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Socioeconomic Determinants and Their Interactions in Shaping Improved Sanitation Access in Indonesia

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Abstract

Access to adequate sanitation facilities is a key agenda in Sustainable Development Goal (SDG) 6, but is still an urgent development issue in Indonesia. The equitable distribution of sanitation services between regions has not been fully achieved due to strong regional disparities, high levels of poverty, and ongoing socio-economic inequality. This study aims to analyze the socio-economic determinants that affect the level of community access to adequate sanitation facilities in Indonesia. The quantitative approach was used through regression analysis of panel data at the provincial level during the 2019-2023 period, utilizing secondary data sourced from the Central Statistics Agency (BPS) and the World Bank. The dependent variable in this study is the proportion of households that have access to proper sanitation facilities. Meanwhile, Gross Regional Domestic Product (GRDP), Gini ratio, poverty rate, and life expectancy are used as independent variables that represent the economic condition of the region, income distribution, social vulnerability, and the level of welfare of the population. The results show that the increase in regional GRDP has a positive and significant effect on sanitation access. Life expectancy also positively related to the availability of good sanitation. On the contrary, higher income inequality and a large prevalence of poverty have been shown to decrease people's chances of obtaining proper sanitation services.

Keywords: Access to Proper Sanitation, GRDP, Gini Ratio, Poverty, Life Expectancy

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INTRODUCTION

National development is a regular and continuous process that seeks to optimize the quality of life in a society, taking into account political, economic, sociocultural, and environmental dimensions (Todaro & Smith,

2020). The priority of development is to build an advanced society, productivity, and competitiveness at the global level. The fulfillment of basic needs such as sanitation and proper drinking water is very important, especially in the context of sustainable development. these two things are very related to ten common diseases in Indonesia and also have an impact on public health, the economy, and environmental sustainability (Hutton & Varughese, 2022; United Nations Water, 2023).

The world still faces the challenge of access to potable water. The World Water Development Report (WWDR) highlights that environmental preservation and human progress are in dire need of good water management which is also affirmed by the United Nations (United Nations Education Scientific and Cultural Organization [UNESCO], 2023). However, developing countries continue to face challenges in providing adequate sanitation and drinking water.

Based on statistics from the WHO-UNICEF Joint Monitoring Program in 2020, the practice of open defecation is still practiced by 1.1 billion people worldwide, especially in low-income countries such as Indonesia (United Nations Children's Fund [UNICEF], 2022; World Health Organization & United Nations Children's Fund, 2021). The findings indicate that there are still many areas with limited sanitation, especially rural or remote areas.

Indonesia still faces major challenges in providing adequate access to Safe Drinking Water and adequate sanitation facilities. The results of a study conducted by the World Bank in the framework of the water and Sanitation Program (WSP) show that the prevalence of environmental diseases such as diarrhea and gastrointestinal infections in Indonesia is getting worse due to most people still defecating in the open (World Bank, 2022).

One of the common diseases in Indonesia and related to household hygiene is diarrhea (Kementerian Kesehatan Republik Indonesia, 2023). Increases in public spending on sanitation and water supply remain constrained due to issues of community disparity and infrastructure development.

Inequality in access to drinking water between villages and cities is shown by data from the National Socio-Economic Survey (Susenas) for the period 2021-2023 (Badan Pusat Statistik, 2023). In 2022, there was still a decrease in the level of access to drinking water, which then began to be restored in 2023. This condition reflects that the increase in population, lack of infrastructure, and poor environmental quality was not offset by the increase in basic services, both sanitation and drinking water.

According to the British Psychological Society (BPS, 2023), Population growth of 1.17% was not accompanied by an increase in national drinking water supply because it was only 0.28%. This condition is a sign of problems with water resources, water quality, and development inequality, especially in dense residential areas.

Access to proper sanitation and drinking water facilities is fundamental to sustainable development. Increased spread of disease, environmental degradation, decreased quality of life, and decreased work productivity are affected by the limitations of proper sanitation infrastructure (Prüss-Ustün et al., 2022).

In line with the Sustainable Development Goals (SDGs) agenda, especially Goal 6, Indonesia is still faced with persistent challenges. In 2020, access to safely managed drinking water was only enjoyed by 11.8% of the

population, while in 2022, the proportion of residents with proper sanitation services was recorded at 10.16% (Badan Perencanaan Pembangunan Nasional, 2024; WHO & UNICEF, 2023). These conditions indicate that structural issues such as water quality decline, climate change, population growth, and high urbanization are still challenges to achieving national development targets.

