Research Paper

EPRA International Journal of Economic and Business Review-Peer Reviewed Journal
Volume - 12, Issue - 9, September 2024 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187

SJIF Impact Factor (2024): 8.808 || ISI Value: 1.433 || Journal DOI URL: https://doi.org/10.36713/epra2012

ASSESSING RURAL INFRASTRUCTURE IN INDIAN STATES THROUGH A COMPOSITE INDEX OF ECONOMIC AND SOCIAL DEVELOPMENT

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ABSTRACT DOI No: 10.36713/epra18441 Article DOI: https://doi.org/10.36713/epra18441

This research paper evaluates infrastructure in rural areas of Indian states, utilizing cross-sectional data from India and its 20 major states. To assess the performance of infrastructure, the study develops a composite index for economic and social infrastructure, incorporating key indicators such as tele-density, rural road length, electrification, the number of schools, access to safe drinking water, and primary health centres. Data is sourced from various secondary reports, including government publications and national surveys, ensuring a comprehensive overview of essential variables. To analyse the data, the Z-score technique standardizes the variables, and min-max scaling normalizes the weighted indicators to a composite index ranging from 0 to 100. States are classified as low, moderate, good, or high performers based on this index. Findings reveal significant disparities in infrastructure development, with states like Kerala, Maharashtra, and Uttar Pradesh performing well in economic infrastructure. However, social infrastructure reveals a more complex landscape, with Uttar Pradesh excelling while states like Assam, Chhattisgarh, and Jharkhand show significant lagging. These differences highlight the fact that gains in social services are not always correlated with progress in the economic infrastructure. The study highlights the need for focused governmental interventions to improve infrastructure on both fronts and support all-encompassing rural development. Ultimately, enhancing the quality of life in rural India and guaranteeing equitable growth rests on narrowing the gap between economic and social infrastructure investment.

KEYWORDS: *Economic Infrastructure, Social Infrastructure, Composite index, Z-Score, Min-max scaling*

INTRODUCTION

The socioeconomic landscape of a country is greatly influenced by the development of its rural infrastructure, especially in countries like India where a large portion of the population lives in rural communities. Adequate infrastructure, including both economic and social dimensions, is crucial not only for enhancing economic growth but also for improving the overall quality of life. This research explores into the multidimensional impact of infrastructure development in rural regions across several states of India. Infrastructure can be broadly classified into economic and social components. Economic infrastructure includes roads, transportation networks, energy supply systems, and communication facilities, which form the backbone of economic operations in rural regions. These infrastructural aspects are vital for enabling the movement of products and services, connecting rural economies to metropolitan centres and global markets, and so boosting growth and development. On the other hand, social infrastructure contains healthcare facilities, educational institutions, safe drinking water supply, sanitation systems, and housing facilities. These are essential for developing human capital, guaranteeing minimal living conditions, and fostering social cohesion in rural areas. The accessibility to healthcare services, hygiene habits, dietary habits, and general living conditions are all strongly impacted by the quantity and calibre of social infrastructure. while economic and social infrastructure has improved, more progress is needed. State-level regression analysis by Srivastava & Mujoo (2017) shows economic infrastructure significantly contributes to development. However, strengthening

and improving social infrastructure is essential for inclusive benefits.

In rural India, there exists a complex and noteworthy correlation between the development of infrastructure and health results. Sufficient road and transportation network infrastructure not only makes healthcare services more accessible, but it also lowers death rates from avoidable causes. Furthermore, dependable energy supply systems are essential for running medical facilities, guaranteeing the ongoing operation of medical devices, cooling medications and vaccines, and upholding hygienic conditions. A key factor in reducing waterborne illnesses and enhancing general hygiene behaviours, which in turn leads to improved health outcomes, is having access to clean drinking water and sanitary facilities. Clean water access affects life expectancy and death rates emphasizing the need for government focus on water provision (Mohapatra, 2022). Furthermore, investments in social infrastructure by healthcare facilities and educational institutions improve community health literacy, encourage preventative healthcare practices, and give communities the authority to effectively control their own health. The study by Varkey, Joy & Panda (2020) examines health infrastructure development's impact on health outcomes and economic growth in major Indian states. It finds a positive relationship between health infrastructure and life expectancy, economic growth, and a negative relationship with infant mortality. State-level analysis confirms these associations with gross state domestic product and life expectancy, and inverse correlations with infant mortality.

