



The Role of Human Capital in Regional Economic Growth: Evidence from Central Java- Indonesia

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Abstract

Human Capital is one of the most powerful support factors for economic performance of a region. Central Java is one of provinces in Indonesia that has high quality human resources with a high Human Development Index (HDI). Programs to improve the quality of human resources in Central Java province need to be encouraged to further support national growth and economic equality for all people. This study uses multiple linear regression using panel data to analyze the simultaneous relationship between several indicators of human capital to economic growth more comprehensively and measure the effect of each independent variable on district/city economic growth of 35 cities and regencies in Central Java Province during 2011 - 2024 period. These findings robustly support endogenous growth theory, that human capital indicators represented by education (expected years of schooling, education expenditure, and literacy) and health (health facilities and life expectancy) have a positive and significant effect on regional economic growth. These results highlight the pivotal role of human capital in enhancing GRDP per capita and support the endogenous growth theory, which emphasizes the importance of internal factors such as knowledge and health in sustaining long-term economic development. As such, regional development policies should prioritize strategic investments in education and healthcare to strengthen human capital and promote inclusive and sustainable growth.

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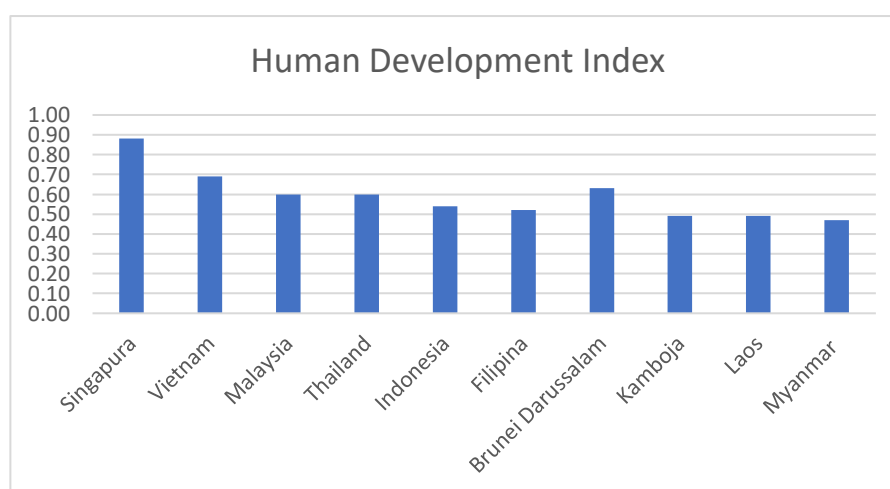
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INTRODUCTION

Economic growth is one indicators of a country's economic performance. Many factors influence the rate of economic growth, including natural resources, human resources, domestic government policies, and international policies. In modern economic theory, economic growth is no longer only determined by physical capital but is also strongly influenced by human capital. Human capital plays an important role in increasing productivity, innovation, and economic efficiency in various development sectors (Becker, 1993). Human capital is a critical driver of economic performance, influencing productivity, innovation, and overall economic growth. Numerous studies confirm a positive relationship between human capital and economic growth. Daňová & Širá (2023b) indicates a significant and positive correlation between Gross Domestic Product (GDP) per capita and workforce innovation and qualifications, where is indicates that higher levels of education and skills contribute to economic growth. Both developed and developing countries exhibit a long-term positive correlation between human capital and economic growth, the impact is stronger in advanced economies (Yilmazer & Çinar, 2015). The relationship between human capital and economic growth is weakly positive up to a certain threshold of governance quality (Apergis et al., 2022). In knowledge-based economies, human capital significantly enhances innovation, productivity, and competitive advantage, emphasizing the need for continuous investment in education and skill development (Hamed et al., 2024). Research by Ali et al. (2018) show that human capital positively impacts per capita GDP growth only in the presence of better economic opportunities and high-quality legal institutions.

The World Bank (2020) has introduced the Human Development Index (HDI) as a measuring tool in assessing the potential productivity of future generations based on investments in education and health. Based on the 2020 HDI report, Indonesia has a score of 0.54 which means in aggregate that a child born in Indonesia will only achieve 54% of his/her potential productivity as an adult under ideal education and health conditions. This score is still relatively low when compared to other ASEAN countries such as Singapore and Vietnam which have HDIs of 0.88 and 0.69 respectively as presented in Figure 1 below.

