

The Effect of ICT on Economic Growth: Empirical Evidence from Indonesia 2017-2022

Shifa Rizkia Yubaidillah¹, Wahyu Widodo^{2*}

^{1,2}Faculty of Economic and Business, Diponegoro University, Semarang, Indonesia

¹shifarizkiay@gmail.com, ²wahyuwid2002@gmail.com

*Corresponding Author

Abstract

In the current digital era, technology plays a crucial role in driving economic growth. Rapid advancements have significantly impacted economic activity. This study aims to analyze the effect of Information and Communication Technology (ICT) on economic growth in Indonesia using panel data from 34 provinces during the period 2017-2022. In this research, ICT is measured through the sub-indices of access and infrastructure, usage, and skills. The method used is panel data regression using a fixed effects model (FEM), with adjustments for robust standard errors. The estimation results indicate that ICT has a positive and significant effect on economic growth. Physical capital has a positive effect, whereas depreciation and population growth negatively affect economic growth. Both variables were statistically significant and aligned with economic theory. While all three ICT sub-indices contribute positively, their impact remains smaller than that of physical capital growth.

Keywords: Solow growth model, information and communication technology, panel data, fixed effect model

Pengaruh TIK terhadap Pertumbuhan Ekonomi: Bukti Empiris di Indonesia 2017 – 2022

Abstrak

Di era digital saat ini, teknologi memainkan peran penting dalam mendorong pertumbuhan ekonomi. Perkembangan pesat telah membawa dampak pada aktivitas ekonomi. Penelitian ini bertujuan untuk menganalisis pengaruh teknologi informasi dan komunikasi (TIK) terhadap pertumbuhan ekonomi di Indonesia menggunakan data panel dari 34 provinsi selama periode 2017-2022. TIK dalam penelitian ini diukur melalui subindeks akses & infrastruktur, subindeks penggunaan, dan subindeks keahlian. Metode yang digunakan adalah regresi panel data dengan *fixed effect model (FEM)* dengan penyesuaian *robust standard error*. Hasil estimasi menunjukkan bahwa variabel TIK memiliki pengaruh positif dan signifikan terhadap pertumbuhan ekonomi. Selain itu, modal fisik juga berpengaruh positif, sedangkan depresiasi dan pertumbuhan penduduk berpengaruh negatif terhadap pertumbuhan ekonomi. Kedua variabel tersebut signifikan secara statistik dan konsisten dengan teori ekonomi. Meskipun ketiga subindeks TIK memberikan dampak positif, pengaruhnya masih lebih kecil dibandingkan pertumbuhan modal fisik.

Kata kunci: Model pertumbuhan Solow, teknologi informasi dan komunikasi, data panel, fixed effect model

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INTRODUCTION

Economic growth refers to a country's increasing production capacity over time, typically measured by the Gross Domestic Product (GDP), which represents the total value of goods and services produced (Mankiw, 2019; Todaro & Smith, 2015). As a key economic

indicator, it influences income levels, employment, and the overall living standards. Sustained economic growth enables a nation to enhance its productive capacity and improve societal well-being. However, growth patterns vary across regions and are dependent on multiple factors.

According to Solow's economic growth theory, growth is driven by capital accumulation, labor, and technological progress (Mankiw, 2019). While capital and labor serve as tangible production inputs, technological advancements significantly enhance productivity. In the digital era, Information and Communication Technology (ICT) has emerged as a crucial driver of innovation, efficiency, and competitiveness in various economic sectors, including trade, public administration, education, and healthcare. ICT facilitates rapid communication, reduces operational costs, and expands market access through digital transactions and automation (Bahrini & Qaffas, 2019).

In Indonesia, ICT development plays a pivotal role in promoting economic growth, particularly in reducing the digital divide among regions. As the largest economy in Southeast Asia, Indonesia has experienced rapid digital transformation owing to increased Internet penetration, mobile connectivity, and digital literacy initiatives. However, challenges such as infrastructure disparities and unequal digital access persist in the country. To assess ICT's progress and economic impact, Indonesia employs the ICT Development Index (ICTDI), which comprises three sub-indices: access and infrastructure, usage, and skills.