The problem of access to sanitation is getting worse because of regional inequality in both socio-economic and development. Sasana & Putri (2022), suggest that the inequality in gross domestic regional product (GDP) between regions also describes the provision of infrastructure and other public services by local governments.

The uneven distribution of income indicates a high Gini index in each province that prevents low-income people from accessing good health infrastructure despite high per capita regional income (Suryahadi et al., 2023). In addition, the ability of households to build proper sanitation will be reduced, especially in areas with high levels of poverty such as Papua, East Nusa Tenggara, and Maluku (BPS, 2023; World Bank, 2022).

The quality of Health and the environment can be indicated by the parameters of life expectancy. A number of studies reveal that household sanitation conditions and long-life expectancy of the population are strongly related because proper sanitation plays a role in reducing the spread of infectious diseases through Environmental media (Prüss-Ustün et al., 2022; Rahman et al., 2021). Thus, low life expectancy in a region may reflect limited access to adequate sanitation infrastructure as well as limited quality of Environmental Health Services.

Given the complexity of the issue, research into factors affecting access to sanitation facilities is essential. The Gini index, regional Gross Domestic Product(GRDP), life expectancy, and poverty levels are indicators that reflect social inequality, economic conditions, quality of life to well-being in a region. A comprehensive empirical understanding of these variables is expected to be a strong foundation in the formulation of more effective, inclusive, and sustainable health policies.

This study analyzes the influence of gross regional domestic product, Gini ratio, proportion of poor people, and life expectancy on the level of household access to adequate sanitation facilities in Indonesia. The resulting findings are expected to contribute to supporting the achievement of Sustainable Development Goals (SDGs), narrowing the development gap between regions, and become a reference in the formulation of national development strategies oriented to improving the common welfare and quality of life of the community.

RESEARCH METHODS

This study employs a quantitative research design to examine the socioeconomic factors that influence household access to improved sanitation in Indonesia. A quantitative approach was chosen because the objective is to estimate the direction and magnitude of relationships among variables using statistical methods.

The analysis applies panel data regression, which allows the integration of regional variation across provinces and changes over time while controlling for unobserved heterogeneity. All statistical estimations are conducted using EViews version 12.

This study used secondary data obtained from the Central Bureau of Statistics to ensure accuracy and consistency at the subnational level. The Unit analysis consisted of 34 provinces in Indonesia observed during the period 2019 to 2023 with a total of 170 observations from a balanced panel dataset.

The selected period represents the availability of the latest data and captures important structural changes before and after the COVID-19 pandemic on economic performance, income distribution, poverty conditions, public health outcomes, and sanitation access. In addition, this period is in line with Indonesia's medium-term national development planning and supports the evaluation of progress towards Sustainable Development Goal six on clean water and sanitation.

The dependent variable in this study is household access to improved sanitation. Improved sanitation measured as the percentage of households that have access to facilities proper sanitation at the provincial level.

The independent variables include gross regional domestic product (GDRP) per capita at constant prices, measured in billion IDR. The Gini ratio as an indicator of income inequality at the provincial level, measured in index ranged between 0 and 1.

Poverty rate is measured as the percentage of the population living below the national poverty line at the provincial level, and life expectancy at birth, which is the average number of years expected to be lived by the newborn baby at the provincial level, is used as a proxy for population health. All variables follow official definitions and measurement standards published by Statistics Indonesia. The relationship between socioeconomic factors and sanitation access is estimated using a panel data regression model expressed as sanitation access equals a constant term plus the coefficients of gross regional domestic product per capita, income inequality, poverty rate, and life expectancy, along with an error term. This specification enables the estimation of both the individual and joint effects of the explanatory variables on sanitation access across provinces and over time.

Three alternative panel data estimators are considered, namely the common effect model, fixed effect model, and random effect model. The most appropriate estimator s selected using a sequence of statistical tests, including the Chow test, Hausman test, and Lagrange multiplier test, to ensure consistency and efficiency.