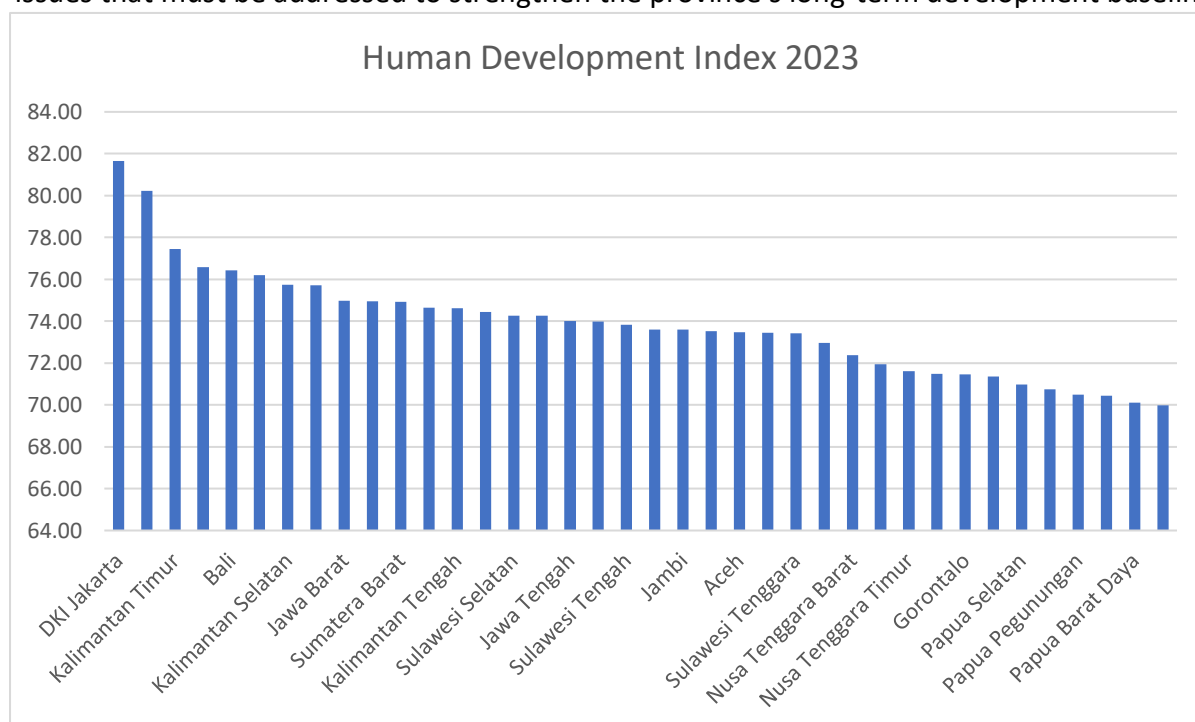


Source: World Bank (2020)

Figure 1. Human Development Index in ASEAN's countries

On the other hand, Indonesia faces the challenge of relatively low labour productivity. Based on the Asian Productivity Production (APO) report in 2022, Indonesia's labour productivity still lags-behind neighbouring countries such as Malaysia and Thailand. This shows that in addition to infrastructure development and fiscal policy, improving the quality of human capital is key to driving inclusive and sustainable economic growth. In Central Java Province, there are significant disparities in economic growth between districts/cities. Some regions experience stable and high growth, while others lag-behind. This reflects possible differences in the level of human capital development in each region. Average years of schooling, life expectancy, and public spending on education and health are important indicators to understand the extent to which investment in human capital contributes to regional economic performance (Todaro & Smith, 2015).

On national aggregate level, human capital development in Indonesia has shown significant progress in the last two decades. This is reflected in the increasing Human Development Index (HDI), which covers three main dimensions: longevity and healthy living, knowledge, and a decent standard of living. In 2023, Indonesia's HDI reached 74.39, categorized as “high” and reflecting a general trend of improving quality of life (BPS, 2023). However, these achievements have not been evenly distributed across regions. At the provincial level, Central Java shows positive developments but still has several challenges. Central Java's HDI in 2023 is 74.01, slightly below the national average and still lagging-behind provinces such as DKI Jakarta (81.65) and Yogyakarta (80.22). Inequalities between districts/cities in access to education, health facilities, and labour productivity are strategic issues that must be addressed to strengthen the province's long-term development baseline.



