EKO-REGIONAL: JURNAL PEMBANGUNAN EKONOMI WILAYAH
Volume 21, Issue 1, March 2026, pp. 94 – 104
https://jos.unsoed.ac.id/index.php/er/article/view/19128
DOI: https://doi.org/10.32424/er.v21i1.19128

Re-Examining Infrastructure-Led Growth Theory: The Role of Telecommunication on Growth in Indonesia

By:
Aisyah Hashinatun Nithosyi[1)], Mahrus Lutfi Adi Kurniawan[2*)], Jihad Lukis Panjawa[3)]
[1)]Faculty of Economy and Business, Universitas Ahmad Dahlan, Indonesia
[2)]Faculty of Economy and Business, Universitas Ahmad Dahlan, Indonesia
[3)]Faculty of Economy and Business, Universitas Tidar Magelang, Indonesia
*)Corresponding Author: mahrus.kurniawan@ep.uad.ac.id

Submission: December 22, 2025; Accepted: January 23, 2026

ABSTRACT: This study re-examines infrastructure-based growth theory by assessing the contribution of telecommunications to regional economic growth in Indonesia. Using panel data from 34 provinces during 2018–2022, panel regression analysis selected the fixed effects model based on Chow and Hausman tests. The dependent variable is the log of gross regional domestic product, while independent variables include foreign direct investment, gross fixed capital formation, labor force, number of base transceiver stations (BTS), and telecommunications network performance. The results show that BTS, telecommunications network performance, and gross fixed capital formation have positive and significant effects, while foreign direct investment has a negative effect and labor force is insignificant. These findings support infrastructure-led growth theory, particularly digital-led growth, highlighting telecommunications infrastructure as a key driver of regional economic growth. The study contributes to the digital-led growth literature and emphasizes policies prioritizing network quality improvement and equitable telecommunications infrastructure development, particularly in disadvantaged areas.
Keywords: Base transceiver stations, Telecommunication, Growth, Panel data.

***ABSTRAK**: Studi ini mengkaji ulang teori pertumbuhan berbasis infrastruktur dengan mengevaluasi kontribusi telekomunikasi terhadap pertumbuhan ekonomi regional di Indonesia. Dengan menggunakan data panel dari 34 provinsi selama periode 2018–2022, analisis regresi panel yang diterapkan memilih model efek tetap (*fixed effects model*) berdasarkan hasil uji Chow dan uji Hausman. Variabel dependen dalam studi ini adalah logaritma dari produk domestik regional bruto (PDRB), sementara variabel independen mencakup investasi asing langsung, pembentukan modal tetap bruto, angkatan kerja, jumlah menara pemancar (*base transceiver station*/BTS), serta kinerja jaringan telekomunikasi. Hasil penelitian menunjukkan bahwa jumlah BTS, kinerja jaringan telekomunikasi, dan pembentukan modal tetap bruto memiliki pengaruh positif dan signifikan; sebaliknya, investasi asing langsung menunjukkan pengaruh negatif, sementara variabel angkatan kerja tidak memberikan pengaruh yang signifikan. Temuan ini mendukung teori pertumbuhan yang didorong oleh infrastruktur—khususnya pertumbuhan berbasis digital—dan menegaskan bahwa infrastruktur telekomunikasi merupakan penggerak utama pertumbuhan ekonomi regional. Studi ini memberikan kontribusi pada literatur mengenai pertumbuhan berbasis digital serta menekankan pentingnya kebijakan yang memprioritaskan peningkatan kualitas jaringan dan pemerataan pembangunan infrastruktur telekomunikasi, terutama di wilayah-wilayah yang kurang berkembang*
***Kata Kunci:** Base traceiver stations, telekomunikasi, Pertumbuhan ekonomi, Data panel.*

2620-8849 © 202X The Author(s). Publihsed by ISEI Purwokerto and Department of Economics and Development Studies Universitas Jenderal Soedirman. This is an open access article under the CC BY-SA 4.0 license

INTRODUCTION

The idea of using information and communication technology (ICT) to drive a country's economic growth is a mainstream concept developed over the past decade. In addition to its irreplaceable "modern day" function, infrastructure also contributes to environmental protection and economic development in a country or region. Maneejuk & Yamaka (2020) argue that telecommunications can increase total factor productivity (TFP) by accelerating information flow, increasing production efficiency, and significantly reducing costs. Cotter et al (2021) explain that improving information and telecommunications channels can improve the business climate, supporting the development of the modern service sector and the digital economy, and accelerating the formation of new businesses. Massive and responsible use of telecommunications can expand market access and connect domestic networks to the outside world (Yang et al., 2025).

