

INDONESIAN WELFARE: THE INFLUENCE OF EMISSIONS, EDUCATION, AND GDP PER CAPITA GROWTH

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Abstract

The growth of the Human Development Index in Indonesia from 1998 to 2022 has slowed down, indicating a slowdown in economic performance. This study aims to determine the influence of independent variables consisting of carbon dioxide emissions, female labor force, and gross domestic product per capita growth on the dependent variable of the human development index. A quantitative approach was employed using multiple linear regression analysis. The results of this study indicate that, partially, carbon dioxide emissions have a negative and significant effect on the Human Development Index, female labor force has a positive and significant effect on the Human Development Index, while GDP per capita growth does not affect the Human Development Index. The independent variables of carbon dioxide emissions, female labor force, and GDP per capita growth collectively influence the human development index.

Keywords: HDI, Health, Education, Economy, Emission

INTRODUCTION

Increasing productivity and expanding employment opportunities with the aim of raising the income level of the community through structural changes is referred to as economic development (Mahroji & Nurkhasanah, 2019). The basic objectives of economic development include improving the standard of living of the community and bringing prosperity and welfare to all levels of society (Ramdani et al., 2021). Improvements in quality of life can occur when there is purchasing power. The fulfillment of purchasing power leads to poverty alleviation and welfare (Rahajuni et al., 2021). Welfare can be achieved if the development process of a nation targets humans as the ultimate goal of development. Individual welfare can be achieved through improvements in access to education, fairer income distribution, and reduced environmental degradation (Tarumingkeng, 2024). The Harrod-Domar theory states that an increasing population will not reduce per capita income as long as physical capital increases (Mulyadi, 2017).

Kuncoro, (2010) states that a country that does not have abundant natural resources but implements a development paradigm that focuses on the human dimension will be able to continue to develop. Human development is defined as a process of expanding choices for society (United Nations Development Programme, 2016). Indicators to measure the level of human development can be measured using the Human Development Index (HDI). The Human Development Index is defined as a measure of the level of human development, which can also explain how people are able to access the results of development in terms of education, health, income, and other aspects (BPS, 2020). The Human Development Index (HDI) provides a more holistic picture of social welfare than conventional economic growth metrics (Akpola & Bakirtaş, 2024). This index is measured using three approaches, namely longevity and health, knowledge, and decent living standards (BPS, 2020).

Indonesia, as a developing country, always strives to implement inclusive development. If the development process in Indonesia takes into account the HDI, then the government must play a role in the dimensions of health, education, and the economy in order to achieve welfare. High and sustainable growth is the focus of government policy in developing countries, including Indonesia

(Gunawan & Gunawan, 2007). Indonesia's HDI has increased overall from 1998 to 2022. Indonesia's HDI in 2022 was 71.3, indicating that Indonesia's HDI is in the high category. However, the growth rate of Indonesia's HDI has fluctuated with a declining trend. The following figure shows the growth of the Human Development Index in Indonesia from 1999 to 2022.

