

THE EFFECTS OF DIGITALIZATION, LABOR FORCE PARTICIPATION, CAPITAL EXPENDITURE, AND INVESTMENT ON GRDP PER CAPITA IN CENTRAL JAVA PROVINCE

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Abstract

Gross Regional Domestic Product (GRDP) per capita is a key indicator commonly used to assess regional economic welfare, as it reflects the average economic output generated per capita. Despite the increasing trend of GRDP per capita across regencies and municipalities in Central Java Province, substantial regional disparities persist, indicating uneven economic development. This study aims to examine the influence of digitalization, labor force participation rate, capital expenditure, and domestic investment on GRDP per capita in Central Java Province during the period 2022–2025. The study employs secondary data obtained from Statistics Indonesia (BPS), the Directorate General of Fiscal Balance (DJPK), and the Ministry of Communication and Informatics. Digitalization is measured using the Indonesian Digital Society Index (IMDI). The analytical approach applied in this study is panel data regression, combining time series data from 2022–2025 and cross-sectional data from 35 regencies/municipalities in Central Java Province. The findings reveal that digitalization, labor force participation rate, capital expenditure, and investment jointly exert a significant effect on GRDP per capita. Partially, digitalization and investment demonstrate a positive and significant effect, whereas capital expenditure shows a negative and significant effect. In contrast, the labor force participation rate does not significantly affect GRDP per capita. These findings highlight the importance of strengthening digital infrastructure, enhancing regional investment capacity, and improving the effectiveness of public expenditure allocation to support equitable regional economic development.

Keywords: GRDP, digitalization, labor, expenditure, investment.

INTRODUCTION

Economic development is an important indicator used to measure community welfare and quality of life. According to Todaro & Smith (2020), development is not only reflected in economic growth but also in the equitable distribution of welfare across regions. One indicator commonly used to measure regional welfare is Gross Regional Domestic Product (GRDP) per capita because it reflects the average economic output generated per resident. However, disparities in GRDP per capita among regions in Indonesia remain relatively high, including in Central Java Province. Although GRDP per capita in Central Java has generally increased, disparities among regencies/municipalities are still visible, indicating uneven regional economic development. Mursalin & Irawan (2025) explained that differences in GRDP per capita indicate unequal economic capacity among regions.

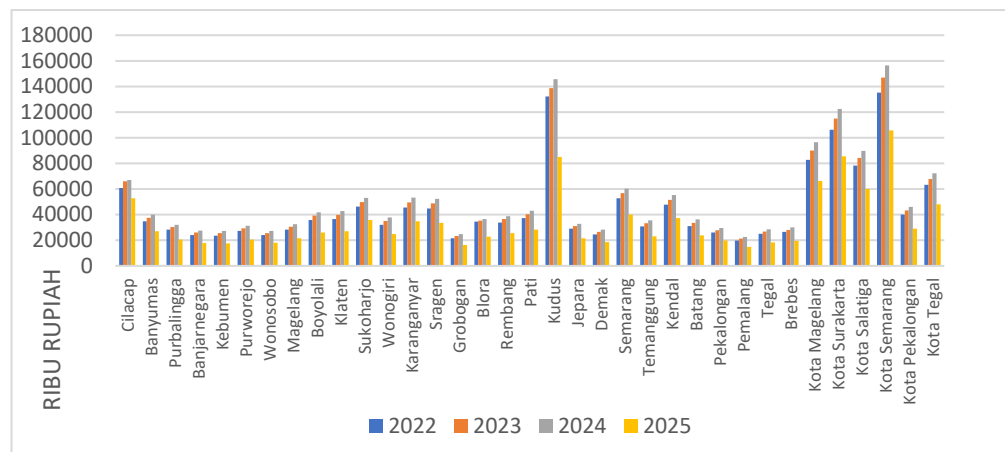


Figure 1. GRDP per Capita of 35 Regencies/Municipalities in Central Java Province, 2022–2025

Based on Figure 1, several cities such as Semarang and Surakarta consistently record higher GRDP per capita compared to several regencies including Grobogan, Blora, and Rembang. This condition reflects differences in economic capacity, infrastructure, labor absorption, and investment distribution across regions (Hartati, 2019).