However, there are several challenges in developing telecommunications as an economic driver, as explained by Kuiper & Beverly (2025) that the installation of BTS as a support for telecommunications networks must be kept away from forests due to their vulnerability to forest fires. In Indonesia, several areas are still inland and mountainous areas that have many tropical and protected forests so that the installation of BTS in these areas can have a negative effect on forest fires. Apart from location, there is also a vulnerability to the "sustainability" effect on the environment, Pintor et al (2025) explained that there is a gap related to access to telecommunications use between residents in villages and in cities, where urban areas that have full access to telecommunications will have easy access to education, health and transportation so that it can widen the infrastructure gap between rural and urban areas. Kang & Kim (2025) stated that the significant role of telecommunications in economic growth must include digital transformation, resilience management and network resilience.

Telecommunications infrastructure affects economic growth through multiple transmission channels including a). productivity enhancement with reduced transaction cost and improved supply chain management. Cross-country studies shows that ICT improves economic sector efficiency and corporate performance and led to economic growth (Toader et al., 2018; Suhendra et al., 2025); b). market expansion through distance cost, expanding consumer access, enabling e-commerce and digital services and integrating regional and global markets. Suhendra et al (2025) argued digital infrastructure creates opportunities for growth through the expansion of economic activity and its relevant for Indonesia as the country has the large cost for logistic; c). innovation and digital economy channel including e-commerce, fintech, start-up ecosystem, knowledge diffusion and technology adoption. Irawan et al (2025) states that telecommunications, fintech, and e-commerce are simultaneously driving economic growth and faster broadbank speeds increase business creation rates.

Another transmission and more appropriate in Indonesia through spatial spillover and regional development channel. Faisal et al (2025) revealed that digital infrastructure produce both direct effects and spatial spillovers on regions and to capture the relevance of inequality between provinces. Digital transformation is necessary to enhance spillover effects to neighboring regions, economic agglomeration, urban–rural linkages, and the diffusion of innovation. Moreover, strengthening the telecommunications sector can improve government performance and quality, as telecommunications support the development of e-government, transparency, the reduction of corruption, and the efficiency of public services. Ding et al (2025) argued that government digitization promotes growth by reducing corruption, transaction time and become more efficient. Therefore the digital transformation become crucial for reducing information and transaction costs, improving connectivity, and enabling new digital economic activities, telecommunications networks strengthen regional integration and total factor productivity, ultimately accelerating economic development.

The re-examination of the role of infrastructure and economic growth stems from Aschauer (1989) which explains that public capital such as roads, ports, telecommunications, energy, and public utilities can increase the productivity of private production factors by reducing transaction costs, facilitating the distribution of goods and services, and improving the efficiency of economic

coordination. Thus, increasing the stock of public capital drives increases in TFP and long-term economic growth. His research introduced the idea that infrastructure is not simply government spending but can be used as a factor of production. In the current Indonesian context, the role of public capital is becoming increasingly relevant as the government focuses on physical and digital infrastructure development. Investments in toll roads, ports, airports, electricity networks, and telecommunications and digital infrastructure strengthen interregional connectivity, reduce logistics cost gaps, and support domestic market integration. This impact aligns with Aschauer (1989) argument that public capital creates spillover effects which increases private sector productivity and improves national economic competitiveness.

In the contemporary digital era, this classical framework can be extended to include digital infrastructure, particularly telecommunications networks, which function as the backbone of information exchange and economic interaction. Unlike traditional infrastructure that primarily supports the movement of physical goods, digital infrastructure reduces informational distance, accelerates decision-making, and enables real-time coordination across regions. Therefore, telecommunications networks represent a modern form of productivity-enhancing capital consistent with Aschauer (1989) on infrastructure-led growth theory. Perspective on economy that telecommunications infrastructure exhibits characteristics of a quasi-public good. While network services are often provided by private operators and subject to pricing mechanisms, their underlying infrastructure generates substantial positive externalities, non-rival informational benefits, and broad spillover effects across sectors. As a result, telecommunications can simultaneously function as a public enabling infrastructure and as a private production input that enhances firm-level efficiency.

Research on the role of telecommunications or supporting telecommunications infrastructure is important because it can increase a country's long-term economic growth. Pradhan et al (2014) using G-20 countries, showed a long-term relationship between telecommunications infrastructure and economic growth. Furthermore, there is a bidirectional relationship between telecommunications infrastructure, FDI, and economic growth. Pradhan et al (2016) using 21 Asian countries, explained that there is a short- and long-term relationship between telecommunications infrastructure, financial development, and economic growth. The massive development of technological infrastructure has led to increased integration between countries. In this context, it is important to note that economic growth theory consistently emphasizes that economic development encompasses the process of innovation. Therefore, it can be said that the interaction between economic activity and information technology is a key driver of dynamic economic growth.

