

The Impact of Digital Inclusivity and Human Development Index (HDI) on Gross Regional Domestic Product (GRDP): The Mediating Role of Peer-to-Peer (P2P) Lending in Indonesia

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Abstract: Digital transformation and improvements in human resource quality play a crucial role in driving regional economic growth. However, levels of access to and use of digital technology and technology-based financial services still vary across Indonesia's provinces. This study aims to analyze the effects of digital inclusivity and the Human Development Index (HDI) on Gross Regional Domestic Product (GRDP), with Peer-to-Peer (P2P) Lending as the mediating variable. Digital inclusivity is measured by the Indeks Masyarakat Digital Indonesia (IMDI), while P2P lending is measured by the volume of financing disbursed in each province. The study uses panel data from 34 provinces in Indonesia for the 2023–2025 period. The analysis was conducted using panel data regression with the Fixed Effects Model (FEM) and the Sobel mediation test. The results show that digital inclusivity and P2P lending have a positive and significant effect on GRDP. In contrast, the Human Development Index (HDI) has no significant direct effect. However, the HDI and digital inclusivity have a positive and significant effect on P2P lending. The mediation test indicates that P2P lending mediates the effects of the HDI and digital inclusivity on GRDP. These findings confirm that the digital economy drives regional economic growth both directly and by expanding access to digital financing. Therefore, strengthening digital infrastructure and improving the quality of human resources must be pursued simultaneously to optimize P2P lending's role in supporting regional economic activities.

Keywords: Digital Inclusivity, Human Development Index, Peer-to-Peer Lending, Gross Regional Domestic Product, Digitalization.

JEL: R11, G23, O33, O15

1. INTRODUCTION

Digital transformation is one of the key factors in building a modern and competitive economy (Ardianto et al., 2024) (Putriana, 2023). In Indonesia, the development of digital technology has not only changed the way people socialize and shop. However, it has also driven economic activities that have given rise to new business models and expanded access to financial services (Purba et al., 2025) (Qur'anisa et al., 2024).

One indicator for measuring the extent to which the public is capable of and ready to utilize digital technology is the Indeks Masyarakat Digital Indonesia (IMDI) (Komdigi, 2025). The IMDI measures key dimensions, including infrastructure and ecosystem, digital skills, empowerment, and the demand for and availability of the digital workforce (Komdigi, 2025). In this study, the IMDI is used to measure digital inclusivity, that is, the extent to which the public can equitably access, use, and benefit from digital technology (Shvets, 2025). The higher a region's level of digital inclusivity, the greater the opportunities for its residents to engage in various technology-based economic activities (Daud, 2023).

The quality of human resources is also an equally important factor. The Human Development Index (HDI) encompasses three main dimensions: education, health, and a decent standard of living (BPS, 2025). Regions with high HDI scores tend to have populations that are more productive, better able to adapt to technological changes, and better prepared to take advantage of economic opportunities emerging in the digital age (Pratama & Yuliani, 2025). Thus, digital

technology and human capital are interrelated in shaping a region's economy (Grigorescu et al., 2021).

One of the financial innovations born from advances in digital technology is Peer-to-Peer (P2P) lending, a technology-based financing platform that connects lenders with borrowers (Ölvedi, 2024). This service is extremely helpful for individuals and businesses that have previously faced barriers to accessing financing from formal financial institutions (Linawati et al., 2020). In Indonesia, P2P lending continues to grow rapidly, according to data from the Otoritas Jasa Keuangan (OJK). Disbursements through these platforms have increased every year.

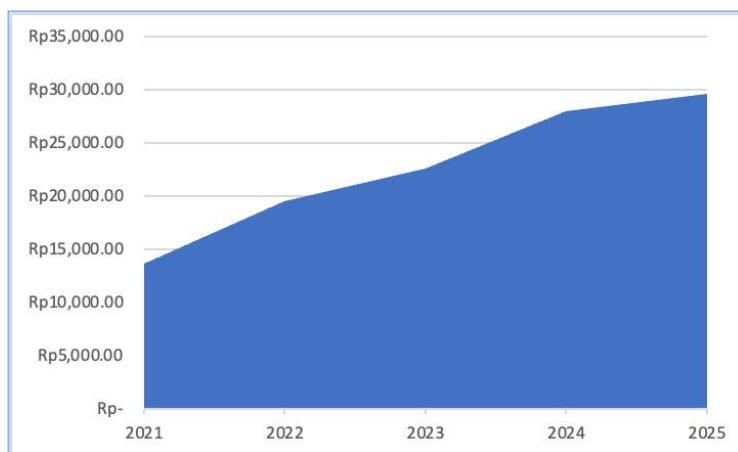


Figure 1. Total Peer-to-Peer (P2P) Lending Disbursements (in billions of Rp) in Indonesia

Source: Otoritas Jasa Keuangan, 2026

Furthermore, P2P lending is also believed to contribute to regional economic growth by increasing access to capital, strengthening business capacity, and creating new economic opportunities (Maskara & Huang, 2025). However, this contribution is heavily influenced by the quality of human resources and the community's ability to utilize technology (Oh & Rosenkranz, 2020). Regions that lag in digital readiness and human development tend to face obstacles to making optimal use of digital financial services, preventing digital finance from fully driving the local economy (Jhamb, 2025).

Although the relationships among digitalization, human development, and economic growth have been extensively studied separately (Amrillah & Felianty, 2024) (Varona & Gonzales, 2025), research integrating all three, with P2P lending as a mediating variable, remains very limited, particularly in the Indonesian context. The use of the IMDI as a measure of digital inclusivity also provides a more dynamic and relevant perspective in studies of the digital-based regional economy.

