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Analysis of Determinants of the Human Development Index in Central Java: A Focus on Health, Education, Wages, and Unemployment

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A B S T R A C T

Main Purpose - This study aims to identify the determinants of the Human Development Index (HDI) in Central Java by examining the roles of outpatient health complaints, education, wages, and unemployment.
Method - This study employs a quantitative approach using balanced panel data from 35 cities in Central Java during 2017–2024, covering 280 observations. Panel data regression with the Fixed Effect Model (FEM) was applied based on Chow and Hausman tests.
Main Findings - Education and wages positively and significantly affect HDI by improving people's capabilities and economic well-being. In contrast, outpatient health complaints and unemployment negatively and significantly affect HDI because they reduce quality of life and productivity. These findings indicate that education, income, health, and employment are key factors influencing human development.
Theory and Practical - The findings support human capital theory, highlighting the importance of education, health, and employment in improving human development outcomes. Practically, local governments should strengthen policies in these sectors to enhance HDI and reduce regional disparities.
Novelty This study provides recent district/city-level empirical evidence using balanced panel data and FEM analysis in Central Java.

Keywords: education, fixed effect model, health, human development index, unemployment

1. INTRODUCTION

Human development is an important concept in development economics that emphasizes improving people's quality of life through health, education, and living standards. The Human Development Index (HDI), developed by the United Nations Development Programme (UNDP), is widely used to measure human development achievements and evaluate regional development performance (UNDP, 2020; UNDP, 2023). HDI is particularly relevant for regional policy analysis because it reflects disparities in welfare and access to public services across regions. In Central Java, although HDI has shown an increasing trend in recent years, significant disparities among districts and cities remain evident, especially between urban and rural areas. Differences in educational attainment, healthcare access, income levels, and employment opportunities indicate that human development outcomes are still uneven across the province. As one of the most populated provinces in Indonesia, Central Java represents an important case for investigating how socio-economic and structural factors influence HDI at the regional level.

HDI is considered a strategic indicator because it reflects the quality of human development more comprehensively than conventional economic indicators. In Central Java, although the provincial HDI has continued to increase, disparities among districts and cities remain significant (Harjanto et al., 2025; Windhani et al., 2023). For example, urban areas such as Semarang City and Salatiga consistently record higher HDI levels compared to several rural districts, indicating unequal access to education, healthcare, income opportunities, and public services (BPS, 2024). These disparities suggest that the benefits of development have not been distributed evenly across the province. Differences in educational attainment, health conditions, wage levels, and unemployment rates are therefore important factors that may explain variations in HDI among regions. As one of the most populated provinces in Indonesia, Central Java represents an important case for examining how socio-economic and structural factors contribute to regional human development disparities (Azis, 2025; Rahajeng et al., 2023).

Previous studies on HDI in Indonesia generally emphasize the roles of education, health, income, and employment in improving human development outcomes. Several studies found that education and income positively affect HDI, while unemployment tends to reduce human development performance (Annastasya et al., 2025; Gradín et al., 2021; Uddin et al., 2023). However, previous research mostly focuses on provincial-level analysis and often examines these variables separately, resulting in limited understanding of how socio-economic and structural factors simultaneously influence HDI at the district level. In addition, disparities in healthcare access, education quality, wages, and employment opportunities across regions remain insufficiently explored, particularly in Central Java.

Health and education are important determinants of HDI because they influence the quality of human capital and people's productivity. Better healthcare services improve individuals' ability to work and participate in economic activities, while education increases

skills, knowledge, and employment opportunities. However, several districts in Central Java still face limited healthcare access, unequal educational quality, and relatively high unemployment rates. Economic factors such as wages also influence people's ability to access education and healthcare services. Theoretically, these factors are interconnected because improvements in health and education tend to increase productivity, income, and employment opportunities, which ultimately contribute to higher HDI achievement (Kula et al., 2025).

