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Sanitation access in the developing country: The impact of human development, income inequality, and economic growth

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Abstract. This study aimed to analyze the correlation between human development, income inequality, economic growth, and access to sanitation in Bali, Indonesia. The research used secondary data from the Indonesian Central Bureau of Statistics (BPS) on sanitation access, the Human Development Index (HDI), the Gini Ratio, and Gross Domestic Product (GDP) in Bali Province from 2017 to 2021. Multiple linear regression analysis was conducted to examine the relationship between these variables. The findings of the study showed that HDI has a significant positive correlation with access to sanitation in Bali, while GDP and Gini Ratio have no significant correlations. The results suggested that investing in human development is crucial for improving access to sanitation. Additionally, the study highlighted the importance of addressing income inequality and promoting sustainable economic growth in order to improve sanitation access. These findings will be important input to policy development for improving sanitation access in Bali Province and other developing regions.

Keywords: Economic growth, Human development, Income inequality, Sanitation access

1. Introduction

Sanitation is a critical concern for public health in Indonesia, with far-reaching repercussions for health and economic growth [1,2]. Access to universally and equitably available sanitation at reasonable prices is essential to the health and well-being of a population. It is directly related to disease prevention and death from diarrhoeal disease, trachoma, and intestinal helminths (Ascaris, trichuriasis, and hookworm). It also helps to mitigate risks associated with malnutrition (i.e. resulting from the inability to derive nutritional value from food) and the underlying determinants of malnutrition [3]. Access to improved drinking water and sanitation significantly reduces the incidence of disease and mortality. Additionally, improvements in sanitation yield significant economic returns through enhanced public health [4].

The Bali Province was recorded to experience the most frequent diarrhea [5]. In addition, the prevalence of diarrhea per province on the island of Bali is also relatively high. According to the 2018 Riskesdas report, most diarrhea in several sections in Java and Bali is higher than the national figure, which ranges from 7.2 to 9.2% [5]. Culture is essential in sanitation planning and assessment, which helps ensure sanitation facilities' long-term viability [6]. Diarrhea is a leading cause of morbidity and mortality in Indonesia, particularly among children under five [7,8]. Poor sanitation practices, including inadequate waste management and lack of access to clean water, contribute significantly to the spread of diarrheal diseases [9]. The frequent occurrence of diarrhea not only affects the health of the population but also imposes economic burdens on families and the healthcare system [10]. It leads to increased healthcare costs, loss of productivity, and reduced school attendance among children [11]. Cultural considerations play a crucial role in sanitation planning and assessment in Bali [12,13]. The island's rich cultural heritage and traditions influence the acceptance and usage of sanitation facilities. To ensure the long-term viability of sanitation projects, it is essential to integrate cultural values and practices into the planning and implementation processes [14,15]. Community involvement and participation are vital for the success of sanitation programs. By engaging local communities and respecting their cultural norms [16,17], sanitation initiatives can achieve greater acceptance and sustainability.

The Human Development Index (HDI) is a combination of three dimensions (indicators, factors): life expectancy at birth, the middle number of years of education, and the expected number of years of schooling combined into a single education index [18,19] and economic benefits expressed by production, or GDP (gross domestic product), according to purchasing power [20]. The HDI is one of the more complex composite indicators of human potential and quality of life. Meanwhile, to see the existence of inequality or whether the Gini Ratio can measure the welfare of the community [21].

Meanwhile, around 9% of people in urban areas still practice open defecation [22].m Regarding open defecation behavior, Indonesia even ranks second worst in the world after India [23]. This condition is very worrying because poor sanitation will affect the quality of the environment and the degree of public health [24]. Both ultimately harm the quality of human resources and hinder Indonesia's growth potential. Facilities and infrastructure related to

environmental health are important factors in social life, even one of the determining factors for the population's degree of health and welfare. Policies related to facilities and infrastructure are crucial to addressing this issue. For example, the government can implement policies that focus on building and maintaining proper sanitation facilities [25], such as public toilets and sewage systems, in urban areas. Additionally, providing education and awareness programs about the importance of sanitation and hygiene can encourage better practices among the population. Globally, the Sustainable Development Goals (SDGs) highlight the importance of ensuring access to clean water and sanitation for all, which directly relates to improving environmental health [26]. Locally, the PAMSIMAS (Program Penyediaan Air Minum dan Sanitasi Berbasis Masyarakat) program aims to enhance water supply and sanitation services in rural areas [27,28], and similar initiatives can be applied to urban settings.. Strategies to improve the quality of environmental health and strategies to improve environmental health as well as access to drinking water and proper sanitation and hygienic behavior to realize policies to improve disease control and environmental health [29,30].

