

Digitalization and Inclusive Growth: The Moderating Role of Human Development

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Abstract

This study examines the effect of the Information and Communication Technology Development Index (ICT-DI) on inclusive economic growth by emphasizing the moderating role of the Human Development Index (HDI). It utilizes provincial panel data of Indonesia from 2017 to 2023. This study employs a panel data regression model with an interaction term, estimated using a random effect approach, to examine the moderating effect of HDI. The findings reveal that digitalization positively affects inclusive growth. However, the moderating effect of HDI is negative and significant. To further examine heterogeneity, the sample is split into two groups based on the 2023 national average HDI as the threshold, and the model is re-estimated separately for provinces above and below this threshold. The split-sample results indicate contrasting dynamics: digitalization has a positive and significant effect on inclusive growth in provinces with low HDI, while it has a negative and significant effect in provinces with high HDI. This suggests that in more developed regions, digitalization tends to favor skilled workers, leading to labor market polarization and reduced inclusivity of growth. These findings highlight the need for context-specific digital policies that consider regional disparities in human development. In lower-HDI provinces, policies should focus on expanding digital infrastructure and access, while in higher-HDI provinces, emphasis should be placed on strengthening digital skills and inclusive labor market policies to mitigate inequality.

Keywords: Digitalization; Inclusive Growth; Human Development; ICT Index; Regional Inequality.

JEL classification: O33, O15, O18, I32

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1. INTRODUCTION

Inclusive growth has increasingly become a central focus in modern development discussions, as countries aim not only for higher gross domestic product (GDP) but also for a fair distribution of its benefits across society (Hay et al., 2022; Chaikin & Usiuk, 2019; Zhukovska, 2019). The concept highlights the importance of ensuring that economic progress results in widespread improvements in living standards, with a particular focus on marginalized communities and underdeveloped regions. Therefore, inclusive growth involves expanding access to high-quality education, healthcare, job opportunities, and avenues for income generation, allowing everyone to participate in and gain from economic growth (Hay et al., 2022; Westmore, 2017). For a country as geographically and socioeconomically diverse as Indonesia, the pursuit of inclusive growth continues to be an urgent yet intricate challenge.

Digital transformation has been a critical driver in redefining the global socio-economic framework. Progress in information and communication technology (ICT) is acknowledged as an essential contributor to productivity, efficiency, and accessibility across various sectors, including education, healthcare, and the economy. Provinces in the western regions such as Java and Sumatra generally demonstrate higher ICT development and Human Development Index (HDI), while eastern regions, including Papua, Maluku, and parts of Nusa Tenggara, continue to face limitations in digital infrastructure, education, and health outcomes (Kartiasih et al., 2023; Statistics Indonesia, 2024a). These disparities are reflected in uneven inclusive growth outcomes, where economic growth does not necessarily translate into equitable distribution of income and opportunities across regions.

Digitalization contributes to inclusive growth through multiple mechanisms. At the macro level, it improves productivity, reduces transaction costs, and enhances market efficiency (Laddha et al., 2022; Pan et al., 2022; Ren et al., 2022). At the micro level, it expands access to economic opportunities, including digital financial services, employment platforms, and online markets (Basnayake et al., 2024; Daud & Ahmad, 2023).

In Indonesia, a significant increase in the ICT Development Index (ICT-DI) highlights the widespread and extensive integration of digital technology (Hartono et al., 2023), emphasizing their role as potential drivers of equitable economic development. However, the benefits of digitalization are not evenly distributed. Aziz & Hossain (2024) and Du & Wang (2024) indicate that disparities in infrastructure and digital literacy persist across regions. These conditions imply that digitalization may both reduce and exacerbate inequality (Aziz & Hossain, 2024; Du & Wang, 2024; Zang et al., 2025), depending on regional conditions and the level of human development. In regions with strong human capital, ICT expansion tends to enhance inclusive participation (Liu et al., 2024), while in regions with limited human development, digitalization may reinforce inequality due to unequal access and capability gaps.