In recent years, digitalization has become one of the important determinants of regional economic growth. Jones (2019) explained that technological progress contributes to productivity and economic growth. Digitalization can improve efficiency, expand market access, and strengthen regional competitiveness (Herlina et al., 2025). In this study, digitalization is measured using the Indonesian Digital Society Index (IMDI). Besides digitalization, labor force participation rate, capital expenditure, and investment are also important factors influencing regional economic performance because they support production capacity and economic activities.

Several previous studies found that digitalization, investment, and capital expenditure positively influence regional economic performance. However, most previous studies focused only on aggregate economic growth and rarely integrated digitalization, labor force participation, capital expenditure, and investment simultaneously within a single empirical model. In addition, the use of IMDI as a comprehensive digitalization indicator remains relatively limited.

Therefore, this study aims to analyze the effects of digitalization, labor force participation rate, capital expenditure, and investment on GRDP per capita across 35 regencies/municipalities in Central Java Province during 2022–2025. This study contributes to regional economic development literature by emphasizing welfare-oriented economic indicators and providing policy recommendations for more equitable regional economic development.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

This study is based on endogenous growth theory, neoclassical growth theory, and the Cobb-Douglas production function theory. Endogenous growth theory explains that technological progress plays an important role in encouraging sustainable economic growth through increased productivity and innovation. In the context of regional development, digitalization can improve economic efficiency, expand market access, and reduce transaction costs, thereby increasing regional output and welfare. Meanwhile, neoclassical growth theory emphasizes the importance of capital accumulation, labor participation, and technological progress as determinants of economic growth. The Cobb-Douglas production function also explains that output is influenced by capital, labor, and technology simultaneously.

GRDP per capita is commonly used as an indicator of regional economic welfare because it reflects the average economic output generated per resident. Differences in GRDP per capita among regencies/municipalities indicate disparities in economic capacity and development

outcomes. Several factors are considered to influence GRDP per capita, including digitalization, labor force participation, capital expenditure, and investment.

Digitalization measured by the Indonesian Digital Society Index (IMDI) reflects the level of digital readiness and technology utilization within society. Regions with higher digitalization levels tend to experience better productivity and economic efficiency. Previous studies by Tudose et al. (2023), Zhang et al. (2022), and de Clercq et al. (2023) found that digital transformation positively affects economic growth and income per capita.

Labor force participation rate (LFPR) reflects the proportion of the working-age population actively involved in economic activities. According to neoclassical theory, labor is one of the main production factors determining output. Previous studies conducted by Sasongko et al. (2019), Maulana et al. (2022), and Sinaga et al. (2025), found that labor participation positively contributes to regional economic performance.

Capital expenditure is government expenditure allocated for infrastructure and public asset development that support economic activities. Keynesian theory explains that government spending can stimulate aggregate demand and create multiplier effects within the economy. Previous studies by Mustaqimah (2022), Syuhada et al. (2023), and Ștefan et al. (2024) found that capital expenditure positively influences regional economic growth and welfare.

Investment also plays an important role in increasing production capacity and regional productivity. According to neoclassical growth theory, investment increases capital accumulation and encourages economic expansion. Previous empirical studies by Saputri & Ananda (2023), Indriawati & Kbarek (2025), and Mankiw (2019) emphasized that investment positively affects regional economic performance and income per capita.

Based on the theories and previous empirical studies, the hypotheses in this study are formulated as follows:

H₁: Digitalization has a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025.

H₂: Labor force participation rate has a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025.

H₃: Capital expenditure has a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025.

H₄: Investment has a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025.

H₅: Digitalization, labor force participation rate, capital expenditure, and investment simultaneously have a significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025.

RESEARCH METHODS

This study employs a quantitative approach using panel data regression analysis to examine the effects of digitalization, labor force participation rate, capital expenditure, and investment on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. The research design used in this study is explanatory research, which aims to explain the causal relationship between independent variables and the dependent variable.