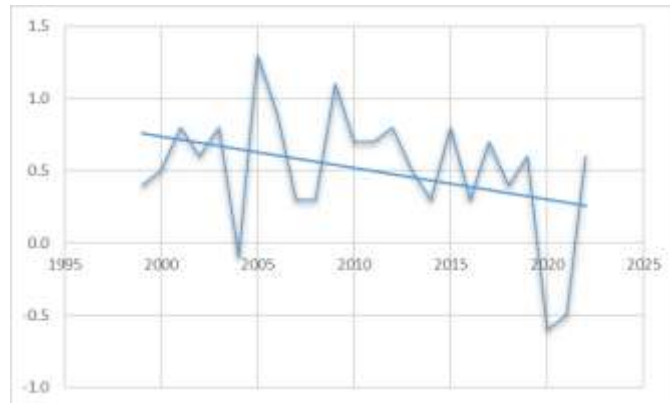


Figure 1. Growth of the Human Development Index in Indonesia from 1999 to 2022

Source: United Nations Development Programme, 2024

The growth of the Human Development Index (HDI) from 1999 to 2022 has experienced fluctuations with a downward trend. This downward trend in HDI growth also indicates that the HDI in Indonesia is experiencing a slowdown in growth. The slowdown in HDI indicates that there is a slowdown in economic performance (Mustafa, 2020). The declining trend is not only observed in HDI growth but also in carbon dioxide (CO₂) emissions from fugitive emissions (energy), also known as Mt CO₂e. The annual carbon dioxide (CO₂) emissions, one of the six Kyoto greenhouse gases (GHGs), from undetected emissions (a subsector of the energy sector) such as petroleum refining, solid fuels, oil, and natural gas (World Bank Group, 2023). Carbon dioxide (CO₂) emissions from fugitive energy emissions refer to the release of greenhouse gases that occur during the extraction, transportation, or use of fossil fuels, which are not fully controlled or measurable. These emissions include gas leaks from pipelines, storage facilities, or energy processing, such as natural gas. Mt CO₂e represents carbon dioxide emissions that are on a downward trend. The following figure shows the development of Mt CO₂e from 1998 to 2022.

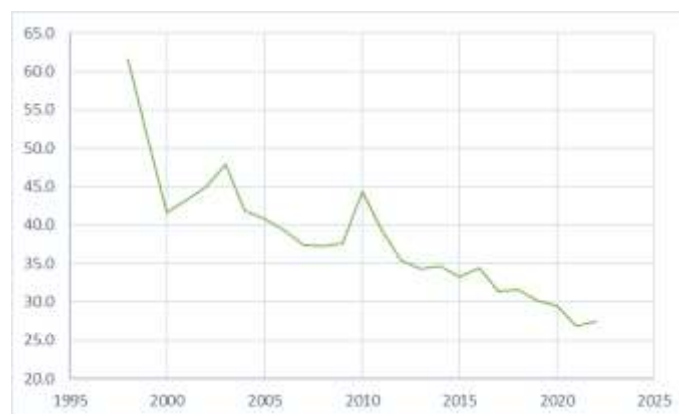


Figure 2. Development of Carbon Dioxide (CO₂) Emissions from Fugitive Emissions (Energy) in Indonesia, 1998-2022 (million tons)

Source: World Bank Group, (2023)

Mt CO₂e from 1998 to 2022 in Indonesia has decreased. In 1998, Mt CO₂e was 61.6 million tons and decreased to 27.5 million tons in 2022. However, when compared to HDI growth, this

decrease in Mt CO₂e actually coincided with a decline in HDI growth in Indonesia. Unlike other carbon dioxide emission measurements, Mt CO₂e represents carbon dioxide emissions that are on a downward trend, meaning that the amount of Mt CO₂e emissions is decreasing and can help reduce global warming. Governments worldwide have taken action to reduce carbon emissions, as carbon emissions have triggered global warming (Chen et al., 2020).

Global warming caused by carbon emissions is one of the most dangerous and complex issues threatening natural ecosystems and human survival and must therefore be addressed effectively (Lin & Ahmad, 2016). Low-carbon development is being achieved at the economic level but must also be expanded to the dimension of well-being (Li et al., 2022). Sustainable development emphasizes harmonious relationships between the social economy and the ecological environment, both at the national, regional, and global levels (Chen et al., 2024). The health dimension can be measured by carbon dioxide (CO₂) emissions from fugitive emissions (energy) or referred to as Mt CO₂e. The education dimension can be measured by the female labor force. Female labor force as a percentage of the total indicates the extent to which women are active in the labor force. The labor force includes people aged 15 years and older who provide labor for the production of goods and services during a specific period (World Bank Group, 2023). The following figure shows the percentage of the female labor force (FLF) out of the total labor force in Indonesia from 1998 to 2022.