Although the government has implemented various programs to improve the Human Development Index (HDI), such as healthcare expansion, compulsory education policies, and employment programs, the outcomes have not yet been fully optimal. Previous studies have examined the determinants of HDI using various approaches; however, several research gaps remain (Chalernphon, 2021; Hussien et al., 2025; Soretz et al., 2025). Existing studies often report inconsistent findings regarding the effects of socioeconomic factors on HDI, while most studies rely on cross-sectional or time-series methods that are limited in capturing both spatial and temporal dynamics simultaneously. In addition, contextual differences across regions may lead to variations in the relationship between health, education, wages, unemployment, and HDI. Therefore, this study adopts a panel data approach to address these gaps and provide a more comprehensive understanding of HDI determinants. This study aims to examine and quantify the effects of health, education, wages, and unemployment on the Human Development Index across districts/cities in Central Java Province during the period 2017-2024. The findings are expected to provide stronger empirical evidence and contribute to the formulation of effective, targeted, and sustainable development policies aimed at improving human development quality.

2. RESEARCH METHODS

This study employs a quantitative research framework to examine the factors influencing the Human Development Index (HDI) in Central Java Province, using balanced panel data spanning 35 regencies and cities from 2017 to 2024. Secondary data were collected from official sources, primarily Statistics Indonesia (BPS), and verified for consistency and completeness across years and regions. HDI is treated as the dependent variable, while the independent variables include outpatient health complaints (KKBJ) as a proxy for health conditions, Expected Years of Schooling (HLS) for educational attainment, Minimum Wage (UMK) as a measure of income conditions, and the Open Unemployment Rate (TPT) to capture labor market dynamics. This approach allows for the quantification of the relative contribution of health, education, income, and employment factors to HDI variations, providing empirical insights to guide policymakers in designing effective strategies for regional human development.

Panel data regression is employed as the main analytical technique in this study because it allows the use of regional observations across several years within a single

estimation framework. To obtain the most suitable specification, three alternative models are evaluated: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). The selection procedure begins with the Chow test, which assesses whether CEM or FEM is more appropriate. Subsequently, the Hausman test is used to choose between FEM and REM. All decisions regarding model selection are made at a 5 percent level of significance.

Before testing the research hypotheses, the regression model is evaluated through several diagnostic procedures. Normality assessment is conducted on the model residuals for descriptive and diagnostic purposes rather than as a strict requirement for obtaining unbiased estimators in panel data regression. Residual normality is reviewed using skewness and kurtosis statistics, while potential heteroskedasticity is examined using the Breusch Pagan test, and multicollinearity among the explanatory variables is assessed through the Variance Inflation Factor (VIF). After these diagnostic procedures are completed, the analysis proceeds with the t-test to evaluate the individual effect of each independent variable, the F-test to assess their simultaneous influence, and the coefficient of determination (R^2) to indicate the extent to which the model explains variations in the dependent variable. The panel regression model used in this study is formulated as follows:

$$HDI_{it} = \alpha_i + \beta_1 KKBJ_{it} + \beta_2 \log(HLS_{it}) + \beta_3 \log(UMK_{it}) + \beta_4 TPT_{it} + \varepsilon_{it}$$

The Human Development Index (HDI) is modeled as the dependent variable, with outpatient health complaints (KKBJ), Expected Years of Schooling (HLS), Minimum Wage (UMK), and Open Unemployment Rate (TPT) included as independent variables. The subscript *i* identifies districts or cities in Central Java, and *t* corresponds to the observation period from 2017 to 2024, while ε denotes the error term. All selected variables are transformed using natural logarithms to improve data normality and allow interpretation in terms of elasticity, facilitating a consistent evaluation of the relative impact of health, education, income, and labor market conditions on regional HDI variations.

3. RESULT AND DISCUSSION

The study analyzed the determinants of the Human Development Index (HDI) across 35 districts and cities in Central Java from 2017 to 2024, focusing on health conditions, educational attainment, minimum wage levels, and unemployment. Descriptive statistics indicate that the average HDI was 72.89 with a standard deviation of 4.53, reflecting relatively homogeneous development across the region, with the lowest HDI observed in Brebes Regency (64.86 in 2017) and the highest in Salatiga City (85.72 in 2024). Health conditions, measured by the proportion of outpatient health complaints (KKBJ), averaged 46.74% and ranged from 22.41% to 100%, indicating uneven access to and utilization of healthcare services across districts. Education outcomes, proxied by expected years of schooling (log_HLS), were relatively consistent (mean 1.11, range 1.06–1.19), while minimum wage levels (log_UMK)

showed very little variation (mean 6.29, range 6.14–6.51), suggesting that regional differences in income were minimal. The open unemployment rate (TPT) averaged 5.05% with a range from 1.76% to 9.97%, highlighting localized labor market challenges. Panel regression using the Fixed Effect Model (FEM) reveals that all four independent variables significantly affect HDI. The regression equation is expressed as:

$$HDI_{it} = -69.716 - 0.0039\ KKBJ + 25.524 \log(HLS) + 18.397 \log(UMK) - 0.231\ TPT_{it} + \varepsilon_{it}$$