The population in this study consists of all regencies/municipalities in Central Java Province. The sample includes 35 regencies/municipalities selected using a saturated sampling technique because all population members are used as research samples. The study combines time series data from 2022–2025 and cross-sectional data from 35 regencies/municipalities, resulting in 140 balanced panel observations.

This study uses secondary data obtained from official institutions, including Statistics Indonesia (BPS), the Directorate General of Fiscal Balance (DJPK), and the Ministry of

Communication and Informatics. Data collection was conducted using documentation and literature study methods through official statistical reports, regional financial reports, and related publications.

The dependent variable in this study is GRDP per capita. Meanwhile, the independent variables consist of digitalization proxied by the Indonesian Digital Society Index (IMDI), labor force participation rate (LFPR), capital expenditure, and domestic investment. Several variables, namely GRDP per capita, capital expenditure, and investment, are transformed into natural logarithm (ln) form to reduce data fluctuations, minimize heteroscedasticity problems, and obtain more stable and normally distributed data. In addition, the logarithmic transformation facilitates the interpretation of coefficients in elasticity form.

The analytical technique used in this study is panel data regression analysis. Estimation is conducted using three approaches, namely the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The most appropriate model is selected using the Chow test, Hausman test and LM test (Gujarati & Porter, 2009).

Before estimating the regression model, classical assumption tests are conducted to ensure that the regression model fulfills statistical requirements. These tests include the multicollinearity test using Pairwise Correlation Test and Variance Inflation Factor (VIF), as well as the heteroscedasticity test using the Glejser test. The autocorrelation test is not conducted because the use of panel data generally makes such testing less relevant.

To examine the explanatory power of the model, this study uses the coefficient of determination (Adjusted R²). Furthermore, the F-test is used to examine the simultaneous effect of all independent variables on GRDP per capita, while the t-test is used to examine the partial effect of each independent variable.

The regression model used in this study is formulated as follows:

$$LNPDRBK_{it} = \alpha + \beta_1 DGT_{it} + \beta_2 TPAK_{it} + \beta_3 LNBM_{it} + \beta_4 LNINV_{it} + e_{it} \dots \dots \dots (1)$$

Explanation:

LNPDRBK	= Gross Regional Domestic Product per Capita (natural logarithm)
α	= Constant
β	= Independent Variable Coefficient
DGT	= Digitalization
TPAK	= Labor Force Participation Rate
LNBM	= Capital Expenditure (natural logarithm)
LNINV	= Investment (natural logarithm)
i	= Cross Section
t	= Time Series
e	= Error Term

This model is used to analyze the effects of digitalization, labor force participation rate, capital expenditure, and investment on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025.

RESULTS AND DISCUSSION

Multicollinearity Test

The multicollinearity test was conducted using the Pairwise Correlation Test and Variance Inflation Factor (VIF) test to determine whether there is a strong correlation among the independent variables. The results are presented in Table 1 and Table 2.

Table 1. Result of Multicollinearity Test VIF

Variable	Coefficient Variance	Centered VIF
DGT	1.01E-06	1.121
TPAK	2.49E-11	1.043
LNBM	0.000	1.096
LNINV	5.90E-05	1.072

Source : Processed secondary data

Table 2. Result of Pairwise Correlation Test

	DGT	TPAK	LNBM	LNINV
DGT	1	0.004	-0.133	0.099
TPAK	0.005	1	-0.178	-0.062
LNBM	-0.133	-0.178	1	0.382
LNINV	0.099	-0.062	0.382	1

Source : Processed secondary data

Table 1 shows that all centered VIF values are below 10. Table 2 shows all correlation coefficient values among independent variables are below 0.85, indicating that the relationship among variables is relatively low. Therefore, it can be concluded that the regression model does not experience multicollinearity problems and fulfills the classical assumption requirements.

