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The transformative impact of information and communication technology on regional economies in Indonesia

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ABSTRACT

The development of information communication technology (ICT) has made it easier for people to carry out activities. People's dependence on ICT has become greater, which impacts increasing per capita income, business efficiency, and costs. The impact of ICT causes the flow of goods and services to be more efficient so that economic growth can be faster. This study aims to analyze the effect of ICT on economic development across all provinces in Indonesia over the period 2012–2022. The data used in this study from the Central Bureau of Statistics and the DJPK or the Ministry of Finance of Indonesia and used Generalized Least Squares (GLS) model approach. The results shows the Information and Communication Technology Development Index as a proxy for ICT, government spending, and investment significantly affected economic growth in all provinces. The labor variable does not significantly affect economic growth. The investment variable has the power prediction on economic growth. Implication of the study the government needs to build digital infrastructure and government budget is more focused on digital literacy.

1. Introduction

Information and Communication Technology (ICT) is one of the key factors supporting various community activities. ICT facilitates the flow of knowledge and information while reducing communication costs. ICT networks have expanded access to the global economy, making trade between countries more efficient. The role of ICT extends beyond communication; it enhances research and development, strengthens financial systems, and improves labor efficiency and skills, all of which indirectly contribute to economic growth. Various economic sectors are experiencing rapid transformation due to ICT advancements, particularly with the emergence of e-commerce, e-business, e-trading, and e-banking. E-commerce, for instance, reduces administrative costs and streamlines the flow of goods across borders by maximizing access to market information (Xing, 2018).

Majeed & Ayub (2018) explains how ICT has significantly improved the banking system by increasing the cost efficiency of commercial banks, thereby enhancing the market value of companies. The integration of ICT into trade and financial systems has also fostered the growth of digital economies, creating new markets and business opportunities. Moreover, the development of e-commerce has played a crucial role in facilitating international trade, ultimately impacting national economies. According to Xing (2018) that ICT-driven e-commerce has strengthened bilateral trade, which in turn supports economic expansion. Countries investing in ICT infrastructure aim to boost GDP by attracting foreign investment and improving export performance (Majeed & Ayub, 2018). Salim et al (2024) states total factor productivity in the most Southeast Asian highly depend on ICT.

In Indonesia, the development of ICT has become an essential component of regional and national economic growth. The Indonesian government continues to monitor and support ICT advancements to optimize their impact on economic development. One of the key indicators used to assess ICT progress in Indonesia is the Information and Communication Technology Development Index or Indeks Pembangunan Teknologi Informasi dan Komunikasi (IPTIK), or the Information and Communication Technology Development Index. IPTIK measures the extent of ICT accessibility, usage, and skills across regions, providing a comprehensive overview of Indonesia's digital transformation. Monitoring and enhancing IPTIK is crucial for ensuring that ICT contributes effectively to national and regional economic growth.

The Central Bureau of Statistics (BPS) makes IPTIK with a scale of 0-10, where the higher index value indicates better ICT development in a region (Badan Pusat Statistik, 2022). The development of IPTIK in Indonesia reached 5.85 in 2022, as shown in Figure 1. The value of ICT increases increases every year, which means that information communication technology benefits the people of Indonesia. The development of IPICT is expected to increase economic activity in Indonesia. Bahrini & Qaffas (2019) shows the influence of Information Communication Technology (ICT) as the main driver of economic growth. Some countries' increasing investment in ICT can increase economic growth. The role of ICT is to encourage bilateral trade, which positively impacts the country's output growth. Pradhan et al (2018) state that ICT infrastructure, such as broadband development, can save transaction and capital costs that generate positive externalities to the country's economy. Ibrahimi & Fetai (2022) states that internet variables can statistically significantly affect GDP growth.