Correa (2006) stated that the development of telecommunications networks provides significant benefits to the industry, increasing TFP and providing broader market access. Early research by Norton (1992) demonstrated a strong positive relationship between telecommunications infrastructure investment and economic growth in 47 countries during the period 1957–1977, and suggested that if certain countries had a higher number of telephones, the rate of economic growth could be significantly increased. However, telecommunications technology infrastructure, currently considered a driver of economic growth, faces complex challenges. Burnham (2007)) explained that the problems are technical in nature, with the most difficult involving changes to institutional frameworks originally designed for a different era and technology. This process of changing these frameworks inherently involves disruptive changes to existing infrastructure and service providers, as well as significant benefits to the economy as a whole. Tang & Lee (2003) explained that telecommunications infrastructure development is not solely explained by economic factors, but non-economic factors play a significant role, such as political, historical, and national security considerations. Therefore, the interaction between the role of the state and economic growth determines whether a region experiences maximum, moderate, or minimal growth in the telecommunications sector.

In Indonesia, there is still a gap between urban and rural areas regarding internet access. According to Pintor et al (2025) the gap in access to telecommunications services between rural and urban populations can create inequalities that hinder sustainable economic development. the gap related to access to telecommunications for rural and urban residents can create inequality that impacts sustainable economic development. Indonesia has the largest number of internet users in

Southeast Asia, predicted to reach 146 billion USD by 2025. Indonesia's digital valuation exceeds other countries in ASEAN, with projections three times greater than Vietnam. Mobile telecommunications has become increasingly popular since the 1990s, especially in developing countries. Magomedov et al., (2020)) explain that the increasing influence of digital technology on people's lifestyles and work is a hallmark of modern society. The use of mobile phone technology aims to measure people's access to technology that contributes to the economy. The more people access the internet via mobile phones, the easier it is for digitalization to improve efficiency and quality of life. Digitalization also drives productivity, resource efficiency, and economic growth (Lechman & Anacka, 2022).

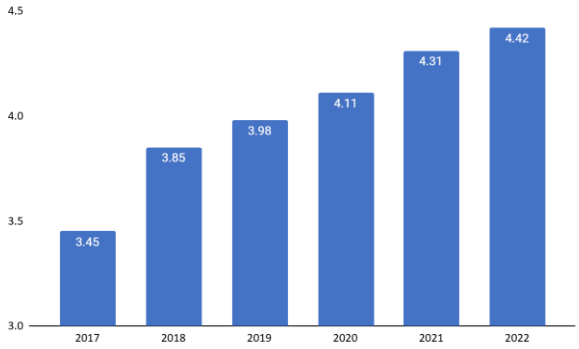


Figure 2. Diversity DC-ICT Tahun 2017-2022
Source: BPS (2023)

Base transceiver stations (BTS) are critical infrastructure supporting mobile telecommunications. With the increasing use of mobile phones for internet access, widespread BTS play a role in providing internet connectivity. Strategic placement allows operators to reach wider areas and serve more users, as well as support business communications, online financial transactions, and economic growth. BTS infrastructure contributes significantly to business development and economic interaction. BTS infrastructure is commonly used as a proxy for physical network availability because each station represents a tangible node in the telecommunications network that determines coverage, signal accessibility, and user capacity within a specific geographic area. Unlike subscription-based indicators, which reflect demand conditions, the number of BTS captures the supply-side deployment of telecommunications infrastructure and the spatial distribution of connectivity. A higher density of BTS generally indicates broader network coverage, reduced signal congestion, and improved access to mobile services, particularly in remote or underserved regions. Internet use in the digital era offers significant opportunities for Indonesia's future and has a positive impact on the economy. However, economic growth has slowed in recent years due to the lack of ICT infrastructure in areas outside Java, such as Papua and Maluku. This gap can hamper the country's economy, impacting social inequ (Mohmand et al., 2017). There are four ways in which telecommunications infrastructure can contribute to economic and social development: first, sustaining businesses; second, diversifying the economy; third, improving the quality of life; and fourth, increasing business competitiveness (Cieslik & Kaniewsk, 2004; Lee et al., 2005; Pradhan et al., 2014).

The research contribution lies in two aspects: first, testing infrastructure-led growth theory within a provincial context in Indonesia, where many previous studies have compared countries. The use of a provincial context in Indonesia presents a novelty and a research gap in this study, as it has not been widely explored by previous researchers in relation to examining the role of telecommunications in economic growth. While previous studies focus on aggregate infrastructure indicators on national level of data, limited empirical evidence on how digital infrastructure quality and access jointly affect growth across regions. Second, the examination of telecommunications and its role in economic growth utilizes a macroeconomic approach. According to Ward & Zheng (2016) the initial macroeconomic approach to the role of telecommunications in economic growth can produce biased estimates due to the limited development of the telecommunications sector in many countries. However, over time, the role of telecommunications has become inseparable from national development strategies. In Indonesia, comprehensive telecommunications development is included in

the long-term national development strategy, and to date, there is still a gap in infrastructure development between islands, resulting in some underdeveloped regions not having full access to telecommunications, a challenge in this research.