Considering the acknowledged significance of infrastructure development, there are differences in the accessibility and calibre of rural infrastructure throughout the various Indian states. These regional differences are caused by a number of variables, including economic inequality, geographic isolation, and differing degrees of government involvement. Despite public initiatives, rural India's infrastructure remains inadequate, showing unsatisfactory progress with varying state performances (Ghosh, 2017). In Arunachal Pradesh and the North East Region, despite progress in health indicators, challenges include remote terrain, poor connectivity, and inadequate healthcare facilities. Shortages and uneven distribution of human resources, coupled with lacking amenities, hinder service quality. Kaushik (2005) A strategic roadmap is crucial to enhance healthcare delivery, ensure skilled staffing, and improve infrastructure sustainably. Comprehending these discrepancies is crucial in order to devise focused policy measures intended to enhance infrastructure and, in turn, improve health outcomes in impoverished rural areas.

In conclusion, public health and economic prosperity in rural India are correlated with the development of infrastructure. Policymakers can better the lives of millions of people who live in rural communities and encourage sustainable development by addressing infrastructure deficiencies and promoting equitable access to essential services. With India's varied and dynamic rural landscape as its backdrop, this research aims to add to the increasing body of evidence on the significance of infrastructure in attaining health equity and societal advancement.

RESEARCH GAP

Despite existing literature on infrastructure's role in development, comprehensive studies focusing on rural infrastructure in Indian states remain scarce. The integration of social and economic factors, regional differences, and longitudinal perspectives is frequently ignored in current research. By creating a composite score that assesses the state of social and economic infrastructure in rural areas, this study seeks fill these gaps. It aims to draw attention to disparities and improve knowledge of how infrastructure affects rural development by examining state performance.

OBJECTIVES

1. To develop a composite index that evaluates the level of economic and social infrastructure in rural areas across Indian states.
2. To analyse the performance of Indian states in terms of rural infrastructure development, highlighting disparities in economic and social infrastructure.

RESEARCH METHODOLOGY

This research paper utilises the cross-sectional data and assess the infrastructure in rural areas of India and its states. India and its 20 major states have been included in the scope of this study. Data is collected from various secondary sources like Annual reports, Ministry of Telecommunication; Basic Road Statistics of India, Ministry of Road Transport and Highways; All India Electricity Statistics, Central Electricity Authority; UDISE+ Report 2021-22, Ministry of Education; Economic Survey 2022-23; Rural Health Statistics 2021-22, National Health Profile, Ministry of Health and Family Welfare; Sample Registration System (SRS), Census of India; to obtain information on key variables such as the availability of Economic and social infrastructure. The selected variables are the composite index of economic infrastructure (EII), the composite index of social infrastructure (SII). Main indicators for Economic Infrastructure include Tele-density, Length of rural roads, Number of electrified villages. Indicators for Social Infrastructure include Number of Schools in Rural areas, Number of Rural households with access to safe drinking water in India, and Primary Health Centres.

Data Analysis: To ensure the variables are on the same scale, Z-Score technique is used to standardize the variables. Prior to computing the composite index, all

of the weighted variables are normalized using min-max scaling to a single scale. Weights are applied to these indicators depending on their relative importance. To create a scale from 0 to 100, this composite index is normalized. States are categorized in terms of low, moderate, good and high performers.