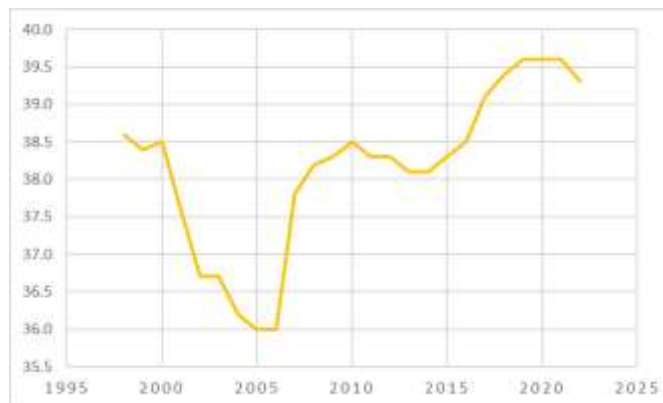


Figure 3. Female Labor Force in Indonesia, 1998-2022 (percent)

Source: World Bank Group, (2023)

The figure above shows that the percentage of female workers fluctuates. Overall, female workers increased from 1998 to 2022, reaching 39.3 percent in 2022. When more women work, this is usually preceded by increased access to and quality of education for women. Higher education for women has been shown to significantly increase their participation in the workforce, especially at the upper secondary and tertiary levels (Pratomo, 2017). As more women work, society tends to place greater value on the importance of education for girls, leading to increased investment in girls' education.

Working women tend to have their own income, which can be used to improve family welfare, including investing in their children's education (Yansyah et al., 2024). Research shows that women's education has a positive impact on economic growth and human resource development, which ultimately contributes to improving the quality of education in society (Lulu et al., 2024). After the health and education dimensions, the next dimension is the economic dimension. The economic dimension can be measured by Gross Domestic Product per capita (GDP per capita), which is the annual percentage growth rate of GDP per capita based on constant local currency (World Bank Group, 2023). The following figure shows the GDP per capita (GDPPG) growth in Indonesia from 1998 to 2022.

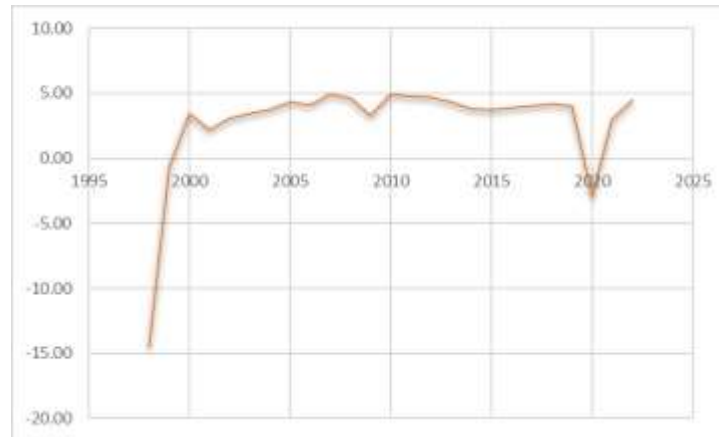


Figure 4. GDP Per Capita Growth in Indonesia, 1998-2022 (percent)

Source: World Bank Group, (2023)

Based on the image above, the GDPPG in Indonesia from 1998 to 2022 has experienced fluctuations. If we look at the GDPPG data, we can see that it declined until it reached negative figures in 1998, 1999, and 2020. The monetary crisis in 1998 and 1999 was the primary cause of the negative GDPPG, while the pandemic in 2020, which affected all countries including Indonesia, was the cause in 2020. Nevertheless, overall GDPPG from 1998 to 2022 has shown an upward trend. Positive economic growth is usually followed by an increase in people's income. This increases purchasing power, improves living standards, and promotes overall social welfare (Fernandes & Putra, 2022).

In terms of studies related to the Human Development Index (HDI), several have been conducted, including according to (Pervaiz et al., 2021), the HDI has a negative impact on CO₂ emissions. According to (Faelassuffa & Yuliani, 2021), the labor force participation rate has a positive impact on the Human Development Index. According to Imelda et al., (2021); Tumbuan et al., (2023), education has a partial influence on the Human Development Index. According to Sanggelorang et al., (2015), government budget allocation for the education sector has a positive impact on the improvement of the Human Development Index.