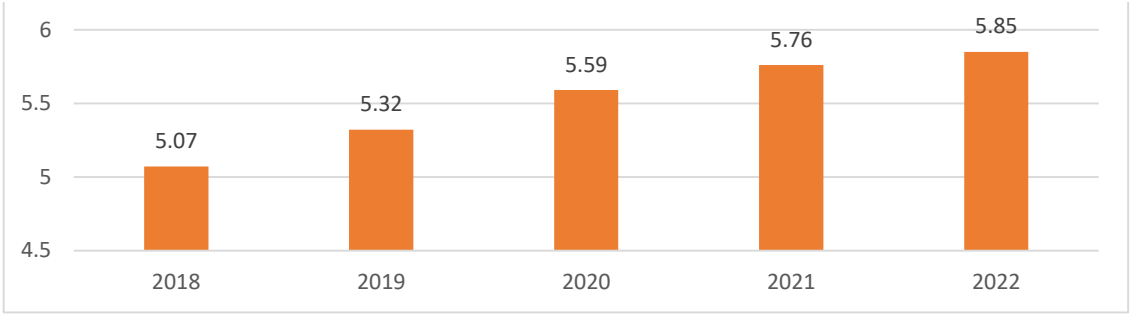

Figure 1. Index of ICT in Indonesia from 2018 – 2022

ICT development encourages human development, employment, innovation, and education, which can indirectly increase GDP growth. The development of ICT is inseparable from the role of ICT sub-indices such as ICT access and infrastructure, ICT usage, and ICT expertise. The growth of ICT usage is the largest contributor to IPTIK. Table 1 shows the population in Indonesia needs easy and very fast penetration of ICT access.

Table 1. Development of Sub Index of ICT from 2021 – 2022

Sub-Index	ICT Development Index		Increase	Growth
	2021	2022	(point)	(%)
ICT Access and Infrastructure	5.76	5.8	+0.04	0.69
ICT Use	5.66	5.82	+0.16	2.83
ICT Skills	5.97	6.00	+0.03	0.05
ICT Development Index	5.67	5.85	0.09	1.56

Source: Badan Pusat Statistik (2022)

The government must strive for ICT infrastructure in every region of Indonesia to meet the community's needs in accessing information. ICT infrastructure development will reduce costs and make it easier for people to carry out work activities. The more effective use of internet access is expected to increase people's income and increase economic growth. The community does not fully feel the benefits of ICT because some regions have been unable to achieve or match the National IPICT value. According to Yovani & Irfan (2024) argued that infrastructure development supports ICT can increase economic growth. Salim et al (2024) argued in the era digitalization, ICT also play pivotal role on labor productivity and in line with the augmented Solow growth model on consequences of workforce growth and capital. Moreover, study from Bergantino et al (2025) indicates there are positive associations between ICT poverty and absolute poverty and the risk of poverty or social exclusion across all geographic areas. Therefore, ICT infrastructure development is crucial not only to boost economic growth but also to reduce inequality across province in Indonesia.