This study is important for analyzing the extent to which digital inclusivity and the quality of human development influence the regional economy, with P2P lending serving as the mediating financing mechanism.

This research is also relevant in supporting the achievement of the Sustainable Development Goals (SDGs), particularly SDG 8 by promoting a more inclusive regional economy, SDG 9 by strengthening the digital economy ecosystem and technology-based financing, and SDG 10 by expanding access to financing for communities and regions that the formal financial system has not optimally served. The results of this study are expected not only to provide a comprehensive empirical overview but also to serve as the basis for effective policy recommendations to realize inclusive digital economic development and sustainable development in Indonesia.

2. LITERATURE REVIEW

2.1 Gross Regional Domestic Product (GRDP)

The GRDP reflects a region's capacity to generate economic output. An increase in GRDP indicates growth in production capacity that can support community welfare and regional development (Fahrudin, 2024). In the context of digitalization, Zhang et al. (2021) argue that the

digital economy plays a role in driving high-quality economic development by strengthening digital integration and infrastructure. Adequate digital infrastructure can expand access to information and markets, improve business efficiency, and support the utilization of technology-based economic services. These conditions can ultimately increase productivity and economic output, as reflected in higher GRDP.

However, Junarsin et al. (2021) argue that the benefits of the digital economy have not always been fully realized; although Indonesia's P2P lending fintech industry is growing rapidly, its impact on the economy remains limited. Loan disbursements remain concentrated in certain regions, and there is an imbalance between productive and consumer loans. This indicates that the development of digital financial technology and services does not automatically lead to equitable economic impacts; the patterns of utilization and distribution of these services also influence it.

In addition to digitalization, the quality of human capital is another factor that can influence regional economic performance. Eldeib et al. (2025) show that an increase in the HDI has a positive effect on GRDP, meaning that improvements in health, education, and living standards can lead to increased economic output. However, this relationship is not always consistent. Nazilah & Hutabarat (2026) explain that the HDI's effect on GRDP may not be significant when a region's economic structure is still dominated by sectors that are relatively less dependent on the quality of human capital. Under such conditions, improvements in the quality of human resources do not necessarily translate directly into an increase in regional economic output.

2.2 Peer-to-Peer (P2P) Lending

The P2P lending is a digital technology-based financial innovation that connects lenders and borrowers through an online platform without the need for face-to-face meetings (Milian et al., 2019) (Ölvedi, 2024). The availability of this service facilitates access to financing for the public and business owners, particularly those who face limitations in obtaining financing from formal financial institutions (Linawati et al., 2020). In addition to serving as an alternative financing option, lending can expand financial inclusion, boost purchasing power, and support public welfare (Benuf, 2020).

Several studies indicate that the growth of P2P lending can positively impact economic activity. (Hu et al., 2023), An analysis of household panel data in China found that the development of digital finance via P2P lending fintech can increase household consumption. In line with this, Maulana & Wiharno (2022) found that P2P lending has a positive and significant effect on economic growth. (Maskara & Huang, 2025) also demonstrated that P2P lending can support the growth of new businesses, thereby serving as a key channel for fostering entrepreneurship and economic prosperity.

Nevertheless, the adoption of P2P lending still faces various obstacles. (Manjare et al., 2025) identified several challenges, such as inconsistent regulations, limited internet access in rural areas, and low financial literacy. These conditions indicate that the contribution of P2P lending to the economy depends not only on technological developments but also on the readiness of infrastructure and regulations, as well as the public's ability to utilize it.

2.3 Human Development Index (HDI)

The HDI is a composite measure that reflects the level of human development across three fundamental dimensions: health, education, and a decent standard of living (United Nations Development Programme, 2026). Improving the quality of human development can boost community productivity and support increased well-being (Varona & Gonzales, 2025).

In the context of digital transformation, the quality of human resources is also a key factor in determining the benefits derived from technological advancements. Grigorescu et al. (2021) demonstrate that digitalization and human capital play significant roles in improving population well-being. Therefore, strengthening human capital is a key factor in maximizing the benefits of digitalization for society and the economy.

2.4 Digital Inclusivity

Digital inclusivity is a multidimensional process that encompasses access, capabilities, and the outcomes of using digital technology to improve the social and economic lives of individuals and groups (Ragnedda et al., 2022). In Indonesia, digital inclusivity is assessed using the Indonesia Digital Society Index (IMDI), which captures public readiness and capability to access and utilize digital technology through four dimensions: infrastructure and ecosystem, digital skills, empowerment, and the demand and supply of the digital workforce (Komdigi, 2025).

The availability of digital access and skills is becoming increasingly important as technology-based financial services expand. Information technology infrastructure is a key prerequisite for the development of P2P lending, a digital financial service, as it enables the public to access and utilize digital financial services (Oh & Rosenkranz, 2020). In line with this, Jia & Kanagaretnam, (2025) demonstrate that digital inclusivity can increase P2P lending penetration and reduce the likelihood of rejection for high-risk loans. These findings indicate that the better the public's access to and ability to utilize digital technology, the greater the opportunity to use P2P lending as an alternative financing service.

3. METHOD

3.1 Research Design and Approach

This study employed a quantitative, explanatory research design to test and explain the effects of digital inclusivity and the Human Development Index (HDI) on Gross Regional Domestic Product (GRDP), with Peer-to-Peer (P2P) lending as the mediating variable. A quantitative approach was used to test the relationships between variables objectively and systematically, using numerical data and statistical analysis.