The negative coefficient for KKBJ indicates that higher health complaints slightly reduce HDI, emphasizing the importance of accessible and quality healthcare for enhancing human development. The positive coefficients for expected years of schooling and minimum wage suggest that improvements in education and income significantly contribute to HDI, supporting human capital development and economic well-being. Conversely, the negative coefficient for unemployment indicates that higher unemployment constrains HDI by limiting household income and access to essential services. The joint significance test shows that the explanatory variables collectively have a statistically significant influence on HDI. Furthermore, the model accounts for 93.53% of the variation in HDI, reflecting a strong explanatory capacity. This suggests that socioeconomic factors play an important role in explaining regional differences in human development outcomes across Central Java.

These findings highlight the intertwined roles of health, education, income, and labor market conditions in shaping regional human development. Education and wages emerge as key drivers, while health limitations and unemployment serve as constraints, suggesting that policy interventions must be holistic and cross-sectoral. Integrated strategies that simultaneously enhance educational access and quality, improve healthcare services, elevate income levels, and strengthen employment opportunities are likely to produce sustainable and equitable improvements in HDI across Central Java

The estimation results indicate that education and wages have positive and significant effects on the Human Development Index (HDI) in Central Java. This finding suggests that improvements in educational attainment and income levels are important drivers of human development. Education enhances human capital through increased knowledge, skills, and productivity, which subsequently improve employment opportunities and living standards. Likewise, higher wages increase people's purchasing power and their ability to access essential services such as education, healthcare, and adequate living conditions. Therefore, these variables play a strategic role in improving regional human development outcomes.

In contrast, the health variable proxied by outpatient health complaints (KKBJ) and the unemployment rate (TPT) show negative and significant effects on HDI. The negative coefficient of KKBJ indicates that increasing health complaints may reduce productivity and quality of life, thereby lowering human development performance. Similarly, higher unemployment rates reduce household income, increase economic vulnerability, and limit access to basic social services. In terms of coefficient interpretation, the education coefficient

(25.524) implies that a 1% increase in Expected Years of Schooling substantially increases HDI, while the wage coefficient (18.397) demonstrates that rising minimum wages positively contribute to improving welfare and living standards. Conversely, the coefficients of KKBJ (-0.0039) and unemployment (-0.231) indicate that worsening health conditions and higher unemployment reduce HDI levels.

Based on the model selection tests, the Fixed Effect Model (FEM) is considered the most appropriate model for this study. The Chow test and Hausman test results, both showing probabilities below 0.05, confirm that FEM is preferred over the Common Effect Model (CEM) and Random Effect Model (REM). The relevance of FEM lies in its ability to control for unobserved heterogeneity across districts and cities in Central Java, where each region possesses different socio-economic and institutional characteristics. By accounting for these regional-specific effects, FEM produces more robust and consistent estimates, enabling a more comprehensive explanation of HDI variations across regions and over time. The estimation results of the Fixed Effect Model (FEM) indicate that health, education, wages, and unemployment significantly influence the Human Development Index (HDI) in Central Java. However, these findings not only confirm statistical relationships but also reveal structural dynamics in human development that remain insufficiently inclusive.

The negative and significant effect of health suggests that the health complaint indicator may reflect persistent limitations in healthcare access and service quality across districts and cities in Central Java. This finding indicates that a higher prevalence of health complaints tends to be associated with lower human development outcomes, as poor health conditions can reduce productivity, limit educational participation, and weaken individuals' capacity to engage in economic activities. In the context of Central Java, disparities in healthcare facilities, medical personnel distribution, and access to health services between urban and non-urban areas may contribute to differences in HDI performance. This finding is consistent with the argument Romadhani and Anwar (2025), who emphasized that health is a fundamental component of human productivity and an essential dimension of development. Recent empirical studies also support this relationship by showing that improved health conditions and broader access to healthcare services contribute positively to human development outcomes. Therefore, health policies should focus not only on improving service quality but also on expanding equitable access and strengthening preventive healthcare approaches across regions.

