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How Border Region Status in West Kalimantan Moderates the Healthcare Accessibility Index

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ABSTRACT
Healthcare service availability remains uneven across regions in Indonesia, particularly in border areas. Although previous studies have examined the relationship between regional economic conditions and healthcare accessibility, limited attention has been given to whether border status moderates this relationship. This study addresses this gap by examining factors associated with the Healthcare Accessibility Index (HAI) and testing the moderating role of border status in the relationship between per capita gross regional domestic product (GRDP) and healthcare service availability in West Kalimantan, Indonesia. Using panel data from 14 regencies and cities for 2020–2023, this study constructs a composite HAI through Principal Component Analysis (PCA), based on the ratio of health center, ratio of hospitals, and ratio of healthcare workforce per 10.000 population. The index captures the relative availability of healthcare facilities and human resources rather than the full range of healthcare accessibility dimensions. Fixed-effects panel regression is employed, with an equal-weighted HAI used for sensitivity analysis. The results indicate that per capita GRDP is positively and significantly associated with HAI, while population density has a positive association at the 10% significance level. Government health expenditure and poverty are not statistically significant. The interaction between per capita GRDP and border status is negative and significant in both index specifications, suggesting that the positive association between economic performance and healthcare service availability is weaker in border areas. The study's novelty lies in treating border status as a moderator, extending analysis beyond the direct associations of socioeconomic factors with healthcare availability. The findings highlight the need for geographically responsive health policies and targeted investment in healthcare facilities and personnel to reduce regional disparities.
Keywords: *Healthcare Accessibility Index; GRDP per capita; health expenditure; border regions; PCA.*

INTRODUCTION

Access to healthcare services is a crucial aspect of achieving the Sustainable Development Goals (SDGs), particularly the third goal, which aims to ensure healthy lives and promote well-being for all. This commitment is realized, in part, through the achievement of universal health coverage, which encompasses access to quality essential healthcare services (WHO, 2025). The availability of healthcare services and supporting infrastructure is a crucial factor in improving public access to healthcare and reducing

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service disparities across regions. Although healthcare development and service coverage in Indonesia continue to advance, disparities in healthcare access and utilization persist between regions, particularly in rural areas and locations with challenging geographical characteristics. (Mulyanto et al., 2019) (Wenang et al., 2021)

Studies by Weiss et al., (2020) indicates that spatial inequality in the distribution of health facilities remains a major issue in various developing countries due to disparities in geographical conditions, infrastructure, and the distribution of health workers. Similar findings were reported by Jia et al., (2022) which states that economic growth alone is insufficient to reduce inequality in access to healthcare services unless accompanied by the equitable provision of health facilities and the development of supporting infrastructure. As a strategic area, West Kalimantan shares a direct boundary with Sarawak, Malaysia, spanning five regencies (Sambas, Bengkayang, Sanggau, Sintang, and Kapuas Hulu). The geographical characteristics of border areas may complicate healthcare provision, as physical barriers can make it difficult for residents to reach health facilities and can hinder the distribution of essential medical supplies (Bosch et al., 2025)

Data from the Ministry of Health and Statistics Indonesia (BPS) indicate that the distribution of health facilities and healthcare personnel in the West Kalimantan border region remains uneven, making the provision of healthcare services a distinct challenge for local governments.

