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# OPTIMIZING HUMAN CAPITAL CAPACITY TO DRIVE GROWTH ABOVE 5%

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**Abstract**

This study explores strategies for optimizing human capital to drive Indonesia's economic growth above 5%. Low labor productivity and disparities in education quality between regions are the main obstacles to achieving higher growth. The results of the panel data analysis show that increasing human capital significantly increases economic growth, especially in sectors that require high skills, such as health and manufacturing. Increasing human capital accelerates technological innovation, where skilled workers can adopt and develop new technologies that drive efficiency and competitiveness. On the other hand, there are fundamental problems in the education system, such as frequent curriculum changes, uneven teacher quality, and bullying in schools, which hinder human capital development. In addition, the increase in human capital is still concentrated in Java, while other regions need to catch up in access and quality of education, which causes inequality. Therefore, close collaboration between the government and the private sector is needed to improve the quality of education and ensure the development of human capital evenly across regions so that its impact can be optimized to drive more inclusive and sustainable economic growth.

**Keywords:** Education and Economic Development, Human Capital, Migration

**JEL Classifications:** I25, J24, O15

# 1. Introduction

## 1.1 Background

After the 1998 Asian financial crisis, Indonesia's economy grew better, but there has been a slowing trend in the last 13 years. Indonesia's average economic growth in the period 2010-2023 only reached 4.72%, lower than other ASEAN countries such as Vietnam (6.02%) and the Philippines (5.22%) (World Bank, 2023). This condition indicates the potential for Indonesia to be still trapped in the middle-income trap. According to Utari et al. (2014) and Bulman et al. (2017), Indonesia must consistently increase economic growth beyond 5% to escape the middle-income trap and achieve developed country status. In addition, the average economic growth that is relatively lower than that of other countries in ASEAN also indicates that Indonesia's move towards developing countries still needs to be solved.

Labor productivity is an important factor in increasing economic growth. In Indonesia, labor productivity continues to show improvement but is still lower than in some countries in ASEAN. During the period 2010-2023, Indonesia's average labor productivity growth was 2.97%, lower than Vietnam (5.38%) and the Philippines (3.11%) (CEIC, 2023). Inequality in education levels is one of the factors that can lead to low levels of labor productivity in Indonesia (Suhendra et al., 2020; Masduki et al., 2022). In addition, foreign workers with high productivity are not interested in staying in Indonesia due to low salaries (Bryan & Morten, 2018). Therefore, the overall productivity of labor in Indonesia is less elevated.

Human capital is important in economic growth (Rossi, 2020). A high level of education often increases individual productivity, especially at a productive age, which contributes directly to economic growth (Agasisti & Bertoletti, 2022). Through education, one can generate inspiring ideas and understand the importance of technology in improving the efficiency of production factors, including by importing machinery and equipment (Zhu & Li, 2016; Chang et al., 2022; Ausat et al., 2023). However, low education expenditure in developing countries, including Indonesia, is a significant obstacle to innovation and productivity (Surya et al., 2021). Therefore, developing human capital and understanding the role of innovation technology in economic development is crucial in developing countries (Pradhan et al., 2018; Widarni & Bawono, 2021).

Innovation is also the main driving force in economic growth, where the higher the level of innovation, the higher the economic growth. Endogenous growth theory explains that economic growth is driven by the improvement and development of human resources (through innovation) to continuously create new processes and ideas that are effective and efficient from within the organization or system itself, without relying on external factors (Grossman & Helpman, 1994). Innovative thinking and reasonable utilization of human capital will help the country's economic development and improve its sustainable economic status (Bourdieu, 1986). Bianchi's (2001) research shows that skilled human resources in an industry play a crucial role in generating innovation activities. This result is corroborated by Vandenbussche, Aghion, and Meghir (2006), who state that countries with advanced technology are more encouraged to innovate than adopt existing technology. Research by Wadho and Chaudhry (2022) also corroborates that innovation is a major contributor to labor productivity growth.

Several previous studies have highlighted the important role of human capital in supporting economic growth in Indonesia. Research by Tjahjono and Anugrah (2006) found that labor share has a more significant role in driving the economy's pace than capital share, with human capital having a significant positive impact on economic growth. Similar findings are supported by the research of Rahmayani et al. (2017) and Affandi, Anugrah, and Bary (2018), which emphasize the important role of human capital in supporting economic growth. However, employment growth is still concentrated in sectors with low productivity (Ryandiansyah & Azis, 2018). This result aligns with research by Sabir et al. (2021) who highlighted the positive role of human capital and technology on Asian economic growth.

Technological developments have also resulted in a shift in demand for labor. This shift also requires the workforce to improve skills and education, leading to technology-based skills to survive and not be replaced by machines. Some previous studies, such as Abuselidze and Mamaladze (2021) and Henkel et al. (2024), show that integrating education and technology can increase human capital, which has implications for increasing productivity and economic growth. Moreover, with the demographic bonus, the potential for increased economic growth is high.

Various studies imply the importance of reviewing the role of human capital in driving economic growth in Indonesia, especially with the rapid development of innovation technology. However, more research in Indonesia needs to be done that specifically discusses the role of human capital in optimizing economic growth. This study also uses microdata to analyze human capital capacity in Indonesia. In addition, no research explores the role of innovation and technology in achieving Indonesia's economic growth above 5%. Therefore, research is needed to understand the optimal role of human capital ovation and technology in promoting sustainable economic growth in Indonesia and achieving growth targets of more than 5%.

### 1.2 Research Objectives

This study aims to analyze the strategy of optimizing *human capital* capacity to drive Indonesia's economic growth above 5% and explore the role of innovation and technology in increasing economic growth in Indonesia. This research focuses on analyzing *human capital* quantitatively and qualitatively, both nationally and regionally, which is strengthened by identifying the main problems in the education sector through FGD activities to encourage Indonesia's economic growth. Therefore, several research questions can be analyzed in depth to explore strategies for optimizing human capital capacity to drive economic growth, such as:

1. How to optimize human capital to increase economic growth in Indonesia?
2. What is the role of innovation and technology in increasing economic growth in Indonesia?

## 2. Literature Review

### 2.1. Theoretical Framework

Mankiw - Romer - Weil's (MRW) (1992) model is a development of the Solow growth model by including human capital as an additional input and defining technology as labor-augmented. Human capital is essential in economic growth because workers' quality and skills positively impact economic growth. The higher the number of workers with good human capital, the greater the output will be compared to workers who do not have skills. The MRW model can be written in the following equation:

$$Y_t = K_t^a H_t^b (A_t L_t)^{1-a-b} \quad (1)$$

where $Y$ is Real GDP, $K$ is Physical Capital Stock, $H$ is Human Capital Stock, $A$ is Total Factor Productivity, $L$ is labor, and $t$ indicates time. The assumption $a + b < 1$ is used to ensure that the production function above is Decreasing Return to Scale

(DRS) by showing the existence of diminishing marginal product on each input used. Parameter $a$ indicates the level of marginal productivity of capital. At the same time, parameter $b$ indicates the level of marginal productivity of human capital. From the above equation, we can convert output into productivity or output per effective unit of labor by moving $A_tL_t$ to the left side as follows:

$$y_t = k_t^a h_t^b; \text{ where } y_t = \frac{Y_t}{A_tL_t},\ \ k_t = \frac{K_t}{A_tL_t},\ \ h_t = \frac{H_t}{A_tL_t} \tag{2}$$

The MRW Model assumes that individuals invest part of their income in human capital ($s_H$) and physical capital ($s_K$). Another assumption is that physical and human capital depreciates at the same rate, which is $\delta$. In addition, both population and technology grow at constant rates $n$ and $g$, as explained in the Solow Growth Model. Therefore, we can form the growth function of physical capital and human capital over time as follows:

$$\dot{K}_t = s_k[K_t^{\alpha} H_t^b (A_tL_t)^{(1-\alpha-b)}] - \delta K_t \tag{3}$$

$$\dot{H}_t = s_h[K_t^{\alpha} H_t^b (A_tL_t)^{(1-\alpha-b)}] - \delta H_t \tag{4}$$

We can transform equations (3) and (4) into the ratio per effective labor based on equation (2), which describes the productivity level of each input. We write this mathematically as:

$$\dot{k}_t = s_K(k_t^a h_t^b) - (n + g + \ \delta)k_t \tag{5}$$

$$\dot{h}_t = s_H(k_t^a h_t^b) - (n + g + \ \delta)h_t \tag{6}$$

In a state of equilibrium, the level of capital productivity per effective unit of labor ($k$t) and human capital productivity per effective unit of labor ($h$t) remain constant. To analyze the variations in physical capital accumulation and human capital accumulation, we can formulate the following equation:

$$k^* = \left(\frac{s_K^{1-b} s_H^b}{n+g+\ \delta}\right)^{\frac{1}{1-a-b}} \tag{7}$$

$$h^* = \left(\frac{s_K^a s_H^{1-a}}{n+g+\ \delta}\right)^{\frac{1}{1-a-b}} \tag{8}$$

Equations (7) and (8) demonstrate that higher physical and human capital investments lead to a more significant accumulation of these resources. This, in turn, results in increased output under steady-state conditions, promoting long-term economic growth. By substituting equations (7) and (8) into the production function, we can express it mathematically as:

$$\ln\left[\frac{Y_t}{L_t}\right] = \ln A\,(0) + g_t - \frac{a+b}{1-a-b}\ln(n + g + \delta) + \frac{a}{1-a-b}\ln s_K + \frac{b}{1-a-b}\ln s_H \tag{9}$$

Equation (9) above illustrates that productivity is affected by both population growth and the accumulation of physical and human capital. To assess the influence of human capital on productivity, we can substitute the steady state conditions of equation (8) for human capital into equation (9), resulting in the following expression:

$$\ln\left[\frac{Y_t}{L_t}\right] = \ln A\,(0) + g_t - \frac{a}{1-a}\ln(n + g + \delta) + \frac{a}{1-a}\ln s_K + \frac{b}{1-a}\ln(h)^* \tag{10}$$

Equation (10) shows that human capital accumulation positively impacts economic growth, as reflected in the partial derivative of human capital on productivity. Mankiw, Romer, and Weil (1992) explain that this model can be applied in two ways using regression analysis. The first is using the investment in human capital as an independent variable, as shown in equation (9). The second is by including the human capital accumulation variable as an independent variable, as seen in equation (10).

