

Resource Rent Redistribution and Socio-Economic Development: A Composite Index Analysis of District Mineral Foundation (DMF) Expenditure in Odisha

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Received: 20 March 2026 Revised: 18 April 2026 Accepted: 24 April 2026 Published: 30 April 2026

Abstract

The mineral extraction in any region comes with a cost termed as the Resource Curse Hypothesis, and to address the issue faced due to intense mining, some countries are implementing the Resource Rent Redistribution. To understand its implementation, our study analyses the correlation between sectoral District Mineral Foundation (DMF) Fund expenditure and socio-economic growth in a resource-abundant region using a composite index based on Min-Max normalization, as used by the United Nations Development Programme (UNDP) and the Organization for Economic Co-operation and Development (OECD). The analysis utilizes annual data from 2016–17 to 2025–26, concentrating on four essential sectors—health, education, infrastructure, and water—that are pivotal to human development outcomes as supported by the existing literature¹. The findings indicate considerable temporal variations in development performance, with the Socioeconomic Development (SED) Index reaching its peak in 2020–21, augmented by relatively equitable sectoral investment, and experiencing a steep decline in subsequent years due to disproportionate allocation and diminished expenditure in critical sectors, notably water and infrastructure. The results indicate that socio-economic development is significantly influenced by both the scale of DMF expenditure and its allocation among various sectors. The research offers empirical validation for the resource rent redistribution framework through the comparison of various development indicators and provides the scope for policy-relevant insights for optimizing the efficacy of decentralized development funds, including the District Mineral Foundation (DMF) Fund.

Key Words: Subnational Mineral Revenue, Resource Rent Redistribution, District Mineral Foundation Fund, Socio-economic Development Index.

Introduction

Regions endowed with natural resources frequently encounter a dilemma in which substantial mineral riches fail to provide enhanced socio-economic results, a phenomenon commonly known as the resource curse (R. Auty, 2002; J. Sachs & Warner, 1995). In response, legislative frameworks like decentralized mineral revenue-sharing procedures have been established to guarantee the equitable distribution of mining revenues among the affected communities (Akeliwira George Ayuune & Anaba Bernard, 2022; Lujala & Narh, 2020; Segal, 2011). The District Mineral Foundation (DMF) Fund in India serves as a crucial instrumental mechanism for directing mining earnings towards local

development, specifically in health, education, infrastructure, potable water along with many other sectors (Mishra et al., 2025b; *National DMF Portal*, n.d.; *Where Is the DMF Money Meant for People Living in Mining Areas Going?*, n.d.). The efficacy of redistributive systems relies on both the extent of expenditure and its sectoral distribution, as well as its efficiency in enhancing living standards. Recent empirical methodologies highlight the formulation of composite socio-economic indices to assess development outcomes (Klugman, 2011; OECD, 2008). In this context, normalizing techniques, along with aggregation methods like the arithmetic mean and geometric mean, offer effective tools for multidimensional evaluation.

This study develops a Socio-Economic Development (SED) Index utilizing normalized measures of sectoral expenditure—Health, Education, Infrastructure, and Water—across a time series from 2016–17 to 2025–26. The analysis indicates considerable changes of *SED Index* over time, with optimal development performance recorded in 2020–21 (SED Index around 0.51) followed by a drop, signifying unpredictability in development results despite ongoing resource inflows.

This research enhances the current body of knowledge in multiple important aspects. Initially, it constructs a thorough Socio-Economic progress (SED) Index utilizing both arithmetic and geometric aggregation techniques, facilitating a comparative evaluation of compensatory and non-compensatory methods for assessing multidimensional progress. Secondly, it methodically analyzes sectoral differences in DMF Fund expenditure on health, education, infrastructure, and water, emphasizing how allocation imbalances affect overall development outcomes. The paper presents empirical information regarding the efficacy of resource revenue usage at the subnational level, illustrating how decentralized funding mechanisms turn financial resources into socio-economic advancement. The study enriches the knowledge of resource-based development dynamics by integrating these variables within a time-series analytical framework, providing a substantial methodological addition to the area.

