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Socio-economic Infrastructure Development in Indian Himalayan Region: Insights from Uttarakhand

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Abstract: *The whole process of economic and social development are based upon the status of socio-economic infrastructure available in the economy. It is recognized fact that quality, capacity and efficiency of a country's infrastructure have profound influence on its growth. By keeping the fact, present study is an endeavour to analyse the district-wise pattern of infrastructure development in Uttarakhand at three points of time i.e. 2000-01, 2010-11 and 2021 with the help of 29 indicators of socio-economic infrastructure development. Level of infrastructural development at district level has been analysed with the help of composite indices by using Principal Component Analysis. It has been used in working out weights/ loadings for the indicators representing different dimensions to construct composite indices of infrastructure development. Inter-district disparities have been evaluated with the help of coefficient of variation. All the thirteen districts of Uttarakhand have been divided into developed, moderate and developing categories in terms of composite indices in decreasing hierarchy, referring to base year i.e. 2000-01. The analysis of spatial patterns of development exhibits improvement in districts of Udam Singh Nagar, Hardwar, Bageshwar during 2000-01 to 2021, whereas districts of Pithoragagh, Uttarkashi, Rudraprayag, Pauri Garwal, remain more or less same during the study period. Hence, the developing/less developed districts require special treatment in the comprehensive regional planning at micro level. The results shown that level of infrastructure development has been increased in Uttarakhand and inter-district disparities has decreased during study period.*

Key Words: *Infrastructure Development, Principle Component Analysis, Composite Indices, Himalayan Region, Uttarakhand*

I. INTRODUCTION

Socio-economic Infrastructure is considered as essential component in the development of any region. It ecompass wide range of facilities and services, including trasportaion networks, heathcare, educational institions, communication channels and energy resources which collectively determine the quality of life and economic productivity. The Himalayan hill states of India, comprising of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Meghalaya, Manipur, Tripura, Mizoram, Arunachal Pradesh, Assam, Nagaland, and Sikkim. Have a population of about 74980000 persons according to 2011census, which is about 6.2 percent of the total population of India. The density of 156 persons per sq. is two and half times lower than the national average (382 persons per sq. km.). These hill states have covered one-eight of the total land area of the total land of the country. Hill states are self-contained politico-administrative units. They were designated as special category states for allocating Central Assistance for development. Initially, states of Jammu & Kashmir, Nagaland and union territories of Himachal Pradesh, Manipur and Tripura were given the status of special category hill states. After the reorganisation in North-Eastern in 1971 and granting of statehood to union territories of Himachal Pradesh, Megahlaya, Tripura and Manipur, the number of hill states rose to six in 1972 from two in 1965. Again, with the grant of statehood to Sikkim, Arunachal Pradesh and Mizoram, the number of such states went up to nine in 1987. Further, the hill districts of Uttar Pradesh, now Uttarakhand were given the statehood in 2000. With this, there are ten hill states considered as special category states (Tiwari 2005). Uttarakhand is a state in Himalayan Region of India having geographical area, of 53,483 sq. kms. Which is 1.69 % of total area of country, state have 46, 035 sq. kms hill area and 7,448 sq. kms of plain area, which is 86.07 percent and 13.93 percent respectively. Having population, 10086292, (census 2011), which scatter over 13 districts, 113, tehsil, 115 towns and 16793 villages (2011). It is lies between 28 degree 44' and 31 degree 28' North latitude and 77 degree 35'&81 degree 01' East longitude. It is surrounded by north-west in Himachal Pradesh, Uttar Pradesh in south and south-west by Haryana.Uttarakhand secures, a prime position in economic development in all the hill states of India, but this this is not homogeneous for entire Uttarakhand, as state is characterised wide ranging inter-regional disparitpies in resource endowment, geographical and agroclimatic condition.

II. REVIEW OF LITERATURE

The previous literature of this subject we find that quite a large number of studies have been accomplished to work out composite index of development using various kind of development criteria. The method for constructing composite index of development by summing up the ranks of the ranks of various indicators has earlier been quite popular among the researchers. The ranking method has two major drawbacks. Firstly, it does not consider the magnitude of difference of values of indicators. Secondly, in this method all the indicators are given equal weights. It is well accepted that different indicators of development have different relative importance and hence, are to be adequately represented (Tiwari, 2010). Therefore, in order to eliminate subjective element, various studies were conducted by using the method of Principal Components Analysis/Factor Analysis. Pal (1975) followed the method of first principal component analysis to work out composite index of development by using 17 indicators of agriculture, secondary activities, tertiary activities and urbanisation. Rao (1977) used multiple factor analysis approach for measuring economic distance between the States of India. Singh (1983) examined the availability of socio-economic infrastructure and economic development in eight hilly districts of Uttar Pradesh, study revealed that main constraints in the process of development was lack of infrastructure development. Tiwari (1984) studied level of development at district level in Uttar Pradesh. The development was defined in terms of the total vector of 31 indicators concerning agriculture, industry, infrastructure and social services, and the principal component analysis was used to construct composite indices of development. he pointed out the achievement in terms of better and diversified structure of economy, higher productivity, efficient economic infrastructure, income level and employment were quite perceptible in developed district.