The access and infrastructure sub-index reflects Internet availability, mobile penetration, and broadband coverage as fundamental components of digital connectivity. The usage sub-index evaluates the extent to which individuals, businesses, and government entities integrate ICT into economic and social activities such as digital transactions and e-government services. Meanwhile, the skills sub-index measures digital literacy and technical proficiency, which are essential for optimizing ICT utilization.

Based on Figure 1, in 2022, the skills sub-index recorded the highest value at 6.00, followed by ICT usage at 5.82 and access and infrastructure at 5.80, with the fastest growth observed in ICT usage at 2.75% owing to rising Internet penetration. Access and infrastructure increased by 0.69% with growing mobile phone adoption, whereas the skills sub-index rose by 0.50%. However, the growth of all three sub-indices has slowed over the past five years, highlighting persistent challenges in equitable ICT access and utilization. The interplay among these sub-indices' shapes ICT's overall impact on efficiency, productivity, and economic inclusivity. Addressing infrastructure gaps, enhancing digital literacy, and implementing supportive policies are crucial for optimizing ICT's role of ICT in fostering sustainable economic growth across Indonesia.

Empirical studies have presented mixed findings regarding the ICT-economic growth relationship. Wardhana et al., (2020) found that the ICTDI positively influenced economic growth in western and eastern Indonesia from 2014 to 2018. Similarly, Ibrahim & Fetai (2022) and Toria Nipo et al. (2022) reported a positive association between ICT, measured by internet users and broadband subscriptions, and economic growth. However, other studies yield different conclusions. Mayer et al., (2020) found that fixed broadband

penetration did not significantly contribute to economic growth in 29 OECD countries from 2008 to 2014. Likewise, Khaira & Ariusni (2020) and Putri & Idris (2020) suggested that ICT had no significant impact on Indonesia's economic growth, highlighting the role of complementary factors such as infrastructure quality and digital literacy.

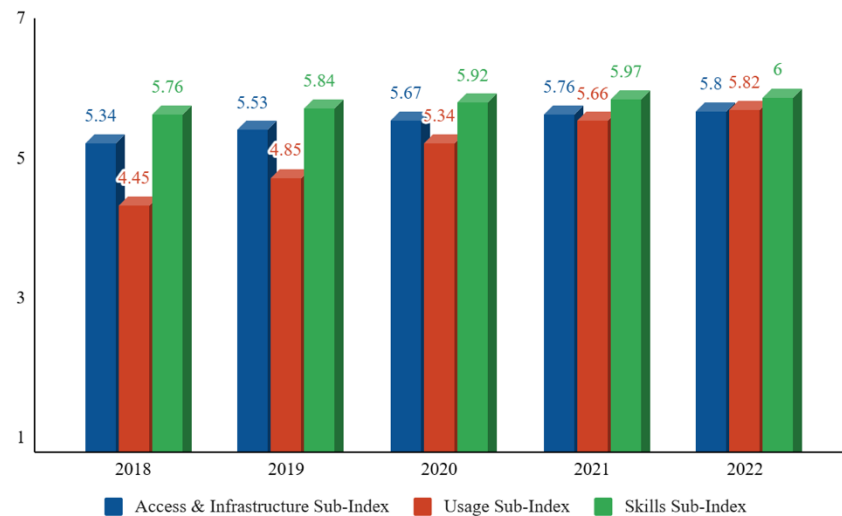


Figure 1. ICT Sub-Index Development from 2018 - 2022 (Index)

This study analyzes ICT's impact on economic growth across Indonesia's 34 provinces, utilizing ICTDI and its sub-indices as key variables. Unlike previous studies, this study also analyzes ICT sub-indices, allowing for a more in-depth look at the components of ICT that contribute to economic growth. This sub-index-level analysis is both technically novel and provides more targeted policy recommendations. By examining ICT development and regional economic performance, this study aims to provide insights into how digital transformation can drive sustainable and inclusive economic growth.