Economic and Social Infrastructure in Rural Areas of Indian States

For the purpose of this study, infrastructure is categorized into economic and social dimensions. The selected variables for economic infrastructure given in Table 1 include tele-density, the length of rural roads, and number of electrified villages. Tele-density measures the number of telephones per hundred people in rural areas. Kerala has the highest tele-density, indicating better communication infrastructure and accessibility, while Jharkhand has the lowest, likely due to economic and geographic challenges. The length of rural roads represents the extent of road infrastructure in rural areas. Maharashtra has the most extensive network with 426,327 km of rural roads, reflecting significant investment in connectivity, while Haryana has only 7,027 km, which may be due to its smaller rural area and higher urbanization. Electrified villages indicate the percentage of villages with electricity access. As of 2022, 100% of villages in India were electrified. Uttar Pradesh has the highest number of electrified villages, aligning with its large rural population, whereas Kerala has the least, consistent with its smaller number of villages.

Table 1: Economic and Social Infrastructure Indicators

States	Tele-density	Length of Rural Roads (km)	All India villages Electrified	Total number of Schools in rural areas	Households with access to Safe Drinking Water	Primary Health Centres (PHCs)
Andhra Pradesh	75.89	100132	16158	49810	88.6	1142
Assam	51.69	372510	25372	57473	68.3	920
Bihar	34.4	259507	39073	84040	93.9	1492
Chhattisgarh	10.92	56575	19567	50168	84.1	770
Gujarat	71.26	132467	17843	41439	84.9	1474
Haryana	68.14	7027	6642	18008	92	394
Himachal Pradesh	96.85	53033	17882	17171	93.2	553
Jammu and Kashmir	61.81	75684	6337	25555	70.1	891
Jharkhand	9.04	44317	29492	40780	54.3	291
Karnataka	69.45	220130	27397	54918	84.4	2138
Kerala	217.59	188517	1017	12917	28.3	780
Madhya Pradesh	30.47	232344	51929	104010	73.1	1266
Maharashtra	64.34	426327	40956	81903	73.2	1853
Odisha	60.97	226922	47677	57186	74.4	1288
Punjab	68	104565	12168	21675	96.7	422
Rajasthan	56.77	220402	43264	88362	72.8	2133
Tamil Nadu	64.17	170246	15049	43180	92.2	1422
Uttarakhand	26.9	44805	15745	19206	89.5	531
Uttar Pradesh	49.44	255576	97813	221117	94.3	2919
West Bengal	55.03	157497	37463	82551	91.4	915
India	57.67	4522228	597464	1234000	82.7	24935

Source: Annual reports, Ministry of Telecommunication; Basic Road Statistics of India, Ministry of Road Transport and Highways; All India Electricity Statistics, Central Electricity Authority; UDISE+ Reports, Ministry of Education; Economic Survey 2022-23; Rural Health Statistics 2021-22, Ministry of Health and Family Welfare.

The selected variables for social infrastructure as represented by Table 1 include the total number of schools, households with access to safe drinking water in rural areas, and primary health centres (PHCs). The total number of schools indicates the educational institutions in rural areas. Uttar Pradesh has the highest number of schools due to its large population and government efforts to improve education, while Kerala has the lowest, possibly due to its focus on

quality over quantity. Households with access to safe drinking water measure the availability of clean water. Uttar Pradesh leads in this area, reflecting successful water supply initiatives that enhance public health by reducing waterborne diseases. Primary health centres (PHCs) provide essential medical services in rural areas. Jharkhand has the lowest number, likely due to resource constraints and challenging terrain, indicating a need for more healthcare investments.

Table 2: Composite Index of Economic and Social Infrastructure

States	EII	SII
Andhra Pradesh	30.95	40.70
Assam	69.67	28.86
Bihar	54.41	54.46
Chhattisgarh	0.00	32.86
Gujarat	35.23	42.65
Haryana	6.83	25.36
Himachal Pradesh	33.36	28.25
Jammu and Kashmir	14.71	23.85
Jharkhand	4.10	9.60
Karnataka	54.63	54.97
Kerala	92.17	0.00
Madhya Pradesh	57.35	44.41
Maharashtra	93.82	49.78
Odisha	66.06	37.42
Punjab	25.70	28.66
Rajasthan	60.32	55.02
Tamil Nadu	36.30	45.63
Uttarakhand	2.08	26.49
Uttar Pradesh	100.00	100.00
West Bengal	45.88	44.09

Source: Author's Calculations.

