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THE STATUS OF RURAL INFRASTRUCTURE: A DISTRICT LEVEL STUDY OF MAHARASHTRA

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Abstract

Infrastructure is vital for economic growth, industrial development, human development, and achieving the Sustainable Development Goals (SDGs). This article constructs a very compressive Rural Development Infrastructure Index covering three dimensions - physical, social, and institutional, using 28 indicators and identifies infrastructure disparities in rural areas across thirty-three districts and eight agricultural divisions of Maharashtra. The results indicate the enormous disparities among districts and divisions in the State. Districts like Sindhudurg, Kolhapur, Satara, Pune and Sangli perform very well. On the other hand, most of the laggard districts are in Marathwada and Vidarbha regions. The disparities are very high among districts within the physical infrastructure compared to social and institutional dimensions. Given the uneven infrastructure development in the State, the authorities need to undertake an infrastructure development programme to reduce infrastructure gaps among districts and regions. Indicators like irrigation facilities, all-weather rural roads and marketing facilities should be emphasised more, particularly in laggard districts such as Osmanabad, Beed, Hingoli, and Parbhani of Marathwada region, and Akola, Yavatmal, and Parbhani of the Vidarbha region.

Keywords: Rural Infrastructure, Rural Development Infrastructure Index, Maharashtra.

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Introduction

The progress of rural India is vital for the sustainable and robust growth of the economy. This is especially relevant given that rural India presently accounts for 909 million (65 per cent) rural population, 70 per cent of the labour force, and 35 per cent of the Fast-Moving Consumer Goods (FMCG) demand. Further, rural India contributes to around 49.5 per cent of the GDP (Chand et al. 2017; The World Bank, 2022). Despite significant progress in India, agriculture remained the major occupation in rural areas and income from agriculture or agricultural growth has been stagnant over the period 2013-2018[1] (NABARD, 2018). However, the lack of adequate infrastructure has been identified as a major factor in driving rural labour into poverty and the low productivity of rural labour (Kundu, 2013). The development of infrastructure[2] is crucial for meeting Sustainable Development Goals (SDGs), particularly poverty, rural livelihood, income, health, education, water, and sanitation (Thacker et al., 2019).

Edeme et al. (2020) provide a comprehensive review of the effect of infrastructure development on agricultural output and employment. Infrastructure (both physical and institutional) such as irrigation, watershed development, power, roads, markets, credit institutions, schools, healthcare, agricultural research, and extension, etc., collectively act as a critical factor in determining the agricultural productivity, non-farm output, and employment generation in small-scale industries in India and overall progress of the economy. Manjunath and Kannan (2017) find positive effects of infrastructure on agricultural productivity. For instance, irrigation infrastructure and power supply increase the land-use intensity for agricultural production and cropping intensity. It incentivises farmers to use yield-increasing inputs, and thus results in higher agricultural output (Dhawan, 1988; Shah, 1993; Narayanamoorthy & Deshpande, 2005; Vaidyanathan et al., 1994; Ghosh, 2017). Access to power is critical for improved livelihoods and quality of life (Sarkodie & Adams, 2020). Well-connected roads to rural areas make it possible for better use of transportation, enhancing mobility, improving the supply chain for agricultural marketing, and promoting technological innovations, resulting in an efficient allocation of resources and a reduction in transaction costs. This profoundly affects agriculture productivity, a better realisation of prices, and a rise in farmers' income (Ahmed & Donovan, 1992; ESCAP, 2000; van de Walle, 2002; Ghosh, 2017; Kumar, 2020; Kamaludin & Qibthiyyah, 2022). Gains from rural infrastructure are not just restricted to agricultural development but affect other sectors positively (Ghosh, 2017; Narayanamoorthy et al., 2022; Sekhon et al., 2022). Improved road infrastructure enhances the transport facility and increases access to healthcare facilities, education, and formal financial inclusion (Ghosh, 2017). Narayanamoorthy et al. (2022) show income of farming households is significantly influenced by paved roads, power, and irrigation. The infrastructure support helps in enhancing the income from rearing livestock. Sekhon et al. (2022) find that market infrastructure is vital for improving marketing efficiency in Punjab. Given the rural background, infrastructure development, accompanied by effective human resources development programmes, plays the role of a crucial catalyst in improving the agriculture sector, reducing poverty, generating employment, and all-round development of rural areas (Chand et al., 2017). Therefore, there is no second opinion that quality infrastructure is vital for sustainable economic growth, poverty reduction, productivity improvement, and human development.

Maharashtra is one of the leading States in India, with a population of 12.3 crore in terms of Gross Domestic Product (GDP), per capita income, and urbanisation. Like India, the rural economy also plays a vital role in Maharashtra in terms of Gross State Domestic Product (GSDP) (11.7 per cent), labour force (60 per cent), population (54 per cent), and food production. However, the State is facing enormous urban-rural, intra-district, and regional disparities in economic development. Various committees such as the Dandekar Committee (1984) and Kelkar Committee (2013)

have also found significant regional disparities in Maharashtra and among others, infrastructure development in backward areas was recommended to reduce regional disparities.[3] Infrastructure development can transform rural livelihoods by improving productivity and living conditions, reducing poverty, and preventing agrarian distress, and is vital for achieving Sustainable Development Goals (SDGs).

Given the importance of infrastructure development for balanced regional development and rural upliftment, this study assesses the infrastructure status and identifies disparities in rural areas by constructing a district-wise compressive rural infrastructure index for Maharashtra. Comparative performance of districts within a State is significant and adds to the existing literature. This paper contributes to the ongoing debate on infrastructure development and its contribution to the rural economy and correcting regional imbalances in Maharashtra. By providing a distinct level analysis of infrastructure conditions, the study helps to identify critical infrastructure gaps necessary for achieving SDGs. At this background, the objectives of this study are:

1. A district-wise construction and development of a very compressive rural infrastructure index comprising three dimensions: Physical Infrastructure Index (PII), Social Infrastructure Index (SII), and Institutional Infrastructure Index (III) using 28 parameters for Maharashtra.
2. The sub-indices, viz. physical, social, and institutional index rankings can help the authorities identify the potential districts wherein the specific infrastructure parameter requires focused attention.
3. The study identifies the gaps and disparities at the district and regional levels and provides set recommendations for the overall and specific infrastructure development at the district level.

Economic and Infrastructure Profile of Maharashtra

The State of Maharashtra is one of the consistent top economic performers with respect to per capita income, which is 1.5 times that of all India (Economic Survey of Maharashtra, 2019-20). Similarly, during the last decade (2009-2019), the average annual growth of the Gross State Domestic Product (GSDP) of Maharashtra (7.8) has outperformed the national level GDP growth (7.2) rate. Maharashtra is also one of the leading industrialised States, with 31 per cent of the GSDP coming from industry compared to the all-India average of 29.6 per cent (Economic Survey of Maharashtra, 2019-20).

Compared to the industrial sector's performance, the agriculture sector's performance remained low and highly inconsistent. For example, during the period from 2012-13 to 2018-19, the average annual growth rate of the agriculture & allied activities sector was 2.2 per cent while the industrial sector grew at an average annual rate of 6.2 per cent. The low performance of the agriculture sector generates enormous urban-rural divergence, inter-district, and regional disparities in terms of per capita income[4] (Apte et al., 2014).

In terms of infrastructure parameters, the performance of Maharashtra vis-à-vis India is mixed. For instance, Maharashtra has done reasonably well in indicators like rural esterification, telecom penetration, literacy rate, credit-deposit ratio, number of beds, and overall human development. On the other hand, some other parameters include cropping intensity, energised pumpsets, warehouse facilities, percentage of female teachers, and banking penetration, were lesser (see Table 1).

Table 1

Selective Infrastructure Parameter (Maharashtra vs. India)

Parameter	Maharashtra	India
Cropping Intensity (%) (2019-20)	141	141.60
Rural Electrification (%) (2017-18)	100	99.9
Power Consumption in Agriculture (2013-14) (% of the total energy produced)	22.07	20.74
Road Connectivity (road length in km per sq.km of rural area)	0.49	0.48
Pumpsets Energised (for '000 Hectares GCA)	16	28.17
Warehouse Facility (in MT/ha) (2016-17)	5.5	9.1
Teledensity (%), 2018	95.4	93.1
Beds per lakh population	101	54
Literacy - Total (%) (2011)	82.3	74.0
Female Teachers (%) 2016-17	42	48
Human Development Index (2017)	0.689	0.639
Number of banking offices per lakh population (2018)	10	10.8
Credit-Deposit ratio (2018)	105	76

Source: Author's compilation from various government publications.