Adequate sanitation can mean that a simple sanitation system in a community that is assessed as adequate by the criteria of the household has access to proper sanitation [31]. For example, using separate or shared defecation facilities and having a final disposal site such as a septic tank or wastewater treatment system. In addition to the strong cooperation between the central and regional governments, periodic evaluations that are carried out should involve all relevant stakeholders [32]such as village officials, user communities, and non-governmental organizations in the regions. Although adequate sanitation will ultimately help the government improve environmental health efforts in residential homes [33], less than optimal results from increasing access to sanitation can impact the risk of exposure to environmental health hazards such as the emergence of various diseases. Basic sanitation of the house is closely related to the morbidity rate of infectious diseases, especially diarrhea [34]. The high prevalence of the diarrheal disease is related to poor sanitation, poor control of environmental conditions, high density, and inadequate clean water supply. Therefore, optimal sustainable development can be supported by increasing community welfare and participation [35,36]. Along with the increase in welfare, the community's standard of living [32] also becomes increasingly important and is aware of health, which has implications for increasing access to sanitation.

HDI is a composite index that measures a country's overall human development, including health, education, and income [19,37]. Access to sanitation is an important component of health, as it can prevent the spread of diseases. Countries with higher HDI tend to have better access to sanitation, as they have more resources to invest in infrastructure and public health. Gini Ratio measures income inequality within a society. High levels of income inequality can result in disparities in access to sanitation. For example, in countries with high income inequality, the wealthy may have access to private sanitation facilities while the poor lack access to even basic sanitation facilities. This can lead to higher rates of disease transmission among the poor. Higher GDP often indicates greater resources and infrastructure, which can improve access to sanitation facilities. Countries with higher GDP tend to have more resources

to invest in public health infrastructure, including sanitation facilities [38,39]. Access to sanitation is a critical component of public health, and it is closely related to a country's overall development and economic status. Improving access to sanitation can lead to improved health outcomes, greater economic growth, and reduced income inequality. This study aims to analyses the correlation between HDI, GDP, and Gini Ratio on access to sanitation. The research question on this research including:

a. What is the causal relationship between human development and access to sanitation in Bali Province? How do changes in HDI over time impact sanitation access, considering factors such as education, healthcare, and income?

b. What are the main factors contributing to income inequality in Bali Province, and how do they affect access to sanitation? What policies and interventions can effectively reduce income inequality and improve access to basic services, including sanitation?

This research is crucial for addressing the critical concern of sanitation in Bali Province, Indonesia. It aims to investigate the relationship between human development, income inequality, and access to sanitation. Understanding this relationship is vital for policymakers and stakeholders to develop effective strategies for improving sanitation access and overall public health in the region. By identifying the key factors influencing sanitation access and evaluating the impact of policy interventions, this research can provide valuable insights into the drivers of sanitation inequality and guide the formulation of evidence-based policies and interventions. The findings of this research will contribute to the existing knowledge base by establishing the causal relationship between human development and access to sanitation. It will provide insights into the specific factors contributing to income inequality and their impact on sanitation access in Bali Province. The research will also shed light on the influence of cultural factors and the effectiveness of policy interventions in improving sanitation access. By quantifying the health and economic benefits of improved sanitation and identifying best practices, this research can inform decision-making processes and guide resource allocation towards sustainable development.

2. Methods

This study uses data collection techniques with secondary data. The secondary data in this study was obtained from the Central Bureau of Statistics of Bali Province in 2022 [40]. The data was processed with statistics to test the hypothesis with multiple linear regression. Multiple linear regression analysis is used to determine whether there is an effect of the independent variable on the dependent variable. In addition, this study examines the relationship between the independent variables, namely HDI (X1), Gini Ratio (X2), and GDP (X3), to the dependent variable, namely Access to Sanitation in Bali Province (Y) (equation 1):

$$Y = b + a1.X1 + a2.X2 + a3.X3 \qquad (1)$$

The hypotheses used are:
a. H1, HDI, has a significant effect on increasing sanitation access in Bali Province
b. H2, Gini Ratio, has a significant effect on increasing sanitation access in Bali Province

c.   H3, GDP, has a significant effect on increasing sanitation access in Bali Province

The coefficient of determination determines the result. This value is used to determine how significant the relationship of several variables is in a more straightforward sense. The coefficient of determination will explain how much change or variation in a variable can be explained by changes or variations in other variables. The value of this coefficient is between 0 and 1. If the results are closer to 0, the independent variables' ability to explain the variation of variables is minimal. But if the result is close to 1, the independent variables provide almost all the information needed to predict the variation of the dependent variable.