According to Irawan & Akbar, (2022), economic growth has a positive and significant effect on the Human Development Index. However, reviews of the effects of variables such as Mt CO₂e, FLF, and GDPPG on the HDI in Indonesia are still very limited, and the newer and longer research period, namely 1998-2022, is a novelty in this study.

The objective of this study is to analyze the influence of Carbon Dioxide Emissions (X₁), Female Labor Force (X₂), and Gross Domestic Product Per Capita Growth (X₃) on the Human Development Index (Y). In line with the objective of this study, the following research questions will be discussed in this study: (1) How does Carbon Dioxide Emissions (X₁), Female Labor Force (X₂), and Gross Domestic Product Per Capita Growth (X₃) on the Human Development Index (Y) simultaneously; (2) How do Carbon Dioxide Emissions (X₁), Female Labor Force (X₂), and Gross Domestic Product Per Capita Growth (X₃) influence the Human Development Index (Y) partially.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

Adam Smith's classical theory assumes that humans are the main production factor determining the level of prosperity of a nation (Mulyadi, 2017). The Harrod-Domar theory states that an increasing population will not reduce per capita income as long as physical capital increases (Mulyadi, 2017). Most development theories emphasize that development agents can be made more productive through improvements in health, knowledge, and skills with the accumulation of human capital (Kuncoro, 2010). Human development is a process of expanding choices for people (BPS,

2020). Todaro explains that human capital is productive investment in a person, encompassing skills, abilities, and health acquired through education, training, and health services (Tarumingkeng, 2024).

The health dimension in this study uses Mt CO₂e. This is the annual carbon dioxide (CO₂) emission measure, one of the six Kyoto greenhouse gases (GHGs), from undetected emissions (a subsector of the energy sector) such as petroleum refining, solid fuels, oil, and natural gas (World Bank Group, 2023). According to (Pervaiz et al., 2021) HDI has a negative effect on CO₂ emissions.

H1: Carbon dioxide emissions have a negative effect on the human development index in Indonesia in 1998-2022.

The education dimension in this study uses the percentage of female labor force. The female labor force as a percentage of the total indicates the extent to which women are active in the labor force. The labor force includes people aged 15 years and older who provide labor for the production of goods and services during a specific period (World Bank Group, 2023). According to Imelda et al., (2021); Tumbuan et al., (2023), education has a partial effect on the human development index. Higher education for women has been proven to significantly increase their participation in the labor force, especially at the upper secondary and tertiary education levels (Pratomo, 2017). According to Faelassuffa & Yuliani, (2021), the level of labor force participation has a positive effect on the human development index.

H2: Female labor force has a positive effect on the human development index in Indonesia from 1998 to 2022.

The standard of living dimension in this study uses GDP per capita growth. GDPPG is the annual percentage growth rate of GDP per capita based on a constant local currency (World Bank Group, 2023). According to Irawan & Akbar, (2022), economic growth has a positive and significant effect on the human development index.

H3: Gross domestic product per capita growth has a positive effect on the human development index in Indonesia from 1998 to 2022.

RESEARCH METHODS

The extent of the influence of independent variables on dependent variables can be determined through analysis in a study, one of which is multiple linear regression (Sunnyoto, 2012). To determine the influence of Mt CO₂e, FL, and GDPPG on HDI, the following multiple linear regression model was formulated.

$$HDI_i = \alpha + Mt\ CO_2e_i + FLF_i + GDPPG_i \dots\dots\dots (1)$$

Keterangan:

HDI_i : Human Development Index
 $Mt\ CO_2e_i$: Carbon dioxide emissions (million tons)
 FLF_i : Female labor force (percent)
 $GDPPG_i$: GDP growth per capita (percent)
 μ_i : error term

Then, it is followed by a normality test to determine whether the data in the study is normally distributed or not. One of the normality tests that will be used in this study is the Jarque Bera test. The assumption is that if the probability value of obs* R-squared > 0.05, then the data is considered to be normally distributed (Gujarati & Porter, 2015). After the normality test is conducted, the classical assumption test is performed so that the test results have a confidence level based on the error rate (alpha 5 percent). The classical assumption tests in multiple linear regression include the heteroscedasticity test, the multicollinearity test, and the autocorrelation test.

