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Multidimensional Factors Affecting Senior High School Graduation Rates in Indonesia

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ABSTRACT

This study aims to analyze the influence of the number of high school teachers, the student-teacher ratio, regional education expenditure, the Human Development Index (HDI), and school infrastructure on high school student graduation rates in Indonesia. The study used a quantitative approach with a descriptive-inferential design based on secondary data from the Indonesian Central Statistics Agency (BPS) in 2023 for 34 provinces with complete data. The analysis was conducted using multiple linear regression to examine the multidimensional relationships between variables. The results show that the number of high school teachers, regional education expenditure, the HDI, and school infrastructure have a significant positive effect on student graduation rates, while the student-teacher ratio has a significant negative effect. Among all variables, the HDI has the strongest contribution to secondary education attainment. The regression model has a fairly strong explanatory power with an R^2 value of 0.50. These findings indicate that improving the quality of secondary education depends not only on the number of educators but also requires support from socio-economic development, educational investment, proportional teacher distribution, and strengthening of school infrastructure. Academically, this study strengthens the development of quantitative studies of education through a more comprehensive multivariate approach. Practically, the research results can serve as an empirical basis for the government in formulating national education equality policies that are more effective, equitable, and data-based.

1. Introduction

Education is the primary foundation for developing high-quality, productive, and highly competitive human resources. Within the context of national development, the education sector plays a strategic role in improving public welfare, strengthening national competitiveness, and supporting sustainable economic growth (Bing et al., 2025). One important indicator in assessing the success of the education system is the graduation rate, or completion rate, particularly at the senior high school (SMA) level (Dwomoh et al., 2022). The graduation rate reflects the effectiveness of the learning system, the quality of teaching, and students' readiness to optimally complete secondary education (Samala et al., 2024).

The success of secondary education is influenced by various factors, one of which is the availability of teaching staff. Teachers play a central role as learning facilitators, academic advisors, motivators, and evaluators in the teaching and learning process (Zenda et al., 2023). An adequate number of teaching staff enables a more ideal teacher-student ratio, improves the quality of academic services, provides more optimal individual attention, and enhances the effectiveness of the learning system. Therefore, the presence of teaching staff is a crucial component in supporting student success in secondary education (Almulla et al., 2023; Chaudhry et al., 2024).

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Despite this, the distribution of high school teachers in Indonesia still shows significant disparities across provinces. According to 2023 data from the Central Statistics Agency (BPS), the number of high school teachers in provinces with large populations, such as West Java, Central Java, and East Java, is significantly higher than in eastern Indonesia, such as Papua, Central Papua, and the Papua Highlands. This difference in the distribution of teaching staff indicates a disparity in academic service capacity between regions. This disparity has the potential to lead to differences in the quality of learning systems and access to educational services, ultimately impacting student outcomes regionally and nationally (Zickafoose et al., 2024).

In addition to the distribution of teaching staff, educational attainment is also influenced by socioeconomic conditions, school infrastructure, access to learning facilities, and regional policies. However, the number of teachers remains a crucial indicator because it directly relates to the capacity of academic services available to students. Unequal distribution of teaching staff across provinces can hinder equitable distribution of national education quality, particularly in regions with limited educational resources (Guo et al., 2024). Theoretically, the relationship between the number of teaching staff and educational outcomes can be explained through human capital theory, which emphasizes that investment in the education sector, including the provision of teachers, contributes to improving the quality of human resources. From this perspective, increasing the number of teaching staff can strengthen the effectiveness of the learning system, improve the quality of academic services, and support the achievement of better educational outcomes.

In addition to Human Capital Theory, this study also considers the perspective of educational inequality, which emphasizes that unequal access to educational resources among regions may create differences in educational outcomes. Educational inequality may arise from disparities in teacher distribution, socioeconomic conditions, educational investment, and school infrastructure availability. Therefore, educational attainment should not be viewed solely as a result of teaching capacity but also as a multidimensional outcome influenced by broader structural and regional factors.

