Village Funds and the Village Development Index Evidence from South Sulawesi

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ABSTRACT

Indonesia's Village Fund program seeks to improve rural development; however, substantial transfers have not uniformly translated into higher village development status. This study examines the association between Village Funds and the Village Development Index (IDM) in South Sulawesi, accounting for economic conditions, environmental conditions, and geographic difficulty. The analysis uses secondary village-level information for two observation years, 2018 and 2021. The reported estimation sample contains 4,100 village-year observations, consistent with 2,050 villages observed twice. The Chow and Hausman tests favor village fixed effects over pooled or random-effects specifications. However, the available coefficient estimates were obtained from a pooled generalized linear model with a normal distribution and identity link; therefore, they do not account for village-specific fixed effects. In this preliminary specification, the coefficient on logged Village Funds is positive (0.049103; $p < 0.001$), the Environmental Index is positive (0.030602; $p < 0.001$), and the Geographic Difficulty Index is negative (−0.003625; $p < 0.001$). The Economic Index was not statistically significant ($p = 0.6898$). These results describe conditional associations rather than identified causal effects. Village fixed-effects estimation with appropriate robust inference and sensitivity checks is required to establish whether the reported relationships persist after controlling for unobserved village heterogeneity. The findings highlight the importance of evaluating fiscal transfers alongside ecological conditions and geographic constraints.

ABSTRAK

Program Dana Desa bertujuan mempercepat pembangunan perdesaan, tetapi peningkatan transfer fiskal belum selalu diikuti kenaikan status pembangunan desa. Penelitian ini mengkaji hubungan antara Dana Desa dan Indeks Desa Membangun (IDM) di Sulawesi Selatan dengan mempertimbangkan indeks ekonomi, indeks lingkungan, dan Indeks Kesulitan Geografis (IKG). Analisis menggunakan data sekunder tingkat desa pada dua tahun pengamatan, yaitu 2018 dan 2021. Hasil pengolahan yang tersedia mencakup 4.100 observasi desa-tahun, konsisten dengan 2.050 desa yang diamati dua kali. Uji Chow dan Hausman mengarah pada model efek tetap desa, tetapi tabel estimasi koefisien yang tersedia menggunakan generalized linear model dengan distribusi normal dan fungsi penghubung identitas tanpa efek tetap desa. Dalam model awal tersebut, koefisien Dana Desa dalam bentuk logaritma positif (0,049103; $p < 0,001$), indeks lingkungan positif (0,030602; $p < 0,001$), dan IKG negatif (−0,003625; $p < 0,001$). Indeks ekonomi tidak signifikan secara statistik ($p = 0,6898$). Karena keterbatasan spesifikasi model, hasil ini ditafsirkan sebagai hubungan kondisional, bukan pengaruh kausal yang telah teridentifikasi. Estimasi ulang efek tetap dengan standar galat yang robust serta pengujian sensitivitas diperlukan untuk memperkuat kesimpulan kebijakan.

1. INTRODUCTION

Law No. 6 of 2014 on Villages strengthened village authority and introduced a fiscal framework intended to move villages from passive beneficiaries to active participants in local development. Through the Village Fund (Dana Desa), the central government provides resources for public services, village infrastructure, community development, and empowerment. The policy reflects the argument that villages need both decision-making authority and fiscal capacity to respond to local needs (Academic Paper of the Law on Villages, 2007; Ginting et al., 2024; Arham & Hatu, 2020). Studies have linked the Village Fund to rural output, household welfare, and village development, although the

magnitude and distribution of benefits vary across settings (Rimawan et al., 2020; Watts et al., 2019; Tohari, 2022; Hilmawan et al., 2023).

National Village Fund allocations rose substantially after the program began in 2015. The original Ministry of Finance data summarized in this study indicate IDR 538 trillion in allocations during 2015–2023, while the planned allocation for 2024 was IDR 71 trillion. South Sulawesi received approximately IDR 18.76 trillion cumulatively during 2015–2024, with a reported average annual growth rate of 14.29%. These fiscal trends establish the policy context; they are not the years or observations used in the econometric analysis, which is restricted to 2018 and 2021.

Indonesia's Village Development Index (Indeks Desa Membangun, IDM) categorizes villages into independent, advanced, developing, disadvantaged, and very disadvantaged groups. The national data in Table 1 show that the number of independent villages rose from 1,741 to 17,203 during 2020–2024. Nevertheless, 24,532 villages were still categorized as developing, 6,100 as disadvantaged, and 4,363 as very disadvantaged in 2024. This simultaneous improvement and persistence of vulnerability raise questions about the conditions under which fiscal transfers accompany better village outcomes.

Table 1. Villages by development status in Indonesia, 2020–2024

Village status	2020	2021	2022	2023	2024
Independent	1,741	3,269	6,238	11,456	17,203
Advanced	11,912	15,321	20,249	23,035	23,063
Developing	40,029	38,083	33,902	28,766	24,532
Disadvantaged	15,934	12,635	9,584	7,154	6,100
Very disadvantaged	5,332	5,649	4,982	4,850	4,363

Source: Ministry of Villages, Development of Disadvantaged Regions, and Transmigration (figures reproduced from original manuscript).