In many underdeveloped regions, people rely on traditional services due to limited access and understanding. Similarly, Hermawan et al. (2024) illustrated that internet access and financial inclusion significantly increase household income among impoverished populations, suggesting that digital connectivity can directly promote inclusivity when paired

with sufficient financial access. While digitalization seemingly improves access to education, financial systems, and job opportunities (Ahmad, 2020), its actual effects are frequently influenced by structural disparities, particularly in terms of human capital and regional development readiness (Liu et al., 2024).

Despite these findings, previous studies provide mixed and inconclusive evidence (Liu et al., 2024; Zang et al., 2025) regarding whether digitalization promotes or hinders inclusive growth, particularly when differences in human development are taken into account. Moreover, empirical studies that explicitly examine how ICT interacts with HDI to influence inclusive growth at the subnational level in Indonesia remain limited (Kartiasih et al., 2023; Liu et al., 2024). Consequently, the transformative potential of digital technologies is contingent (Liu et al., 2024; Zang et al., 2025), and their impact on inclusive economic outcomes differs according to a region's human development framework. Therefore, this study addresses this gap by examining how digitalization interacts with HDI to influence inclusive growth across provinces with varying levels of development. Given that a region's capacity to adopt and utilize technology is significantly influenced by the quality of its human resources, it is essential to assess how the HDI either promotes or obstructs the effects of digitalization on economic inclusion. Research by Wargadinata and Tendean (2024) reveals that insufficient digital literacy and lack of human resource capacity are significant obstacles to the equitable distribution of the benefits of digital transformation across various regions. Furthermore, previous studies on the correlation between digitalization and inclusive growth have yielded conflicting results. Tsaurai & Ndou (2019) argue that regions with improved infrastructure and human capital experience greater economic benefits, while Jamil (2022) suggests that internet accessibility may hinder inclusive growth in specific areas of Indonesia. These mixed findings indicate that the impact of digitalization on inclusive growth is context-dependent, and that differences in human development may explain these inconsistencies across regions.

This study contributes to the existing literature in several ways. First, it extends the literature by explicitly examining the moderating role of human development in the relationship between digitalization and inclusive growth at the subnational level, thereby addressing the limited empirical evidence on regional heterogeneity in developing countries (Kartiasih et al., 2023), particularly in Indonesia. Second, from a methodological perspective, this study employs a panel data regression model with an interaction term combined with a split-sample approach based on the national HDI threshold, allowing for a more detailed identification of heterogeneous effects across provinces with different levels of development. Third, in terms of policy relevance, this study provides differentiated policy insights by demonstrating that the impact of digitalization varies across regions, implying that uniform digital policies may not be effective in promoting inclusive growth. Instead, region-specific strategies that integrate digital development with human capital improvement are required (Amaglobeli et al., 2023; Bello et al., 2024). Previous research has emphasized that human development significantly determines the extent to which economic growth is inclusive. Sari et al. (2022) discovered that improvements in population health and education substantially boost regional economic performance in Indonesia, highlighting the importance of human

capital in promoting sustainable growth. In line with this, the HDI, which includes metrics related to health, education, and living standards, reflects the capacity of individuals and communities to access, understand, and effectively utilize digital technologies (Laitsou et al., 2025). This implies that HDI not only serves as an indicator of welfare, but also represents a region's absorptive capacity in utilizing digital technologies, which is crucial in determining whether digitalization leads to inclusive or unequal economic outcomes. Therefore, it is reasonable to suggest that HDI conditions the impact of ICT-DI on inclusive growth, such that the effect of digitalization may vary depending on the level of human development across regions. Despite Indonesia's national HDI reaching 74.39 in 2023 (Statistics Indonesia (BPS), 2023a), significant disparities between provinces persist, presenting a major obstacle to achieving inclusive development. In alignment with this reasoning, Iskandar (2017) found that investments in human development has a positive effect on economic growth. This finding resonates with Ratnasari (2021) who noted that the use of the internet by entrepreneurs in the informal sector significantly enhanced their earnings, illustrating how digital technologies can empower economically impoverished groups when basic access barriers are overcome.