### 2.1.3. Endogenous Technological Change (1990)

Romer (1990) became one of the pioneers in developing the Solow economic growth model, which adopted the technology variable as public goods and endogenous. Romer (1990) explained that economic growth is influenced by at least four main inputs: labor, physical capital, human capital, and technology. Technology and human capital are variables broken down from Total Factor Productivity (TFP) or knowledge based on the competitive nature of the goods. The technology variable represents non-rivalry knowledge, while human capital represents rivalry knowledge. Romer's (1990) growth equation is derived from a production function as follows:

$$Y(H_A,\ L,\ x) = H_\gamma^a L^b \int_0^\infty x(i)^{1-a-b}\, di \tag{11}$$

The equation above shows that the output level of a country is influenced by the accumulation of human capital working in the manufacturing sector ($H_\gamma$), labor ($L_b$), and raw materials ($x(i)^{(1-a-b)}$). The integral solution of raw materials to the level of durability ($i$) produces a new equation that has selected quality raw materials as inputs in production. Therefore, the mathematical equation for this can be written as follows:

$$Y(H_A,\ L,\ x) = H_\gamma^a L^b A\bar{x}^{1-a-b} \tag{12}$$

When the assumption of physical capital accumulation, which is the multiplication value of the level of knowledge ($A$) and quality raw materials ($\bar{x}$) in equation (17), is substituted into the previous equation (16), the calculation forms a new production function that has the characteristics of human capital and labor augmenting with the level of technology. This equation can be written mathematically in the following equation (18).

$$K = A\bar{x} \tag{13}$$

$$Y(H_A,\ L,\ x) = \left(H_\gamma A\right)^\alpha (LA)^b (K)^{1-a-b} \tag{14}$$

This model also discusses the endogeneity of technology adoption originating from research activities. Romer (1990) explains that technology adoption is an endogenous variable influenced by research and development (R&D) activities. R&D activities are defined by Romer (1990) as production activities that require at least two inputs, namely human capital in research activities (researchers) and technology adoption. Mathematically, the growth of technology adoption can be written in the following equation:

$$\dot{A} = \delta H_a A \tag{15}$$

Variable $\dot{A}$ shows the growth rate of technology adoption. $\delta H_a A$ shows R&D activities for technology development. Variable $H_a$ shows the accumulation of human capital used in research activities. Variable $A$ represents the applicable level of technology adoption. At the same time, parameter $\delta$ shows the level of researcher productivity in R&D activities. Jerbashian et al. (2015) explained that only specific human capital, unique expertise with high specialization, can increase researcher productivity in R&D activities. Romer (1990) also explained that in an economy, human capital can be divided into two types according to the following equation:

$$H = H_A + H_\gamma \tag{16}$$

H is the total accumulation of human capital in the economy, which can be divided into human capital that directly affects production activities, namely human capital in the manufacturing industry ($H_Y$), and human capital that plays a role in developing science, innovation, and technology in research activities ($H_A$).

Romer (1990) describes that R&D activities can increase the variety and capability of technology adoption, increasing economic growth. The endogeneity of the level of technology adoption is also confirmed by Roller & Waverman (2001), Gruber et al. (2011), and Nair et al. (2020). Jerbashian et al. (2015) continued Romer's (1990) explanation by including the level of technological growth as an input for physical capital. Technological growth can improve the quality of physical capital due to more diverse capabilities and variances. Mathematically, it can be written in the following equation:

$$K = \dot{A}k \tag{17}$$

The variable $K$ shows the stock of physical capital, and the variable $\dot{A}$ is the level of technological growth. The parameter $k$ has a value between 0 and 1. Technological growth can directly improve the quality of physical capital and increase output through variable $A$ in the previous equation (14).

Technological progress in the current digital era leads to the development of information and communication technology (ICT). Roller and Waverman (2001) also developed the Solow (1956) and Romer (1990) growth models specifically for the adoption of technology in the 2000s, which led to ICT. Roller and Waverman (2001) revealed that the determinants of economic growth can come from increased investment in technology by developing a production function framework that assumes the telecommunications sector is endogenous and influenced by the market model.

## 2.2. Previous Studies

### 2.2.1. Human Capital on Growth

Solow's (1956) theoretical framework, further developed by Romer (1990), emphasized human capital and technology as crucial inputs in an innovation-based economy. Mankiw, Romer, and Weil (1992) expanded this by incorporating human capital and technology as labor-augmented in the Cobb-Douglas production function, creating new opportunities for countries to enhance economic growth. Lucas (1988) highlighted human capital, proxied by education level, as a significant input in production activities. Ogundari and Awokuse (2018) and Lenkei, Mustafa, and Vecchi (2018) further demonstrated that increasing human capital positively impacts economic growth in Africa and Asia.

Kwok & Leland (1982) were among the first to document the brain drain phenomenon in Taiwan, where highly educated workers migrated abroad due to low wages and limited job opportunities. Petrakis and Stamatakis (2002) explored the impact of primary, secondary, and tertiary education on economic growth in developing and developed countries. Self & Grabowski (2004), Idrees & Siddiqi (2013), and Glewwe et al. (2014) used years of schooling as a human capital proxy. However, Ahsan and Haque (2017) noted that using years of schooling as a proxy for human capital could be problematic due to variations in education quality, leading to discrepancies in skills and knowledge across the workforce.

Hanushek (2013) incorporated the quality of education as a critical variable for measuring human capital, showing that cognitive abilities significantly impact economic growth. He found that students in developing countries had lower cognitive abilities, even after nine years of schooling than their counterparts in developed nations. Dang et al. (2023) analyzed Vietnam's education reform, focusing on parental support and high-order thinking skills (HOTS). Although not yet statistically proven, cognitive development in Vietnam has improved faster than in other developing countries, illustrating the importance of education quality.

Petrakis and Stamatakis (2002) argued that primary and secondary education have a more substantial impact in developing countries, while tertiary education is more important in developed nations. Kocourek and Nedomlelova (2017) supported these findings, and Sultana, Dey, and Tareque (2022) confirmed that developed countries benefit more from quantitative human capital due to better education standards. In contrast, developing nations see a more significant impact from qualitative aspects due to lower education levels and standards.

Ahsan and Haque (2017) emphasized that overqualified human capital can only become productive once an economy reaches a certain development threshold. Lenkei, Mustafa, and Vecchi (2018) added that higher and vocational education in developing countries might negatively impact growth in the long term, as job opportunities for skilled workers are limited, and technology adoption remains low. This lack of opportunities leads to brain drain, as seen in Taiwan (Kwok & Leland, 1982), Greece (Ifanti et al., 2014), and Suriname (Dulam & Franses, 2015), where wage differentials and limited employment opportunities led to migration.

Oosterbeek and Webbink (2011) found that Dutch students who studied abroad had a 25-30% chance of remaining abroad due to better educational opportunities. Nifo and Vecchione (2014) emphasized that the quality of educational institutions plays a significant role in labor migration, while Poppe et al. (2014) and Ibrahim et al. (2019) highlighted family factors, such as quality of life and job opportunities, as key determinants of migration decisions in regions like sub-Saharan Africa and the UAE. More recently, Bhawana and Sharma (2023) identified 11 determinants of brain drain, including education, employment, income, and political stability. Jovcheska (2024) pointed out that corruption in higher education institutions in North Macedonia also plays a crucial role in driving skilled labor out of the country.

Baerlocher, Parente, and Neto (2019) examined Brazil's demographic shift, showing that while changes in the working-age population can influence income, education plays a much larger role in driving economic growth. Jain & Goli (2021) demonstrated that India's demographic dividend, which began in 2005 and will continue until 2061, can significantly impact economic growth, provided the country improves education, healthcare, and infrastructure. Nuta, Lupu, and Nuta (2021) examined government spending on education in Eastern European countries and found that spending directed at improving cognitive abilities and integrating technology into education systems positively affects long-term growth.

In Indonesia, Affandi, Anugrah, and Bari (2018) found that the quality and quantity of human capital significantly contribute to economic growth, with years of schooling and cognitive abilities in math and science being key drivers. However, Dang et al. (2023) revealed that Indonesian students lag behind other countries in cognitive skills, with low PISA scores in mathematics and reading, partly due to the country's lower GDP levels. As Indonesia approaches its demographic bonus, Risandini and Silvi (2019) stressed that increasing labor force participation will not directly translate into growth unless workforce quality is improved. Challenges such as limited internet access, migration, and child marriage must be addressed to fully capitalize on the demographic bonus.

Saraswati (2013) pointed out that uneven population distribution across regions in Indonesia hinders the optimal allocation of government spending on education. Rifa'i & Moddilani (2021) found that while increasing government spending on education may not significantly impact short-term growth, it could have negative effects in the long term if not managed properly. Targeted reforms are needed to improve education quality and ensure sustained economic growth.

### 2.2.2. Tech and Innovation on Growth

Gajjala (2006) analyzes how Internet adoption in India attracted foreign companies to invest, leading to significant GDP growth through knowledge and technology transfer. Malamud et al. (2019) found that providing free laptops to students in Peru increased ICT skills and productivity. Hampton et al. (2021) similarly noted the positive effects of ICT skills on student achievement in the U.S. Awad and Albaity (2022) expand on this by exploring how technological advances drive economic growth in sub-Saharan countries through education, foreign investment, and trade, with both direct and indirect impacts. Zhao and Chen (2023) emphasize how integrating technology into education in rural China improved student achievement by enhancing access to learning resources and fostering cognitive and non-cognitive development.

Hamel (2000) discusses the importance of business models in turning inventions into successful innovations, arguing that commercialization is crucial to innovation success. Grant (2002) echoes this sentiment, emphasizing that a solid business model is necessary for inventions to have a lasting impact. Schoen et al. (2015) describe the innovation process in three stages: basic research, invention, and innovation commercialization. Nguyen and Doytch (2022) focus on the role of patents, particularly in the technology sector, as crucial drivers of economic growth, showing that technology patents have a more significant impact in developed countries than in developing ones.

Coe and Helpman (1993) estimate that the U.S. accounted for a significant portion of industrial R&D in OECD countries during the early 1990s, with their research showing a positive spillover effect of R&D investment on global productivity. Cooke, Uranga, and Etxebarria (1997) stress the role of companies, universities, and research institutions in national innovation systems, while Freeman (2004) highlights patents as critical indicators of innovation activity. Chen, Chen, and Vanhaverbeke (2011) expand on these findings, identifying R&D spending, FDI, and human resource development as crucial factors influencing national innovation capacity.