METHODS

The examination of the role of telecommunications infrastructure stems from Romer's (1990) research, which developed endogenous growth theory as a critique of Solow's neoclassical growth model. Romer (1990) explained that technology is endogenous, generated through economic activity, particularly R&D, innovation, and investment in knowledge. Therefore, technology does not occur naturally but rather results from rational economic decisions. Simply put, Romer (1990) output function can be written as follows:

$$Y = f(K, L, A)$$

Where Y is the output; K is the capital; L is the employment or workforece; and A is the level of technology. Notation A continue to grow because there is investment in knowledge and R&D. Equation also shows that economic growth is endogenous and long-term. The study used the quantitative data and the combination of time series data (*time series*) and cross-sector data (*cross* section). Panel data is applied to estimate the role of telecommunications and supporting infrastructure in the economic growth model in Indonesia, which can combine time-series and cross-section data. According to Gujarati et al (2019) panel data offers several advantages, namely a). Increasing the number of observations has a positive impact on model estimation, increasing degrees of freedom, and reducing the risk of collinearity between independent variables, and b). Allowing the estimation of individual characteristics and time-based characteristics to be considered separately. Meanwhile, according to Khasanah & Kurniawan (2025) the use of panel data can capture the heterogeneity of each cross-section used in the study. The panel data equation developed in the study is as follows:

$$LnGRDP_{it} = \alpha_0 + \beta_1 FDI_{it} + \beta_2 GFCF_{it} + \beta_3 LF_{it} + \beta_4 BTS_{it} + \beta_5 Telcom_{it} + \varepsilon_{it}$$

The research uses data from 2018-2022, where $LnGRDP$ is the gross regional domestic product in logarithmic form; FDI is the foreign direct investment inflow; $GFCF$ is the gross fixed capital formation; LF is the labor force; BTS is Base transceiver station or telecommunications infrastructure support; $Telcom$ is a telecommunications network; α_0 is the constant for panel regression; $\beta_1 - \beta_5$ is the coefficient of independent variables; ε_{it} is the error term; notation i for cross-section and t for bentuk time-series. The use of independent variables in research as a proxy for the equation developed by Romer (1990), where Y as output in research using $LnGRDP$ aor the GDP value of each province; function of K for capital use FDI and $GFCF$ namely foreign investment entering each province during the research period and capital accumulation from each province; function of L is the labor force using LF or labor force for each provinces in Indonesia and function of A as technology using BTS or base transceiver station as a means of telecommunications infrastructure and $Telcom$ a telecommunications network.

Table 1. Definition of Variables

Variables	Notation	Definition	Sources
Gross Regional Domestic Product	LnGRDP	GRDP using GDP for each province on constant value (Billion)	BPS
Foreign Invesment	FDI	Foreign direct investment to each province (percentage)	BPS
Gross Fixed Capital Formation	GFCF	Investment in physical capital (percentage)	BPS
Labor Force	LF	the population of working age (million)	BPS
Base Transceiver Station	BTS	The number of BTS for infrastructure of	BPS

telecommunications network	Telcom	telecommunication (unit) Telecommunications systems and their associated equipment used for communication purposes (percentage)	BPS

In panel data, there are three analyses that can be used: pooled regression, fixed effect model (FEM), and random effect model (REM) (Gujarati et al., 2019). The best panel data selection test is carried out sing the F-test from the Hausman test. The fundamental difference between the FEM and REM panel data models lies in the variation between entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model (Greene, 2008). The REM model assumes that the entity error term is uncorrelated with the predictor variable, allowing variables that do not change over time to act as explanatory variables (Baltagi, 2005; Ilyasa et al., 2025). Meanwhile, the FEM assumes that there are factors within individuals that can influence or bias the predictor or outcome variables, and we need to control for these to reduce the effect of bias on the developed model (Greene, 2008). Moreover Henningsen & Henningsen (2019) states that FEM is more appropriate because it accounts for unobserved regional characteristic that remain constant over time but has the effect on economic growth on regional perspectives. Early from Wooldridge (2010) argued that FEM preferred because these characteristics are likely correlated with explanatory variables in the study such as telecommunication infrastructure and investment.

RESULTS AND DISCUSSIONS

Table 2 explains that the obs (observation) value is 170 which is a combination of data from 34 provinces in Indonesia over a period of 5 years, namely 2018-2022. Output or Gross Regional Domestic Product value has an average value of 43,516.06 billion rupiah with a standard deviation of 32,438.73 billion rupiah. The province with the highest GRDP value is Jakarta Province with the highest value of 183,598.5 billion rupiah and the lowest is East Nusa Tenggara Province in 2018 amounting to 12,273.85 billion rupiah. The difference in the value of foreign investment and capital accumulation shows that foreign investment not only looks at provinces with abundant natural resources as investment destinations but high human resources are also able to attract investors, where Jakarta Province has the highest value of foreign investment up to 89,223.6 billion rupiah, while the highest capital accumulation (% GRDP) is North Maluku Province at 65.97%.