The use of moderating variables, such as HDI, is crucial in clarifying the variations in the effects of digitization across diverse regions. According to the diffusion theory proposed by Nelson and Phelps (1966), technology investments are most effective in regions characterized by high-quality human capital. The ability to adapt to and innovate with new technologies is largely dependent on the education and health levels of the population. This study considers HDI not only as a control variable but also as a conditional element that might enhance or reduce the influence of ICT-DI on inclusive economic growth. Endogenous growth theory (Romer, 1990) asserts that technology and knowledge are essential drivers of continuous economic advancement. Digitalization serves as a form of technological capital, yet its impact is dependent on the quality of human resources. Regions with high HDI are more proficient in leveraging digital infrastructure for inclusive development, whereas those with low HDI may struggle to fully realize its advantages. The human capital theory (Schultz, 1961) supports this idea, asserting that investment in human capital improves a society's capacity to adapt to technological advancements. This perspective is also consistent with the diffusion of innovations theory (Rogers, 1962), which emphasizes that the adoption of new technologies depends on the socio-economic characteristics and readiness of individuals and communities. Some studies suggest that internet connectivity could potentially hinder inclusive growth in certain regions of Indonesia, perhaps due to weak digital literacy and insufficient institutional support (Jamil, 2022). These variances highlight the influence of confounding variables such as education, health, and governance.

Accordingly, the HDI serves as a significant metric for assessing a region's capacity to adopt and effectively utilize digital technologies. Indonesia has systematically pursued inclusive development through the establishment of the Inclusive Growth Index. The second pillar of this index, which focuses on equitable distribution of developmental results, is fundamentally linked to digitalization and human capital. Empirical evidence demonstrates that the impact of digital adoption on inclusive growth is more significant in regions with

superior ICT infrastructure and high educational attainment (Amaglobeli et al., 2023; Bello et al., 2024). The educational aspect of HDI is critical in promoting inclusive economic outcomes. Evidence from Indonesia highlights a persistent digital divide, particularly in remote and rural regions, where insufficient digital literacy and underdeveloped ICT infrastructure hinder the effective integration of digital transformation initiatives (Hadi, 2018). However, a significant lack of empirical research exists that specifically investigates the moderating role of HDI in the ICT-DI and inclusive growth in developing countries, especially in Indonesia. This study aims to address this gap by analyzing whether and how regional human development conditions affect the effectiveness of digital infrastructure in promoting inclusive economic outcomes.

2. METHODS

2.1 Data and Descriptive Statistics

This study employs panel data from 32 Indonesian provinces over the period 2017–2023. Two provinces, DKI Jakarta and DI Yogyakarta, are excluded as they exhibit substantially higher HDI and ICT levels compared to other provinces, indicating potential high-leverage observations that may disproportionately influence the estimation results. This exclusion is applied to obtain more representative estimates for the majority of provinces, and robustness checks including all provinces yield consistent directional results. The dependent variable is the inclusive economic growth indicator (IG), obtained from pillar 2 data on a scale of 1 to 10. This index comprises sub-pillars of income equality and poverty alleviation, derived from Ministry of National Development Planning (2025). The independent variable is the Information and Communication Technology Development Index (ICT-DI). The ICT-DI data was sourced from Statistics Indonesia annual publication (Statistics Indonesia, 2019-2024). The HDI data derived from the Statistics Indonesia annual reports (2024).

Model selection follows standard panel data procedures, including the Chow, Hausman, and Lagrange Multiplier (LM) tests, followed by relevant classical assumption tests. The Chow test is utilized to choose the appropriate model in panel data regression by comparing the common effect and fixed effect models. The Hausman test evaluates the relationship between individual effects and independent variables in the model. The Lagrange multiplier test is utilized to ascertain the more effective model between random effects and common effects models. If the selected model is categorized as Ordinary Least Squares (OLS), such as the fixed effect model or the common effect model, the classical assumption tests performed are limited to the heteroscedasticity test and the multicollinearity test. When utilizing the Generalized Least Squares (GLS) model, including the random effects model, the standard assumption tests involve the residual normality test and the multicollinearity test.

