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Digital Inequality: E-Commerce Access and Its Implications for Underdeveloped Regions in Indonesia

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ABSTRACT

Indonesia is undergoing a significant digital transformation, but the disparity between developed and underdeveloped regions remains evident in internet access, infrastructure, and digital economic integration. This study investigates how gaps in digital infrastructure specifically internet density, logistics facilities, and internet speed affect the number of online MSMEs, e-commerce GDP contribution, and poverty rate across four provinces: Jakarta, West Java, East Nusa Tenggara, and Papua. Using a quantitative approach with SPSS analysis, strong correlations were found. Internet density has a highly significant positive correlation with online MSMEs ($r = 0.994$, $p = 0.006$). Logistic warehouses strongly predict e-commerce GDP contribution ($R^2 = 0.991$, $F = 214.27$, $p = 0.005$), and internet speed has a significant negative impact on poverty ($\beta = -1.228$, $p = 0.021$). A composite digital inequality index also highlights substantial gaps between the developed and underdeveloped regions, confirming hypothesis H_4. These findings validate that digital infrastructure directly influences economic outcomes, particularly in marginalized regions. The study concludes that bridging the digital divide is essential for inclusive development. Policymakers should prioritize investment in digital infrastructure as a strategic tool for reducing poverty and stimulating regional economic growth.

Keywords: *Digital Divide; E-Commerce Accessibility; Regional Inequality; Digital Infrastructure; Inclusive Economic Development*

INTRODUCTION

In the age of digital transformation, e-commerce has emerged not only as a significant driver of economic growth but also as a pivotal platform that fosters inclusivity, entrepreneurship, and innovation. However, the benefits of e-commerce are not universally accessible. Digital inequality characterized by uneven access to information and communication technologies (ICT), poses a major challenge, particularly in underdeveloped regions of developing countries like Indonesia. This paper investigates how limited access to e-commerce in these regions perpetuates broader socioeconomic disparities and proposes strategic interventions to bridge this divide.

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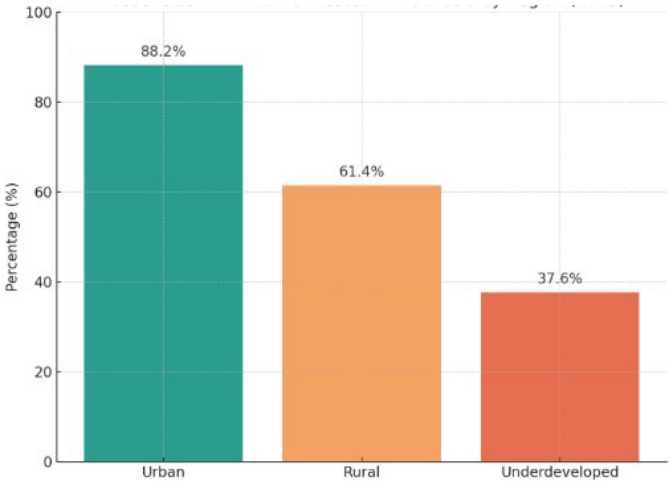

Figure 1: Digital Access Disparities in Indonesia (2023)
Source: Badan Pusat Statistik. (2023)

Recent statistics from Indonesia provide a clear illustration of the digital chasm. As shown in the chart above, while 88.2% of urban households enjoy internet access, only 61.4% of rural households and a mere 37.6% of households in underdeveloped regions are connected to the digital world (Badan Pusat Statistik, 2023). Such disparity in access to the digital infrastructure has critical implications for economic participation, especially in relation to the adoption and utilization of e-commerce platforms. For the digitally underserved, the absence of this connectivity represents more than just a technical shortcoming it is a missed opportunity to engage in an increasingly digital economy.

The purpose of this research is to explore the dynamics of digital inequality in the context of e-commerce, with a specific focus on its implications for underdeveloped regions. While many studies have analyzed digital access in general, few have specifically addressed how unequal e-commerce access influences economic marginalization, especially in rural and remote provinces. This study aims to fill that gap by examining the relationship between ICT access, e-commerce penetration, and socioeconomic outcomes in Indonesia's least developed areas (Ramadhani et al., 2024).