Table 2. Descriptive Statistics

Variables	Obs	Mean	Std Dev	Min	Max
GRDP	170	43516.06	32438.73	12273.85	183598.5
FDI	170	12484.07	16444.06	50.9	89223.6
GFCF	170	33.29%	6.97%	19.25%	65.97%
LF	170	4.083.596	5.825.811	254.829	2.480.007
BTS	170	1187.36	1317.59	179.00	7136.5
Telcom	170	64.35%	8.34%	35.33%	82.37%

Source: data processed

Table 2 also shows that there is a gap in the construction of BTS towers as a means of telecommunications infrastructure, where the highest BTS towers are in East Java Province at 7136.5 units and the lowest are in West Sulawesi Province at 179 BTS towers. Meanwhile, the communication network in Indonesia has an average speed value of 64.35% with the highest value of telecommunications network speed being in East Kalimantan Province at 82.37% and the lowest being

in West Papua Province at 35.33%. This still large gap is arn obstacle to the development of telecommunications networks and their supporting infrastructure, thus impacting the gap in access to education, health and other social services.

Table 3. Result of Panel Data

Variables	CEM	FEM	REM
C	8.256***	9.771***	9.666***
	(0.000)	(0.000)	(0.000)
FDI	0.112***	-0.027***	-0.021***
	(0.005)	(0.001)	(0.013)
GFCF	-0.005	0.004***	0.004***
	(0.177)	(0.001)	(0.004)
LF	0.102*	-0.013	-0.004
	(0.081)	(0.576)	(0.850)
BTS	-0.311***	0.066**	0.013
	(0.000)	(0.032)	(0.652)
Telcom	0.031***	0.008***	0.013***
	(0.000)	(0.001)	(0.000)
Diagnostic Tools			
Chow Test	283.93***		-
	(0.000)		
Hausman Test	-		26.880***
			(0.001)

Source: data processed

Table 3 shows that based on the results of the Chow Test and the Hausman Test, the probability values of both tests are below 5% alpha, indicating that both tests are consistent, the FEM model is the best model used in the analysis. The FEM model shows that foreign investment (FDI) has a negative coefficient value and a probability below 5% alpha, indicating that an increase in FDI can reduce the output of each province. This happen because not every province has abundant natural resources, so the nature of FDI is enclave or extractive, namely investment that only targets natural resources such as mining and oil and gas and FDI that only targets developed provinces, resulting in large differences between FDI in each province in Indonesia. FDI inequality can also be caused by complicated bureaucracy, resulting in delays in the flow of investment to less developed provinces that do not have adequate natural resources. Waburton (2024) explains that in the last decade, the growth of the Indonesian nickel industry has grown at an astonishing pace, export revenues have soared, and economic growth along the country's nickel belt has increased to more than three times the national average. Indonesian leaders position the downstream sector as an economic success story and a source of national pride, creating nickel-led growth. Furthermore, according to Nguyen (2025) the FDI market is narrowing to developed countries rather than developing and underdeveloped ones due to low levels of digitalization, complicated licensing processes, and rising transaction costs.

However, the capital accumulation variable shows a positive influence on GRDP in Indonesia. This may be due to the fact that capital accumulation does not solely depend on foreign investors, but also includes the role of domestic investors, export-oriented industrial economic activity within the country, and the role of domestic savings. Therefore, increasing the GFCF can increase output. The greater the GFCF, the greater the national production capacity, thus increasing GDP. Ngundu et al (2024) explain that GFCF or capital accumulation in the short term plays a role in increasing aggregate demand, absorbing labor, and increasing derived consumption. In the last decade, the role of derived consumption from the extractive industry in the mining sector has increased sharply (Waburton, 2024). The largest increase in GFCF in Indonesia occurred on the island of Java and several islands with extractive natural resources, accelerating industrialization. The results of this study are similar to those of Roy (2024) who explained that there is a positive relationship between capital accumulation and economic development, but this occurs in the extractive sector of natural resources. Rothenberg et al

(2025) highlighted that the large number of Special Economic Zones (SEZs) that were opened could encourage capital increases but were vulnerable to local regional conditions if not accompanied by local or regional-based improvements.

The panel data analysis using the FEM model shows that LF has no effect on output in 34 provinces in Indonesia. The labor force is considered a crucial factor in economic growth. The greater the available labor force, the greater the potential for increasing a country's productivity. However, when the labor force is dominated by low-skilled workers, an increase in the number of workers will not result in increased productivity and output (Vikia, 2023). Furthermore, if the skills of the labor force do not match the needs of the labor market, a large number of the labor force cannot be absorbed and thus cannot contribute to economic growth (Wahyuni et al., 2025; Wardhana et al., 2025).