South Sulawesi has experienced a similar, but uneven, pattern. Table 2 shows that independent villages increased from 25 in 2020 to 745 in 2024, while the combined number of disadvantaged and very disadvantaged villages decreased from 446 to 140. Despite this progress, 567 villages remained in the developing category in 2024. The figures indicate substantial progress across the province but do not establish that the Village Fund alone caused the change in status.

Table 2. Villages by development status in South Sulawesi, 2020–2024

Village status	2020	2021	2022	2023	2024
Independent	25	115	235	471	745
Advanced	311	480	786	873	814
Developing	1,473	1,354	1,028	757	567
Disadvantaged	386	268	195	162	138
Very disadvantaged	60	38	11	3	2

Source: Ministry of Villages, Development of Disadvantaged Regions, and Transmigration (figures reproduced from original manuscript).

The gap between transfers and outcomes can also be observed at the village level. The descriptive records reported in the original manuscript show that Ilan Batu Uru Village (Luwu Regency) received approximately IDR 15.70 billion over 2015–2024 but retained disadvantaged status in 2023. Baruppu' Parodo Village (North Toraja Regency) reportedly received IDR 11.97 billion and had a 2023 IDM score of 0.4617, corresponding to very disadvantaged status. Such cases motivate village-level analysis while also cautioning against interpreting cumulative transfers as a sufficient condition for higher IDM scores.

Empirical findings are mixed. Studies from Gowa and other Indonesian settings report positive relationships between village funds, village-owned enterprises, development outcomes, and poverty reduction (Iftitah & Wibowo, 2022; Arina et al., 2021; Arifin et al., 2020; Arham & Payu, 2020). Other studies emphasize weak implementation capacity, low participation, and uneven impacts across regions (Faoziyah & Salim, 2020; Ginting et al., 2024; Anam et al., 2023; Halim & Taryani, 2023). Evidence from East Nusa Tenggara suggests that effects on village status may emerge with a time lag rather than within the same year (Dana & Dan, 2023). Research focusing on rural poverty or village proliferation in other provinces cannot automatically establish the same relationship for South Sulawesi, whose geography spans coastal, lowland, and mountainous areas (Azmi et al., 2020; Oktavia & Wihastuti, 2020; Yulitasari & Tyas, 2020).

This study contributes a village-level assessment of the association between village funds and the IDM in South Sulawesi. It supplements the fiscal variable with Podes-based economic and environmental indices and the geographic difficulty index to examine contextual correlates. Unlike province-level aggregates, this approach makes heterogeneity across village settings visible. The data used for estimation comprise two observations per village in 2018 and 2021; the

2015–2024 series is descriptive background only. The study asks whether village funds and the three contextual indicators are statistically associated with IDM, and whether the available estimation method supports inferences beyond pooled associations. This distinction matters because geographically difficult or poorer villages may both receive more transfers and face lower development outcomes.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

2.1. The Village Development Index

The Village Development Index (IDM) is a composite measure of village progress established by the Indonesian government under Law No. 6 of 2014 and Ministerial Regulation No. 2 of 2016. It combines social, economic, and environmental dimensions of sustainability. Social resilience encompasses social capital, education, health, and settlement conditions. Economic resilience reflects production diversity, trade, financial access, and economic institutions. Ecological resilience encompasses environmental quality and disaster risk management. Figure 1 illustrates the three-part conceptual structure of the official IDM indicators.

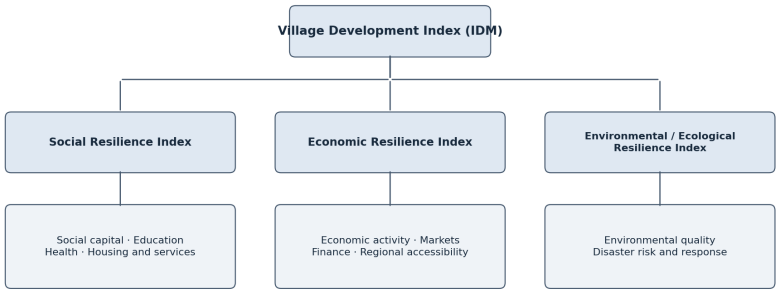


Figure 1. Structure of the Village Development Index (IDM) indicators.
Source: Ministry of Villages, Development of Disadvantaged Regions, and Transmigration; redrawn from the conceptual structure in the original manuscript.

Villages are assigned to one of five categories based on their IDM scores: very disadvantaged, disadvantaged, developing, advanced, or independent. These categories distinguish the ability to mobilize social, economic, and ecological resources for sustainable welfare improvements. IDM should not be treated as a direct measurement of fund utilization; the score also reflects geographic constraints, access to services, and institutional conditions that may evolve independently of the Village Fund. Because the official IDM contains economic and environmental domains, any independently constructed explanatory indices covering those domains must be checked for overlap with the dependent variable (Ministerial Regulation No. 2 of 2016).