3. Result and discussion

The area in this study is the Province of Bali, which can be seen in Figure 1. Bali is an island in Indonesia with a distinct culture and economy. It is a popular tourist destination, and tourism plays a significant role in the island's economy. Studying the relationship between HDI, Gini ratio, GDP, and access to sanitation in Bali can provide insights into the unique economic and social factors that affect access to sanitation in a tourist-based economy. Despite being a popular tourist destination, Bali faces challenges in providing adequate sanitation facilities. The island's rapid development and population growth have put pressure on the sanitation infrastructure, resulting in inadequate sanitation facilities in some areas. Studying the relationship between HDI, Gini ratio, GDP, and access to sanitation in Bali can provide insights into the challenges faced by developing countries in providing adequate sanitation facilities. Bali's government collects and publishes data on HDI, Gini ratio, GDP, and access to sanitation. Researchers can access this data to study the relationship between these factors and access to sanitation. This data availability makes Bali a convenient research location for studying the relationship between HDI, Gini ratio, GDP, and access to sanitation.
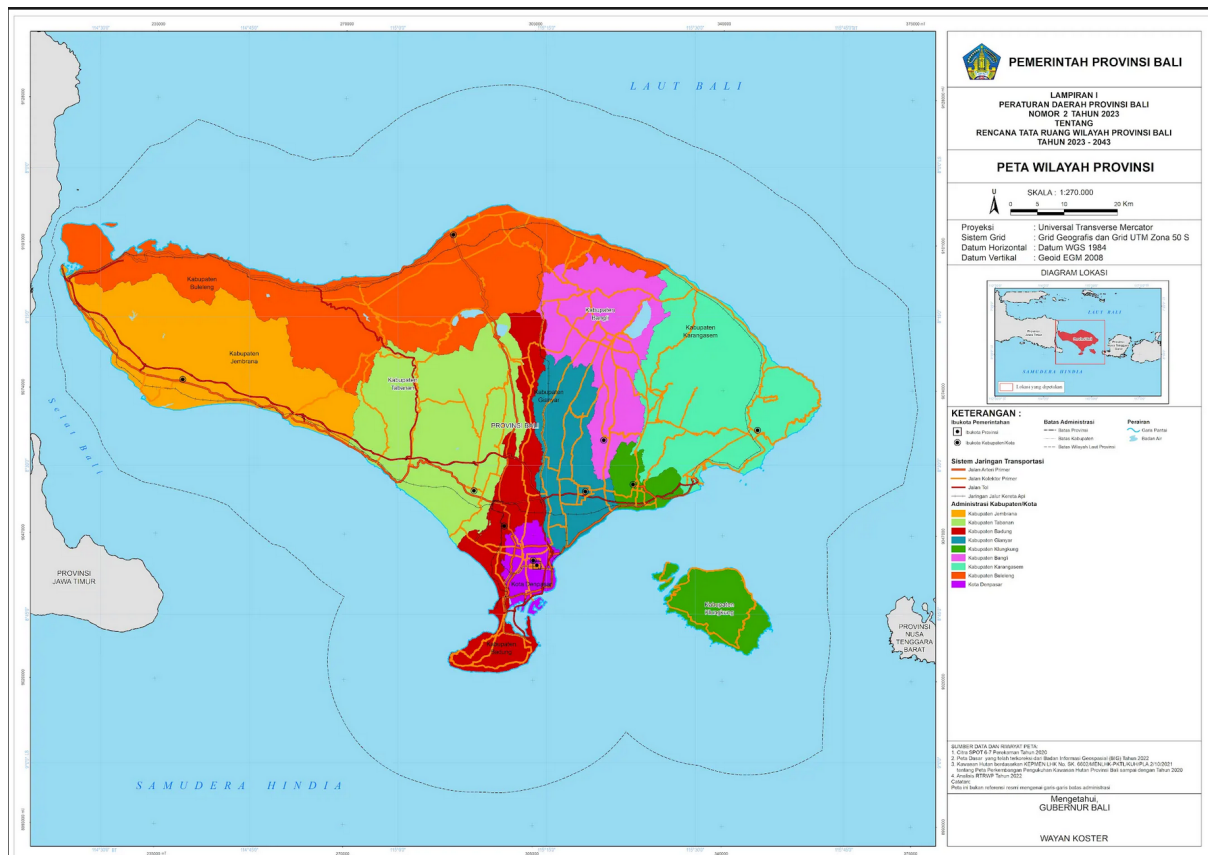
Figure 1. Study location map [41].

As one of the alternative indicators to assess society's welfare, HDI includes three components considered fundamental to humans and are operationally easy to calculate to produce a measure that reflects human development[42]. In the second year of the COVID-19 pandemic, human development in the Province of Bali showed a direction of improvement [40]. This can be seen from the growth of the HDI, which has increased compared to the previous year. Bali's HDI in 2021 is 75.69 or growing 0.25 % (an increase of 0.19 points) compared to the last year's achievement (Figure 2).
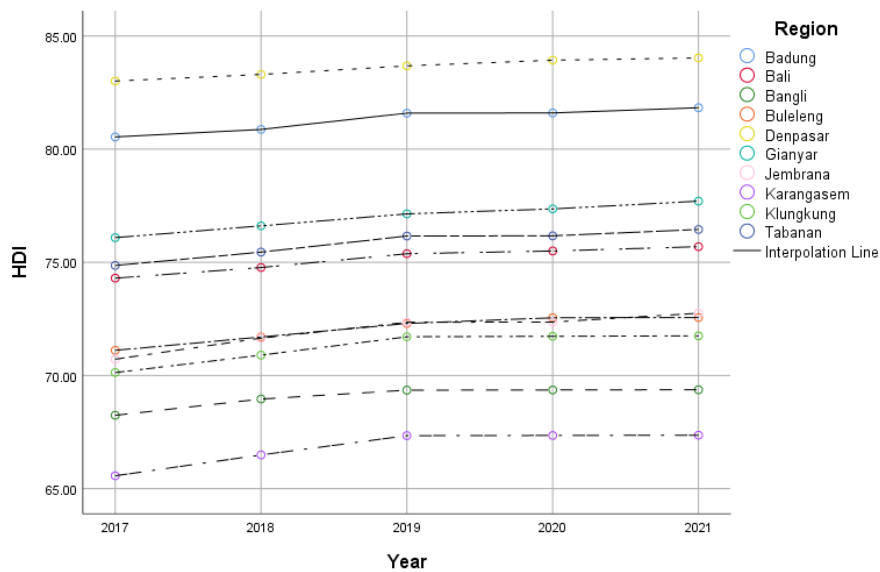
Figure 2. Changes in HDI in Bali Province from 2017 to 2021.