Rohman and Bohlin (2014) examine the impact of ICT adoption on Indonesia's economic growth, finding that early ICT adoption in the 1980s had a more substantial effect than recent developments. Nielsen, Rohman, and Lopes (2018) point out that gaps in technology infrastructure and affordability have hindered the full impact of technology on economic growth in Indonesia. Rath and Hermawan (2019) find that while long-term ICT development positively impacts growth in Indonesia, ICT exports have had a negative effect due to trade challenges. Kartiasih (2022) explores the wage gap associated with ICT skills in Indonesia, noting that workers with strong ICT skills and higher education earn significantly more than their less-educated counterparts. Wahyuni, Hamzah, and Syahnur (2023) focus on Aceh Province, showing that technology per workforce positively influences local economic growth. However, they warn that dependence on external aid may limit long-term sustainability.

Seo et al. (2021) explores the benefits and risks of AI in education, highlighting its potential to improve learning while cautioning against data misuse. In Georgia, Abuselidze and Mamaladze (2021) emphasize that while AI can enhance productivity, it may also disrupt labor markets by displacing workers, particularly those with low ICT skills. Henkel et al. (2024) demonstrate how AI-powered tools like Rori in Ghana can personalize learning and improve cognitive abilities, especially in math and science. Albinowski and Lewandowski (2024) find that ICT and robotics significantly impact employment in Europe, with younger workers benefitting more from these technologies than older workers.

The ongoing development of ICT and AI shows potential for significant shifts in economic structures, particularly in education, labor markets, and productivity. While technology adoption continues to grow across regions, factors such as infrastructure gaps, wage disparities, and generational skill differences suggest a complex relationship between technology and economic growth. These dynamics may evolve differently depending on the level of development, regional capacity, and investment in technological infrastructure.

## 3. Methodology

This study uses primary and secondary data. Primary data is qualitative data obtained from Focus Group Discussions (FGD) and interviews. Meanwhile, secondary data is obtained through national and international data sources such as the Central Bureau of Statistics, World Bank, CEIC, OECD, and other sources supporting this study. The object of observation in this study is Indonesia at the provincial level from 2010 to 2023. However, this study also uses data from other countries as a comparison for the case of Indonesia. The variables used in the study are three types of variables, namely dependent variables, independent variables, and instrument variables. A summary of the research variables is as follows:

Table 3.1 Summary of Variables

| No | Variable | Code | Unit | Hypo | Source |
|---|---|---|---|---|---|
| 1. | Gross Domestic Product | $GDP_{it}$ | Billion Rupiah | | BPS/WB/OECD |
| 2. | Human Capital | $HC_{it}$ | Annual | + | BPS/WB |
| 3. | Technology | $ICT_{it}$ | *% of Population* | + | BPS/WB |
| 4. | Innovation | $Patent_{it}$ | Unit | +/- | DJKI/BPS/WB |
| 5. | Labor | $Labor_{it}$ | Person | +/- | BPS/ILO |
| 6. | Domestic investment | $Invest_{it}$ | Billion Rupiah | +/- | BPS/WB |
| 7. | Foreign Direct Investment | $FDI_{it}$ | Juta USD | +/- | BPS/WB |
| 8. | STEM Labor | $STEM_{it}$ | Person | + | SAKERNAS |
| 9. | ICT Skill | $ICTskill_{i}$ | *% of Population* | | BPS/WB/OECD |
| 10. | Productive Ages | $UsiaPro$ | *% of Population* | | BPS/WB |

### 3.1. Econometric Model

This study uses two empirical models. First, this study uses the Cobb-Douglas model proposed by Hall (2010) and Inekwe (2015) to analyze optimizing human capital in increasing economic growth in Indonesia. This study modifies the Cobb-Douglas model by including innovation as an additional factor influencing economic growth, capital, and labor. This study modifies the Cobb-Douglas model by assuming the capital stock variable ($K$) is proxied by innovation and technology, the external capital variable ($K0$) is proxied by Foreign Direct Investment ($FDI$), the innovation variable is proxied by R&D and patents, and the technology variable is proxied by the level of ICT adoption. Based on the framework above, this study formulates the following empirical model:

$$\ln GDP_{it} = b_0 + b_1 HC_{it} + b_2 Labor_{it} + b_3 ICT_{it} + b_4 Patent_{it} + b_5 Inv_{it} + b_6 FDI_{it} + \varepsilon_{it} \qquad (22)$$

This study adopts equation (22) above to analyze the variation between islands to see the impact of human capital heterogeneity on economic growth in Indonesia. By applying this fixed-effect equation, we can identify how differences in human capital in each island contribute to regional economic growth. This model allows us to control the fixed effects of each island, thus providing a clearer picture of the influence of human capital on economic growth by considering the unique characteristics of each region.

In addition, this study also explores the influence of human capital on growth in leading sectors such as manufacturing, trade, agriculture, health, and construction—sectors that significantly contribute to GDP and are closely related to the STEM (Science, Technology, Engineering, and Mathematics) fields. Each of these sectors shows different sensitivities to investment in education and training, which directly impact sectoral growth. This approach guides more effective policies in optimizing human capital to drive economic growth at the regional level and strategic sectors.

This study also discusses the impact of STEM on the manufacturing and health sectors, which are crucial to post-COVID-19 economic recovery. In this transition period, both sectors are highly dependent on innovation and technology, which requires the readiness of human capital with a STEM background to implement and utilize technology optimally. In manufacturing, STEM accelerates automation and digitalization, increasing productivity and competitiveness. Meanwhile, in the health sector, STEM supports the development of medical technology, telemedicine, and digital health systems essential in the post-pandemic era. Based on the framework above, this study formulates the following empirical model:

$$\ln GDP_{it} = b_0 + b_1 HC_{it} + b_2 STEM_{it} + b_3 ICT_{it} + b_4 Patent_{it} + b_5 Inv_{it} + b_6 FDI_{it} + \varepsilon_{it} \qquad (18)$$

Second, to analyze the role of innovation and technology in driving economic growth in Indonesia, this study accommodates Romer's theory (1990) and previous research findings such as Roller & Waverman (2001), Gruber et al. (2011) and Nair et al. (2020) who found that the technology variable or $ICT_{it}$ is very susceptible to endogeneity, especially from R&D activities. Therefore, this study tries to overcome this problem by developing a GMM instrument variable (IV) model and making the ICT Skills variable an instrument variable for technology that represents the ICT Framework developed by ITU (2017). In addition, this study also includes a market model of the technology market in the form of the number of people of the productive age as a proxy for technology demand. This study uses the market mode as an instrument variable for technology by referring to the findings of Guha and Mukerji (2021) regarding the determinants of the level of technology adoption. Mathematically, this study could write an empirical model as follows:

$$\ln GDP_{it} = b_0 + b_1 HC_{it} + b_2 Labor_{it} + b_3 ICT_{it} + b_4 Patent_{it} + b_5 Inv + b_6 FDI_{it} + \varepsilon_{it} \qquad (19)$$

$$ICT_{it} = z_0 + z_1 ICTskill_{it} + z_2 ProductiveAge_{it} + \epsilon_{it} \qquad (20)$$

The methodology is mixed methods, a combination of quantitative and qualitative research methods. Quantitative methods will optimize the use of fixed-effect model regression and IV-GMM to analyze the impact of optimizing human capital and innovation technology on economic growth. Qualitative research methods will optimize Focus Group Discussions (FGD) activities and interviews as the complemantary of quantitative method to dig deeper into information related to research topics.

# 4. Results / Analysis

## 4.1. Empirical Result

This study used the IV-GMM model to overcome the endogeneity problem in the technology variable. Moreover, this study used ICT skills and productive age to represent the technology market's demand side, as Guha and Mukerji (2021) explained. This study tested the validity of the two instruments using the Hansen J test, a joint hypothesis. The joint hypothesis means that the instrument variable (IV) does not contain an error term and does not have a correlation with the dependent variable. The results of the IV-GMM estimation, along with the post-estimation test in the form of the Hansen J test and the endogenous test, are as follows.

Table 4. 1 Instrumental Variabel GMM Estimation

| VARIABLES | Model (1) lngdp | Model (2) lngdp | Model (3) lngdp |
|---|---|---|---|
| hc | 0.052*** | 0.043*** | 0.056*** |
| | (0.014) | (0.014) | (0.015) |
| lnlabor | 0.264*** | 0.228** | 0.377*** |
| | (0.089) | (0.103) | (0.079) |
| lninvdom | 0.008** | 0.006 | 0.039*** |
| | (0.003) | (0.006) | (0.004) |
| lnfdi | 0.026*** | 0.013*** | 0.004 |
| | (0.006) | (0.005) | (0.007) |
| Internet | 0.006*** | | |
| | (0.000) | | |
| mobile | | 0.017*** | |
| | | (0.002) | |
| komputer | | | 0.039*** |
| | | | (0.003) |
| Hansen J Stat | 0.060 | 0.838 | 0.115 |
| Endogeneity | 0.259 | 0.127 | 0.149 |
| Observations | 431 | 437 | 442 |
| R-squared | 0.857 | 0.888 | 0.795 |
| Number of id | 34 | 34 | 34 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The estimation results above show that *human capital* consistently positively impacts GDP with a coefficient value between 0.04% - 0.06%. This result means that an increase in Indonesia's *human capital* can boost economic growth by transmitting knowledge and skills that will increase worker productivity and economic growth. These results align with the *baseline* regression results above and those of Affandi, Anugrah, and Bary (2018). Technology variables have also been proven to affect Indonesia's GDP significantly, especially the computer variable, which has a coefficient value of 0.06%. This figure is greater than the coefficient of having an internet of 0.01% and a *mobile phone* of 0.02%. The coefficient of the technology variable above indicates that technology has an important role in encouraging economic growth. This finding aligns with previous research conducted by

Nuryartono and Pasaribu (2023) in Indonesia and Awad and Albaity (2022) in Sub-Saharan Africa, with coefficient values of 0.03% and 0.001%, respectively. At the same time, other control variables such as patents, labor, domestic investment, and FDI are proven to positively impact economic growth and become one of the important components of the economy.

With the proof that *human capital* positively impacts growth, the deepening of *human capital* optimization strategies is significant. The education sector needs to be improved to strengthen the impact of *human capital* in Indonesia. Ministry of Education (2024) revealed three main elements to create an advanced and quality education sector: access to education, quality of learning, and equitable and inclusive distribution of education. However, Kemendikbudristek (2024) also explained that a rigid and material-based curriculum, gaps in teaching and learning quality, and bullying are the main elements that hinder human capital improvement in Indonesia.