This topic is particularly significant given Indonesia's unique digital landscape. According to Ariansyah et al. (2021), barriers to e-commerce adoption include infrastructural deficits, digital illiteracy, and the high cost of internet services. On the other hand, mobile broadband has been shown to play a transformative role in reducing income inequality, especially in remote regions (Ariansyah et al., 2023). These findings suggest that while the potential for digital transformation exists, it remains largely untapped in regions where technological adoption is constrained.

The central hypothesis of this research posits that improving digital infrastructure and expanding e-commerce access in underdeveloped regions can significantly reduce economic disparities and enhance local entrepreneurship. This hypothesis is grounded in existing literature that emphasizes the role of ICT in promoting equitable growth (Faizah et al., 2021; Kustanto, 2024). Additionally, previous studies have shown that regional digital development is closely associated with socioeconomic indicators such as income, employment, and education (Kartiasih et al., 2023).

This issue warrants scholarly attention for several reasons. First, as digital economies grow, the digital divide could further entrench existing inequalities if not addressed systematically. Second, underdeveloped regions possess untapped human and resource potential that could be unlocked through digital inclusion. Finally, understanding the specific barriers to e-commerce access in these regions allows policymakers and private stakeholders to design more targeted and effective intervention (Akbariah et al., 2024).

By analyzing Indonesia as a case study, the research argues that increasing e-commerce access

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in marginalized regions can promote equitable development, reduce urban-rural income gaps, and foster greater national resilience in the face of global digital trends. Moreover, this paper positions e-commerce not just as a platform for consumption, but as a tool for production and distribution that can empower rural entrepreneurs, farmers, and artisans.

Several academic contributions support the foundation of this study. Jurriens & Tapsell (2017) emphasized the duality of digital connectivity in Indonesia while offering unprecedented opportunities, it also introduces new inequalities if left unregulated. Kustanto (2024) further elaborates on how ICT diffusion directly impacts income distribution and economic quality of life across provinces. Meanwhile, Velicia (2025) discusses the broader macroeconomic implications of the digital economy in accelerating national development. Together, these studies offer a rich backdrop against which this paper positions its inquiry.

Despite these contributions, a notable gap in the literature exists: the specific linkage between regional e-commerce access and localized economic development outcomes remains underexplored. While many studies acknowledge the role of ICT in reducing poverty, they often overlook the granular mechanisms through which e-commerce can empower underserved communities. This research addresses that gap by providing empirical insights and grounded policy recommendations tailored to underdeveloped settings.

Although many studies have examined digital access, there is still a clear gap in understanding the direct link between regional e-commerce access and local socioeconomic outcomes. This study seeks to fill that gap by focusing on Indonesia's underdeveloped regions and exploring how unequal digital access limits economic participation.

Based on this aim, the research is guided by the following main question. How does limited access to e-commerce in Indonesia's underdeveloped regions affect socioeconomic inequality, and what practical interventions can help reduce this divide?

To answer this question, the study sets out three objectives.

1. Examine the differences in digital infrastructure and e-commerce access across Indonesia's regions.
2. Evaluate the socioeconomic impacts of unequal e-commerce participation, with a focus on rural and remote provinces.
3. Propose practical strategies and policy recommendations for building inclusive digital ecosystems that support fair economic growth.

In conclusion, this research not only adds to the discussion on digital inequality but also offers practical value. The insights are expected to help policymakers, local governments, and communities understand how e-commerce can be used more fairly and effectively. By doing so, the study aims to support local entrepreneurs, farmers, and small businesses in underdeveloped areas, while at the same time contributing to more balanced economic growth across Indonesia.

LITERATURE REVIEW

The rapid expansion of the digital economy has sparked scholarly interest in understanding how access to e-commerce platforms varies across different socioeconomic and geographic contexts. In Indonesia, a country marked by stark regional disparities, this issue becomes even more pressing. Numerous studies have examined the factors driving and inhibiting digital access, yet few have explicitly focused on how these dynamics affect underdeveloped regions in terms of inclusive economic participation.

Ariansyah et al. (2021) investigated the drivers and barriers of e-commerce adoption based on individual perspectives across Indonesia. Their findings emphasized the roles of digital literacy, trust, and infrastructure availability in determining the level of e-commerce engagement. While their study laid the foundation for understanding individual-level motivations and challenges, it did not delve deeper into the regional inequalities that exacerbate these individual-level barriers. The current research builds on their insights but focuses more sharply on regional digital exclusion, particularly in economically marginalized areas.