Literature Review

2.1 Resource Curse and Revenue Allocation

The foundational literature on natural resources talks the relevant that shows how resource-abundant regions frequently encounter adverse socio-economic outcomes due to governance deficiencies, institutional frailties, and ineffective revenue allocation, characteristics commonly referred to as the resource curse (R. M. Auty, 1994; J. D. Sachs & Warner, 2001). These studies contend that an abundance of natural resources may provoke rent-seeking behavior, corruption, and the neglect of productive areas, ultimately obstructing long-term growth. Recent research has redirected attention to

institutional remedies, highlighting that effectively structured revenue-sharing arrangements might alleviate these negative impacts. Bauer et al., 2016 emphasized on the significance of transparency, accountability, and effective governance in the management of extractive revenues, whereas Loayza and Rigolini (2016) illustrate that the decentralized distribution of mining revenues can markedly enhance local welfare outcomes when executed efficiently. These viewpoints offer a robust theoretical basis for assessing decentralized institutional frameworks like the District Mineral Foundation (DMF) Fund, which seeks to allocate resource rents to communities impacted by mining activities.

2.2 Sectoral Public Expenditure and Development Results

A major body of literature highlights the essential importance of public expenditure in fostering socio-economic development, especially in vital sectors such as health, education, infrastructure, and water. Barro, 1991 finds a robust correlation between government expenditure and economic growth, emphasizing the need of effective public investment. Gupta et al., 2002 similarly demonstrate that augmented expenditure on health and education substantially improves human development metrics, such as life expectancy and literacy rates. Investment in infrastructure has been recognized as a crucial catalyst for economic growth and the mitigation of inequality, with Calderón & Servén, 2010 illustrating its enduring influence on productivity and regional advancement. In the Indian context, the efficacy of public expenditure is frequently challenged by sectoral disparities and inappropriate allocation, resulting in uneven developmental outcomes. This propels the necessity for integrated and multidimensional assessment frameworks capable of considering the aggregated effects of sectoral investments instead of evaluating them in isolation.

2.3 Composite Indices and Development Measurement

Composite indices function as a crucial mechanism for assessing and evaluating socio-economic performance, reflecting the multifaceted nature of

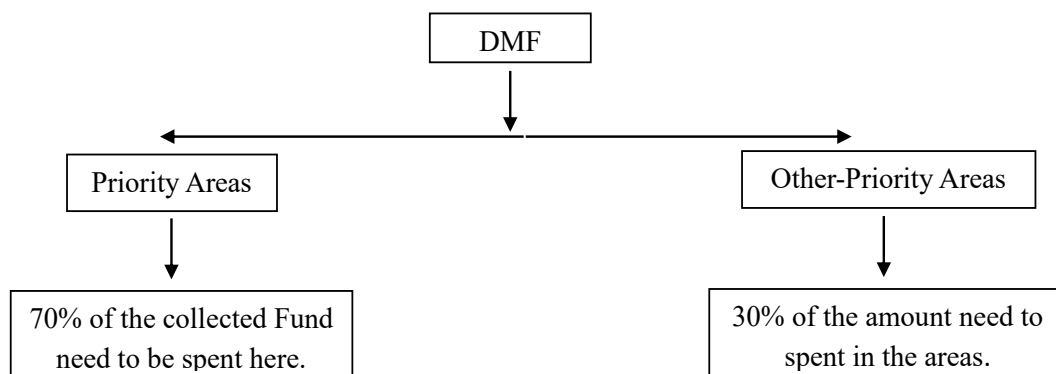
progress. The Human Development Index (HDI), created by UNDP, signifies a robust methodology by integrating standardized indices of health, education, and wealth into a singular composite metric through the geometric mean (Klugman, 2011). The implementation of geometric aggregation reduces the extent of replacement between dimensions, thereby holding that extreme performance in one dimension cannot be entirely varied upon the performance in another. The OECD, 2008 offers a detailed methodological framework for developing composite indicators, including normalization, weighting, and aggregation methods. The application of the geometric mean in the current study's SED Index adheres to established best practices, since it omits the disparities in sectoral performance and offers a more equitable depiction of development. Moreover, research by Mazziotta & Pareto, 2016 Substantiates the efficacy of composite indices in the examination of regional development, especially in identifying disparities and multidimensional advancement.

