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The Influence of Natural Disasters, Road Infrastructure Quality, Social Assistance Expenditure, and the Human Development Index on Regional Economic Growth in Indonesia

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Abstract

This study examines how environmental vulnerability and development capacity shape regional economic growth across 34 Indonesian provinces during 2020–2024. Addressing a gap in endogenous growth and regional resilience literature, the study investigates whether natural disaster risk, road infrastructure quality, social assistance expenditure, and the Human Development Index (HDI) exert differential effects on provincial economic performance. Annual panel data were analyzed using a Fixed Effect Model, selected through model specification tests to control for unobserved provincial heterogeneity. The findings indicate that natural disaster risk significantly suppresses economic growth by disrupting productive assets and economic activities, whereas HDI positively promotes growth through improvements in human capital quality. In contrast, road infrastructure quality and social assistance expenditure do not exhibit significant effects, suggesting that their growth impacts may depend on implementation efficiency, institutional capacity, and longer-term transmission mechanisms. These results highlight the predominance of human capital and disaster resilience over short-term fiscal interventions in shaping regional development outcomes. The study extends endogenous growth theory by integrating environmental risk and regional resilience perspectives within a subnational development context in a disaster-prone developing economy.

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INTRODUCTION

Economic growth is a fundamental indicator that represents the dynamics of welfare and development performance within a region, including the success of structural transformation and the enhancement of production capacity over a certain period. Theoretically, the discourse on regional economic growth is rooted in two major grand theories. First, the Neoclassical Growth Theory developed by Solow and Swan, which emphasizes the accumulation of physical capital and labor as the primary drivers of aggregate output. Second, the Endogenous Growth Theory pioneered by Romer and Lucas, which extends the neoclassical perspective by incorporating human capital, technology, and the efficiency of public policies (such as infrastructure and social protection) as determinants of long-term growth originating from within the economic system itself (Amsyah, 2025). From this perspective, each region is expected to move toward an equilibrium point through the mobility of production factors; however, the reality of development in Indonesia demonstrates that the stability of this transition is often distorted by exogenous shocks, resulting in disparities in regional growth.

The sharp fluctuations in Indonesia's regional economy became particularly evident during the 2020–2024 period, which was characterized by a deep recession caused by the pandemic followed by an uneven recovery phase. In 2020, the national economy contracted by -2.07%; however, this aggregate figure concealed far more extreme realities at the provincial level. The Province of Bali experienced a severe economic downturn, with growth declining drastically to -9.31% due to the collapse of the tourism sector, which constitutes the primary engine of its economy (Lidyana, 2021). In contrast, North Maluku displayed an opposing trend by maintaining positive growth of 5.39% at the peak of the pandemic, supported by the intensive downstream development of the nickel industry and mining sector (Bank Indonesia Perwakilan Maluku Utara, 2021). A similar trend was observed in Central Sulawesi, which recorded positive growth of 4.86%. These conditions demonstrate that differences in regional economic structures determine the degree of resilience to crises, and that regions with extractive industry-based economies possess substantially stronger resilience to external shocks compared to regions dependent on the service and consumption sectors (Widjaja et al., 2022).

On the other hand, economic stagnation was evident in provinces such as East Nusa Tenggara (NTT). The economic growth trajectory of NTT tended to remain stable but at a very low level, forming what appeared to be a flat line with no significant post-pandemic recovery dynamics. This condition was caused by the dominance of subsistence agriculture and limited regional fiscal capacity, which weakened the driving force of economic growth. In contrast to the stagnation observed in other eastern regions, West Papua experienced a sharp surge in growth in 2024. This increase was driven by the commencement of strategic national projects based on natural resources, such as liquefied natural gas (LNG) downstream industries, as well as massive government expenditures on infrastructure development in newly established administrative regions, which instantly boosted regional Gross Regional Domestic Product (GRDP) figures following a prolonged period of contraction.

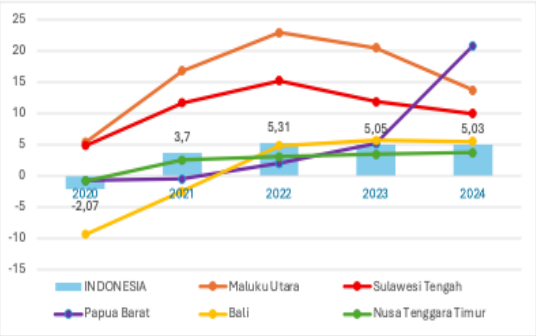

Figure 1. Trends in Indonesia's Regional Gross Domestic Product (GRDP): The Phenomenon of Divergence in Regional Economic Recovery (2020–2024)

Source: Badan Pusat Statistik (2025)

The extreme disparities in the trends of Gross Regional Domestic Product (GRDP) provide a strong indication that aggregate macroeconomic policies implemented by the central government are insufficient to create growth convergence. There are local factors ranging from regional vulnerability, the quality of physical capital, to human resource capacity that function either as accelerators or decelerators of regional recovery (Sultan et al., 2025; Widjaja et al., 2022).

One of the exogenous variables that systematically threatens the spatial economic stability of Indonesia and is capable of disrupting a region's capital accumulation process within a short period is the risk of natural disasters. Indonesia's geographical position along the Ring of Fire places the country at the epicenter of global hydrometeorological and geological disasters. Theoretically, disasters constitute a negative supply shock that disrupts supply chains, destroys productive assets, and reallocates resources from long-term investment toward emergency financing.

The theoretical foundation concerning these destructive impacts is explained through the Broken Window Theory, which argues that disasters lead to the destruction of existing physical capital stocks (capital stock destruction) (Amsyah, 2025). Consequently, economic resources that should have been allocated to new productive investments must instead be forcibly redirected toward non-productive rehabilitation and reconstruction activities, ultimately reducing the long-term economic output potential of the affected regions.