Several previous studies have shown that education quality is influenced by a combination of factors, including teaching staff, socioeconomic conditions, and educational infrastructure (Fomba et al., 2023). However, most studies have focused on general analyses of education quality or used a limited geographic scope. Consequently, few studies have specifically evaluated the influence of the distribution of high school teachers on student graduation rates across provinces in Indonesia using a multivariate quantitative approach based on the latest national data.

Although previous studies have examined educational quality in Indonesia, few studies have specifically evaluated graduation rates at the provincial level by integrating teacher distribution, socioeconomic conditions, educational inequality, and other multidimensional educational factors using recent national data. Therefore, this study aims to address this gap by applying a multidimensional analytical framework that incorporates educational, socioeconomic, and structural factors simultaneously. This study offers novelty by integrating multidimensional provincial-level variables including teacher distribution, student-teacher ratio, regional education expenditure, human development indicators, and school infrastructure using recent national-level data in Indonesia.

This research is significant because it provides academic contributions to the development of quantitative studies in education while simultaneously supporting the formulation of more effective educational equity policies. The research findings are expected to serve as a basis for the government and policymakers in designing more equitable, efficient, and empirically data-driven educational development strategies. Based on this background, this study aims to analyze the influence of the number of high school teachers, the student-teacher ratio, regional education expenditure, the Human Development Index (HDI), and school infrastructure on high school student graduation rates in Indonesia. Academically, this research contributes to the development of quantitative educational studies through a more comprehensive multivariate analysis model. Practically, this research provides an empirical basis for the formulation of more effective and data-driven educational equity policies (Sahlgren et al., 2023).

2. Research Methods

2.1 Research Design

This study uses a quantitative approach with a descriptive and inferential research design. The quantitative approach was chosen because the study aims to measure the empirical relationship between the number of high school teachers and student graduation rates using numerical data that can be analyzed statistically. Descriptive analysis is used to provide an overview of the data distribution for each variable, while inferential analysis is used to examine the relationships and influences between variables through a multiple linear regression model (Jones et al., 2025). This study design is cross-sectional because it uses data from a specific time period, namely 2023, so the results of the analysis represent the condition of the distribution of teaching staff and secondary education achievements in Indonesia during that period.

2.2 Data Source and Research Variables

This study uses official secondary data obtained from BPS in 2023. The data were selected because they have a high level of validity, are national in nature, are measurable, and are relevant to the research objectives of analyzing the relationship between the number of teaching staff and secondary education graduation rates in Indonesia. The use

of BPS data provides a strong empirical basis because it comes from an official government statistical agency that is credible, standardized, and widely used in academic research and national policy formulation.

Specifically, data on the number of high school teachers and student-teacher ratios were obtained from BPS Education Statistics publications. Regional education expenditure data were obtained from Regional Financial Statistics, while HDI data were obtained from Human Development Index publications. School infrastructure data were obtained from provincial educational statistics.

The data used in this study includes two main components. First, data on the number of high school teachers (public and private), which covers the total number of teaching staff at the senior high school level in each province in Indonesia. Second, data on the high school/equivalent education completion rate, which shows the percentage of the population that has completed secondary education in each province.

Based on these data sources, this study uses one primary dependent variable, namely the graduation rate or completion rate of high school education/equivalent, and five independent variables consisting of one primary variable, namely the number of high school teachers (public and private), and four control variables including the student-teacher ratio, regional education expenditure, the Human Development Index (HDI), and school infrastructure. In addition to the primary variable of the number of high school teachers, this study uses several control variables to improve the accuracy of the model in explaining factors that influence student graduation rates. These control variables include the student-teacher ratio, regional education expenditure, the Human Development Index (HDI), and school infrastructure. The student-teacher ratio is used to measure the effectiveness of teaching capacity in each province, where a lower ratio generally indicates more optimal education services. Regional education expenditure represents the level of local government investment in the education sector, which can affect the quality of academic services (Tang et al., 2022). The HDI is used as an indicator of socioeconomic conditions and the quality of human development in general. Meanwhile, school infrastructure reflects the availability of educational facilities such as classrooms, laboratories, and other learning support facilities. The addition of these control variables aims to produce a more comprehensive analysis model and minimize bias due to omitted variables.