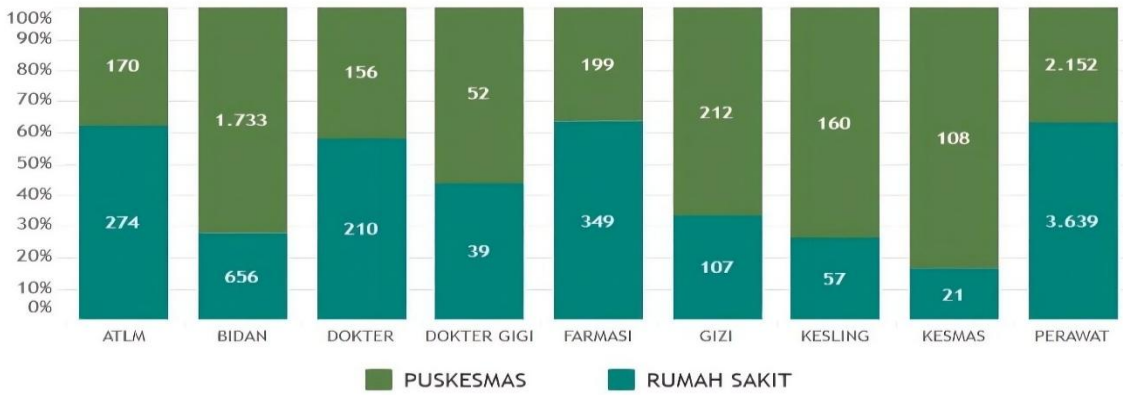


Figure 1: Distribution of Registered Priority Health Workers in Hospitals and Health Centers in West Kalimantan
Source: Ministry of Health, 2024

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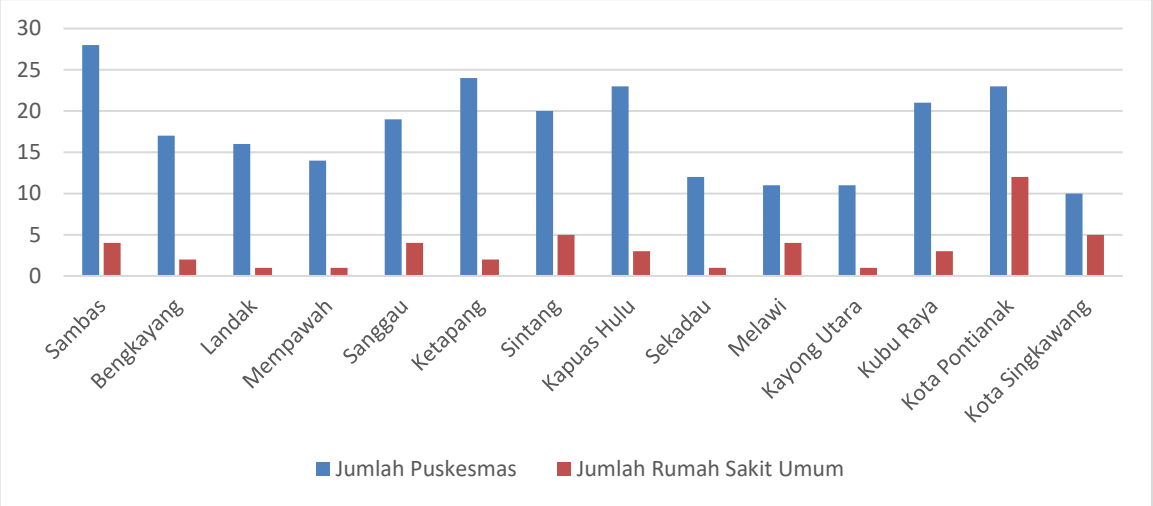


Figure 2: Number of Community Health Centers and General Hospitals in West Kalimantan
Source: BPS, 2024

This situation highlights the importance of examining healthcare accessibility more comprehensively, particularly by considering the differing characteristics of border and non-border regions. These findings align with (Aina et al., 2023), who indicates that communities living in border areas face greater challenges in accessing healthcare services, primarily due to the rural and remote nature of these regions. This situation highlights the importance of policies capable of improving the availability and accessibility of healthcare services in border areas (Iskandar, 2021).

Research by (Dwi et al., 2017) indicates a relationship between regional fiscal capacity and health expenditure allocation, although local governments remain heavily dependent on central government transfers. Research at the regional level also indicates that GRDP per capita is associated with the distribution of health resources, although this distribution varies spatially across regions across regions (Shi et al., 2021).

Barber et al., (2017) further demonstrate the relevance of socioeconomic conditions to healthcare access and health system performance. In addition to economic conditions, poverty and population density may also be associated with differences in healthcare accessibility. Poverty can constrain people's ability to obtain healthcare, while population density may influence the concentration of healthcare needs and the distribution of facilities and personnel. Government health expenditure is also relevant

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because it represents one of the channels through which local governments can support healthcare provision. However, the relationships between these factors and healthcare accessibility depend on how health resources are distributed relative to the population and should therefore be examined empirically (Wang et al., 2024).