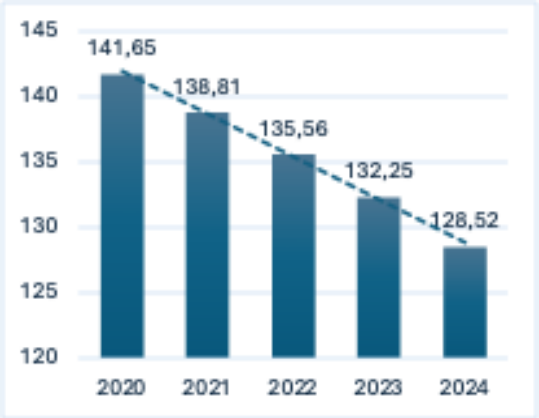

Figure 2. National Disaster Risk Index Frequency (2020–2024)

Source: Badan Nasional Penanggulangan Bencana (BNPB), 2025

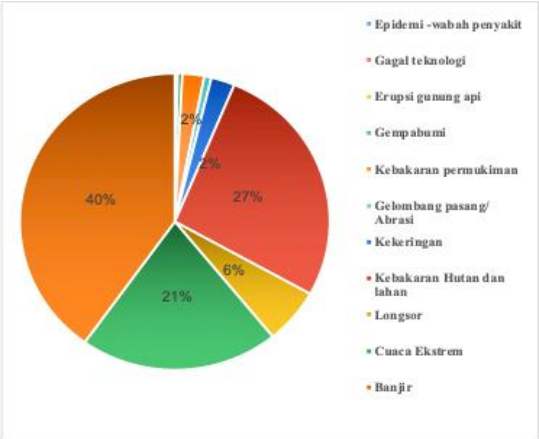

Figure 3. Disaster Occurrence Data by Disaster Category in 2024

Source: Badan Nasional Penanggulangan Bencana (BNPB), 2025

These theoretical concerns are justified by the persistently high frequency of disasters in Indonesia over the past five years. Data indicate that nearly all regions of Indonesia are exposed to hydrometeorological disaster risks, such as floods and landslides,

which accounted for more than 60% of total national disaster occurrences in 2024 (National Disaster Management Agency, 2025). The high intensity of these disasters represents a substantial loss of regional economic potential, as each disaster shock not only damages physical assets but also significantly reduces local productivity levels. Regions with high disaster risk indices tend to experience obstacles to economic growth due to uncertainty that discourages long-term investment inflows (Wariyanti & Rahmayani, 2025).

The empirical literature concerning these destructive impacts remains characterized by intense debate Ilham et al. (2023) and Purwa & Bahri (2024) demonstrated that disaster frequency is significantly negatively correlated with regional economic growth because it triggers capital outflows and local deindustrialization. However, this thesis is challenged by the perspective of Creative Destruction (Fischer, 2021), which argues that, in the medium term, disasters may instead stimulate the inflow of reconstruction funds from the central government, encourage the modernization of more resilient infrastructure, and generate positive spatial spillover effects on regional GRDP. This divergence in findings implicitly raises the hypothesis of whether the accumulation of disasters in Indonesia is, on balance, destructive in nature or instead serves as a catalyst for spatial economic renewal. Therefore, the integration of natural disaster risk variables into economic growth models becomes highly crucial, considering Indonesia's geographical position, which necessitates synchronization between economic policies and sustainable disaster resilience strategies.

The process of renewal and accumulation of regional physical capital is highly dependent on the quality of basic infrastructure, in which road condition serves as a central manifestation of the efficiency of government capital expenditure. The provision of high-quality road infrastructure constitutes a vital component of Social Overhead Capital, functioning to reduce logistics costs and improve the efficiency of goods and services distribution. From the perspective of development economics, road infrastructure quality is a fundamental prerequisite for the creation of market integration capable of generating multiplier effects on local economic activities (Amsyah, 2025). High-quality roads enable production inputs and industrial outputs to move more efficiently, thereby directly supporting the process of capital accumulation within the framework of regional economic growth through efficient connectivity.

However, the condition of connectivity in Indonesia continues to be overshadowed by severe disparities in infrastructure quality across regions. While provinces on Java Island consistently record road condition levels exceeding 80%, regions outside Java, such as Kalimantan and Papua, continue to face a substantial proportion of damaged roads. This disparity results in persistently high economic transaction costs outside Java, thereby weakening the competitiveness of local products and causing economic growth to remain concentrated in regions with already well-established infrastructure. Without equitable improvements in road quality, remote regions will struggle to escape the cycle of poverty and economic underdevelopment. Gertler et al. (2024) provided empirical justification that every increase in the percentage of road condition quality generates multiplier effects that reduce transportation costs and stimulate regional economic growth in absolute terms. Conversely, Ndii (2022) criticized this infrastructure-led

growth model, demonstrating that aggressive physical development in regions lacking strong economic base sectors merely creates a phenomenon of "ghost infrastructure." Such investments burden regional fiscal capacity through maintenance costs without providing a tangible contribution to GRDP growth. This contradiction necessitates further empirical examination regarding the actual influence of road infrastructure quality on regional economies.

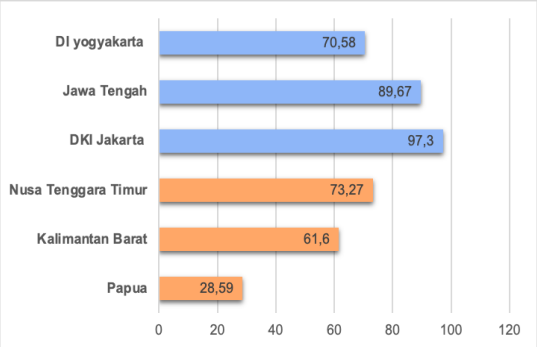

Figure 4. Disparities in Road Infrastructure Quality Between Java and Non-Java Regions (2024)

Source: Dinas Bina Marga (2025)

The failure to achieve equitable road infrastructure quality has become a major obstacle to economic convergence among regions in Indonesia. Damaged roads in major commodity-producing regions prevent the economic potential of these areas from being optimally integrated into national and international supply chains. This condition creates barriers for the private sector to expand beyond Java Island due to the high logistical capital costs that must be incurred. Therefore, measuring the extent to which road quality contributes to regional GRDP has become increasingly urgent in order to evaluate the effectiveness of government capital expenditure in promoting more inclusive economic growth across all provinces.

Another form of public intervention is centered on fiscal policy through social assistance expenditure, which has evolved into a crucial economic safeguard instrument in the face of the dual shocks of the pandemic and natural disasters. Based on the Keynesian approach, social assistance expenditure functions as an automatic stabilizer capable of mitigating declines in household consumption when public income experiences a sharp contraction (Amsyah, 2025). This fiscal stimulus is expected to stimulate economic activity at the grassroots level through increased domestic consumption, which constitutes the largest component of the GRDP structure in most regions of Indonesia, thereby maintaining economic growth at a stable level.