The importance of poverty alleviation is a major issue discussed worldwide, as evidenced in the SDGs by stating no poverty (without poverty) as the priority point. To show this, can be explained by the Gini ratio value. For example, the Gini ratio in the Province of Bali can be seen in Figure 3.
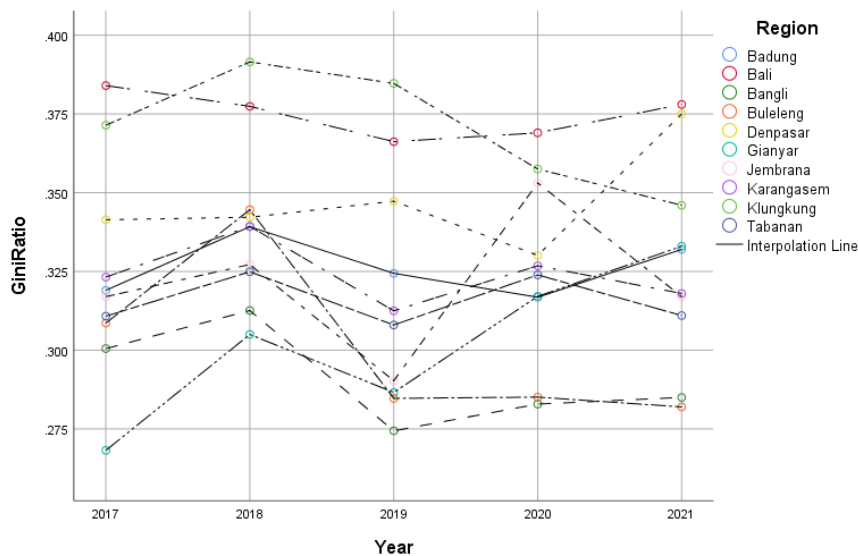

Figure 3. Changes in the gini ratio in Bali Province from 2017 to 2021.

It can be seen in Figure 4 that there is a downward trend in GDP in Badung in 2020 and 2021. This cannot be separated from Badung being an area that relies heavily on the tourism sector as its primary economic income. Despite experiencing general growth acceleration, one of the

components that make up the HDI, namely the adjusted average real expenditure per capita, recorded a decline in 2021 [40]. This indicator fell from 13.93 million rupiahs in 2020 to 13.82 million rupiahs in 2021 [40].
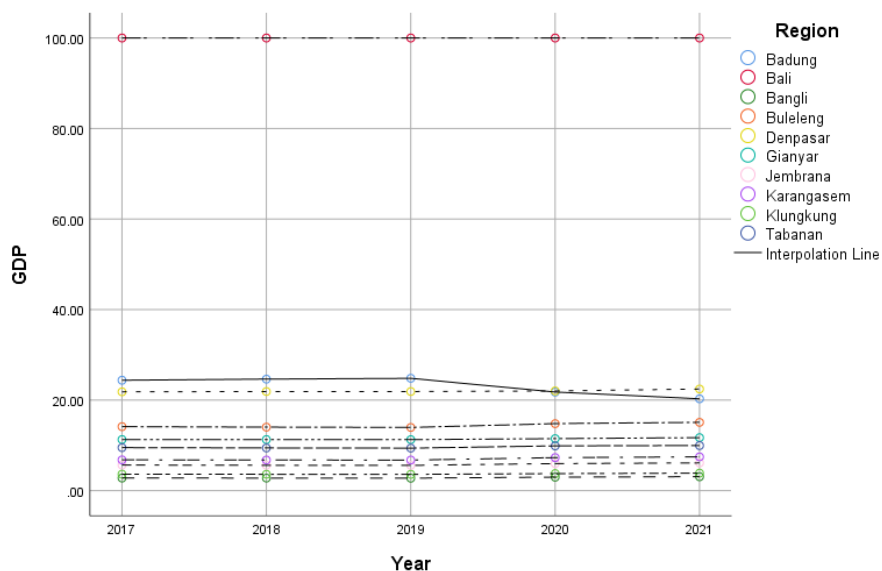

Figure 4. Change in % of GDP in Bali Province from 2017 to 2021.