Source: Badan Pusat Statistik, BPS (2023)

Figure 2. Human Development Index in Indonesia's Provinces

Previous empirical research shows that investments in education and health can boost long-run economic growth, both at the national and regional levels (Lucas, 1988; Mankiw, Romer & Weil, 1992). As a result of studies by (Javeed et al., 2018a), education is widely recognized as the primary component of human capital. It promotes cognitive and non-cognitive skills, which are essential for productivity and economic growth. Investment in education leads to higher value-added creation, better job opportunities, higher wages, and overall economic development (Erjavec, 2020). Greater education levels strengthen worker skills and output, boosting overall productivity (Rossi, 2020) leading to improved economic performance (Morozova et al., 2024a). Education not only imparts cognitive skills but also develops non-cognitive skills such as emotional intelligence and personality traits, which are essential for overall productivity (Javeed et al., 2018b) which higher educational attainment is associated with higher earnings and better employment opportunities (Ismail & Awang, 2017). Study by Korres et al. (2021) shown that education enhances human capital, which in turn increases labor productivity, income, and overall economic growth. Further, higher education levels improve employment prospects and earning capacity, contributing to economic development (Guliyeva et al., 2023).

Health of human capital positively affects economic growth by increasing life expectancy, health expenditure, and technological progress, while reducing poverty, infant mortality, and fertility rates (Jayadevan, 2021). Improved health can enhance productivity and economic growth, particularly in countries that have achieved certain health benchmarks (Chakroun, 2024). Health improvements contribute to a more efficient labor force, which in turn boosts economic output (Demidova et al., 2023a). Empirical evidence supports a positive effect of population health on GDP per capita, although the magnitude and direction of this effect can vary based on demographic and economic contexts (Fumagalli et al., 2024). Connolly & Postma (2010) shown that investments in health services can lead to future tax revenues and sustained economic growth. Better health improves labor productivity, which is a key driver of economic growth, where maintaining productivity is crucial as the labor supply contracts (Demidova et al., 2023b). Health has a significant positive impact on economic growth in the short term, but its long-term influence can vary (Awad, 2021).

Based on previous studies, both education and health contribute to the overall productivity of the labor force. Higher human capital ensures higher progress and economic growth (Morales-Urrutia et al., 2023). Effective investment in human capital, including education and health, is essential for fostering economic development. Policymakers should focus on sustainable strategies that prioritize human capital development (Morozova et al., 2024b). However, these effects are dynamic and may vary across regions and over time. Therefore, the use of district/city panel data over the period 2011-2024 provides methodological advantages in observing spatial and temporal variations simultaneously. Using panel data-based multiple linear regression, this study aims to analyze the effect of human capital indicators on economic growth in Central Java Province. The results of this analysis are expected to provide a scientific basis for the formulation of development policies that focus

on improving the quality of human resources in-order-to create inclusive and equitable economic growth.

This study aims to analyze the role of human capital in regional economic growth in Central Java, Indonesia, focusing on two main aspects: education (covering average years of schooling, education budget, and literacy rate) and health (covering health facilities and life expectancy). Through panel data analysis for the period 2011-2024 using multiple linear regression, this study seeks to measure the effect of each human capital indicator on GRDP per capita at the district/city level, test the relevance of endogenous growth theory in the context of regional development in Indonesia, and provide evidence-based policy recommendations for strengthening human capital to promote inclusive and sustainable economic growth in Central Java. The results of this study are expected to contribute to the empirical literature on regional economic development as well as a reference for local governments in formulating effective human capital development strategies.

RESEARCH METHOD

This study uses a quantitative approach with explanatory research, which aims to analyze the effect of human capital on economic growth at the district/city level in Central Java Province. The analysis technique used is multiple linear regression with panel data from 2011 to 2024. Type of data used in this research are secondary data obtained from official agencies, including Badan Pusat Statistik (BPS) Central Java Province, Regional Development Planning Agency (Bappeda) Central Java Province, Official Local Government Central Java Publications. The model used in this study refers to [Daňová & Širá \(2023a\)](#) with modifications as shown in equations below:

$$GDPR_{it} = \beta_0 + \beta_1 AYOS_{it} + \beta_2 LIEX_{it} + \beta_3 LITE_{it} + \beta_4 FASC_{it} + \beta_5 FAHE_{it} + \beta_6 PROD_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (1)$$

$$\ln GDPR_{it} = \beta_0 + \beta_1 \ln AYOS_{it} + \beta_2 \ln LIEX_{it} + \beta_3 \ln LITE_{it} + \beta_4 \ln FASC_{it} + \beta_5 \ln FAHE_{it} + \beta_6 \ln PROD_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (2)$$