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Extending the discourse, Kartiasih et al. (2023) employed a spatial and multivariate analysis to explore inequalities in digital development across Indonesia's provinces. They found that disparities in ICT infrastructure strongly correlate with economic indicators like GDP per capita and education levels. However, their work largely remains descriptive and lacks empirical analysis on how these disparities directly affect access to specific digital services such as e-commerce, especially in peripheral regions. This study addresses that gap by quantitatively assessing the relationship between digital access and e-commerce usage using regional data.

Faizah et al. (2021) contributed to the literature by connecting ICT access with changes in regional inequality. Their results show that ICT can be a double-edged sword: while it offers development potential, it may widen gaps where access is uneven. The current research aligns with this perspective but pushes the conversation forward by examining e-commerce as a specific ICT application and evaluating whether it mitigates or intensifies inequality in remote and underdeveloped regions.

From a macroeconomic lens, Velicia (2025) highlighted the role of the digital economy in promoting national economic growth, focusing primarily on urban centers and well-developed regions. Although insightful, her work did not address how these digital economic benefits could be equitably distributed. In contrast, this study argues that without targeted policies, the digital economy including e-commerce may reinforce existing spatial inequalities.

Kustanto (2024), in two separate publications, discussed how ICT diffusion could help reduce income inequality in Indonesia. He presented compelling econometric evidence that wider access to ICT correlates with improved income distribution. However, his studies primarily focus on general ICT indicators (e.g., mobile phone penetration, internet use), with minimal exploration of digital commerce adoption. The novelty of this paper lies in focusing on e-commerce as a key digital channel that connects marginalized regions to wider markets arguably a more direct driver of economic empowerment than general ICT access.

Jurriens and Tapsell (2017), in their critical work on Indonesia's digital revolution, highlighted the divergence between urban and rural experiences with digital technology. They noted that while connectivity infrastructure has improved, systemic barriers remain in underdeveloped regions. This work strongly supports the central hypothesis of the present research that digital inequality is not just a technological issue, but a deeply structural one, influenced by policy, education, and economic opportunity.

Finally, Ariansyah et al. (2023) provided evidence that mobile broadband can reduce income inequality in Indonesia's underdeveloped regions. Their findings are encouraging but primarily focused on mobile data usage, not the quality or utility of digital engagement such as online marketplaces, financial inclusion, or business creation. This study extends their findings by assessing how e-commerce functions as an enabler of economic inclusion when basic infrastructure (i.e., broadband) is already present.

Author's Position and Research Gap

The present study agrees with previous scholars that digital infrastructure and ICT adoption are critical to development. However, it identifies a key gap: most existing studies treat e-commerce as a secondary or background variable, rather than the central subject of analysis in the context of underdeveloped regions. Additionally, while qualitative insights abound, quantitative and region-specific statistical evidence on how digital inequality affects e-commerce access and by extension, local economies is still lacking.

Therefore, this research offers a novel contribution by using quantitative methods (SPSS analysis) to measure the degree to which digital infrastructure correlates with e-commerce usage in Indonesia's underdeveloped provinces. This empirical approach allows for more concrete policy recommendations and contributes to a more granular understanding of how digital inequality translates into economic opportunity gaps.

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METHOD

This research employs a quantitative, comparative-descriptive approach to analyze the extent of digital inequality in Indonesia, particularly in relation to access to e-commerce platforms. The goal is to statistically evaluate disparities between developed regions (Jakarta and West Java) and underdeveloped regions (East Nusa Tenggara/NTT and Papua) using structured secondary data and quantitative indicators.

1. Research Design and Approach

The study adopts a quantitative comparative design. This design is appropriate for measuring differences between predefined groups in this case, regions with contrasting levels of digital development. The approach is non-experimental and cross-sectional, as it captures data at a single time point across multiple regions for comparative analysis. This method enables the researcher to identify relationships and disparities in key indicators such as internet access, infrastructure, e-commerce participation, and economic indicators. As noted by Sugiyono (2017), quantitative research emphasizes the use of measurable data to formulate facts and uncover patterns in research. Similarly, Creswell (2014) highlights that quantitative approaches are effective when the objective is to test theories or examine relationships among variables using statistical procedures.