2.4 Utilization of Resource Revenue for Local Development (DMF Context)

Recent literature has increasingly emphasized the significance of resource revenue allocation in augmenting local development, especially in places impacted by mining activities (Söderholm & Svahn, 2015). This underscores the sustainability issues posed by extractive industries, stressing the necessity for robust legislative frameworks to secure enduring advantages. Wall & Pelon (2011) analyze governance challenges in the allocation of mining revenues, highlighting that inadequate institutional

capacity frequently diminishes the developmental benefits of resource richness. Lundstøl (2022) emphasizes the significance of institutional efficacy in converting resource earnings into concrete socio-economic results, whereas Gunton et al., (2021) contends that inadequately managed mining profits often do not enhance living conditions in impacted communities. In the Indian context, growing information regarding the operation of the District Mineral Foundation (DMF) indicates considerable diversity in resource allocation, with a propensity for sectoral bias, especially in infrastructure expenditure, and a little effect on wider human development metrics. The empirical trends seen in the current dataset illustrate these issues, including disproportionate water expenditure in 2018–19, a significant rise in infrastructure investment in 2020–21, and a pronounced fall in overall development performance in subsequent years, specifically 2024–25 and 2025–26. These trends reveal discrepancies in allocation and underscore the difficulties of attaining sustained and equitable development using resource revenue sources (Mishra et al., 2025a).

Mineral resources play a crucial role in a country's economic growth and self-sufficiency; however, mineral-rich regions often lag behind in socio-economic development due to governance gaps and unequal benefit distribution (Mishra et al., 2025b). To address this disparity, the Government of India introduced the District Mineral Foundation (DMF) under the MMDR Act, 2015, as a non-profit mechanism to channel mining revenues toward the welfare of affected communities (Revised PMKKKY Guidelines Ministry of Mines, n.d.).



Source-(Mishra et al., 2025b)

2.5 Limitations found in the Current Literature

Notwithstanding the expanding corpus of research on resource income management and public expenditure, significant gaps persist. Initially, there is an absence of time-series composite index analysis at the subnational level (Odisha Specific), especially for mining-affected areas. Secondly, current research seldom contrasts various aggregation methods, such as arithmetic and geometric means, to evaluate their effects on development measurement. Third, empirical data connecting the sectoral distribution of resource income to comprehensive socio-economic development outcomes within a multidimensional framework is limited. This study fills these gaps by developing a longitudinal SED Index utilizing normalized sectoral expenditure data and applying both arithmetic and geometric aggregation methods to deliver a thorough evaluation of development performance. This contributes to the literature on resource revenue usage and provides policy-relevant insights into the efficacy of decentralized development interventions.

Research Methodology

This study employs a quantitative and time-series research design to analyze the correlation between sectoral DMF expenditure and socio-economic growth from 2016–17 to 2025–26. The analysis centers on four essential sectors—health, education, infrastructure, and water—acknowledged as fundamental pillars of human growth and regional economic advancement (Barro, 1991; Gupta et al., 2002). These sectors are especially pertinent in resource-abundant areas, where institutional frameworks like decentralized mining revenue funds aim to enhance local welfare through routed public investment. The study develops a composite Socio-Economic Progress (SED) Index to include the multifaceted nature of progress, utilizing normalized expenditure data and aggregation methods based on recognized composite indicator methodologies (OECD, 2008).