Note: GCA: Gross Cropped Area.

Data and Methodology

There have been few studies in India, which have attempted to compute infrastructure index. Ghosh and De (1998, 2004), Bhatia (1999) and Singh (2004) prepared a State-level infrastructure index for India. Bhatia's (1999) work was a novel attempt to build a composite index of state-wise rural infrastructure. Bhatia employed 14 sub-items of agricultural infrastructure which were identified under nine major sub-heads, viz. transport, power, irrigation, fertiliser, agricultural credit, health, agricultural marketing, agricultural extension, and agricultural research. The paper provided ad-hoc weights to those earlier-mentioned nine major sub-heads, with the highest weights. Sarma (2013) and Nayak (2014) attempted a district-level rural infrastructure index for Assam and Odisha, respectively. Sarma (2013) computed the rural infrastructure index as a composite index of two-dimension indices of the rural road index and rural electricity index. Nayak (2014) prepared three separate indices, viz. Physical Infrastructure Index (PII), Social Infrastructure Index (SII), and Financial Infrastructure Index (FII), district-wise, for Odisha using the Principal Component Analysis (PCA). Each of these indexes had three indicators. These three indices were combined to find the overall Rural Infrastructure Index (RII). Kumar (2020) constructed the agricultural infrastructure index at the district level for Uttar Pradesh. Manjunath and Kannan (2017) and Majumdar et al. (2021) constructed infrastructure availability and utilisation index for Karnataka and Assam, respectively. The number of parameters in all these indices was limited in scope, as most of them relied on 7-10 indicators. This paper proposes a modified index, which we name as Rural Development Infrastructure Index (RDII). This index is comprehensive, taking into consideration additional parameters related to rural infrastructure (refer to Table 2 for the detailed description of selected parameters and indicators used in the computation of RDII). For instance, cropping intensity is a proxy of land utilisation, and irrigation potential realised indicates the extent to which water resources are utilised. Pumpsets energised indicate efficient use of energy in agriculture. These indicators measure

the utilisation aspect of infrastructure and are closely linked to rural development.

The composite Rural Development Infrastructure Index (RDII) was built on a six-stage process. In the first stage, infrastructure has been classified into three dimensions; Physical, Social, and Institutional infrastructure. In the second stage, parameters that represent the respective dimensions of infrastructure were identified. In the third stage, 28 indicators were selected based on the availability of data representing three dimensions. Based on Thorat and Sirohi (2004), the comprehensive parameters and indicators of infrastructure development in rural India have been added. For instance, parameters such as land use efficiency, communication, storage, agricultural markets, and technology have been added under the physical infrastructure index in this paper. Agricultural extension and institutional capacity have been added under the institutional infrastructure index. For agricultural technology, we use a number of soil testing laboratories. Soil testing evaluates soil fertility and recommends crops that can be grown along with fertiliser usage. Thus, soil testing facilitates technology adoption. In education, we have also taken the percentage of schools with only a single teacher variable that looks at the quality aspect. Similarly, for health, we used institutional deliveries in proportion to total deliveries. Within institutional infrastructure, coverage crop insurance and total agricultural extension staff to the gross cropped area (GCA) have been used. In the fourth stage, indicators are normalised with respect to either population or area when required. Since the units of measurement of the selected indicators are different, they give rise to problems of aggregation. In the fifth stage, the indicators are made unit-free using the following formula:

$$X_{scaleddown} = \frac{X - min^*(X)}{max(X) - min^*(X)}$$

Where X = observed value, min*(X) < min(X), that is, min* is less than the minimum value of the parameters across districts (simply to avoid zeros in scaling down), and max (X) is the maximum value of the parameter. In the fifth stage, all the parameters are made unidirectional, i.e. higher is the better by subtracting the scaled value from one. In the sixth stage, Principal Component Method was applied to the scaled-down variables and the number of components having Eigenvalues greater than unity was retained for constructing the infrastructure index.[5] Once the Principal Components have been identified using the Eigenvalue criteria, the factor loadings are multiplied with the corresponding values of the variables (scaled-down values) and summed up to produce the Infrastructure Index. In case multiple Principal Components are retained based on Eigenvalue, the average value will provide the Infrastructure Index.

$$PC_i = \sum_i \sum_j W_{ij} X_{ij} i = 1,2,\ldots\ldots \text{No. of components retained and j} = Paramters\ (1,2,\ldots)$$

Depending on the criteria of Eigenvalues, many components will be retained and after calculating the scores of each component for each district, they will be averaged with equal weightage to produce the composite index of each district as follows:

$$Index = {\textstyle\sum_i} PC_i / {}_{\text{No of component}} \quad i = 1,2,\ldots.. No\ of\ components\ retained$$

Finally, the districts are ranked based on the final composite index for all three dimensions. There are eight agricultural divisions in Maharashtra, viz. Konkan, Nasik, Pune, Kolhapur, Aurangabad, Latur, Amravati, and Nagpur, and each of the divisions include many districts with different varying infrastructural facilities. The study relies on secondary data collected from various government publications (see Table 2).

Table 2

Selected Parameters, Indicators, Description and Source of Data

Parameters	Indicators	Description & reference year	Data Source
		Physical Infrastructure	
Land use efficiency	Cropping Intensity	The ratio of net area sown to the total cropped area in 2015-16	Commissionerate of Agriculture
Irrigation	Pumpset	No. of Pumpsets per thousand hectares of GCA. Measures the status farm mechanisation, 2011	Agricultural Census
	Irrigation Potential Realised	Percentage of the actual irrigated area to irrigation potential created in 2014-15	GoM (2017)
	Pumpset energized	Total agriculture pump sets energised per thousand hectares of GCA, 2017-18	Mahavitaran
Electricity	Power consumption in agriculture	Per capita electricity consumption in agriculture and measured in kW per year, 2015	GoM (2017)
	Rural electrification	Percentage of households electrified out of the total census household, 2011	Census
Transport	Tractors	Number of tractors registered per unit of GCA, 2015	GoM (2017)
	Road connectivity	Total rural road per square km of rural area, 2011	GoM (2017)
Communication	Connectivity	Percentage of households out of total households having access to mobile connections, 2011	Census
Storage	Warehouse facility	The total storage and warehouse facility capacity (in tons) with respect to GCA, 2017	MSAMB
Agricultural Marketing	Wholesale market	The number of wholesale markets per lakh GCA, area, 2017-18	MSAMB
Agricultural Technology	Agricultural Laboratory	Number of soil testing laboratories per lakh hectares of GCA, 2017-18	Commissionerate of Agriculture
		Social infrastructure	
Education	Rural Literacy Rate	Total rural literate population out of the total census rural population, 2011	Census
	School density	Total schools per thousand children population in the age group of 6-13, 2015-16	U-DISE
	Schools with a single teacher	Percentage of schools with only a single teacher, 2015-16	U-DISE
Amenities	Households with drinking water facilities	Percentage of households with drinking water facilities of the total census households, 2011.	Census
	Households with Latrine facilities.	Percentage of households with latrine facilities of the total census households, 2011.	Census

Contd...

Parameters	Indicators	Description & reference year	Data Source
Health	Hospitals	The ratio of total rural hospitals to thousand population, 2014-15	GoM (2017)
	Beds per persons	Total beds available in rural hospitals to thousand rural population, 2014	GoM (2017)
	Institutional Deliveries	Number of deliveries supported by medical equipment under the supervision of skilled medical staff to the number of total deliveries	Census
		Institutional Infrastructure	
Finance	Household Banking	Percentage of households with banking facilities of the total census households, 2011	Census
	Bank	Number of banks per lakh rural population, 2017-18	Bank of Maharashtra
	PACs	Number of PACs per lakh rural population, 2016-17	Office of GoM
	Credit	Sum of ground-level credit outlets, Agribusiness clinics and Farmer producers' companies per lakh rural population, 2017	Bank of Maharashtra
	SHGs	Number of SHGs to per lakh rural population	NRLM
Agricultural Extension	Extension capacity	Total agricultural extension staff to per lakh hectares of GCA.	Commissioner ate of Agriculture
Institutional Capacity	Post office	The number of rural post office branches per lakh rural population.	GoM (2017)
	Insurance	Insurance is measured as a percentage of crop insurance coverage (hectares) to GCA	Department of Agriculture, GoM

Source: Authors' compilation from various sources.