Overall, in 2021 access to sanitation in Bali Province has reached above 85% (Figure 5). Primary sanitation access is defined as a means for defecating that is only used by the household itself, the type of goose-neck toilet, and a final disposal site for feces with a septic tank. Desludging has been carried out; limited latrines, namely defecation facilities that are used with other households, type of goose-neck toilet, and final disposal of feces. Improper latrines mean defecation with or without a lid, and a cubluk (traditional type/nonservice type of latrines); the last one does not use the latrine [43].
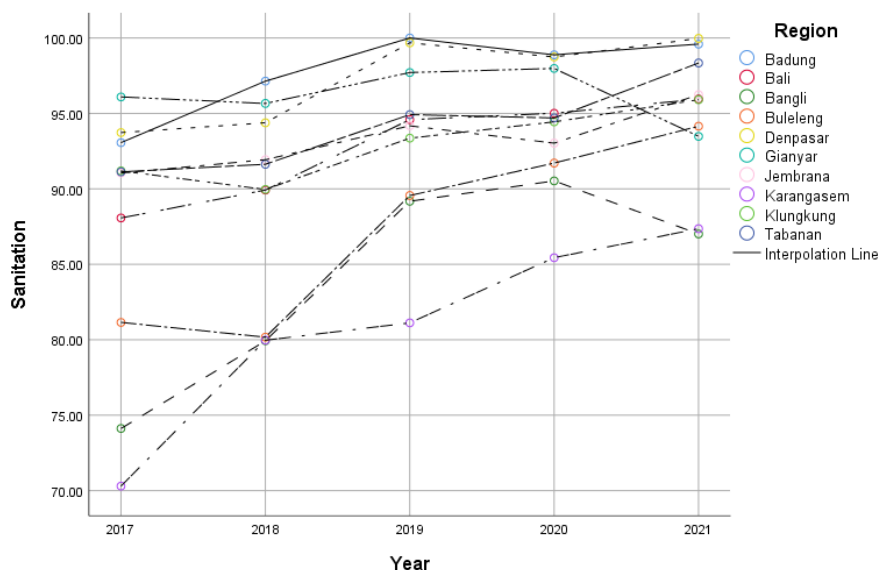
Figure 5. Changes in access to sanitation in Bali Province from 2017 to 2021.

The next test is a simultaneous test using the comparison value of the F table and calculated F or with the resulting significance value. Based on the test results in Table 1, the significance value or Prob(F-statistic) = 0.00 is known. This value shows the probability of the value of the F statistical test (simultaneous test of the effect of all independent variables on the dependent variable), which is smaller than the 5 % (0.05) significance level. So, it can be concluded that there is a simultaneous effect between all independent variables on the dependent variable.

Table 1. Results of analysis of parameters in multiple linear regression.

Parameters	Value
R	0.754
R Square	0.568
Adjusted R Square	0.54
Std. Error of the Estimate	4.54223
R Square Change	0.568
F Change	20.148
Sig. F Change	0

The multiple linear regression ANOVA analysis with independent variables of HDI, GDP, and Gini Ratio to the dependent variable of access to sanitation would examine the relationship between these variables and determine their significance in predicting access to sanitation. The analysis would involve creating a regression equation that predicts access to sanitation based on HDI, GDP, and Gini Ratio. The ANOVA test would then determine if the model as a whole (i.e., the combination of HDI, GDP, and Gini Ratio) is significant in predicting access to sanitation. If the ANOVA test indicates that the model is significant, individual coefficients of

the independent variables (HDI, GDP, and Gini Ratio) would be tested for significance using t-tests (Table 2). This would determine which independent variables are significantly related to access to sanitation.

Table 2. Results of multiple linear regression ANOVA analysis.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	1247.066	3	415.689	20.148	0.000
Residual	949.064	46	20.632		
Total	2196.129	49			

The next test is a simultaneous test using the comparison value of F table and calculated F or with the resulting significance value. The significance value or Prob (F-statistic) = 0.00 is known (Table 3). This value shows the probability of the value of the F statistical test (simultaneous test of the effect of all independent variables on the dependent variable). Which is smaller than the 5 % (0.05) significance level, so it can be concluded that there is a simultaneous effect between all independent variables on the dependent variable. Table 3 also shows that HDI has a higher significance level and positive coefficient than other variables. This shows that an increase in HDI will simultaneously increase access to sanitation in Bali Province. A pairwise correlation test between HDI and access to sanitation also shows a strong relationship with a positive relationship (Figure 6).

Table 3. Results of multiple linear regression ANOVA analysis.

Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t
(Constant)	17.919	11.997		1.494
HDI*	1.005	0.133	0.761	7.578
Gini Ratio	-2.775	23.943	-0.013	-0.116
GDP	-0.005	0.028	-0.022	-0.187

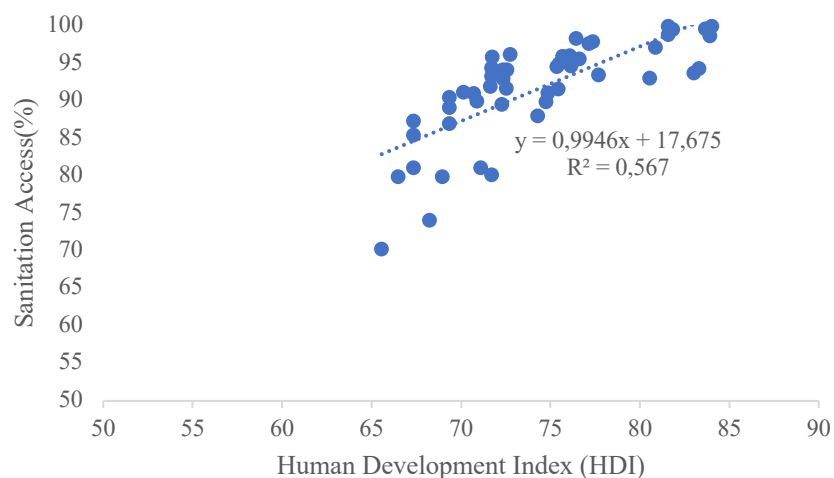******* $p_{value}>0.001$

Figure 6. Relationship between sanitation access variables and HDI.