2. Population and Sample

The population consists of all provinces in Indonesia, but through purposive sampling this study selects four provinces to represent contrasting categories. DKI Jakarta and West Java are consistently at the top in terms of internet penetration, digital literacy, and online transaction volume, while East Nusa Tenggara (NTT) and Papua record some of the lowest levels on the same indicators (BPS, 2023; Kominfo, 2023; World Bank, 2023). These four provinces were therefore chosen as representative of the two extremes in Indonesia's digital landscape, providing a clear empirical basis for analyzing how unequal e-commerce access relates to socioeconomic outcomes.

Developed Provinces:

a. DKI Jakarta: The capital city with advanced digital infrastructure, high e-commerce penetration, and the highest digital literacy index.
b. West Java: A populous and economically dynamic province with a rapidly growing digital economy.

Underdeveloped Provinces:

a. East Nusa Tenggara (NTT): Among the provinces with the lowest digital infrastructure and internet penetration rates.
b. Papua: Known for its remote geography and one of the lowest internet access and e-commerce engagement levels.

These provinces were selected based on recent reports from BPS (2023), Kominfo (2023), and World Bank Indonesia (2023), which show significant gaps in digital development between the selected regions.

3. Data Collection Techniques

This study uses secondary data obtained from authoritative institutional sources, including:

a. Badan Pusat Statistik (BPS, 2023) – for socioeconomic and e-commerce indicators.
b. Ministry of Communication and Information Technology (Kominfo, 2023) – for data on digital infrastructure and internet access.
c. World Bank & Google Temasek Report (2023) – for regional digital economy metrics.
d. Association of Indonesian Logistics and Kominfo – for logistics accessibility indicators.

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Variables analyzed include:

a. Digital infrastructure (internet access, broadband speed)
b. E-commerce participation (online transaction users per capita, % of MSMEs online)
c. Economic indicators (GRDP per capita, poverty rate)
d. Logistics infrastructure (availability of warehouses and delivery services)

4. Data Analysis Procedures

Quantitative data were processed and analyzed using SPSS version 26. The analysis followed these stages:

Descriptive Statistics

To summarize the central tendency and distribution of digital and economic variables across the four provinces.

Independent Sample T-Test

Used to compare digital access and e-commerce indicators between developed and underdeveloped groups to test for statistically significant differences.

Pearson Correlation Analysis

To assess the relationship between digital infrastructure (e.g., internet access) and e-commerce activity.

Linear Regression Analysis

To examine whether digital infrastructure significantly predicts the level of e-commerce use in a given province.

Each statistical test was preceded by data cleaning, normality testing, and homogeneity of variance testing (Levene's Test), to ensure assumptions were met and results valid.

The use of SPSS in social research is well-established. As noted by Santoso (2019) in Mengolah Data Statistik dengan SPSS 26, this software allows researchers to handle complex data sets and perform reliable statistical analysis for decision-making and interpretation.

5. Formulation of Hypotheses

Based on the theoretical framework and the compiled data, the hypotheses in this study are formulated as follows:

H_1: There is a positive relationship between internet density (X1) and the number of online MSMEs (Y1).

H_2: The higher the number of logistic warehouses (X2), the greater the contribution of e-commerce to regional GDP (Y2).

H_3: Internet speed (X3) is inversely related to the poverty rate (Y3).

H_4: Regions with low combined values of X1–X3 (NTT and Papua) exhibit a significant gap in e-commerce access compared to more developed regions (Jakarta and West Java).

RESULT AND DISCUSSION

1. Overview of Regional Digital Infrastructure Gaps

The digital infrastructure landscape in Indonesia remains highly uneven across regions, contributing to significant disparities in access to and benefits from e-commerce. This study compares two economically developed provinces, DKI Jakarta and West Java, with two underdeveloped provinces, East Nusa Tenggara (NTT) and Papua, using three core indicators: internet density (X1), the number of logistic warehouses (X2), and internet speed (X3).

As shown in the dataset, DKI Jakarta leads with an internet density of 89.3%, 120 logistic warehouses, and an average internet speed of 25.1 Mbps. West Java follows with a slightly lower digital capacity: 65.2% internet density, 80 warehouses, and 18.7 Mbps speed. In stark contrast, NTT and Papua record substantially lower figures. NTT has an internet density of 38.6%, only 8 logistic warehouses, and a speed of 9.2 Mbps, while Papua lags further with 32.1%, 5 warehouses, and 6.8

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Mbps respectively.