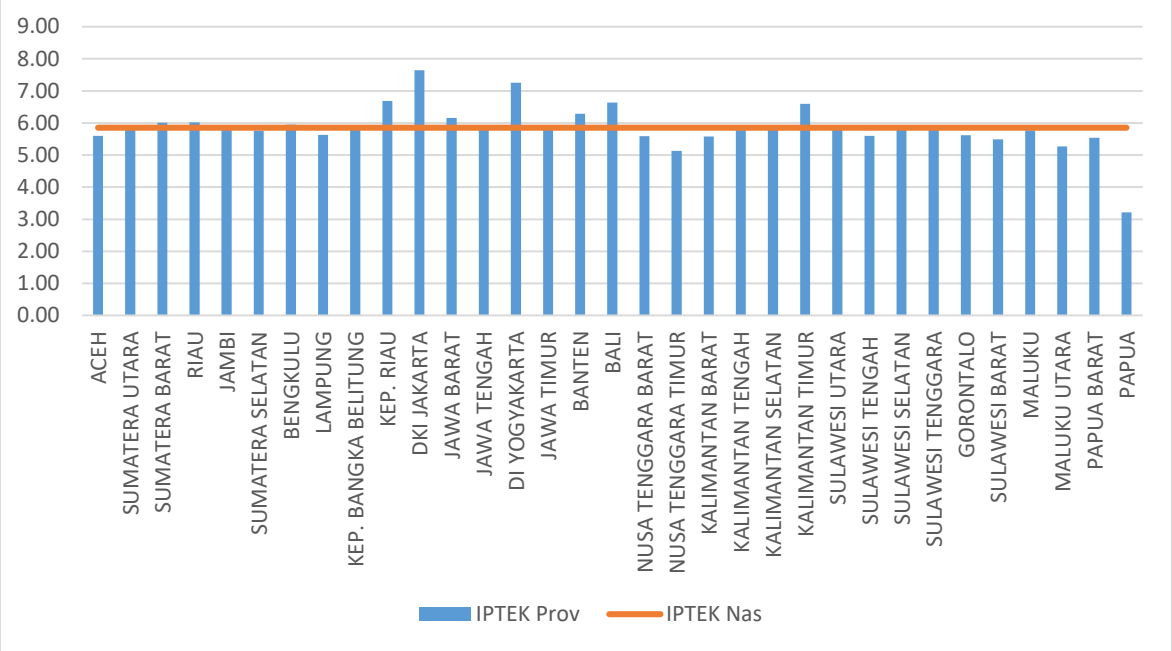

Figure 2. Development of ICT based on Province in 2022

Figure 2 shows, in general, several provinces have equaled and even exceeded the national ICT score. The development of IPTIK in several regions in Indonesia has utilized ICT to improve business activities. However, some regions have not been able to utilize ICT due to inadequate ICT infrastructure. Some regions in Indonesia have better infrastructure than others, such as faster and more stable internet access. Public knowledge of ICT in DKI and other Java islands dominates other regions. Several studies explain that the role of ICT has not fully increased regional economic growth. According to Kamilla et al (2021) the ICT variable has no significant effect on economic growth in Indonesia. There is a need for digital literacy in the community so that information can be utilized effectively.

Government policies try to mobilize institutions to manage ICTs and ensure rapid economic growth. Adeleye et al (2023) suggests that policymakers prioritize institutional quality and innovation and the use of ICT so that economic growth results in better living conditions for the community. According to Farooqi et al (2020) that government effectiveness is a determining factor in improving information communication technology. The government must make effective rules and regulations to improve ICT in developing countries. As a policy maker, the government evaluates the determinants of economic growth and provides digital literacy to the public to introduce information communication technology. The government strives for ICT infrastructure to reduce ICT disparities between regions. This study analyzes the role of ICT on economic growth in Indonesia. In addition, this study will look at the effect of government spending, investment, and labor on economic growth in Indonesia.

The relationship between Information and Communication Technology (ICT) and economic growth has been widely studied, yet its impact at the regional level, particularly in Indonesia, remains an area that requires further exploration. While previous research has largely focused on national economies or developed countries, there is still a gap in understanding how ICT influences economic performance across different provinces in Indonesia. This study seeks to address that gap by analyzing provincial-level data from 2012 to 2022, applying the Generalized Least Squares (GLS) method to account for regional differences and improve the precision of the findings. The results indicate that ICT significantly contributes to economic growth, aligning with the findings of Majeed & Ayub (2018) and Xing (2018). However, this study also provides a contrasting perspective to Kamilla et al (2021) argued that ICT's role in Indonesia's economic growth is not always significant. By incorporating a broader dataset and a more robust analytical approach, this research strengthens the empirical evidence supporting ICT as a driver of regional economic development. One of the key

insights from this study is that investment plays a more critical role in driving economic growth than either ICT or government spending. This suggests that while ICT provides a foundation for development, its impact is maximized when combined with strong investment policies that enhance infrastructure, innovation, and productivity.

Additionally, this research highlights the uneven distribution of ICT benefits across Indonesian provinces. Some regions, particularly those with better infrastructure and digital literacy, have been able to leverage ICT more effectively, while others lag due to limited access and resources. This finding underscores the importance of policies that promote digital inclusivity and ensure that all regions can benefit from technological advancements. Another notable finding is that the labor force does not significantly influence economic growth in this study. This challenges the conventional assumption that a larger workforce directly leads to higher economic output. Instead, the results suggest that without adequate investment in technology and skill development, increasing the number of workers alone is not sufficient to drive economic progress. These findings offer valuable insights for policymakers, emphasizing the need for strategies that focus not only on expanding ICT infrastructure but also on fostering digital literacy and encouraging investments that support long-term, sustainable growth.