Tiwari (2000) evaluated the level of infrastructure facilities and economic development at district level in Himachal Pradesh by using PCA/Factor Analysis for construction of composite index of development, it was revealed that in the entire districts there were positive relationship between infrastructure and economic development. In another study, Tiwari (2007), the method of first principal component analysis was used to construct composite index of development, he recognised the need of upgradation of physical infrastructure, in this study he has mainly focused on road and road transportation, hydroelectric power and irrigation facilities for promoting economic activities all over the state. Kar (2007) assesses the growth of the economy of Uttarakhand study showed that, there were lack of infrastructure mainly in the agriculture and horticulture sector which are less developed in the economy. Tiwari (2008), examined the progress made during 1981-2001, in Himachal Pradesh in respect of two major components of development, viz. the agriculture and economic infrastructure level at district level. Mittal et.al (2008) examined inter-district development in Uttarakhand, he focused on geographical, economic and infrastructural disparities between hills and plain areas. They found that poor status of infrastructure hinders the development of the economy. Tiwari (2010) in his study Infrastructure for sustainable rural development in Himachal Pradesh has applied method of first principal component analysis for the measurement of district-wise infrastructure and rural development. He stressed that efficient rural infrastructure is essential for sustainable rural development. Dutt (2015) in his study Infrastructural Development in Himachal Pradesh and Uttarakhand compared the district-wise level of infrastructure development. This analysis was done with the help of composite indices of infrastructural development at two points of time (i.e. 2000-01 and 2010-2011) by pooling the selected indicators, following the methodology of first principal component analysis. It was revealed that developing districts of both the states have greater degree of disparities than the developed category districts. Kumar and Singh (2020) in their study Health Infrastructure Disparities in Punjab: An Inter-district Analysis have attempted to examine the inter-district disparities in health infrastructure in Punjab. Using principal component analysis, a district-level health infrastructure index (HII) for Punjab has been constructed at three points of time, that is, 1994, 2008 and 2018. The found presence of inter-district disparities in health infrastructural facilities in Punjab. By review literature, it is found that there is no comprehensive study at district level in Uttarkhand. Thus, the present research is an endeavour to assess the level of infrastructure development in Uttarakhand at the district level.

III. OBJECTIVES OF THE STUDY

The main objective of the study is to analyse the socio-economic infrastructure development at district level in Uttarakhand at three point of time, i.e. 2001,2011and 2021. The specific objectives of study are:

(i) To rank the districts on the basis of level of socio-economic infrastructure development.
(ii) To evaluate the inter-district disparities in infrastructure development in Uttarakhand.
(iii) To identify backward districts, this could be helpful in formulating regional policies for achieving the objective of balanced regional development.

III. METHODOLOGY

The present study is based upon secondary data. The concerned data has been collected from various publication of Reserve Bank of India, various issues of census of Government of India, Statistical Diary, Sankhiyiki Patrika at district level publication of Government of Uttarakhand. The most crucial is to analyses the level of infrastructure development at district level, where multi-area unit analysis has been used. For this purpose, construction of composite indices of socio-economic infrastructure development has considered for the analysis. The indicators used to construct Composite Indices are as follows:

I_1 Length of roads per hundred sq. kms. of area;

I_2 Length of roads per lakh population;

I_3 Number of bank branches per hundred sq. kms. of area;

I_4 Number of bank branches per lakh of population;

I_5 Percentage of credit deposit ratio;

I_6 Credit per capita;

I_7 Deposit per capita;

I_8 Number of post offices per hundred sq. kms. of area;

I_9 Number of post offices per lakh of population;

I_{10} Percentage of Villages Electrified;

I_{11} Number of primary agricultural cooperative society per hundred sq. kms. of area;

I_{12} Number of primary agricultural cooperative society per lakh of population;

I_{13} Percentage of forest land;

I_{14} Number of Veterinary Hospital and Dispensaries per hundred sq. of area;

I_{15} Percentage of Rural Population;

I_{16} Number of primary schools per hundred sq. kms. of area;

I_{17} Number of primary schools per lakh of population;

I_{18} Number of middle schools per hundred sq. kms of area;

I_{19} Number of middle schools per lakh of population;

I_{20} Number of high/higher secondary school per hundred sq. kms. of area;