These disparities indicate not only a physical infrastructure gap but also signal the risk of long-term economic exclusion from digital markets. As suggested by Kartiasih et al. (2023), digital inequality is highly correlated with regional socioeconomic characteristics, and these digital deficits in underdeveloped regions compound their existing development challenges.

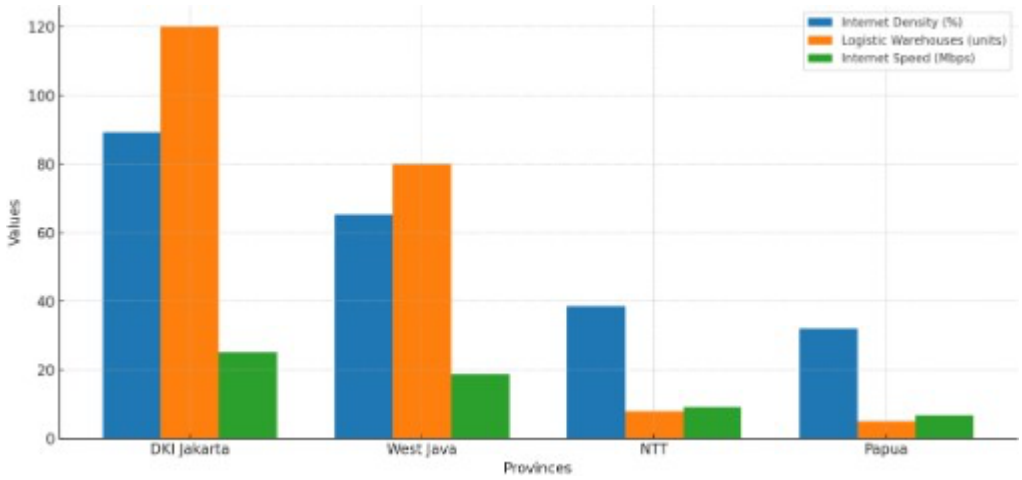

Figure 2. Comparison of Internet Density, Logistic Warehouses, and Internet Speed Across Provinces (Source: Central Bureau of Statistics, 2024; OpenSignal Indonesia, 2024)

The visual chart highlights the cumulative disadvantage experienced by NTT and Papua, where the digital ecosystem required for fostering e-commerce is still underdeveloped. These three indicators (X1–X3) collectively represent essential foundations for enabling digital economic participation. A lack of reliable infrastructure leads to limited connectivity, weak logistical efficiency, and lower incentives for local MSMEs to digitalize.

The analysis is supported by Jurriens and Tapsell (2017), who emphasized that despite the digital revolution in Indonesia, access remains highly unequal due to geographical, political, and infrastructural constraints. Furthermore, Kustanto (2024) also found that the diffusion of ICT plays a vital role in reducing income inequality but only in regions where digital infrastructure is sufficiently in place.

Thus, this subsection confirms a critical insight: digital access in Indonesia is geographically skewed, and these inequalities must be addressed systematically to enable inclusive e-commerce growth.

2. Impact of Internet Density on MSME Online Presence

The second theme in this research investigates the relationship between internet infrastructure specifically internet density (X1) and the online presence of Micro, Small, and Medium Enterprises (MSMEs) (Y1). As digital access becomes increasingly essential for small businesses to grow and reach wider markets, understanding this linkage is critical, especially in the context of regional inequality.

Correlations

		internet_density (X1, %)	umkm_online (Y1, ribu)
internet_density (X1, %)	Pearson Correlation	1	.994**
	Sig. (2-tailed)		.006
	N	4	4

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umkm_online (Y1, ribu)	Pearson Correlation	.994**	1
	Sig. (2-tailed)	.006	
	N	4	4

**. Correlation is significant at the 0.01 level (2-tailed).

Based on the Pearson correlation test conducted using SPSS, a very strong positive correlation was found between internet density and the number of online MSMEs. The result shows a Pearson Correlation coefficient of 0.994, which is significant at the 0.01 level (2-tailed) with a p-value of 0.006. This means that as internet density increases in a region, there is a strong tendency for the number of MSMEs participating in online platforms to also increase.