The use of composite indicators to measure access to healthcare services is increasingly common, as they allow multiple service dimensions to be integrated into a single measure. Principal Component Analysis (PCA) is a multivariate method capable of reducing a set of correlated variables into a smaller number of principal components while retaining the majority of the information contained in the data (Jolliffe et al., 2016)(Abdi & Williams, 2010). PCA has also been used to construct health-related indices, including the Healthcare Access and Quality (HAQ) Index, which combines multiple indicators into a composite measure (Barber et al., 2017). Building on this approach, this study constructs a Healthcare Accessibility Index (HAI) using PCA and three indicators: the ratios of hospitals, community health centers, and healthcare workers per 10,000 populations. The HAI is intended to represent the relative availability of healthcare resources across regencies and cities. It does not directly measure other dimensions of access, such as geographical distance, travel time, affordability, or actual service utilization.

However, an important question remains as to whether the relationship between regional economic conditions and healthcare resource availability is consistent across different geographical contexts**.** Previous studies have generally examined the direct relationship between economic growth and health development or treated border status as a regional characteristic. There is limited research examining border status as a moderating variable in the relationship between economic growth and healthcare accessibility, particularly at the regency/city level in Indonesia. Addressing this gap, this study makes three contributions. First, it develops a Healthcare Accessibility Index (HAI) as a composite measure of relative healthcare resource availability at the regency/city level PCA, integrating indicators of health facility availability and the healthcare workforce. This approach allows multiple healthcare indicators to be consolidated into a single measure for inter-regional comparison. Second, it analyzes the relationship

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between GRDP per capita and the HAI and tests whether border area status moderates this relationship.

The moderation analysis examines whether the association between GRDP per capita and HAI differs between border and non-border regions. Third, it provides empirical evidence based on panel data. regencies/cities in West Kalimantan during the 2020–2023 period, taking into account regional characteristics when explaining variations in healthcare resource availability. This period was selected based on the availability of consistent local government health expenditure data starting in 2020. The year 2019 was excluded because it preceded the COVID-19 pandemic, which was associated with different healthcare service and government expenditure conditions that could affect the comparability of the study period.

Accordingly, this study aims to (1) develop a Healthcare Accessibility Index (HAI) as a composite measure of the relative healthcare resources in regencies/cities in West Kalimantan; (2) analyze the relationship between GRDP per capita and the HAI; and (3) examine whether status moderates the relationship between GRDP per capita and the HAI. The findings are expected to enrich the literature on the relationship between regional economic conditions and healthcare resource availability, while providing empirical evidence on whether border characteristics influence this relationship. These findings may inform policies aimed at reducing disparities in the availability of healthcare resources across regions with different geographical and economic characteristics.

THEORETICAL BACKGROUND

Healthcare Accessibility and the Availability of Healthcare Resources

Healthcare accessibility is a multidimensional concept that encompasses the relationship between the characteristics of health service systems and the ability of populations to obtain appropriate care. Penchansky, R. Thomas, (1981) conceptualized access through five dimensions, namely availability, accessibility, accommodation, affordability, and acceptability. In this framework, availability refers to the adequacy of the volume and type of healthcare resources relative to the needs of the population, whereas accessibility in the narrower geographical sense concerns the location of services and the ease with which people can reach them. Levesque et al.,(2013) subsequently

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developed a broader framework that integrates supply-side characteristics of healthcare systems with the abilities of individuals to recognize needs, seek care, reach services, pay for care, and engage with healthcare providers.

These frameworks indicate that healthcare access is not a single-dimensional concept and that its measurement depends on the specific dimensions and indicators employed. The distinction between healthcare availability and geographical accessibility is particularly important when interpreting regional indicators of healthcare provision. Studies that explicitly measure spatial accessibility generally incorporate geographical relationships between populations and healthcare providers, often using travel time, distance, service areas, or spatial interaction methods. Luo & Wang, (2003) developed geographic information system (GIS) based measures that account for both the availability of healthcare providers and the spatial relationship between providers and the populations they serve. Such approaches differ from indicators based solely on the number of facilities or health workers relative to population size.

In this study, the Healthcare Accessibility Index (HAI) is operationalized from the supply side of healthcare access, specifically through the relative availability of healthcare resources. The index combines three indicators: the ratios of community health centers, hospitals, and healthcare personnel per 10.000 population. Using population standardized ratios allows regional comparisons to account for differences in population size rather than relying on absolute counts of facilities and personnel. The three indicators are combined into a composite index using Principal Component Analysis (PCA), with an equal weighted index constructed as an alternative measure for sensitivity analysis.