1. Heteroscedasticity Test

Variables in research data can be determined to have the same or different variances by conducting a heteroscedasticity test. The Glejser test is one of the tests used in heteroscedasticity, which assumes that if the value of $\text{obs} \times R\text{-squared} > 0.05$, the data in this study is considered to pass or be free from heteroscedasticity (Widarjono, 2018).

2. Multicollinearity Test

The variables in this study can be determined whether the regression equations between the independent variables have a correlation, so to test this, a multicollinearity detection test was carried out (Ghozali, 2018). The results of the multicollinearity test are determined by the Variance Inflation Factor (VIF) value of each independent variable relative to the dependent variable in the research model (Ghozali, 2018). This study has a model that is free from multicollinearity if the VIF value is < 10 , then it passes or is free from multicollinearity, if the VIF value is > 10 , then it does not pass or is affected by multicollinearity.

3. Autocorrelation Test

The relationship between variables in the study can be determined by testing for autocorrelation between the same variables at subsequent time lags. The Breusch Godfrey test is one of the most widely used tests for autocorrelation (Gujarati & Porter, 2015). The assumption from the test results is that if the Chi-Square probability value is greater than 0.05 (alpha 5 percent), the data in this study is considered to have passed and is free from the autocorrelation test. However, if the Chi-Square probability value is less than 0.05, it indicates that the data is affected by autocorrelation (Gujarati & Porter, 2015).

4. Determination Coefficient (R²)

The relationship between independent and dependent variables in terms of the level of variance can be seen from the determination coefficient (Gujarati & Porter, 2015). The assumption is that if the value of the coefficient of determination (adjusted R-squared) is closer to one, it indicates that the analysis results produce estimates that are close to the actual situation, or that the independent variable can explain the dependent variable.

5. t-test

The magnitude of the influence of independent variables on dependent variables individually or partially in a study can be determined using a t-test (assuming that the independent variables are constant) (Ghozali, 2018). The assumptions from the t-test results can be seen from the p-value or significance level. If the significance value is < 0.05 (alpha 5 percent), then the independent variable is declared to have a significant effect on the dependent variable partially.

6. F-test

The magnitude of the influence of independent variables on dependent variables simultaneously can be determined using the F-test (Ghozali, 2018). The results of the F-test can be seen from its significance level. If the significance level is < 0.05 (alpha 5 percent), then the independent variable is considered to have a significant effect on the dependent variable simultaneously.

RESULTS AND DISCUSSION

The results of this study include normality test results, classical assumption test results (heteroscedasticity test, multicollinearity test, autocorrelation test), and hypothesis test results (t-test and F-test). The normality test with a probability of $0.418683 > 0.05$ (alpha 5 percent) indicates that the data in this study does not have any problems with the normality test or can be said to be normally distributed. The heteroscedasticity test with the $\text{Obs} \times R\text{-squared}$ value showed a figure of $0.8658 > 0.05$, indicating that the data in this study did not encounter problems in the heteroscedasticity test or can be stated that the data is free from heteroscedasticity.

The multicollinearity test with VIF values for each variable, where all variables have VIF values < 10 , indicates that the data in this study is not affected by multicollinearity or can be stated to have passed the multicollinearity test. The autocorrelation test with a value of $0.0887 > 0.05$ (alpha 5 percent) indicates that the data in this study does not exhibit autocorrelation or passes the

autocorrelation test. The coefficient of determination (adjusted R-squared) is 0.835980, indicating that Mt CO₂e, FLF, and GDPPG can explain 83.6% of the variance in the Human Development Index (HDI), while the remaining 6.4% is explained by other variables outside the scope of this study.