2.2. Village Funds as a development instrument

The Village Fund is a central-government transfer financed from the national budget and channeled to villages through district or municipal fiscal arrangements. It is distinct from the Allocation of Village Funds (Alokasi Dana Desa) originating from district transfers. Village Fund expenditures can finance infrastructure, services, local economic activities, and community empowerment, as reflected in priority-use regulations, including Ministerial Regulation No. 7 of 2023. These pathways can contribute to different components of IDM rather than raising all dimensions at the same rate (Fahri, 2017; Permatasari et al., 2021; Hilmawan et al., 2023).

Infrastructure investment may expand road access and public services; funding for village-owned enterprises (BUMDes) may support economic activity; and health and education interventions may strengthen social resilience. Existing evidence documents the links between Village Funds and construction value, enterprise formation, rural welfare, and stunting prevention (Akbar & Sihaloho, 2019; Arifin et al., 2020; Iftitah & Wibowo, 2022; Indra & Khoirunurrofik, 2022; Syavira et al., 2023). However, the literature also reports weak implementation, limited administrative capacity, and uneven poverty outcomes (KOMPAK, 2017; Faoziyah & Salim, 2020; Anam et al., 2023; Ginting et al., 2024). Institutional capacity, allocation quality, participation, and the lag between expenditure and observable outcomes may influence these differences (Hendrianto, 2019; Prabasari et al., 2021; Dana & Dan, 2023).

2.3. Hypothesis development

Village Fund and IDM. Additional fiscal resources can support investment in infrastructure and public services. The village-level association observed in Gowa (Iftitah & Wibowo, 2022) and broader evidence on BUMDes and rural development (Arifin et al., 2020; Hilmawan et al., 2023) motivate a positive expected relationship, although allocation endogeneity prevents this theoretical expectation from being interpreted as an identified causal mechanism.

H1: Village fund allocations are positively associated with the village development index.

Economic Index and IDM. Access to markets, finance, services, and productive activities may facilitate higher economic resilience and improve household opportunities (Iskandar & Aritenang, 2020; Wardhana et al., 2018). However, because economic conditions also contribute to the official IDM, a positive estimated association may partly reflect shared indicator content rather than an independent channel.

H2: The economic index is positively associated with the village development index.

Environmental Index, and IDM. Better sanitation, clean water access, waste management, and pollution control are relevant to ecological resilience and living conditions. Environmental projects funded through village transfers have been investigated as potential mechanisms for sustainability (Watts et al., 2019; Permatasari et al., 2021). As with economic conditions, overlap with the ecological component of the IDM requires cautious interpretation.
H3: The Environmental Index is positively associated with the Village Development Index.

Geographic Difficulty Index (GDI) and IDM. The Geographic Difficulty Index (Indeks Kesulitan Geografis, IKG) measures geographic and accessibility-related constraints, not nutrition or food insecurity. Difficult terrain and weak connectivity can increase the cost of delivering public services and limit access to education, health care, markets, and infrastructure. Consequently, villages facing greater geographic difficulty are expected to have lower IDM scores, conditional on the other included characteristics (Hartojo et al., 2022; Arham & Hatu, 2020).
H4: The Geographic Difficulty Index is negatively associated with the Village Development Index

2.4. Conceptual framework
Figure 2 connects the four explanatory variables to IDM and distinguishes their hypothesized signs. The arrows summarize the associations to be tested; they do not establish causal pathways. Unobserved village characteristics, common time shocks, and potential definitional overlap may influence the estimated coefficients.

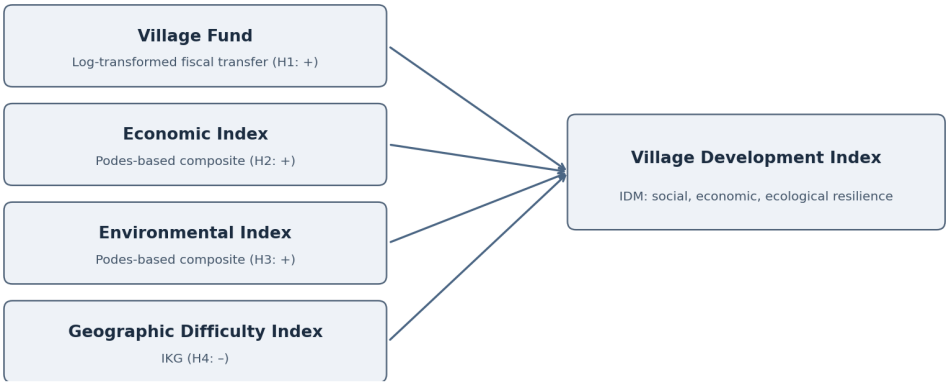


Figure 2. Conceptual framework and directional hypotheses
Source: Authors' framework based on the variables in the original estimation.