In addition, the deepening of human capital optimization strategies must also be directed to meet the needs of Indonesia's economic sectors. Indonesia's leading economic sectors, such as manufacturing, health, mining, construction, and agriculture (BPS, 2023), are closely related to Science, Technology, Engineering, and Mathematics (STEM) expertise. STEM plays a crucial role in fostering innovation, increasing productivity, and strengthening the competitiveness of these sectors in the global market (Peri, Shih, & Sparber, 2015). In manufacturing, technology and engineering are needed to improve productivity and product quality. In the health sector, STEM supports medical research and the development of more advanced health technologies. Similarly, engineering and technology are used in mining and construction for more efficient exploration and sustainable infrastructure development. However, despite the vital role of STEM in these sectors, Sakernas data (2022) shows that the number of professionals with STEM skills in Indonesia still needs to grow, especially in the non-Java region.

PII (2023) notes that Indonesia has only 2,600 engineers per 1 million population, far less than Vietnam's 9,000 and South Korea's 25,000. Most of the engineers in Indonesia are centered in Java, especially in West Java, as 29.38% of factories in Indonesia are in this province (BPS, 2023). Apart from engineers, the government also needs help meeting the demand for doctors, especially after the Covid-19 pandemic. WHO (2023) reported that Indonesia has a low ratio of 6,896 doctors per 10,000 population, lagging behind Vietnam, with 8,326 doctors, and South Korea, with 25,174 doctors. Bappenas (2024) revealed that the ideal ratio of doctors in Indonesia is 20,000 doctors (general and specialist) per 10,000 population, and Bappenas (2024) noted that Indonesia still needs to be more than 146 thousand general practitioners and 27 thousand specialists to achieve this optimal condition This shortage of professionals in the STEM sector reflects problems in Indonesia's education system that need to be improved immediately to increase *human capital* in Indonesia.

### 4.1.1. Quality of Human Capital

The quality of *human capital*, particularly in terms of cognitive ability, plays an important role in driving economic growth. Affandi, Anugrah, and Bary (2018) argued that high cognitive skills, as measured through academic achievement in science and mathematics, correlate with increased labor productivity, which drives economic output in Indonesia. This study estimates the impact of improving students' cognitive ability as a proxy of *human capital* quality using STEM-related UN scores on growth. The following table shows the panel data regression results incorporating *human capital* quality.

Tabel 4. 2 Quality of Human Capital Estimation

| VARIABLES | Model (1) lngdp | Model (2) lngdp | Model (3) lngdp | Model (4) lngdp | Model (5) lngdp |
|---|---|---|---|---|---|
| computer | 0.012*** | 0.004 | 0.004 | 0.004 | 0.004 |
| | (0.003) | (0.006) | (0.006) | (0.005) | (0.005) |
| lnpaten | 0.027*** | 0.055*** | 0.051*** | 0.047*** | 0.056*** |
| | (0.007) | (0.009) | (0.010) | (0.010) | (0.010) |
| lnlabor | 0.262** | 0.710*** | 0.708*** | 0.619*** | 0.734*** |
| | (0.103) | (0.137) | (0.126) | (0.132) | (0.137) |
| lninvdom | 0.008** | 0.013** | 0.013** | 0.009* | 0.013** |
| | (0.003) | (0.005) | (0.004) | (0.004) | (0.005) |
| lnfdi | 0.009** | 0.010* | 0.010* | 0.009 | 0.010* |
| | (0.004) | (0.005) | (0.005) | (0.005) | (0.005) |
| lneng | 0.123** | | | | |
| | (0.051) | | | | |
| Lnmath | | 0.062*** | | | |
| | | (0.022) | | | |
| lnphy | | | 0.085*** | | |
| | | | (0.026) | | |
| lnchem | | | | 0.205** | |
| | | | | (0.076) | |
| lnbio | | | | | 0.088** |
| | | | | | (0.035) |
| Constant | 6.498*** | 0.603 | 0.584 | 1.471 | 0.148 |
| | (1.390) | (1.875) | (1.742) | (1.763) | (1.869) |
| Observations | 169 | 169 | 169 | 169 | 169 |
| R-squared | 0.830 | 0.752 | 0.757 | 0.765 | 0.748 |
| Prov | 34 | 34 | 34 | 34 | 34 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The estimation results show that cognitive ability significantly affects economic growth, with chemistry expertise having the most significant impact on GDP at 0.20%. The role of chemistry is crucial in Indonesia's leading sectors, such as manufacturing, pharmaceuticals, and natural resource processing, which are the main pillars of economic growth. In addition, English proficiency also contributes significantly, with a coefficient of 0.12%, especially in the international trade, tourism, and services sectors. English is an important instrument for expanding access to global markets, strengthening international relations, and improving the competitiveness of Indonesia's leading sectors in the global arena. In addition, other STEM fields, such as math, physics, and biology, were also shown to affect growth significantly. This result is consistent with Affandi, Anugrah, and Bary's research (2018). The above findings are also reinforced by the results of FGDs, which reveal that one of the designs for upper secondary education in Indonesia is still oriented to meet the needs of the industrial workforce, especially in the manufacturing sector.

Glewwe, Huang, and Park (2017) showed that cognitive skills, in addition to non-cognitive skills, have a significant impact on labor market outcomes. However, the contribution is more prominent in high-skilled occupations. Cognitive skills not only increase an individual's productivity potential but also serve as a foundation for the development of job-relevant non-cognitive skills, which together lead to more inclusive and equitable economic growth (Affandi, Anugrah, & Bary, 2018; Glewwe, Huang, & Park, 2017).

Although STEM education is increasingly needed in this digital and globalized era, many individuals in Indonesia are reluctant to choose this path. Sakernas (2022) notes that in 2022, the average number of graduates in STEM fields in Indonesia will only be around 20.01 percent. One of the main factors is the perception that the *rewards* need to be commensurate with the challenges of working in these fields. Sakernas (2022) shows that the average salaries of STEM workers in the manufacturing, healthcare, construction, and mining sectors tend to be lower than those of non-STEM workers in the finance and insurance sectors. In addition, many see that jobs in the STEM sector tend to lack public exposure or recognition, especially for women (Fadhilah, Wardatussaidah, & Wardhani, 2024). The lack of positive representation and recognition of achievements in this field has further decreased public interest in STEM careers.

On the other hand, Rafanan, De Guzman, and Rogayan (2020) explained that challenges related to career prospects are also why many people avoid STEM education. Although the sector has a high demand for skilled labor, career prospects in STEM fields are less promising in the long run, especially in Indonesia's job market, which is often hampered by a mismatch between required and available skills. Coupled with the view that STEM courses are more complex and costly, this further exacerbates the situation. Some people even feel deterred from entering these fields for fear of struggling to keep up with the material or needing help to cope with the high academic demands. As a result, many prefer other majors that are considered more accessible and more secure in terms of employment and income.

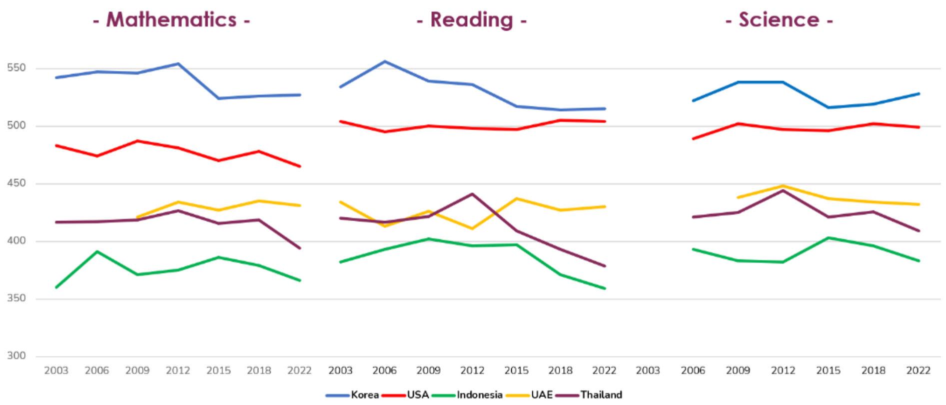



Figure 4. 1 PISA Score 2003-2022

Source: OECD PISA (2022)

Indonesia's 2022 PISA scores highlight serious challenges in the education sector, with low results in three key areas: math (366), reading (371), and science (383). The OECD (2022) focuses on students' reasoning skills. Indonesia's 2022 PISA scores show that students struggle to master reasoning skills. Research by Dang et al. (2023) explained that there is a tendency for countries with high-income levels to have higher average PISA scores than lower-income countries. This condition happens because high-income countries can optimize reasoning skills in daily life and apply them from early education. For Indonesia, this low score also reflects the need to improve the quality of teaching and educational approaches that are more effective in developing students' critical and analytical thinking skills.

In the PISA 2022 graph above, Indonesia is at the bottom compared to other countries. This lag is a significant challenge for Indonesia's education sector, especially compared to Thailand, which excels in all areas and has higher scores. Thailand's success reflects the effectiveness of its education strategy, which focuses on strengthening academic fundamentals and critical thinking skills early on. On the other hand, Indonesia needs to improve teaching methods that encourage students to think more analytically and innovatively to improve the competitiveness of education at the international level.

In response to the need to improve students' reasoning skills, Indonesia has adopted the Merdeka Curriculum and implemented the National Assessment (Kemendikbudristek, 2024). The Merdeka Curriculum aims to provide greater freedom to students in determining their learning paths. This curriculum allows students to focus more on the areas they like and are good at to develop their potential optimally. In addition, implementing the National Assessment, which replaces the national exam, focuses on measuring critical thinking, literacy, and numeracy skills, not just memorization. This approach aims to familiarize students with analytical and critical thinking as a starting point for entering higher education.

#### 4.1.2. Heterogenity of Human Capital

This study estimates the impact of increasing human capital in various regions of Indonesia. It aims to analyze the differences in the impact of increasing *human capital* on GDP, which is inseparable from the socio-economic characteristics of each region. For this purpose, this study categorizes Indonesia into five central regions based on the principal island groups in Indonesia. Sumatera, Java, Bali and Nusa Tenggara, Kalimantan, and Sulawesi Maluku Papua are the five regions. The regression estimation results using the panel data approach are as follows.