An explanatory design was used to explain the causal relationships among the research variables, including both direct and indirect effects. The objects of analysis in this study were provinces in Indonesia, making this a regional macroeconomic study.

3.2 Types and Sources of Data

This study uses secondary panel data, combining cross-sectional and time-series data, covering 34 provinces in Indonesia, excluding South Papua, Central Papua, Papua Pegunungan, and Southwest Papua, for the period 2023–2025.

The data sources for this study are as follows:

- a. Indeks Masyarakat Digital Indonesia (IMDI), sourced from the Ministry of Communication and Digital Affairs, serves as a proxy for digital inclusivity.
- b. The Human Development Index (HDI) and annual Gross Regional Domestic Product (GRDP) at Constant Market Prices were obtained from the Badan Pusat Statistik (BPS).
- c. Data on Peer-to-Peer (P2P) lending disbursements by province were obtained from the Otoritas Jasa Keuangan (OJK).

3.3 Data Collection Methods

Data collection for this study was conducted using a documentary study approach, which involves gathering secondary data officially published by relevant agencies. The data were obtained from annual reports and statistical publications.

In addition, this study was supported by a literature review of scientific journals, books, and other academic publications relevant to digital inclusivity, human development, P2P lending, and GRDP. This technique was used to strengthen the conceptual framework and support the interpretation of the empirical analysis results.

3.4 Research Variables and Measurement of Variables

This study aims to analyze the effects of digital inclusivity and the Human Development Index (HDI) on Gross Regional Domestic Product (GRDP), with Peer-to-Peer (P2P) Lending as the mediating variable. Therefore, the research variables are grouped as follows:

a. Independent Variables

- Digital Inclusivity (X_1)
Measured using the Indeks Masyarakat Digital Indonesia (IMDI), which reflects the public's readiness and ability to access and utilize digital technology based on four main pillars: infrastructure and ecosystem, digital skills, empowerment, and the demand for and availability of the digital workforce, reported annually by province.
- Human Development Index (HDI) (X_2)
Measured using the HDI value, which represents the quality of human development based on the dimensions of education, health, and a decent standard of living, reported annually by province.

b. Mediating Variables

- Peer-to-Peer (P2P) Lending (Z)
Proxied by the annual volume of Peer-to-Peer lending disbursements per province.

c. Dependent Variable

- Gross Regional Domestic Product (GRDP) (Y)
Measured using the annual GRDP at Constant Prices per province.

3.5 Data Analysis

Data analysis was conducted using panel data regression in Stata 16 to empirically test the relationships among the study variables. The best model was determined using the Chow, Hausman, and Lagrange Multiplier tests to choose among Pooled Least Squares, Fixed Effects, and Random Effects.

The Chow and Hausman tests consistently recommend retaining the Fixed Effects model with province-specific effects in the estimation. After detection of heteroscedasticity and autocorrelation, the Fixed Effects specification was retained, but statistical inference was based on province-clustered robust standard errors. This approach accounts for heteroscedasticity and within-province serial correlation in the estimated variance–covariance matrix while retaining the Fixed Effects estimator's ability to control for unobserved time-invariant province-specific heterogeneity (Stock & Watson, 2008) (Wooldridge, 2020)

Next, to test the mediating role of P2P lending, this study used the Sobel test. This test aims to determine the significance of the indirect effect (Ghozali, 2011) of digital inclusivity and the HDI on GRDP through P2P lending. With this approach, the study can explain both the direct and indirect effects among the variables in greater depth.

4. RESULTS AND DISCUSSION

RESULTS

4.1 Selection of the Panel Data Model

A panel data regression model was selected to determine the most appropriate estimation method for this study. Tests were conducted using the Chow and Hausman tests. The Chow test was used to choose between the Pooled Least Squares (PLS) and the Fixed Effects Model (FEM), while the Hausman test was used to choose between the Fixed Effects Model (FEM) and the Random Effects Model (REM) in this study; the estimation process was performed in Stata 16.

4.1.1 Chow Test

Based on the results of the Chow test in Table 4.1 for Structural Equation I and Structural Equation II, the cross-sectional F probability value for each equation is 0.0000, which is less than the 5% significance level (0.05). Thus, H_0 is rejected, and the FEM is more appropriate than the PLS method for both equations.

Table 4.1 Chow Test for Equation I and Equation II

Equation	Probability Value	Criteria	Decision	Selected Model
I	0.0000	Prob. < 0.05	Reject H_0	Fixed Effect Model (FEM)
II	0.0000	Prob. < 0.05	Reject H_0	Fixed Effect Model (FEM)

Source: Author's Analysis, 2026

4.1.2 Hausman Test

The results of the Hausman test for Structural Equation I show a chi-square probability value of 0.0000, while for Structural Equation II, the value is 0.0046. Both values are less than 0.05, so H_0 is rejected. Thus, the FEM is more appropriate than the REM.

Table 4.2 Hausman Test for Equation I and Equation II

Equation	Probability Value	Criteria	Decision	Selected Model
I	0.0000	Prob. < 0.05	Reject H_0	Fixed Effect Model (FEM)
II	0.0046	Prob. < 0.05	Reject H_0	Fixed Effect Model (FEM)

Source: Processed data, 2026

4.1.3 Selection of the Final Model

Based on the results of the Chow Test and the Hausman Test for both Structural Equation I and Structural Equation II, all test results indicate that the FEM is the most appropriate model to use. These results indicate that the FEM is superior to both the PLS and the REM, so a Lagrange Multiplier (LM) test is not necessary. Therefore, all panel data regression analyses in this study use the FEM as the final estimation model. After determining the best model, the next step is to conduct classical assumption tests.