3. RESEARCH METHOD
3.1. Data, observation years, and unit of analysis
This study combines secondary village-level records from Statistics Indonesia (BPS/Podes), the Ministry of Finance, and the Ministry of Villages, Development of Disadvantaged Regions and Transmigration. The dependent variable was the official IDM score. The Village Fund variable comes from the Ministry of Finance's village-level records, while PODES variables are used to build local economic and environmental indices. The IKG captures geographic constraints. Table 3 reproduces the inventory of source variables reported in the original manuscript; its 46 entries are source indicators rather than the number of variables simultaneously entered into the final regression analysis.
The estimation uses two observation years, 2018 and 2021, not four consecutive annual observations or the entire 2015–2024 period. The model output reports 4,100 village-year observations, and the Chow-test cross-section degrees of freedom equal 2,049, which is consistent with 2,050 village units observed twice. Thus, the regression sample is smaller than the total of 2,255 villages implied by the 2020–2024 South Sulawesi status counts in Table 2. The village matching procedure and the reasons for missing or excluded villages should be documented from the underlying microdata before the analysis is finalized. The 2015–2024 data were used exclusively to motivate the study and describe the policy setting.
Notes: BPS = Statistics Indonesia; PODES = Village Potential Data. The original dataset lists 46 source variables; exact coding and English translations should be reconciled with the questionnaire and the estimation code.
IDM and IKG are defined differently: IDM is the outcome index of village development, whereas IKG summarizes geographic difficulty. The Ministry of Finance variable was log-transformed in the original variable inventory. However, the manuscript alternates between the terms 'allocation' and 'realization'; the amount actually passed to the logarithm must be reconciled with the estimation dataset. Similarly, cross-year matching identifiers, missing-value rules, and the underlying Podes codebook are necessary for full replication.

3.2. Construction of the Economic and Environmental Indices
The Economic Index combines five equally weighted components: (1) industrial and production activity, (2) trade and market access, (3) consumer and accommodation services, (4) economic institutions and programs, and (5) financial services and supporting activities. The Environmental Index combines four equally weighted components: (1) waste management, (2) waste disposal and sanitation, (3) clean-water availability, and (4) water, soil, and air pollution. These categories are derived from the indicators in Table 3 and the original Podes-based variable construction. Within each component, indicator values are oriented so that larger scores denote more favorable conditions and standardized using z-scores before aggregation.

Table 3. Source variables, measurement types, and data sources

No.	Indicator or source variable	Type	Source
1	Village Fund (log-transformed)	Log value	Ministry of Finance
2	Topography of the Mountainous Region	Dummy	BPS
3	Bordering the Sea	Dummy	BPS
4	Utilization of the Sea for Capture Fisheries	Dummy	BPS
5	Marine Fisheries Use for Aquaculture	Dummy	BPS
6	Utilization of the Sea for Salt Ponds	Dummy	BPS
7	Utilization of the Sea for Marine Tourism	Dummy	BPS
8	Utilization of the Sea for Public Transportation	Dummy	BPS
9	Mangrove Conditions	Dummy	BPS
10	Location Against Forest	Dummy	BPS
11	Primary Sources of Income	Dummy	BPS
12	Types of Transportation Infrastructure	Dummy	BPS
13	The Existence of Superior Products	Dummy	BPS
14	Mitigation Facilities	Dummy	BPS
15	Households with PLN electricity	Dummy	BPS
16	Households with non-PLN electricity	Dummy	BPS
17	Households without electricity	Dummy	BPS
18	The Existence of Waste Transportation System Facilities	Dummy	BPS
19	Ownership of Every Household's Toilet	Dummy	BPS
20	The Existence of Pumped Water Facilities or PDAM	Dummy	BPS
21	The Importance of Slum Settlements	Dummy	BPS
22	The Existence of Environmental Pollution	Dummy	BPS
23	Existence of Public Schools	Dummy	BPS
24	Ease of Access to Public Schools	Dummy	BPS
25	The Existence of Village-Owned Learning Facilities	Dummy	BPS
26	Existence of Health Facilities	Dummy	BPS
27	Lack of Access to Health Facilities	Dummy	BPS
28	The Existence of Posyandu	Dummy	BPS
29	Presence of Doctors	Dummy	BPS
30	The Existence of Midwives	Dummy	BPS
31	Managed public open space	Dummy	BPS
32	Community mutual assistance (gotong royong)	Dummy	BPS
33	4-Wheel Access All Year Round	Dummy	BPS
34	Presence of Telephone Signals	Dummy	BPS
35	Existence of Internet Signals	Dummy	BPS
36	The Existence of Micro and Small Industries	Dummy	BPS
37	The Existence of Small Villages	Dummy	BPS
38	The Existence of Village Unit Cooperatives	Dummy	BPS
39	The existence of a market or shopping facility	Dummy	BPS
40	Easy access to markets or shopping facilities	Dummy	BPS
41	The Existence of Business Credit Facilities	Dummy	BPS
42	The Existence of Financial Institutions	Dummy	BPS
43	The Existence of Village Economic Support Facilities	Dummy	BPS
44	Ease of Access to Village Economic Support Facilities	Dummy	BPS
45	Reported crime (original label: "The Existence of Evil")	Dummy	BPS
46	The Existence of Efforts to Maintain Security	Dummy	BPS

For indicator j, the reported standardization procedure is z(j,it) = [x(j,it) − mean(x(j))] / SD(x(j)). The component score is the mean of its standardized indicators, and each composite index is the unweighted mean of its component scores. Equal weighting was retained as a transparent baseline because the original manuscript did not report empirically validated importance weights. Nevertheless, equal weights do not demonstrate that the components contribute equally to village welfare. A principal-component-based or alternative weighting sensitivity analysis would be valuable; however, no such re-estimation is available in the supplied materials. Reproducibility also requires specifying whether the means and standard deviations are pooled across years or calculated separately.
A further measurement issue is the possibility that these Podes-based composites replicate variables already included in the official IDM's economic and ecological dimensions. Indicators common to both sides of the regression can generate such definitional correlations. Before treating their coefficients as independent relationships, the item lists must be matched against the official IDM construction and tested using non-overlapping measures or alternative specifications.