Sanitation, characterized as one of the basic amenities for human life, is fundamental for the overall welfare of communities [44,45]. Access to sanitation, particularly in developing countries, has been the focus of numerous studies, given its ramifications on public health, human dignity, and socio-economic development [46,47]. The recent study in Bali Province, Indonesia, brings to light the intertwined relationship between human development, income inequality, economic growth, and sanitation access. The Human Development Index (HDI), a composite measure incorporating education, life expectancy, and per capita income, is widely used to classify countries into development tiers [48,49]. Improved educational attainment, a component of HDI [50], is likely to foster better awareness regarding sanitation and hygiene, while higher life expectancy might indicate better health facilities, including sanitation. Previous studies have shown similar trends; where there's a high level of human development, access to basic services such as sanitation and clean water is also usually higher [51–53].

While intuitively, one might expect regions with higher GDP growth to have better infrastructure [54], including sanitation facilities, the study's findings refute this correlation in the context of Bali Province. This could be attributed to the nature of GDP, which is a broad economic indicator and might not necessarily trickle down to infrastructural developments, especially in regions where economic benefits might be skewed towards certain sectors, neglecting basic amenities [55]. Other literature has also suggested that a country's GDP does correlate with improved sanitation services [56]. Regions might experience economic growth, but unless focused policies are directed towards improving sanitation, the growth might not benefit the larger populace [57,58].

The Gini Ratio, a measure of income inequality, has been a critical index in understanding disparities within regions [59,60]. In this study, the Gini Ratio exhibited no significant correlations with sanitation access. One possible reason could be the cultural and communal framework in Bali, which might prioritize community well-being over individual prosperity, ensuring basic facilities for all regardless of income disparities. However, other studies have

identified a clear relationship between income inequality and reduced access to sanitation, especially in urban areas, where income disparities often manifest in stark differences in living conditions and access to basic amenities [32,61,62]. An increase in GDP or superficial economic growth might not translate to improved sanitation access. Instead, efforts should be concentrated on holistic human development, which appears to have a more direct and significant impact on sanitation. Furthermore, addressing income inequality can pave the way for more equitable access to basic amenities. For regions with cultural dynamics similar to Bali, understanding the local context becomes paramount.

Figure 2. also showed Bali's HDI continues to increase, but the wide difference in HDI numbers between districts/cities in Bali is a significant problem to overcome. These differences indicate inequality between regions, especially in metropolitan areas. Bali's metropolitan area, including Denpasar, Badung, Gianyar, and Tabanan (Sarbagita), is higher than the other region. One of the factors thought to affect HDI is the number of poverty [63,64]. Inequality or the gap between people and regions in Bali, as measured by the Gini ratio in 2014, reached 0.42, which is included in the category of moderate inequality [65]. This study showed that Gini Ratio is already lower than in 2014. Inequality in the distribution of investment between regions can also be considered one of the main factors that cause inequality in the distribution of income between regions [66].

The macro economic growth of districts/cities in Bali Province has made significant progress after several events that shook the tourism industry as the mainstay sector in Bali Province. This economic growth is inseparable from the development of GRDP per capita, such as the joint role of the government, society, and economic actors in restoring the image of Bali in the international world, especially the tourism sector as the biggest supporter of the economy. Bali Province is known as a popular tourist destination, and the tourism industry has been the mainstay sector driving the economy of Bali. However, events such as natural disasters, political instability, and the COVID-19 pandemic have had a significant impact on the tourism industry, which in turn affected the overall economy of the province [67] Adaptation Strategy of Tourism Industry Stakeholders During the COVID-19 Pa. Despite these challenges, the statement suggests that the government, society, and economic actors have worked together to restore the image of Bali in the international world, particularly in the tourism sector. This joint effort has resulted in a recovery of the tourism industry and has contributed to the overall economic growth of districts/cities in Bali Province. The development of GRDP per capita is an important indicator of economic growth and development as it reflects the level of economic activity and production in a region. The increase in GRDP per capita indicates an increase in the economic well-being of the people in the region.

