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DIGITAL TRANSFORMATION AND INCLUSIVE ECONOMIC DEVELOPMENT IN INDONESIA: HUMAN DEVELOPMENT AS A CONDITIONAL REGIONAL FACTOR

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Abstract

This article critically examines how digital transformation is associated with inclusive economic growth across Indonesian provinces and whether human development conditions that relationship. The study uses provincial panel data for 2017 to 2023 and applies panel regression with an interaction specification. Inclusive growth is represented by the income distribution and poverty reduction dimension of the inclusive economic development index, while digitalization is proxied by the information and communication technology development index. The empirical pattern suggests that digitalization is positively related to inclusive growth. However, the interaction between digitalization and human development is negative and statistically meaningful, indicating that higher human development does not automatically intensify the inclusive benefits of technology. A sub sample reading reveals different regional dynamics. Digitalization appears to expand economic access in provinces with lower human development, whereas in more developed provinces it may concentrate gains among workers and firms with stronger digital capability. The article argues that digitalization should not be treated as a socially neutral development instrument. Its inclusive value depends on the distribution of skills, infrastructure, labor protection, and regional absorptive capacity. Policy responses therefore need to be differentiated, with basic access and literacy prioritized in lagging regions and advanced digital skills, labor transition support, and platform regulation strengthened in more developed regions.

Keywords: *Digital Transformation; Inclusive Growth; Human Development; ICT Development; Regional Inequality.*

1. Introduction

Inclusive growth has become a crucial analytical category in contemporary development economics because the success of development can no longer be assessed only through aggregate output expansion. A growth indicator that privileges gross domestic product may obscure the distributive question of who benefits, who remains excluded, and how economic opportunities are socially organized. Inclusive growth therefore needs to be interpreted as a process through which income, decent work, education, health care, and productive participation become more widely accessible across social groups. This interpretation is consistent with the multidimensional view

advanced by Hay et al. (2022), in which inclusion is not a technical add on to growth but a constitutive dimension of development itself.

Indonesia offers a particularly important setting for examining this issue because regional development is marked by pronounced spatial and socioeconomic unevenness. Provinces with strong economic agglomeration tend to possess better infrastructure, higher human capability, deeper markets, and stronger institutional support. By contrast, peripheral regions continue to face constraints in connectivity, basic services, and labor market opportunity. Under such conditions, national economic progress may coexist with unequal access to the benefits of modernization. The critical issue is therefore not whether growth occurs, but whether growth widens or narrows the social and regional distance between those who can participate productively and those who remain structurally constrained.

Digital transformation has increasingly been presented as a pathway for overcoming these constraints. Information and communication technology can accelerate information flows, reduce transaction costs, expand market access, and widen the reach of financial, educational, and public services. Recent empirical work shows that digital finance, digital infrastructure, and internet based services can support economic participation by improving access and productivity, particularly among groups that were previously excluded from formal markets (Basnayake et al., 2024; Daud & Ahmad, 2023; Ren et al., 2022). Nevertheless, the social consequences of digitalization are not uniform. Technology can serve as an inclusion bridge, yet it can also become a new sorting mechanism that privileges actors with devices, literacy, capital, and institutional support.

The central tension lies in the social conditions that make digitalization inclusive. Internet access and digital devices do not automatically produce welfare gains when people lack the education, health, income security, and skills required to transform access into meaningful economic capability. Human development therefore becomes analytically significant. The human development index reflects basic capabilities through health, education, and living standards. In this article, human development is read not merely as a welfare indicator but as an absorptive capacity that shapes whether digitalization becomes a channel of shared opportunity or a mechanism that deepens inequality.

Recent scholarship on the digital divide confirms the ambivalent character of digitalization. Aziz and Hossain (2024) and Du and Wang (2024) show that gaps in access, resources, and digital literacy condition the ability of technology to generate broad based benefits. Liu et al. (2024) further argue that digitalization does not automatically reduce regional inequality because its effect depends on initial conditions, human capital, and local economic structure. Evidence from Indonesia also cautions against a deterministic view of internet penetration, since digital expansion may coincide with less inclusive growth in some regional contexts (Jamil, 2022). These studies indicate that digitalization should be examined as a contingent social and economic process rather than a universal development remedy.