Table 4. 3 Heterogenity Estimation

| VARIABLES | Model (1) Sumatera | Model (2) Jawa | Model (3) Bali Nustra | Model (4) Kalimantan | Model (5) Sulampua |
|---|---|---|---|---|---|
| hc | 0.128*** | 0.192*** | 0.072* | 0.117*** | 0.069*** |
| | (0.034) | (0.030) | (0.041) | (0.056) | (0.023) |
| lnpaten | 0.061*** | 0.108*** | 0.011 | 0.017 | 0.060** |
| | (0.013) | (0.014) | (0.028) | (0.020) | (0.028) |
| lnlabor | 0.225** | 0.240*** | 0.260 | 0.217 | -0.088 |
| | (0.101) | (0.069) | (0.296) | (0.253) | (0.169) |
| lninvdom | 0.003 | 0.018*** | 0.001 | -0.0245 | 0.014** |
| | (0.004) | (0.004) | (0.006) | (0.019) | (0.006) |
| internet | 0.115*** | 0.249*** | 0.126* | 0.107*** | 0.020*** |
| | (0.016) | (0.021) | (0.065) | (0.013) | (0.029) |
| Constant | 6.712*** | 6.609*** | 5.661 | 0.469 | 10.470*** |
| | (1.410) | (1.004) | (4.206) | (1.535) | (2.301) |
| Observations | 129 | 78 | 39 | 65 | 125 |
| R-squared | 0.921 | 0.965 | 0.925 | 0.819 | 0.866 |
| Number of id | 10 | 6 | 3 | 5 | 10 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The estimation results above show that human capital significantly affects economic growth in each region. However, the estimation results show differences in the impact of human capital based on each region's characteristics. Java Island shows the most significant human capital impact when compared to other regions, with a human capital coefficient of 0.19%, followed by Sumatra Island with a coefficient of 0.13%, Kalimantan Island with a coefficient of 0.12%, Balinusra with a coefficient of 0.07%, and Sulampua area with a coefficient of 0.07%. These results are in line with the findings of Affandi, Anugrah, & Bary (2018), which show that Java Island has the most significant human capital coefficient value with a value of 0.20%, followed by Sumatra Island with a coefficient of 0.12%, Kalimantan Island with a coefficient value of 0.02%, and eastern Indonesia with a coefficient of 0.02%. However, Kalimantan and eastern Indonesia have yet to be proven to affect GDP significantly. This result is consistent with the FGD findings that the best level and quality of education is still concentrated in the western region of Indonesia.

The heterogeneity estimation results above also show that several other independent variables in the model are proven to affect GDP significantly. The patent variable as a proxy for innovation significantly affects GDP in Sumatra, Java, and Sulampua. Moreover, Java has the most significant impact of patents on growth with a coefficient of 0.19%, Sumatra with a coefficient of 0.06%, and Sulampua with a coefficient of 0.06%. Java has the most significant impact due to the presence of science and manufacturing centers that have an important role in increasing innovation in Indonesia. This finding also explains that innovation is important in keeping the economy growing. Sawang, Zhou, and Yang (2017) research explains that innovation affects economic growth by transmitting increased productivity.

Labor, investment, and internet variables are also proven to affect economic growth significantly. For labor, only Java (0.24) and Sumatra (0.22) significantly impact GDP. Meanwhile, investment, which is a proxy for capital, shows that Java (0.018) and Sulampua (0.014) significantly impact GDP. The internet variable is proven to significantly affect growth in all regions, with Java having the most significant impact with a coefficient value of 0.25%. This finding aligns with Affandi, Anugrah, and Bary (2018).

Indirectly, the estimation results above show a tendency for Western Indonesia to have a higher impact on increasing human capital than Eastern Indonesia. One of the main reasons is that Java is an industrial center that requires a lot of skilled and highly educated labor (Bappenas, 2023). Adding skilled labor in Java is important in maintaining productivity and economic contribution to Indonesia's GDP. In addition, Java also has more top schools with more competition, which plays a crucial role in improving the quality of education.

Non-Java regions, such as Sumatra, Kalimantan, Balinusra, and Sulampua, have a minor impact on economic growth due to differences in economic structure with Java. Non-Java regions rely on agriculture, marine, and mining sectors to drive economic growth. However, Ryandiansyah and Aziz (2019) explained that most jobs in these sectors contain unskilled and uneducated labor and tend to produce low productivity levels. Therefore, the strategy of optimizing human capital in the regions can be encouraged by increasing vocational education and informal education per the characteristics of the local area.

### 4.2. Indonesia's Education System Review

#### 4.2.1. Role of Government

Ministry of Education (2024) explains that three main factors are causing educational inequality in Indonesia: access, affordability, and infrastructure issues. Access to education is a concern due to the high number of out-of-school children. Currently, the Government has found that at least 131 thousand children from various levels of education have been verified to have dropped out of school, most of whom have reasons for preferring to work rather than go to school and do not want to go to school. BPS (2024) notes that the highest percentage of child laborers aged 10-17 years is in West Sulawesi Province (5.61%), followed by Gorontalo (5.37%), NTT (5.1%), and South Sulawesi (4.29%) which are in the Eastern Indonesia Region. Other reasons, such as lack of funds and marriage, were also common. This finding shows that the problem of access to education is closely related to the financial capability of the student's family and the affordability of education. Hence, providing quality and affordable schools is urgent because education is an important need for every Indonesian child.

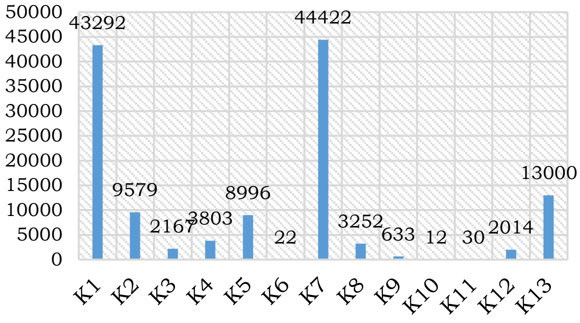



Figure 4. 2 Reason of Dropping out of School[1]

Source: Ministry of Education (2024)

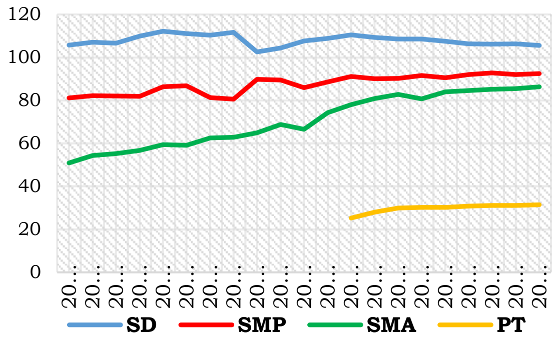



Figure 4. 3 Gross Enrollment Ratio

Source: BPS (2023)

The problem of access to education also correlates with the limited education infrastructure. The findings in the FGDs revealed that infrastructure availability and capacity are still a concern for the government in its efforts to equalize education in Indonesia. Facts on the ground show that the number of graduates in one level of education does not equal the number of seats available at the next level. This finding aligns with Indonesia's gross enrollment rate (APK) in the graph above, which continues to decline at each higher level. This problem threatens the sustainability of education in Indonesia because students cannot study for a minimum of 13 years due to inadequate educational capacity.

The available educational infrastructure is not free from serious challenges, not only because of its limited number but also because many are in disrepair. Kemendikbudristek (2024) states that nationally, 51.60% of education units (said) have moderately or severely damaged spaces, with some education levels, such as primary and junior high schools, experiencing high levels of damage, at 69.30% and 61.30%, respectively. Moreover, most of the damage is in Eastern Indonesia, with West Sulawesi (71%), NTT (67%), and Papua (66%) being the provinces with the worst levels of damage to education infrastructure in Indonesia.

These infrastructure-related problems require urgent attention, but the solutions require a large budget. Kemendikbudristek (2024) estimates that at least IDR 500 trillion is needed to repair all damaged education infrastructure, while the annual budget allocation is only IDR 15 trillion. This considerable cost is due to the

[1] K1: Does not want to go to school; K2: No money; K3: School is far from home; K4: Enough with current education level; K5: Married/Managing the neighborhood; K6: Experienced *violence/bullying* at school; K7: Working; K8: Influence of friends/environment; K9: Thinks school is not important; K10: Do not have school uniform: K11: Not having a birth certificate; K12: Health problem/Disability; K13: Other.

lack of a regular maintenance budget, so the government usually only intervenes when the infrastructure is already in severe disrepair. Without ongoing maintenance, education infrastructure will continue to degrade, hampering efforts to improve the quality of education in Indonesia.

Education problems in Indonesia have implications for *human capital*. Regions with limited access to education tend to have shorter average years of learning, significantly affecting people's knowledge, creativity, and skill levels (Affandi, Anugrah, & Bary, 2018). The lack of time spent in formal education limits the development of essential knowledge and skills needed to compete in the job market. As a result, regions with lower average years of study often need to catch up in labor productivity, which hinders their economic growth. This imbalance not only exacerbates the economic gap between the western and eastern regions of Indonesia but can also hinder the potential for optimal human capital development at the national level. The following figure shows the distribution of average years of study in Indonesia in 2023.

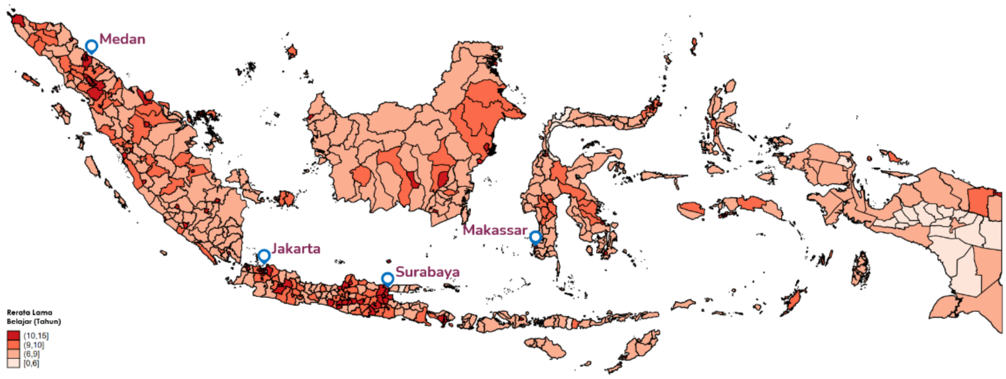
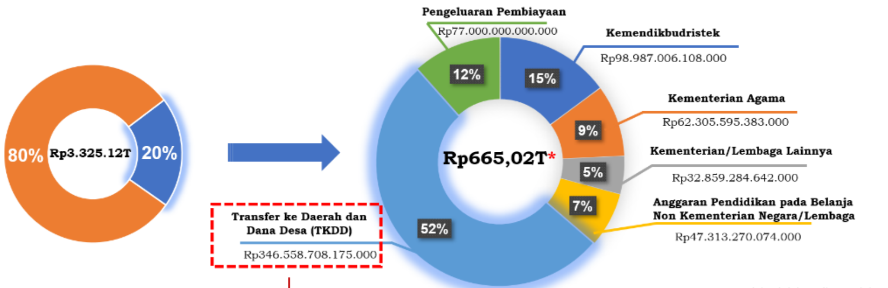



Figure 4. 4 Average Years of Schooling in Indonesia (2022)

Source: Sakernas (2022)

This map shows the average years of study in Indonesia and a very uneven distribution between regions across the country. The western regions of Indonesia, particularly Java and its surrounding islands, have higher average years of study, ranging from 10 to 15 years, as seen in the darker areas of the map. Large cities such as Jakarta, Surabaya, and Medan also show higher average years of study, reflecting better access to education in urban areas. In contrast, Eastern Indonesia, including Papua and parts of Nusa Tenggara, has much lower average years of study, with many areas where a large proportion of the population still needs to graduate from junior high school, as seen by the lighter colors. This disparity indicates that access to quality education remains a significant challenge in many remote areas, affecting these regions' human capital development and economic growth.