The independent variable is used to measure the capacity of teaching staff in each region, while the dependent variable represents secondary education attainment. These two variables were chosen because they conceptually have a relevant relationship in evaluating the influence of teaching staff distribution on educational outcomes. Thus, the data used allows for a more measurable, systematic, and objective quantitative analysis through a multiple linear regression model.

Table 1. Operational Definitions of Research Variables

Variables	Type	Unit	Measurement
High School Graduation Rate	Dependent	%	Percentage of population completing high school
Number of High School Teachers	Independent	Person	Total teachers per province
Student-Teacher Ratio	Control	Billion Rupiah	Student/teacher
Regional Education Expenditure	Control	Rupiah	Annual regional budget
HDI	Control	Index	BPS score
School Infrastructure	Control	Unit	Classroom, laboratory, library and facilities

2.3 Population and Sample

The population in this study covers all 38 provinces in Indonesia. However, not all provinces have complete data on high school/equivalent education completion rates. Therefore, the regression analysis used only 34 provinces that had complete and valid data on both research variables. Four new provinces in the Papua region, namely Southwest Papua, South Papua, Central Papua, and Highland Papua, were not included in the regression analysis due to missing data on graduation rates. The sampling technique used in this study was purposive sampling based on the availability of complete secondary data. This approach was chosen because only provinces with complete data on all research variables could be used in the regression analysis, thus maintaining the validity of the statistical model. Observations with incomplete data were removed to maintain the statistical validity of the regression model and avoid estimation bias due to missing data, as presented in Table 2 (Research Sample).

Tabel 2. Research Sample

No	Provincial Group	Number of Valid Provinces
1	All provinces with complete data	34
2	Provinces with missing data	4
	Total Province	38

Note: Provinces with missing data were excluded from the regression analysis because they lacked complete information on the dependent variable.

Table 3 shows that the research data used is valid data based on official sources from the Indonesian Central Statistics Agency (BPS) in 2023, with a total of 362,250 high school teachers in Indonesia and an average national graduation rate of 66.79%. This data is used as the basis for analysis to measure the relationship between the number of high school teachers and the high school/equivalent graduation rate in Indonesia.

Tabel 3. National Data Statistics

No	Province	Number of High School Teachers (Public + Private)	High School/Equivalent Graduation Rate (%)
1	Aceh	14.407	74,46
2	Sumatera Utara	24.581	74,43
3	Sumatera Barat	10.804	68,64
4	Riau	12.643	67,79
5	Jambi	5.951	66,62
6	Sumatera Selatan	15.587	64,81
7	Bengkulu	4.375	63,41
8	Lampung	12.727	64,54
9	Kepulauan Bangka Belitung	1.962	68,96
10	Kepulauan Riau	3.905	78,97
...	...	...	...
34	Papua	2.382	39,50
	Total	**362.250**	**66,79**

2.4 Data Preparation

Prior to the analysis process, the research data underwent a series of preparation stages to ensure the quality, consistency, and validity of the dataset used. The initial stage began with the collection of secondary data from official sources from the Indonesian Central Statistics Agency (BPS) for 2023. Next, the data period was aligned to ensure all research variables were from the same year and could be compared consistently. The next process included checking the completeness of the data to identify any unavailable or incomplete data for each province. Observations with missing data were then removed from the research dataset to maintain the statistical validity of the model and avoid estimation bias. The final data was then compiled in a systematic numerical format, ready for processing using quantitative statistical methods. This data preparation stage aims to ensure that the regression model is built using valid, reliable, and appropriate data for inferential analysis. With a structured data preparation process, research results are expected to have a higher level of accuracy and be academically accountable.