Description of Variables

$GDPR_{it}$	: Gross Domestic Product in province i in year t
$AYOS_{it}$	: Average Years of Schooling in province i in year t
$LIEX_{it}$	: Life Expectancy in province i in year t
$LITE_{it}$	: Literacy Rate in province i in year t
$FASC_{it}$	: Number of Health Facilities in province i in year t
$FAHE_{it}$	: Number of Schools in province i in year t
$PROD_{it}$	: Labor Productivity in province i in year t
μ_i	: Unobserved heterogeneity
λ_t	: Time effect
ϵ_{it}	: Error term

Table 1. Explanation of Variables Used in Model

Type of Variable	Name	Variable Definition	Hypothesis (Expected Sign)	Source of Data
Dependent	GDPR (Gross Domestic Product Regional)	Logarithm natural of gross domestic product regional of 35 districts in Central Java Province		Yearly Published Reports from Badan Pusat Statistik (BPS) Central Java province
Independent	Human Capital Index's Indicators			
	AYOS (Average Years of School)	Logarithm natural average years of school 35 districts in Central Java Province	lnAYOS (+)	Yearly Published Reports from Badan Pusat Statistik (BPS) Central Java province
	LIEX (Life Expectancy)	Logarithm natural of life expectancy 35 districts in Central Java Province	lnLIEX(+)	Yearly Published Reports from Badan Pusat Statistik (BPS) Central Java province
	LITE (Literacy)	Logarithm natural of literacy 35 districts in Central Java Province	lnLITE (+)	Yearly Published Reports from Badan Pusat Statistik (BPS) Central Java province
	FASC (Facility of School)	Logarithm natural number of school facilities 35 districts in Central Java Province	lnFASC(+)	Yearly Published Reports from Badan Pusat Statistik (BPS) Central Java province
	FAHE (Facility of Health)	Logarithm number of health facilities f 35 districts in Central Java Province	lnFAHE(+)	Yearly Published Reports from Badan Pusat Statistik (BPS) Central Java province
	PROD (Productivity)	Logarithm natural of productivity of 35 districts in Central Java Province	lnPROD(+)	Yearly Published Reports from Badan Pusat Statistik (BPS) Central Java province

Source: Author's estimation

This study's selection of human capital indicators is theoretically anchored in endogenous growth theory (Lucas, 1988; Romer, 1990) and human capital theory (Becker, 1964), which collectively posit that education and health investments constitute fundamental drivers of economic development. The inclusion of years of schooling and literacy rates reflects Lucas's emphasis on knowledge accumulation as the engine of growth, while life expectancy and health facilities operationalize in Grossman (1972) health capital model by measuring population health's impact on workforce productivity. School facilities capture the institutional dimension of human capital formation, consistent with Romer's focus on knowledge spillovers from quality education systems, and labor productivity serves as the critical nexus between human capital attributes and economic output, embodying Becker's

core proposition about skills-health-productivity linkages. These indicators were selected based on their strong theoretical foundations, empirical validity in development economics literature, policy relevance for regional planning, and practical measurability - providing a comprehensive framework that captures both stock (education and health levels) and flow (supporting infrastructure) dimensions of human capital's contribution to subnational economic growth, while maintaining analytical rigor and policy applicability for developing country contexts where human capital development remains central to sustainable growth strategies.

The steps involved in multiple linear regression in this study include several steps. The first step is the Chow Test to determine whether the regression will be conducted in the Common-Effect-Model or the Fix-Effect-Model. The next step is the Hausman Test to determine whether the Random-Effect-Model is compared to the Fix-Effect-Model. After these steps are taken, a classical assumption test is required to ensure the validity and reliability of the model estimation results. Classical assumptions are conditions that must be met in order for the regression parameter estimator to be BLUE (Best Linear Unbiased Estimator), in accordance with the Gauss-Markov Theorem (Wooldridge, 2016).