Notes: Infrastructure Statistics of Maharashtra in 2013-14 and 2014-15, have been cited as GoM (2017); U-DISE: Unified District Information System for Education; Department of Establishments, Commissionerate of Agriculture; Bank of Maharashtra is the Lead Bank of Maharashtra.

Measuring Disparities

To measure disparities among districts, we compared districts' scores with the State averages. Accordingly, we grouped districts into four categories: very good, good, poor, and very poor. Further, the coefficient of variations is also used to measure the disparities. To make an inter-division comparison, one-way ANOVA with Tukey posthoc analysis has been applied. Accordingly, we list the null and alternate hypotheses for the physical infrastructure index (PII) as follows:

$$H_0: PII_{konkan} = PII_{nasik} = PII_{pune} = PII_{kolhapur} = PII_{aurangabad} = PII_{latur} = PII_{amravati} = PII_{nagpur} Against$$

$$H_1: Not\ all\ PII\ are\ equal$$

Similarly, the null and alternate hypothesis is tested separately for the social and institutional infrastructure index.

Results and Discussion

Performance of Districts on Physical Infrastructure Index (PII): The districts' index scores and rankings in terms of physical infrastructure are presented in Table 3 and Figure 1. It is seen that the scores vary from the lowest value of 0.008 (Osmanabad) to a maximum of 1.561 (Kolhapur) with a gap of 1.553. Only eleven out of thirty-three districts are above the State average score of 0.614 and the remaining districts are underperforming. Osmanabad, Beed, Parbhani, Nadurbar, Hingoli, Yavatmal, and Akola districts are identified as poor-performing districts (ranked among the seven bottom districts). Moreover, by looking at the score, it is clear that some polarisation has occurred regarding the availability of physical infrastructure in rural Maharashtra. The index scores further demonstrate a high level of variation as measured by the coefficient of variation (64.89 per cent) which is relatively high compared to variations in social and institutional indices.

Table 3

Scores and Ranking of Districts (Physical Infrastructure Index)

Districts	PII	Rank	Districts	PII	Rank
Kolhapur	1.561	1	Raigad	0.435	18
Satara	1.554	2	Ratnagiri	0.433	19
Pune	1.276	3	Aurangabad	0.430	20
Nasik	1.251	4	Buldhana	0.420	21
Gondia	1.109	5	Washim	0.403	22
Sangli	1.018	6	Jalna	0.369	23
Sindhudurg	1.006	7	Jalgaon	0.362	24
Solapur	0.979	8	Amravati	0.348	25
Bhandara	0.784	9	Latur	0.342	26
Nagpur	0.774	10	Hingoli	0.297	27
Ahmadnagar	0.712	11	Yavatmal	0.290	28
Thane	0.609	12	Nandurbar	0.237	29
Wardha	0.564	13	Beed	0.235	30
Chandrapur	0.537	14	Parbhani	0.207	31
Gadchiroli	0.531	15	Akola	0.201	32
Dhule	0.498	16	Osmanabad	0.008	33
Nanded	0.476	17	-	-	
State Average	0.614	SD	0.398	CV	64.8

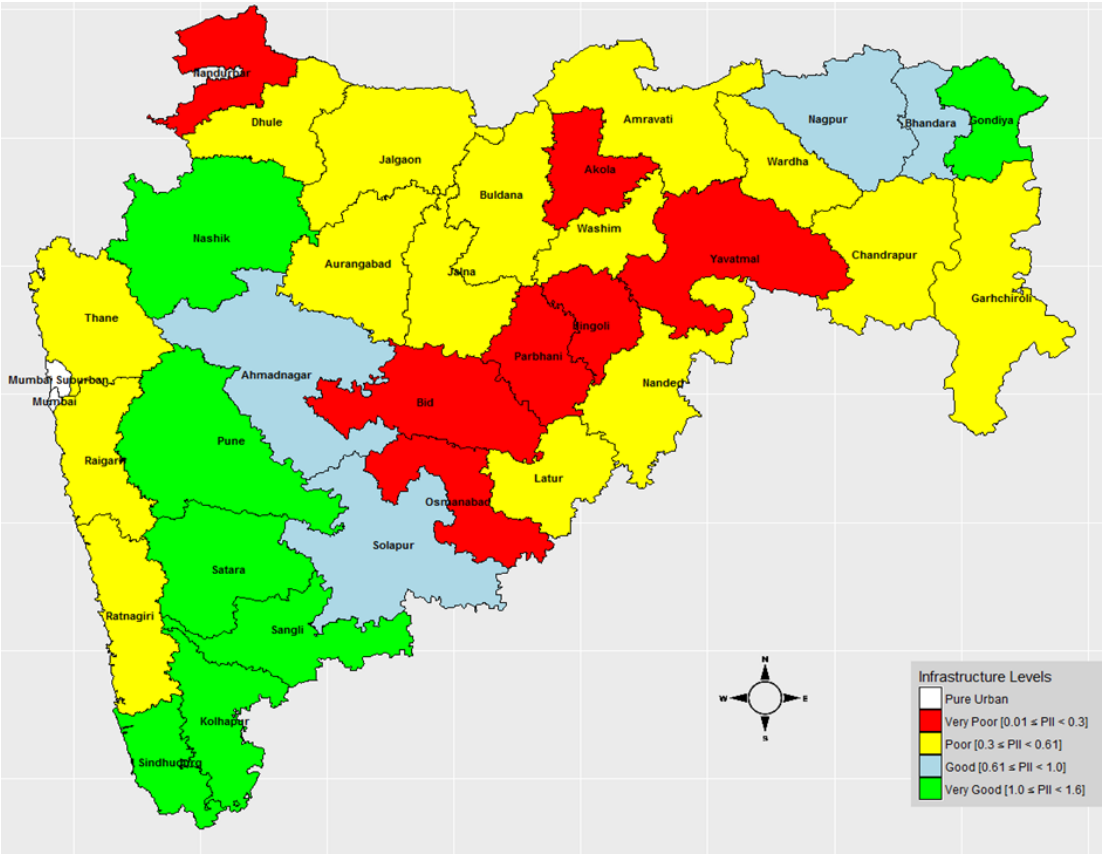
Source: Authors' Calculation

Note: The score for Maharashtra is the average value of thirty-three districts considered above.

The performance of districts in terms of physical infrastructure indicate that the State has failed to develop balanced physical infrastructure development across districts. Kolhapur, Pune, and some districts of Nagpur are well off in terms of physical infrastructure while the rest of Maharashtra is far away from providing sufficient physical infrastructure for the development of rural areas.

Figure 1

District-wise Physical Infrastructure Index



Source: Authors' own.

Performance of Districts in Terms of Social Infrastructure Index (SII): The social infrastructure index includes education, health, housing amenities and environment, which are crucial parameters contributing to enhancing the liveability of the rural population. Like physical infrastructure, the social sector is also vital in the economy because it improves the quality of human life as well as helps to stimulate economic development. The district-level composite social infrastructure score for rural areas is presented in Table 4 and Figure 2. It is seen that the index scores vary from the lowest value of 0.97 (Nandurbar) to a maximum of 2.30 (Sindhudurg) with a gap of 1.23. The State average is 1.43 and the social index scores demonstrate a moderate level of variation as measured by the coefficient of variation (24 per cent) across the districts, which is lower than physical index variations.