The education budget in Indonesia is allocated through various channels to ensure optimal and equitable utilization across regions. Overall, Kemendikbudristek (2024) explains that the education budget allocation constitutes 20% of the national budget, most of which is managed for transfers to regions and village funds (TKDD). TKDD funds are channeled through various schemes, such as the General Allocation Fund (DAU), Revenue Sharing Fund (DBH) prioritized for education, and physical and non-physical Special Allocation Fund (DAK). These transfer schemes to the regions are intended to improve the quality of education services at the local level and address education disparities between regions.




| | alokasi | % |
|---|---|---|
| Anggaran Pendidikan melalui Transfer ke Daerah dan Dana Desa (TKDD) | 346.558.708.175 | 100,00% |
| a. DAU dan DBH yang diperkirakan untuk Anggaran Pendidikan | 212.177.520.091 | 61,22% |
| b. Dana Alokasi Khusus | 132.135.766.740 | 38,13% |
| 1. DAK Fisik | 15.820.300.000 | 4,56% |
| 2. DAK Non Fisik | 116.315.466.740 | 33,56% |
| c. Otsus yang Diperkirakan untuk Anggaran Pendidikan | 2.245.421.344 | 0,65% |

Figure 4.5 Budget of Education Sector in Indonesia

Source: Perpres No.76 Tahun 2023

The composition of the overall education budget allocation also includes the various ministries that are responsible for education. The Ministry of Education receives the largest share of the ministry's education budget, with an allocation of IDR98.99 trillion or 15% of the total national education budget. In addition, the Ministry of Religious Affairs allocates IDR62.31 trillion to handle religious and religious education, demonstrating the government's commitment to supporting education in all sectors, including faith-based education. Other education-related expenditures, such as the education budget in other non-ministerial and institutional expenditures, are also considered to support the sector more broadly.

Of the total national education budget allocation of IDR665.02 trillion, the government allocates 52% for transfers to regions, indicating the government's focus on improving the quality of education at the local level. This condition signifies a decentralized approach to education management, where the central government allows local governments to manage funds according to their specific needs. This approach is expected to significantly impact equalizing education and improving the quality of Indonesia's human resources in various regions.

The education budget through the Transfer to Regional and Village Funds (TKDD) shows the government's attention to improving the quality of education in Indonesia, with an allocation of IDR 346.56 trillion. Most of these funds, 61.22%, are allocated to the General Allocation Fund (DAU) and Revenue Sharing Fund (DBH) which are prioritized for education, with around 60% of this TKD value used for personnel expenditure. This allocation reflects the need for local governments to finance the salaries and benefits of state civil servants in the education sector, including teachers and administrative staff. The significant use of DAU for personnel expenditure demonstrates the government's commitment to ensuring the welfare of educators, which is expected to contribute to improving the quality of education. In addition, 38.13% of the TKDD budget is channeled through the Special Allocation Fund (DAK) to support specific projects, both in the form of DAK Fisik and DAK Non-Fisik. This DAK distribution aims to address inequality and ensure equitable education services, including through school operational assistance, teacher professional allowances, and other education subsidies.

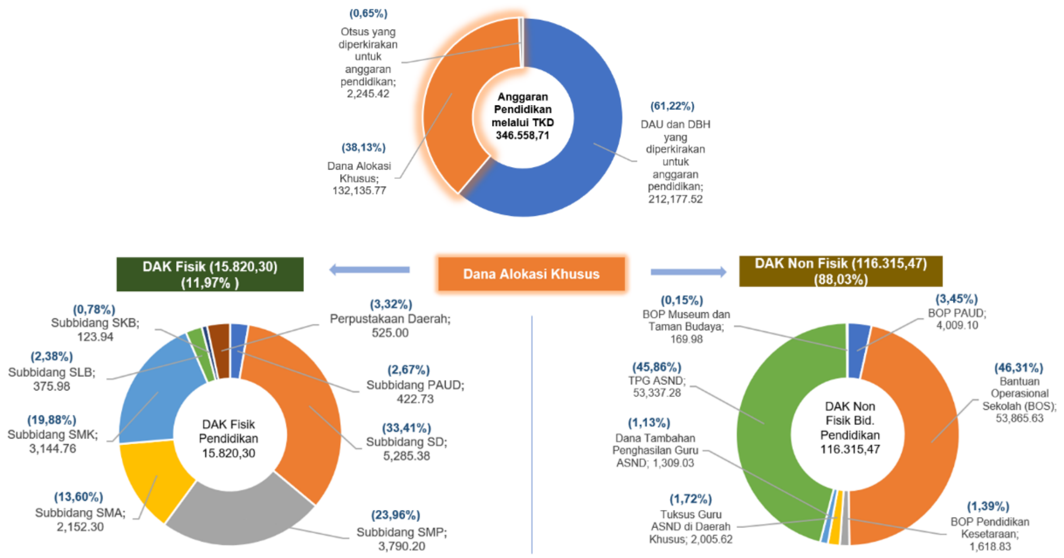



Figure 4.6 TKDD Structure of Education Budget

Source: Perpres No.76 Tahun 2023

Further analysis of the composition of DAK reveals that the largest allocations are in the Non-Physical DAK, particularly in the form of School Operational Assistance (BOS) which takes up 46.31%, and the Regional ASN Teacher Professional Allowance (TPG) at 45.86%. These allocations emphasize the importance of supporting education operations in schools, as well as providing incentives for educators in an effort to improve the quality of teaching. On the other hand, DAK Fisik, which has a value of around IDR15 trillion, focuses on improving and repairing educational facilities with the largest percentage allocated to primary schools (SD) at 33.41%, and junior secondary schools (SMP) at 23.96%, reflecting the government's priority in meeting the infrastructure needs of primary and secondary education. [However, FGDs revealed that the budget for maintenance costs is still very small, resulting in a high rate of deterioration of education units in Indonesia, especially in Eastern Indonesia. This financing structure illustrates a holistic approach in supporting education at the national level, from infrastructure aspects to improving teacher competencies, in order to achieve equity and improve the quality of education throughout Indonesia.

Although the education budget in Indonesia continues to increase every year, the quality of education has not shown an optimal improvement. The large allocation of funds, including transfers to regions for education, is expected to improve infrastructure, increase teacher welfare and expand access to education. However, the challenges faced are complex, such as unequal distribution of qualified teachers, limited facilities and infrastructure in remote areas and ineffective budget management at the local level. In addition, the significant use of budget for personnel expenditure, especially for salaries and allowances of state civil servants in the education sector, while important for the welfare of educators, often reduces the portion of funds that could be allocated to programs that directly support the improvement of learning quality.

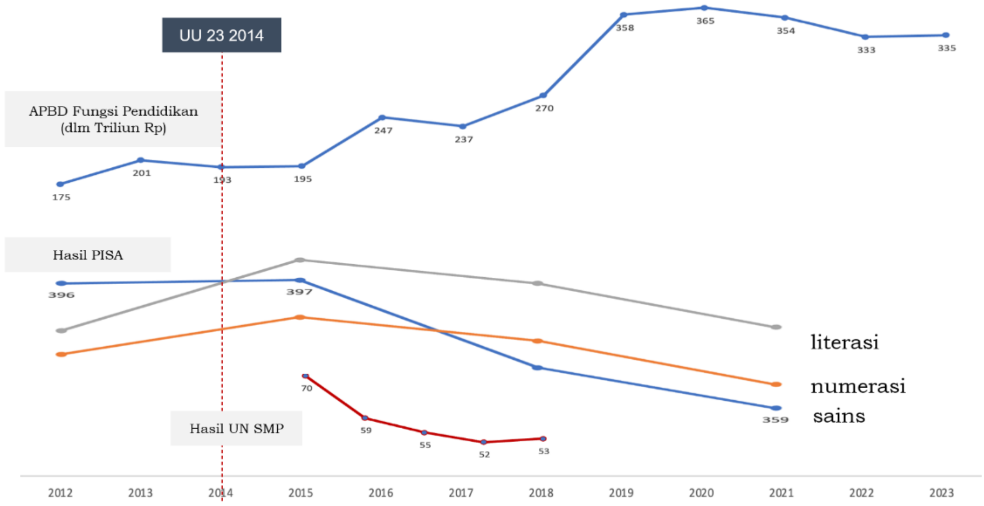



Figure 4.7 Growth of Education Budget on Academic Result

Source: Perpres No.76 Tahun 2023

The lack of improvement in the quality of education despite a growing budget can also be attributed to the low effectiveness of budget use for programs to develop teacher competencies and innovate teaching methods. Often, funds that are expected to strengthen the quality of teaching in schools do not fully reach this goal due to bureaucratic red tape and lack of strict supervision of budget utilization at the local level. In addition, problems such as a curriculum that is not adaptive to the needs of the world of work and low community participation in the education process are also obstacles. Thus, while the budget has been increased, comprehensive policy reforms and a more targeted approach to managing education funds are needed to have a significant impact on the quality of education across Indonesia.