To validate the regression results, diagnostic tests were performed. Multicollinearity is examined using a correlation matrix, while heteroskedasticity was assessed through residual variance analysis. The results indicate that the selected model satisfies the required statistical assumptions and provides reliable and valid inference regarding the determinants of improved sanitation access in Indonesia. The resulting equation model is as follows:

$$RT\ presentation_{it} = \beta_0 + \beta_1 GRDB_{it} + \beta_2 GINI_{it} + \beta_3 PERSENTASE_{it} + \beta_4 AVE_{it} + \varepsilon_{it}$$

In this model, the index i represents the province as a unit of analysis, while the index t represents the time period. Next, ε_{it} is an erros component that captures the influence of other factors outside the model that is not observed. Variables in the model are symbolized by RT presentation for good sanitation, GRDP for gross

regional domestic product, GINI for the Gini index, PERSENTASE for the poverty rate, and AVE for life expectancy.

RESULTS AND DISCUSSION

The selection of the panel data estimation model is very important in the empirical analysis of konomi so that the conclusions are credible and relevant. panel data regression mainly uses three types of general effects model (CEM), random effects model (REM), and fixed effects model (FEM).

Each model is based on different structural assumptions regarding diversity among economic entities. Therefore, it is necessary to implement a systematic and structured model selection procedure to ensure that the model specifications used are in line with the nature and characteristics of the analyzed data.

Table 1. Chow Test Findings

Effects Test	Statstic	d.f	Prob
Cross-section F	94.465016	(33,132)	0.0000
Cross-section Chi-square	544.579182	33	0.0000

Source: Data processed, 2025

The Model is based on several statistical tests, including the Chow test, the Hausman test, and the Lagrange multiplier (LM) test. The Chow test assesses the significance of fixed effects compared to the global effects method by checking the statistical significance of intercept differences between economic entities, such as regions or nations.

Subsequently, a Hausman test is performed to compare the fixed effects model (FEM) and the random effects model (REM), checking the consistency of the estimators, mainly with regard to the correlation between unobserved effects and explanatory variables. In addition, a Lagrange multiplier (LM) test is performed to decide whether the fixed effects model (REM) is more appropriate than the common effects model (CEM), by searching for the presence of entity-specific error components.

Table 2. Hausman Test Finding

Test Summary	Chi-Sq.Statistic	Chi-Sq. d.f	Prob
Cross-section random	17.098303	4	0.0018

Source: Data processed, 2025

Table 1 presents the results of the Chow test, with a p-value of 0.0000, which is below the significance threshold $\alpha = 0.05$. Thus, we reject the null hypothesis (H_0) in favor of the alternative hypothesis (H_a), proving that the fixed effects model (FEM) is more appropriate than the common effects model for the data examined.

Table 3. LM Test Finding

	Cross-section	Test Hypothesis Time	Both
Breush-Pagan	286.6400	0.754255	287.3942
	(0.0000)	(0.3851)	(0.0000)

Source: Data processed, 2025

The results of the Hausman test in Table 2 show statistical significance (p-value = 0.0018), which is below the threshold of 0.05. As a result, the alternative hypothesis (H_a) was accepted and the estimation model was chosen fixed effect Model (FEM). The data in Table 3, which presents the results of the Lagrange multiplier (LM) test, show a p-value of 0.0000, which is

below the alpha threshold of 0.05 for significance. Thus, the alternative hypothesis (H) is accepted and the random effects model (REM) is an appropriate estimation technique.

Table 4. Multikolinearity Test Finding

	GRDP - constant prices	GINI RATIO	PRESENTASE	AVE
GRDP	1.000000	0.371216	-0.240050	0.420341
GINI RATIO	0.371216	1.000000	0.267701	-0.006505
PRESENTASE	-0.240050	0.267701	1.000000	-0.609531
AVE	0.420341	-0.006505	-0.609531	1.000000

Source: Data processed, 2025

The results of the Chow, Hausman, and Lagrange Multiplier tests help us select the common effects model (CEM), fixed effects model (FEM), or random effects model (REM). These results show that the random effects method (REM) is the most appropriate and effective estimation approach for this research.