Table 4

Scores and Rankings of Districts (Social Infrastructure Index)

Districts	Score	Rank	Districts	Score	Rank
Sindhudurg	2.30	1	Akola	1.30	18
Kolhapur	2.14	2	Beed	1.30	19
Satara	2.09	3	Solapur	1.27	20
Ratnagiri	1.88	4	Osmanabad	1.27	21
Nagpur	1.85	5	Latur	1.27	22
Wardha	1.84	6	Jalgaon	1.23	23
Sangli	1.71	7	Washim	1.22	24
Bhandara	1.65	8	Yavatmal	1.18	25
Amravati	1.65	9	Hingoli	1.16	26
Pune	1.64	10	Dhule	1.15	27
Gondia	1.52	11	Parbhani	1.15	28
Ahmadnagar	1.50	12	Nasik	1.12	29
Chandrapur	1.35	13	Thane	1.10	30
Raigad	1.35	14	Jalna	1.07	31
Buldhana	1.33	15	Nanded	1.03	32
Gadchiroli	1.32	16	Nandurbar	0.97	33
Aurangabad	1.31	17	Maharashtra	1.43 (24%)	

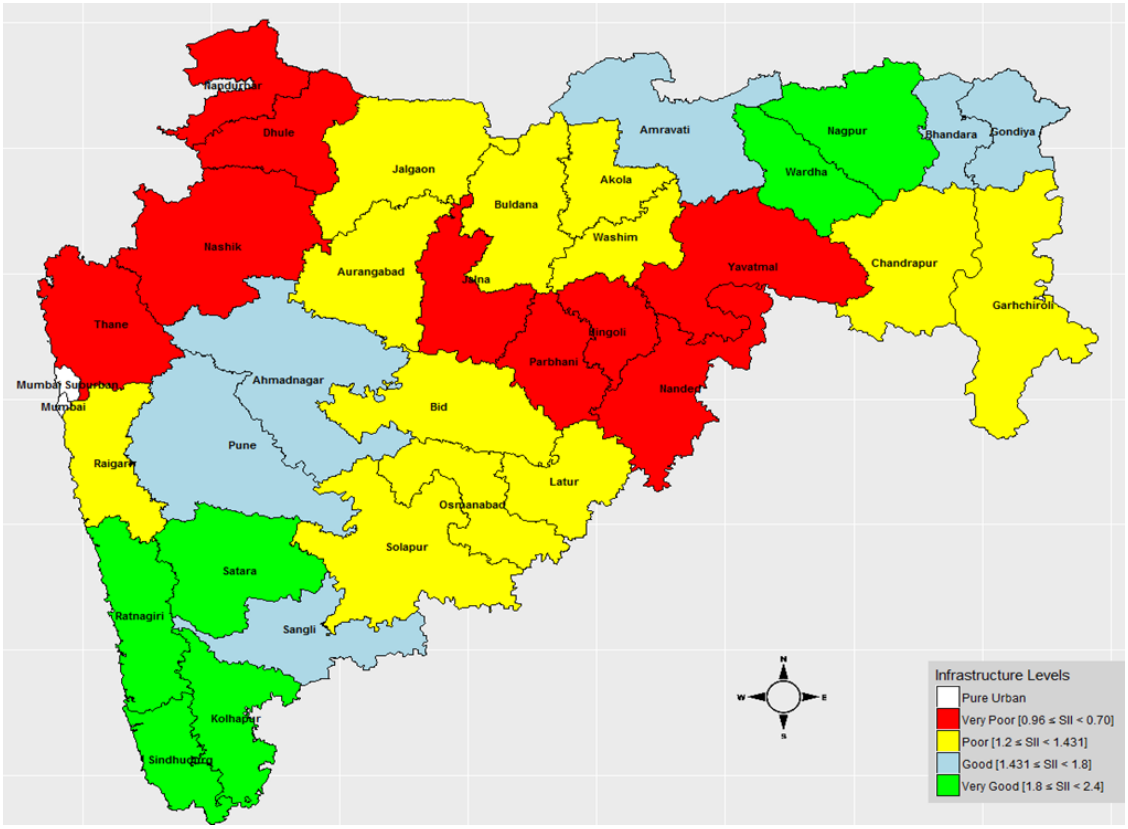
Source: Authors' calculation.

Note: The score for Maharashtra is the average value of thirty-three districts considered above. The figure in the bracket is the coefficient of variation.

The relative performances show that districts such as Sindhudurg, Kolhapur, Satara, Ratnagiri, Nagpur, Wardha and Sangli perform relatively better than other districts, classified as over-performing districts. However, other districts like Yavatmal, Hingoli, Dhule, Parbhani, Nasik, Thane, Jalna, Nanded and Nandurbar have a relatively lower ranking, thus falling in the category of least-performing districts. Bhandara, Amravati, Pune, Gondia and Ahmednagar can be classified as average-performing districts, and these districts are doing relatively better compared to the State average. Finally, districts such as Chandrapur, Raigad, Buldhana, Gadchiroli, Aurangabad, Akola and Beed perform just below the State average, and are hence classified as moderately performing districts.

Figure 2

District-wise Social Infrastructure Index



Source: Authors' own.

Institutional Infrastructure Index (III): Institutional infrastructure is crucial for the effective functioning and monitoring of both physical and social infrastructures by reducing the transaction cost for society (Acemoglu et al., 2005). Institutions are drivers of socioeconomic development for a country. Research shows that institutions can be a major source of growth; effective institutions aid investment in physical and human capital, research and development, and technology (Acemoglu et al., 2005). District-level performance in terms of the Institutional Infrastructure index is presented in Table 5 and Figure 3.

Table 5

Scores and Rankings of Districts (Social Infrastructure Index)

	III	Rank	Districts	III	Rank
Sindhudurg	1.972	1	Amravati	0.886	18
Kolhapur	1.463	2	Gondia	0.876	19
Ratnagiri	1.432	3	Nasik	0.784	20
Satara	1.386	4	Aurangabad	0.767	21
Sangli	1.261	5	Parbhani	0.764	22

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	III	Rank	Districts	III	Rank
Solapur	1.232	6	Latur	0.756	23
Nagpur	1.196	7	Yavatmal	0.703	24
Pune	1.130	8	Washim	0.702	25
Wardha	1.095	9	Beed	0.690	26
Raigad	1.029	10	Buldhana	0.648	27
Gadchiroli	1.018	11	Nanded	0.639	28
Osmanabad	1.005	12	Hingoli	0.632	29
Ahmadnagar	1.003	13	Jalgaon	0.580	30
Bhandara	0.975	14	Nandurbar	0.520	31
Jalna	0.969	15	Thane	0.468	32
Chandrapur	0.966	16	Dhule	0.468	33
Akola	0.887	17	Maharashtra	0.937 (38%)	

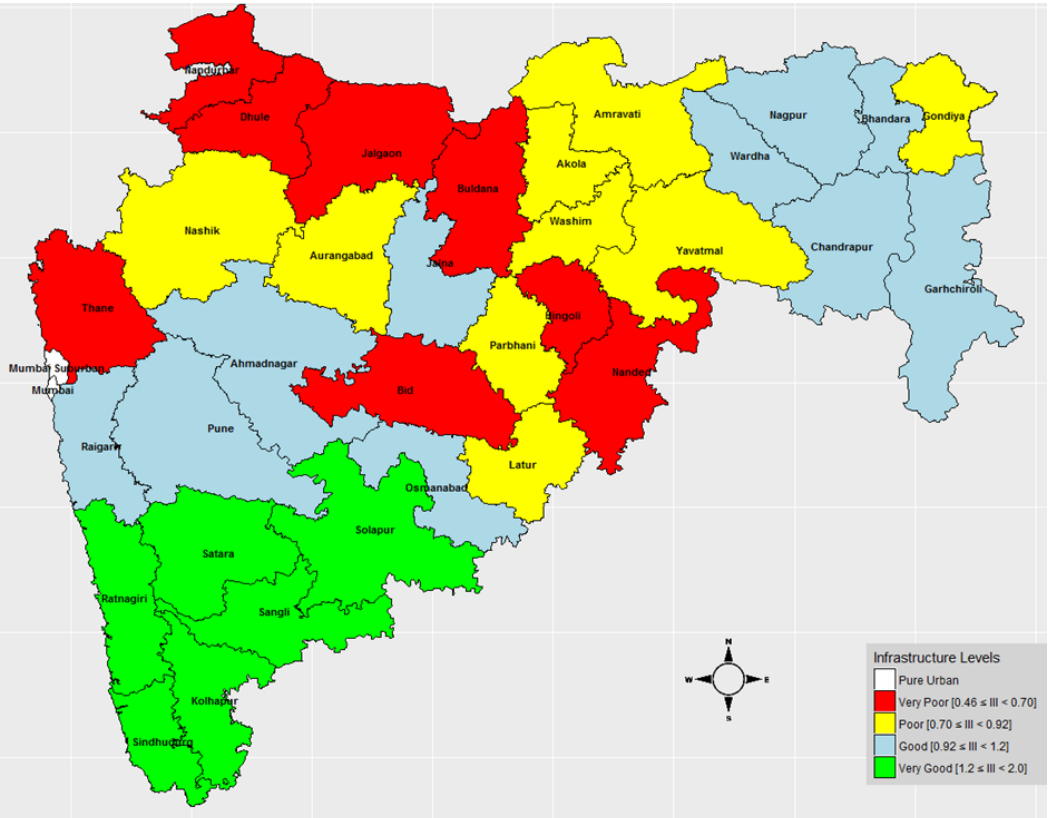
Source: Authors' calculation.