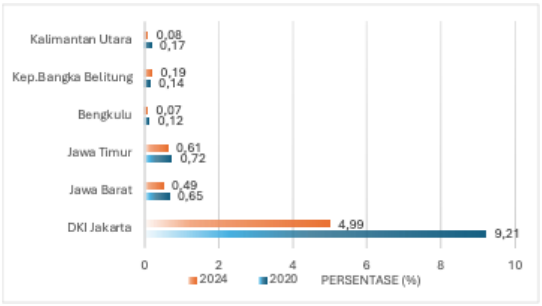

Figure 5. Comparison of the Proportion of Realized Social Assistance Expenditure to Total Regional Expenditure in Selected Provinces (2020 vs. 2024)

Source: Portal Kemenkeu (2025)

The effectiveness of this fiscal instrument becomes highly contrasting when comparing the extremely unequal fiscal capacities across regions in Indonesia. The Special Capital Region of Jakarta (DKI Jakarta) was recorded as having the capacity to allocate up to 9.21% of its total expenditure to social assistance in 2020 in order to protect its citizens from the massive impacts of the pandemic crisis. In contrast, regions with low fiscal capacity, such as North Kalimantan, were only able to allocate 0.08% of their expenditure to social assistance in 2024. This disparity, reaching hundreds of times in

proportional difference, indicates that social protection in Indonesia remains heavily dependent on the wealth of individual regions, thereby creating implications for inequality in citizens' rights, particularly in underdeveloped areas. Grosh et al. (2022) concluded that social expenditure has a significantly positive effect on the economy by alleviating liquidity constraints among lower-income households. In contrast, Taariwuan et al. (2025) identified anomalies in several regions where massive social assistance injections triggered a crowding-out effect. High levels of targeting inaccuracy (inclusion and exclusion errors) caused these social funds to become trapped merely as consumptive expenditures without generating leverage effects on the productivity of the real sector or long-term regional economic growth.

As a comprehensive pillar within the endogenous growth model, the accumulation of human capital represented by the Human Development Index (HDI) serves as the foundation of regional innovation capacity. HDI measures the fundamental capabilities of the labor force through dimensions of health, educational attainment, and standards of living, which collectively determine a region's capacity to absorb technology. Although the national Human Development Index (HDI) trend has continued to increase, its contribution to regional economic growth is often constrained by structural factors. Empirically, academic debates regarding the elasticity of HDI toward GRDP have not yet reached an equilibrium point. Mustaqim (2025) validated the classical paradigm that improvements in HDI exhibit the strongest positive correlation with regional economic expansion because the availability of an educated workforce attracts incoming investment. However, this paradigm was deconstructed by the findings of Taariwuan et al. (2025), who identified a significantly negative effect of HDI in certain regions. This phenomenon was attributed to a skills mismatch, occurring when the increasing output of educated labor is not accommodated by the structural transformation of local industries, ultimately resulting in educated unemployment or large-scale intellectual migration (brain drain) to more developed provinces. This logical discrepancy suggests that the effectiveness of HDI is highly dependent on the absorptive capacity characteristics of each regional economy.

This study formulates a comprehensive framework based on the debates and phenomenological disparities described above. The novelty of this study lies in the simultaneous integration of environmental shock variables (natural disasters), physical capacity (road infrastructure), fiscal policy protection (social assistance expenditure), and human capital accumulation (HDI) into a robust panel data regression model. Unlike previous studies, such as Amsyah (2025), which reduced macroeconomic analysis by excluding ecological disturbance variables, this manuscript incorporates all these determinant dimensions using the latest data from 34 provinces during the period of extreme transition from 2020 to 2024. Based on this research gap argument, this study aims to comprehensively analyze the influence of natural disasters, road infrastructure quality, social assistance expenditure, and the Human Development Index on the determinants of regional economic growth in Indonesia.

METHOD

This study employs a quantitative research design with a causal-explanatory approach. This approach

was selected because the study aims to explain the direction and magnitude of the causal relationships between the independent variables (natural disaster risk, road infrastructure quality, social assistance expenditure, and the Human Development Index) and the dependent variable (regional economic growth) in Indonesia.

The dependent variable in this study is Regional Economic Growth, which is measured using the growth rate of Gross Regional Domestic Product (GRDP) at Constant Prices in percentage terms (%). Meanwhile, four independent variables are analyzed in this study. First, Natural Disaster Risk, which is measured using the Disaster Risk Index data for each province in point units per year. Second, Road Infrastructure Quality, which is measured using the ratio of provincial road condition quality to the total length of provincial roads (categorized as good and moderate condition) in percentage terms (%). Third, Social Assistance Expenditure, which is measured through the proportion of realized social assistance expenditure in each province in billion Rupiah (Rp). Fourth, the Human Development Index (HDI), which is measured using a composite achievement score ratio (0–100) derived from the dimensions of health, education, and decent living standards in each province.

The population in this study encompasses all provinces in Indonesia during the research period. The sampling method employed is purposive sampling, namely a sampling technique based on specific considerations or criteria to ensure that the analyzed data are valid and comprehensive. The criteria used in determining the sample in this study include: (1) provinces in Indonesia that were administratively active during the observation period from 2020 to 2024; (2) provinces that published complete reports on the realization of Social Assistance Expenditure through the Ministry of Finance portal; and (3) provinces that possessed complete secondary data for all variables (GRDP, disaster frequency, road condition quality, and HDI) published by the Central Bureau of Statistics (BPS), the National Disaster Management Agency (BNPB), and the Directorate of Highways. Based on this sampling method, while considering the existence of newly established provinces in Papua whose historical data have not been available since 2020, the final sample consisted of 34 provinces. Using a five-year observation period (2020–2024), the total number of observations (balanced panel) in this study amounted to 170 observation units.