Table 3 of the FEM results shows that BTS as a means of telecommunications infrastructure has a positive effect on output in Indonesia. UNDP (2011) explains that internet access can improve market efficiency and create economic opportunities. The increase in the number of mobile users expands public access to information and communication, which in turn accelerates economic activity in a region. BTS, as part of the telecommunications network infrastructure, provides essential connectivity for various economic sectors. With the presence of BTS, previously isolated or underserved areas can enjoy better internet access and communication. The results of this study support the research of Aschauer (1989) explained that public capital, in this case telecommunications infrastructure, can increase the productivity of production factors by reducing transaction costs, facilitating the distribution of goods and services, and improving the efficiency of economic coordination. In addition, the important role of telecommunications infrastructure can contribute to economic and social development through business maintenance and expansion, economic diversification, improving the quality of life, and increasing business competitiveness (Cieslik & Kaniewsk, 2004; Lee et al., 2005; Pradhan et al., 2014). According to Ward & Zheng (2016) telecommunications infrastructure enables local businesses to connect with wider markets, improves operational efficiency, and opens up new opportunities for trade and investment. Furthermore, better access to information and technology facilitates the growth of digital industries and innovation, which can create new jobs and improve people's quality of life.Therefore, the empirical results of this study provide strong support for the infrastructure-led growth theory, particularly in its modern extension toward digital-led growth, where telecommunications infrastructure such as BTS serves as a key driver to growth in Indonesia. Improved connectivity not only enhances existing economic activities but also enables the emergence of digital industries and innovation, contributing to job creation and improved quality of life.

Telecommunication networks also play a crucial role in economic growth. FEM results show that telecommunications networks have a positive impact on economic growth in 34 provinces in Indonesia. The influence of information and communication on economic growth is particularly significant in the current era of globalization. Information and communication have become key drivers of change in various economic sectors, such as industry, trade, education, and public services. The increasing integration of ICT infrastructure substantially impacts long-term growth in developing countries (Lam & Shiu, 2010; Lunku, 2025). This finding is consistent with economic growth theories that identify investment in information and communication as a key element of production that increases economic productivity. The use of digital technology enables process automation, improved data management, and faster access to information, all of which reduce operational costs and increase output (Pradhan et al., 2016). Information and communication also drive innovation by creating new opportunities for products, services, and business models that were previously impossible. This not only expands markets but also creates new jobs in the technology and related services sectors (Maneejuk & Yamaka, 2020).

CONCLUSIONS

This study provides empirical evidence on the critical role of base transceiver stations (BTS) as a fundamental component of telecommunications infrastructure in supporting regional economic growth in Indonesia. Using panel data from 34 provinces, the findings demonstrate that the expansion

of BTS networks significantly contributes to higher gross regional domestic product by improving connectivity, reducing communication costs, and enabling the diffusion of digital technologies across regions. Furthermore, the role of telecommunications also serves as a test of the theory of endogenous economic growth related to the role of technology and innovation. The study used panel data combining time-series (2018-2022) and cross-sectional (34 provinces) data. The results show that infrastructure-led growth theory positively influences the role of telecommunications on economic growth in Indonesia.

The result provide strong support for the infrastructure-led growth theory, particularly in its modern extension toward digital-led growth, where telecommunications infrastructure such as BTS and telecommunication network serves as a key driver to growth in Indonesia and these findings contributes to the growing literature on digital-led growth by demonstrating the importance of equitable deployment and quality improvement of telecommunication infrastructure. The limitations of this study do not map or diversify the easy and difficult telecommunications access due to limited data. Future research is expected to map the conditions of telecommunications coverage to provide a more comprehensive picture of the condition of telecommunications in Indonesia.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the Department of Economics Development, Universitas Ahmad Dahlan and Universitas Tidar for providing the facilities and resources necessary to carry out this research. The authors also thank our family and friends for their unwavering encouragement and understanding during the research process.

REFERENCES

Aschauer, D. A. (1989). Is public expenditure productive? *Journal of Monetary Economics*, *23*(2), 177–200. https://doi.org/10.1016/0304-3932(89)90047-0

Baltagi, B. H. (2005). Econometric Analysis of Panel Data (3rd ed.). In *John Wiley & Sons*.

BPS. (2023). *Statistik Telekomunikasi Indonesia 2023*.