LITERATURE REVIEW

Research on the relationship between Information and Communication Technology (ICT) and economic growth suggests that ICT plays a crucial role in driving economic development. However, its impact varies depending on infrastructure quality, digital adoption levels, and macroeconomic conditions across regions. ICT infrastructure, including broadband access, Internet penetration, and mobile phone subscriptions, generally contributes positively to economic growth; however, its effectiveness depends on technological readiness and supportive policies. As previously mentioned and will be discussed in more depth in the following discussion, some of these studies include: (Ibrahimi & Fetai, 2022; Khaira & Ariusni, 2020; Mayer et al., 2020; Toria Nipo et al., 2022; Wardhana et al., 2020) and (Putri & Idris, 2020).

Several studies focusing on European and OECD countries have highlighted the significant impact of ICT on economic growth. Toader et al., (2018) ICT infrastructure contributed to economic growth in 28 European Union countries, although the extent of the impact varied. Mayer et al., (2020) emphasized that broadband speed had a significant

positive effect on economic growth in 29 OECD countries, whereas broadband penetration alone was insufficient to do so. Similarly, Myovella et al. (2020) compared OECD and Sub-Saharan African countries and found that digitalization contributed positively to economic growth in both regions.

In Asia, research indicates that ICT plays a crucial role in boosting economic growth. Shodiev et al. (2021) found that increased broadband and Internet usage significantly enhanced per capita GDP in Central Asian countries. Toria Nipo et al. (2022) confirmed that ICT positively influenced economic growth in 20 Asian countries, although fixed-line telephone subscriptions had no significant impact because of their high costs and lower practicality compared to other forms of ICT. Additionally, studies in ASEAN and Belt and Road Initiative (BRI) countries by Thoyibah & Sugiharti (2022) and Zhao et al., (2022) demonstrated that digital and technological advancements positively contribute to economic growth, particularly through ICT exports and internet user growth.

Research in Indonesia has produced mixed findings regarding ICT's impact of ICT on economic growth. Wardhana et al., (2020) found that the ICT Development Index contributed to economic growth in both Western and Eastern Indonesia. Nurlela et al., (2021). found that Internet users and mobile phone subscribers positively influenced economic growth, whereas fixed-line telephone subscribers had no significant effect. However, Putri & Idris, (2020) , found that ICT had no significant impact on Indonesia's economic growth, possibly due to the uneven infrastructure distribution across provinces.

Overall, existing studies indicate that ICT has the potential to drive economic growth, but its impact depends heavily on infrastructure readiness, digital adoption levels, and economic policies in each country. As previously mentioned, and will be discussed in more detail in the following discussion, some of these empirical studies are include (Ibrahimi & Fetai, 2022; Khaira & Ariusni, 2020; Mayer et al., 2020; Toria Nipo et al., 2022; Wardhana et al., 2020) (Putri & Idris, 2020). While most research supports a positive relationship between ICT and economic growth, some studies present mixed or even negative findings, particularly when infrastructure is inadequate or regulatory frameworks are underdeveloped. Therefore, ICT development should be accompanied by strategies tailored to local conditions to maximize its benefits. Empirically, the research gap that provides space for further investigation of this issue is the existence of inconclusive findings. Thus, it creates an opportunity to conduct a deeper study on how ICT development influences regional economic growth based on province level in Indonesia.

METHOD

This study analyzes panel data regression using three main approaches: the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). CEM is the simplest method, as it ignores individual and time characteristics and utilizes the Ordinary Least Squares (OLS) approach. FEM accounts for individual differences through specific intercepts that remain time-invariant and often uses dummy variables. Meanwhile, the REM assumes that individual effects are random and uncorrelated with independent variables, improving parameter estimation efficiency.

A series of statistical tests were conducted to determine the most suitable model. The Chow test compares the CEM and FEM, with the decision based on the probability value of the cross-section F. If the value is greater than 0.05, CEM is preferred; otherwise, FEM is more appropriate. Next, the Hausman test distinguishes between FEM and REM using the probability value of the random cross-section. A value greater than 0.05 supports the REM, whereas a lower value favors the FEM. Finally, the Lagrange Multiplier (LM) test determines whether CEM or REM is more suitable, based on the probability value of the cross-section Breusch-Pagan. If the value is greater than 0.05, the CEM is preferred; otherwise, the REM is more appropriate. The results of these tests help identify the most suitable panel data regression model, ensuring accuracy in measuring the impact of variables on economic growth.