Heterokedastisity Test

Table 3. Result of Heterokedastisity Test

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	0.014	0.063	0.236	0.813
DGT	-0.000	0.000	-0.027	0.797
TPAK	2.222	2.277	0.976	0.333
LNBM	0.005	0.006	0.956	0.340
LNINV	-0.001	0.003	-0.291	0.771

Source : Processed secondary data

Based on Table 3, all probability values are greater than 0.05. These results indicate that the regression model does not experience heteroscedasticity problems, meaning that the residual variance is relatively constant.

Model Selection Test

The model selection test was conducted using the Chow test and Hausman test to determine the most appropriate panel regression model. The results are presented in Table 4.

Table 4. Result Selection Test

Test	Probability	Desicion
Chow Test	0.000	FEM selected
Hausman Test	0.046	FEM selected

Source : Processed secondary data

Based on Table 4, the probability values of both the Chow test and Hausman test are below 0.05. Therefore, the Fixed Effect Model (FEM) is selected as the most appropriate estimation model.

Panel Data Regression Results

Table 5. Result of Panel Data (FEM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.169	0.138	73.241	0.000
DGT	0.004	0.001	3.978	0.000
TPAK	2.88E-07	4.99E-06	0.057	0.954
LNBM	-0.073	0.013	-5.371	0.000
LNINV	0.019	0.007	2.603	0.010

Effects Specification

Cross-section fixed (dummy variables)			
R-squared	0.995	Mean dependent var	10.221
AdjustedR-squared	0.993	S.D. dependent var	0.509
S.E. of regression	0.041	Akaike info criterion	-3.281
Sum squared resid	0.176	Schwarz criterion	-2.461
Log likelihood	268.678	Hannan-Quinn criter.	-2.948
F-statistic	539.815	Durbin-Watson stat	1.366
Prob(F-statistic)	0.000		

Source : Processed secondary data

Based on Table 5, the regression equation in this study can be formulated as follows:

$$LNPDRBK_{it} = 10.169 + 0.004DGT_{it} + 2.88E - 07TPAK_{it} - 0.073LNBM_{it} + 0.019LNINV_{it} \dots\dots\dots (2)$$

- The digitalization variable obtained a coefficient value of 0.004 with a probability value of $0.000 < 0.05$. This means that H1 is accepted, indicating that digitalization has a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. The coefficient value indicates that every one-point increase in the digitalization index will increase GRDP per capita by 0.004 percent, assuming other variables remain constant.
- The labor force participation rate variable obtained a coefficient value of $2.88E-07$ with a probability value of $0.954 > 0.05$. This means that H2 is rejected, indicating that labor force participation rate does not have a significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025.

- c. The capital expenditure variable obtained a coefficient value of -0.073 with a probability value of $0.000 < 0.05$. This means that H3 is accepted, indicating that capital expenditure has a negative and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. The coefficient value indicates that every 1 percent increase in capital expenditure will decrease GRDP per capita by 0.073 percent, assuming other variables remain constant.
- d. The investment variable obtained a coefficient value of 0.019 with a probability value of $0.010 < 0.05$. This means that H4 is accepted, indicating that investment has a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. The coefficient value indicates that every 1 percent increase in investment will increase GRDP per capita by 0.019 percent, assuming other variables remain constant.

R-Squared

The coefficient of determination test is used to measure the ability of the independent variables in explaining the variation of the dependent variable. Based on the regression results, the Adjusted R-squared value obtained is 0.993 or 99.3 percent. This indicates that digitalization, labor force participation rate, capital expenditure, and investment are able to explain 99.3 percent of the variation in GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. Meanwhile, the remaining 0.7 percent is explained by other variables outside the model that are not included in this study.

F-test

The F-test is used to determine whether all independent variables simultaneously affect the dependent variable. Based on the regression results, the F-statistic value obtained is 539.815 with a probability value of 0.000, which is lower than 0.05. This indicates that digitalization, labor force participation rate, capital expenditure, and investment simultaneously have a significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. Therefore, the regression model used in this study is considered feasible and capable of explaining the relationship between the independent variables and GRDP per capita.

t-test

The t-test is used to determine the partial effect of each independent variable on GRDP per capita. Based on the regression results, the digitalization variable has a t-statistic value of 3.978 with a probability value of $0.000 < 0.05$. This means that H1 is accepted, indicating that digitalization has a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. The coefficient value of 0.004 indicates that every one-point increase in the digitalization index will increase GRDP per capita by approximately 0.400 percent, assuming other variables remain constant.