Burnham, J. B. (2007). Telecommunications policy in Turkey: Dismantling barriers to growth. *Telecommunications Policy*, *31*(3–4), 197–208. https://doi.org/10.1016/j.telpol.2007.01.007

Cieslik, A., & Kaniewsk, M. (2004). Telecommunications infrastructure and regional economic development: The case of Poland. *Regional Studies*, *38*(6), 713–725. https://doi.org/10.1080/003434042000240996

Correa, L. (2006). The economic impact of telecommunications diffusion on UK productivity growth. *Information Economics and Policy*, *18*(4), 385–404. https://doi.org/10.1016/j.infoecopol.2006.04.001

Cotter, C., Rousseau, P. L., & Vu, N. T. (2021). Electrification, telecommunications, and the finance-growth nexus: Evidence from firm-level data. *Energy Economics*, *94*, 105073. https://doi.org/10.1016/j.eneco.2020.105073

Ding, Y., Chin, L., Taghizadeh-Hesary, F., & Yan, X. (2025). Does government digitization contribute to economic growth? Empirical evidence from 109 countries. *Technological and Economic Development of Economy2*, *31*(5), 1457–1477. https://doi.org/10.3846/tede.2025.24060

Faisal, M. G., Asfo, N. S., Wibowo, N., Khaldun, F., & Hamdallah, M. A. H. (2025). The Effect of Digital Infrastructure Development on Regional Economic Growth in Indonesia. *Jurnal Informasi Dan Teknologi*, *7*(2).

Greene, W. H. (2008). *Econometric Analysis* (6th ed.). Prentice Hall.

Gujarati, D. N., Porter, D. C., & Pal, M. (2019). *Basic Econometrics* (Sixth Edit). Mc Graw Hill.

Henningsen, A., & Henningsen, G. (2019). Analysis of Panel Data Using R. In M. Tsionas (Ed.), *Panel Data Econometrics Theory*. Elsevier. https://doi.org/10.1016/B978-0-12-814367-4.00012-5

Ilyasa, W. N., Kurniawan, M. L. A., Lubis, F. R. A., & Salim, A. (2025). The role of credit for poverty alleviation in Indonesia: Evidence from panel data analysis. *IJBE (Integrated Journal of Business and Economics)*, *9*(2), 203–217. https://doi.org/10.33019/ijbe.v9i2.1101

Irawan, H., Yunani, A., & Rahmini, N. (2025). The Impact of Telecommunications Infrastructure, Fintech, and E-Commerce on Economic Growth in Indonesia. *Endless: International Journal of Future Studies*, *8*(3), 19–31.

Kang, M. H., & Kim, S. (2025). Resilience in telecommunications networks: A Korean case study. *Telecommunications Policy*, *49*(6), 102987. https://doi.org/10.1016/j.telpol.2025.102987

Khasanah, D. U., & Kurniawan, M. L. A. (2025). Panel seemingly unrelated regression on employment in tourism sector: Evidence in Central Java province. *Eko-Regional: Jurnal Pembangunan Ekonomi Wilayah*, *19*(1), 11–19. https://doi.org/10.32424/er.v19i1.16851

Kuiper, C. S., & Beverly, J. L. (2025). Assessing telecommunication vulnerabilities to wildfire in Alberta, Canada. *International Journal of Disaster Risk Reduction*, *120*, 105761. https://doi.org/10.1016/j.ijdrr.2025.105761

Lam, P.-L., & Shiu, A. (2010). Economic growth, telecommunications development and productivity growth of the telecommunications sector: Evidence around the world. *Telecommunications Policy*, *34*(4), 185–199. https://doi.org/10.1016/j.telpol.2009.12.001

Lechman, E., & Anacka, H. (2022). Digitalization Process and Its Impact on Economic Growth: A Panel Data Study for Developing Countries. In *Digitalization and Economic Development: Insights from Developing Countries* (pp. 28–46). https://doi.org/10.4324/9781003198284-2

Lee, S. T., Gholami, R., & Tong, T. Y. (2005). Time series analysis in the assessment of ICT impact at the aggregate level – Lessons and implications for the new economy. *Information and Management*, *42*(7), 1009–1022. https://doi.org/10.1016/j.im.2004.11.005

Lunku, H. S. (2025). The criticality of clean energy and ICT invesment in achieving environmental sustainability in the EU member states. *Optimum: Jurnal Ekonomi Dan Pembangunan*, *15*(2), 207–221. https://doi.org/10.12928/optimum.v15i2.12981

Magomedov, I. A., Murzaev, H. A., & Bagov, A. M. (2020). The role of digital technologies in economic development. *IOP Conference Series: Materials Science and Engineering*, *862*(5). https://doi.org/10.1088/1757-899X/862/5/052071

Maneejuk, P., & Yamaka, W. (2020). An analysis of the impacts of telecommunications technology and innovation on economic growth. *Telecommunications Policy*, *44*(10), 102038. https://doi.org/10.1016/j.telpol.2020.102038

Mohmand, Y. T., Wang, A., & Saeed, A. (2017). The impact of transportation infrastructure on economic growth: empirical evidence from Pakistan. *Transportation Letters*, *9*(2), 63–69. https://doi.org/10.1080/19427867.2016.1165463