I_{21} Number of high/higher secondary school per lakh of population;

I_{22} Number of medical institutions per hundred square kms. of area;

I_{23} Number of medical institutions per lakh of population;

I_{24} Number of beds available in medical institutions per lakh of population;

I_{25} Percentage of household with toilet facilities;

I_{26} Percentage of urban population to total population;

I_{27} Density of population;

I_{28} Percentage of net irrigated area to net area sown:

I_{29} Percentage of net area sown to total geographical area;

Construction of Composite Indices

The method which has been generally used for construction of composite indices of development by polling several indicators of are those of indexing, ranking and Principal component analysis including factor analysis. To determine the weights of selected indicators and to identify basic factors which are crucial for constructing Principal Component Analysis (PCA) based on statistical techniques termed as factor analysis (Tiwari 2007). In the first two method that is indexing and ranking for construction of composite index of various physical variables, either subjective weights are assigned or they are left unweighted (Tiwari 2007). Since the variables differ in terms of their relative importance, assignment of equal weight not impart accuracy to estimates, therefore some objective method of assigning suitable weights has been employed for constructing the composite index of infrastructure development. This problem has been taken care of by the method of 'Principal Component Analysis' or 'Factor Analysis', because this method provides a better system of composite classificatory indices. Further PCA or FA has been used as a statistical technique for assigning weights to the selected indicator and identifying basic factors, which are crucial for infrastructure development (Tiwar 2007).

The principal component analysis is a branch of well-known multivariate technique of factor analysis. It is a relatively straight forward method of transferring a given set of variables and indicators into a new set of composite variables or principal components that are orthogonal to each other. Principal component method of factor analysis, developed by Harrod Hottelling(1933) seek to maximize the sum of squared loadings of each factor extracted in turn. Accordingly, principal component factor explains more variance than would the loadings obtained from any other method of factoring (Tiwari 2007). The full-fledged principal component model can be expressed as follows:

$$Z_j = a_{j1} P_1 + a_{j2}P_2 + \dots a_{ji} P_i + a_{jn} P_n \qquad \dots(1)$$

Where, Z_j = 1 to n, are the standardized values of the observed variables. P_1, i = q o n are the new uncorrelated components and a_j1, i = 1 to n and i = 1 to n, the coefficients are the 'factor loading or weights. Each of the n observed variables is described linearly in terms of n new uncorrelated components P1, P2 …. P_n, each of which is in turn, defined as combination of the n original variables. Since each component is defined as the best linear summary of variance left in the data after the previous components are taken care of, the first m component usually much smaller than the number of variables in the set may explain most of the variance in the data. In the model, the factor loadings, or co-efficient of principal components are the correlations of the variables with the principal components. Thus, a_{ij} is correlated to variables zj with the principal component (P1). Principal components are linear combination of standardized variables with weights in terms of factors loadings. Thus, principal component P1 is determined as:

$$P_1 = a_{1i} Z_1 + a_{2i} Z_2 + \dots + a_{ni} Z_n \qquad \dots(2)$$

$P_1 = \sum_{i-1}^{n} aij \times Zi$ where, P1 = the first principal component; a_{ij} = factor loading of the first principal vector relating to jth indicator of the ith district; Zi = standardized value of the observed variables. Thus, the first principle component, which gives maximum correlation with variables and explains maximum of the total variance, is considered as composite index of development for a vector (Tiwari 1984). Since the indicators selected for working out composite indices has been measured in different units and such they cannot be directly added, it is necessary to convert the variables into standard units so the initial scale selected for measuring the variables not bias the results. The following method has been applied in the present study in order to eliminate the bias of scale:

$$Z_{ij} = \frac{x_{ij} - \overline{x}_j}{\sigma_{xj}} X100 \qquad \dots(3)$$

Where, x_{ij} = value of xj variables on the ith observation; $\overline{X}_j$= mean value of xj variables; and σx_j= standard deviation on the x_j variables.

Determining Inter-District Disparities

In order to measure disparities in the level of development, the method of coefficient variation has been used. This method is the most commonly used measure of relative importance, coefficient of variation is the percentage variation in the mean, the standard deviation being treated as the total variation in the mean. Coefficient of variation has been calculated by using the following formula:

$$C.V. = \frac{\sigma_{xj}}{\overline{X}} x100 \qquad \ldots(4)$$

Where, C.V. = Coefficient of variation, σ_{xj}= Standard Deviation and $\overline{X}$ = Mean