The construction of composite indicators requires transparent choices regarding indicator selection, normalization, weighting, and aggregation, as emphasized in the (Nardo et al., 2005). Accordingly, HAI in this study represents a relative, supply-side measure of healthcare accessibility based on the availability of healthcare resources in relation to population size. It does not directly measure geographical accessibility through distance or travel time, nor does it capture affordability, service utilization, perceived quality, or the ability of individuals to obtain care. A higher HAI therefore indicates greater relative availability of the measured healthcare resources per population, rather

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than necessarily indicating that healthcare facilities are easier to reach or that all dimensions of access are better. This operational definition provides a specific and measurable basis for examining differences in healthcare accessibility across regencies and cities in West Kalimantan, while acknowledging that healthcare access is broader than the dimensions captured by the index.

Healthcare Accessibility in Border and Non-Border Regions

Differences in healthcare accessibility are particularly relevant in border regions, where geographical conditions, population distribution, infrastructure, and the organization of public services may differ from those in non-border regions. Remote settlements, low population density, and limited transport connectivity can complicate the provision and distribution of healthcare resources. These conditions may affect not only people's ability to reach services but also the government's capacity to maintain adequate facilities and healthcare personnel across territories. Aina et al., (2023) in their literature review on healthcare access in border areas, highlight the multiple challenges faced by border communities, including limitations in healthcare resources, transportation, geographical conditions, and socioeconomic circumstances.

Laksono & Wulandari, (2021) using data from the Indonesian Basic Health Research survey, found that residents of border areas on the island of Kalimantan had a lower likelihood of hospital inpatient utilization than residents of non-border areas. Their findings identify differences in hospital utilization, travel time, transportation costs, and socioeconomic characteristics as relevant considerations in understanding healthcare access. Although utilization is distinct from the supply-side measure used in the present study, the findings demonstrate that border status can be associated with structural differences in the relationship between populations and healthcare services. For the present study, border status is therefore treated as a contextual characteristic that may condition the relationship between regional economic conditions and HAI.

This approach does not assume that border status necessarily has a uniform or directly measurable effect on the index. Instead, it recognizes that the capacity of regional economic growth to coincide with greater healthcare resource availability may depend on the structural conditions of a region. In border areas, remoteness, infrastructure

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constraints, and difficulties in distributing public services may limit the extent to which economic advantages are reflected in the relative availability of healthcare resources. Conversely, targeted public investment or improvements in service provision may help mitigate such constraints. Border status is consequently conceptualized as a potential moderator of the relationship between regional economic conditions and HAI.

Regional Economic Conditions and Healthcare Accessibility

Regional economic conditions associated with differences in healthcare accessibility because economic resources influence both the fiscal capacity of local governments and the broader environment in which public services are provided. Pratiwi et al., (2021) found substantial regional variation in health needs, service availability, health expenditure, and service utilization. Their analysis also showed that limited service availability can constrain the ability of populations to benefit from health insurance and other health financing arrangements. These findings suggest that economic resources and formal health financing mechanisms do not necessarily ensure adequate service provision when healthcare resources remain unevenly distributed. Accordingly, this study hypothesizes that GRDP per capita is positively associated with HAI, while recognizing that the strength of this relationship may differ across regional contexts.

Government Health Expenditure and Healthcare Accessibility

Government health expenditure is an important fiscal instrument for financing healthcare infrastructure, maintaining health facilities, and supporting the recruitment and distribution of healthcare personnel. Sari et al., (2025) using data from Indonesian regencies and cities, found a positive relationship between local government health expenditure and life expectancy. Pratiwi et al., (2021) also demonstrated that health expenditure and service availability vary considerably across Indonesian regions and that limited-service provision can constrain the benefits of health financing. In this study, government health expenditure is examined in relation to HAI because expenditure may support the provision and maintenance of healthcare resources.