Ngundu, M., Zerihun, M. F., & Nyathi, M. C. (2024). Comparing the effectiveness of the African Growth and Opportunity Act (AGOA) and Forum on China-Africa Cooperation (FOCAC) in South Africa: An application of Keynes' Macroeconomic Theory. *Asia and the Global Economy*, *4*(2), 100081. https://doi.org/10.1016/j.aglobe.2024.100081

Nguyen, V. B. (2025). Digitalization's divergent impact on FDI inflows: A comparative analysis between advanced and developing countries. *Transnational Corporations Review*, *17*(3), 2001468. https://doi.org/10.1016/j.tncr.2025.200148

Norton, S. W. (1992). Transaction costs, telecommunications, and the microeconomics of macroeconomic growth. *Economic Development and Cultural Change*, *41*(1). https://doi.org/10.1086/452002

Pintor, L., Atzori, L., & Iera, A. (2025). Sustainability in telecommunication networks and Key Value Indicators: A survey. *Computer Networks*, *271*, 111466. https://doi.org/10.1016/j.comnet.2025.111466

Pradhan, R. P., Arvin, M. B., & Hall, J. H. (2016). Economic growth, development of telecommunications infrastructure, and financial development in Asia, 1991–2012. *The Quarterly Review of Economics and Finance*, *59*, 25–38. https://doi.org/10.1016/j.qref.2015.06.008

Pradhan, R. P., Arvin, M. B., Norman, N. R., & Bele, S. K. (2014). Economic growth and the development of telecommunications infrastructure in the G-20 countries: A panel-VAR approach. *Telecommunications Policy*, *38*(7), 634–649. https://doi.org/10.1016/j.telpol.2014.03.001

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, *98*(5 Part 2: The

Problem of Development: A Conference of the Institute for the Study of Free Enterprise Systems), 71–102. https://doi.org/10.1086/261725

Rothenberg, A. D., Wang, Y., & Chari, A. (2025). When regional policies fail: An evaluation of Indonesia's Integrated Economic Development Zones. *Journal of Development Economics*, *176*, 103503. https://doi.org/10.1016/j.jdeveco.2025.103503

Roy, A. (2024). Impacts of economic development, globalization, and gross capital formation on natural resources rents: Evidence from India. *Resources Policy*, *97*, 105259. https://doi.org/10.1016/j.resourpol.2024.105259

Suhendra, I., Istikomah, N., Anwar, C. J., Supriadi, A., Wakhid, A. A., Purwanda, E., & Salim, A. (2025). Influence of the digital economy on economic growth: empirical study of a region in Indonesia. *Cogent Economics & Finance*, *13*(1). https://doi.org/10.1080/23322039.2025.2457477

Tang, H. S.-C., & Lee, P. S. . (2003). Growth in adversity: non-economic factors in telecommunications development in China. *Telematics and Informatics*, *20*(1), 19–33. https://doi.org/10.1016/S0736-5853(01)00027-2

Toader, E., Firtescu, B. N., Roman, A., & Anton, S. G. (2018). Impact of Information and Communication Technology Infrastructure on Economic Growth: An Empirical Assessment for the EU Countries. *Sustainability*, *10*(10), 3750. https://doi.org/10.3390/su10103750

UNDP. (2011). *Annual Report 2011: Preventing Crisis, Enabling Recovery*.

Vikia, Y. M. (2023). The Solow-Swan theories: An empirical evidence in various Indonesia provinces. *Optimum: Jurnal Ekonomi Dan Pembangunan*, *13*(2), 155–174. https://doi.org/10.12928/optimum.v13i2.8123

Waburton, E. (2024). Nationalist enclaves: Industrialising the critical mineral boom in Indonesia. *The Extractive Industries and Society*, *20*, 101564. https://doi.org/10.1016/j.exis.2024.101564

Wahyuni, R. N. T., Retnaningsih, & Yuliana, L. (2025). Heterogeneity of social returns to education across employess education levels in Indonesia. *Eko-Regional: Jurnal Pembangunan Ekonomi Wilayah*, *20*(2), 202–213.

Ward, M. R., & Zheng, S. (2016). Mobile telecommunications service and economic growth: Evidence from China. *Telecommunications Policy*, *40*, 89–101. https://doi.org/10.1016/j.telpol.2015.06.005

Wardhana, A., Kharisma, B., Fauzy, M. Z., & Anggana, A. K. (2025). The transformative impact of information and communication technology on regional economies in Indonesia. *Optimum: Jurnal Ekonomi Dan Pembangunan*, *15*(2), 187–194. https://doi.org/10.12928/optimum.v15i2.12529

Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data* (2nd ed.). The MIT Press.

Yang, S., Vialle, P., & Whalley, J. (2025). Is disruption the second time around easier? The case of Iliad and the Italian telecommunications market. *Telecommunications Policy*, *49*(8), 103013. https://doi.org/10.1016/j.telpol.2025.103013