The figure in the bracket is the coefficient of variation.

Notes: The score for Maharashtra is the average value of thirty-three districts considered above.

Figure 3

District-wise Institutional Infrastructure Index



Source: Authors' own.

The relative score for districts for rural areas shows that as many as 16 districts scored above the State average (0.94). Districts such as Sindhudurg, Kolhapur, Ratnagiri, Satara, Sangli, and Solapur are performing relatively better than other districts. These districts are classified as top-performing districts for institutional infrastructure. However, districts like Beed, Buldhana, Nanded, Hingoli, Jalgaon, Nandurbar, Thane and Dhule are underperforming, and therefore are ranked the least-performing districts in Maharashtra.

Further, Wardha, Raigad, Gadchiroli, Osmanabad, Ahmadnagar, Bhandara, Jalna, and Chandrapur are classified as average-performing districts, doing moderately better compared to the State average. The index scores demonstrate a moderate level of variation as measured by the coefficient of variation (38 per cent) across the districts, which is lower than physical index variations but higher than social infrastructure.

Region-Wise Rankings: The scores and rankings divisions in terms of physical, social, and institutional infrastructure are presented in Table 6. In terms of physical infrastructure, Kolhapur is top-ranked, followed by Pune and Nagpur divisions at second and third positions, respectively. Amravati, Latur, and Aurangabad divisions are at the bottom of the table having physical infrastructure index scores less than the State average. Therefore, it is quite evident that there is a skewed availability of physical infrastructure across districts and divisions in the State.

Table 6

Physical Infrastructure Index of Agriculture Divisions of Maharashtra

Division	PII	Rank	SII	Rank	II	Rank
Kolhapur	1.378	1	1.979	1	1.371	1
Pune	0.989	2	1.469	4	1.122	3
Nagpur	0.717	3	1.590	3	1.022	4
Konkan	0.621	4	1.650	2	1.226	2
Nasik	0.587	5	1.116	8	0.588	8
Aurangabad	0.344	6	1.227	6	0.810	5
Amravati	0.332	7	1.335	5	0.766	6
Latur	0.266	8	1.174	7	0.760	7

Source: Authors' calculation.

Similarly, Kolhapur is the top division in Maharashtra followed by Konkan and Nagpur in terms of the Social Infrastructure Index. Nasik, Latur, and Aurangabad are laggard divisions as most of the laggard districts are concentrated in these divisions. The ranking of divisions in terms of social infrastructure also provides a similar picture. Kolhapur is the top division in Maharashtra followed by Konkan and Pune. Nasik, Latur, Amravati, and Aurangabad are laggard divisions and most of the laggard districts are concentrated in these divisions.

The One-way ANOVA technique is applied for comparing the relative performance of divisions (physical, social, and institutional) and the F-test statistics are shown in Table 7. F-test results indicate that the eight divisions of the State are not performing at par in terms of physical, social, and institutional infrastructures. The analysis suggests that there are significant regional disparities among districts and divisions in Maharashtra.

Table 7

One-way ANOVA for Physical, Social, and Institutional Infrastructure Index among Divisions

Particulars	F-statistic	P-value
PII	$F_{(7,25)} = 7.569$	0.000
SII	$F_{(7,25)} = 4.798$	0.000
III	$F_{(7,25)} = 4.338$	0.000

Source: Authors' calculation.

Composite Rural Development Infrastructure Index (RII)

The composite rural Development infrastructure index (a simple arithmetic average) has been constructed based on three indices—physical, social, and institutional infrastructure —for the 33 districts and eight divisions of Maharashtra. The ranking of the thirty-three districts is shown in Table 8.

Table 8

Scores and Rankings of Districts on the Composite Index (RDII)

Districts	Score	Ranking	Districts	Score	Ranking
Sindhudurg	1.761	1	Raigad	0.937	17
Kolhapur	1.721	2	Aurangabad	0.835	18
Satara	1.676	3	Jalna	0.804	19
Pune	1.349	4	Buldhana	0.799	20
Sangli	1.331	5	Akola	0.796	21
Nagpur	1.275	6	Latur	0.788	22
Ratnagiri	1.248	7	Washim	0.774	23
Gondia	1.170	8	Osmanabad	0.760	24
Wardha	1.167	9	Beed	0.742	25
Solapur	1.160	10	Thane	0.726	26
Bhandara	1.138	11	Yavatmal	0.724	27
Ahmadnagar	1.072	12	Jalgaon	0.723	28
Nasik	1.053	13	Nanded	0.715	29
Amravati	0.962	14	Parbhani	0.706	30
Gadchiroli	0.955	15	Dhule	0.705	31
Chandrapur	0.953	16	Hingoli	0.698	32
			Nandurbar	0.575	33
Maharashtra	0.97 (32%)				

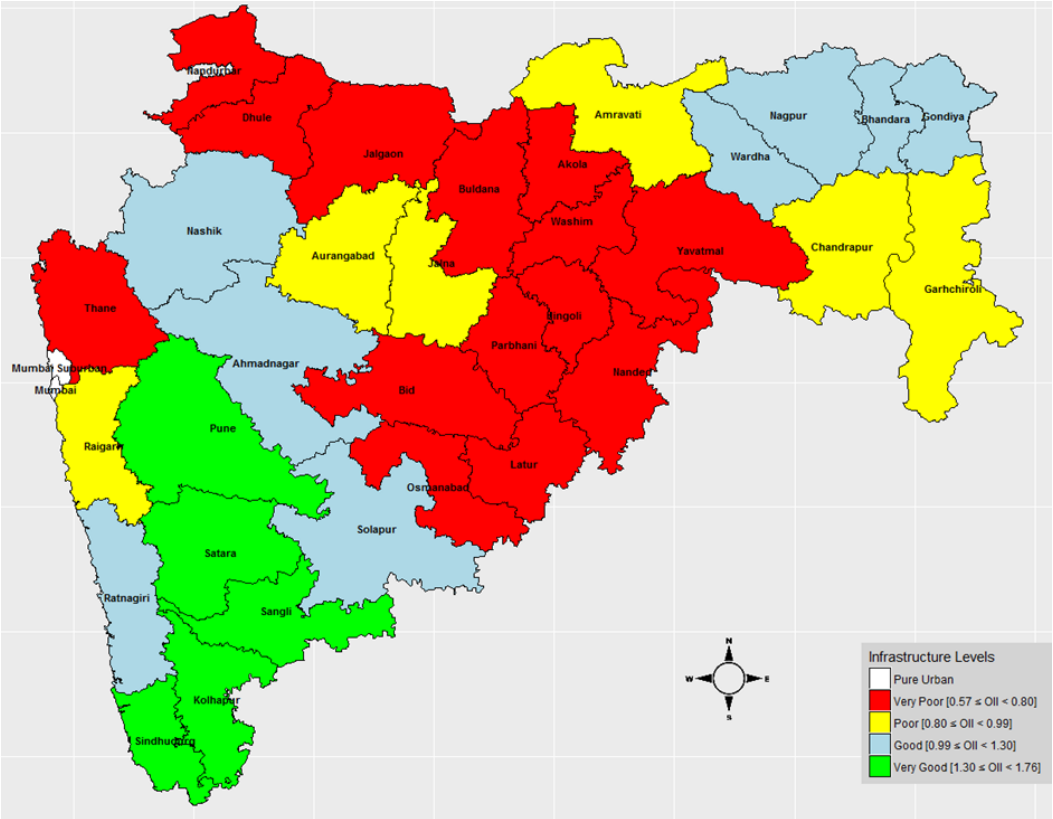
Source: Authors' calculation.

Notes: The score for Maharashtra is the average value of thirty-three districts considered above. The figure in the bracket is the coefficient of variation.