The analytical tool employed in this study is panel data regression, which combines time series data and cross-sectional data. The use of panel data regression is considered the most appropriate because it is capable of controlling individual heterogeneity across provinces, minimizing multicollinearity, and providing greater degrees of freedom, thereby producing more efficient model estimations. The basic regression model employed in this study is formulated as follows:

$$\boldsymbol{REG_{it}} = \boldsymbol{\alpha} + \boldsymbol{\beta_1 DRI_{it}} + \boldsymbol{\beta_2 RIQ_{it}} + \boldsymbol{\beta_3 Log(SAE)_{it}} + \boldsymbol{\beta_4 HDI_{it}} + \boldsymbol{\epsilon_{it}}$$

Where:

REG_{it} : Regional Economic Growth of province i in year t

DRI_{it} : Disaster Risk Index of province i in year t

RIQ_{it} : Percentage of Road Infrastructure Quality in province i in year t

SAE_{it} : Per capita social assistance expenditure of province i in year t

HDI_{it} : Human Development Index

of province i in year t

$\beta_1, \beta_2, \beta_3, \beta_4$: Regression coefficient parameters to be estimated

α : Constant term

ϵ_{it} : $Error\ term$

Log : Logarithm

To determine the most robust panel data regression estimation method (whether the Common Effect Model/CEM, Fixed Effect Model/FEM, or Random Effect Model/REM), a series of statistical tests were conducted sequentially through the Chow Test, Hausman Test, and Lagrange Multiplier (LM) Test. After obtaining the best estimation model, hypothesis testing was carried out by analyzing partial significance through the t-statistical test (at a 5% significance level), assessing the simultaneous model feasibility through the F-statistical test, and evaluating the explanatory power of the model using the Coefficient of Determination (Adjusted R-squared). The entire process of secondary data processing and inferential statistical analysis in this study was conducted using the econometric software EViews.

RESULTS AND DISCUSSION

This study employs panel data regression to estimate the influence of independent variables on regional economic growth across 34 provinces during the 2020–2024 period, with a total of 170 observation units. In panel data analysis, it is necessary to determine the most appropriate model among the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The best model is selected through the Chow Test and Hausman Test. The Chow Test is conducted to determine the most suitable approach between the Common Effect Model (CEM), which assumes a constant intercept, and the Fixed Effect Model (FEM), which accommodates differing intercepts across individuals. Meanwhile, the Hausman Test is used to compare and determine the most appropriate model between the Fixed Effect Model (FEM) and the Random Effect Model (REM).

Based on a series of model selection tests, the results of the Chow Test indicate that the probability value of the Cross-section Chi-square is 0.0000, which is smaller than 0.05. This finding suggests that the Fixed Effect Model (FEM) is superior to the Common Effect Model (CEM). Furthermore, the results of the Hausman Test show that the probability value of the Cross-section Random is 0.0000 < 0.05, thereby statistically establishing the Fixed Effect Model (FEM) as the most robust and efficient estimation model in this study compared to the Random Effect Model (REM). Based on these two tests, it can be concluded that the Fixed Effect Model (FEM) was selected as the most appropriate model for this research. The results of the tests are presented in Table 1 below:

Table 1. Results of the Hausman Test and Chow Test

Best Model Test	Prob.
Chow Test	0.0000
Hausman Test	0.0000

Source: Eviews 12 SV, processed by the author (2026)

Subsequently, classical assumption tests were conducted to evaluate the adequacy of the regression model and to ensure that the estimated coefficients satisfied the BLUE (Best Linear Unbiased Estimator) criteria, indicating that the estimation results are valid, unbiased, and reliable for drawing economic inferences (Gujarati, 2009). The classical assumption tests employed in this study consisted of the Multicollinearity Test and the Heteroskedasticity Test.

The results of the Multicollinearity Test reveal that all correlation coefficients among the independent variables remained well below the critical threshold of 0.80, indicating the absence of severe multicollinearity issues (Gujarati, 2009). Specifically, the correlation coefficient between the Disaster Risk Index (DRI) and Road Infrastructure Quality (RIQ) was -0.404226, while the correlation between Road Infrastructure Quality (RIQ) and Social Assistance Expenditure (SAE) was 0.351964. In addition, the correlation between Social Assistance Expenditure (SAE) and the Human Development Index (HDI) was 0.178525. These findings confirm that the model does not suffer from serious multicollinearity problems.

The absence of multicollinearity further indicates that the four independent variables: disaster risk, road infrastructure quality, social assistance expenditure, and HDI represent distinct yet complementary dimensions of economic development without significant overlap. This finding is consistent with the endogenous growth framework, which conceptualizes physical capital and human capital as separate determinants of long-term economic growth (Barro, 1990). Therefore, the regression model is considered statistically valid and appropriate for subsequent estimation procedures. The results of the Multicollinearity Test are presented in Table 2 below:

Table 2. Multicollinearity Test Results (Correlation Matrix)

Variables	DRI	RIQ	LN_SAE	HDI
DRI	1.000000	-0.404226	-0.510955	-0.514216
RIQ	-0.404226	1.000000	0.351964	0.373922
LN_SAE	-0.510955	0.351964	1.000000	0.178525
HDI	-0.514216	0.373922	0.178525	1.000000

Source: Eviews 12 SV, processed by the author (2026)

In the heteroskedasticity test, the Glejser Test approach was initially employed to detect the presence of heteroskedasticity symptoms. The results indicate that most independent variables were free from heteroskedasticity problems, as reflected by the probability values of the Disaster Risk Index (DRI) at 0.3254, Road Infrastructure Quality (RIQ) at 0.0904, and Social Assistance Expenditure (SAE) at 0.5059. However, the Human Development Index (HDI) variable exhibited a probability value below the 0.05 significance threshold, namely 0.0035.

As a remedial measure to address the detected heteroskedasticity issue without reducing the number of observations, this study applied a standard error correction method using the White Heteroskedasticity-Consistent Standard Errors approach (White Diagonal & Cross-section Covariance, d.f. corrected in EViews). According to Wooldridge (2019), the application of the White Robust Standard Error method does not alter the original regression coefficient estimates; rather, it adjusts the standard errors to make them robust against non-constant residual variance. By implementing the White Robust correction within the Fixed Effect Model (FEM), the bias in the standard errors was effectively neutralized. Consequently, the statistical significance tests (t-test and F-test) employed in the hypothesis-testing stage remain valid, reliable, and unbiased. The results of the heteroskedasticity test using the White

Diagonal approach are presented in Table 3 below:

Table 3. Heteroskedasticity Test Results (White Diagonal)

Variable	Prob.
C	0.1872
DRI	0.3972
RIQ	0.2820
LN_SAE	0.6032
HDI	0.1219

Source: Eviews 12 SV, processed by the author (2026)

After the model was confirmed to be statistically appropriate, hypothesis testing was conducted using the t-test, F-test, and coefficient of determination (R^2). The t-test results indicate that the Natural Disaster variable, proxied by the Disaster Risk Index (DRI), produced a regression coefficient of -0.2184 with a probability value of 0.0000 (<0.05). This finding suggests that natural disasters exert a negative and statistically significant effect on Regional Economic Growth. In other words, regions characterized by higher disaster risk tend to experience lower levels of economic growth.