3.3. Panel specification and model selection

The intended village-level model is presented as follows:

$$IDM(i,t) = \alpha(i) + \tau(t) + \beta1 \ln(VillageFund(i,t)) + \beta2\ EconomicIndex(i,t) + \beta3\ EnvironmentalIndex(i,t) + \beta4\ IKG(i,t) + u(i,t). \quad (1)$$

Here, i denotes a village, and t denotes 2018 or 2021; α(i) captures time-invariant village heterogeneity, τ(t) is a time effect, and u(i,t) denotes the remaining disturbance. The signs expected under H1–H4 are $\beta1 > 0$, $\beta2 > 0$, $\beta3 > 0$, and $\beta4 < 0$. The written specification is the preferred confirmatory analysis, rather than a claim that the coefficients for it have already been estimated.
Pooled/common-effects, random-effects, and fixed-effects specifications were originally compared. The Chow test examines the null that a pooled model is sufficient relative to village fixed effects; the Hausman test compares fixed and random effects. Both reported tests favor village fixed effects. Retaining village effects matters because geographic location, governance, and institutional capacity may be correlated with fiscal transfers and IDM. Year fixed effects should also be considered to account for changes common to villages between the two observations.
The only coefficient table available in the source document is a generalized linear model (GLM) with a normal family and identity link, a common intercept, and four explanatory variables. Such a GLM with no effects for village entities has the same conditional mean as an ordinary pooled linear regression. It does not implement the fixed effects selected by the Chow and Hausman tests and does not, by itself, remedy heteroscedasticity or correlated errors. To avoid overstating identification, this revised paper treats that table as a preliminary pooled benchmark. The necessary confirmatory analysis is a village fixed-effects model with village-clustered standard errors, with sensitivity checks for alternative covariance estimators where feasible. Results from this confirmatory model cannot be supplied without the underlying data and a new estimation run.

3.4. Diagnostic tests and inference

The original analysis includes a Jarque–Bera test of residual normality, a correlation matrix of covariates, a Breusch–Godfrey serial-correlation test, and a White heteroscedasticity test. These diagnostics provide useful warnings but do not substitute for panel-specific inference. With two observed time points per village, a pooled Breusch–Godfrey test at two lags does not necessarily diagnose serial correlation within villages in the appropriate panel ordering. The White test indicates nonconstant residual variance in the original working model; robust or cluster-robust standard errors rather than a normal-identity GLM alone are needed for valid uncertainty quantification. Pairwise correlations can reveal very strong simple relationships, but they cannot guarantee the absence of all multicollinearity, especially in a fixed-effects transformed model.

4. DATA ANALYSIS AND DISCUSSION

4.1. Panel specification tests

The model-comparison tests provide evidence that villages differ in ways not captured by a common intercept. Table 4 reports an F statistic of 2.834062 and cross-section chi-square statistic of 5514.532933, both with reported p-values below 0.001. The Chow test rejects the pooled common-effects specification in favor of fixed effects. This finding is substantively relevant in South Sulawesi because villages differ in terrain, transport access, and economic infrastructure.

Table 4. Chow test: pooled model versus village fixed effects

Test	Statistic	Degrees of freedom	p-value
Cross-section F	2.834062	(2049, 2046)	<0.001
Cross-section chi-square	5514.532933	2049	<0.001

Source: Original EViews output, Redundant Fixed Effects Tests (MODEL_FEM).

The Hausman test further rejects the random-effects restriction (chi-square = 1071.364896; df = 4; $p < 0.001$), as shown in Table 5. Accordingly, the model selection evidence favors the village fixed effects. These results were not incorporated into the available pooled GLM coefficient table, and this discrepancy limits the interpretation of the latter.

Table 5. Hausman test: fixed effects versus random effects

Test	Chi-square	df	p-value
Cross-section random	1071.364896	4	<0.001

Source: Original EViews output, Correlated Random Effects – Hausman Test (MODEL_REM).

4.2. Diagnostics reported for the working model

The residual histogram in Figure 3 shows a Jarque–Bera statistic of 394.9342 with a reported p-value below 0.001. The normality assumption is therefore rejected for the residuals of the model used to construct this figure. With a large sample, normality of raw regression errors is not in itself the decisive condition for consistent estimates; the more serious issues concern the appropriate error covariance, village heterogeneity, and the specification of the conditional mean.