Poverty and Healthcare Accessibility

Poverty can influence healthcare accessibility by limiting the economic capacity of the population to cover the costs of services, transportation, medication, and other

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expenses related to medical care. Within the framework established by Penchansky, R. Thomas, (1981) this relates to the dimension of affordability. Levesque et al., (2013) also emphasize that an individual's ability to pay for services is a crucial element in the process of obtaining healthcare. Empirical evidence in Indonesia supports the relevance of poverty in the study of healthcare accessibility. In their research on hospital accessibility in Indonesia, Nantabah et al., (2021) found that provinces with higher indices of poverty depth and severity tend to have a lower percentage of households with easy access to hospitals. These findings suggest that poverty can create barriers to obtaining healthcare services. Nevertheless, the poverty level used in this study serves as a socioeconomic indicator at the regency/city level, rather than a direct measure of an individual's ability to pay or their actual utilization of services.

Population Density and Healthcare Accessibility

Population density can influence healthcare accessibility through the concentration of service needs and the distribution patterns of healthcare resources. Research by Nantabah et al., (2021) identified a positive correlation between population density and the percentage of households with easy access to hospitals at the provincial level in Indonesia. Meanwhile Silalahi et al., (2024) through an analysis of the spatial patterns of healthcare facilities on the island of Kalimantan observed a concentration of health-related issues in certain urban areas, alongside limited distribution in more remote and border regions. These findings suggest that population concentration and the distribution of healthcare facilities are significant factors in understanding regional variations in healthcare services. However, the relationship between population density and healthcare access is not necessarily positive. In this study, HAI is calculated based on the ratio of healthcare facilities and personnel to the total population, rather than by distance or travel time to these facilities. Densely populated areas may possess a higher absolute number of facilities, yet this does not automatically translate to a higher ratio of facilities per capita. Conversely, sparsely populated areas may exhibit a relatively high ratio, even if the facilities are geographically dispersed.

Based on the theoretical arguments and empirical evidence discussed above, this study examines the following hypotheses:

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H1: GRDP per capita is positively associated with the Healthcare Accessibility Index (HAI) across regencies and cities in West Kalimantan.

H2: Government health expenditure is positively associated with the Healthcare Accessibility Index (HAI) across regencies and cities in West Kalimantan.

H3: The regional poverty rate is negatively associated with the Healthcare Accessibility Index (HAI) across regencies and cities in West Kalimantan.

H4: Population density is associated with the Healthcare Accessibility Index (HAI) across regencies and cities in West Kalimantan.

H5: The relationship between GRDP per capita and HAI differs significantly between border and non-border regions in West Kalimantan.

METHOD, DATA AND ANALYSIS

This study employs a quantitative approach with an explanatory design to analyze the relationship between regional economic and demographic characteristics and the Healthcare Accessibility Index (HAI), and to examine whether a region's status as a border area moderates the relationship between Gross Regional Domestic Product (GRDP) per capita and the HAI. The study utilizes panel data from regencies/cities in West Kalimantan Province for the 2020–2023 period. The unit of analysis encompasses all 14 regencies/cities in West Kalimantan, consisting of 12 regencies and 2 cities, resulting in a total of 56 observations. The data used are secondary data obtained from official publications and databases of the Ministry of Health of the Republic of Indonesia and Statistics Indonesia (BPS).

In the first stage, the Healthcare Accessibility Index (HAI) is constructed using Principal Component Analysis (PCA) based on three indicators, namely the ratio of hospitals, the ratio of community health centers (puskesmas), and the ratio of healthcare workforce per 10.000 population. PCA is employed to synthesize the information contained within these indicators into a composite index (Jollife & Cadima, 2016) (Abdi & Williams, 2010).

PCA based index is formulated as follows:

$$\boldsymbol{HAI}_{\text{PCAit}} = \sum_{\boldsymbol{k=1}}^{\boldsymbol{K}} \mathbf{w}_{\text{k}}\text{PC}_{\text{kit}} \quad \text{.....(1)}$$

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where (PC_{kit}) is the score of the (k) principal component for region (i) in year (t), (w_k) is the weight assigned to each retained component, and (K) denotes the number of components retained based on the PCA results. The weight for each component is calculated using the following formula:

$$\boldsymbol{W}_k = \frac{\boldsymbol{\lambda k}}{\sum_{\boldsymbol{k=1}}^{\boldsymbol{K}} \boldsymbol{\lambda k}} \quad \text{.....(2)}$$

where λ_k represents the eigenvalue of the (k) component. The number of components retained, along with their respective weights, is determined based on the results of the PCA and is presented in the research findings section.