The initial phase of the analytical framework entails the normalization of unprocessed data. The expenditure levels across the four sectors are

represented in monetary units (crores), although they demonstrate significant fluctuation in quantity and distribution over time. Certain years exhibit unusually elevated expenditures in the water sector relative to other sectors, potentially skewing comparative analyses if raw values are utilized directly. Therefore, the study utilizes the Min–Max normalization technique to tackle this issue, as it is commonly employed in the development of composite indices due to its simplicity and clarity (OECD, 2008). The normalization method converts each variable into a unitless scale from 0 to 1, facilitating comparability among indicators while maintaining the relative distribution of values. The normalized value of an indicator is mathematically derived as follows:

$$X_{Normalisation} = \frac{X_{ACT} - X_{MIN}}{X_{MAX} - X_{MIN}}$$

Where:

X_{ACT} = Actual value of the indicator

X_{MIN} = Minimum value of the indicating variables across all years

X_{MAX} = Maximum value of the indicating variables across all years

A normalized value of 1 (one) signifies the peak observed performance, while a value of 0 (zero) denotes the least performance. This transformation guarantees that all sectoral indicators are presented on a uniform scale, thus removing unit-based discrepancies and enabling aggregation.

The application of Min–Max normalization is crucial for several reasons. Initially, it preserves the original distributional attributes of the data without imposing assumptions regarding its statistical qualities, rendering it appropriate for very small time-series datasets (OECD, 2008). Secondly, it offers inherent interpretation, as normalized data explicitly indicate relative performance within the measured range. Third, this approach aligns with established methodologies in the formulation of multidimensional indices, such as the Human Development Index (HDI), which similarly use normalization to normalize several indicators (Klugman, 2011). Min–Max normalization is

recognized for its sensitivity to extreme values; however, this issue is alleviated in the current analysis due to the constrained nature of the dataset and the lack of extreme outliers beyond plausible policy variance.

Subsequent to normalization, the study develops four sector-specific indices: Health Index (Hnorm), Education Index (Enorm), Infrastructure Index (Inorm), and Water Index (Wnorm). Each index signifies the comparative performance of sectoral expenditure over time. The fundamental assumption is that increased expenditure signifies enhanced developmental effort, a prevalent proxy employed in public finance and development research in the absence of outcome-based indicators (Gupta et al., 2002). This assumption, although not directly reflecting efficiency or effectiveness, offers a reliable and quantifiable foundation for comparison study across time.

The study consolidates the normalized sectoral indices to build a composite Socio-Economic Development (SED) Index. Two distinct aggregation techniques are utilized: the arithmetic mean and the geometric mean. The arithmetic mean offers a straightforward average of the four sectoral indexes and is computed as follows:

$$SED_{Average} = (H + E + I + W) / 4$$

where H, E, I, and W are the normalized indices for health, education, infrastructure, and water, respectively. The arithmetic mean presupposes complete substitutability between sectors, suggesting that a deficit in one area can be entirely offset by a surplus in another. This feature serves as a valuable baseline metric; yet, it may be volatile for development levels in instances of significant sectoral imbalances. For instance, disproportionately large spending in a single sector—such as water—may artificially elevate the total index, despite subpar performance in other sectors.

To mitigate this constraint, the study additionally utilizes the geometric mean to build the final SED Index. The geometric mean is computed as:

$$SED_{Index} = (H \times E \times I \times W)^{1/4}$$

In contrast to the arithmetic mean, the geometric mean reduces the extent of substitutability among indicators and penalizes disproportionate development across sectors. Inferior performance in any single sector disproportionately adversely affects the total index. The application of the geometric mean is especially suitable in multidimensional development analysis, since it inculcate the idea that equitable advancement across sectors is crucial for sustainable development (UNDP, 2010). This methodology has been extensively embraced in the updated HDI framework and is substantiated by empirical studies on composite indicators (Mazziotta & Pareto, 2016).