IV. RESULTS AND DISCUSSIONS

This section presents the results of the investigation of socio-economic infrastructure development in Uttarakhand. Since infrastructure development includes various indicators, an attempt has been made to formulate a Composite Index (CI) in order to analyse socio-economic infrastructure development in the state. Composite Index (CI) has been constructed using the weights computed by PCA approach of factor analysis for the year 2000-01, 2011 and 2021. The results of factor analysis of 29 indicators for the year 2000-01 are presented in Table1.1shows that two factors are extracted from 29 infrastructure development indicators for 13 districts of Uttarakhand, which explain 69. 27 percent variations. The first principal explains 46.48 percent of total variations in infrastructure development in Uttarakhand. The most important indicators loaded on the first factor is Number of bank branches per hundred sq. kms. of area with factor loading 0.938 followed by Percentage of household with toilet facilities (0.920), Credit per capita (0.919), Number of post offices per lakh population (0.903), Density of population (0.903), Percentage of urban population to total population (0.895), Percentage of Rural Population (0.895), Number of primary agricultural cooperative society per lakh of population (0.804) Number of high/higher secondary school per lakh of population (0.797) Percentage of net irrigated area to net area sown (0.850), Number of primary schools per hundred sq. kms. of area (0.813), Number of medical institutions per hundred square kms. of area (0.810), Number of middle schools per hundred sq. kms of area (0.787), Length of roads per hundred sq. kms. of area (0.772), Percentage of net area sown to total geographical area (0.716), Credit per capita (0.684), Number of Veterinary Hospital and Dispensaries per hundred sq. of area (0.683), Number of medical institutions per lakh of population (0.649), Percentage of Villages Electrified (0.644) and Percentage of credit deposit ratio (0.515). The second factor accounts for 22.78 percent of total infrastructure development variations and contains indicators such as, Number of primary schools per lakh of population (0.878), Number of middle schools per lakh of population (0.861), Number of bank branches per lakh of population (0.581), Percentage of forest land (0.678), Deposit per capita (0.634), Length of roads per lakh population (0.627), Percentage of net area sown to total geographical area (0.590), Number of beds available in medical institutions per lakh of population (0.584), Number of medical institutions per lakh of population (0.574), Percentage of credit deposit ratio (0.505), Number of high/higher secondary school per hundred sq. kms. of area (0.496), Number of middle schools per hundred sq. kms of area (0.495) and Length of roads per hundred sq. kms. of area (0.488). The results of factor analysis for the year 2011 are presented in table 1.2 show that two factors are extracted from 29 indicators for thirteen districts of Uttarakhand explaining 69.331 percent variation. The first factor explains 48.49 percent variance and includes indicators, Length of roads per hundred sq. kms. of area (0.963), Number of bank branches per hundred sq. kms. of area (0.952), Credit per capita (0.950), Density of population (0.940), Percentage of Rural Population (0.903), Percentage of urban population to total population (0.903), Number of middle schools per hundred sq. kms of area (0.892), Percentage of net irrigated area to net area sown (0.864), Percentage of household with toilet facilities (0.853), Number of primary schools per hundred sq. kms. of area (0.845), Number of post offices per lakh population (0.*843)*, Number of primary agricultural cooperative society per lakh of population (0.819), Number of high/higher secondary school per hundred sq. kms. of area (0.732), Number of medical institutions per hundred square kms. of area (0.732), Percentage of net area sown to total geographical area (0.717), Percentage of net area sown to total geographical area (0.681), Number of middle schools per lakh of population (0.647), Number of Veterinary Hospital and Dispensaries per hundred sq. of area (0.625), Number of primary schools per lakh of population (0.585), Percentage of credit deposit ratio (0.563), Percentage of forest land (0.562) and Length of roads per lakh population (0.543).

Table1.1. Principle Component of Infrastructural Development in Uttarakhand (2000-01)

Variable	Factor Loading		h^2
	P_1	P_2	
I_1	**.772**	**.488**	.953
I_2	-.358	**.627**	.807
I_3	**.938**	.129	.986
I_4	-.218	**.851**	.880
I_5	**.515**	**-.505**	.730
I_6	**.919**	.049	.902
I_7	**.684**	**.634**	.974
I_8	.071	.267	.955
I_9	**-.903**	.186	.877
I_{10}	**.644**	.077	.636
I_{11}	.149	.024	.769
I_{12}	**-.804**	.185	.703
I_{13}	-.362	**.678**	.824
I_{14}	**.683**	-.057	.850
I_{15}	**-.895**	-.241	.934
I_{16}	**.813**	.457	.977
I_{17}	-.191	**.878**	.923
I_{18}	**.787**	**.495**	.970
I_{19}	.123	**.861**	.937
I_{20}	.438	**.496**	.925
I_{21}	**-.797**	.423	.874
I_{22}	**.810**	.406	.935
I_{23}	**-.649**	**.574**	.891
I_{24}	.122	**.584**	.821
I_{25}	**.920**	.207	.956
I_{26}	**.895**	.241	.934
I_{27}	**.903**	-.279	.939
I_{28}	**.850**	-.390	.957
I_{29}	**.716**	**-.590**	.965
Eigen Value	**13.481**	**6.608**	
Percentage Variance	**46.487**	**22.787**	
Cumulative Variance (%age)	**46.487**	**69.274**	

Source: Author Calculation.