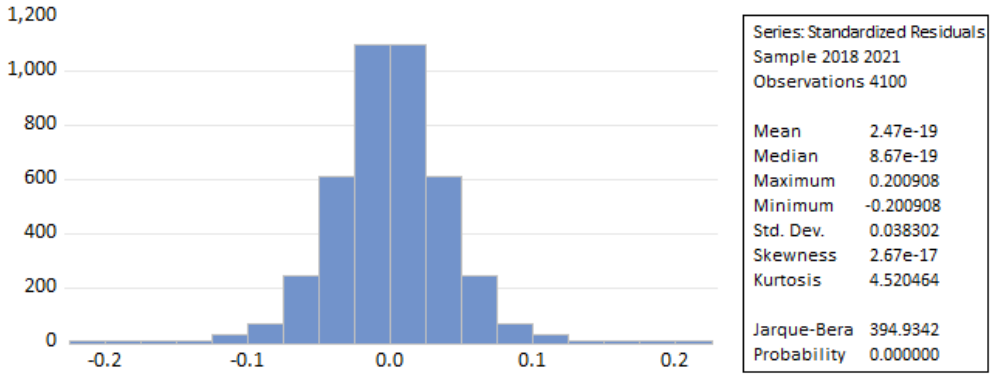


Figure 3. Standardized residual distribution and Jarque–Bera normality test

Source: Original EViews histogram supplied in the manuscript (4,100 observations).

The largest absolute off-diagonal pairwise correlation in Table 6 is approximately 0.090, suggesting that there are no exceptionally strong pairwise linear correlations among the four variables shown. This result does not address more complex collinearity or the feasibility of estimating variables with little within-village variation under fixed-effects models.

Table 6. Pairwise correlation matrix for explanatory variables

Variable	Village Fund	Economic Index	Environmental Index	IKG
Village Fund	1.000000	0.008616	0.074868	0.089877
Economic Index	0.008616	1.000000	−0.003275	0.051631
Environmental Index	0.074868	−0.003275	1.000000	−0.075998
IKG	0.089877	0.051631	−0.075998	1.000000

Source: Original EViews correlation matrix. The table describes pairwise correlations and is not a variance-inflation-factor test.

The original pooled Breusch–Godfrey and White tests reported p-values below 0.001 (Tables 7 and 8). The White test supports concern about heteroscedasticity. The two-lag Breusch–Godfrey result signals residual dependence under the ordering and specification used, but its interpretation as within-village serial correlation is uncertain with just two observation years and should not be treated as a validated panel diagnostic.

Table 7. Breusch–Godfrey residual serial-correlation LM test

Statistic	Value	Reference distribution	p-value
F statistic	122.0985	F(2, 4093)	<0.001
Obs. × R^2	230.8422	Chi-square(2)	<0.001

Source: Original EViews output. Null hypothesis: no residual serial correlation at up to two lags; applicability to two-wave panel data requires a separate assessment.

Table 8. White test for heteroskedasticity

Statistic	Value	Reference distribution	p-value
F statistic	32.08575	F(14, 4085)	<0.001
Obs. × R^2	406.1845	Chi-square(14)	<0.001
Scaled explained SS	560.5733	Chi-square(14)	<0.001

Source: Original EViews output. Null hypothesis: homoscedasticity.

4.3. Preliminary pooled normal-identity GLM results

Table 9 presents the coefficient estimates available in the original manuscript. The model reports a normal family, identity link, and an observed-Hessian covariance estimator. It includes an intercept but no village- or year-specific effects. Consequently, it should be read as a pooled benchmark that documents conditional associations, rather than as the preferred fixed-effects result. Switching the label from OLS to normal-identity GLM does not resolve the heteroscedasticity and dependence revealed by the working-model diagnostics.

Table 9. Preliminary pooled normal-identity GLM: dependent variable IDM

Variable	Coefficient	Std. error	z statistic	p-value
Intercept	−0.287625	0.113402	−2.536323	0.0112
Log Village Fund	0.049103	0.005514	8.905258	<0.001
Economic Index	0.011030	0.027638	0.399098	0.6898
Environmental Index	0.030602	0.006413	4.771471	<0.001
Geographic Difficulty Index (IKG)	−0.003625	0.000189	−19.18845	<0.001

Source: Original EViews GLM output, 4,100 observations; normal family, identity link, no reported village fixed effects or cluster-robust standard errors. Root MSE = 0.075030; log likelihood = 4800.788; AIC = −2.339409; Schwarz criterion = −2.331703; LR statistic = 467.0791. Significance tests are those originally reported and may change under valid panel inference.

The Village Fund is positively associated with IDM in this pooled model (coefficient = 0.049103, $p < 0.001$). Table 3 describes the fiscal variable as log-transformed. If it is a natural logarithm, a 1% rise in Village Funds corresponds to an approximate 0.00049-point difference in an IDM score measured on a 0–1 scale, because $0.049103 \times \ln(1.01) \approx 0.000489$. This is not a 0.049% proportional increase in IDM. The exact base of the logarithm and whether the fiscal variable measures allocation or realization must be confirmed before the numerical interpretation is finalized.