The selection of the aggregate method is additionally substantiated by theoretical considerations. The arithmetic mean signifies a compensatory method, appropriate when trade-offs across dimensions are permissible, while the geometric mean denotes a non-compensatory method, prioritizing equity and balance across dimensions (OECD, 2008). Utilizing both methodologies, the study offers a more thorough evaluation of growth, facilitating a comparison between idealized and practical circumstances.

The study used an equal weighting scheme, attributing identical significance to each of the four areas. This indicates that each sector contributes 25 percent to the aggregate index. Equal weighting is frequently employed in the development of composite indices because of its normative neutrality and simplicity (OECD, 2008). It mitigates subjective bias in the allocation of varying significance to sectors and is especially suitable for exploratory investigations where empirical support for other weighting methodologies is rare. Furthermore, equal weighting guarantees alignment with known indices like the HDI, which similarly allocates equal weights to its components (Klugman, 2011). While alternate techniques like principal component analysis (PCA) based weighting can be utilized, they necessitate larger datasets and may increase complexity without enhancing interpretability.

The developed SED indices are examined throughout time to discern trends, patterns, and

structural alterations in developmental performance. This temporal study facilitates the identification of phases of elevated and diminished development, together with sectoral contributions to overall performance. The dataset reveals a maximum in the SED Index during 2020–21, followed by a downward trend in the ensuing years. These trends offer insights into the efficacy and sustainability of public expenditure strategies.

To support the methodological reliance, various factors are integrated into the analysis. Initially, normalization rectifies scale disparities among sectors, hence facilitating comparability. Secondly, employing both arithmetic and geometric aggregation reduces aggregation bias and improves analytical robustness. The selection of sectors guarantees comprehensive coverage of development, encompassing both social (*health and education*) and physical (*infrastructure and water*) dimensions. The utilization of consistent data sources improves reliability and internal validity.

Notwithstanding its advantages, the technique possesses specific restrictions. Utilizing expenditure as a criterion for development fails to encompass outcomes such as enhancements in health status, educational achievement, or access to services. Moreover, the equal weighting approach may not accurately represent the true relative significance of various sectors in shaping development outcomes. The normalization procedure is susceptible to outliers, although this concern is mitigated in the current dataset by adopting expert views. Moreover, qualitative criteria, including governance quality, institutional capability, and implementation efficiency, are not explicitly integrated into the analysis.

Although sectoral public expenditure (DMF Fund) has been used as a proxy for developmental effort, future studies may benefit from incorporating direct outcome indicators. Through the integration of normalization, aggregation, and temporal analysis, it provides a vital methodology for assessing the efficacy of sectoral public expenditure. The application of the geometric mean-based SED Index notably augments the policy significance of the findings by highlighting equitable development

across sectors, thus conforming to modern methodologies in development assessment and resource governance literature (Klugman, 2011; Mazziotta & Pareto, 2016).

Results and Discussion

The empirical examination of the Socio-Economic Development (SED) Index from 2016–17 to 2025–26 indicates notable temporal variations influenced by changes in sectoral DMF Fund spending in health, education, infrastructure, and water. The findings indicate that development outcomes are not merely contingent on the level of expenditure but are significantly affected by the distribution of resources among sectors, in alignment with multidimensional development frameworks (OECD, 2008).