Against this background, this article asks how digitalization influences inclusive economic growth at the provincial level in Indonesia and how human development conditions that influence. The analysis begins from the premise that technology does not

operate in an institutional vacuum. Digital transformation interacts with prior inequalities, regional capability, and the structure of economic opportunity. The contribution of this article lies in showing that human development may alter the strength and direction of the association between digitalization and inclusive growth, thereby challenging the assumption that better human development always strengthens the inclusive payoff of technological expansion.

2. Research Method

2.1 Design, Data, and Epistemological Positioning

The study uses a quantitative panel design at the provincial level. Ontologically, inclusive growth is understood as a material and distributive phenomenon. It can be represented through statistical indicators, yet those indicators refer to broader social relations such as access to employment, public services, market participation, and poverty reduction. Epistemologically, the econometric model is treated as an instrument for reading patterned empirical relationships rather than as a complete account of causality detached from institutional and historical context. This position is important because digitalization is not only a technical variable but also a socially mediated process.

The dataset covers Indonesian provinces for the period 2017 to 2023. The main unit of analysis is the province. DKI Jakarta and DI Yogyakarta are excluded from the main specification because both display markedly higher levels of human development and ICT advancement than most other provinces. Their exclusion is a methodological decision intended to reduce the influence of high leverage observations and to approximate the pattern experienced by the majority of provinces. Even so, the interpretation of the results remains cautious because removing extreme observations may narrow the scope of generalization.

Inclusive economic growth is proxied by the income equality and poverty reduction pillar of the inclusive economic development index. Digitalization is measured using the ICT development index, which captures the extent of regional information and communication technology development. Human development is measured by the human development index, which summarizes basic capabilities related to health, education, and living standards. The data sources are official statistical publications and the inclusive economic development index compiled by national development authorities.

A statistical reporting note is necessary. Because the raw dataset was not provided with the manuscript, the numerical values presented in the estimation tables are rounded presentations of the available draft output rather than a new independent re estimation. If the manuscript is used as an original empirical article, the authors should rerun the model with their own verified dataset and replace the rounded tables with the official estimation output.

2.2 Panel Model Specification

The empirical model combines insights from endogenous growth theory and human capital theory. Endogenous growth theory places knowledge and technological progress at the center of sustained economic performance, while human capital theory

emphasizes the role of education, health, and capability in enabling societies to adopt and use technology productively. Based on this logic, digitalization is expected to be associated with inclusive growth, but the magnitude and meaning of that association depend on the level of human development.

The baseline model is specified to estimate the association between digitalization and inclusive economic growth as follows:

IG_it = alpha + beta1 ICT_it + epsilon_it

The moderation model then includes human development and the interaction between digitalization and human development:

IG_it = beta0 + beta1 ICT_it + beta2 HDI_it + beta3 (ICT_it x HDI_it) + epsilon_it

In this specification, IG_it denotes inclusive economic growth in province i at time t, ICT_it denotes the ICT development index, HDI_it denotes the human development index, and epsilon_it denotes the error component. Model selection follows the standard panel procedure by comparing common effect, fixed effect, and random effect specifications through the Chow test, Hausman test, and Lagrange Multiplier test. Prior to constructing the interaction term, the independent variables are mean centered to reduce the multicollinearity commonly produced by interaction models.

3. Results and Discussion

3.1 Model Selection and Diagnostic Tests

The first analytical step is to identify the most appropriate panel model. The Chow test indicates that the fixed effect specification performs better than the common effect specification. The Hausman test then suggests that the random effect approach is acceptable because the available evidence does not indicate a systematic correlation between unobserved individual effects and the explanatory variables. The Lagrange Multiplier test further confirms that the random effect model is preferable to the common effect model. The main estimation is therefore interpreted using the random effect framework.

Table 1. Chow Test Summary

Effects test	Statistic	df	p value
Cross section F	116.812	31; 189	<0.001
Cross section chi square	672.825	31	<0.001

Source: Data processing results, 2026.

Table 2. Hausman Test Summary

Test summary	Chi square statistic	df	p value
Cross section random	4.332	3	0.228

Source: Data processing results, 2026.

Table 3. Lagrange Multiplier Test Summary

Test	Cross section	Time	Both
Breusch Pagan	565.819 (<0.001)	1.520 (0.218)	567.339 (<0.001)

Source: Data processing results, 2026.