Estimation Model

To analyze the impact of ICT on economic growth, this study references Solow's growth theory. Solow (1956) introduced the concept of technological progress as an additional factor influencing long-term economic growth. In Solow's model, technological progress is incorporated to enhance productivity. The Solow production function can be represented using a Cobb-Douglas function, as shown in Equation (1), where $K(t)$ represents capital, $A(t)$ denotes technological progress, and $L(t)$ refers to labor:

$$Y(t) = K(t)^{\alpha} (A(t)L(t))^{1-\alpha} \dots\dots\dots (1)$$

In Equation (2), labor $L(t)$ and technological progress $A(t)$ are assumed to grow at constant exogenous rates $(n+g)$:

$$L(t) = L(0)e^{nt} \text{ and } A(t) = A(0)e^{gt} \dots\dots\dots (2)$$

Equation (1) portrays (A) as the factor enhancing labor productivity, leading to Equation (3), where output per labor unit is written as:

$$Y(t) = A(t)k(t)^{\alpha} \quad 0 < \alpha < 1 \dots\dots\dots (3)$$

In the Solow model, capital accumulation is the primary driver of economic growth. Changes in capital determine changes in total income, as described by the following equation:

$$\dot{k}(t) = S_k y(t) - (n + g + \delta)k \dots\dots\dots (4)$$

Here, S_k is the rate of physical capital accumulation, (δ) is depreciation, (n) is population growth, and (g) is technological progress. Equation (5) denotes convergence,

where steady-state conditions are met when $k' = 0$. The steady-state capital-per-worker equation is as follows:

$$K^* = \left(\frac{sk}{n+g+\delta} \right)^{\frac{1}{1-a}} \dots\dots\dots (5)$$

This can be simplified into Equation (6), representing steady-state output per worker:

$$y^* = \left(\frac{sk}{n+g+\delta} \right)^{\frac{a}{1-a}} \dots\dots\dots (6)$$

Based on this theory, this study focuses on the impact of ICT, decomposed into three sub-indices: access and infrastructure, usage, and ICT skills. Thus, the research model equation is formulated as follows:

$$\ln PE_{it} = \beta_0 + \beta_1 ACCESS_{IT} + \beta_2 USE_{it} + \beta_3 SKILL_{it} + \beta_4 \ln SK_{it} + \beta_5 (n + g + \delta)_{it} + e_{it} \dots (7)$$

Where $\ln PE$ represents the natural logarithm of GRDP per capita as a proxy for economic growth. The ICT variables are measured by $ACCES$ (the ICT access & infrastructure sub-index), USE (the ICT usage sub-index), and $SKILL$ (the ICT skills sub-index). Meanwhile, the term $(n+g+\delta)$ combines population growth (n) with technological progress (g) and depreciation (δ), which are assumed to be constant at 0.05. $\ln Sk$ represents the natural logarithm of gross fixed capital formation per capita. The subscripts i and t denote provinces and years, respectively, and e is the error term. Based on the theoretical background and empirical model, the hypotheses in this study are formulated as follows:

1. The ICT access and infrastructure sub-index has a positive effect economic growth in Indonesia's 34 provinces from 2017-2022.
2. The ICT usage sub-index has a positive effect economic growth in Indonesia's 34 provinces from 2017-2022.
3. The ICT skills sub-index has a positive effect economic growth in Indonesia's 34 provinces from 2017-2022.
4. Physical capital has a positive effect economic growth in Indonesia's 34 provinces from 2017-2022.
5. Depreciation and population growth has a negative effect economic growth in Indonesia's 34 provinces from 2017-2022.

