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THE ROLE OF INFORMATION TECHNOLOGY AND HUMAN CAPITAL ON ECONOMIC GROWTH IN INDONESIA

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ABSTRACT
Indonesia's economic growth in the digital era faces strategic challenges, one of which is the imbalance in contributions between technology investment and the standard of human capital. This research intends to investigate the impact of information technology and human capital on economic growth in 34 Indonesian provinces in the period 2018–2023. The main issue raised is the unclear extent to which technology and education (human capital) are empirically capable of driving sustainable economic growth. Data were analyzed using panel data regression methods, with the optimal framework chosen via the Chow, Hausman, and Lagrange Multiplier tests. The findings indicate that information technology exerts a notable impact on economic development, while human capital, as measured by average years of schooling, has no significant effect. These findings indicate that mastery of digital technology is more relevant in driving economic growth than the duration of formal education alone. Therefore, educational reforms are needed that are more adaptive to technological developments and industrial needs to generate inclusive and sustainable economic growth. These results highlight the urgency for Indonesia to strengthen digital skills, innovation capacity, and workforce adaptability to sustain long-term competitiveness.

Key words: Information Technology; Human Capital; Economic Growth

INTRODUCTION

In recent decades, advances in communication technology, demographic transformation, and shifts in the global economic paradigm have significantly reshaped the world economy. The digital revolution drives countries to invest in information and communications technology (ICT) to enhance efficiency and market reach. Liu et al. (2025) found that optimal investment in ICT improves production efficiency, accelerates sectoral integration, and fosters innovation, making it crucial for Indonesia's digitalization efforts such as 5G infrastructure and digital literacy development. At the same time, demographic transitions like aging populations and declining birth rates affect labor availability, requiring strategic human capital management (Bairoliya & Miller, 2021).

Bairoliya and Miller (2021) highlight that sustainable growth depends on improving education and health to strengthen human resources amid demographic changes. For Indonesia, which is at the peak of its demographic dividend, maximizing the productive-age population is essential for economic progress. After a contraction of -2.07% in 2020, Indonesia rebounded with growth of 3.70% in 2021, 5.31% in 2022, and 5.05% in 2023 (BPS, 2024). However, sustaining growth above 5% requires strengthening the synergy between technology investment and workforce quality. According to Becker's (1964) human capital theory, investing in education, training, and health enhances productivity and long-term economic stability.

Lina (2024) found that the use of information technology, especially big data, strengthens sustainable economic governance (green growth) by improving efficiency, fiscal transparency, and data-based decision-making. However, the success of technology integration depends on the quality of human resources managing it. According to endogenous growth theory (Romer & Lucas, 1990), internal factors such as research, innovation, and human capital accumulation are key drivers of long-term economic growth. Thus, synergy between technological innovation and human capital development is crucial. For Indonesia, balancing digital transformation and human resource quality will ensure economic growth that is not only rapid and competitive but also inclusive and sustainable in the long term.

Furthermore, the acceleration of digital transformation in Indonesia is aligned with global megatrends emphasizing the Fourth Industrial Revolution (Industry 4.0). The Ministry of Industry launched the "Making Indonesia 4.0" roadmap to boost manufacturing competitiveness through automation, artificial intelligence and Internet of Things applications. Nevertheless, the effectiveness of such initiatives hinges on digital readiness and adaptive capabilities of the labor force. According to the World Bank (2023), Indonesia still faces digital inequality, particularly between urban and rural areas, where limited infrastructure and low digital skills hinder productivity gains. Therefore, ICT investment must be accompanied by inclusive policies that expand access to technology and education, ensuring that all segments of society benefit from digitalization.

Education reform and lifelong learning systems play a pivotal role in preparing human resources for technological shifts. UNESCO (2023) emphasizes that digital literacy, problem-solving, and creativity are the new core competencies for 21st-century economies. Indonesia's vocational and higher education systems must thus adapt curricula to align with digital industry demands. Strengthening partnerships between academia,

industry, and government (the triple helix model) can accelerate technology transfer and innovation. Additionally, entrepreneurship education and digital startups can serve as alternative drivers of employment and economic resilience, especially among the youth population entering the labor market.

From a macroeconomic perspective, the integration of technology and human capital enhances not only productivity but also economic inclusiveness. ICT expansion fosters financial inclusion through digital banking and e-commerce, enabling small and medium enterprises (SMEs) to access wider markets. This democratization of economic opportunities can reduce regional disparities and contribute to poverty alleviation. However, as emphasized by Acemoglu and Restrepo (2019), automation may also displace certain jobs if human capital adaptation lags behind technological progress. Hence, the government's role in reskilling and upskilling programs becomes vital to mitigate structural unemployment.