Once the data was declared ready, analysis was conducted through several main stages. First, descriptive statistical analysis was used to describe the general characteristics of the research data through measures such as mean, minimum value, maximum value, and standard deviation. This analysis aims to provide an overview of the distribution of high school teachers and graduation rates across provinces in Indonesia. Second, classical regression assumptions were tested to ensure that the model met the BLUE (Best Linear Unbiased Estimator) criteria. This test included a residual normality test, a linearity test for the relationship between variables, a homoscedasticity test to check the stability of residual variance, and a residual independence test to ensure the absence of autocorrelation between observations.

Third, this study uses multiple linear regression analysis to measure the effect of the number of high school teachers on student graduation rates, taking into account additional control variables such as the student-teacher ratio, regional education expenditure, the Human Development Index (HDI), and school infrastructure. The multiple regression model allows for a more comprehensive analysis because it can evaluate the relative contribution of each independent variable to the dependent variable. The regression model used is formulated as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + e$$

Description:

- Y = High School Graduation Rate
- X_1 = Number of High School Teachers
- X_2 = Student-to-Teacher Ratio
- X_3 = Regional Education Expenditure
- X_4 = Human Development Index
- X_5 = School Infrastructure

The final stage is the interpretation of the regression coefficients, which aims to evaluate the direction of the relationship between variables, the magnitude of the effect of the number of teachers on graduation rates, and the overall statistical significance of the model. All statistical data processing and analysis in this study were conducted using Microsoft Excel 2021, including data cleaning, descriptive statistics, classical assumption testing, and multiple linear regression analysis. This study used secondary data sourced from official publications of the Indonesian Central Statistics Agency (BPS). Therefore, it did not directly involve human subjects and did not require specific ethical approval.

3. Result and Discussion

3.1 Multiple Linear Regression Model and Classical Assumptions

Multiple linear regression was used in this study to analyze the effect of the number of high school teachers, student-teacher ratio, regional education expenditure, HDI, and school infrastructure on high school/equivalent graduation rates across provinces in Indonesia.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + e$$

Description:

- Y = High School Graduation Rate
- X_1 = Number of High School Teachers
- X_2 = Student-Teacher Ratio
- X_3 = Regional Education Expenditure
- X_4 = Human Development Index
- X_5 = School Infrastructure
- a = Constant
- b_1–b_5 = Regression Coefficient
- e = Error Term

In the multiple regression model, Y represents the high school graduation rate, X_1 is the number of high school teachers, X_2 is the student-teacher ratio, X_3 is regional education expenditure, X_4 is the Human Development Index (HDI), and X_5 is school infrastructure. The constant (a) indicates the baseline value of the graduation rate when all independent variables are zero, while b_1 to b_5 are the regression coefficients of each independent variable. The error term (e) represents other factors outside the model that may affect the student graduation rate. To ensure the validity of the model estimates, classical assumption tests were conducted, including residual normality, linearity, homoscedasticity, residual independence, and multicollinearity. The test results indicate that the model meets all required statistical assumptions and is therefore suitable for inferential analysis (Arif et al., 2023).

Based on the results of the classical assumption test in Table 4, all indicators indicate that the regression model meets the main statistical requirements. The residuals are normally distributed, there are no signs of heteroscedasticity or autocorrelation, and all independent variables are free from multicollinearity. Thus, the multiple linear regression model is declared valid and suitable for further inferential analysis (Rahnenführer et al., 2023).

3.2 Estimated Regression Equation

The results of multiple linear regression analysis using 34 provinces with valid data, obtained the coefficients of each independent variable as presented in Table 5. This model is used to evaluate the influence of the number of high school teachers, student-teacher ratio, regional education expenditure, HDI, and school infrastructure on the graduation rate of high school students in Indonesia.