Description of Variables

This study uses secondary data to analyze economic growth, measured by the regional GDP per capita at constant prices. Physical capital is measured through Gross Fixed Capital Formation (GFCF) per capita, while depreciation and population growth are calculated as the sum of population growth (n), technological progress (g), and depreciation (δ). The combined value of $(g+\delta)$ is typically assumed to be 0.05 and is consistent across regions and time periods. ICT is proxied by the sub-indices of access, infrastructure, usage, and skills.

The data used are panel data, combining time-series and cross-sectional observations. This study uses data from 34 provinces in Indonesia from 2017 to 2022, sourced from the Central Bureau of Statistics, Indonesia (BPS).

Table 1. *Description of Variables*

Variables	Measurement	Source
Economic Growth	GRDP per-capita (million rupiah)	Central Bureau of Statistics Indonesia
Physical Capital	Gross Fixed Capital Formation (million rupiah)	
Depreciation and Population Growth	Population growth rate (%) + 0.05 (assumed constant rate for technological progress and depreciation)	
Access & Infrastructure Sub-index	ICT readiness, including access and infrastructure (Index)	
Usage Sub-index	ICT usage level or intensity (Index)	
Skills Sub-index	ICT-related skills and capabilities (Index)	

Source: Central Bureau of Statistics Republic of Indonesia (*Badan Pusat Statistik – BPS*)

FINDING AND DISCUSSION

Finding

This study employs the Ordinary Least Squares (OLS) method. To ensure the selection of the most appropriate model, a series of tests were conducted, including the Chow and Hausman tests. These tests aim to determine whether the best model to be used is the common effect, fixed effect, or random effect model. To obtain accurate results, it is essential to conduct tests to select the best panel regression model. Table 2 presents the results of the Chow test, which shows an F-statistic probability value of 0.00, which is smaller than α (0.05). Additionally, the Hausman test reveals a cross-section random probability value of 0.00, which is smaller than α (0.05). Based on the results of the Chow and Hausman tests, the fixed effects model (FEM) was chosen as the best model, outperforming the common effects model (CEM) and the random effects model (REM).

Table 2. *Selection Method of Panel Data Regression*

Chow Test	Hausman Test
Prob. F-statistic = 0,000	Chi-square = 65,01
	Prob. chi-square = 0,0000

After selecting the best panel regression model, classical assumption tests were performed to validate the regression results. These tests aimed to detect issues related to multicollinearity, autocorrelation, and heteroskedasticity. A multicollinearity test was performed to identify correlations among the independent variables. In this study, the correlation values were compared using a threshold of 0.8. The results shown in Table 3 indicate that some correlation values exceed 0.8, suggesting the presence of multicollinearity in the regression model.

Table 3. *Multicollinearity Test Results*

Variable	ACCESS	USE	SKILL	lnSk	(n+g+ δ)
ACCESS	1,0000	0,8032	0,4323	0,4386	-0,2309
USE	0,8032	1,0000	0,3455	0,4683	-0,2045
SKILL	0,4323	0,3455	1,0000	0,1521	-0,1012
lnSk	0,4386	0,4683	0,1521	1,0000	-0,0459
(n+g+ δ)	-0,2309	-0,2045	-0,1012	-0,0459	1,0000

The Wooldridge test was used to evaluate the correlation of variables over time. As shown in Table 4, the results reveal an F-statistic probability of 0.0000, which is less than α (0.05), indicating the presence of autocorrelation in the regression model.

Table 4. *Autocorrelation Test Results*

F(1,33)	114,796
Prob > chibar-square	0,0000

A heteroskedasticity test was performed to assess the inequality of the residual variances. The Wald test results, as presented in Table 5, show a chi-square probability value of 0.0000, which is less than α (0.05). This confirms that the regression model suffers from heteroscedasticity.

Table 5. *Heteroscedasticity Test Results*

Chi-square	1470,82
Prob > chi-square	0,0000

This study uses the fixed effects model (FEM) but encounters issues with heteroskedasticity and autocorrelation, which violate classical assumptions. These issues can result in inefficient estimations and inaccurate standard error. To address this, robust standard errors were employed to provide more consistent standard error estimates, even in the presence of heteroscedasticity and autocorrelation (Wooldridge, 2010).