Note: Bold value indicates highest factor loading of a variable on components. (Critical Value 0.483 at 5 % Significance level and 0.605 at 1 % Significance level)

The second factors explained 20.83 percent of total variance and includes, Number of medical institutions per lakh of population (0.824), Number of high/higher secondary school per lakh of population (0.785), Number of bank branches per lakh of population (0.767), Number of beds available in medical institutions per lakh of population (0.676), Credit per capita (0.666), Number of medical institutions per hundred square kms. of area (0.647), Number of high/higher secondary school per hundred sq. kms. of area (0.627), Percentage of credit deposit ratio (0.623), Percentage of net area sown to total geographical area (0.575) and Number of primary schools per lakh of population (0.568).

Table1.2. Principal Component of Infrastructural Development in Uttarakhand (2010-11)

Variable	Factor Loading		h^2
	P_1	P_2	
I_1	**.963**	-.033	.992
I_2	**-.543**	.222	.915
I_3	**.952**	.224	.973
I_4	.110	**.767**	.872
I_5	**.563**	**-.623**	.793
I_6	**.950**	.051	.931
I_7	**.681**	**.666**	.950
I_8	.123	.447	.965
I_9	**-.843**	.205	.861
I_{10}	.293	.111	.856
I_{11}	.061	.082	.890
I_{12}	**-.819**	.169	.810
I_{13}	**-.562**	.377	.823
I_{14}	**.625**	-.099	.673
I_{15}	**-.903**	-.192	.942
I_{16}	**.845**	.438	.985
I_{17}	**-.585**	**.568**	.993
I_{18}	**.892**	.317	.967
I_{19}	**-.647**	.398	.882
I_{20}	.732	**.627**	.984
I_{21}	-.288	**.785**	.888
I_{22}	**.732**	**.647**	.988
I_{23}	-.324	**.824**	.888
I_{24}	.099	**.676**	.802
I_{25}	**.853**	.328	.935
I_{26}	**.903**	.192	.942
I_{27}	**.940**	-.253	.986
I_{28}	**.864**	-.403	.944
I_{29}	**.717**	**-.575**	.955
Eigen Value	**14.063**	**6.043**	
Percentage Variance	**48.494**	**20.838**	
Cumulative Variance (%age)	**48.494**	**69.331**	

Source: Author Calculation.

Note: Bold value indicates highest factor loading of a variable on components. (Critical Value 0.483 at 5 % Significance level and 0.605 at 1 % Significance level)

The results of factor analysis for the year 2021 are presented in Table 1.3. Two factors are extracted on the basis of selected indicators of infrastructure development indicators for thirteen districts of Uttarakhand which explain 68.08 percent of total variations. The first factor explains 51. 66 percent of total variation in infrastructure development. The most important indicators in the first factor are Number of primary schools per lakh of population (0.949), Number of bank branches per hundred sq. kms. of area (0.932), Density of population (0.931), Length of roads per hundred sq. kms. of area (0.929), Number of middle schools per hundred sq. kms of area (0.928), Percentage of net irrigated area to net area sown (0.921),

Table1.3. Principal Component of Infrastructural Development in Uttarakhand (2020-21)

Variable	Factor Loading		
	P_1	P_2	h^2
I_1	**.929**	-.094	.992
I_2	**-.512**	.204	.958
I_3	**.932**	.282	.973
I_4	-.167	**.820**	.910
I_5	**.589**	**-.540**	.863
I_6	**.853**	.284	.970
I_7	.467	**.725**	.981
I_8	.095	**.861**	.958
I_9	**-.875**	.244	.893
I_{10}	.207	.247	.922
I_{11}	-.000114	.460	.867
I_{12}	**-.844**	.189	.982
I_{13}	**-.681**	.032	.784
I_{14}	**.619**	.173	.919
I_{15}	**-.869**	-.215	.926
I_{16}	**.771**	.144	.953
I_{17}	**-.949**	.116	.980
I_{18}	**.928**	.084	.934
I_{19}	**-.874**	.117	.830
I_{20}	**.876**	.297	.940
I_{21}	**-.895**	.264	.968
I_{22}	**.641**	**.643**	.931
I_{23}	**-.560**	**.559**	.767
I_{24}	.180	**.484**	.890
I_{25}	.028	**.682**	.790
I_{26}	**.873**	.206	.922
I_{27}	**.931**	-.105	.945
I_{28}	**.921**	-.297	.977
I_{29}	**.783**	-.309	.984
Eigen Value	**14.984**	**4.762**	
Percentage Variance	**51.668**	**16.420**	
Cumulative Variance (%age)	**51.668**	**68.088**	

Source: Author Calculation.