After the random effect specification is selected, diagnostic testing focuses on residual normality and multicollinearity. The Jarque Bera probability is above the conventional five percent threshold, indicating that the residual distribution does not show serious deviation from normality. The variance inflation factor values for the centered variables are also below the critical threshold of 10. These diagnostics suggest that the interaction model can be interpreted without major concern regarding residual distribution or excessive multicollinearity.

Table 4. Residual Normality Summary

Indicator	Value
Observations	224
Mean	0.000
Median	-0.111
Maximum	1.855
Minimum	-1.664
Standard deviation	0.720
Skewness	0.126
Kurtosis	2.570
Jarque Bera	2.314
Probability	0.315

Source: Data processing results, 2026.

Table 5. Multicollinearity Test Summary

Variable	Coefficient variance	Uncentered VIF	Centered VIF
Constant	0.0156	1.016	NA
ICT	0.0031	4.256	4.256
HDI	0.0006	4.094	4.094
ICT x HDI	0.000063	1.097	1.081

Source: Data processing results, 2026.

3.2 Digitalization and Inclusive Growth

The baseline regression shows that ICT development is positively and significantly associated with inclusive economic growth. The rounded coefficient of 0.455 indicates

that higher digital development corresponds with higher inclusive growth scores. Substantively, this finding supports the argument that digitalization can widen economic participation by improving connectivity, lowering transaction costs, opening online market channels, and expanding access to digital financial services. Yet the positive aggregate result should not be interpreted as proof that the benefits of digitalization are automatically distributed across all groups and regions, because an aggregate coefficient may conceal important regional differences.

Table 6. Baseline Regression Results

Variable	Coefficient	Std. error	t statistic	p value
Constant	6.654	0.140	47.465	<0.001
ICT	0.455	0.028	16.333	<0.001

Source: Data processing results, 2026.

This result is consistent with the logic of endogenous growth theory, which views technological progress as a source of productivity improvement. Digital technologies can improve the flow of market information and reduce the cost of participation for small firms, informal entrepreneurs, and households with limited access to formal services. Studies by Wang et al. (2023), Li et al. (2024), and Basnayake et al. (2024) similarly suggest that digital finance and ICT infrastructure can support broader economic inclusion. However, the ability of digitalization to become genuinely inclusive remains dependent on the social and institutional readiness of each region.

3.3 Human Development as a Moderating Factor

When human development and the interaction term are included in the model, ICT development remains positive and statistically significant. Human development also has a positive direct coefficient. The interaction between ICT and human development, however, is negative and significant. This means that the marginal inclusive effect of digitalization becomes weaker as human development increases. At first glance, this appears counterintuitive because human development is often assumed to strengthen the capacity of a region to benefit from technology. A more careful interpretation is required.

Table 7. Moderation Regression Results

Variable	Coefficient	Std. error	t statistic	p value
Constant	6.698	0.125	53.619	<0.001
ICT	0.221	0.055	3.997	<0.001
HDI	0.110	0.024	4.603	<0.001
ICT x HDI	-0.022	0.008	-2.798	0.006

Source: Data processing results, 2026.

The negative interaction does not imply that human development is harmful to inclusive growth. Rather, it indicates that in more developed regions digitalization enters a more complex stage of economic restructuring. Technology not only expands access but also changes labor demand, skill premiums, and the organization of production. Workers

with stronger education and advanced digital competence are more likely to capture productivity gains, while workers with limited skills may be displaced or excluded from higher value opportunities. This mechanism resembles skill biased technological change, where digital transformation increases productivity while simultaneously narrowing the groups able to benefit fully from it.

3.4 Sub Sample Analysis by Human Development Level

To examine regional heterogeneity, provinces are grouped according to whether their 2023 human development index is below or above the national average. The regression for provinces with lower human development shows a positive and significant association between ICT development and inclusive growth. In this group, digitalization appears to operate as an access expanding mechanism. Internet based services and digital infrastructure can reduce geographical barriers, connect communities to market information, and provide financial or public services that were previously difficult to reach.

Table 8. Regression for Provinces Below the National HDI Average

Variable	Coefficient	Std. error	t statistic	p value
Constant	1.248	0.620	2.012	0.047
ICT	1.017	0.121	8.375	<0.001

Source: Data processing results, 2026.

In contrast, the coefficient for ICT development is negative and significant among provinces with human development above the national average. This pattern suggests that digitalization in more developed regions does not necessarily produce wider distribution of economic benefits. More advanced regions often have differentiated labor markets and more complex production systems. When digital transformation progresses faster than the adaptive capacity of all workers, the gains may be concentrated among professional workers, formal firms, and actors with stronger knowledge, capital, and networks.