A better picture of the relative performance of districts in terms of the Rural Development Index (RDII) is presented in Figure 4. Based on the relative performances, districts are divided into four performance groups: top performance (very good) districts, good performance, poor performance, and very poor performance districts. As it is observed, there is clear polarisation or skewed infrastructure development across districts. The lowest index score starts from a minimum of 0.574 (Nandurbar) to the maximum value of 1.76 (Sindhudurg), indicating that Sindhudurg has more than three times the infrastructure facilities. The results confirm the existence of significant inter-district variations in terms of infrastructure development. At the extreme, Sindhudurg followed by Kolhapur, Satara, Pune, Sangli, Nagpur, Ratnagiri, Gondia, Wardha, and Solapur are performing very well compared to the State average.

Figure 4

Composite Rural Development Infrastructure Index



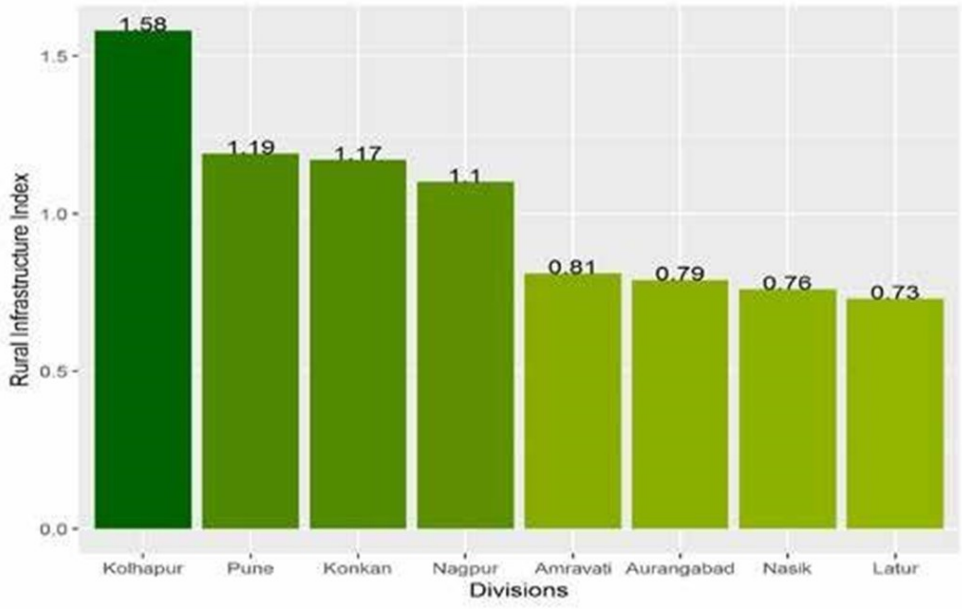
Source: Authors' own.

On the other hand, Osmanabad, Beed, Thane, Yavatmal, Jalgaon, Nanded, Parbhani, Dhule, Hingoli, and Nadurbar are underperforming or lagged districts in terms of the rural development infrastructure index in Maharashtra.

Rankings of Divisions and Districts within Region: The relative performances of the eight divisions and the districts within each of these eight divisions are provided in Figures 5 and 6. Results indicate that four divisions, namely Kolhapur, Pune, Konkan and Nagpur are better performing compared to the State average. The remaining four divisions are lagging in terms of infrastructure development.

Figure 5

Rankings of Divisions on Rural Development Infrastructure Index



Source: Authors' own.

Further, it is evident from Figure 5 that the relative performance of districts within divisions shows wide variations in Konkan, Nasik, Latur and Amravati compared to other divisions. For instance, the score of Sindhudurg is three times higher than the score of Thane in Konkan divisions. On the other hand, there is no significant difference in the performances among districts in Latur division.

Overall, the above analysis indicates that there exist large gaps not only among districts but also divisions in the State in terms of infrastructure facilities in rural areas. It is found that Sindhudurg, Kolhapur, Satara, Pune, Sangli, Nagpur, Ratnagiri, Gondia, Wardha and Solapur are among the top performers with respect to the composite rural infrastructure index, while Osmanabad, Beed, Thane, Yavatmal, Jalgaon, Nanded, Parbhani, Dhule, Hingoli and Nandurbar are the laggard ones.

Causes of Uneven Infrastructure Development

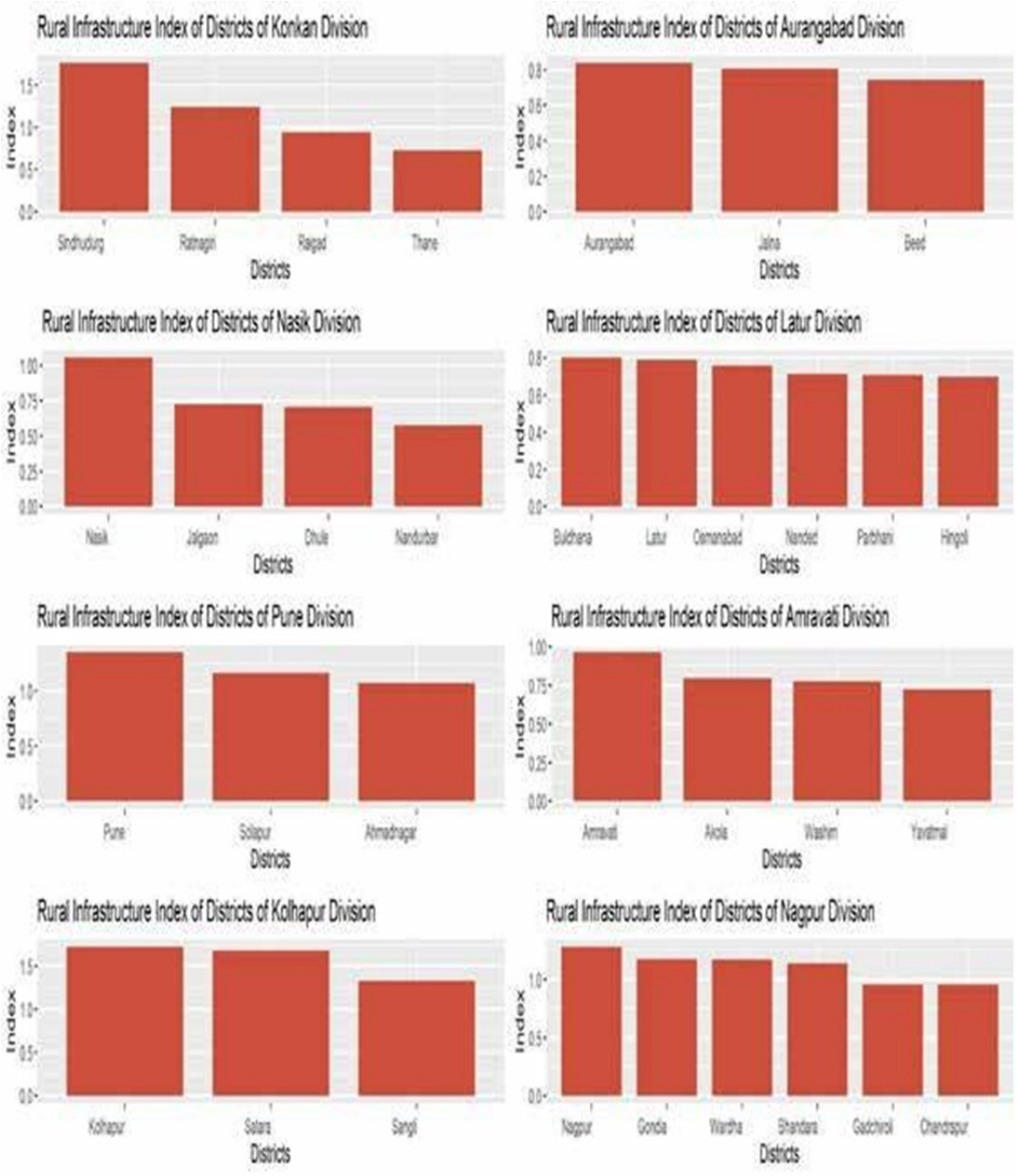
A few studies examine the cause of the variation in infrastructure development across countries and regions in a country. Among others, economic growth, the structure of GDP, government expenditure, financial development, urbanisation, and human development influence infrastructure development (Timilsina et al., 2022; Cerra et al. 2017). In this section, we review some of the factors that may have contributed to skewed infrastructure development in Maharashtra.