2. Method

This study used secondary data in the form of time-series and cross-section data obtained from various reputable sources, including Central Bureau of Statistics (BPS) and the Directorate General of Fiscal Balance (DJPK) of the Ministry of Finance of Indonesia. The dataset covers all provinces in Indonesia over the period 2012–2022. The main variables in this study include economic growth as the dependent variable, while the independent variables consist of the Information and Communication Technology Development Index (ICTD) as a proxy for ICT development, government spending (lnGOV), gross fixed capital formation (lnGFCF) as an indicator of investment, and the number of workers (lnTW). To analyze the relationship between these variables, this study employs the Generalized Least Squares (GLS) method, chosen to address potential heteroscedasticity and autocorrelation in panel data. Model selection was conducted using the Chow Test to compare the Fixed Effect Model (FEM) and the Common Effect Model. The test results indicated that the fixed effect model was more suitable. Subsequently, the Hausman Test was performed to determine whether the fixed effect or random effect model was more appropriate. The Hausman test confirmed that the fixed effect model was the most suitable for this study.

Panel data has the advantages including able to provide more information and increasing degree of freedom (Hakim et al., 2024), and more efficient and minimize bias when combining time-series and cross section data (Hayat et al., 2023). The equation for panel data based on Nurcahyo et al (2025) as follows:

$$lnGDRP_{it} = \alpha_0 + \beta_1 ICTD_{it} + \beta_2 lnGOV_{it} + \beta_3 lnGFCF_{it} + \beta_4 lnTW_{it} + \varepsilon_{it} \quad (1)$$

Where $lnGDRP$ is the proxy for economic growth, $ICTD$ is the technology and information development index, $lnGOV$ is the government spending, $lnGFCF$ is the gross fixed capital formation, $lnTW$ is the number of workers, α_0 is the constanta, $\beta_1 - \beta_4$ is the coefficient independent variables, ε is the disturbance error, i is the notation for cross-section, t notation for time-series and ln is the form of logarithm. This study also considers key assumptions in panel regression models, including tests for heteroscedasticity and autocorrelation, to ensure the accuracy of the estimation results. A potential limitation of this research is the variation in data quality across provinces, as well as the inability to capture external factors that may also influence economic growth, such as macroeconomic policies and global economic conditions.

3. Results and Discussion

Table 2 shows the ICTD variable has a mean of 4.570, with a range between 1.910 and 7.660, and a standard deviation of 1.271. This indicates a relatively high variation in ICTD data. Meanwhile, the lnGFCF variable has a mean of 7.735, with a minimum value of 6.668 and a maximum of 9.042, along with a standard deviation of 0.527, indicating a more concentrated data distribution compared to ICTD. Furthermore, the lnTW variable has a mean of 6.338, with values ranging from 5.541 to 7.361, and a standard deviation of 0.446, reflecting a relatively low data variation. Similarly, the lnGOV

variable has an average value of 5.913, with a range between 5.169 and 7.463, and a standard deviation of 0.379, indicating that the data is stable with minimal fluctuations.

Table 2. Descriptive Statistics

Parameters	ICTD	lnGOV	lnGFCF	lnTW
Mean	4.570	5.913	7.735	6.338
Median	4.735	5.875	7.677	6.319
Max	7.660	7.463	9.042	7.361
Min	1.910	5.169	6.668	5.541
Std Dev	1.271	0.379	0.527	0.446
Obs	362	362	362	362

Source: data processed

The estimation results were carried out using the Chow test and the Hausman test; the three equations using the Chow test produced a fixed effect model suitcase for analysis. Then, the Hausman test was conducted on these equations, resulting in this study's most appropriate fixed effect model (attachment). This study uses quantitative descriptive analysis with the Generalized Least Square (GLS) model.