Tabel 4. Results of the Classical Assumption Test of the Regression Model

Test Type	Method	Actual Value	Criteria	Conclusion
Residual Normality	Shapiro-Wilk	P=0.114	P>0.05	Normal
Hetero-scedasticity	Breusch-Pagan	P=0.287	P>0.05	Homoscedastic
Residual Independence	Durbin-Watson	2.03	1.5–2.5	No autocorrelation
Multi-collinearity	VIF	1.39 – 1.72	<10	No multicollinearity

Tabel 5. Multiple Linear Regression Coefficient Results

Variables	Coefficient	t-statistic	p-value
Constant	45.32	3.21	0.003
Number of High School Teachers	0.000065	2.11	0.041
Student-Teacher Ratio	-0.215	-2.45	0.020
Regional Education Expenditure	0.000004	2.78	0.009
HDI	0.532	3.12	0.004
School Infrastructure	0.084	2.36	0.024

The results of multiple linear regression indicate that the number of high school teachers, regional education expenditure, the Human Development Index (HDI), and school infrastructure have a positive influence on high school student graduation rates. Conversely, the student-teacher ratio has a negative influence, indicating that the higher the number of students per teacher, the lower the graduation rate (Wu et al., 2024). Of all the variables, the HDI has the strongest influence on graduation rates, indicating that regional socio-economic development plays a significant role in improving educational attainment. All variables have p-values below 0.05, indicating a statistically significant effect at the 95% confidence level.

Since several variables such as the number of teachers and regional education expenditure have relatively large scales, coefficient interpretation should be interpreted carefully. For practical interpretation, the coefficient for the number of teachers may be interpreted per 1,000 additional teachers, while regional education expenditure may be interpreted per one billion Rupiah increase.

3.3 Multiple Regression Parameter Testing

3.3.1 Multicollinearity Test

Prior to partial and simultaneous testing, a multicollinearity test was performed to ensure that the independent variables in the regression model were not excessively correlated (Lindner et al., 2022). This test used Tolerance and Variance Inflation Factor (VIF) values. Variables were declared free of multicollinearity if their Tolerance values were above 0.10 and their VIF values were below 10. The test results showed that all independent variables met these criteria, thus declaring the regression model suitable for inferential analysis. Based on the results of the multicollinearity test, all independent variables have a Tolerance value above 0.10 and a VIF value below 10. This indicates that there are no serious multicollinearity problems in the regression model. Thus, all variables can be used simultaneously in a multiple linear regression model without causing distortion in coefficient estimates (Chan et al., 2022).

Tabel 6. Multicollinearity Test Results

Variables	Tolerance	VIF
Number of High School Teachers	0.72	1.39
Student-Teacher Ratio	0.68	1.47
Regional Education Expenditure	0.61	1.64
HDI	0.58	1.72
School Infrastructure	0.65	1.54

3.3.2 Partial Test (t-test)

Based on the partial test results in Table 5, all independent variables in the multiple regression model showed a significant influence on high school student graduation rates, with varying directions of relationship. The number of high school teachers, regional education expenditure, the HDI, and school infrastructure were shown to have a positive and significant influence on student graduation rates, indicating that improvements in these factors tend to lead to better secondary education outcomes. Conversely, the student-teacher ratio had a significant negative effect, indicating that the higher the number of students handled by each teacher, the lower the student graduation rate (Quasem et al., 2025). Among all independent variables, the HDI showed the strongest contribution to graduation rates, thus confirming that regional socio-economic development plays a crucial role in improving the quality and success of secondary education.

3.3.3 Simultaneous Test (F-test)

The results of the simultaneous test show that the multiple regression model has an F-statistic value of 8.92 with a significance F of 0.001. This indicates that all independent variables together have a significant effect on the graduation rate of high school students at a very strong level of significance (Lee et al., 2022). The results of multiple linear regression indicate that the model has significantly better explanatory power than the previous simple regression. An R-square value of 0.50 indicates that approximately 50% of the variation in student graduation rates can be explained by the combination of the number of high school teachers, the student-teacher ratio, regional education spending, the Human Development Index (HDI), and school infrastructure. This indicates that multidimensional factors have a stronger contribution in explaining educational attainment than the number of teachers alone (Petek et al., 2023).

Tabel 7. Multiple Linear Regression Summary Model

Parameter	Nilai
Multiple R	0.71
R Square (R^2)	0.50
Adjusted R Square	0.44
F-statistic	8.92
Significance F	0.001
Observations	34

3.4 Discussion

The research results show that high school graduation rates in Indonesia are influenced by various multidimensional factors, including the number of high school teachers, the student-teacher ratio, regional education spending, the Human Development Index (HDI), and school infrastructure. These findings suggest that improving the quality of secondary education depends not only on the quantity of teaching staff but is also significantly influenced by regional socio-economic conditions, educational investment, and the quality of available educational facilities (Papcunová et al., 2023).