### 4.2. Teacher Condition in Indonesia

OECD (2022) stipulates that the optimal teacher education standard is having at least a bachelor’s degree (S1). This standard was also recognized by the West Java and Bandung City Education Offices in FGDs, where they emphasized the importance of equalizing teacher education to at least S1 to improve the quality of education in the regions. Teachers with higher education are expected to be better prepared to face the challenges of modern education, including implementing more complex curricula and ever-evolving learning technologies. Adopting this standard will strengthen the national education system and improve student learning outcomes.

Kemendikbudristek (2024) states that by 2023, Indonesia will have 2.99 million teachers (excluding religious teachers) spread across the country. Of this number, around 44.96% are certified teachers, 71.9% of teachers have S1 education, 14% with S2 education, and 0.3% with S3 education. However, OECD (2022) shows that there are still 13.9% of teachers in Indonesia who have not reached the minimum education standard of S1. This figure tends to be greater than some other countries such as Korea (4.8%), USA (8.4%), UAE (6.3%), and Vietnam (3.2%).

Academics in the field of teaching emphasize the importance of teachers having at least a bachelor's degree. An undergraduate education not only provides more in-depth academic knowledge, but also allows student teachers to learn and practice the characteristics essential to the teaching profession. These characters include professionalism, generosity, commitment, and teacherly character that includes caring and willingness to go the extra mile for students. Similar findings in the FGDs revealed that the role of the teacher is as a second parent at school who also teaches character education for students. With undergraduate education, prospective teachers can be equipped with the necessary counseling skills and attitudes to carry out their duties effectively and inspiringly, which will ultimately improve the overall quality of education.

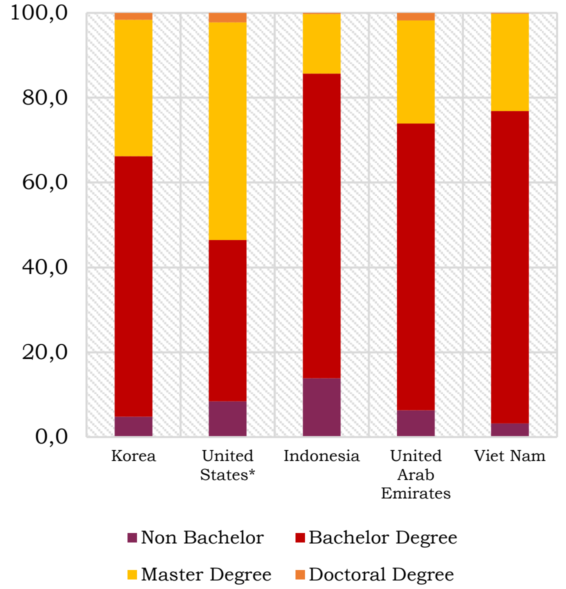



Figure 4. 8 Percentage of Teacher Based on Education Level

Source: OECD (2022)

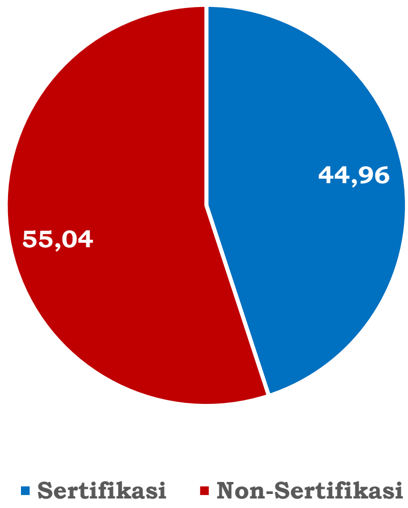



Figure 4. 9 Percentage of Sertified Teacher

Source: OECD (2022)

The distribution of teachers in Indonesia still needs to be more equal, mainly due to location factors, incentives, and family considerations. Many teachers are reluctant to be placed in remote or less developed areas due to difficult access and inadequate facilities. In addition, the incentives given to teachers in these areas often need to be more attractive to offset their challenges. Family considerations are also essential, with many teachers preferring to stay close to their families, often in urban or more developed areas. As a result, this uneven distribution of teachers impacts the gap in the quality of education across Indonesia. The figure below shows the distribution of teachers in Indonesia.

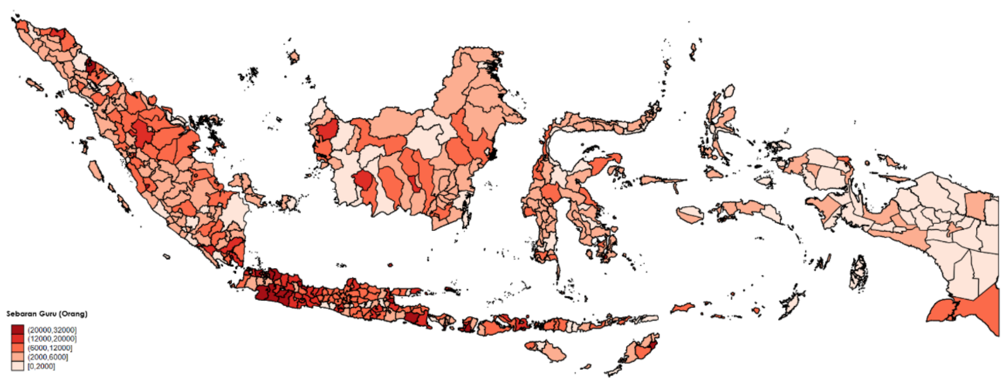


Figure 4.10 The Distribution of Teacher in Indonesia (2022)

Source: Sakernas (2022)

The western regions of Indonesia, especially Java and Sumatra, have a higher concentration of teachers, mainly due to the larger population in these areas. However, even though population factors play a role, eastern Indonesia, such as Papua and Maluku, still needs more teachers. The minimal number of teachers in the eastern regions indicates a significant challenge in distributing teaching staff evenly, directly impacting the quality of education in these areas. This highlights the need for more effective policies to address this disparity and ensure that every region has adequate access to quality teachers.

To address the disparity in teacher distribution in Indonesia, a strong push is needed from the Government to send quality teachers to areas that still need to be improved, especially in eastern regions such as Papua and Maluku. This initiative could include providing more attractive incentives, improving facilities in remote areas, and special programs that support teachers in carrying out their duties in challenging areas. With the proper support, quality teachers can be motivated to improve the quality of education in areas that need it most so that the education gap between regions can be significantly reduced.

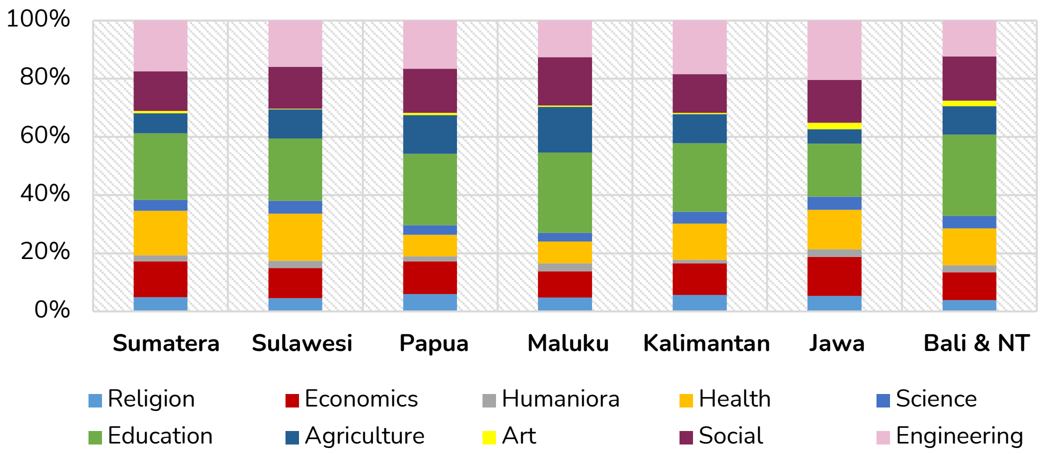



Figure 4.11 Percentage of University Graduates Based on Field of Study

Source: Sakernas (2022)

Although teaching and education graduates have the most significant percentage across the islands, many are reluctant to become teachers for various reasons. Challenges such as low salaries, lack of incentives, difficult working conditions in remote areas, and lack of support for career development often make these graduates choose other careers outside the teaching profession. In addition, tremendous pressure from parents of students is also a factor in considering education graduates tend to be reluctant to become teachers. Sakernas data (2022) shows that 22.32% of teacher training graduates chose not to work as teachers but instead to trade (5.36%) or become farmers (3.3%). To overcome this problem, a more effective strategy is needed to attract and retain teacher training graduates in the teaching profession, including improving teacher welfare and providing attractive incentives for placement in areas with a shortage of teachers.

The low welfare of teachers in Indonesia often makes them unable to entirely focus on teaching in class. Low salaries force some teachers to seek additional income by sacrificing their regular school duties, such as teaching private tutoring elsewhere. In addition, many teachers are trapped in debt, especially from online loans, which often have high interest rates and stifling conditions. This situation not only threatens the personal lives of teachers but also seriously impacts the quality of teaching received by students because teachers' attention and energy are focused on their financial problems. The following table shows the highest and lowest average teacher salaries by province in Indonesia.

BPS (2022) shows that the teacher salary in Indonesia, the provinces with the highest average teacher salaries include DKI Jakarta, with a permanent teacher salary of IDR 5,078,894, followed by Banten with IDR 4,475,258, and East Kalimantan, with IDR 3,894,285. These salaries show significant differences in teacher welfare levels between provinces, with Jakarta at the forefront of providing better compensation for its teachers, both permanent and honorary teachers.

BPS (2022) also shows that the provinces with the lowest average teacher salaries are East Nusa Tenggara, with a permanent teacher salary of only IDR 2,045,909; West Nusa Tenggara, with IDR 2,697,251; and East Java, with IDR 2,704,697. This condition shows that teacher welfare is still inadequate in several provinces, especially in eastern Indonesia. In addition, there are many cases where teachers' salaries are not paid on time or at all, worsening their conditions. These low salaries and payment uncertainty not only impact teacher motivation and performance but also exacerbate the inequality in the quality of education in various regions in Indonesia, given that teachers who experience financial difficulties are more likely to be distracted from their primary task of teaching.

### 4.4. Brain Drain

This study examines the brain drain phenomenon in Indonesia by highlighting the push and pull factors that influence educated workers to migrate abroad. Push factors in Indonesia, such as income inequality, limited economic opportunities, low levels of happiness, and high levels of corruption, encourage skilled workers to seek better opportunities abroad. On the other hand, pull factors from destination countries, such as high-quality education, wider economic opportunities, a more conducive environment for personal and professional well-being, and low levels of corruption, are solid attractions for skilled workers to leave Indonesia. The following graph shows the determinant values that influence the decision of skilled workers to work abroad.