Uji Chow

The Chow test is used to test whether the FEM model is statistically better than the CEM model. The null hypothesis (H_0) states that the CEM model is more appropriate, while the alternative hypothesis (H_1) states that the FEM model is more appropriate. If the Chow test results show a significance value of less than 0.05, the null hypothesis is rejected, so the FEM model is more appropriate. However, if the significance value is more than 0.05, then the CEM model is considered sufficient and simpler to use (Gujarati & Porter, 2009). In this chow test, the hypothesis used is:

H_0 : Common Effect model is better (no need for fixed effects)

H_1 : Fixed Effect model is better (significant fixed effects)

To calculate the Residual Sum of Squares (RSS) of the CEM Model (RSS_{pooled}) and FEM Model (RSS_{fixed}), the F-statistic formula in equation 3 is used as follows:

$$F = \frac{(RSS_{pooled}) - (RSS_{fixed}) / (N-1)}{RSS_{fixed} / (N \times T - N - k)} \quad (3)$$

Where:

N : number of individu (unit)

T : time-period (year)

k : number of dependent variables

After obtaining the statistical value, the next step is to compare the calculated F value with the F table, or see the significance value, namely: If p-value < 0.05, then use FEM and if p-value > 0.05, then use CEM. The interpretation and decision of this Chow test are:

a. If H_0 is rejected: Fixed Effect model is more appropriate, so better using FEM

- b. If H_1 is accepted: no significant difference, better using CEM as simpler

Uji Hausman

To determine whether the most appropriate model to use is the Random Effect Model (REM) or the Fixed Effect Model (FEM), the Hausman test can be performed. The first step is to estimate the FEM model, which assumes that differences between individuals (cross-section units) are fixed and can affect the dependent variable. Then, the REM model is estimated, which assumes that differences between individuals are random and uncorrelated with the independent variables. After both models are estimated, the Hausman test is conducted to test whether there is a significant difference between the coefficient estimates of the FEM and REM models. The Hausman test statistic used is the chi-square statistical test with as many free degrees as the number of independent variables referring to Gujarati & Porter (2009) in equation 4 as follows:

$$H = (\beta^{FE} - \beta^{RE})' [Var(\beta^{FE}) - Var(\beta^{RE})] - 1(\beta^{FE} - \beta^{RE}) \quad (4)$$

After obtaining the test statistical value with the critical value, the next step is to compare the statistical value with the critical value according to the decision-making criteria. If the p-value $< \alpha$ (usually 0.05), then reject H_0 so the decision is to use the fixed effect. Meanwhile, if the p-value $\geq \alpha$ then the decision is to use random effects.

H_0 : RE model is more appropriate (no correlation between individual effects and independent variables)

H_1 : FE model is more appropriate (there is correlation)

RESULT AND DISCUSSION

Based on the results of Chow test and Hausman test, the model in this study is more appropriate to use Fixed-Effect Model (FEM). The results of the classical assumption test which includes multicollinearity test and heteroscedasticity test can be seen in Figures 3 and 4. The multicollinearity test results show that all independent variables in the model have a Tolerance value above 0.1 and a Variance Inflation Factor (VIF) value below 10. In general, this indicates that there is no serious multicollinearity problem among the independent variables in the regression model. A low VIF value implies that there is no strong linear relationship between the independent variables, so that the estimated regression coefficients can be interpreted individually without distortion due to correlation between variables. Thus, the regression model used has met the multicollinearity-free assumption and is suitable for use in further analysis.

Results of the heteroscedasticity test show that the regression model has an indication that the error variance is not constant (heteroscedasticity). However, to overcome this problem, regression has been performed using robust standard errors. This approach aims to produce more accurate and unbiased standard error estimates even though the assumption

of homoscedasticity is not met. Thus, the significance test of the regression coefficients can still be interpreted validly. Therefore, despite indications of heteroscedasticity, the use of robust standard errors ensures that the estimation results remain reliable and can be used for scientific inference.

```
. correlate lnayos lnliex lnlite lnfasc lnfahe lnprod
(obs=490)
```

	lnayos	lnliex	lnlite	lnfasc	lnfahe	lnprod
lnayos	1.0000					
lnliex	0.6661	1.0000				
lnlite	0.5867	0.3058	1.0000			
lnfasc	-0.5845	-0.2240	-0.3119	1.0000		
lnfahe	-0.5099	-0.1617	-0.3405	0.9515	1.0000	
lnprod	0.7328	0.3915	0.3648	-0.8852	-0.8483	1.0000

Source: Author's estimation with STATA

Figure 3. Result of Multikolinearitas Test

```
. hettest
```

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of lngdpr

chi2(1)	=	26.57
Prob > chi2	=	0.0000

Source: Author's estimation with STATA

Figure 4. Result of Heteroskedastisitas Test

The results of estimating multiple linear regression models with a fixed effect approach, it was found that the human capital variable (which is part of the Human Development Index) has a significant influence on economic growth in 35 districts / cities in Central Java during the observation period (2011-2024) as shown in Figure 5 as follows.