2.2 Panel Data Model

The empirical model is constructed based on endogenous growth theory and human capital theory, which emphasize the role of technological progress and human capability in driving

inclusive economic outcomes. From a theoretical perspective, digitalization enhances productivity and access to economic opportunities, thereby promoting inclusive growth. However, the extent of this impact depends on the level of human development, which determines a region's capacity to adopt and effectively utilize digital technologies. From an empirical perspective, this relationship is operationalized by specifying ICTDI as the main explanatory variable and HDI as a moderating variable, allowing the estimation of both direct and interaction effects.

The baseline model examining the impact of digitalization on inclusive economic growth is specified as follows:

$$IG_{it} = \alpha + \beta ICTDI_{it} + \varepsilon_{it} \quad (1)$$

The model is estimated using panel data approaches, including the Common Effects Model (CEM), Fixed Effects Model (FEM), and Random Effects Model (REM). Model selection is based on the Chow test, Hausman test, and Lagrange Multiplier test.

To examine the moderating role of HDI, a moderated regression model is employed as follows:

$$IG_{it} = \beta_0 + \beta_1 ICTDI_{it} + \beta_2 HDI_{it} + \beta_3 ICTDI \times HDI_{it} + \varepsilon_{it} \quad (2)$$

Where:

IG_{it} = Inclusive economic growth in region i period t

$ICTDI_{it}$ = ICT development index in region i period t

HDI_{it} = Human development index in region i period t

α, β_0 = constant

$\beta, \beta_1, \beta_2, \beta_3$ = regression coefficients

ε_{it} = error term

To reduce potential multicollinearity arising from the interaction term, all independent variables are mean-centered prior to constructing the interaction variable. This procedure ensures more stable coefficient estimates and facilitates interpretation of the moderating effect.

3. RESULTS AND DISCUSSIONS

3.1 Results

3.1.1 Total Sampel

This study aims to examine the impact of digitalization on inclusive economic growth in Indonesia, integrating HDI as a moderating component. Consequently, to achieve the best results from panel data analysis, the first necessary action is to conduct the Chow Test. The results of the Chow Test are presented in Table 1.

Table 1. Result of Chow Test

Effects Test	Statistic	d.f	Prob
Cross-section F	116.811834	(31,189)	0.0000
Cross-section Chi-square	672.824598	31	0.0000

Source: Author's computation using EViews 13

As shown in Table 1, the Chow Test results indicate the rejection of H_0 . Therefore, the employed model is the Fixed Effects Model. Additionally, to determine the link between the aggregate error in the model and one or more explanatory variables, the Hausman Test is required.

Table 2. Result of Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f	Prob
Cross-section random	4.332244	3	0.2278

Source: Author's computation using EViews 13

As shown in Table 2, the Hausman test results indicate that the Random Effect Model is the most appropriate. Subsequently, the Lagrange Multiplier (LM) test was conducted to validate the suitability of the Random Effects Model compared to the Common Effect Model, as presented in Table 3.

Table 3. Result of Lagrange Multiplier Tests

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	565.8187 (0.0000)	1.520097 (0.2176)	567.3388 (0.0000)

Source: Author's computation using EViews 13

As shown in Table 3, the Breusch-Pagan probability leading to the rejection of H_0 . As a result, the preferred model is the random effects model. Given that the model utilized is random effects model, the relevant classical assumption assessments are the residual normality test and the multicollinearity test. Before conducting the classical assumption tests, data validation and outlier detection were performed. In 2023, DKI Jakarta and DI Yogyakarta emerged as the two provinces with the highest HDI and were identified as outliers and subsequently removed from the dataset to prevent bias in the residual distribution. Following this, all independent variables, including ICT-DI and HDI, were mean-centered to reduce any multicollinearity resulting from variable interactions. The results that follow relate to the assessment of residual normality.