Meanwhile, the Road Infrastructure Quality (RIQ) variable generated a regression coefficient of -0.040421 with a probability value of 0.2784 (>0.05), indicating that road infrastructure quality did not have a statistically significant effect on Regional Economic Growth during the observation period. A similar result was found for the Social Assistance Expenditure (SAE) variable, which recorded a coefficient value of 0.168363 and a probability value of 0.7783 (>0.05). Thus, partially, social assistance expenditure was not found to significantly influence Regional Economic Growth.

Furthermore, the Human Development Index (HDI) variable produced a regression coefficient of 0.390308 with a probability value of 0.0851 (>0.05), indicating that HDI did not have a statistically significant effect on Regional Economic Growth. The results of the t-test are presented in Table 4 below:

Table 4. t-Test Results

Variables	Coefficient	Prob.
C (Constant)	4.117311	0.8853
DRI	-0.218426	0.0000
RIQ	-0.040421	0.2784
LN_SAE	0.168363	0.7783
HDI	0.390308	0.0851

Source: Eviews 12 SV, processed by the author (2026)

The next stage involved conducting the F-statistical test to determine whether all independent variables included in the model jointly (simultaneously) influence the dependent variable, as well as to evaluate the overall goodness of fit of the regression model. Based on the regression results, the model produced an F-statistic value of 4.116781 with a Prob(F-statistic) value of 0.000000 (<0.05). Therefore, the regression model can be considered statistically fit and appropriate for analysis. Simultaneously, the variables of Natural Disaster Risk (DRI), Road Infrastructure Quality (RIQ), Social Assistance Expenditure (LN_SAE), and Human Development Index (HDI) were found to jointly exert a significant effect on Regional Economic Growth across 34 provinces in Indonesia during the 2020–2024 period.

Furthermore, the R-squared test results indicate an R-squared value of 0.535736, or 53.57%. This finding implies that the independent variables included in the model (DRI, RIQ, SAE, and HDI) collectively explain 53.57% of the variation in Regional Economic

Growth. Meanwhile, the remaining 46.43% is explained by other variables or factors outside the scope of this regression model. The results of both the F-test and R-squared test are presented in Table 5 below:

Table 5. Results of the F-Test and R-squared Test

Indicators	Value
F-statistic	4.116781
Prob(F-statistic)	0.000000
R-squared	0.535736
Adjusted R-squared	0.405601

Source: Eviews 12 SV, processed by the author (2026)

Discussion of Research Findings

The Effect of the Disaster Risk Index on Regional Economic Growth

The estimation results of the panel data regression model indicate that the Natural Disaster Risk variable, proxied by the Indonesian Disaster Risk Index (IDRI), carries a negative coefficient (-0.0421) and has a statistically significant effect on regional economic growth (Probability 0.0000 < 0.05). These findings confirm that higher levels of disaster risk within a province tend to suppress regional economic growth. The results strongly support the Broken Window Theory in macroeconomics, which postulates that external destructive shocks, such as natural disasters, lead to the destruction of physical capital accumulation (capital stock destruction). In addition, a high IDRI score reflects the presence of a fundamental economic system failure in the form of negative externalities, whereby environmental degradation resulting from anthropogenic activities triggers hydrometeorological disasters, while the resulting economic losses are ultimately borne by regional economies. This interpretation is consistent with contemporary disaster-risk literature, which argues that disaster risk is not merely a natural phenomenon but the outcome of interactions among hazard exposure, vulnerability, and insufficient adaptive capacity within socio-economic systems (Djalante, 2019; Sett et al., 2022; Otto et al., 2017).

Empirical evidence of this phenomenon is clearly reflected in the research data. West Sulawesi Province, for instance, recorded an extremely high Indonesian Disaster Risk Index (IDRI) score of 166.56 points in 2020. This elevated level of disaster vulnerability directly contributed to the contraction of the province's economic growth, which declined sharply to -2.34%. A similar pattern was observed in Maluku Province, which recorded an IDRI score of 161.50 points in 2024 and experienced relatively low GRDP performance, amounting to only IDR 37,209.36 billion. In contrast, regions equipped with more comprehensive mitigation infrastructure, such as the Special Capital Region of Jakarta (DKI Jakarta), succeeded in reducing their IDRI score to 59.29 points, thereby safeguarding physical capital accumulation and maintaining more stable economic growth. Such findings are aligned with resilience theory, which emphasizes that regions possessing stronger adaptive capacity, disaster preparedness systems, and mitigation infrastructure tend to recover more rapidly from shocks and experience lower long-term economic losses (Sutton et al., 2022; Matsumoto, 2020; Liu et al., 2021).

These findings are consistent with the empirical study conducted by Ilham et al. (2023), which revealed that every 1% increase in the disaster damage index directly reduced regional GRDP by approximately 0.45% in the year of occurrence. Natural disasters generate a scarring effect, forcing regional governments to reallocate up to 30% of

productive capital expenditure toward emergency rehabilitation spending. The negative impact becomes even more severe in regions lacking adequate mitigation systems, where economic recovery may require more than three years. This argument is further supported by Wariyanti and Rahmayani (2025), who emphasized that recurring natural disasters reduce both capital stock and labor capacity within affected regions, thereby directly constraining productivity growth and ultimately lowering aggregate GRDP output (Ilham et al., 2023; Wariyanti & Rahmayani, 2025). Similar conclusions were reached by Hallegatte et al. (2017), who demonstrated that disaster shocks disproportionately reduce productive assets, lower household resilience, and slow economic recovery, particularly in regions characterized by weak institutional capacity and limited disaster-risk governance. Moreover, recent studies suggest that repeated disaster exposure can create long-term development traps by discouraging investment, reducing labor productivity, and weakening regional competitiveness (Djalante, 2019; Zhao et al., 2022; Wan et al., 2024).