4.2 Classical Assumption Tests

To determine whether the regression model yields Best Linear Unbiased Estimator (BLUE) criteria parameters, it must satisfy the classical assumptions of regression. The classical assumption tests conducted in this study are the multicollinearity test, the heteroscedasticity test, and the autocorrelation test.

4.2.1 Multicollinearity Test

Multicollinearity tests were conducted to assess the presence of strong relationships among the independent variables in the regression model. A good regression model should not exhibit multicollinearity. The tests were performed using the Variance Inflation Factor (VIF) and Tolerance (1/VIF). The model is considered free of multicollinearity if the VIF value is < 10 and the Tolerance is > 0.10.

Table 4.3 Multicollinearity Test for Equation I and Equation II

Equation	Variable	VIF	Tolerance (1/VIF)	Decision
I	Digital Inclusivity	1.84	0.5447	Multicollinearity-free
	HDI	1.75	0.5715	Multicollinearity-free
	P2P Lending	1.67	0.6002	Multicollinearity-free
	Mean VIF	1.75	-	Multicollinearity-free
II	Digital Inclusivity	1.58	0.6314	Multicollinearity-free
	HDI	1.58	0.6314	Multicollinearity-free
	Mean VIF	1.58	-	Multicollinearity-free

Source: Processed data, 2026

Based on the test results in Table 4.3, all independent variables in both Structural Equation I and Structural Equation II have VIF values below 10 and Tolerance (1/VIF) values above 0.10. Furthermore, the Mean VIF values are 1.75 for Structural Equation I and 1.58 for

Structural Equation II, indicating that the level of correlation among the independent variables is relatively low.

Thus, it can be concluded that neither regression model exhibits multicollinearity, indicating that the independent variables are suitable for further analysis.

4.2.2 Heteroscedasticity Test

The heteroscedasticity test aims to determine whether the residual variance in the regression model is constant (homoscedasticity) or not. In this study, the test was conducted using the Modified Wald Test for Groupwise Heteroscedasticity on FEM. The model is said to be free of heteroscedasticity if the Prob. > Chi-square value is greater than 0.05.

Table 4.4 Heteroscedasticity Test for Equation I and Equation II

Equation	Chi-square	Prob. > Chi-square	Decision
I	14942.72	0.0000	Heteroscedasticity is detected
II	2365.66	0.0000	Heteroscedasticity is detected

Source: Processed data, 2026

Based on Table 4.4, the results of the Modified Wald Test show that the Prob. > Chi-square value in both Structural Equation I and Structural Equation II is 0.0000, which is smaller than the significance level of 0.05. Thus, H_0 is rejected, indicating that both models exhibit heteroscedasticity.

Heteroskedasticity in panel data does not bias the Fixed Effects estimator but can lead to unreliable statistical inference in the absence of correction to the standard errors (Wooldridge, 2020). Therefore, in this study, the specification of the Fixed Effects Model, determined by the Chow and Hausman tests, is maintained. However, cluster-robust standard errors are used at the provincial level. Statistical inference is therefore robust to heteroskedasticity.

4.2.3 Autocorrelation Test

An autocorrelation test was conducted to determine whether there is a relationship between residuals in one period and those in another. A good regression model should not exhibit autocorrelation. In this study, the autocorrelation test was performed using the Wooldridge Test for Autocorrelation in Panel Data.

The decision criterion for this test is that if the Prob. > F value is greater than 0.05, then the model does not exhibit autocorrelation. Conversely, if the Prob. > F value is less than 0.05, then the model exhibits autocorrelation.

Table 4.5 Autocorrelation Test for Equation I and Equation II

Equation	F-statistic	Prob. > F	Decision
I	4.787	0.0359	Autocorrelation is detected
II	72.915	0.0000	Autocorrelation is detected

Source: Processed data, 2026

Based on the results of the Wooldridge Test in Table 4.5, the probability values for Structural Equation I and Structural Equation II were 0.0359 and 0.0000, respectively. Both values are less than the 5% significance level (0.05), so H_0 is rejected. Thus, both regression models suffer from autocorrelation.

Autocorrelation is a common problem in panel data analysis, affecting mainly the efficiency of the estimator and the accuracy of the standard error (Baltagi, 2021). In an effort to solve this problem, this study keeps the Fixed Effects Model specification (previously determined by Chow and Hausman tests) and applies cluster-robust standard errors at the provincial level to ensure that statistical inference remains consistent even in the presence of autocorrelation and heteroskedasticity.

4.2.4 Correcting Heteroscedasticity and Autocorrelation

Based on the diagnostic tests, both Structural Equation I and Structural Equation II exhibited heteroscedasticity and autocorrelation. However, the Chow and Hausman tests consistently indicated that the Fixed Effects Model was the appropriate specification. Therefore, province-specific fixed effects were retained in the final estimation procedure. Statistical inference was subsequently corrected using province-clustered robust standard errors while preserving the fixed-effects structure. Consequently, all reported coefficients continue to control for unobserved province-specific characteristics while providing reliable inference (Baltagi, 2021) (Wooldridge, 2020).

4.3 Path Analysis Results

The coefficients shown in this section correspond to the last fixed-effect specification with robust standard errors clustered at the province level. Thus, the estimates still have unobserved heterogeneity across provinces, but correct for heteroscedasticity and serial correlation.