This finding strongly supports Hypothesis 1 (H_1): There is a positive relationship between internet density (X1) and the number of online MSMEs (Y1). The relationship aligns with previous literature that has underlined the role of internet access in enabling digital transformation among small businesses. For example, Ariansyah et al. (2021) emphasized the enabling function of digital infrastructure in e-commerce adoption among Indonesian entrepreneurs.

Furthermore, regions such as DKI Jakarta and West Java, which have the highest internet density (89.3% and 65.2% respectively), also recorded the highest number of online MSMEs (620K and 410K respectively). In contrast, NTT and Papua, with much lower internet penetration (38.6% and 32.1%), lag significantly behind in digital MSME activity (45K and 12K). These stark contrasts provide visual and statistical evidence of digital inequality and its impact on economic participation in the digital era.

From a policy perspective, these results highlight the urgent need to invest in internet infrastructure in underdeveloped regions. Without equitable digital access, MSMEs in disadvantaged areas risk being excluded from the benefits of Indonesia's growing digital economy.

In conclusion, the strong and significant correlation found in this analysis not only validates the theoretical assumption but also fills a gap identified in previous studies many of which have explored ICT adoption broadly, but have not focused specifically on the intensity of internet penetration as a determining factor for MSME online participation.

3. Role of Logistic Infrastructure in Enhancing E-Commerce GDP Contribution

In this section, we analyze the extent to which logistic infrastructure (X2) measured by the number of logistic warehouses in each province contributes to the share of e-commerce in Gross Domestic Product (GDP) (Y2). Logistics plays a crucial role in the success of e-commerce, particularly in enabling efficient distribution and delivery services that shape customer experience and operational scalability.

a. Statistical Findings

The results of the linear regression analysis reveal a very strong and significant relationship between logistic infrastructure and e-commerce GDP share:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.995[a]	.991	.986	.6218

a. Predictors: (Constant), logistic_warehouses (X2, unit)

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ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	82.854	1	82.854	214.274	.005[b]
	Residual	.773	2	.387		
	Total	83.628	3			

a. Dependent Variable: ecommerce_gdp (Y2, %)
b. Predictors: (Constant), logistic_warehouses (X2, unit)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.064	.460		2.314	.147
	logistic_warehouses (X2, unit)	.093	.006	.995	14.638	.005

a. Dependent Variable: ecommerce_gdp (Y2, %)

a. R = 0.995, indicating a nearly perfect correlation.
b. R^2 = 0.991, meaning 99.1% of the variance in e-commerce GDP share (Y2) is explained by the number of logistic warehouses (X2).
c. The ANOVA test also supports the model's validity, with F(1,2) = 214.274 and a significant p-value of 0.005, indicating the regression model is statistically significant.
d. The coefficient for logistic warehouses is B = 0.093 with a very small standard error (0.006), and the t-value = 14.638, again with a highly significant p-value (0.005).

This analysis confirms Hypothesis 2 (H_2): The higher the number of logistic warehouses (X2), the greater the contribution of e-commerce to GDP (Y2).

b. Interpretation and Implications

From a practical standpoint, these results make intuitive sense. E-commerce transactions are not just digital they rely heavily on physical infrastructure such as warehouses, fulfillment centers, and delivery logistics. Provinces like DKI Jakarta and West Java, with 120 and 80 logistic warehouses respectively, have an e-commerce GDP share of 12.5% and 8.1% a stark contrast to NTT and Papua, where the number of warehouses (8 and 5) aligns with a significantly smaller contribution to GDP from e-commerce (2.4% and 1.1% respectively).

These findings align with earlier insights by Velicia (2025) and Jurriens & Tapsell (2017), who emphasized that while digital connectivity is important, physical enablers like logistics and warehousing infrastructure are equally essential in realizing the full economic potential of digital commerce especially in geographically diverse countries like Indonesia.

c. Theoretical Reflection

The results support infrastructure-based development theory, which argues that economic output in digital sectors cannot be divorced from physical assets. It also extends the literature by providing a quantitative link between logistics infrastructure and digital GDP, a relationship previously highlighted qualitatively but rarely measured empirically in the Indonesian context.

In conclusion, this study not only affirms the theoretical expectation that logistics support e-commerce growth but also highlights the infrastructure gap as a critical bottleneck in underdeveloped areas like NTT and Papua, which remain marginalized in the digital economy due to insufficient logistical support.