To examine the consistency of the findings using an alternative weighting scheme, a sensitivity analysis is conducted employing an equal-weighted index. First, each indicator is standardized using z-scores, calculated according to the following formula:

$$\boldsymbol{Z}_{jit} = \frac{\boldsymbol{X jit - \bar{x} j}}{\boldsymbol{s j}} \quad \text{.....(3)}$$

where (X_{jit}) denotes the value of indicator (j) in region (i) for year (t), $\bar{\mathbf{x}}$ is the mean of indicator (j), and (s_j) is its standard deviation. Subsequently, an equal-weighted index is calculated as the arithmetic mean of all the standardized indicators:

$$\boldsymbol{HAI}_{EW,\,it} = \frac{\mathbf{1}}{\mathbf{J}} \sum_{\boldsymbol{j=1}}^{\boldsymbol{J}} \boldsymbol{Z}_{jit} \quad \text{.....(4)}$$

where (J) denotes the number of indicators used in the construction of the index. This alternative index is used to assess whether empirical findings remain consistent when all indicators are assigned equal weight.

In the second stage, panel regression analysis is employed to examine the relationship between regional economic and demographic characteristics and the HAI. The dependent variable is the HAI, which is analyzed using a PCA based index as the primary measure and an equal weighted index as an alternative measure. Independent variables include the logarithm of GRDP per capita, the logarithm of realized local government health expenditure, the poverty rate, population density, and an interaction term between the logarithm of GRDP per capita and the status of a region as a border

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area. Border area status is coded as 1 for regencies that share a direct border with another country, and 0 for non-border areas. Since the border status remains constant over time for each regional unit, its main effect is absorbed into the regional fixed effects and cannot be estimated separately within a fixed-effects model. This aligns with the principles of fixed effects modeling, where time invariant characteristics are absorbed into the unit-specific fixed effects and thus cannot be estimated as distinct, independent coefficients (Sommet & Lipps, 2025). Consequently, border status is not included as a standalone main effect. Instead, an interaction term between border status and GRDP per capita is included to test whether the relationship between regional economic conditions and the HAI differs between border and non-border areas.

$$HAI_{it} = \alpha_i + \beta_1 \text{GRDP}_{it} + \beta_2 \text{Health Expenditure}_{it} + \beta_3 \text{Poverty}_{it} + \beta_4 \text{Population Density}_{it} + \beta_5 (\text{Border}_i \times \text{GRDP}_{it}) + \varepsilon_{it} \quad (5)$$

Where:

HAI: Healthcare Accessibility Index

GDRP: Gross Regional Domestic Product (GRDP) per capita of the regency

Health Expenditure: Realized local government health expenditure

Poverty: Poverty rate

Population Density: Population density level

Border x GRDP: Interaction between GRDP per capita and border area status

Border: Border area status; 1 = border regency/city and 0 = non-border

β1–β5: Regression coefficients

ε: Error term

i: Regency/City in West Kalimantan

t: Year

RESULTS

Healthcare Accessibility Index (HAI) using PCA

Principal Component Analysis (PCA) is used to consolidate the three indicators into a composite index. The suitability of applying PCA is subsequently evaluated using the Kaiser Meyer Olkin (KMO) measure and Bartlett's test. Given that the obtained KMO

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value falls below the conventional threshold, this study also constructs an alternative equal weighted index to test the sensitivity of the regression results to the index construction method.

Table 1: Total Variance Explained by Principal Components

Component	Eigenvalue	Variance (%)	Cumulative (%)	Decision
1	1,787	59,567	59,567	Retained
2	1,071	35,686	95,254	Retained
3	0,142	4,746	100,000	Not Retained

Source: Authors' calculations, 2026

Based on Table 1, two principal components have eigenvalues greater than one and are therefore retained according to the Kaiser criterion. The first component accounts for 59.567% of the total variance, while the second component explains an additional 35.686%. Cumulatively, these two components explain approximately 95.254% of the variation across the three indicators used. The proportion of variance explained indicates that these two components are capable of capturing the majority of the data's variation. However, a high cumulative variance does not, in itself, prove that the data meets all the requirements for PCA suitability. Consequently, these results should be interpreted in conjunction with the KMO and Bartlett test outcomes, as well as the pattern of component loadings presented in the following table.