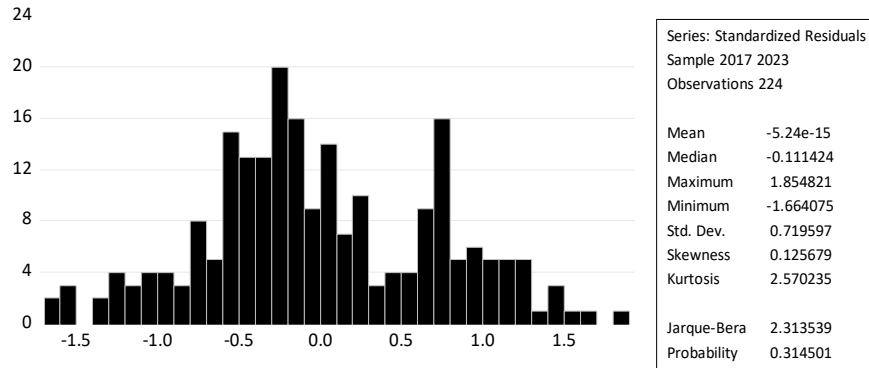


Figure 1. Results of Normality Test

As Illustrated in Table 4, the Jarque–Bera test results suggest that H_0 is not rejected, indicating that the residuals are normally distributed. Consequently, a multicollinearity test was performed on all independent variables, including the mean-centered interaction variable (ICT×HDI). The correlation matrix among independent variables is presented below:

Table 4. Results of Multicollinearity Test

Variable	Coefficient	Uncentered	Centered
	Variance	VIF	VIF
C	0.015603	1.015631	NA
ICT-DI	0.003065	4.255644	4.255644
HDI	0.000567	4.093884	4.093884
ICT-DI × HDI	6.28E-05	1.096863	1.081232

Source: Author’s computation using EViews 13

The multicollinearity test was conducted directly using the Variance Inflation Factor (VIF). All three centered VIF values are beneath the standard critical limit of 10. Thus, H_0 is accepted, indicating that the model does not exhibit significant multicollinearity issues. Accordingly, all independent variables can be retained in the regression analysis without requiring further adjustment or elimination.

Additionally, an assessment was conducted regarding the impact of digitalization on inclusive economic growth, as illustrated in Table 5.

Table 5. Results of simple regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.654286	0.140195	47.46465	0.0000
ICT-DI	0.454774	0.027843	16.33343	0.0000

Source: Author’s computation using EViews 13

According to Table 5, the error probability for the ICT-DI variable is less than $\alpha = 0.05$, indicating that ICT-DI has a significant positive effect on inclusive economic growth. To

further examine this relationship, this study aims to fill the gap in previous studies by using the HDI variable as a moderating factor.

Table 6 displays the findings of the moderation regression analysis to ascertain if HDI moderates the association between ICT and inclusive economic growth.

Table 6. Results of moderation regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.697651	0.124913	53.61853	0.0000
ICT-DI	0.221297	0.055362	3.997245	0.0001
HDI	0.109610	0.023814	4.602869	0.0000
ICT-DI × HDI	-0.022183	0.007927	-2.798453	0.0056

Source: Author's computation using EViews 13

Table 6 indicates that ICT-DI has a strong positive influence on inclusive economic growth. Meanwhile, the interaction variable between ICT-DI and HDI is negative and statistically significant, indicating that HDI weakens positive relationship between ICT-DI and inclusive economic growth. This suggests that the impact of digitalization on inclusive economic growth may vary based on the HDI level within a province.

This finding can be explained by the presence of skill-biased technological change (Liu et al., 2024; Zang et al., 2025). In provinces with higher HDI, digitalization tends to benefit skilled workers who are better able to utilize digital technologies, thereby increasing their income and productivity. However, lower-skilled workers may not experience similar gains, leading to unequal distribution of economic benefits (Zang et al., 2025). As a result, although digitalization promotes economic growth, its contribution to inclusive growth becomes weaker in regions with higher HDI due to widening disparities in access to opportunities.

To further explore heterogeneity, we conduct a subgroup regression using the original (non-mean-centered) data, classifying provinces based on their 2023 HDI. This exploratory analysis includes all 34 provinces to capture the full variation across regions, while the main model uses 32 provinces after excluding high-leverage observations to ensure robust estimation. The subgroup results are therefore interpreted as complementary rather than directly comparable to the main estimates.