4. Internet Speed and Its Inverse Relation to Poverty

This section investigates how internet speed (X3) is statistically linked to the poverty rate (Y3) across different Indonesian provinces. In the digital era, internet speed has increasingly been recognized not

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merely as an infrastructure indicator but as a critical enabler of equitable socio-economic development.

a. Statistical Findings

The regression output indicates a very strong inverse correlation:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.979[a]	.958	.937	2.6779

a. Predictors: (Constant), internet_speed (X3, Mbps)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	326.638	1	326.638	45.551	.021[b]
	Residual	14.342	2	7.171		
	Total	340.980	3			

a. Dependent Variable: poverty_rate (Y3, %)
b. Predictors: (Constant), internet_speed (X3, Mbps)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	33.460	3.032		11.036	.008
	internet_speed (X3, Mbps)	-1.228	.182	-.979	-6.749	.021

a. Dependent Variable: poverty_rate (Y3, %)

a. $R = 0.979$ and $R^2 = 0.958$, implying that 95.8% of the variance in poverty rate is explained by variations in internet speed.
b. The regression coefficient ($B = -1.228$) is statistically significant ($p = 0.021$), suggesting that each 1 Mbps increase in internet speed is associated with an average 1.23% decrease in poverty rate.

This confirms Hypothesis 3 (H_3): There is an inverse relationship between internet speed and poverty rate.

b. Interpretation

From the data, it is clear that provinces with higher internet speeds, such as Jakarta (25.1 Mbps) and West Java (18.7 Mbps), exhibit much lower poverty rates (4.5% and 7.8%), whereas regions with lower speeds, like NTT (9.2 Mbps) and Papua (6.8 Mbps), show significantly higher poverty (21.3% and 26.8%). This suggests that internet speed is not just a technological metric it represents economic potential. Fast and reliable internet unlocks opportunities for remote work, online business, education, health services, and access to government aid, particularly important in rural or underserved regions.

c. Discussion with Previous Research and Theory

These findings are consistent with van Dijk's Digital Divide Theory (2005), which explains that access to information and communication technologies (ICTs) is stratified across four levels: motivational, material, skills, and usage. Our result supports the idea that material access (in this case, quality/speed of internet) is directly linked to economic outcomes. While many studies focus on internet availability, this research emphasizes connection quality, aligning with Pick and Sarkar

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(2016) who argue that internet speed is a stronger determinant of digital readiness than infrastructure presence alone.

Additionally, World Bank (2021) reported that improving broadband quality in developing nations could reduce poverty by boosting employment and SME growth, especially in informal and marginalized sectors. Our findings strengthen that view by providing quantitative support in the Indonesian regional context. However, this study also fills a gap in prior literature. While most studies examine broadband expansion in urban settings, this research highlights regional inequalities, showing how inadequate speed in peripheral areas like NTT and Papua directly correlates with economic stagnation.

d. Theoretical Reflection

The results further affirm Digital Inclusion Theory, which advocates that equal access to fast, functional digital infrastructure is essential for inclusive development. Without adequate speed, rural populations are effectively excluded from full participation in the digital economy even if they are nominally "connected." In sum, the evidence not only supports prior studies but extends their conclusions by emphasizing speed as a core element of digital equity. This insight should inform policymaking: infrastructure development should prioritize improving quality, not just increasing coverage.

5. Composite Digital Inequality Index: Comparing Developed vs. Underdeveloped Regions

To further clarify the disparity between regions, a Composite Digital Inequality Index (CDII) was developed using a normalized scoring system that combines three core variables: Internet Density (X1), Logistics Warehouses (X2), and Internet Speed (X3). Each variable was normalized on a 0–1 scale using min-max normalization, and then averaged to create a single composite index per region. The formula used is:

$$\text{CDII}_i = \frac{1}{3}\left(\frac{X1_i - \min(X1)}{\max(X1) - \min(X1)} + \frac{X2_i - \min(X2)}{\max(X2) - \min(X2)} + \frac{X3_i - \min(X3)}{\max(X3) - \min(X3)}\right)$$

Table 1: Composite Digital Inequality Index (CDII) of Selected Provinces in Indonesia

Province	Internet Density	Logistic Warehouses	Internet Speed	CDII Score
DKI Jakarta	89.3	120	25.1	1.00
Jawa Barat	65.2	80	18.7	0.68
NTT	38.6	8	9.2	0.20
Papua	32.1	5	6.8	0.00