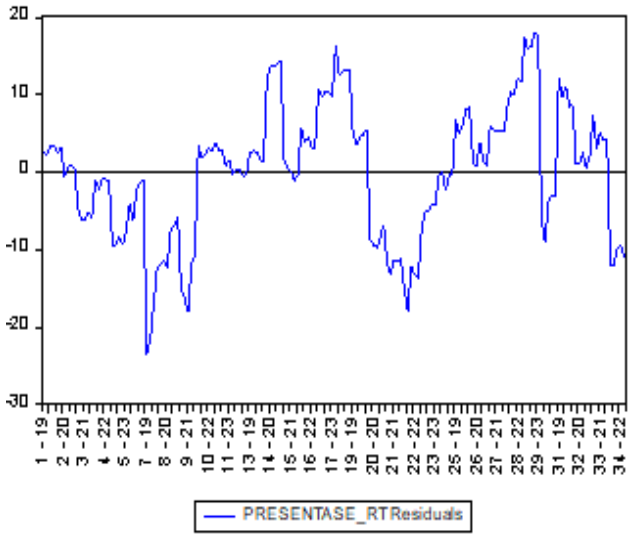

Figure 1. Heteroskedasticity Test Finding
Source: Data processed, 2025

Subsequently, two classical hypothesis tests were conducted first. The preliminary examination of multicollinearity (see Table 4) indicates that the correlation coefficients between the independent variables are generally below 0.8, suggesting that the explanatory variables do not exhibit strong correlation. The results of the analysis showed that the relationships between variables in the model do not overlap excessively, so multicollinearity is not a problem and does not interfere with the regression results.

Table 5. Final Estimation Results

Variable	Coefici-ent	Std. err	t-Statist-ic	Prob.
GRDP	6.34E-06	2.49E-06	2.54122	0.0120
GINI RATIO	-48.3059	16.3680	-2.9512	0.003
PRESENTASE	-0.281764	0.142311	-1.97991	0.049
AVE	0.779476	0.10190	7.64901	0.000
C	47.62558	10.26137	4.64125	0.000
R-Squared	0.398925			
Adj R-squared	0.384354			
F-statistic	27.37708			
Prob (F-statistic)	0.000000			

Source: Data processed, 2025

In addition, heteroscedasticity tests are also performed to see if the errors (residues) in the model spread evenly throughout the data. If

the spread of error is uneven, then the estimated results can be less accurate and the statistical conclusions can not be trusted (Cox, 1975; Lehmann, 1983).

If, on the other hand, the spread of errors is relatively the same in all observations, then the model is considered stable and feasible to use, since it has fulfilled one of the important conditions in regression analysis.

The heteroskedasticity test results in Figure 1 indicate that the residuals remain within the predefined upper and lower bounds of ±500. This finding demonstrates that the residual variance is constant across observations. Consequently, no heteroskedasticity is detected, and the model meets the homoskedasticity assumption.

Table 5 presents the final estimation results obtained through a series of tests. Based on these results, the estimated regression equation can be expressed as follows:

$$RT\ presentation = 47.62558 + 6.34E - 06\ GRDB_{it} - 48.3059 GINI_{it} - 0.281764\ PERSENTASE_{it} + 0.779476 AVE_{it}$$

The hypothesis-testing methods employed in this study include partial significance testing (t-test), simultaneous significance testing (F-test), and the calculation of the coefficient of determination (R^2).

The results of T-test on GRDP variables showed that the statistical value of T-black is 1.9741 < t-Table value is 2.5412. While the obtained probability of 0.0120 is below the significance level of 5 percent, the measurement results remain unchanged on the comparison of t-table and t-table.

Therefore, an alternative hypothesis (H_a) is accepted which suggests that gross regional domestic product does not have a statistically significant effect on the situation of households that have access to improved sanitation facilities.

Thus, regional economic growth does not necessarily automatically describe access to sanitation at the household level because there are other structural factors that are more dominant. Previous empirical studies have found that regional economic growth may remain non-inclusive unless accompanied by public expenditure policies that prioritize basic infrastructure. In such cases, the benefits of growth often concentrate among specific groups rather than being distributed to low-income households (Anderson et al., 2021; Camacho & Rodríguez, 2019).

The Gini index produces a t-value of 1.9741 which exceeds the critical threshold of -2.9512 at a significance level of 0.0036 < 0.05. As a result, an alternative hypothesis (H_a) was accepted. These results show that income inequality has a statistically significant effect on the proportion of households that have access to good sanitation.

These results are in line with the findings of Anderson et al. (2021) and Haller et al. (2023), who reports that the increase in the gap in access to basic services is due to income inequality. Financial and structural barriers to accessing adequate sanitation facilities are often faced by low-income households, despite living in areas with high average incomes.