3.1.2 Split sample

Table 7. Simple regression results on provinces with HDI below the national average

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.248167	0.620457	2.011691	0.0469
ICT-DI	1.016549	0.121376	8.375232	0.0000

Source: Author's computation using EViews 13

Table 7 indicates that the error probability value for the ICT variable is less than $\alpha = 0.05$, signifying that ICT-DI maintains a significant positive impact on inclusive economic growth. This suggests that in regions with lower HDI, the utilization of ICT-DI potentially improve the inclusivity of economic growth.

Table 8. Simple regression results on provinces with HDI above the national average

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.03668	0.717967	13.97931	0.0000
ICT-DI	-0.572281	0.121916	-4.694073	0.0000

Source: Author's computation using EViews 13

ICT-DI has a negative impact on inclusive economic growth, as indicated by the error probability value for the ICT-DI in Table 8, accompanied by a negative coefficient. This result indicates that in regions with high human development levels, ICT-DI does not necessarily promote inclusive economic growth and may have a more complex effect.

According to Tables 7 and 8, the effect of digitalization on inclusive growth shows different patterns in regions with HDI levels above and below the national average in provinces where the HDI is below the national average (15 provinces), digitalization has a positive and significant effect on inclusive economic growth. This can be attributed to several key factors. Digitalization facilitates new economic prospects, especially for populations that have faced challenges in accessing information, financial services, and market participation (Saladin & Faoziyah, 2024).

3.2 Discussion

This study's findings reveal that digitalization has a positive and significant effect on inclusive growth. This finding is consistent with endogenous growth theory (Romer, 1990), which emphasizes that technological progress enhances productivity and expands economic opportunities. This suggests that digitalization can act as a mechanism to promote social and economic inclusion (Basnayake et al., 2024; Ren et al., 2022). Empirical research demonstrates that digital finance, digital governance, and ICT infrastructure correlate with improvements in inclusive growth metrics (Daud & Ahmad, 2023; Li et al., 2024; Wang et al., 2023). This suggests that digitalization improves inclusivity by reducing barriers to access and enabling broader participation in economic activities. A significant focus of digitalization is the transformation of the public sector. Digital public administration is increasingly associated with improved equitable and sustainable development outcomes, such as better budget management and increased accessibility of services (Kwilinski et al., 2023). Moreover, digital finance and e-governance can boost income generation, improve fiscal efficiency, and promote educational achievement, all of which are essential components of inclusive growth (Wang et al., 2023). Digital inclusive finance operates through intermediary processes, encompassing human capital development and innovative activities (Yang et al., 2024). These findings are consistent with the results of this study, which show

that ICT development significantly enhances inclusive growth across Indonesian provinces by expanding access to economic opportunities and public services.

The findings of Nchake and Shuaibu (2022) show that ICT infrastructure has a positive and significant impact on inclusive growth in Africa, with an average increase of 0.4% to 0.7%, using robust empirical analysis covering 46 countries from 2000 to 2019. Internet access, broadband, and mobile connectivity have shown benefits across all economic strata, especially for the underprivileged (Kouladoum, 2023). Furthermore, energy, transportation, and digital infrastructures have a redistributive effect, diminishing wealth inequalities (Mutirira et al., 2020). In contrast, Ofori et al. (2024) illustrate that digital infrastructure does not significantly contribute to inclusive growth, highlighting the importance of supportive institutions and additional investments. An agreement exists regarding the necessity of extensive infrastructure development to effectively realize the potential of digitalization (Kouladoum, 2023; Nchake & Shuaibu, 2022). These findings from other developing regions provide important context for understanding the Indonesian case, where similar patterns of uneven digital benefits are observed. This aligns with the findings of this study, where the positive impact of digitalization is evident, but its effectiveness varies depending on regional conditions, particularly differences in human development levels.

However, the positive effect of digitalization on inclusive growth observed in the aggregate analysis may mask important heterogeneity across regions with different levels of human development. The literature has increasingly highlighted the importance of a comprehensive approach in assessing inclusive growth. Sharma (2019) emphasizes that inclusive economic growth must involve raising incomes, expanding access to quality employment, and improving essential services such as education and healthcare. In this regard, indices such as the HDI are especially relevant as a metric of regional capacity to adopt and utilize the benefits of digitalization.