Growth Performances: One of the major determinants of infrastructure is the per capita income level. Higher the per capita income level higher will be infrastructure development through both demand and supply-side effects (Randolph et al.,1999; Vinogradova et al., 2015; Jadhav & Choudhury, 2019). The growth performances of districts in Maharashtra indicate the widening inequality among districts due to lower growth by backward districts and higher growth by richer districts. According to the Economic Survey 2019-20, the per capita income in Thane is Rs. 3.30 lakh followed by Pune Rs. 3.16 lakh against Rs. 1.02 lakh in Washim and Rs. 1.07 lakh in Nandurbar in 2019-20, two lowest per capita income districts. The same backward districts occupy the last

positions in terms of infrastructure development, indicating a direct relationship between growth performance and infrastructure development. The correlation between per capita income and the infrastructure index is very high supporting the above hypothesis (See Table 9).

Figure 6

Composite Infrastructure Index of Districts of Agricultural Divisions



Source: Authors' own.

Table 9

Correlation Coefficient Matrix between Index and Development Indicators

Variables	PINC	PII	SII	III	RDII	UR	HDI	PGEXP	IND
PINC	1.00								
PII	0.49*	1.00							
SII	0.42*	0.61*	1.00						
III	0.38*	0.56*	0.86*	1.00					
RDII	0.49*	0.84*	0.92*	0.89*	1.00				
UR	0.78*	0.22	-0.02	-0.13	0.02	1.00			
HDI	0.91*	0.60*	0.53*	0.44*	0.61*	0.69*	1.00		
PGEXP	0.44*	0.59*	0.43*	0.38*	0.55*	o.23	0.48*	1.00	
IND	0.77*	0.45*	0.34	0.31	0.40*	0.84*	0.66	0.43*	1.00

*Indicates significant at 5% level.

PINC-Per capita district level income, PII-Physical Infrastructure Index, SII-Social Infrastructure Index, RDII- Rural Development Infrastructure Index, UR-Urbanisation Rate, HDI-Human Development Index, PGEXP- Per capita district-wise government expenditure and IND – share of manufacturing in district domestic product.

Uneven Industrialisation: Another factor that also influences infrastructure development is a pattern of industrialisation. Districts with higher industrialisation will have higher infrastructure development through both supply and demand effects. Higher industrialisation leads to higher infrastructure development, which in turn, facilitates higher industrialisation through backward and forward linkages (Luger et al., 2013). Most of the high-income districts in Maharashtra have a higher industry share in GDP except Sindhudurg. On the other hand, most of the low-income districts also have lower industrialisation rates (see Table 9).

Skewed Government Expenditure: Studies (Mallick, 2013; Okolo et al., 2018) highlight the role of government expenditure, particularly, capital expenditure in positively affecting the provision of infrastructure facilities. Further, government expenditure has the ability to correct regional imbalances, and promote investment and infrastructure development (Mohanty et al., 2017). Therefore, districts with higher public expenditure are having higher levels of infrastructure development as there exists a positive significant correlation (0.55) between government expenditure and infrastructure index.

Uneven Urbanisation: Another factor that may have contributed to uneven infrastructure development across districts is the skewed development of urbanisation. Districts such as Pune, Nagpur, Nashik, and Thane have high urbanisation rates. More importantly, these districts are also doing well in terms of infrastructure facilities. On the other hand, districts such as Hingoli, Buldhana, Gadchiroli, Nandrubar and Washim are lagging behind both in urbanisation as well as infrastructure development.

Complementarily between Infrastructure: The empirical literature suggests that there exists complementarity among different kinds of infrastructure services. The development of one set of infrastructure facilities can lead to the development of other types of infrastructure through positive externalities (Timilsina et al., 2022 and Cerra et al., 2017). For example, the development of physical infrastructure can increase demand for social and financial infrastructure and vice-versa. This is evidenced from this study as there exists significant complementarity among different infrastructure facilities. Results from Table 9 suggest that there exists a significant correlation among infrastructure indices.

Conclusion and Policy Recommendations

This study computes the RDII (covering physical, social, and institutional dimensions and 28 parameters) by using the PCA to assess the regional disparities in infrastructure development in Maharashtra as it is one of the most critical factors for economic growth and sustainable development. The study results indicate significant disparities among districts and regions regarding the availability of infrastructure facilities. For instance, districts like Sindhudurg, Kolhapur, Satara, Pune and Sangli are performing well above the State average. On the other hand, districts such as Washim, Nadurbar, Hingoli, Nanded, Prabhani and Beed are significantly lagging behind in terms of infrastructure facilities. Division-wise infrastructure development indicates that Kolhapur, Pune, and Konkan divisions are the best-performing, and Nasik, Latur and Amravati are the worst-performing regions in Maharashtra. Most of the laggard districts are in Marathwada and Vidarbha regions, which are well-known backward areas in Maharashtra.

The findings of this study have a few implications. First, major emphasis should be given to physical infrastructure development as higher disparities exist among districts. Second, indicators like irrigation facilities, all-weather rural roads, and marketing facilities should be given higher emphasis, particularly in laggard districts such as Osmanabad, Beed, Hingoli, and Parbhani of Marathwada region and Akola, Yavatmal and Parbhani of the Vidarbha region. Third, there are certain components on which variation is registered across districts and where the State government must chalk out plans of action to improve the specific parameters. Within social infrastructure, major emphasis should be given to health infrastructure such as increasing the number of hospitals and beds to increase accessibility. Jalna, Nanded, Nandurbar, Nasik and Thane are the laggard districts as far as the social infrastructure is concerned and require higher attention. Regarding institutional infrastructure, parameters such as crop insurance, financial facilities and extension capacity should be prioritised. Overall, efficient policies with proper implementation mechanisms and the participation of local-level institutions are vital for infrastructure development. The index is replicable over time and can be applicable to other States, given that many of the indicator data are available in the public domain.

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End Notes:

1. According to the Government of India’s Economic Survey 2019-20, the real growth rate for agriculture and its allied sectors was 2.88 per cent annually from 2014-15 to 2018-19.
2. World Development Report of 1994 (World Bank, 1994, p. 2) refers to infrastructure as an umbrella term for activities that share technical features (such as economies of scale) and economic features (such as spillovers from users to nonusers). Thorat and Sirohi (2004, p. 63) cite Lewis (1955), Higgins (1959), and Hirschman (1958) and discuss the various parameters of infrastructure.
3. Few studies also find that infrastructure development is vital to reduce the regional disparities (Sarma, 2013; Nayak, 2014; Bakshi, et al., 2015).
4. In 2017-18, only seven districts had per capita net income above the state average (Economic Survey of Maharashtra, 2019-20).
5. Before Principal Component analysis, Kaiser-Meyer-Oklin statistic (KMO statistic) and Bartlett's Test of Sphericity have been used to check the suitability of the parameters.

Author's Contribution:

Ranjan Kumar Dash: Conceptualisation of the study, development of methodology, analysis and interpretation of results and final manuscript preparation.

Jyoti Chandiramani: Conceptualisation of the study, draft preparation, contributed to the Introduction and Conclusion sections.

Shrabani Mukherjee: Analysis and interpretation of results, contributed in review of literature section, PCA methodology and contributed to the Social Infrastructure Index section.

Bidyut Kumar Ghosh: Development of methodology, analysis and interpretation of results and contributed to the Physical Infrastructure Index section the of draft

Varun Miglani: Conceptualisation of the study, Data collection and data cleaning, contributed to the Introduction and Literature Review sections of the draft.

References

Acemoglu, D., Johnson, S., & Robinson, J. A. (2005). Institutions as a Fundamental Cause of Long-Run Growth. *Handbook of Economic Growth, 1*, 385-472.

Ahmed, R., & C. Donovan (1992). Issues of Infrastructural Development: A Synthesis of the Literature. International Food Policy Research Institute. Washington, D.C.

Apte, P., Bodkhe, N., & Dhume, A. (2014). Regional Growth Strategies for the Rest of Maharashtra. *Artha Vijnana, LVI*(2), 278-293.

Bakshi, S., Chawla, A., & Shah, M. (2015). Regional Disparities in India: A Moving Frontier. *Economic and Political Weekly, 50*(1), 44-52.