The independent variables in the model are part of the HDI which is represented through investment in the Education and Health sectors. Education variables included in the model are average years of schooling, literacy rate, and number of schools. Meanwhile, the health sector is represented by life expectancy and the number of health facilities. The average year of schooling shows how long the population of a region takes in formal education (without repeating), literacy shows the level of literacy, and the number of schools shows the number of school facilities ranging from elementary schools and/or equivalent, junior high schools and/or equivalent, senior high schools and/or equivalent, and universities/colleges. Meanwhile, the health sector in the model is represented by life expectancy and the number of health facilities. Life expectancy represents how long the average population lives in a region. The number of health facilities refers to the number of public hospitals, private hospitals, health centers, and other health facilities. The productivity variable represents the efficiency of labor in a region. Result of regression can be seen in Table 2.

Fixed-effects (within) regression				Number of obs	=	490
Group variable: id				Number of groups	=	35
R-sq:				Obs per group:		
within = 0.9298				min	=	14
between = 0.5249				avg	=	14.0
overall = 0.5471				max	=	14
corr(u_i, Xb) = -0.4957				F(6,449)	=	991.08
				Prob > F	=	0.0000
lngdpr	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
lnayos	1.418863	.0712959	19.90	0.000	1.278748	1.558978
lnliex	.6587673	.1554975	4.24	0.000	.3531739	.9643606
lnlite	.7907719	.17069	4.63	0.000	.4553214	1.126222
lnfasc	.2410618	.0788929	3.06	0.002	.0860167	.396107
lnfahe	1.592109	.1653765	9.63	0.000	1.267101	1.917117
lnprod	.4950433	.0303721	16.30	0.000	.4353543	.5547323
_cons	-7.253203	1.477045	-4.91	0.000	-10.15598	-4.350424
sigma_u	.50962827					
sigma_e	.04985581					
rho	.99052045	(fraction of variance due to u_i)				
F test that all u_i=0: F(34, 449) = 907.22				Prob > F = 0.0000		

Figure 5. Fixed-Effects Regression

Table 2. Results of Regression

Model	Regression Coefficient	t	Sig
Constant	-7.25	-4.91	0.000
lnAYOS	1.42	19.90	0.000
lnLIEX	0.66	4.24	0.000
lnLITE	0.79	4.63	0.000
lnFASC	0.24	3.06	0.002
lnFAHE	1.59	9.63	0.000
lnPROD	0.50	16.30	0.000

Source: Author's estimation

Based on the estimation results of multiple linear regression models with fixed effects, it shows that the variables in the Human Development Index (HDI) have an influence on economic growth in Central Java province. The model has a very good level of explanation, indicated by the R-squared value (within) of 0.9298. This means that the variation in the logarithm of gross domestic regional population (*lngdpr*) can be explained by the independent variables in one region of Central Java Province over time. The R-squared between and overall values of 0.5249 and 0.5471 respectively indicate that the model is also quite capable of explaining differences between districts/cities in Central Java Province. Meanwhile, the F-test results show that the overall model is statistically significant at the 99% confidence level with a Prob> F = 0.0000 value, which indicates that the independent variables together have a significant effect on GRDP in Central Java Province. While individually, all

variables in the model show significant coefficients and have a positive direction of relationship to regional economic growth.