This study's findings on moderation regression analysis show that the interaction between digitalization and HDI has a negative and significant effect on inclusive growth. This indicates that higher levels of HDI weaken the inclusivity-enhancing effect of digitalization, confirming that its impact is not uniform across regions with different levels of human development. Importantly, this negative moderating effect is particularly evident in provinces with higher HDI levels, where digitalization does not necessarily translate into more inclusive outcomes. Instead, the benefits of digitalization tend to be concentrated among specific groups, particularly those with higher education and digital skills.

This finding highlights that higher human development does not automatically guarantee equitable distribution of digital benefits, but may instead intensify inequality under certain conditions. This result can be explained by skill-biased technological change, where digitalization disproportionately benefits individuals with higher education and digital skills. As a result, the gains from digital transformation are concentrated among more skilled groups, while lower-skilled individuals face limited access to digital opportunities. In high-HDI regions, digitalization also accelerates labor market transformation, including automation and job restructuring, which reduces employment opportunities for routine and low-skilled workers. Consequently, this leads to widening income disparities, unequal access

to employment, and limited participation of vulnerable groups in digital economic activities, thereby weakening inclusive growth.

The evidence from previous studies highlights a complex and at times non-linear relationship. Multiple studies suggest that although digitalization may initially obstruct inclusive outcomes, its long-term benefits become apparent once essential thresholds of infrastructure and human capital are attained. Kwilinski et al. (2023) discovered a U-shaped relationship between government digitalization and inclusive growth, while Xiang et al. (2022) found an inverted U-shaped correlation between the rise of the digital economy and low-carbon, inclusive growth in China. These findings indicate diminishing returns or potential negative externalities at high levels of digitalization, such as increased digital inequality or technological unemployment. The role of governance remains a topic of discussion: while effective governance can promote digitalization (Daud & Ahmad, 2023), certain data suggests it may hinder its effectiveness under particular circumstances (Nguyen, 2021). The varied results emphasize the importance of contextually informed and adaptable strategies.

A substantial segment of the research highlights the importance of understanding initial conditions and contextual factors in evaluating the effects of digitization on equitable growth. Wiston and Edgar (2019) argue that innovation-driven growth requires adequate institutional preconditions and human capital competencies to mitigate future inequalities. Research by the World Bank (2025), indicates that effective digitalization promoting equitable growth consists of three fundamental components: digital connectivity, digital skills, and inclusive digital public services. In developing countries, deficiencies in digital skills and inclusive digital services can intensify social and economic disparities.

Kou (2024) indicates that the effect of digitalization on income equality may be affected by the labor market. They suggest that automation and digitalization could replace conventional employment, especially in informal or labor-intensive sectors, unless accompanied by reskilling and the improvement of digital competences. This insight highlights that the capacity of a population to adapt to digital transformation reflected in their human development level may fundamentally shape whether digitalization promotes or obstructs inclusive growth.

To better understand the negative moderation effect, subgroup analysis was conducted by categorizing provinces based on their HDI levels relative to the national average. This analysis reveals contrasting dynamics in how digitalization affects inclusive growth across different human development contexts.

The findings of the subgroup regression indicate that in provinces with a 2023 HDI below the national average, digitalization has a positive and significant effect on inclusive growth. This suggests that digitalization can act as a mechanism to promote social and economic inclusion in regions with relatively underdeveloped human capital. A study by Ha and Chuah (2023) in Southeast Asia reveals that regions with higher urbanization experience more immediate benefits from digital transformation compared to rural regions characterized by insufficient infrastructure and limited educational opportunities. This finding aligns with research in Indonesia that reveals inequalities among provinces in the

utilization of digital technologies (Adiningsih et al., 2019; Ariansyah et al., 2019; Kartiasih et al., 2023).

According to Bai et al. (2021), digital technology facilitates the active participation of MSMEs and informal sector workers in the economy through digital payments, especially mobile money. Moreover, technology leapfrogging allows underdeveloped countries to rapidly improve their technological capabilities by bypassing traditional development stages and directly adopting innovative advancements (Tan et al., 2018). This concept is particularly relevant to provinces with a HDI below the national average, where digitalization fosters inclusive growth by opening new pathways for economic participation.