The labor force participation rate variable has a t-statistic value of 0.057 with a probability value of $0.954 > 0.05$. This means that H2 is rejected, indicating that labor force participation rate does not significantly affect GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. The coefficient value of $2.88\text{E-}07$ indicates that every 1 percent increase in labor force participation rate only increases GRDP per capita by approximately $2.88\text{E-}07$ percent, assuming other variables remain constant.

Furthermore, the capital expenditure variable has a t-statistic value of -5.371 with a probability value of $0.000 < 0.05$. This means that H3 is accepted, indicating that capital expenditure has a negative and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. The coefficient value of -0.073 indicates that every 1 percent increase in capital expenditure will decrease GRDP per capita by approximately 0.073 percent, assuming other variables remain constant.

Meanwhile, the investment variable has a t-statistic value of 2.603 with a probability value of $0.010 < 0.05$. This means that H4 is accepted, indicating that investment has a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. The coefficient value of 0.019 indicates that every 1 percent increase in investment will increase GRDP per capita by approximately 0.019 percent, assuming other variables remain constant.

The results of this study are consistent with several previous studies. Tudose et al. (2023); Zhang et al. (2022); de Clercq et al. (2023) explained that digitalization positively contributes to productivity improvement and regional economic growth through increased efficiency and broader market access. Furthermore, Novita & Samsuddin (2024); Sinaga et al. (2025); Maulana et al. (2022) found that labor force participation does not always significantly affect regional welfare because labor absorption is often dominated by low-productivity and sectors local governments need to evaluate capital expenditure allocation because the benefits of capital expenditure are generally not immediately visible in the short term and require a longer period to generate economic returns. In terms of government expenditure, Wahyudi & Nofianti (2025); Setiasih et al. (2025); Chandra et al. (2022) explained that ineffective capital expenditure allocation may reduce the effectiveness of regional economic development, particularly when infrastructure spending has not been directed toward productive sectors. Meanwhile, Saputri & Ananda (2023); Indriawati & Kbarek (2025); Soava et al. (2020) stated that investment positively affects regional economic performance through capital accumulation, production expansion, and productivity improvement.

CONCLUSION

Based on the results of the study, it can be concluded that digitalization and investment have a positive and significant effect on GRDP per capita in regencies/municipalities of Central Java Province during 2022–2025. Meanwhile, capital expenditure has a negative and significant effect, while labor force participation rate does not significantly affect GRDP per capita. Simultaneously, digitalization, labor force participation rate, capital expenditure, and investment significantly affect GRDP per capita.

The implications of this study indicate that local governments need to improve the equal distribution of digitalization through strengthening digital infrastructure, expanding internet access, and improving digital literacy. In addition, local governments need to evaluate capital expenditure allocation so that its benefits can be felt more effectively in the short term. The government is also expected to create a more conducive investment climate through licensing simplification, supporting infrastructure provision, and regional potential development. Furthermore, cooperation between local governments, business sectors, and society is necessary to improve digital utilization, workforce quality, capital expenditure effectiveness, and investment distribution in order to encourage more equitable regional economic welfare.

This study has several limitations. First, the GRDP per capita data for 2025 still use forecast data, so the results may not fully reflect actual conditions. Second, the observation period only covers 2022–2025 due to the limited availability of Indonesian Digital Society Index (IMDI) data. Third, the investment variable only uses Domestic Investment (PMDN) and does not include Foreign Direct Investment (FDI) or other investment types. Fourth, the study period partly reflects the post-COVID-19 economic recovery transition, so the findings may still be influenced by external factors such as economic recovery, policy changes, investment dynamics, labor conditions, and post-pandemic digital acceleration.

Therefore, future research is expected to use a longer and more stable observation period, include broader investment indicators, and add other variables related to regional economic welfare in order to obtain more comprehensive and representative results.

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