Table 6. *Empirical Model Estimation Results (With Robust Standard Error), Dependent Variable is Economic Growth (lnPE)*

Independent Variables	Coefficient	t-statistic
lnSk	0,3697313	16,65*
(n+g+ δ)	-0,0046406	4,22*
ACCESS	0,0284438	-3,35*
USE	0,0175488	2,76*
SKILL	0,0216348	3,04**
Constant	13,57611	16,65*
N	204	
R ²	0,8191	
F-statistic	36,42	
Prob (F-statistic)	0,0000	

Notes: The variable n refers to population growth, with (g+ δ) assumed constant at 0.05, while * and ** indicate significance levels at 1% and 5%, respectively.

In conducting the F-test, the F-statistic was compared with the F-table value. This study used a significance level of $\alpha = 0.05$, with a numerator degree of freedom of 5 ($dfn = 6 - 1$) and a denominator degree of freedom of 198 ($dfd = 204 - 6$). The resulting F-table value was 2.259697. According to Table 6, the F-test result shows an F-statistic of 36.42, which is greater than the F-table value of 2.259697. Thus, the null hypothesis (H_0) is rejected, indicating that the sub-indices of access and infrastructure, usage, skills, physical capital, as well as depreciation and population growth have a simultaneous and significant influence on economic growth in the 34 provinces of Indonesia. Furthermore, the coefficient of determination test results indicate an R-squared value of 0.8191, meaning that approximately 81.91% of the variability in economic growth can be explained by these variables, while the remaining 18.09% is influenced by other factors not included in the model.

The t-test results indicate that the ICT sub-index for access and infrastructure (with a t-statistic = 2.76), usage (t-statistic = 3.04), and skills (t-statistic = 2.31), along with physical capital ($\ln Sk$, t-statistic = 4.22), and the combined factor of depreciation and population growth ($n + g + \delta$, t-statistic = 3.35), all have t-statistics exceeding the critical value of 1.97. This implies that these variables have a statistically significant effect on economic growth in the 34 provinces in Indonesia during the study period. The high t-statistics provide strong evidence that ICT development, in terms of access to infrastructure, effective usage, and skill enhancement, contributes positively to economic expansion. Additionally, physical capital and the combined variable representing depreciation and population growth play crucial roles in shaping provincial economic performance. This analysis aligns with the underlying assumptions of the Augmented Solow model, in which technological advancement and capital accumulation are key drivers of growth.

Discussion

The Effect of ICT Access & Infrastructure Sub-index on Economic Growth

The ICT access and infrastructure sub-index has a positive and significant effect on economic growth, indicating that improvements in this sub-index contribute to economic growth. A coefficient of 0.0284438 suggests that each unit increase in the ICT access and infrastructure sub-index boosts economic growth by 0.02844%. Conceptually, access to ICT increases economic productivity from both the demand and supply sides. From the demand side, transactions between economic actors become more efficient and reduce transaction costs. Meanwhile, from the supply side, producers' access to information technology increases total factor productivity, which ultimately contributes to economic growth. The same condition applies to improvements in information technology infrastructure, which will encourage the efficiency of capital used. This finding aligns with the initial hypothesis and corroborates the research of Sibarani et al., (2023), which found that the ICT access and infrastructure sub-index significantly influences economic growth. Nabi et al., (2023) . further emphasized that ICT access and infrastructure play a critical role in fostering economic growth. According to Pradhan et al., (2017), efficient and widespread

telecommunications infrastructure contributes to economic development by providing essential revenue sources for innovation and knowledge-based economies.

The Effect of ICT Usage Sub-index on Economic Growth

The ICT usage sub-index also exhibits a positive and significant effect on economic growth, implying that improvements in ICT usage contribute to economic growth. The coefficient of 0.0175488 indicates that every unit increase in the ICT usage sub-index enhances economic growth by 0.0175488%. As with other ICT sub-indices, the use of ICT boosts productivity by improving time efficiency. This will reduce transaction and production costs and drive economic growth. This result is consistent with the initial hypothesis and supported by (Ebrahimi et al., 2023), who found that the ICT usage sub-index significantly affects economic growth. Similarly, Shodiev et al., (2021) identified variables such as internet users and fixed broadband subscribers, which serve as indicators of the ICT usage sub-index, as contributors to economic growth. Their study highlights that ICT adoption can enhance economic output, which is a crucial indicator of economic growth.