Table 2: Component Loadings dan Communalities

Indicator	Component 1	Component 2	Communality
Health center ratio	0,239	**0,964**	0,986
Hospital ratio	**0,899**	-0,363	0,940
Healthcare workforce ratio	**0,960**	0,100	0,932

Source: Authors' calculations, 2026

Table 2 shows that the hospital ratio and the healthcare workforce ratio have their highest loadings on Component 1, with values of 0.899 and 0.960, respectively. Conversely, the community health center (puskesmas) ratio has its highest loading on Component 2, at 0.964. The communality values for these three indicators range from 0.932 to 0.986, indicating that the two components collectively account for a large

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proportion of the variance in each indicator. Nevertheless, this loading pattern suggests that healthcare service capacity, as represented in this dataset, may consist of more than one dimension. The PCA index should be interpreted as a composite measure that summarizes these indicators, rather than as evidence that all the indicators fully reflect a single, homogeneous dimension.

Table 3: Component Weights in the Construction of the HAI

Component	**Eigenvalue**	**Varians (%)**	**Weight**
Component 1	1,787	59,567	0,6253
Component 2	1,071	35,686	0,3747
Total	**2,858**	**95,254**	**1,0000**

Sumber: Authors' calculations (2026)

The HAI-PCA index is constructed by combining the scores from the two retained components. The weight for each component is determined proportionally based on its contribution to the total variance explained by the retained components. This weighted linear aggregation approach, based on principal components, is discussed in the literature concerning the interpretability of PCA-based composite indicators, including (Boudt et al., 2022).

Based on the results in Table 3, the index is calculated as follows:

$$\boldsymbol{HAI}_{\text{PCA, i}} = 0\ 6253FAC\ 1_{\text{i}+} + 0{,}2747FAC\ 2_{\text{i}}$$

Table 4: KMO and Bartlett's Test of Sphericity

Test	**Statistic**	**Result**
Kaiser Mayer Olkin (KMO)	0.339	Below the conventional 0.50 threshold
Bartlett's Test of Sphericity	$\chi^2 = 69.138$	-
Degress of freedom	3	-
Significance	$p < 0.001$	Significant

Sumber: Authors' calculations (2026)

Table 4 illustrates the limitations of applying PCA, as the KMO value of 0.339 (below the 0.50 threshold) indicates insufficient partial correlation. Although the Bartlett test is significant ($\chi^2 = 69.138 < 0.001$), these two tests assess different aspects, the Bartlett test evaluates the presence of correlations, while the KMO measure assesses the adequacy

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of the pattern for PCA, meaning that the significance of the Bartlett test does not negate the limitation indicated by the KMO value. Therefore, while HAI-PCA is still employed as the primary measure with interpretations made cautiously this study also incorporates an equally weighted index as a sensitivity test.

Table 5: Descriptive Statistics of Equal-Weighted HAI

Indicator	Mean	Std.Dev
Health center ratio	0,495511	0,160506
Hospital ratio	0,103311	0,073608
Healthcare workforce ratio	41,434206	14,495223

Source: Authors' calculations, 2026

To demonstrate empirical sensitivity to the index construction method, regression models are estimated using HAI PCA and HAI EW as dependent variables. Comparisons are made by examining the signs of the coefficients and their statistical significance across both models. Since HAI PCA and HAI EW are constructed using different methods and may have different scales, the raw coefficient magnitudes are not directly compared.

Table 6: Regression Results Using HAI PCA and HAI EW

Variable	HAI-PCA	HAI-EW
Constant	-1.466.095,0	-6,7801**
	(911.941,3)	(2,8310)
GDRP	259.962,5***	0,7475***
	(71.571,15)	(0,2225)
Health Expenditure	-9.530,229	0,0840
	(31.714,38)	(0,0990)
Poverty	-2.084,337	-0,0526
	(18.659,13)	(0,0580)
Population Density	120,0164*	0,0004*
	(69.5318)	(0,0002)
Border x GRDP	-229.179,5**	-0,6906**
	(101.291,4)	(0,3172)
observations	56	56
R-squared	0,8990	0.9879
Adjusted R-squared	0.8499	0.9821
F-statistic	18.310	168.90
Prob(F-statistic)	0.0000	0.0000

Note: Standard errors are reported in parentheses. * p < 0.1, p < 0.05, *** p < 0.01.