Recent policy efforts such as National Digital Literacy Movement and Digital Talent Scholarship have shown promising results in expanding digital competence among educators, students, and professionals. These initiatives support Indonesia's broader vision of becoming Southeast Asia's largest digital economy by 2030, as projected by Google and Temasek (2023). To sustain momentum, continuous collaboration between the public and private sectors is required to close the skills gap, enhance research capacity, and ensure ethical use of digital technologies. Moreover, attention must be given to cybersecurity, data protection, and digital ethics to maintain public trust in the digital ecosystem.

In addition, Indonesia's regional development strategy should integrate digital transformation with local economic potential. Strengthening digital infrastructure in outer islands, supporting local startups, and enhancing access to digital finance can stimulate inclusive growth. According to the OECD (2023), digital transformation is most effective when accompanied by institutional reform and public sector digitalization. The adoption of e-government services and open data initiatives increases transparency, efficiency, and citizen participation. These changes not only modernize governance but also enhance public trust and policy effectiveness. Moreover, gender equality in digital participation remains a crucial component of inclusive growth. The World Economic Forum (2024) reports that women are still underrepresented in STEM and digital sectors in Indonesia. Encouraging women's participation through digital skills training and entrepreneurship support can significantly expand the productive labor pool and foster innovation diversity. Inclusive policies that address both gender and regional gaps will help ensure that the benefits of digitalization are equitably distributed.

Moreover, the digital empowerment of MSMEs has become a cornerstone of Indonesia's economic resilience and inclusivity. According to the Ministry of Cooperatives and SMEs (KemenKopUKM, 2024), MSMEs contribute more than 60% to Indonesia's GDP and absorb over 97% of the national workforce. Therefore, the shift towards digital is not solely a matter of technology but a strategic pathway toward sustainable and equitable growth. The expansion of e-commerce platforms, digital payment systems, and logistics technology enables MSMEs to reach broader markets beyond their local boundaries, promoting regional economic diversification. However, the digital divide remains visible, particularly among micro enterprises in rural and remote areas that struggle with connectivity limitations, low awareness of digital opportunities, and inadequate human capital. To address this, multi-stakeholder collaboration is essential. Public–private partnerships can play a vital role in building digital ecosystems that integrate capacity building, mentorship, and innovation hubs tailored for local entrepreneurs. Encouraging youth involvement through digital entrepreneurship programs also accelerates intergenerational knowledge transfer and innovation. Furthermore, ensuring access to microfinance and venture capital for digital startups can stimulate competitiveness and productivity in the MSME sector. Through these synergistic efforts, Indonesia can transform its MSMEs into dynamic drivers of the national digital economy, bridging structural inequalities and reinforcing inclusive, long-term economic growth.

In conclusion, Indonesia's sustainable economic growth in the digital era depends on strategic alignment between technological advancement and human capital development. The integration of ICT should not only focus on infrastructure but also prioritize digital inclusion, education quality, and innovation capacity. By leveraging its demographic dividend and strengthening the synergy between digital transformation and human resource empowerment, Indonesia can build an economy that is resilient, competitive, and equitable—positioning itself as a leading digital hub in the ASEAN region and a model for inclusive growth in the 21st century.

METHOD

This research adopts a quantitative methodology utilizing a panel data technique, which combines cross-sectional and time series data. Panel data allows for a more comprehensive analysis by considering inter-individual variability and changes over time. The information utilized is secondary data sourced from the Central Statistics Agency, covering the period 2018 to 2023 in 34 provinces across Indonesia. The variables studied include economic growth, technology, and human capital. Economic growth variable data was obtained from the workforce by province, the human capital variable was obtained from the average length of schooling per province and the technology variable was obtained from the proportion of adolescents and adults aged 15-24 years with information and computer technology (ICT) skills by province. Data analysis was carried out using a panel data model. To determine the best model, model specification tests are used, such as the Chow Test, Hausman Test, and Lagrange Multiplier (LM) Test.

Chow test is an examination employed to identify the most suitable model for panel data regression, contrasting the Common Effect model with the Fixed Effect model. The Hausman test serves to assess if the fixed effect model or the random effect model is more advantageous. The Lagrange Multiplier test is utilized to ascertain which model, between the common effect and random effect models, is the most fitting. The mathematical model equation is:

$$Yit = \beta\ 0 + \beta\ 1\ X\ 1\ it + \beta\ 2\ X\ 2\ it + \varepsilon$$

Where represents economic growth in the i-th entity and time t, $\beta\ 0$ is a constant, β1 and β2 are the regression coefficients for the independent variables Technology Information ($X1it$), Human Capital ($X2it$), respectively. Meanwhile, ε represents the error term that reflects the influence related to other elements beyond the model. Below are the operational definitions of the variables examined in this study.