The impact that can arise from not achieving access to sanitation is quite large on the environment, especially the impact of eutrophication resulting from open defecation or septic tanks compared to WWTP [68]. The complete framework for measuring the hypothesis in this

study can be seen in Figure 7. The relationship between HDI, GDP, and Gini ratio in sanitation access was then tested by linear regression.
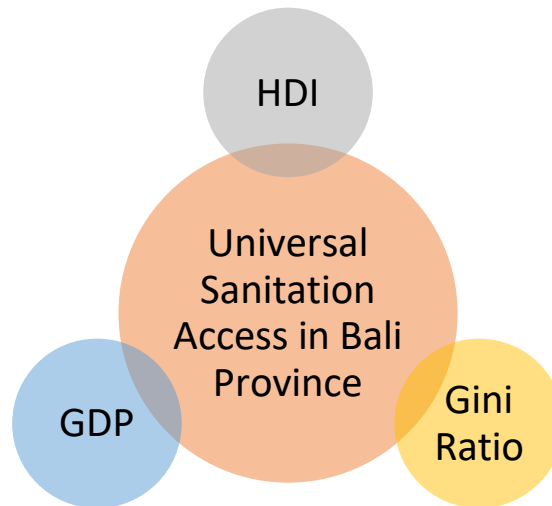

Figure 7. Multiple regression analysis study framework in the study.

Based on the 2017-2021 Bali Province sanitation access model regression test results in table 1, an R-squared value of 0.568 is obtained. This means that 56.8 % of the variable %age of the population that has access to proper sanitation can be explained using the HDI, GDP, and Gini Ratio. In contrast, other variables outside the model explain the rest. It is possible that HDI shows a significant level in the regression model with a positive coefficient and p-value less than 0.001 because it has a stronger relationship with access to sanitation compared to GDP and Gini Ratio. The p-value measures the probability of observing a result as extreme as the one obtained in the regression analysis, assuming that there is no true relationship between the independent variables (HDI, GDP, and Gini Ratio) and the dependent variable (access to sanitation). A p-value less than 0.05 is generally considered statistically significant, which means that the relationship between the variables is unlikely to have occurred by chance.

In this case, a p-value of less than 0.001 suggests a very strong relationship between HDI and access to sanitation. However, the fact that the p-value for GDP and Gini Ratio is not statistically significant (greater than 0.05) indicates that there is not enough evidence to conclude that these variables have a significant impact on access to sanitation in the regression model. It is important to note that a lack of statistical significance does not necessarily mean that there is no relationship between the independent and dependent variables. There may be other factors that are not included in the model that could explain the relationship between access to sanitation and GDP or Gini Ratio. Additionally, the sample size, data quality, and other assumptions of the regression analysis can affect the results and

interpretation. Therefore, further investigation may be necessary to understand the reasons for the lack of significance of GDP and Gini Ratio and explore other potential factors that could influence access to sanitation.

In contrast to HDI, the Gini Ratio, in this case, has a negative effect, which means that an increase in the Gini ratio will reduce access to sanitation in the Province of Bali. Regarding the community's welfare, [69,70] included that inequality, as measured by the Gini ratio, has a negative correlation with the welfare of the community. In contrast to the study's results, the Gini ratio positively correlates with the community's welfare. The effect of population on income distribution inequality, according to [71], shows that the population has a positive and significant correlation to income inequality.

Increased access to sanitation has been shown to improve child health and development and reduce waterborne diseases. However, [72] claims that this improvement is not statistically significant in increasing or decreasing many desirable outcomes. In addition, these advancements may help explain the worldwide global convergence found in the findings. Statistical correlation tests, on the other hand, can be used to examine the connections between these findings and the previously mentioned variables. Our goal was to find a correlation between each UN Member State's performance change, technological shift, and worst practice shift in terms of HDI components, including SDG3's life expectancy at birth, SDG4's expected years of schooling and mean years of schooling, and SDG8's gross national income per capita. Since 2005, Brazil has had an HDI of 0.800, making it one of the world's most developed countries; nevertheless, the country has also been plagued by high levels of social inequality, with 2007 data showing that Brazil has the 11th greatest level of income concentration in the world. From a different perspective, the country's physical and demographic characteristics—with extreme climate conditions and uneven distribution of surface water availability, as well as a wide range of demographic occupation patterns—act as systemic conditions that influence and even shape policies and actions in the sanitation sector [73].

Based on the regression analysis results, it appears that HDI has a stronger relationship with access to sanitation compared to GDP and Gini Ratio in the context of Bali (Figure 8). Therefore, a framework for increasing HDI and access to sanitation could include improving basic needs. Policies and programs that focus on improving access to basic needs, such as clean water and sanitation facilities, can have a direct impact on access to sanitation. For example, the government could invest in the construction and maintenance of public toilets in areas w Although GDP was not found to be significant in the regression analysis, it is still an important factor in improving HDI and access to sanitation. Promoting economic development can lead to increased job opportunities and income, which in turn can support access to sanitation. This could include investment in key sectors such as tourism and agriculture, which