On the poverty level variable t test shows the results of the value of T-table (-1.9799) < Value t-count (1.9741). The significance value obtained, which is 0.0494, is less than the significance limit of 0.05. Based on these results, an null hypothesis (H_0) was accepted. These findings indicate that poverty levels play a

significant role in limiting households ' access to adequate sanitation facilities.

These results are in line with the research of Mara et al. (2021) and Alderman et al. (2023) which affirms that economic limitations cause poor households to experience financial constraints in building and utilizing sanitation facilities that meet health standards. The condition increases vulnerability to inadequate health practices as well as a higher risk of health disorders.

Table 6. T-test result

Variable	Coefficient	Std. err	t-Statistic	Prob.
GRDP - constant prices	6.34E-06	2.49E-06	2.541224	0.0120
GINI RATIO	-48.30592	16.36808	-2.951227	0.0036
PRESENTASE	-0.281764	0.142311	-1.979912	0.0494
AVE	0.779476	0.101905	7.649015	0.0000
C	47.62558	10.26137	4.641250	0.0000

Source: Data processed, 2025

The results of the t-test for the variable "average life expectancy" (AVE) showed that the calculated t-value (1.9741) < table of t-values (7.6490). The significance value is 0.0000, which is below the threshold of 0.05. Thus, the accepted null hypothesis (Ho) is confirmed.

Table 7. F Test Result

Category	Value
F-statistic	27.37708
Prob (F-statistic)	0.000000

Source: Data processed, 2025

These findings suggest that life expectancy and households accessing adequate sanitation facilities are not significantly related. Life expectancy as a measure of long-term health is influenced by the quality of health services, environmental conditions, and consumption habits of the community.

In line with this, Cutler et al. (2021) and Schmidt et al. (2022) affirm that sanitation is a long-term and sustainable factor in influencing the level of Public Health. The impact of sanitation on increasing longevity is not independent, but is strongly influenced by wider structural support and consistent and long-term improvements. A summary of the t-test results is presented in Table 6.

Table 8. Coefficient of Determination Results

Category	Value
R-squared	0.398925
Adjusted R-squared	0.384354

Source: Data processed, 2025

Table 7 shows the results of the simultaneous significance test with the results of the critical F value (2.4264) < F value table 27.37708, with a probability of 0.0000 is below the threshold of 0.05. Thus, the alternative hypothesis (Ha) was accepted, proving that the dependent variable is strongly influenced by all the independent variables present in the model.

The coefficient of determination of 0.384354 indicates that the 38.43% variation in the level of households with adequate sanitation facilities can be explained jointly by the variables

of gross regional domestic product (GRDP), Gini index, poverty level, and life expectancy. Meanwhile, another 61.57% of the variation was explained by other factors that were not included in the research model. The results of testing the coefficient of determination are presented in Table 8.

The significant regional variation in economic growth in Indonesia's provinces during the 2019-2023 period is demonstrated by the development of GRDP, which is further linked to access to basic services, such as sanitation and drinking water. Based on available data, a decline in economic growth was experienced by most provinces in 2019 to 2021, before a gradual recovery began in the following years.

This was triggered by the economic and social shock caused by the global coronavirus pandemic (SARS-COVID). The impact of the pandemic is reflected in the weakening of production activities, declining household income, and limited fiscal capacity of local governments. Similar findings have also been reported in numerous previous empirical studies examining the effects of pandemics on regional economic dynamics in developing countries.

The glaring gap between regional gross domestic product levels causing structural inequality in development continues to occur in various provinces in Indonesia, ranging from low-income areas to economically developed regions. Superior infrastructure, large fiscal capacity, and investment potential in public services are often seen from the high GRDP value of a province.

This finding is in line with previous research showing that increased public investment and service quality, access to basic services can be expanded in line with economic expansion at the local level (Abdou et al., 2024). In contrast, budget constraints are generally faced by provinces with lower GRDP, so the ability to maintain and improve sanitation infrastructure is hampered and service inequality continues to be maintained.

The Gini coefficient as a further indicator of income inequality highlights gaps in access to sanitation services. Uneven economic recovery, social protection mechanisms and uneven distribution of employment opportunities are reflected by the high disparities during the pandemic years.

Empirical findings show that the effectiveness of economic growth in improving people's welfare, especially access to sanitation facilities, is reduced when the income gap widens because the benefits of growth are not distributed evenly. This conclusion is in line with the results of previous studies that indicate that regions with high levels of inequality tend to be characterized by lower health care coverage (Zhang et al., 2022). Indeed, despite overall economic progress, vulnerable populations continue to be left behind in terms of service improvements.