During the beginning years, 2016–17 and 2017–18, the SED Index is comparatively low, indicating restricted and uneven sectoral investment. Despite a little enhancement in 2017–18 attributed to elevated health expenditure, the absence of equitable growth across sectors hampers comprehensive development. A considerable increase is noted in 2018–19, during which the SED Index markedly improves, mostly due to extraordinarily elevated expenditures in the water sector. The disparity between the arithmetic mean and the geometric mean this year underscores sectoral imbalance, suggesting that substantial investment in a particular area does not result in holistic development (Mazziotta & Pareto, 2016). The index experiences a significant decrease in 2019–20, although robust infrastructure investment, primarily due to exceedingly poor performance in the water sector. This illustrates the ambiguity of the geometric mean-based SED Index to sectoral shortcomings and underscores the necessity of sustaining minimum investment thresholds across all facets of development. The peak of socio-economic performance is in 2020–21, during which the SED Index attains its apex value, bolstered by comparatively equitable and substantial investment in infrastructure, water, education, and health. This discovery highlights the significance of synchronized and multifaceted investment

techniques in attaining optimal developmental results (Gupta et al., 2002).

Nevertheless, the improvement is not continued in the following years. In 2021–22, despite optimal normalized values in health and education, the SED Index experienced a considerable reduction due to minimal water expenditure, demonstrating the non-compensatory characteristic of the geometric mean. The decline persists during 2022–23 and 2023–24, signifying diminished investment across several sectors and highlighting inappropriateness in resource distribution. The situation becomes a concern in 2024–25 and 2025–26, when the SED Index attains minimal levels, indicating a significant decline in developmental performance and heightening concerns regarding sustainability. An important observation in the analysis is the persistent discrepancy between the arithmetic and geometric means, with the former exaggerating development amid sectoral imbalance. This substantiates the application of the geometric mean as a more dependable indicator for socio-economic

development, as it penalizes disparate sectoral performance and underscores the importance of balanced growth (Klugman, 2011). The results underscore the key importance of infrastructure and water sectors in influencing overall development outcomes, suggesting that investments in physical and essential services are vital complements to social sector expenditures (Dash & Sahoo, 2010).

The findings empirically validate the Resource Rent Redistribution theory, indicating that although financial resources are essential, their efficacy is contingent upon equitable distribution and optimal utilization (Bauer et al., 2016). The observed volatility in the SED Index suggests that erratic and biased expenditure patterns can be challenging developmental achievements, highlighting the necessity for cohesive planning and governance reforms. The study indicates that sustainable socio-economic development necessitates not just augmented DMF expenditure but also smart allocation across critical sectors to guarantee inclusive and enduring advancement.

Table-1 SED Index interpretation (Similar to HDI index value as given by UNDP)

SED Avg=(Hnorm+Enorm+Inorm+Wnorm)/4	
SED Indx=GEOMEAN(Hnorm*Enorm*Inorm*Wnorm)	
Index Value	Meaning
0	Lowest performance
0–0.3	Low
0.3–0.7	Medium
0.7–1	High
1	Highest performance

Hnorm-Health Normalisation;
 Inorm-Infrastructure Normalisation;

Enorm-Education Normalisation;
 Wnorm-water Normalisation

Table-2 : DMF Fund Expenditure and their Normalisation figure of Last 10 Years for SED index calculation

Year	Health (Cr)	Hnorm	Education (Cr)	Enorm	Infrastructure (Cr)	Inorm	Water (Cr)	Wnorm	SED Avg	SED Index(geometric Mean Index)
2016-17	1.57	0.013787	14.8	0.068149	7.56	0.029832367	47.01	0.074543	0.046578	0.03801915
2017-18	46	0.541835	17.77	0.0819932	3.83	0.015015492	62.29	0.098773	0.184404	0.090095992
2018-19	7.77	0.087473	71.69	0.3333333	21.4	0.084809724	630.63	1	0.376404	0.222997465
2019-20	42.24	0.497148	57.46	0.2670023	56.63	0.2247557	1.66	0.002631	0.247884	0.094123024
2020-21	11.32	0.129665	133.16	0.6198667	251.79	1	547.99	0.868956	0.654622	0.5140787
2021-22	84.55	1	214.71	1	65.85	0.26138079	0.88	0.001394	0.565694	0.138156763
2022-23	11.02	0.126099	137.99	0.642381	25.91	0.102725034	4.67	0.007404	0.219652	0.088594743
2023-24	3.08	0.031733	27.91	0.1292593	55.03	0.218399936	3.38	0.005358	0.096188	0.046806842
2024-25	0.41	0.001	2.4	0.0103482	10.24	0.040478271	2.68	0.004248	0.014019	0.006494884
2025-26	2.03	0.019254	0.18	0.001	0.05	0.001	0.001	0.001	0.005563	0.00209473