RESULTS AND DISCUSSION

Chow Test

The Chow test is conducted to ascertain the superior model among the Common Effect Model and the Fixed Effect Model in panel data analysis. According to the findings from Table 4.1, the probability value for the Cross-section F statistic is 0.0067, which is lower than 0.05; hence, H_0 is dismissed, and H_a is validated. This suggests that the Fixed Effect Model represents the best option. Subsequently, to confirm the optimal model selection between Fixed Effect and Random Effect, the Hausman test was performed.

Table
Chow Test Results

Effects Test	Statistics	df	Prob.
Cross-section F	1.840278	(33,168)	0.0067

Source: Eviews

Hausman test

The Chow test is conducted to ascertain the superior model between the Common Effect Model and the Fixed Effect Model in panel data regression. According to the findings from Table 4.1, the probability value for the Cross-section F statistic is 0.0067, which is lower than 0.05; hence, H_0 is dismissed, and H_a is validated. This suggests that the Fixed Effect Model represents the best option. Subsequently, to confirm the optimal model selection between Fixed Effect and Random Effect, the Hausman test was performed.

Table
Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. df	Prob.
Random cross-section	3.376927	2	0.1848

(Source: Eviews)

Lagrange Multiplier Test

The Lagrange Multiplier (LM) test is designed to differentiate between the Common Effect and Random Effect models. As indicated by the Breusch-Pagan test findings, the p-value is 0.0000, which is less than 0.05; therefore, H_0 is not supported, and H_a is substantiated. This signifies that the Common Effect model is the most suitable option for panel data regression in this analysis.

Table
Lagrange Multiplier Test

	Hypothesis Test		
	Cross-section	Time	Both
Breusch-Pagan	5.912567 (0.0150)	36.06473 (0.0000)	41.97729 (0.0000)

(Source: Eviews)

Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.167126	2.168228	-2.383111	0.0181
IT	0.064440	0.022940	2.809027	0.0055
RLS	0.083520	0.216600	0.385598	0.7002

(Source: Eviews)

Regression analysis using the Panel EGLS (Cross-section weights) method with a period of 2018–2023, covering 34 provinces and a total of 204 observations. The estimation results show that the constant variable (C) has a coefficient of -5.167126 with a probability value of 0.0181, the Information Technology (IT) variable is 0.064440 with a probability of 0.0055, and the Human Capital variable measured by the average length of schooling (RLS) is 0.083520 with a probability of 0.7002. Based on these results, the Information Technology variable is significant to economic growth ($p < 0.05$), while the Human Capital variable is not significant ($p > 0.05$).

The study reveals that advances in information technology significantly contributed to Indonesia's economic growth during 2018–2023, consistent with Lina's (2024) findings that big data utilization and digital innovation enhance fiscal efficiency, transparency, and sustainable green growth. In line with Shalaby's (2024) Digital Sustainable Growth Model and Romer's (1986) endogenous growth theory, technological advancement reflects internal investment in knowledge, research, and innovation that strengthens productivity. However, human capital—measured by average years of schooling—does not significantly influence economic growth, contrasting with Becker's (1964) and Schultz's (1961) classical human capital theories. This insignificance may result from the gap between educational quantity and quality (Xu & Li, 2020) and a mismatch between educational outcomes and labor market demands. Globally, Elfaki and Ahmed (2024) and Dankyi et al. (2022) emphasize that synergy between technology and human capital is essential for inclusive and sustainable growth, yet in Indonesia, this synergy remains weak as rapid technological advancement outpaces human resource development. Therefore, future economic strategies must prioritize digital literacy, vocational training, and stronger alignment between education and industry to ensure Indonesia's growth remains sustainable, inclusive, and adaptive in the digital economy era.

CONCLUSION

Based on the research results, it can be inferred that information technology exerts a significant influence on the economic development of Indonesia, while human capital, as measured by average years of schooling, does not show a significant effect. This indicates that improving technological skills among young people can boost efficiency and productivity, while the quality and relevance of formal education still need to be improved to significantly contribute to economic growth. Therefore, it is recommended that the government not only focus on expanding access to education but also reform the curriculum and vocational training based on the needs of the digital industry. As a recommendation, strategic integration between information technology development and strengthening the quality of human capital must be prioritized in the formulation of national economic development policies to achieve inclusive and sustainable growth. In addition, collaboration between the government, private sector, and educational institutions is essential to accelerate digital transformation and skill alignment. Continuous investment in digital infrastructure and research innovation can further enhance Indonesia's competitiveness in the global economy. Strengthening digital literacy and entrepreneurship programs will also empower communities to adapt to technological changes and reduce the digital divide.

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