Table 1. t test

Variable	Prob. t statistic
Mt CO ₂ e	0,0010
FLF	0,0098
GDPPG	0,2346

Sumber: Hasil Olah Data, 2025

The table above shows the t-statistic probability values for each variable in this study. The Mt CO₂e variable has a probability value of $0.0010 < 0.05$, so Mt CO₂e is declared to have a significant effect on HDI. The FLF variable has a probability value of $0.0098 < 0.05$, so FLF is declared to have a significant effect on HDI. The GDPPG variable has a probability value of $0.2346 > 0.05$, indicating that GDPPG is not significantly influenced by HDI. The F-statistic probability value is $0.00 < 0.05$, indicating that the variables Mt CO₂e, FLF, and GDPPG simultaneously have a significant influence on HDI.

The influence of independent variables on the dependent variable is shown by the t-statistic value and the regression coefficient value of each independent variable. Based on the t-statistic probability value of carbon dioxide emissions of 0.0010, it means that carbon dioxide emissions have a significant effect on the human development index. Furthermore, the regression coefficient value of carbon dioxide emissions of -0.195129 indicates that if carbon dioxide emissions increase by one percent, it will decrease the human development index by 19.5 percent. According to (Pervaiz et al., 2021), the HDI has a negative effect on CO₂ emissions. Therefore, it can be concluded that carbon dioxide emissions have a negative and significant effect on the human development index.

The influence of female labor on the human development index can be demonstrated by a t-statistic probability value of 0.0098, which means that female labor has a significant influence on the development index. Furthermore, the regression coefficient value for secondary education students is 0.020065, indicating that if the female labor force increases by one percent, it will also increase the human development index by two percent. According to Imelda et al., (2021); Tumbuan et al., (2023), education has a partial effect on the human development index. Higher education for women has been proven to significantly increase their participation in the labor force, especially at the upper secondary and tertiary education levels (Pratomo, 2017). According to (Faelassuffa & Yuliani, 2021), the level of labor force participation has a positive effect on the human development index. Thus, it can be concluded that female labor has a positive and significant effect on the human development index.

Based on the value of the t-statistic probability of the gross domestic product per capita variable, there is no significant effect on the human development index. According to (Mauludin, 2020), economic growth does not affect the human development index. High economic growth is not always followed by high human development index growth, and vice versa. In this study, the growth of gross domestic product per capita does not affect the human development index, possibly because per capita income is calculated as an average that does not reflect the distribution of wealth in society. Per capita income may be high, as may economic growth, but if income inequality is also high, it can be indicated that per capita income or economic growth only impacts the elite group, while the general public/entire population may not be affected by it. Therefore, per capita income or economic growth does not impact the human development index.

CONCLUSION

This study uses the Human Development Index (HDI) as the dependent variable, while the independent variables in this study are carbon dioxide emissions from industrial processes (Mt CO₂e), female labor force participation (FLF), and gross domestic product per capita growth (GDPPG). The analysis indicates that the data has passed the normality test and classical assumption tests (multicollinearity test, heteroscedasticity test, and autocorrelation test). The analysis results indicate that Carbon Dioxide Emissions (Mt CO₂e) have a negative and significant effect on the Human Development Index (HDI), while Female Labor Force (FLF) has a positive and significant effect on the Human Development Index (HDI). Gross Domestic Product Per Capita Growth (GDPPG) has no effect on the Human Development Index (HDI), while simultaneously the variables Carbon Dioxide Emissions (Mt CO₂e), Female Labor Force (FLF), and Gross Domestic Product Per Capita Growth (GDPPG) have an effect on the Human Development Index (HDI).

Based on the results of the study, there are limitations such as limited literature, limited analytical techniques and variables. Therefore, for further research, additional literature can be added, and other analytical techniques such as Autoregressive Distributed Lag (ARDL) can be used to identify and analyze short-term and long-term relationships between different variables. ARDL analysis is necessary when we want to understand how changes in variables in the short term affect other variables, as well as how those effects persist in the long term.

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