Structural Equation I

$$\begin{aligned} Y_{it} &= \beta_0 + \beta_1 Z_{it} + \beta_2 X1_{it} + \beta_3 X2_{it} + \varepsilon_{1it} \dots\dots\dots (1) \\ GRDP_{it} &= \beta_0 + \beta_1 P2P_{it} + \beta_2 HDI_{it} + \beta_3 DigitalInclusivity_{it} + \varepsilon_{1it} \\ GRDP_{it} &= 40,326.76 + 125.6709 P2P_{it} + 1,869.614 HDI_{it} + 2,282.422 DI_{it} + \varepsilon_{1it} \end{aligned}$$

Structural Equation II

$$\begin{aligned} Z_{it} &= \beta_0 + \beta_2 X1_{it} + \beta_3 X2_{it} + \varepsilon_{2it} \dots\dots\dots (2) \\ P2P_{it} &= \beta_0 + \beta_2 HDI_{it} + \beta_3 DigitalInclusivity_{it} + \varepsilon_{2it} \\ P2P_{it} &= -2,928.22 + 36.40572 HDI_{it} + 22.40003 DI_{it} + \varepsilon_{2it} \end{aligned}$$

Results of Direct and Indirect Effects

Direct Effect

- 1) Direct effect of HDI on P2P Lending: $HDI_{it} \rightarrow P2P \text{ Lending}_{it}$: 36.40572
- 2) Direct Effect of Digital Inclusivity on P2P Lending: $Digital \text{ Inclusivity}_{it} \rightarrow P2P \text{ Lending}_{it}$: 22.40003
- 3) Direct effect of P2P Lending on GRDP: $P2P \text{ Lending}_{it} \rightarrow GRDP_{it}$: 125.6709
- 4) Direct effect of HDI on GRDP: $HDI_{it} \rightarrow GRDP_{it}$: 1,869.614
- 5) Direct Effect of Digital Inclusivity on GRDP: $Digital \text{ Inclusivity}_{it} \rightarrow GRDP_{it}$: 2,282.422

Indirect Effect

- 1) Indirect effect of the HDI on GRDP through P2P Lending:
 $HDI_{it} \rightarrow P2P \text{ Lending}_{it} \rightarrow GRDP_{it}$
 $(36.40572) \times (125.6709) = 4575.1396$
Therefore, $HDI_{it} \rightarrow P2P \text{ Lending}_{it} \rightarrow GRDP_{it} = 4,575.1396$
- 2) Indirect Effect of Digital Inclusivity on GRDP through P2P Lending:
 $Digital \text{ Inclusivity}_{it} \rightarrow P2P \text{ Lending}_{it} \rightarrow GRDP_{it}$
 $(22.40003) \times (125.6709) = 2,815.0319$
Therefore, $Digital \text{ Inclusivity}_{it} \rightarrow P2P \text{ Lending}_{it} \rightarrow GRDP_{it} = 2,815.0319$

4.4 Partial Significance Test (t-Test)

- 1) The Effect of P2P Lending on GRDP
The significance value of P2P lending on GRDP is $0.000 < 0.05$, so H_0 is rejected, and H_1 is accepted. This means that P2P lending has a significant effect on GRDP. The calculated t-value is $8.30 > \text{the critical t-table of } 1.997$, so it can be concluded that P2P lending has a positive and significant effect on GRDP.
- 2) The Effect of Digital Inclusivity on GRDP
The significance value of Digital Inclusivity on GRDP is $0.033 < 0.05$, so H_0 is rejected, and H_1 is accepted. This means that digital inclusivity has a significant effect on GRDP. The calculated t-value is $2.18 > \text{the critical t-table of } 1.997$, so it can be concluded that digital inclusivity has a positive and significant effect on GRDP.

3) The Effect of the HDI on P2P Lending

The significance value of the HDI on P2P lending is $0.022 < 0.05$, so H_0 is rejected, and H_1 is accepted. This means that the HDI has a significant effect on P2P lending. The calculated t-value is $2.34 >$ the critical t-table of 1.997, so it can be concluded that the HDI has a positive and significant effect on P2P lending.

4) The Effect of Digital Inclusivity on P2P Lending

The significance value for the effect of digital inclusivity on P2P lending is $0.007 < 0.05$, so H_0 is rejected, and H_1 is accepted. This means that digital inclusivity has a significant effect on P2P lending. The calculated t-value is $2.77 >$ t-table = 1.997, so it can be concluded that digital inclusivity has a positive and significant effect on P2P Lending.

5) The Effect of the HDI on GRDP

The significance value of the HDI on GRDP is $0.351 > 0.05$, so H_0 is accepted, and H_1 is rejected. This means that the HDI does not have a significant effect on GRDP. The calculated t-value is $0.94 <$ the critical t-table of 1.997, so it can be concluded that the HDI does not have a significant effect on GRDP.

4.5 Test of Mediating Effects

1) Indirect Effect of the HDI on GRDP through P2P Lending

HDI $\rightarrow$ P2P Lending $\rightarrow$ GRDP

$$ab = (36.40572) \times (125.6709) = 4,575.142$$

Sobel test formula:

$$S_{ab} = \sqrt{b^2 S_a^2 + a^2 S_b^2 + S_a^2 S_b^2}$$

Given:

$$a = 36.40572; S_a = 15.54386; b = 125.6709; S_b = 15.13442$$

Therefore:

$$S_{ab} = \sqrt{(125.6709)^2(15.54386)^2 + (36.40572)^2(15.13442)^2 + (15.54386)^2(15.13442)^2}$$

Thus, we obtain $S_{ab} = 2043.2$

Sobel test statistic value:

$$t = \frac{ab}{S_{ab}} = t = \frac{4575.1426}{2043.2} = 2.239$$

Since t-statistic = 2.239 > t-table = 1.997, H_0 is rejected, and H_1 is accepted.