The Effect of Road Infrastructure Quality on Regional Economic Growth

The estimation results indicate that road infrastructure quality did not exert a statistically significant effect on regional economic growth during the 2020–2024 period. In fact, the variable exhibited a negative coefficient, with a regression coefficient value of -0.040421 and a probability level of 0.2784 (>0.05). At first glance, this finding appears to contradict the Social Overhead Capital (SOC) paradigm proposed by Rosenstein-Rodan, which views road infrastructure as a fundamental prerequisite for economic growth. However, the absence of statistical significance does not imply that road infrastructure is unimportant; rather, it reflects the presence of an investment time lag phenomenon in Indonesia. Road infrastructure development constitutes a long-term investment that cannot be immediately transformed into additional GRDP value within a short annual period, particularly during the research timeframe, which was heavily distorted by the COVID-19 pandemic.

During this period, although the proportion of roads in good condition increased, their utility remained suboptimal due to mobility restriction policies that severely disrupted the national transportation and logistics sectors. Between 2020 and 2022, mobility restriction policies (PSBB/PPKM) significantly reduced the utilization of land transportation infrastructure. Data from the Central Bureau of Statistics (BPS) show that the land transportation sector contracted by as much as -15.04% at its peak. Although the proportion of stable road conditions improved across several provinces, these infrastructure assets effectively became “passive assets” that failed to generate the movement of goods and services. This condition is consistent with infrastructure resilience literature, which emphasizes that infrastructure contributes to economic performance only when supported by sufficient utilization rates, network connectivity, and integration with productive sectors of the economy (Otuoze et al., 2021; Wan et al., 2024).

Furthermore, the negative coefficient may indicate the existence of sectoral dissonance. In provinces experiencing rapid GRDP growth, such as North Maluku and Central Sulawesi, the primary growth drivers were nickel downstream industries and extractive-sector activities, which relied more heavily on maritime infrastructure (sea toll systems) and electricity supply for

smelter operations than on conventional road transportation networks. This argument is empirically supported by Irwandi et al. (2025) and Putra and Maryanti (2026), whose studies demonstrated that the impact of road infrastructure development on GRDP in Indonesia typically involves a time lag of approximately three to five years. Their findings further suggest that the estimated coefficients often become statistically insignificant, or even negative, within the first two years following infrastructure construction. Without direct integration with industrial zones or major port facilities, road infrastructure tends to stimulate consumptive mobility rather than productive activities capable of generating significant value-added contributions to GRDP (Irwandi et al., 2025; Putra & Maryati, 2026). Recent resilience-oriented infrastructure studies similarly argue that transportation investments generate substantial economic returns only when embedded within broader production, logistics, and regional development ecosystems rather than functioning as stand-alone physical assets (Wan et al., 2024; Matsumoto, 2020).

The Effect of Social Assistance Expenditure on Regional Economic Growth

The Social Assistance Expenditure variable in this study exhibited a positive but statistically insignificant effect, with a regression coefficient of 0.168363 and a probability value of 0.7783 (>0.05). This finding suggests that fiscal intervention through social assistance programs across the 34 provinces during the observation period functioned primarily as a pure stabilization mechanism (automatic stabilizer) rather than as a distributive instrument capable of stimulating economic growth. From the perspective of Musgrave's fiscal theory, social assistance expenditure is designed to protect the purchasing power of vulnerable populations from falling into poverty during periods of economic shocks, such as health crises or natural disasters. However, due to its predominantly consumptive and short-term nature, aimed mainly at fulfilling subsistence needs such as food and basic healthcare, social assistance spending has not been able to transform into productive capital capable of encouraging regional capital accumulation or investment. In other words, during the study period, social assistance primarily functioned as a survival mechanism rather than a productive economic stimulus.

This interpretation is strongly supported by the adaptive social protection literature, which argues that social assistance programs are generally more effective in preventing welfare deterioration and strengthening household resilience than in directly accelerating economic growth (Bowen et al., 2020; Tenzing, 2020; Midgley, 2022). The lack of statistical significance may also be attributed to the relatively small proportion of social assistance expenditure compared to total regional government budgets (APBD), averaging less than 5% of provincial expenditure across Indonesia, as well as persistent challenges related to targeting accuracy at the regional level.

Although social assistance programs were effective in maintaining household consumption levels and preventing further economic deterioration, they lacked sufficient leverage to accelerate sectoral productivity, which serves as the primary driver of GRDP growth. Moreover, the Marginal Propensity to Consume (MPC) associated with social assistance funds was almost entirely concentrated in inelastic sectors, particularly basic necessities such as rice and cooking oil,

which generate only limited sectoral multiplier effects. This finding is consistent with the empirical study conducted by Nurul Dieniah Alfath et al. (2024), which emphasized that in order to generate substantial GRDP growth, social assistance policies must be accompanied by labor-intensive employment creation programs rather than merely relying on short-term cash transfer schemes that are rapidly exhausted without generating long-term capital accumulation within regional economies. Similar evidence from Indonesia indicates that social protection programs are highly effective at reducing vulnerability and poverty risks during crises but tend to have limited impacts on long-term productive transformation unless integrated with employment, entrepreneurship, and human capital development policies (Suryahadi et al., 2021; Gasior et al., 2024; Costella et al., 2023; Sengupta & Costella, 2023).

The Effect of the Human Development Index on Regional Economic Growth

The hypothesis testing results indicate that the Human Development Index (HDI) does not have a statistically significant effect on regional economic growth, as reflected by a regression coefficient of 0.390308 and a probability value of 0.0851 (>0.05). Although Endogenous Growth Theory (Romer, 1990) posits human capital as a key driver of innovation and long-term economic expansion, these findings reveal the presence of serious structural problems within Indonesia's labor market, particularly skill mismatch and limited labor market absorption capacity. The increase in HDI scores, measured through indicators such as mean years of schooling and life expectancy, was not accompanied by proportional improvements in economic productivity due to persistently high levels of educated unemployment.

According to data from the Central Bureau of Statistics (BPS), the Open Unemployment Rate (OUR) among university and diploma graduates remained consistently high during the 2020–2023 period, exceeding 5.5%. This condition suggests that while regions have succeeded in improving human capital quality, as reflected in rising HDI levels, regional economic structures have not been capable of generating sufficient formal employment opportunities to absorb educated workers effectively. Consequently, improvements in education and health outcomes have not automatically translated into higher economic output. This phenomenon is consistent with contemporary human-capital and resilience literature, which argues that the economic returns of human development depend heavily on complementary factors such as labor market efficiency, technological adoption, institutional quality, and productive employment opportunities (Holmemo et al., 2020; Midgley, 2022).