Note: Bold value indicates highest factor loading of a variable on components. (Critical Value 0.483 at 5 % Significance level and 0.605 at 1 % Significance level)

Number of high/higher secondary school per lakh of population (0.895), Number of high/higher secondary school per hundred sq. kms. of area (0.876), Number of post offices per lakh population (0.875), Number of middle schools per lakh of population (0.874), Percentage of urban population to total population (0.873), Percentage of Rural Population (0.869), Credit per capita (0.853), Number of primary agricultural cooperative society per lakh of population (0.844), Percentage of net area sown to total geographical area (0.783), Number of primary schools per hundred sq. kms. of area (0.771), Percentage of forest land (0.681), Number of medical institutions per hundred square kms. of area (0.641), Number of Veterinary Hospital and Dispensaries per hundred sq. of area (0.619), Percentage of credit deposit ratio (0.589), Number of medical institutions per lakh of population (0.560) and Length of roads per lakh population (0.512).

The second factor explained 16.42 percent variation and includes Number of post offices per hundred sq. kms. of area (0.861), Number of bank branches per lakh of population (0.820), Deposit per capita (0.725), Percentage of household with toilet facilities (0.682), Number of medical institutions per hundred square kms. of area (0.643), Number of medical institutions per lakh of population (0.559), Percentage of credit deposit ratio (0.540) and Number of beds available in medical institutions per lakh of population (0.484).

Table 1.4. Composite Index of Socio-economic Infrastructure Development in Uttarakhand

Sr. No.	District (i)	$CI_{periodt}$ (ii)	$Rank_{periodt}$ (iii)	$CI_{periodt'}$ (iv)	$Rank_{perodt'}$ (v)	$CI_{periodt''}$ (vi)	$Rank_{periodt''}$ (vii)
1.	Almora	12.3856	5	12.68027	6	11.67029	6
2.	Bageshwar	6.06787	9	15.75942	5	12.9983	5
3.	Chamoli	0.9119	13	2.9719	11	1.8981	12
4.	Champawat	8.26105	7	9.41245	7	10.69172	8
5.	Dehradun	39.81487	1	41.31211	1	37.78725	3
6.	P. Garhwal	7.10061	8	9.27694	9	5.93844	9
7.	Haridwar	30.86899	3	34.72719	3	39.25552	2
8.	Nainital	22.45749	4	22.24188	4	22.4581	4
9.	Pithoragarh	1.7719	12	2.5875	12	0.6664	13
10.	Rudrapryag	4.72837	10	5.01304	10	5.33439	10
11.	Tehri Garhwal	10.08894	6	9.38253	8	11.50586	7
12.	Udam Singh Nagar	35.27442	2	36.40867	2	41.28701	1
13.	Uttarkashi	2.268	11	0.2947	13	2.4381	11
	Mean	**14.00**		**15.54374**		**15.68688**	
	S.D.	**12.95224**		**13.31465**		**14.15409**	
	C.V.	**92.51599**		**85.65928**		**90.22885**	

Source: Author Calculation

Notes: (1) Period t, t' and t'' represents year 2000-01, 2010-11 and 2020-21 respectively.

(2) See vertically columns (iii) (v) and (vii) rank 1st represents relatively better position of a district, wheras 13th rank represents worst position of a district in terms of infrastructure development in the state.

(3) See horizontally, row wise perusal of descending ranks [e.g. from 11th rank in period t to 10th rank in peiod t' and 9th rank in period t'' shows improvement in infrastructure development in particular district and vice versa.

District-wise level of infrastructure development has been analyzed with the help of composite index. These indices have been calculated by taking first principal component matrix (PCM) derived from intercorrelation matrix of 29 indicators.