Conclusion: P2P lending significantly mediates the effect of the HDI on GRDP.

2) The Indirect Effect of Digital Inclusivity on GRDP through P2P Lending

Digital Inclusivity $\rightarrow$ P2P Lending $\rightarrow$ GRDP

$$ab = (22.40003) \times (125.6709) = 2,815.032$$

Sobel test formula:

$$S_{ab} = \sqrt{b^2 S_a^2 + a^2 S_b^2 + S_a^2 S_b^2}$$

Given

$$a = 22.40003; S_a = 8.073724; b = 125.6709; S_b = 15.13442$$

Therefore:

$$S_{ab} = \sqrt{(125.6709)^2(8.073724)^2 + (22.40003)^2(15.13442)^2 + (8.073724)^2(15.13442)^2}$$

Thus, we obtain $S_{ab} = 1076.7$

Sobel test statistic value

$$t = \frac{ab}{S_{ab}} = t = \frac{2815.032}{1076.7} = 2.615$$

Since t-statistic = 2.615 > t-table = 1.997, H_0 is rejected, and H_1 is accepted.

Conclusion: P2P lending significantly mediates the effect of digital inclusivity on GRDP.

4.6 Coefficient of Determination Test (R^2)

In accordance with the Fixed Effects estimation output, the values reported below refer to the Overall R-squared statistics.

1) Residual Coefficient of Equation I

The Fixed Effects estimation shows an Overall R-squared of 0.8303, indicating that approximately 83.03% of the variation in GRDP is explained by P2P Lending, HDI, and Digital Inclusivity. The remaining 16.97% is accounted for by other factors not included in the model.

Residual error value (e_1):

$$e_1 = \sqrt{1 - R^2} = \sqrt{1 - 0.8303} = \sqrt{0.1697} = 0.4120$$

Thus, the value of e_1 is 0.4120.

2) Residual Coefficient of Equation II

The Fixed Effects estimation shows an Overall R-squared of 0.1905, indicating that approximately 19.05% of the variation in P2P Lending is explained by HDI and Digital Inclusivity. The remaining 80.95% is accounted for by other factors not included in the model.

Residual error value (e_2):

$$e_2 = \sqrt{1 - R^2} = \sqrt{1 - 0.1905} = \sqrt{0.8095} = 0.8997$$

Thus, the value of e_2 is 0.8997.

4.7 Simultaneous Significance Test (F-Test)

1) Simultaneous Test (F-Test) of Equation I

Based on the regression results, the F-value was 38.26, with an F-test probability ($\text{Prob} > F$) of 0.0000. Since the probability value of 0.0000 is less than 0.05 (the significance level), H_0 is rejected, and H_1 is accepted. This indicates that the variables P2P lending, HDI, and digital inclusivity have a significant effect on GRDP at the 95% confidence level. Thus, the regression model used is suitable for explaining the variation in GRDP.

2) Simultaneous Test (F-Test) of Equation II

Based on the regression results, the F-value was 8.09, with an F-test probability ($\text{Prob} > F$) of 0.0007. Since the probability value of 0.0007 is less than 0.05 (the significance level), H_0 is rejected, and H_1 is accepted. This indicates that the HDI and digital inclusivity variables have a significant effect on P2P lending at the 95% confidence level. Thus, the regression model used is suitable for explaining the relationship between the independent variables and the P2P lending variable.

Discussion

1) The Direct Effect of P2P Lending on GRDP

The test results show that P2P lending has a positive and significant effect on GRDP (coefficient = 125.6709; $p = 0.000$). This indicates that the greater the volume of funds disbursed through P2P lending platforms in a region, the higher the achievable real GRDP. This finding is consistent with a study (Amrillah & Felianty, 2024) that found P2P lending has a positive and significant effect on real GRDP, even though its implementation still faces various challenges. These results indicate that P2P lending can serve as an alternative source of financing that supports economic activity and drives regional economic growth.

These findings are also supported by Narayan (2019), who states that fintech startups, including P2P lending platforms, tend to be disruptive in the early stages of their operations and do not yet have a significant impact on the economy. However, as the number of users increases and services expand, their contribution becomes evident and can drive significant economic growth in subsequent years. In line with this, Maulana & Wiharno (2022) affirm that P2P lending has a positive and significant impact on economic growth.

Overall, these findings reinforce the argument that P2P lending not only provides access to alternative financing but also serves as an instrument capable of boosting productive economic activity. By bridging the funding needs of public and business actors, P2P lending contributes to increased economic output, as reflected in the rise in real GRDP.

2) The Direct Impact of Digital Inclusivity on GRDP

The test results show that digital inclusivity has a positive and significant effect on GRDP (coefficient = 2,282.422; $p = 0.033$). This means that the higher the level of digital inclusivity in a region, the higher the resulting GRDP. Access to and use of digital technology are key factors driving Indonesia's economic growth (Elfrian & Putri, 2025). Through digital technology, people can obtain information, access financial services, expand markets, and improve the efficiency of economic activities. In line with this, Ikhsanti et al. (2025) state that the convenience and flexibility of digital financial services can also enhance people's lifestyles.

These findings are also supported by Minh et al. (2025), who show that digital transformation has a significant positive impact on regional economic growth. They found that a one-unit increase in the Digital Transformation Index (DTI) is associated with higher annual GRDP growth. The magnitude of this effect indicates that digitalization has become an important driver of economic growth, on par with traditional development factors.