These findings indicate that, within a short-term period characterized by economic volatility and pandemic-related shocks, improvements in education and health outcomes were not immediately translated into substantial increases in GRDP growth. Irzain and Sihombing (2025) further argued that human capital accumulation requires stable economic structures and adequate labor market absorption capacity in order to contribute significantly to regional economic value added (Irzain & Sihombing, 2025). Recent studies similarly suggest that human capital contributes to economic resilience and growth only when supported by productive economic structures capable of transforming educational attainment into innovation, entrepreneurship, and labor productivity gains (Sutton et al., 2022; Zhao et al., 2022; Man et al.,

2021). Therefore, the insignificant effect of HDI in this study likely reflects not a failure of human capital itself, but rather the inability of regional labor markets and industrial structures to effectively utilize the available stock of human capital.

CONCLUSION

Based on the results of the analysis and discussion, this study concludes that natural disaster risk significantly hampers regional economic growth in Indonesia, as high levels of disaster vulnerability trigger physical capital destruction and negative externalities that suppress regional productivity. Meanwhile, road infrastructure quality has not yet made a significant contribution to regional economic growth in the short term, indicating the presence of investment time lags as well as a shift toward reliance on alternative forms of transportation capital in extractive-industry regions. Similarly, social assistance expenditure was found to have no significant effect on accelerating economic output, primarily because its function remains more oriented toward consumptive social protection mechanisms rather than productive economic stimulus. Finally, the Human Development Index (HDI) also did not exhibit a statistically significant effect on regional economic growth at the 95% confidence level, reflecting the existence of structural constraints in the form of skill mismatch and the limited absorption capacity of formal labor markets for educated workers across regions.

Recommendations

This study is subject to several limitations, particularly the relatively short observation period and the presence of economic anomalies caused by the COVID-19 pandemic, which distorted infrastructure utilization and the effectiveness of public expenditure. In addition, the infrastructure variables examined in this study were limited solely to land transportation connectivity. For future research, it is recommended that subsequent studies extend the observation period in order to capture the long-term effects of infrastructure investment and human capital accumulation more accurately. Further development may also be achieved by integrating additional connectivity indicators, such as digital and maritime infrastructure, as well as incorporating moderating variables such as labor absorption capacity or industrial sector investment. These additions would provide a more comprehensive understanding of how human capital quality improvements and social policy interventions can be transformed into sustainable regional economic value added.

REFERENCES

Amsyah, U. (2025). Faktor-faktor yang berpengaruh terhadap pertumbuhan ekonomi daerah dalam era desentralisasi Indonesia. *JIMBE, 3*(1). https://malaqbipublisher.com/index.php/JIMBE

Bank Indonesia Perwakilan Maluku Utara. (2021). *Ekonomi Maluku Utara bertumbuh positif, produk hilirisasi feronikel jadi faktor utama*. Tribun Ternate.

Bowen, T. V., Del Ninno, C., Andrews, C., Coll-Black, S., Gentilini, U., Johnson, K., Kawasoe, Y., Kryeziu, A., Maher, B. P., & Williams, A. M. (2020). *Adaptive social protection: Building resilience to shocks*. World Bank. https://doi.org/10.1596/978-1-4648-1575-1

Costella, C., van Aalst, M., Georgiadou, Y.,

Slater, R., Reilly, R., McCord, A., Holmes, R., Ammoun, J., & Barca, V. (2023). Can social protection tackle emerging risks from climate change, and how? A framework and a critical review. *Climate Risk Management, 40*, 100501. https://doi.org/10.1016/j.crm.2023.100501

Djalante, R. (2019). Key assessments from the IPCC Special Report on Global Warming of 1.5°C and the implications for the Sendai Framework for Disaster Risk Reduction. *Progress in Disaster Science, 1*, 100001. https://doi.org/10.1016/j.pdisas.2019.100001

Fischer, S. (2021). Post-disaster spillovers: Evidence from Iranian provinces. *Journal of Risk and Financial Management, 14*(5), 193. https://doi.org/10.3390/jrfm14050193

Gasior, K., Wright, G., Barnes, H., & Noble, M. (2024). Adaptive social protection in Indonesia: Stress-testing the effect of a natural disaster on poverty and vulnerability. *Social Policy & Administration, 58*(3), 505–520. https://doi.org/10.1111/spol.12983

Gertler, P., Gonzalez-Navarro, M., Gracner, T., & Rothenberg, A. D. (2024). *Road maintenance and local economic development: Evidence from Indonesia's highways*.

Grosh, M., Wadhwa-P. M., & Tesliuc, E. (2022). *Revisiting targeting in social assistance: A new look at old dilemmas*. World Bank. https://openknowledge.worldbank.org/handle/10986/37228

Hallegatte, S., Vogt-Schilb, A., Bangalore, M., & Rozenberg, J. (2017). *Unbreakable: Building the resilience of the poor in the face of natural disasters*. World Bank. https://doi.org/10.1596/978-1-4648-1003-9

Holmemo, C., Acosta, P., George, T., Palacio, R. J., Pinxten, J., Sen, S., & Tiwari, S. (2020). *Investing in people: Social protection for Indonesia's 2045 vision*. World Bank. http://hdl.handle.net/10986/33767

Ilham, A. P., Muljaningsih, S., & Sasongko. (2023). The effect of natural disaster on regional economic growth, unemployment, poverty, and human development index in thirty Indonesian provinces. *Journal of Indonesian Applied Economics, 11*(1), 40–59. https://doi.org/10.21776/ub.jiae.2023.011.01.4

Irwandi, H., Jamal, A., & Nasir, M. (2025). How investment mediates infrastructure effect on economic growth in Indonesia. *Grimsa Journal of Business and Economics Studies, 2*(2), 89–103. https://doi.org/10.61975/gjbes.v2i2.59

Irzain, K. M., & Sihombing, P. R. (2025). Analisis pengaruh indeks pembangunan manusia dan tingkat kemiskinan terhadap produk domestik regional bruto di 34 provinsi Indonesia (2020–2024). *Hasina: Jurnal Akuntansi dan Bisnis Syariah, 2*(2), 203–212. https://doi.org/10.35897/hasina.v2i2.2019

Lidyana, V. (2021). *Luhut beberkan 3 cara "sembuhkan" ekonomi Bali, apa saja?* DetikFinance.