Table 3. Result of Generalized Least Squared of Panel Data

Variable	Coefficient	Prob
C	6.153	0.000
ICTD	0.079	0.000
lnGOV	0.063	0.000
lnGFCF	0.190	0.000
lnTW	-0.010	0.278
Diagnostic Tools		
Adj R-Squared	0.963	
F-stat	2518.67	

Source: data processed

Table 3 shows information communication technology can increase economic growth with faster access to information, which results from the development of digital infrastructure. These results are based on the research of Bahrini & Qaffas (2019) state that the role of ICT can increase economic growth through sustainable infrastructure development. The government can increase access to technology in remote areas so that ICT can be utilized evenly. ICT can increase product innovation to achieve business processes that have the opportunity to increase economic growth. This finding is based on the study of Ibrahimi & Fetai (2022) which states that the existence of ICT can develop human capital by making it easier to access digital information, especially new product innovations. ICT's role can mis to international trade's needs to market global products that can increase economic growth. This finding is based on the research of Pradhan et al (2018) which explains that government collaboration with the private sector to market products globally through information and communication technology can trigger economic growth.

Furthermore, government spending (lnGOV) has a positive and significant impact on increasing economic growth. Government investment by allocating a budget to build ICT infrastructure will reduce operational costs, efficient bureaucracy, and increase economic growth. This finding is consistent with Majeed & Ayub (2018) who state that the government budget for ICT infrastructure can encourage economic growth. Agustina & Pramana (2019) states government budget allocation for ICT will increase development inputs and impact economic growth. The government can allocate the budget for ICT research and development, which can encourage innovation. The existence of innovation has the opportunity to create a quantity of new products that encourage increased economic growth. Government spending by improving information accessibility can create new businesses. The more internet access is utilized, the easier for people to carry out work activities that can boost regional economic growth. The government can develop startups that support business growth and increase the contribution of ICT to economic growth. Ibrahim et al (2023) shows that the government budget needs to be directed to encourage economic growth. Allocation of government funds by digital development planning can increase economic growth.

Then, government investment proxied by gross fixed capital investment (lnGFCF) has a real effect on economic growth. The role of GFCF or capital is expected to increase production capacity, which will impact economic growth. Capital formation can encourage new technological innovations to make companies more competitive and produce better products. Therefore, government efforts to make regulations that encourage investment in the digital field can increase economic growth in the long run. This finding is consistent with Farooqi et al (2020) that explain the government needs to regulate digital investment and infrastructure to increase economic growth. Digital investment will attract foreign investment because ICT plays a role in integrating the global economy. This result is based on the research of Majeed & Ayub (2018) which states that countries that invest in ICT can attract foreign investment to encourage economic growth. Investment can encourage human development and expand employment. The research of Hindrayani et al (2024) shows that ICT investment development multiplies GDP growth. ICT investment results in increased productivity, human capital, and global integration. Although ICT investment does not directly impact digital technology as a key element triggers sustainable economic growth.

Labor or workers variables do not significantly affect economic growth in Indonesia. Labor with limited education and skills is still high in Indonesia, making it difficult to trigger economic growth. This finding was found by Febrianto (2020) which shows that number workers with low education tend to work in the informal sector. Hence, the contribution to increasing economic growth is not optimal. The existence of technology to carry out production more efficiently than increasing labor makes the number of workers insignificant in encouraging economic growth and Afrianti et al (2024) highlighted that human capital is more powerfull to affect economic growth in Indonesia than number of labors. This finding is similar to the research of Majeed & Ayub (2018) which shows that the role of labor is limited due to investment and infrastructure having a major impact on economic growth.

4. Conclusion

Information and communication technology, government spending, and investment variables significantly influence economic growth in all regions of Indonesia. Information and communication technology contributes positively to economic growth efficiently. Government budgeting for ICT infrastructure needs has proven effective in supporting economic growth through bureaucratic efficiency and reduced operational costs. Investment is the variable that most affects economic growth. Investment can increase production capacity, technological innovation, and global competitiveness. In contrast, the labor variable has no significant effect on economic growth. Production supported by technology is more effective than increasing the number of workers.

The government needs to build digital infrastructure, especially in Indonesia; some regions still lag in utilizing digital technology. The government budget is focused on digital literacy so people can understand digital technology through training and workforce skills. In addition, the government invests in the technology sector to reduce the digital divide between regions in Indonesia. There is cooperation with the private sector to improve the quality of human resources as a development input that is expected to increase sustainable economic growth.

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Declarations

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