are important drivers of economic growth in Bali. Education and health are important components of HDI and can indirectly support access to sanitation. Policies and programs that focus on improving education and health outcomes, such as increasing access to quality healthcare and education, can have a positive impact on HDI and access to sanitation. Although Gini Ratio was not significant in the regression analysis, income inequality is an important factor that can impact access to sanitation. Policies and programs that focus on reducing income inequality, such as progressive taxation and social safety nets, can help to improve access to sanitation for those who are most vulnerable. here access to sanitation is limited.
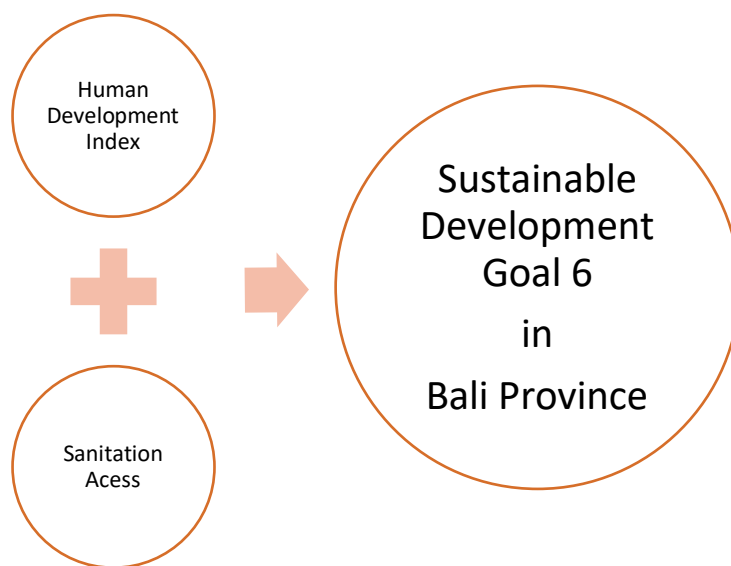

Figure 8. Framework for increasing HDI and access to sanitation to achieve *Sustainable Development Goals* 6 ensure that people achieve universal access to sanitation in Bali Province.

Sustainable development is important for ensuring that improvements in HDI and access to sanitation are long-lasting and do not come at the expense of the environment or future generations. Policies and programs that focus on promoting sustainable development, such as renewable energy and environmentally friendly tourism, can help to support both HDI and access to sanitation. The joint efforts of the government, society, and economic actors in Bali Province have contributed to the economic growth of the region. Other developing countries can learn from Bali's experience and prioritize policies that promote economic growth and development, such as investing in infrastructure and promoting tourism. The tourism industry, which is the mainstay sector in Bali Province, has had both positive and negative impacts on the environment and local communities. Other developing countries can learn from Bali's experience and prioritize sustainable development policies that balance economic growth with environmental protection and social equity.

d.   4. Conclusions

In conclusion, the findings of this study suggest that there is a significant correlation between human development and access to sanitation in Bali Province. Specifically, the results indicate that an increase in HDI can significantly increase sanitation access in Bali, while Gini Ratio and GDP may have negative impacts on access to sanitation. This highlights the importance of prioritizing investments in human development, such as education and healthcare, in order to improve access to basic services such as sanitation. Furthermore, the study also indicates that the three variables (HDI, Gini Ratio, and GDP) have a simultaneous impact on sanitation access in Bali Province, with HDI having the strongest positive impact. The regression analysis showed that these variables collectively explain approximately 56.8% of the variation in sanitation access in Bali. These findings have important policy implications for improving sanitation access in Bali Province and other developing regions. Policymakers should prioritize investments in human development, while also addressing income inequality and promoting sustainable economic growth to improve access to basic services such as sanitation.

Based on the findings of this study, several future research recommendations can be made. Firstly, future studies could explore the causal relationship between human development and access to sanitation in Bali Province. This could involve conducting a longitudinal study to examine how changes in HDI over time impact sanitation access in the province. Secondly, further research could investigate the factors that contribute to income inequality in Bali Province, and how these factors impact access to sanitation. This could involve examining policies and interventions aimed at reducing income inequality and improving access to basic services. Thirdly, future studies could explore the potential impact of cultural factors on access to sanitation in Bali Province. This could involve examining cultural beliefs and practices that may influence sanitation behaviors and attitudes and identifying strategies to promote better sanitation practices. Finally, further research could examine the effectiveness of policy interventions aimed at improving access to sanitation in Bali Province. This could involve evaluating the impact of specific policies and programs, such as sanitation infrastructure development or public education campaigns, on sanitation access and health outcomes.

While this research aims to contribute to the understanding of the relationship between human development, income inequality, and access to sanitation in Bali Province, we acknowledge certain limitations that impact the study's findings and generalizability. Firstly, the research relies on secondary data sources, which may be subject to limitations in terms of data quality and availability. The accuracy and reliability of the data collected from various reports and surveys can vary, and there may be inconsistencies or gaps in the data. Therefore, caution should be exercised when interpreting the results and drawing conclusions. Secondly, this research focuses specifically on the context of Bali Province in Indonesia. The findings may not be directly applicable to other regions or countries, as access to sanitation and its determinants can vary significantly depending on the socio-cultural, economic, and geographical context. Therefore, generalizing the results to other settings should be done with caution. Furthermore, the analysis in this study is based on aggregated data at the provincial level. This may overlook potential variations within the province, such as disparities in

sanitation access between urban and rural areas or among different sub-regions. Future research could consider conducting more localized studies to capture such nuances and provide a more comprehensive understanding of the factors influencing sanitation access. Lastly, this research is based on a cross-sectional study design, which limits the ability to establish causal relationships between the variables of interest. While correlations can be identified, the study cannot determine the direction of causality or account for potential reverse causality. Future research utilizing longitudinal or experimental designs could provide further insights into the causal relationships and dynamics between human development, income inequality, and access to sanitation.

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