Meanwhile, education has the most dominant positive effect on HDI, highlighting the importance of investment in human capital. However, improvements in expected years of schooling do not necessarily guarantee better education quality. The key challenge lies in the mismatch between educational outcomes and labor market needs. This finding aligns with human capital theory, in which Singh et al. (2025) emphasized that education should not merely increase years of schooling but also enhance productive skills and human capabilities.

Recent empirical evidence also supports this relationship. Kafando et al. (2022) found that educational indicators significantly contribute to improvements in human development outcomes, as better educational attainment strengthens human capital quality, productivity, and employment opportunities. In addition, human capital development has been shown to improve socioeconomic welfare through higher income and broader access to economic opportunities. In the context of Central Java, differences in educational quality and unequal access to skill oriented education across districts and cities may explain variations in HDI performance. Therefore, education policies should focus not only on expanding educational attainment but also on improving education quality, strengthening curriculum relevance, and enhancing linkages between educational institutions and labor market demands.

The positive and significant effect of wages indicates that increased income directly contributes to higher living standards. However, the reliance of HDI on wage levels also reflects disparities in income distribution across regions. According to Badan Pusat Statistik (2024), wage inequality remains a major issue in regional development. Therefore, minimum wage policies should be complemented by efforts to enhance labor productivity and promote more balanced economic growth. On the other hand, the negative and significant effect of unemployment suggests that the labor market remains a key constraint in human development. High unemployment not only reduces income but also limits access to education and healthcare. This is consistent with the view of Budhijana (2019) who argues that unemployment directly affects welfare and quality of life. Accordingly, policies should focus on job creation, skills development, and reducing skill mismatch.

Furthermore, the findings of this study also indicate limitations in development approaches that remain sectoral in nature and are not yet fully integrated. Although education and wages have been proven to be the primary drivers of HDI improvement, their effectiveness can be diminished if not balanced by improvements in the health sector and the labor market. This points to a policy gap, where policy interventions have not yet been able to create optimal synergy across sectors. From a human development perspective, the United Nations Development Programme emphasizes that effective development must be holistic and sustainable, integrating health, education, and economic dimensions simultaneously. Therefore, local governments need to adopt a cross-sectoral policy approach, strengthen coordination among institutions, and ensure that the policies adopted are not implemented in isolation but rather support one another in improving the overall quality of life for the community. Overall, the findings indicate that human development in Central Java is still constrained by multidimensional factors. Education and wages act as driving forces, while health and unemployment serve as limiting factors. Therefore, development policies must be integrated, focusing on improving the quality of basic services, strengthening competency-based education systems, and fostering an inclusive and sustainable labor market.

4. CONCLUSION

This study concludes that health, education, wages, and unemployment significantly influence the Human Development Index (HDI) in Central Java, as evidenced by the panel data analysis of 35 regencies and cities during 2017–2024 using the Fixed Effect Model (FEM), which is appropriate for capturing unobserved regional heterogeneity. The findings support the proposed hypotheses by showing that education and wages have positive effects on HDI, with education emerging as the strongest determinant, while health complaints and unemployment negatively affect HDI. These results indicate that human development in Central Java is strongly shaped by the quality of human capital, regional economic capacity, health conditions, and labor market opportunities. The study provides new empirical evidence that socioeconomic determinants of HDI may differ across regions and over time, thereby enriching the literature on human development and regional economics in Indonesia. From a policy perspective, the findings imply that provincial and local governments should prioritize education improvement, wage enhancement, healthcare accessibility, and unemployment reduction in designing regional development strategies. For educational institutions and labor market agencies, the results highlight the need to strengthen skill-based learning, improve workforce readiness, and align education outcomes with labor market demands. For society, better access to quality education, decent employment, and health services may contribute to more inclusive and sustainable improvements in welfare. For firms and institutions, the findings suggest the importance of supporting productivity improvement, employment creation, and human resource development as part of regional development efforts. However, this study is limited to Central Java Province and selected socioeconomic indicators, so the findings may not be fully generalizable to other regions. Future studies are encouraged to include broader variables such as poverty, government expenditure, infrastructure, institutional quality, and environmental factors, as well as apply dynamic panel data or spatial econometric approaches to provide deeper insights into human development dynamics in Indonesia.

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