Table Two represents the composite indices of economic infrastructure (EII), and social infrastructure (SII). A composite index is a statistical tool that combines multiple individual indicators into single aggregate measure which is used to summarise multiple individual indicators. Here this index is constructed to represent and overall picture of the infrastructure quality present in the rural areas of Indian states. The selected variables have different units of measurement, Z-Score standardization is used to ensured that all indicators are comparable.

The Z-score formula is:

$$\mathbf{Z = (X - \mu) / \sigma}$$

Where: Z = Z-score (standardized value)
X = Raw value (data point)
μ = Mean
σ = Standard deviation

Weights are assigned to these indicators based on their relative importance. Once standardised, the weighted indicators are combined through summation. Thus, EII and SII is constructed as follows:

EII = (0.35×tele-density) +(0.35×length of rural roads) +(0.3×number of electrified villages)

SII = (0.3×total number of schools) +(0.3×households with access to safe drinking water in rural areas) +(0.4×primary health centres)

All the variables are normalized to a common scale using min-max scaling before calculating the composite index. This compositive score is normalised to get a 0-100 scale.

$$\mathbf{Normalized\ Value = (X - Min) / (Max - Min) \times 100}$$

Where: X = Raw value (data point)
Min = Minimum value
Max = Maximum value

Table 3: States' performance categorized based on Composite index

Categories	Economic Infrastructure	Social Infrastructure
Low Performers: 0-40	Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Punjab, Tamil Nadu, Uttarakhand	Assam, Chhattisgarh, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Kerala, Odisha, Punjab, Uttarakhand
Moderate Performers:40-60	Bihar, Karnataka, Madhya Pradesh, West Bengal	Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, West Bengal
Good Performers: 60-80	Assam, Odisha, Rajasthan	
High Performers: 80-100	Kerala, Maharashtra, Uttar Pradesh	Uttar Pradesh

Source: Author's Calculations based on Table 2.

The categorization of states in Table 3 based on economic and social infrastructure reveals diverse levels of development across Rural areas of India. In terms of economic infrastructure, states like Kerala, Maharashtra, and Uttar Pradesh are high performers, showcasing strong infrastructure, while states such as Andhra Pradesh, Chhattisgarh, and Gujarat fall into the low-performing category. Moderately performing states, like Bihar, Karnataka, and Madhya Pradesh, exhibit mid-level infrastructure development. When it comes to social infrastructure, however, the distribution differs. Uttar Pradesh stands out as the only high performer, while states such as Assam, Chhattisgarh, and Kerala show weaker social infrastructure. Surprisingly, despite being high performers in economic infrastructure, Kerala and Maharashtra lag in social sectors like health and education. Conversely, states like Andhra Pradesh and Gujarat show moderate development in social infrastructure but remain low performers in economic infrastructure, highlighting the uneven progress across regions.

CONCLUSION

The analysis of economic and social infrastructure in rural Indian states reveals significant disparities in development levels across the country. By utilizing a composite index, the study highlights key variables such as tele-density, rural road length, and electrification for economic infrastructure, along with the number of schools, access to safe drinking water, and primary health centres for social infrastructure. States like Kerala, Maharashtra, and Uttar Pradesh excel in economic infrastructure, indicating substantial investments in connectivity and access. However, the findings also show that social infrastructure presents a more complex picture, with Uttar Pradesh standing out as a high performer while states like Assam, Chhattisgarh, and Jharkhand lag significantly.

This disparity implies that gains in social services are not always a result of economic advancements. Furthermore, Andhra Pradesh and Gujarat have a moderate level of social infrastructure; nonetheless, their economic performance is inadequate, indicating an unequal improvement. These observations highlight the necessity of focused policy interventions that improve social and economic infrastructure in order to guarantee comprehensive rural development. In the end, increasing the overall quality of life in rural parts of India and promoting equitable growth depend on closing the gap between these two dimensions. The significance of investing in infrastructure with a balanced approach is emphasized by this study.

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