. These results provide a sound measurement basis for examining the multidimensional factors associated with academic promotion.

The diagnostic assessment of the regression model verified compliance with the classical assumption requirements. The residuals were normally distributed, multicollinearity among the predictor variables remained within acceptable limits, and no heteroscedasticity was detected. These outcomes confirm the suitability of the multiple linear regression model and provide greater confidence in the validity of the estimated effects of the predictor variables on academic promotion.

The simultaneous test showed that the regression model was statistically significant ($F = 3.840$, $p = 0.001$), indicating that the independent variables collectively were significantly associated with Academic Promotion (AP). This finding suggests that academic promotion should be viewed as a multidimensional process in which different aspects of lecturers' academic performance may contribute collectively to promotion outcomes. Such a perspective is consistent with the broader responsibilities of academics, which encompass education, research, community service, professional development, and participation in institutional and scientific activities.

However, the partial analysis revealed that Technological Works (Y6) was the only variable with a statistically significant positive coefficient ($\beta = 0.157$, $p = 0.007$). This finding suggests that technological outputs and innovation-oriented academic contributions

were more strongly associated with Academic Promotion than the other predictors included in the model. One possible interpretation is that technological works may represent tangible, innovative, and applicable academic outputs that differentiate lecturers' promotion profiles. Nevertheless, this result should not be interpreted as evidence that technological works alone determine academic promotion, particularly because the present study employed an observational regression design.

In contrast, Educational Activities (X1), Scientific Publications (Y1), Training (Z3), Community Service (Z6), Committee Involvement (N1), and Scientific Participation (N6) did not show statistically significant individual associations with Academic Promotion at the 5% significance level. Importantly, the absence of statistical significance does not imply that these dimensions are unimportant in academic promotion. Rather, their unique contributions may not have been sufficiently strong after accounting for the other variables in the regression model. This pattern may be related to limited variability among respondents, overlap in the information captured by different academic performance indicators, measurement characteristics of the questionnaire, or contextual factors that were not incorporated into the model.

An important finding is the contrast between the significant overall regression model and the limited number of individually significant predictors. While the predictors collectively contributed significantly to explaining variation in Academic Promotion, only Y6 reached individual statistical significance. This pattern indicates that academic promotion may result from the combined contribution of multiple dimensions rather than from isolated indicators. It also suggests that interpreting academic promotion solely on the basis of individual regression coefficients may overlook the broader structure of academic performance represented by the model.

From a practical perspective, these findings demonstrate the potential of a data-driven approach to support Academic Promotion Recommendation Framework. The proposed model can provide empirical information about the relative contribution of different academic performance indicators and may complement existing institutional assessment procedures. Rather than replacing formal promotion regulations or expert judgment, such a model could function as a decision-support mechanism that helps institutions identify relevant performance patterns, improve transparency, and support more consistent evidence-based evaluation.

Nevertheless, several limitations should be considered when interpreting the findings. First, the use of multiple linear regression assumes predominantly linear relationships between predictors and Academic Promotion and may therefore be unable to capture more complex or nonlinear patterns. Second, the analysis relies on questionnaire-based data, which may be affected by self-report and perception biases. Third, the statistical significance of the model does not necessarily establish causal relationships between the predictors and academic promotion. Therefore, future studies could integrate objective administrative and academic performance records, employ larger and more diverse samples, and use longitudinal data to examine changes in promotion outcomes over time. More advanced analytical approaches, including machine learning, nonlinear predictive models, or hybrid decision-support models, could also be compared with conventional regression to determine whether they improve predictive performance and the practical usefulness of academic promotion recommendation systems.

CONCLUSION

This study proposes and validates a data-driven academic promotion recommendation framework based on multidimensional indicators of lecturers' academic

performance and comprehensive statistical evaluation. The empirical findings demonstrate that the research instruments achieved acceptable levels of validity and reliability, while the regression model satisfied all classical assumption requirements. These results confirm the robustness of the proposed framework and provide a reliable statistical foundation for evidence-based academic promotion decision-making in higher education institutions.