Economic factors are one of the main drivers of the brain drain phenomenon in Indonesia, where significant push factors include income inequality and limited economic opportunities, especially for women. Inequality in the distribution of wealth causes dissatisfaction among skilled workers, while limited economic opportunities worsen the situation. In contrast, pull factors from destination countries such as the United Arab Emirates include a more equitable distribution of wealth and more significant economic opportunities. Although the cost of living in Indonesia is relatively low, the imbalance between the cost of living and quality of life, especially in terms of infrastructure and public services, is a reason for skilled workers to migrate to countries such as Vietnam, which offer more value for their income.

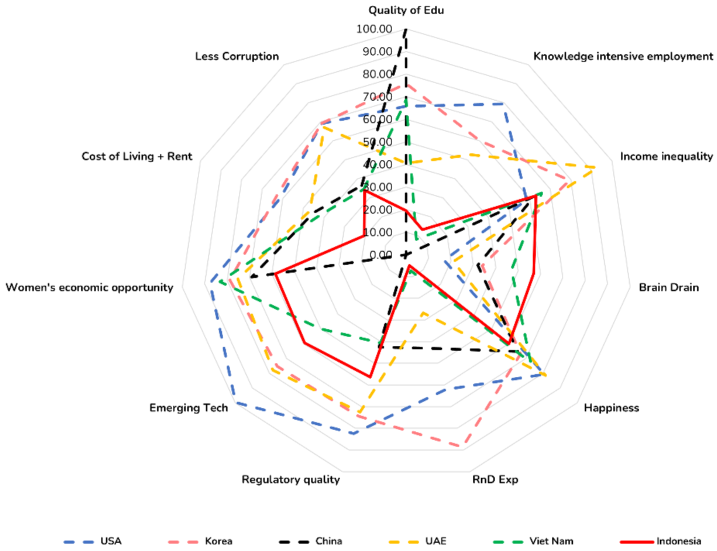



Figure 4. 12 The Determinant of Brain Drain in Indonesia

Source: Network Readiness Index (2023) & Fragile States Indeks (2023)

From a social perspective, Indonesia's low happiness level is another factor driving skilled labor migration. Low happiness scores indicate a lack of personal and professional well-being, so skilled workers are attracted to countries such as the United States and South Korea, which have higher happiness scores, as a pull factor. The environment in these countries is more supportive of well-being and career growth. On the other hand, Indonesia's high level of corruption creates uncertainty and unfairness in the workplace, which triggers frustration among professionals. Countries such as Vietnam, which have lower levels of corruption, offer a fairer and more transparent working environment, making them attractive to those seeking stability and clarity in their career development.

In terms of education, the main push factors are the still low quality of education in Indonesia and the lack of investment in research and development (R&D). This limits opportunities for knowledge and technology-based career development domestically. As a pull factor, countries such as the United States and South Korea offer high-quality education and large investments in R&D, which create a more supportive environment for skilled workers to develop their potential in technology and innovation-based sectors. This condition makes these countries more attractive to skilled workers seeking opportunities for professional development.

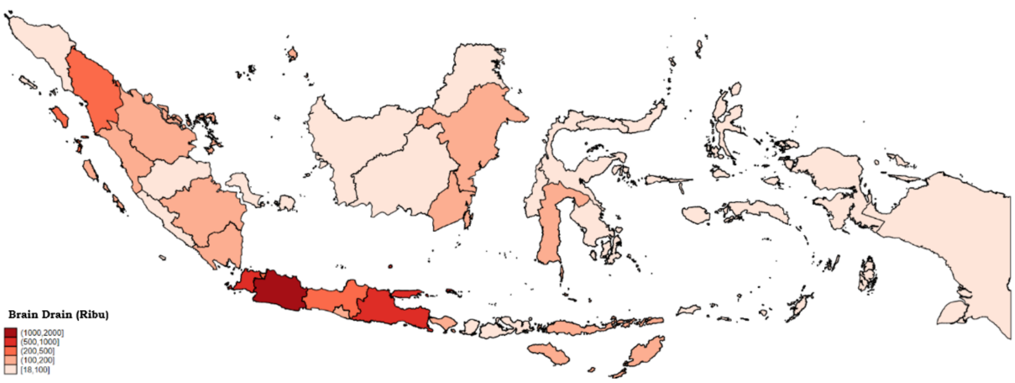



Figure 4. 13 The Destination of Domestic Brain Drain in Indonesia

Source: Sakernas (2022)

The brain drain phenomenon also occurs domestically in Indonesia due to uneven development, especially between Indonesia's western and eastern regions. Domestic brain drain can occur due to push and pull factors, such as finding work, continuing higher education, joining a family, or gaining access to better social services (Sukamdi & Muhajid, 2015). Less developed regions tend to lose highly educated workers due to migration to more developed regions, such as Java (Corcoran et al., 2010; Wajdi, Mulder, & Adioetomo, 2017). Based on the graph above, Java Island, especially West Java Province, is the leading destination for domestic brain drain because it has the largest number of factories/industries in Indonesia (Ministry of Industry of the Republic of Indonesia, 2023). Domestic brain drain can worsen inequality between regions in Indonesia, as more developed regions continue to attract skilled workers while less developed regions lose valuable human resources. This can hamper development in disadvantaged regions and widen economic and social disparities between regions in Indonesia.

To reduce the level of brain drain in Indonesia, the reverse brain drains policy needs to be implemented comprehensively and in synergy with other policies, such as the development of science and technology, as well as building cooperation between academics, businesses, and the government (Saefuloh, 2012). One of the central policies that can be implemented is the expansion of employment opportunities throughout Indonesia, especially considering the increasing unemployment rate among skilled workers every year. The Government must provide jobs that can accommodate the needs of skilled workers by providing adequate income, thus preventing them from migrating abroad. In addition, improving facilities and opportunities in less developed areas is essential to retain skilled workers so that they continue to contribute in their home regions, thereby reducing disparities between regions (Corcoran et al., 2010; Sukamdi & Muhajid, 2015; Wajdi, Mulder, & Adioetomo, 2017).

## 5. Implication / Policy Recommendation

This study recommends several policies supporting human capital development and deepening understanding of its relationship to economic growth. The recommendations include the following steps:

(1) Improve access to and quality of education, especially in areas with low education levels. The government should improve education equity by promoting the 13-year compulsory education policy, improving education accessibility and capacity, and providing tuition assistance.

(2) Equalizing and improving education infrastructure across regions. The government needs to increase spending on education infrastructure development in all regions, especially infrastructure spending and maintenance costs.

(3) Strengthening STEM learning and English language acquisition with a stable curriculum. Education programs need to be directed at strengthening STEM (science, technology, engineering and mathematics) learning and English language skills. These two aspects are needed to equip the Indonesian workforce to be more adaptive to the needs of technology-based industries and more competitive in the global market.

(4) Improve teacher welfare and *anti-bullying* programs. The government needs to improve teachers' welfare and provide regular training to improve their competencies. In addition, it is important to ensure that the school environment

is free from social problems such as *bullying*, so that students can learn in an atmosphere that is safe and supportive of their development.

(5) Conduct a *reverse brain drain* policy by increasing career opportunities in *knowledge-intensive* jobs in the country. The government needs to create knowledge-based jobs, provide incentives for skilled labor, and support innovation through a conducive ecosystem. By providing attractive opportunities domestically, Indonesia can retain its best talent to support national economic growth.

## 6. Conclusion and Further Research

This study highlights the important role of *human capital* in driving Indonesia's economic growth. Through a panel data regression approach, this study finds that increasing *human capital*, especially quantitatively through education, has a significant positive impact on economic growth. This is due to the ability of education to improve the skills and knowledge of the workforce, which in turn leads to increased productivity. Higher productivity can increase economic growth.

This study also estimates the role of qualitative *human capital* , which is measured through cognitive ability. In this case, expertise in STEM fields such as chemistry, biology, physics, and math, has a significant positive impact on economic growth. This is because these skills are needed in key sectors of the Indonesian economy that are increasingly based on technology and innovation. In addition, English language proficiency is also an important factor, especially in the face of globalization which increasingly requires the workforce to be able to compete internationally. Expertise in STEM combined with mastery of the English language creates a more adaptive and competitive workforce, thereby driving stronger economic growth.

The study also found that the impact of *human capital* on economic growth varies across regions. The Java region shows the largest impact on growth, followed by Sumatra and Kalimantan. This is because regions on large islands tend to have better education infrastructure, more competitive levels, and high demand for skilled labor from industry. In addition, problems related to access, affordability and education infrastructure in the regions are the main causes of inequality in the quality of education in Indonesia.

The government has a strategic role in addressing education inequality and maximizing *human capital* impact. The education budget allocation of 20% of the state budget shows great commitment, but its use has not been fully optimized. Most of the budget is still allocated to teachers' salaries, while investment in education infrastructure, teacher training and learning quality improvement programs is still very limited. The school zoning policy that aims to equalize access to education also faces implementation challenges, especially in areas that lack good education facilities.

Teachers, students and parents play an important role in creating a quality education system. However, teachers still face various challenges that hamper their effectiveness, ranging from inadequate qualifications to unequal distribution. Low teacher welfare also exacerbates the situation, making it difficult for many teachers to provide optimal learning in schools. On the other hand, the school environment is often not fully supportive, with social issues such as *bullying* still occurring, disrupting students' safety at school. Parents also play an important role in ensuring that children have access to adequate education, as well as providing emotional support and motivation to help them develop their potential and achieve optimally.

The *brain drain* phenomenon is a serious challenge for Indonesia in optimally utilizing *human capital*. Many skilled workers, including STEM professionals, choose to work abroad due to higher wages and better career opportunities. This condition results in the loss of potential human resources to drive domestic economic growth. To overcome this, the government needs to encourage the creation of *knowledge-intensive* jobs, provide incentives for skilled workers, and build a conducive education/innovation climate in Indonesia. With the right strategic steps, the *brain drain* phenomenon can be minimized so that Indonesia's *human capital* can make the maximum contribution to the economy.

This study has limitations because its main focus is on education at the high school level, with discussions limited to universities and yet to cover elementary, junior high, and vocational education. These levels, including early STEM-based education and vocational education oriented to industry needs, have an important role in supporting human capital development. This limitation opens up opportunities for further research to explore the broader contribution of all levels of education to economic growth.

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