$$CI_1=(0.772)Z_1+(0.358)Z_2+(0.938)Z_3+(0.218)Z_4+(0.515)Z_5+(0.919)Z_6+(0.684)Z_7+(0.071)Z_8+(0.903)Z_9+(0.644)Z_{10}+(0.149)Z_{11}+(0.804)Z_{12}+(0.362)Z_{13}+(0.683)Z_{14}+(0.895)Z_{15}+(.0813)Z_{16}+(0.191)Z_{17}+(0.787)Z_{18}+(0.123)Z_{19}+(0.438)Z_{20}+(0.797)Z_{21}+(0.810)Z_{22}+(0.649)Z_{23}+(0.122)Z_{24}+(0.920)Z_{25}+(0.895)Z_{26}+(0.903)Z_{27}+(0.850)Z_{28}+(0.716)Z_{29} \quad \ldots(5)$$

$$CI_2=(0.963)Z_1+(0.543)Z_2+(0.952)Z_3+(0.110)Z_4+(0.563)Z_5+(0.950)Z_6+(0.681)Z_7+(0.123)Z_8+(0.843)Z_9+(0.293)Z_{10}+(0.061)Z_{11}+(0.819)Z_{12}+(0.562)Z_{13}+(0.625)Z_{14}+(0.903)Z_{15}+(0.845)Z_{16}+(0.585)Z_{17}+(0.892)Z_{18}+(0.647)Z_{19}+(0.732)Z_{20}+(0.288)Z_{21}+(0.732)Z_{22}+(0.324)Z_{23}+(0.099)Z_{24}+(0.853)Z_{25}+(0.903)Z_{26}+(0.940)Z_{27}+(0.864)Z_{28}+(0.717)Z_{29} \quad \ldots(6)$$

$$CI_3=(0.929)Z_1+(-0.512)Z_2+(0.932)Z_3+(-0.167)Z_4+(0.589)Z_5+(0.853)Z_6+(0.467)Z_7+(0.095)Z_8+(-0.875)Z_9+(0.207)Z_{10}+(.0.000114)Z_{11}+(0.844)Z_{12}+(0.681)Z_{13}+(0.619)Z_{14}+(0.869)Z_{15}+(0.771)Z_{16}$$

$$+(0.949)Z_{17}+(0.928)Z_{18}+(0.874)Z_{19}+(0.876)Z_{20}+(0.895)Z_{21}+(0.641)Z_{22}+0(.560)Z_{23}+(0.180)Z_{24}+(0.028)Z_{25}+(0.873)Z_{26}+(0.931)Z_{27}+(0.921)Z_{28}+(0.783)Z_{29} \quad \ldots(7)$$

Where, CI, CI and CI are the composite index for infrastructural development for the year 2000-01, 2010-11 and 2020-21 respectively of the district and Z_1 Z_2 Z_3………Z_{29} are the values in standardized form and the figures in parenthesis are factor loading or weights.

The equation (5) reveals that the first principal component of infrastructriural sector for the year ranges between 0.938 and -0.903, the sum the square of the factor loading of the first principal componenst are largest eigen value which measure proportion of variance explained by the first principal component as given in Table1.1. Table 1.2 and Table 1.3. On the other hand, the sum of the square of the facor loading of all the principal components retained corresponding to variables is communality (h^2) which expresess percentage of variance explained by the factor model. The values of communalities(h^2) has been given in table 1.1, table 1.2 and table 1.3 for the years 2000-01, 2010-11 and 2020-21 respectively. The district-wise indices are presented in Table1.4. All the districts have been ranked according to their level of infrastructure development during the three point of time. In 2000-01, Dehradun was at the top of Composite Index (CI) with a value (39.81487), followed by Udam Singh Nagar (35.27442), Haridwar (30.86899), Nainital (22.45749) and Almora (12.3856). Chamoli had the lowest CI (0.9119). Other districts with low CI were Pithoragarh (1.7719), Uttarkashi (2.268), Rudrapryag (4.72837) and Bageshwar (6.06787). The district Tehri Garhwal (10.08894), Champawat (8.26105) and P. Garhwal (7.10061) were found moderate districts in the level if infrastructure development in Uttarakhand. Table 1.5 shows that CI of infrastructure development in 2010-11 lies between 41.31211 to 0.2947.

In 2010-11 first four districts retained their position in ranking, which are Dehradun, Udam Singh Nagar, Haridwar and Nainital with CI values 41.31211, 36.40867, 34.72719 and 22.24188 respectively and Bageshwar placed at fifth with CI value (15.75942). Uttarkashi had a lowest position with index value (0.2947) immediately preceded by Pithoragarh and followed by (2.5875), Chamoli (2.9719), Rudrapryag (5.01304), and P Garwal (9.27694). The districts Almora (12.68027), Champawat (9.41254) and Tehri Garhwal (9.38253) followed the way moderate level of infrastructure development in the state. In 2020-21 Udan Singh Nagar occupied top position with CI (41.28701) followed by Haridwar (39.25552), Dehradun (37.78725), Nainital (22.4181) and Bageshwar (12.9983). It further shows that Pithoragarh (0.6664) perform worst in 2020-21, followed by Chamoli (1.8981), Uttarkashi (2.4381), Rudrapryag (5.33439) and Pauri Garhwal (5.93844), whereas the districts Almora (11.67029), Tehri Garwal (11.50586), Champawat (10. 69172) found to be moderate districts in the level of infrastructure development. The analysis infrastructure development exhibits improvement in districts of Udam Singh Nagar, Hardwar, Bageshwar during 2000-01 to 2021, whereas districts of Pithoragagh, Uttarkashi, Rudraprayag, Pauri Garwal, have deteriorated not shown any improvement in Infrastructure development during the study period. Hence, the developing/less developed districts require special treatment in the comprehensive regional planning at micro level. The results shown that level of infrastructure development has been increased in Uttarakhand and inter-district disparities has decreased in the study time period. On the basis of performance in composite index (CI) of infrastructutre development from 2000-01 to 2020-21 have been categorized in three category, the districts which have composite index value higher than state average, nearer to state average and father from the state average, have been categories as, developed, moderate and developing districts respectively. The Table 1.5 shows that in 2000-01 four district namely, Dehradun, Udam Singh Nagar, Haridwar,