Liu, X., Li, S., Xu, X., & Luo, J. (2021). Integrated natural disasters urban resilience evaluation: The case of China. *Natural Hazards, 107*(2),

2105–2122. https://doi.org/10.1007/s11069-021-04684-z

Man, S., Wu, X., Yang, Y., & Meng, Q. (2021). An assessment approach to urban economic resilience of the rust belt in China. *Complexity, 2021*, Article 6641726. https://doi.org/10.1155/2021/6641726

Matsumoto, T. (2020). Strengthening urban resilience/disaster risk management in Asian cities. In M. Tanaka & K. Baba (Eds.), *Resilient policies in Asian cities* (pp. 1–18). Springer. https://doi.org/10.1007/978-981-15-4328-9

Midgley, J. (2022). *Advanced introduction to social protection*. Edward Elgar Publishing. https://doi.org/10.4337/9781802207220

Mustaqim, A. A. (2025). *Pengaruh pendapatan daerah, indeks pembangunan manusia (IPM) dan pandemi Covid-19 di Sumatera Barat* [Skripsi sarjana, Universitas Andalas].

Ndii, D. (2022). *Africa's infrastructure-led growth experiment is faltering: It is time to focus on agriculture*. Carnegie Endowment for International Peace.

Nurul Dieniah Alfath, P., Andiny, P., Rizal, Y., & Safuridar, S. (2024). Pengaruh belanja bantuan sosial dan belanja subsidi terhadap kemiskinan di Provinsi Sumatera Utara. *Jurnal Ekonomi dan Pembangunan Indonesia, 3*(1), 13–23. https://doi.org/10.61132/jepi.v3i1.1050

Otto, I. M., Reckien, D., Reyer, C. P. O., Marcus, R., Le Masson, V., Jones, L., Norton, A., & Serdeczny, O. (2017). Social vulnerability to climate change: A review of concepts and evidence. *Regional Environmental Change, 17*(6), 1651–1662. https://doi.org/10.1007/s10113-017-1105-9

Otuoze, S. H., Hunt, D. V. L., & Jefferson, I. (2021). Neural network approach to modelling transport system resilience for major cities: Case studies of Lagos and Kano (Nigeria). *Sustainability, 13*(3), 1371. https://doi.org/10.3390/su13031371

Purwa, T., W., W., & Bahri, E. N. A. (2024). Indonesian economy under the shadow of catastrophic natural disasters: Empirical evidences from additive mixed model with P-spline smooth function. *Journal of Computing Research and Innovation, 9*(2). https://doi.org/10.24191/jcrinn.v9i2.433

Putra, V. V., & Maryati, S. (2026). The impact of infrastructure on economic growth in West Sumatra: A dynamic panel analysis. *Jurnal Informatika Ekonomi Bisnis*. https://doi.org/10.37034/infeb.v8i1.1372

Rana, I. A., Khaled, S., Jamshed, A., & Nawaz, A. (2022). Social protection in disaster risk reduction and climate change adaptation: A bibliometric and thematic review. *Journal of Integrative Environmental Sciences, 19*(1), 65–83. https://doi.org/10.1080/1943815X.2022.2108458

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5, Part 2), S71–S102. https://doi.org/10.1086/261725

Sengupta, S., & Costella, C. (2023). A framework to assess the role of social cash transfers in building adaptive

capacity for climate resilience. *Journal of Integrative Environmental Sciences, 20*(1). https://doi.org/10.1080/1943815X.2023.2218472

Sett, D., Widjaja, C. N., Sanady, P., Greco, A., Setiadi, N., Sagala, S., & Sandholz, S. (2022). *Hazards, exposure and vulnerability in Indonesia: A risk assessment across regions and provinces to inform the development of an adaptive social protection road map*. United Nations University Institute for Environment and Human Security (UNU-EHS), Munich Climate Insurance Initiative (MCII), & Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). https://doi.org/10.53324/UVRD1447

Sultan, L., Lito, J., Samudro, B. R., & Soesilo, A. M. (2025). *Digital transformation and regional development disparities in Indonesia*. The Fourth International Conference on Government Education Management and Tourism (ICoGEMT-4).

Suryahadi, A., Al Izzati, R., & Yumna, A. (2021). The impact of COVID-19 and social protection programs on poverty in Indonesia. *Bulletin of Indonesian Economic Studies, 57*(3), 267–296. https://doi.org/10.1080/00074918.2021.2005519

Sutton, J., & Arku, G. (2022). Regional economic resilience: Towards a system approach. *Regional Studies, Regional Science, 9*(1), 497–512. https://doi.org/10.1080/21681376.2022.2117331

Taariwuan, E., Kalangi, J. B., & Sumual, J. I. (2025). Pengaruh indeks pembangunan manusia dan kemiskinan terhadap pertumbuhan ekonomi di Kabupaten Nabire tahun 2010–2022. *Jurnal Berkala Ilmiah Efisiensi, 25*(7), 61–72.

Tenzing, J. D. (2020). Integrating social protection and climate change adaptation: A review. *WIREs Climate Change, 11*(2), e626. https://doi.org/10.1002/wcc.626

Wan, G., Sun, D., Peng, B., & Mao, X. (2024). Risk assessment of urban transportation complex hub from resilience perspective: An empirical study on Xi'an North Railway Station. *Natural Hazards Review, 25*(4), 04024042. https://doi.org/10.1061/NHREFO.NHENG-1897

Wariyanti, N. J., & Rahmayani, D. (2025). Pengaruh bencana alam terhadap PDRB provinsi di Indonesia: Pendekatan model pertumbuhan Solow-Swan. *Jurnal Ekonomi dan Pembangunan Indonesia, 25*(1). https://doi.org/10.7454/jepi.v25i1.1638

Widjaja, I., Deddy T. Tikson, & Rahmadanih. (2022). Association of development disparity, economic growth on poverty in South Sulawesi Province. *The Journal of Indonesia Sustainable Development Planning, 3*(3), 246–255. https://doi.org/10.46456/jisdep.v3i3.213

Zhao, R., Fang, C., Liu, J., & Zhang, L. (2022). The evaluation and obstacle analysis of urban resilience from the multidimensional perspective in Chinese cities. *Sustainable Cities and Society, 86*, 104160. https://doi.org/10.1016/j.scs.2022.104160