Table 9. Regression for Provinces Above the National HDI Average

Variable	Coefficient	Std. error	t statistic	p value
Constant	10.037	0.718	13.979	<0.001
ICT	-0.572	0.122	-4.694	<0.001

Source: Data processing results, 2026.

3.5 Critical Discussion

The findings reveal the double movement of digitalization in development. On the one hand, digital transformation can broaden inclusion by making information, financial services, markets, and public services more accessible. On the other hand, it can produce new forms of exclusion when the capacity to benefit from digital tools is distributed unequally. This means that digitalization is not simply an infrastructure agenda. It is also a distributional question concerning who has the skills, devices, networks, and institutional protection needed to translate technology into welfare.

The positive association in lower HDI provinces can be interpreted through the idea of technological leapfrogging. Regions with weak physical infrastructure may still benefit from digital services because digital platforms can bypass some conventional development stages. Mobile financial services, for example, may reach people who have limited access to bank branches, while online platforms can connect micro and small enterprises to wider markets. Evidence from Bai et al. (2021), Kouladoum (2023), and Nchake and Shuaibu (2022) supports the argument that ICT infrastructure can increase participation in regions where traditional infrastructure has been limited.

The negative association in higher HDI provinces points to a different policy challenge. In these areas, the issue is less about basic access and more about the quality and distribution of digital use. Automation, platform based work, and data driven business models may increase demand for highly skilled labor while reducing opportunities for routine and low skill occupations. If reskilling, vocational education, social protection, and fair platform regulation do not keep pace with technological change, digitalization can increase productivity while weakening inclusiveness. This is why the inclusive effects of digitalization require labor market institutions that protect transitions rather than merely celebrate innovation.

Theoretically, the results challenge a deterministic view of technology. Digitalization should be understood as a social institution whose outcomes are conditioned by education systems, health capability, labor market structure, and governance. Epistemologically, the regression coefficients should not be read as purely technical numbers. They provide an entry point for interpreting the unequal distribution of digital opportunity. Those who possess advanced skills, stable employment, social networks, and institutional support are better positioned to convert digital transformation into income and mobility, while vulnerable groups may remain at the margin of the digital economy.

The policy implication is therefore differentiated. Provinces with lower human development require policy packages that prioritize affordable connectivity, basic digital literacy, device accessibility, and the integration of digital public services with local needs. Provinces with higher human development require a more advanced agenda, including continuous digital skill upgrading, worker transition support, vocational redesign, social protection for platform and informal workers, and competition policy that prevents digital markets from being dominated by already advantaged actors. A uniform digital policy would risk reproducing the very inequalities it seeks to overcome.

4. Conclusion

This article concludes that digitalization is positively associated with inclusive economic growth in Indonesia, but its effect is not uniform across regions. Human development plays a significant moderating role, yet the direction of moderation is negative. This finding suggests that higher human development does not automatically intensify the inclusive benefits of digitalization. In more developed regions, digital transformation may generate gains that are disproportionately captured by high skill workers and firms with stronger digital capability.

The sub sample analysis shows that digitalization has a stronger inclusive association in provinces with human development below the national average. In these regions, digital technology can operate as a mechanism for expanding access to information, markets, and services. Conversely, in provinces above the national average, digitalization may intensify labor market polarization when it is not accompanied by skill upgrading and protection for vulnerable groups. These findings indicate that digital transformation requires region sensitive policy design rather than a single national template.

The study is limited by its use of provincial level data, which cannot fully capture variations across districts, municipalities, households, occupations, and social groups. The moderation analysis is also limited to human development, while other potentially important factors such as institutional quality, digital literacy, industrial structure, gender inequality, and social protection are not explicitly modeled. Future studies could use microdata or mixed methods to examine the mechanisms through which digitalization becomes inclusive in some contexts and exclusionary in others.

Practically, the government needs to distinguish policy priorities across regional contexts. Lagging regions require infrastructure equalization and basic digital literacy, while more developed regions require advanced digital skills, labor protection, and fairer digital market governance. Digitalization should therefore be framed not only as economic modernization but also as a redistributive development project. Its success depends on whether technological progress can be institutionally guided so that vulnerable groups are not merely connected to the digital economy but are also empowered to benefit from it.

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