The difference in access and services to water and proper sanitation is very large in a province. Rural areas generally experience many obstacles due to limited infrastructure, institutions, and geographical locations that are sometimes remote in contrast to urban access is almost evenly distributed.

BPS revealed that the gap between villages and cities is due to the uneven distribution of development. For example, a province such as Aceh illustrates a national trend with very visible levels of rural-urban inequality. Development inequality between provinces can be seen from life expectancy as an indicator of well-being and

health. high life expectancy in a region means better access to basic services, including sanitation, this finding supports the findings of Irandoust et al. (2025). Infectious diseases and sustainable health are achieved when the sanitation obtained is accessible properly so that it illustrates the relationship between life expectancy and health access. conversely an area with inadequate access to basic services is more vulnerable to socioeconomic conditions.

This finding is reinforced by empirical data showing that in the last 10 years of proper sanitation in Indonesia has increased from 61.08% in 2014 to 82.36% in 2023 which shows improvements caused by improving economic conditions, decreasing inequality to increasing life expectancy. Economic factors, income distribution, and public health conditions have a complex relationship with improved access to health infrastructure in Indonesia, according to these findings.

Although expanding access to sanitation depends largely on economic growth as measured by gross regional domestic product, its effect is modulated by levels of poverty and income inequality. This finding confirms that policy making must be a multidimensional approach by integrating economic development, gap reduction, and special investment in infrastructure, especially health in all provinces, especially less developed areas. To reduce regional disparities and ensure better overall access to healthcare facilities in Indonesia, it is important to increase collaboration between governments and ensure resources are distributed fairly.

CONCLUSION

Empirical results show that gross regional domestic product (GRDP) has a significant impact on the increase in the percentage of households with improved sanitation facilities. Regions with higher gross regional domestic product (GRDP) generally tend to have greater fiscal capacity, enabling them to increase investment in health infrastructure and improve the quality of public services.

This observation is in line with the targets set out in the National Medium Term Development Plan (RPJMN) of Indonesia, where economic growth is positioned as a strategic element in strengthening the provision of basic services including efforts to achieve access to proper sanitation as a whole for all communities.

The results suggest that achieving sanitation objectives is more feasible in areas where economic development is paired with effective public investment in infrastructure sectors. In contrast, income inequality, as measured by the Gini index, is negatively associated with sanitation access.

This finding indicates that economic expansion alone cannot ensure equitable sanitation outcomes if the benefits of progress are distributed unevenly. Significant disparities restrict access for low-income and marginalized households, thereby calling into question the inclusive nature of the sanitation targets set out in the RPJMN and regional development plans (RPJMD).

Poverty rates continue to significantly limit access to sanitation, especially in provinces with consistently high poverty levels, such as Papua and East Nusa Tenggara. These results indicate that in order to achieve contemporary sanitation goals, it is necessary to link sanitation actions more closely to poverty reduction plans.

There is a positive correlation between life expectancy and access to improved sanitation facilities, highlighting the close relationship

between sanitation, public health outcomes, and human progress. Areas with better health coverage often have higher life expectancy, confirming once again that improving sanitation is crucial to reducing water-related diseases and optimizing the overall health of residents.

This evidence supports the Ministry of Health's strategic objectives, particularly as implemented through the Community-Based Total Sanitation (STBM) program, which prioritizes behavioral change and universal sanitation access as essential for improved health outcomes.

Several policy recommendations emerge from these findings. First, sanitation development programs should align with regional economic infrastructure investments, particularly in provinces experiencing high Gross Regional Domestic Product (GRDP) growth, to ensure that economic expansion leads to improved access to sanitation services.

Second, sanitation policies should incorporate explicit measures to reduce inequality by prioritizing investments in regions and sub-regions with high gini index, rather than focusing resources exclusively on already developed urban areas.

Third, in provinces with elevated poverty rates, sanitation interventions—especially the first pillar of Community-Based Total Sanitation (STBM), Stopping Open Defecation should be integrated with social protection initiatives such as the Conditional Cash Transfer Program (PKH) through targeted subsidies for household sanitation facility construction.

Finally, it is essential to improve collaboration between regional governments and the health sector to ensure that sanitation spending contributes more effectively to broader public health goals, including reducing stunting and water-related diseases.

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