The results indicate particularly strong effects from education-related variables. Expected years of schooling (*lnayos*) shows the largest impact, with a 1% increase associated with a 1.42% rise in GRDP per capita ($p = 0.000$). While variable of literacy rates (*lnlite*) contribute a 0.79% increase in GRDP per capita for each 1% improvement. The presence of school facilities (*lnfac*), though having a more modest effect (0.24), remains statistically significant, highlighting the importance of educational infrastructure. These results are in line with research by [Kubík \(2015\)](#) that show education generally has a positive impact on economic growth and an additional year of schooling contributes positively to per capita output growth. In addition, previous research in China also shows that education has been shown to have significant effects on economic growth both in the short term and long term, emphasizing the importance of government investment in education to sustain economic growth ([Qi et al., 2022](#)). Good education, adequate literacy, availability of school facilities, will have a positive influence on economic growth will have a positive influence on economic growth. Education also improves the quality of workers and increases labor productivity, which in turn contributes to economic growth ([Wang & Xiao, 2017](#)). In other hands, the impact of education on economic growth can vary depending on the income level of a country. Education has a positive effect on growth only after a certain income threshold is reached, suggesting that the benefits of education are more pronounced in higher-income countries

Click or tap here to enter text.

Health indicators similarly demonstrate substantial economic impacts. Life expectancy (*lnliex*) shows a coefficient of 0.66, comparable to education expenditure, while health facilities (*lnfahe*) contribute a 1.59% increase in GRDP per capita ($p = 0.000$). These findings underscore the complementary relationship between health and education in driving economic growth. Additionally, labor productivity (*lnprod*) exhibits a positive coefficient of 0.50, confirming that human capital improvements translate into enhanced workforce efficiency. Results show that health positively impacts economic growth, in line with research by [Ridhwan et al. \(2022\)](#) states that health improvements lead to higher productivity, better educational outcomes, and increased labor force participation, which collectively boost economic growth. Improved health reduces mortality rates, increases life expectancy, and enhances caloric consumption, all of which contributes to economic growth ([Karimi et al., 2017](#)). Increased government expenditure on health positively impacts economic growth, particularly in low-income countries ([López-Casasnovas & Soley-Bori, 2014](#)), and investments in preventive care, access to quality medical services, and health education are crucial for enhancing human capital and promoting sustainable economic growth ([Jiang, 2021](#)). Policies should integrate health considerations into economic strategies to maximize the economic returns from improved health outcomes ([Jiang, 2021](#)).

From these results and reinforced by previous research we find that education and health facilities are very important in human development. The existence of adequate facilities provides wider opportunities for people to access education and health easily. These

facilities can be provided by the government or the private sector with the aim of ensuring the quality of life of the people in a particular area. Meanwhile, the constant value ($_cons$) of -7.2532 has mathematical significance in the model but is substantively irrelevant as there is no condition where all independent variables are zero. Overall, the regression results suggest that investment in human capital, particularly through education, health, and productivity improvement, are important factors in driving regional economic growth. The results of the analysis show that all human capital variables used in this study have a positive and significant influence on regional economic growth. Education (represented by expected years of schooling, education expenditure, and literacy) proved to be a very important factor in increasing GRDP per capita. Similarly, public health (as measured by health facilities and life expectancy) contributes significantly to economic growth. These results support the endogenous growth theory which states that improving the quality of human capital is a major factor in driving long-term economic growth. Therefore, investment in the education and health sectors should be prioritized in regional development policy.

CONCLUSION

The findings of this study confirm that human capital indicators represented by education (expected years of schooling, education expenditure, and literacy) and health (health facilities and life expectancy) have a positive and significant effect on regional economic growth. These results highlight the pivotal role of human capital in enhancing GRDP per capita and support the endogenous growth theory, which emphasizes the importance of internal factors such as knowledge and health in sustaining long-term economic development. As such, regional development policies should prioritize strategic investments in education and healthcare to strengthen human capital and promote inclusive and sustainable growth. Policymakers should allocate greater resources to expand access to quality education, where simultaneously improving healthcare infrastructure and services will enhance workforce productivity and life expectancy. Local governments should adopt integrated approaches that link education and health initiatives, such as digital literacy and school-based health programs or vocational training tied to regional industry needs. The use of a panel data model strengthens the robustness of the analysis, as it allows for the control of unobserved heterogeneity across provinces and captures temporal dynamics that influence economic growth over time. Overall, the results emphasize that policy efforts aimed at improving educational attainment and healthcare access are vital for fostering inclusive and sustainable regional economic development in Indonesia. For future research, studies could explore subregional disparities in human capital outcomes, examine the quality (rather than just quantity) of education and healthcare services, or investigate sector-specific impacts of human capital on local industries. Longitudinal analyses would also help assess the long-term effects of human capital investments on economic development. By combining evidence-based policymaking with further research, regions can better leverage human capital for sustainable and inclusive growth.

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