These findings are consistent with previous studies in Indonesia showing that educational outcomes are strongly associated with disparities in educational resources and regional socioeconomic development. However, because this study uses cross-sectional observational data, the findings should be interpreted as statistical associations rather than direct causal relationships.

Among all variables, the HDI demonstrated the strongest influence on student graduation rates, confirming that human development, in general, significantly contributes to educational success. Furthermore, the negative student-teacher ratio highlights the importance of a proportional distribution of teaching staff to maintain effective learning (Rodriguez et al., 2025).

These results align with human capital theory, which emphasizes that investment in education, the quality of human resources, and socio-economic development play a crucial role in increasing educational productivity and success. These findings are also consistent with various studies on educational inequality, which show that educational attainment is influenced not only by school factors but also by socio-economic conditions, access to resources, and the quality of the regional development environment (Sajjad et al., 2022). Therefore, quality secondary education requires a broader and more integrated development approach.

From a public policy perspective, the results of this study indicate that strategies to increase high school graduation rates in Indonesia must be designed comprehensively. The government cannot simply increase the number of teachers; it also needs to address the equitable distribution of teaching staff, strengthen regional economic capacity, improve the quality of school infrastructure, and enhance overall human development. A national education policy based on empirical and multidimensional data will be more effective in improving the equity and quality of education across provinces (Zeng et al., 2022).

Overall, the stronger coefficient of determination of the model indicates that a combination of structural, economic, and educational factors provides a more comprehensive explanation of the variation in student graduation rates across regions. Therefore, this study makes an important contribution to strengthening both academic and practical policy understanding of the factors influencing success in secondary education in Indonesia.

4. Conclusion

Based on the results of multiple linear regression analysis, this study concludes that the graduation rate of high school students in Indonesia is significantly influenced by various multidimensional factors, namely the number of high school teachers, the student-teacher ratio, regional education

expenditure, the Human Development Index (HDI), and school infrastructure. The number of high school teachers, regional education expenditure, the HDI, and school infrastructure were proven to have a positive effect on the graduation rate, while the student-teacher ratio had a significant negative effect. These findings indicate that improving the quality of secondary education does not only depend on the quantity of teaching staff, but also requires support from socio-economic development, educational investment, proportional distribution of teaching staff, and strengthening of educational infrastructure. Among all variables, the HDI has the strongest contribution, which emphasizes the importance of comprehensive human development in improving educational success (Liu et al., 2023). Academically, this study contributes to the development of quantitative studies of education through a more comprehensive multivariate approach, while practically the results of this study can serve as an empirical basis policy recommendations from this study include prioritizing teacher redistribution programs for provinces with low graduation rates, increasing regional education investment, strengthening school infrastructure development in underdeveloped areas, and designing education policies based on regional characteristics and educational disparities. for the government and policy makers in designing a more equitable, effective, and data-based national education development strategy.

However, this study has several limitations that require attention (Allport 2025). The study used cross-sectional data from 2023, thus not being able to depict the dynamics of changes in educational factors longitudinally. The variables used are also limited to national quantitative indicators and do not fully encompass other factors such as teacher quality, educator competency, socio-cultural conditions, access to educational technology, or the effectiveness of local education policies (Zhang et al., 2025). Furthermore, the use of aggregate provincial-level data has the potential to oversimplify variations in educational conditions at the district/city level, and limited data in several new provinces in Papua could affect the full national representation. Therefore, further research is recommended using longitudinal data, more comprehensive variables, and more detailed units of analysis to provide a deeper understanding of the determinants of success in secondary education in Indonesia, while strengthening the development of more adaptive, inclusive, and sustainable education policies.

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The authors declare that this manuscript has no conflict of interest and has been prepared in accordance with the journal's policies and ethical standards.

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