The Environmental Index had a positive reported coefficient (0.030602; $p < 0.001$). Because the index is a standardized composite rather than a percentage variable, the coefficient represents IDM-score differences per index unit; it cannot be reported as the percentage change in IDM following a 1% increase in environmental conditions. The Geographic Difficulty Index has a negative coefficient (−0.003625; $p < 0.001$), indicating a lower IDM for otherwise similar observations with a one-unit higher IKG in the pooled specification. The Economic Index coefficient is small and statistically indistinguishable from zero in this model (0.011030; $p = 0.6898$), which does not demonstrate that village economic capacity is unimportant or has no influence on the model.

The reported root mean squared error of 0.075030 is a descriptive measure of the residual prediction error on the IDM scale. It does not establish that the model is correctly specified, eliminates endogeneity, or validates causal inference. Formal uncertainty statements require re-estimation that preserves the panel structure and accounts for relevant dependence. Therefore, the hypothesis tests in Table 9 are preliminary and should be revisited after the preferred fixed-effects model is estimated.

4.4. Discussion

Village Funds and rural-development pathways

The positive pooled Village Fund coefficient is consistent in direction with previous evidence linking transfers to infrastructure, economic opportunities, and social welfare (Akbar & Sihaloho, 2019; Arham & Payu, 2020; Hilmawan et al., 2023). Infrastructure has often absorbed a substantial proportion of village spending; the fiscal policy and village-level case-study literature describes important investments in roads, bridges, irrigation, and basic services (Aziz, 2016; KOMPAK, 2017; Wardhana et al., 2018; Iskandar & Aritenang, 2020; Permatasari et al., 2021). Evidence from specific localities also reports improvements in physical infrastructure and agricultural access (Harahap & Sagala, 2024; Yussa et al., 2020; Firmasyah et al., 2020; Mangeto, 2018; Supriadi et al., 2020; Indraningsih et al., 2021). These studies suggest plausible channels, but the spending composition and mediation through these channels are not directly estimated in the present model.

Village-owned enterprises provide another possible route. Wardhana et al. (2018), Arifin et al. (2020), and Iftitah and Wibowo (2022) describe the links between Village Fund support, BUMDes development, and local economic outcomes. Other studies have documented associations between village transfers and household consumption or

poverty alleviation (Setiawan et al., 2020; Saragi et al., 2021; Daforsa & Handra, 2019; Sari & Abdullah, 2017; Oktavia & Wihastuti, 2020). However, evidence that some locations did not achieve corresponding poverty reductions indicates that the amount transferred is not a sufficient measure of implementation quality (Faoziyah & Salim, 2020; Anam et al., 2023).

South Sulawesi's descriptive transition—from 446 disadvantaged or very disadvantaged villages in 2020 to 140 in 2024—provides a policy context rather than proof of an aggregate Village Fund effect. It is also distinct from the years in which the regression is estimated. More persuasive evidence would compare changes within the same villages between 2018 and 2021, after controlling for common shocks and additional time-varying confounders.

Why is the economic index not statistically significant?

The Economic Index is a core constructed variable of this study; however, its pooled coefficient has $p = 0.6898$. This result should be discussed rather than treated as evidence of no economic relationship. First, the composite combines five domains with equal weights; averaging indicators with different relevance or limited variations can attenuate measured associations. Second, the official IDM already includes economic indicators, and differences in item content or aggregation could distort, rather than cleanly separate, the relationship. Third, a two-wave specification may not capture the long-run returns to enterprise investment or improvements that materialize with a delay. Fourth, measurement errors and unobserved village differences may have influenced the pooled estimates. These explanations are hypotheses for further testing and are not established empirical findings.

Further analysis should report component-wise correlations with the IDM and the official economic-resilience sub-index; assess sensitivity to alternative weighting, including PCA if appropriate; and estimate the fixed-effects specification on the same sample. This would show whether non-significance reflects the composition of the index, minimal within-village change, or lack of a robust conditional association. The discussion is consistent with mixed evidence on BUMDes development and rural employment (Arifin et al., 2020; Hilmawan et al., 2023), while stopping short of asserting that economic development is irrelevant to village outcomes.

Environmental conditions and the construction of IDM

A positive coefficient on the Environmental Index is consistent with the conceptual importance of waste management, sanitation, safe water, and pollution control for village well-being and ecological resilience. The literature identifies a potential environmental role for fiscal transfers and rural sustainability programs (Watts et al., 2019; Permatasari et al., 2021). Improved environmental conditions could reinforce health and settlement outcomes in addition to the ecological domain. Nevertheless, the Environmental Index may contain indicators that also enter the IDM itself. Part of the strong positive association may therefore be definitional, particularly if the regressor and dependent variable share the same Podes inputs. The appropriate policy interpretation is that environmental quality is closely linked to measured village development, not that an exogenous increase in the Environmental Index necessarily causes a higher IDM score.