Matli & Wamba (2023) highlight that the lack of traditional infrastructure renders digital technology a more effective for remote work means of promoting economic activities. For instance, instead of investing in physical bank branches, digital financial services can swiftly connect with communities that were previously unbanked, thus improving access to financial services and fostering economic participation.

Additionally, digitalization has transformed workforce productivity by facilitating greater access to online training and educational materials, allowing employees to augment their skill sets (Dao et al., 2025; Gegenfurtner et al., 2020). Moreover, community-level digitalization, especially in rural areas, has the potential to strengthen the resilience and independence of local communities. According to Manoby et al. (2021), initiatives aimed at digitalizing villages play a crucial role in promoting inclusive development by improving human capital within the grassroots framework.

Wargadinata and Tendean (2024) observed that the process of digital transformation is still facing challenges associated with regional disparities, especially in terms of digital literacy and the readiness of infrastructure. Numerous communities in undeveloped regions continue to depend on traditional services due to their limited capacity or access to utilize digital technology effectively. This highlights the importance of a digital strategy that is based on community readiness to ensure that technology implementation is inclusive.

Conversely, in provinces with HDI exceeding the national average, digitalization has a negative and significant effect on inclusive growth. This indicates that in high-HDI regions, digitalization may reinforce existing inequalities rather than promote inclusivity. Specifically, this effect is reflected in widening income disparities, reduced employment opportunities for low-skilled workers, and limited participation of vulnerable groups in digital economic activities.

This can be explained by the nature of digitalization in more developed regions, where technological adoption tends to favor highly skilled individuals, leading to a digital divide. At the same time, automation and efficiency gains may reduce demand for routine labor, thereby limiting job opportunities for lower-income populations. In such contexts, digitalization no longer expands inclusion but instead concentrates economic benefits among already advantaged groups. This mechanism is consistent with the empirical finding of this study, where the negative interaction term between ICT-DI and HDI indicates that higher human development levels are associated with a weaker inclusivity effect of digitalization.

In public policy discussions, digitalization is perceived as a means to improve inclusion in service delivery. Digital governance promotes increased citizen engagement through e-participation and e-services, hence improving accountability and transparency (United Nations Department of Economic and Social Affairs, 2024). However, these benefits are only experienced in regions with sufficient digital literacy and internet connectivity, which explains why high HDI provinces may not automatically translate digital advancement into inclusive outcomes, as the benefits tend to concentrate among already advantaged groups, potentially widening rather than narrowing socioeconomic gaps.

4. CONCLUSIONS

This study finds that the impact of digitalization on inclusive economic growth is conditional on the level of human development across regions. In provinces with lower HDI, digitalization serves as a catalyst for inclusive growth by expanding access to economic opportunities and improving productivity. In contrast, in high-HDI regions, digitalization may reinforce existing inequalities by favoring skilled labor, altering labor market structures, and limiting participation among vulnerable groups.

These findings demonstrate that digitalization does not automatically lead to inclusive outcomes, but depends on the capacity of human resources and the distribution of digital opportunities. Therefore, achieving inclusive growth in the digital era requires policies that align technological advancement with human capital development and equitable access.

This study has several limitations. First, the analysis is limited to the period 2017–2023 and uses provincial-level data, which may not capture variations at more granular levels such as districts or municipalities. Second, the moderating analysis focuses solely on HDI and does not incorporate other relevant factors such as digital literacy, institutional quality, or social inclusion. Future research could explore these dimensions to provide a more comprehensive understanding of digital inequality.

From a policy perspective, the findings highlight the need for differentiated strategies. In low-HDI regions, policies should prioritize expanding ICT access, strengthen digital literacy, and improve basic infrastructure. In high-HDI regions, policy efforts should focus on mitigating digital inequality, supporting workforce adaptation, and ensuring that technological advancement does not lead to economic exclusion. A context-specific and integrated policy approach is therefore essential to ensure that digitalization contributes to equitable and sustainable economic development.

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