Barnes, D. F., & Binswanger, H. P. (1986). Impact of Rural Electrification and Infrastructure on Agricultural Changes. *Economic and Political Weekly, 21*(1), 26-34.

Bhatia, M. S. (1999). Rural Infrastructure and Growth in Agriculture. *Economic and Political Weekly, 34*(2), A43-A48.

Chand, R.; Srivastava, S., Singh, J. (2017). Changing Structure of Rural Economy of India Implications for Employment and Growth. NITI Aayog, New Delhi.

Cerra, V., Cuevas, A., Goes, C., Karpowicz, I., Matheson, T., Samake, I., & Vtyurina, S. (2017). Determinants of Infrastructure and Its Financing, *Emerging Economy Studies, 3*(2):1-14.

Dandekar Committee (1984). *Report of the Fact Finding Committee on Regional Imbalance*. Bombay: Planning Board, Government of Maharashtra.

Dhawan, B. D. (1988). *Irrigation in India's Agricultural Development: Productivity, Stability, Equity*. New Delhi: SAGE Publications.

Edeme, R. K., Nkalu, N. C., Idenyi, J. C., & Arazu, W. O. (2020). Infrastructural Development, Sustainable Agricultural Output and Employment in ECOWAS Countries. Sustainable Futures, 2, 100010. https://doi.org/10.1016/j.sftr.2020.100010.

ESCAP. (2000). *Evaluation of Infrastructural Interventions for Rural Poverty Alleviation*. The United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand.

Ghosh, M. (2017). Infrastructure and Development in Rural India. Margin: *The Journal of Applied Economic Research, 11*(3), 256-289.

Ghosh, B., & De, P. (1998). Role of Infrastructure in Regional Development: A Study over the Plan Period. *Economic and Political Weekly, 33*(47/48), 3039-3048.

Ghosh, B., & De, P. (2004). How do Different Categories of Infrastructure Affect Development? Evidence from Indian States. *Economic and Political Weekly, 39*(42), 4645-4657.

GoM. (2017). *Infrastructure Statistics of Maharashtra State 2013-14 and 2014-15*. Mumbai: Planning Department, Directorate of Economics and Statistics, Government of Maharashtra.

Higgins, B. (1959). *Economic Development*, New York: Norton.

Hirschman, A.O. (1958). *The Strategy of Economic Development*. New Haven, Conn. USA: Yale University Press.

Jadhav, P., & Choudhury, R. N. (2019). *Determinants of Public-Private Partnership in Infrastructure: Empirical Evidences from India*. In Innovative research in Transportation Infrastructure (pp. 65-75). Springer, Singapore.

Kamaludin, A. S., & Qibthiyyah, R. M. (2022). Village Road Quality and Accessibility on Transforming Rural Development. AGRARIS: *Journal of Agribusiness and Rural Development Research, 8*(2), 160-180.

Kelkar Committee. (2013). *Report of the High Level Committee on Balanced Regional Development Issues in Maharashtra*. Government of Maharashtra.

Kumar, S. (2020). Role of Agricultural Infrastructure and Climate Change on Crop Diversification in Uttar Pradesh: Panel Data Analysis. *Journal of Rural Development, 39*(2), pp. 207-225.

Lewis, W.A. (1955). *The Theory of Economic Growth*. London: Allen Unwin.

Luger, M., Butler, J., & Winch, G. (2013). *Infrastructure and Manufacturing: Their Evolving Relationship*. Manchester Business School and UK Government's Foresight Future of Manufacturing Project

Majumder, S. H., Deka, N., Mondal, B., & Bisen, J. (2021). Does Rural Infrastructure Development Affect Agricultural Productivity? Evidence from Assam, India. *Agricultural Research Journal, 58*(1), 125-129.

Mallick, Jagannath (2013). Public Expenditure, Private Investment and States Income in India, *The Journal of Developing Areas, 47*(1), 181-205

Manjunath, S., & Kannan, E. (2017). Effects of Rural Infrastructure on Agricultural Development: A District Level Analysis in Karnataka. India. *Journal of Infrastructure Development, 9*(2), 113-126.

Mohanty, B., Bhanumurthy, N. R., & Dastidar, A. G. (2017). What explains Regional Imbalances in Infrastructure?: Evidence from Indian States. *Working Papers*, Article 17/197. https://ideas.repec.org//p/npf/wpaper/17-197.html

NABARD (2018). *NAFIS All India Financial Inclusion Survey (NAFIS) 2016-17*. Mumbai: National Bank for Agricultural and Rural Development

Narayanamoorthy, A. & Deshpande, R. S. (2005). *Where Water Seeps!: Towards a New Phase in India's Irrigation Reforms*. New Delhi: Academic Foundation.

Narayanamoorthy, A., & Hanjra, M. A. (2006). Rural Infrastructure and Agricultural Output Linkages: A Study of 256 Indian Districts. *Indian Journal of Agricultural Economics, 61*(3),444 -459.

Narayanamoorthy, A., Nuthalapati, C. S., Sujitha, K. S., & Suresh, R. (2022). Dynamics of Farmers' Income Growth: Regional and Sectoral Winners and Losers from Three-Time SAS Data. *Indian Journal of Agricultural Economics, 77*(3), 368-384.

Nayak, C. (2014). Rural Infrastructure in Odisha: An Inter-District Analysis. PRAGATI: *Journal of Indian Economy, 1*(1), 17-38.

Okolo, C. V., Edeme, R. K., & Emmanuel, C. (2018). Economic Analysis of Capital Expenditure and Infrastructural Development in Nigeria. *Journal of Infrastructure Development, 10*(1-2), 52-62.

Randolph, S., Bogetic, Z., & Hefley, D. (1999). *Determinants of Public Expenditure on Infrastructure: Transportation and Communication*. The World Bank.

Sarkodie, S. A., & Adams, S. (2020). Electricity Access and Income Inequality in South Africa: Evidence from Bayesian and NARDL Analyses. *Energy Strategy Reviews, 29*, 100480.

Sarma, A. (2013). An Investigation into the Status of Rural Infrastructure and Its Impact on the Rural Economy of Assam. Guwahati: PhD. Thesis (Unpublished), Gauhati University. Retrieved from http://shodhganga.inflibnet.ac.in/handle/10603/29214?mode=full

Sekhon, M. K., Kaur, A., & Chopra, S. (2022). Marketing Infrastructure Development in Punjab and Farm Laws 2020: Some Observations. *Journal of Agricultural Development and Policy, 32*(2), 180-187.

Shah, T, (1993). *Groundwater Markets and Irrigation Development: Political Economy and Practical Policy*. New Delhi: Oxford University Press.

Shah, T.; O. P. Singh and A. Mukherji (2006). Some Aspects of South Asia's Groundwater Irrigation Economy: Analyses from a Survey in India, Pakistan, Nepal Terai and Bangladesh. *Hydrogeology Journal, 14*(3), 286-309.

Singh, R. (2004). Rural Infrastructure, Agricultural Development and Poverty in India: An Inter-State Study. *Journal of Rural Development, 23*(1), 31-58.

Thacker, S., Adshead, D., Fay, M., Hallegatte, S., Harvey, M., Meller, H., O'Regan, N., Rozenberg, J., Watkins, J. & Hall, J. (2019). Infrastructure for Sustainable Development. *Nature Sustainability, 2*, 324–331. https://doi.org/10.1038/s41893-019-0256-8

The World Bank (2020), *Rural Population (% of Total Population) – India*, The World Bank, available at: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?end=2021&start=2011

Timilsina, G. R., Sahoo, P., & Dash, R. K. (2022). Why Do Indian States Differ in Their Infrastructure Development? *Policy Research Working Paper Series*, Article 10086. https://ideas.repec.org//p/wbk/wbrwps/10086.html

Vaidyanathan, A.; Krishanakumar, A., Rajagopal, A. & Varatharajan, D. (1994). Impact of Irrigation on Productivity of Land. *Journal of Indian School of Political Economy, 6*(4), 60-145.

van de Walle, D. (2002). Choosing Rural Road Investments to Help Reduce Poverty. *World Development, 30*(4), 575-589.

Vinogradova, M., Kulyamina, O., Koroleva, V. & Larionova, A. (2015). The Impact of Migration Processes on the National Security System of Russia. *Mediterranean Journal of Social Sciences, 5*, 161-168.