In the Indonesian context, Arvianti & Suliswanto (2024) found that the use of the internet, financial technology (fintech), electronic money, and e-commerce simultaneously influences GRDP. These findings indicate that the more widespread the use of the digital ecosystem, the greater its contribution to increased economic activity and regional output.

Conversely, low levels of digital inclusivity can act as a barrier to economic development. This is consistent with findings (Li et al., 2025) showing that the digital divide, which reflects inequities in access to and use of digital technology, can hinder the achievement of high-quality economic development across various regions in Asia. Therefore, improving digital inclusivity is not only important for expanding access to technology but also serves as a strategy that can drive economic growth and boost a region's GRDP performance.

3) The Direct Impact of the HDI on P2P Lending

The test results show that the HDI has a positive and significant effect on P2P lending (coefficient = 36.40572; $p = 0.022$). This means that the higher the quality of human resources as reflected in education levels, health, and a decent standard of living, the higher the volume of P2P lending in a given region.

This finding is consistent with a study (R. K. Brahmana & Lau, 2024) showing that education level, one of the main components of the HDI, has a significant effect on the number of accounts and transaction volume in P2P lending. These findings suggest that improving the quality of education can encourage wider use of P2P lending services.

The results of this study are also consistent with the findings of Al Hakim & Nisa (2024), who identified a positive relationship between P2P lending disbursements and the Human Development Index across 33 Indonesian provinces. According to them, the disbursement of funds through P2P lending, particularly to productive sectors, can support improvements in community well-being. At the same time, higher-quality human capital also creates conditions that support the growth of digital financing activities. Thus, regions with higher HDI tend to have higher levels of P2P lending disbursements than regions with lower-quality human capital.

4) The Direct Impact of Digital Inclusivity on P2P Lending

The test results show that digital inclusivity has a positive and significant effect on P2P lending (coefficient = 22.40003; $p = 0.007$). This means that the higher the level of digital inclusivity in a region, the higher the level of financing disbursed through P2P lending.

These results are consistent with a study (Oh & Rosenkranz, 2020) that confirms that adequate information technology infrastructure is a key prerequisite for the growth of the P2P

lending market. Therefore, regions with better digital access tend to have higher levels of P2P lending development compared to regions with limited digital infrastructure.

The results of this study are also consistent with the findings of R. K. Brahmana & Lau, (2024), who used provincial panel data from Indonesia to analyze the factors influencing the adoption of P2P lending fintech. They found that internet literacy has a significant effect on the number of accounts and the transaction volume in P2P lending. These findings indicate that the public's ability to use the internet plays a key role in increasing the use of digital financing services.

Furthermore, Jia & Kanagaretnam (2025) found that higher levels of digital inclusivity are positively correlated with the efficiency of P2P lending. This is reflected in an increase in the frequency of repeat loans, shorter funding times, and higher funding success rates. Thus, digital inclusivity not only expands public access to P2P lending services but also enhances the effectiveness and quality of the financing processes within them.

Overall, these findings reinforce the argument that digital inclusivity is a key driver of P2P lending growth. The more equitable the access to and use of digital technology in a region, the greater the opportunity for the public to utilize digital financing services, and thus the disbursement of funds through P2P lending platforms also tends to increase.

5) The Direct Impact of the HDI on GRDP

The test results show that the HDI has no significant effect on GRDP (coefficient = 1,869.614; $p = 0.351$). Although the coefficient on the HDI's effect on real GRDP is positive, it is not statistically significant at the 95% confidence level. Thus, improvements in the quality of human resources, as reflected in better education, health, and living standards, have not yet been able to directly and significantly increase real GRDP in the period and regions studied.

This finding is consistent with a study (Saleh & Wulandari, 2024) that found that the HDI does not have a positive and significant effect on GRDP in Indonesia. According to the authors, these results may be influenced by the fact that most Indonesian provinces remain in the moderate HDI category, with some even in the low HDI category. This situation indicates that the quality of the existing human resources has not yet reached a level capable of generating a strong and equitable economic impact.

Furthermore, Nazilah & Hutabarat (2026) suggest that the lack of a significant effect of the HDI on GRDP may be due to a regional economic structure dominated by sectors less dependent on the quality of human capital. Under such conditions, improvements in the quality of human resources do not necessarily translate directly into an increase in regional economic output.

Furthermore, several studies indicate that the relationship between human capital and economic growth is not always direct but often requires intermediary mechanisms or channels. (Boachie & Adu-Darko, 2024) found that the contribution of human capital to economic growth is maximized when supported by an adequate level of financial inclusion.

Therefore, the lack of a significant direct effect of the HDI on GRDP in this study does not necessarily imply that the quality of human resources is unimportant to the economy. Rather, these results suggest that the HDI's influence operates through various intermediary channels, one of which is access to and utilization of digital financial services such as P2P lending, which can subsequently stimulate economic activity and increase real GRDP.

6) Indirect Effect of the HDI on GRDP through P2P Lending

Based on the results of the indirect relationship, the HDI, mediated by P2P lending, was found to influence GRDP significantly ($ab = 36.40572 \times 125.6709 = 4,575.142$; $t\text{-value} = 2,239 > \text{critical } t\text{-table} = 1,997$). This means that as the HDI increases, GRDP will also increase through P2P lending. Although the HDI does not directly affect real GRDP, this effect can still be channeled through P2P lending. These results are consistent with the study by R. K. Brahmana & Lau (2024), which found that education level, as one of the components of the HDI, has a significant effect on the number of accounts, transactions, and loan disbursements in

P2P lending in Indonesia. These findings indicate that higher levels of human capital can drive the use of P2P lending services.