Source-Constructed by Authors after extracting Data from Odisha DMF Portal

Hnorm-Health Normalisation; Enorm-Education Normalisation; Inorm-Infrastructure Normalisation; Wnorm-water Normalisation and SED Avg-Socioeconomic Development Average and SED Index-GM of all key variables in consideration for Indexation

* Expenditure figures for 2024-25 and 2025-26 are provisional estimates based on available trends and the budget document

Conclusion

This study offers a thorough evaluation of socio-economic growth through a composite index methodology grounded in sectoral DMF Fund expenditure on health, education, infrastructure, and water. The results indicate that developmental outcomes fluctuate significantly over time and are profoundly affected by the allocation of expenditures among various sectors. Although specific years, notably 2020–21, illustrate that strategic and synchronized investment can markedly improve development performance, the general trend reveals instability and an absence of sustainability in developmental results. The study's primary contribution is to illustrate the methodological significance of aggregation

procedures. The comparison of arithmetic and geometric means indicates that the former often overestimates progress amid sectoral imbalances, while the latter offers a more reliable and policy-relevant indicator by prioritizing balanced growth. This corresponds with multidimensional development frameworks like the Human Development Index, which emphasize equity across various aspects (Klugman, 2011).

The findings underscore that essential areas like water and infrastructure are relevant in influencing overall development outcomes. Despite substantial investments in health and education, inadequacies in fundamental services markedly diminish the overall development rating. This highlights the interconnection of developmental sectors and the necessity for cohesive policy strategies. The recent drop in the SED Index indicates concerns regarding the effectiveness and sustainability of resource revenue usage, indicating that financial availability is inadequate without efficient allocation and governance procedures. The analysis substantiates the primary assertion of the resource rent redistribution theory: the developmental influence of natural resource income is contingent not only on their scale but also on the efficacy of their

management and distribution (Bauer et al., 2016). The results align with the extensive research on the resource curse, highlighting that inadequate governance can hinder development outcomes, even in the presence of abundant resources (J. D. Sachs & Warner, 2001).

This study's findings indicate significant policy implications for enhancing the efficacy of decentralized resource revenue mechanisms, including the District Mineral Foundation (DMF). Policymakers must prioritize an equitable distribution of finances among essential -health, education, infrastructure, and water- because evidence indicates that disproportionate spending severely hampers overall development results. Specifically, fundamental services such as water and infrastructure want prioritized focus, as inadequacies in these domains significantly diminish socio-economic performance, notwithstanding increased expenditure in other sectors (Calderón & Servén, 2010). Secondly, there is an urgent necessity to enhance institutional capacity, openness, and accountability in the deployment of funds to reduce inefficiencies and guarantee that resources are linked with local development requirements (Bauer et al., 2016). Third, implementing composite index-based monitoring systems, such as the SED Index formulated in this study, can assist policymakers in monitoring multidimensional progress and making evidence-based decisions. Furthermore, there is a necessity for sustained and consistent investment strategies to prevent the pronounced volatility in development performance shown in recent years. Policy frameworks should prioritize minimum sectoral allocation thresholds, periodic review using composite indices, outcome-based evaluation, correlating financial expenditures with quantifiable enhancements in living standards, thereby ensuring that resource revenues contribute to sustainable and equitable development (Loayza & Rigolini, 2016).

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ⁱ MDPI-Multidimensional Poverty Index, OXFAM Report