The Effect of ICT Skills Sub-index on Economic Growth

The ICT skills sub-index has a positive and significant effect on economic growth. An increase in this sub-index boosts economic growth, with a coefficient of 0.0216348, suggesting that each unit increase in the ICT skills sub-index drives economic growth by 0.0216348%. Conceptually, this sub-index contributes to economic growth through the quality of human capital. The higher the mastery of information and technology skills, the higher the level of labor productivity. As evidenced by numerous empirical studies, such as those by (Mankiw, 2019), human capital is a crucial factor in driving economic growth. This outcome aligns with the initial hypothesis and is consistent with findings from (Remeikiene et al., 2021), who stated that the ICT skills sub-index positively influences economic growth. Additionally, (Habibi & Zabardast, 2020), who used the gross enrollment ratio as an indicator for the ICT skills sub-index, found a significant impact on economic growth. A more educated and skilled workforce can utilize technology more efficiently, thereby fostering ICT development (Arbia et al., 2023).

The Effect of Physical Capital on Economic Growth

Physical capital has a positive and significant effect on economic growth, with a coefficient of 0.3697313, indicating that each 1% increase in physical capital contributes to a 0.3697313% increase in economic growth. This finding is in line with the initial hypothesis and is supported by research from (Myovella et al., 2020), who found that physical capital significantly affects economic growth. (Kurniawati, 2022) similarly confirmed that Gross Fixed Capital Formation (GFCF), assumed to represent physical capital, has a significant impact on economic growth. These studies suggest that investment in physical capital, such as telecommunications and information technology infrastructure, can improve productivity and efficiency across various economic sectors, ultimately driving economic growth.

The Impact of Depreciation and Population Growth on Economic Growth

Depreciation and population growth have a negative and significant effect on economic growth. This finding indicates that increases in depreciation and population growth contribute negatively to economic expansion, with a coefficient of -0.0046406, meaning each 1% increase in capital depreciation reduces economic growth by 0.0046406%. This result supports the initial hypothesis and is consistent with studies by (Nakabashi, 2018; Waqar, 2015), which found that depreciation and population growth have a negative and significant impact on economic growth. High population growth tends to suppress economic growth, as it becomes more difficult to maintain a high capital-per-worker ratio when the number of workers increases rapidly, while capital depreciation reduces the efficiency and capacity of the economy (Mankiw, 2019).

CONCLUSION

This study examines the impact of Information and Communication Technology (ICT) on economic growth across 34 provinces in Indonesia from 2017 to 2022. The findings indicate that ICT, as measured by the sub-indices of access and infrastructure, usage, and skills, has a positive and significant effect on per capita GRDP. A one-unit increase in these sub-indices contributes to economic growth, although the magnitude of the impact varies depending on the specific sub-index analyzed. Additionally, physical capital exhibits a positive and significant influence, whereas depreciation and population growth have negative effects. Despite the positive contributions of ICT, its influence remains weaker than that of physical capital, likely due to the predominant use of ICT for non-economic activities. These results suggest that the provinces in Indonesia have yet to fully leverage ICT advancements for economic development.

However, this study has certain limitations, primarily related to the availability of data. Incomplete historical data restricted the research period to only six years, which may have limited the depth of the analysis. Future research should extend the study period to allow for a more comprehensive assessment of ICT's long-term impact on economic growth. Based on these findings, several policy recommendations are proposed. The government should strengthen collaboration with ICT-related companies to ensure equitable ICT development across Indonesia, particularly by expanding Internet access (3G, 4G, and 5G) to enhance ICT adoption and productivity across sectors. Additionally, policymakers should implement strategies to promote physical capital accumulation, as increased income per capita is expected to drive ICT demand, stimulate investment in the sector, and foster economic growth.

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