Furthermore, Amrillah & Felianty (2024) demonstrated that P2P lending has a positive and significant impact on real GRDP. This means that the more financing is channeled through P2P lending, the greater its contribution to regional economic activity.

The role of P2P lending as an intermediary is also supported by research by Naysary & Daud (2021). They found that the impact of the P2P lending industry on economic indicators in China does not occur directly but rather through improved SME performance as a mediating variable. These findings suggest that P2P lending often serves as a conduit through which a particular factor influences economic performance.

Overall, the results of this study reinforce the finding that P2P lending serves as a channel through which the quality of human capital influences economic growth. Thus, the relationship between the HDI and real GRDP in this study is fully mediated. While the direct effect of the HDI on real GRDP is not significant, the indirect effect via P2P lending is significant. In other words, improvements in human capital quality can drive economic growth by facilitating better access to financing through P2P lending.

7) The Indirect Effect of Digital Inclusivity on GRDP through P2P Lending

Based on the results of the indirect relationship analysis, digital inclusivity mediated by P2P lending was also found to have a significant effect on GRDP ($ab = 22.40003 \times 125.6709 = 2,815.032$; $t\text{-value} = 2.615 > \text{critical } t\text{-table} = 1.997$). This means that as Digital Inclusivity increases, GRDP will also increase through P2P lending. Unlike the HDI pathway, digital inclusivity in this study had a direct and significant effect on real GRDP. This indicates that the relationship follows a partial mediation pattern, meaning that P2P lending amplifies the effect of digital inclusivity on real GRDP but is not the sole pathway of influence. This finding on the direct effect aligns with a study (Sibarani et al., 2023) showing that access to digital infrastructure and ICT use have a positive and significant effect on GRDP across 33 Indonesian provinces. In other words, the more inclusive a region's digital access is, the greater the opportunity for increased economic activity and output.

Meanwhile, the indirect impact of digital inclusivity on real GRDP through P2P lending is also supported by several prior studies. (Davaadorj, 2024) demonstrates that the level of the digital divide (Digital Divide Index) affects P2P lending outcomes. At the same time, Naysary & Daud (2021) found that P2P lending's impact on economic indicators can operate through mediating mechanisms rather than direct relationships. These findings are also consistent with Czernich et al. (2011), who showed that broadband infrastructure drives per capita GDP growth not only directly but also through various more specific digital economic channels, including technology-based financing services.

In the Indonesian context, Amrillah & Felianty (2024) also found that P2P lending contributes positively to real GRDP. This finding reinforces the role of P2P lending as a mechanism linking digital economy development to regional economic growth.

Overall, the results of this study indicate that digital inclusivity influences real GRDP through two channels simultaneously. First, directly through the expansion of public participation in digital-based economic activities. Second, indirectly through P2P lending, where more equitable digital access and capabilities increase the public's opportunities to utilize digital financing services. Furthermore, such financing can support a range of productive economic activities that ultimately increase real GRDP. Thus, P2P lending serves as a channel that strengthens the impact of digital inclusivity on regional economic growth.

Research Limitations

This study uses panel data consisting of 34 provinces observed during the period 2023-2025. Although the cross-sectional dimension is relatively large, the time dimension is relatively short ($T = 3$). As a result, the model may be less capable of capturing long-run economic dynamics and more sensitive to short-term shocks during the observation period. Therefore, the findings should primarily be interpreted as evidence of short-run relationships among digital inclusivity, human

development, P2P lending, and regional economic performance. Future studies are encouraged to employ longer observation periods and dynamic panel approaches to further assess the long-run robustness of the estimated relationships (Arellano, 2003) (Baltagi, 2021) (Wooldridge, 2020).

5. CONCLUSION AND SUGGESTION

CONCLUSION

Based on research conducted in 34 provinces in Indonesia from 2023 to 2025, Peer-to-Peer (P2P) lending and digital inclusivity have a positive and significant impact on Gross Regional Domestic Product (GRDP). This indicates that access to digital financing and the public's ability to utilize technology can drive regional economic activity.

Meanwhile, the Human Development Index (HDI) does not have a significant direct effect on GRDP, although it does have a positive directional effect. However, the HDI has been shown to positively affect P2P lending, suggesting that higher-quality human capital can increase the use of digital financing services.

This study also found that digital inclusivity positively impacts P2P lending, indicating that technological advancements and the public's digital capabilities contribute to the growth of technology-based financing.

Furthermore, P2P lending significantly mediates the effects of the HDI and digital inclusivity on GRDP. In other words, improvements in human capital and digital inclusivity can have a greater impact on the regional economy when supported by access to digital financing.

Overall, the research results indicate that P2P lending serves as a crucial bridge linking human development and digital inclusivity to regional economic growth.

SUGGESTION

1. The governments need to expand equitable access to digital infrastructure, improve the public's digital skills, and encourage the use of technology in productive economic activities, as well as access to digital financial services. These efforts must be supported by improving the quality of education and healthcare, and the standard of living, and reinforced through collaboration among the government, businesses, financial institutions, and fintech companies to expand access to financing, thereby boosting economic activity and regional value added.
2. The OJK and P2P lending platforms need to expand access to digital financing responsibly, particularly for businesses and the productive sector. These efforts must be accompanied by improvements in financial literacy and consumer protection to ensure the industry's growth remains healthy and sustainable.
3. Future research is recommended to use a longer observation period and include additional variables, such as financial inclusion, investment, MSMEs, education, unemployment, digital infrastructure, and the regional economic structure. Additionally, research could distinguish between productive and consumer-oriented P2P lending to gain a deeper understanding of each's contribution to the regional economy.

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