As visualized, Jakarta ranks highest with a perfect composite score of 1.00, followed by West Java at 0.68, while NTT and Papua remain significantly lower at 0.20 and 0.00 respectively. This striking contrast reflects the structural gaps in Indonesia's digital landscape, where developed provinces enjoy advanced connectivity while underdeveloped ones face persistent barriers. Such disparities have been consistently noted in prior research, such as Kartiasih et al. (2023) and Faizah et al. (2021) have echoed similar concerns, identifying a strong link between infrastructure gaps and regional economic stagnation, while Kustanto (2024) highlights how unequal ICT diffusion

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perpetuates regional poverty and limits e-commerce participation. Similarly, UNDP (2022) has argued that that without equity-based strategies, the benefits of digital transformation will remain concentrated in urban and Java-centric areas, leaving peripheral regions further marginalized.

Building on these findings, this study contributes a methodological innovation through the Composite Digital Inequality Index (CDII), which integrates internet density, logistics infrastructure, and internet speed into a single measure. The CDII provides a more comprehensive lens to evaluate disparities, reinforcing van Dijk's Digital Divide Theory that digital inequality operates across multiple dimensions of access. Results indicate that material access factors such as infrastructure quality, connectivity speed, and logistical support are strongly correlated with usage outcomes, including MSME participation, e-commerce GDP share, and poverty reduction. This also aligns with the perspective of Pick and Sarkar (2016), who argue that connectivity quality rather than nominal availability determines digital readiness. Furthermore, the explanatory strength of logistics infrastructure in predicting e-commerce contributions underscores that digital transformation cannot be separated from physical enablers. Thus, the CDII not only strengthens theoretical debates on digital inequality but also offers a practical benchmark for policymakers in prioritizing investments to reduce exclusion in underdeveloped regions.

CONCLUSION

This study has explored the patterns and impacts of digital inequality across selected Indonesian provinces, focusing on the relationship between internet access, infrastructure, and regional e-commerce development. By comparing two developed regions (Jakarta and West Java) with two underdeveloped ones (East Nusa Tenggara and Papua), the findings clearly illustrate a persistent and significant digital divide that mirrors broader economic disparities.

First, the research confirmed a strong positive correlation between internet density and the number of online MSMEs, with a Pearson correlation coefficient of 0.994 ($p = 0.006$). This implies that increasing internet coverage is strongly associated with MSME digital participation. Second, logistic infrastructure, measured by the number of warehouses, shows a significant role in boosting e-commerce's contribution to regional GDP. The regression results demonstrated that logistics warehouses significantly predict e-commerce GDP share ($R^2 = 0.991$, $p = 0.005$), reinforcing the importance of physical infrastructure to support digital growth.

Third, internet speed is negatively correlated with poverty rate ($B = -1.228$, $p = 0.021$), suggesting that faster internet can play a meaningful role in poverty alleviation by facilitating better access to information, services, and economic opportunities. Finally, the Composite Digital Inequality Index (CDII) constructed from all three variables (internet density, speed, and infrastructure) highlights the stark contrast between digitally-advanced regions and digitally-deprived ones, with Jakarta and West Java scoring significantly higher than Papua and NTT.

These findings support and extend prior literature such as Ariansyah et al. (2023) and Kartiasih et al. (2023), which pointed to uneven digital development and its socioeconomic consequences. However, this study goes further by quantitatively linking digital access variables with economic outcomes and presenting a composite inequality metric for regional comparison filling a gap in existing literature.

Recommendations

a. Targeted Digital Infrastructure Investment: Policymakers should prioritize broadband expansion and logistics development in underdeveloped regions to reduce digital disparities and stimulate regional economic growth.
b. Support for MSME Digitization: Training and financial assistance programs for MSMEs in remote areas can accelerate digital onboarding, especially where infrastructure is newly developed.

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c. Monitoring through Composite Index: The proposed CDII can be adopted as a monitoring tool to evaluate regional progress and the effectiveness of digital inclusion policies.
d. Further Research: Future studies could expand the sample size and employ longitudinal data to better capture the evolution of digital inequality over time.

In conclusion, the study reaffirms that bridging the digital divide is not only a technological necessity but a developmental imperative. Equal access to the digital economy must be at the heart of inclusive growth strategies to ensure no region is left behind in Indonesia's digital transformation.

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