Geographic difficulty and uneven village opportunities

The negative IKG coefficient is consistent with the practical disadvantages of difficult terrain, long travel distances, and constrained access to markets and public facilities. This helps explain why villages receiving substantial transfers can remain disadvantaged: equal nominal resources may purchase fewer services in geographically challenging settings. The IKG should not be confused with an index of nutritional vulnerability. However, geographic difficulty may enter the formula used to allocate Village Funds, and some components may change little between 2018 and 2021. In a fixed-effects model, a time-invariant IKG will be absorbed by village-specific intercepts; the within-village identification of this coefficient must be checked before it is interpreted as an independent-panel effect.

Implications for interpretation and comparison across regions

Village-level work in Gowa, South Sulawesi, directly documents a relationship between transfers and IDM-related outcomes (Iftitah & Wibowo, 2022). Other provincial studies from East Nusa Tenggara and Aceh highlight fiscal-management constraints and mixed development or poverty outcomes (Halim & Taryani, 2023; Dana & Dan, 2023; Azmi et al., 2020). Compared with these settings, the present contribution examines multiple development dimensions jointly within South Sulawesi, where coastal and highland villages face diverse constraints. The results do not yet demonstrate that this province has a uniquely large or small effect; a harmonized cross-provincial comparison would be needed to test that claim.

The research design also faces possible simultaneity and omitted variable problems. Transfer amounts reflect population, poverty, land area, and geographical difficulty, and IDM may respond to or be associated with these characteristics. The available pooled regressions do not address this selection process. Moreover, the association between Podes-based controls and IDM may partly result from the construction of the index. Stronger causal claims would require a defensible identification strategy, such as exogenous variation in allocations or a suitable quasi-experimental design, together with longitudinal village identifiers and covariate measurements that avoid mechanical overlap (Anam et al., 2023; Ginting et al., 2024).

5. CONCLUSION, IMPLICATIONS, SUGGESTIONS, AND LIMITATIONS

5.1. Conclusion

This study investigates the association between village funds, economic conditions, environmental conditions, and geographic difficulty and the village development index in South Sulawesi. The available pooled normal-identity GLM reports a positive coefficient for log village funds (0.049103), a positive environmental index coefficient (0.030602), a

negative IKG coefficient (−0.003625), and a statistically non-significant economic index coefficient (0.011030). These patterns are preliminary because the reported coefficients do not incorporate the village fixed effects favored by the Chow and Hausman tests, and their standard errors do not address the dependence and heteroscedasticity concerns identified in the source analysis. The data support an association in the working specification, but not a verified causal Village Fund effect on IDM.

The descriptive improvement in South Sulawesi's village status during 2015–2024 is compatible with the program's development objectives but cannot be attributed to the Village Fund using two observation years from 2018 and 2021. The principal contribution is the examination of village-level fiscal transfers alongside Podes-based economic and environmental composites and indicators of geographic difficulty. This disaggregated perspective brings differences in village settings into the policy discussion and identifies measurement and model specification issues that aggregate analyses can obscure.

5.2. Practical and methodological implications

Village development policy should evaluate not only the nominal amount of Village Fund transfers but also whether expenditures improve relevant services and whether geographically difficult communities receive adequate implementation support. Environmental infrastructure, drinking water, sanitation, and disaster preparedness merit attention because they are connected to the measured village resilience. Similarly, development strategies in remote villages should consider access and delivery costs. These are priorities for policy evaluation, not causal prescriptions derived from pooled coefficients. Investment in village officials' planning, reporting, and participatory oversight capacities remains important in light of the implementation concerns documented in earlier studies (Hendrianto, 2019; Ginting et al., 2024; Prabasari et al., 2021).

Methodologically, this study shows the potential value of village-level Podes-based composite indicators but also the need for documented weights, sensitivity analyses, and transparency about overlaps with the dependent index. Given that model selection favors fixed effects, retaining village heterogeneity in the final specification was essential. Switching to a normal-identity GLM does not, by itself, correct the issues revealed by the diagnostic tests. Therefore, the final econometric results should be re-estimated with village fixed effects and valid robust inference before stronger statements about policy effectiveness are advanced.

5.3. Limitations and future research

First, the econometric data cover only 2018 and 2021, whereas the historical context extends from 2015 to 2024. Two waves cannot reveal annual trends, identify multi-year lags, or convincingly test cumulative mechanisms. Second, the analytic sample implied by the output contains 2,050 villages, and the criteria for matching or excluding villages are not documented in the manuscript's underlying tables. Third, the fiscal variable's precise distinction between allocations and realizations and the logarithm base require verification using the estimation file.

Fourth, unobserved village heterogeneity, potential time shocks, heteroscedasticity, and dependence mean that the preliminary pooled specification is insufficient for preferred panel inference. Village- and time-fixed-effects specifications with village-clustered standard errors should be reported where identifiable; attention should be paid to predictors such as IKG that may exhibit very little within-village variation. Fifth, potential endogeneity in the allocation rule and overlap between constructed Podes indices and official IDM indicators limit causal interpretations. Future work could compare the baseline equal-weight composites with PCA-derived or otherwise validated weights, use non-overlapping index components, extend the panel, and evaluate quasi-experimental identification strategies based on credible sources of exogenous fiscal variation. Finally, broader provincial comparisons would clarify whether the patterns observed in South Sulawesi generalize to other regions.

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