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Source: Authors' calculations, 2026

DISCUSSION

Regional Economic Conditions and Accessibility to Healthcare Services

GRDP per capita is positively associated with relative healthcare service capacity in West Kalimantan, suggesting that stronger regional economic performance may support the availability of healthcare infrastructure and human resources. This finding is broadly related to the relationship between regional economic performance, government health expenditure, and health-sector outcomes discussed by Kusumawardhani and Liana (2025). However, the relationship should be interpreted cautiously because economic growth does not automatically translate into more equitable healthcare provision across regions. Differences in local fiscal capacity, resource allocation, and the geographical distribution of health facilities may influence how economic resources are converted into healthcare capacity. Health expenditure exhibits different coefficient signs across the two index specifications but remains statistically insignificant, indicating insufficient evidence of an independent association with healthcare service capacity in the estimated models.

Research on primary healthcare facilities in remote Indonesian areas has highlighted challenges related to facilities, activities, and financing, suggesting that the availability of financial resources should be considered alongside the capacity to deliver services (Soewondo et al., 2019). Similarly, Suharmiati et al. (2012), in their study of Sajingan Besar, Sambas, identify both supply-side factors, such as healthcare resources, and demand-side factors as relevant to healthcare accessibility. Poverty has a negative but statistically insignificant coefficient. One possible explanation is that the HAI primarily captures the relative availability of healthcare resources rather than households' financial ability to use those services. Healthcare resource availability and actual access are related but distinct dimensions. Putri et al., (2021) demonstrate that geographical access is an important factor associated with healthcare-seeking behaviour in geographically challenged districts in Indonesia.

Population density is positively associated with healthcare capacity at the 10% significance level, potentially reflecting the concentration of healthcare resources in more

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densely populated areas. Nevertheless, this association should not be interpreted as evidence that all residents in densely populated areas necessarily enjoy easier access to healthcare. These findings are particularly relevant to West Kalimantan, where geographical conditions and the distribution of healthcare resources may create differences between districts and cities. Studies of remote primary healthcare facilities and healthcare accessibility in border areas have documented challenges involving service provision and the availability of resources (Soewondo et al., 2019; Suharmiati et al., 2012). Research on hospital utilization in border and non-border areas of Kalimantan also provides a regional context for examining healthcare disparities (Laksono & Wulandari, 2021). These studies suggest that healthcare capacity should be understood not only in relation to economic resources and population concentration but also in the context of geographical and institutional conditions.

Border Status as a Moderator of the GRDP

The interaction between border status and GRDP is negative and statistically significant in both the HAI-PCA and HAI-EW models. The finding is consistent with research emphasizing geographical barriers and inequalities in healthcare access across Indonesian regions. Suharmiati et al. (2012) examine healthcare accessibility in Sajingan Besar, a border area in Sambas, while Putri et al., (2021) show that geographical access is an important factor associated with decisions to seek healthcare outside one's home district. Laksono & Wulandari, (2021) also examine disparities in hospital utilization between border and non-border areas in Kalimantan. Although these studies investigate outcomes that differ from the HAI used in this research, they provide relevant contextual evidence that healthcare provision and access may vary across geographically distinct areas. This finding highlights the importance of geographically responsive healthcare policies and resource allocation that accounts for regional service delivery constraints.

CONCLUSIONS

This study constructed a Healthcare Accessibility Index (HAI) using Principal Component Analysis (PCA) to measure the relative capacity of healthcare services across regencies and cities in West Kalimantan. The results show that GRDP is positively and

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significantly associated with HAI, while population density has a positive association at the 10% significance level. Health expenditure and poverty are not statistically significant. The interaction between border status and GRDP is negative and significant, indicating that the positive association between GRDP and healthcare service capacity is weaker in border regions than in non-border regions. The alternative equal-weighted index (HAI-EW) produces consistent results for GRDP, population density, and the interaction term, although health expenditure changes sign. These findings suggest that regional economic performance alone may not translate into comparable healthcare service capacity across border and non-border regions. Future research should incorporate additional indicators, such as travel time, geographical distance, healthcare utilization, and affordability, to capture broader dimensions of healthcare accessibility. Given the low KMO value of the PCA, further research should also assess alternative index construction methods and validate the resulting measures.

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