The multiple linear regression analysis demonstrated that the independent variables collectively had a statistically significant association with Academic Promotion (AP), as indicated by the simultaneous test ($F = 3.840$, $p = 0.001$). However, the partial analysis revealed that Technological Works (Y6) was the only variable with a statistically significant positive coefficient ($\beta = 0.157$, $p = 0.007$). This finding indicates that technology-oriented outputs and innovation were more strongly associated with academic promotion than the other predictors included in the model. Nevertheless, the non-significant individual effects of Educational Activities, Scientific Publications, Training, Community Service, Committee Involvement, and Scientific Participation should not be interpreted as evidence that these dimensions are unimportant. Rather, their contributions may operate collectively or may depend on contextual and institutional factors not fully captured by the present model.

Overall, the proposed framework demonstrates the potential of a data-driven approach to support a more objective, transparent, consistent, and evidence-based academic promotion assessment process. The model can serve as a decision-support mechanism by providing empirical information on the relative contribution of different academic performance indicators. However, it should complement rather than replace formal institutional regulations, established academic promotion criteria, and expert judgment.

Based on these findings, higher education institutions are encouraged to strengthen the use of data-driven approaches in academic promotion assessment to improve transparency, consistency, and accountability. The weighting and evaluation of performance indicators should also be periodically reviewed to ensure an appropriate balance among education, research, community service, institutional participation, and innovation. Future research should extend the proposed framework by incorporating more advanced analytical methods, such as machine learning, nonlinear predictive models, or hybrid decision-support approaches, and compare their predictive performance with conventional regression models. The integration of objective administrative records, longitudinal data, larger and more diverse samples, and data from multiple higher education institutions is also recommended to improve predictive accuracy, external validity, and the generalizability of the model across different institutional contexts.

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Author's short biography

Authors Name:

Name : Joni Maulindar

Affiliation : Universiti Kuala Lumpur (UniKL), Malaysia

Phone Number : +62 878-3965-4504

Email : maulindar.joni@s.unikl.edu.my

Joni Maulindar is a postgraduate researcher at Universiti Kuala Lumpur (UniKL), Malaysia. He received his Bachelor's degree in Computer Science and a Master's degree in Engineering. His research interests include data science, machine learning, recommender systems, decision support systems, educational data mining, and artificial intelligence in higher education. His current research focuses on developing data-driven models for academic promotion recommendation using statistical analysis and predictive modeling. He has experience in conducting research on educational technology, Internet of Things (IoT), and intelligent information systems.

Authors Name:

Name : Jawahir Che Mustapha

Affiliation : Universiti Kuala Lumpur (UniKL), Malaysia

Phone Number : +60 19-609 7083

Email : jawahir@unikl.edu.my

Jawahir Che Mustapha is a senior academic at Universiti Kuala Lumpur (UniKL), Malaysia. She holds a doctoral degree and has extensive experience in higher education, research supervision, and academic publication. Her research interests include artificial intelligence, machine learning, data analytics, decision support systems, educational technology, and digital transformation. She has supervised numerous postgraduate research projects and actively contributes to international research collaborations.

Authors Name:

Name : Singgih Purnomo

Affiliation : Universitas Duta Bangsa Surakarta, Indonesia

Phone Number : +62 813-2951-0666

Email : singgih_purnomo@udb.ac.id

Singgih Purnomo is a lecturer in the field of Management at Universitas Duta Bangsa Surakarta, Indonesia. He holds a doctoral degree in Management and has extensive experience in teaching, research, and community engagement. His research interests include strategic management, human resource management, organizational performance, decision support systems, and data-driven management. His research focuses on applying quantitative methods and information technology to support evidence-based decision making and improve organizational performance in higher education and business environments.