Table 1.5. Classification of the Districts of Uttarakhand According to Performance in Composite Index of Infrastructure Development.

District Category	Number of Districts			Districts		
	$C_{periodt}$	$C_{periodt'}$	$C_{periodt''}$	$C_{periodt}$	$C_{periodt'}$	$C_{periodt''}$
Developed	4	5	4	Dehradun, Udam Singh Nagar, Haridwar, Nainital	Dehradun, Udam Singh Nagar, Haridwar, Nainital, Bageshwar	Udam Singh Nagar, Haridwar, Dehradun, Nainital
Moderate	2	4	4	Almora,Tehri Garhwal	Almora, Champawat, Tehri Garhwal, P. Garhwal	Bageshwar, Almora, Tehri Garhwal, Champawat
Developing	7	4	5	Champawat, P. Garhwal, Bageshwar, Rudrapryag, Uttarkashi, Pithoragarh, Chamoli	Rudrapryag, Chamoli, Pithoragarh Uttarkashi	P. Garhwal, Rudrapryag, Uttarkashi, Chamoli, Pithoragarh

Source: Authors Calulation.

Notes: Cperiod t, t' t'' represents category of districts in 2000-01, 2010-11 and 2020-21 respectively.

Nainital were in developed category, whereas, seven districts Champawat, P. Garhwal, Bageshwar, Rudrapryag, Uttarkashi, Pithoragarh, Chamoli were in developing and in moderate category there were only two districts Almora,Tehri and Garhwal. In 2010-11, five district namely, Dehradun, Udam Singh Nagar, Haridwar, Nainital and Bageshwar were in developed category, while districts, Bageshwar, Almora, Tehri Garhwal and Champawat were in moderate category, and in moderate category there were Almora, Champawat, Tehri Garhwal and P. Garhwal. In 2020-21, four districts namely, Udam Singh Nagar, Haridwar, Dehradun and Nainital were in developed category, while districts P. Garhwal, Rudrapryag, Uttarkashi, Chamoli and Pithoragarh and moderate category contains the districts Rudrapryag, Chamoli, Pithoragarh and Uttarkashi. Table 1.5 shows that the in intial time period in developed category contains four districts which increase to five districts in 2010-11 and finally to four districts in 2020-21. In developing category, there were seven distrists in intial time period, four and five districts in 2010-11 and 2020-21 respectively. In moderate category there were two districts, which increase to four in 2010-11 and remained same in 2020-21. As a whole, Table 1.5 revealed that level of infrastructure development has been increased in study period.

V. Summary and Conclusion

The present study evaluates the level of infrastructure development at district level in the hill state of Uttarakhand for the year 2000-01, 2010-11 and 2020-21. On the basis of composite index of infrastructure development, it revealed that district Dehradun occupied top position followed by Udam Singh Nagar, Haridwar and Nainital in year 2000-01, on the other hand, district Chamoli was placed at the bottom of position in infrastructure development preceded immediately by Pithoragarh, Uttarkashi, Rudrapryag, Bageshwar, Pauri Garhwal, Champawat, and Tehri Garhwal. In 2010-11, Dehradun, had retained its position on the top followed by Udam Singh Nagar, Haridwar and Nainital. While district Uttarkashi was at the bottom immediately preceded by Pithoragarh, Chamoli, Rudrapryag, Pauri Garhwal, Tehri Garhwal and Champawat. For the year 2020-21 district Udam Singh Nagar has improved its position and placed at the top, followed by district Haridwar, while the condition of Dehradun deteriorated from 1st position to 3rd position among all districts of Uttarakhand. But, district Nainital remained at the 4th position throughout the study period. The leases developed districts doring 2020-21 were Pithoragarh, Chamoli, Uttarkashi, Rudrapryag, Pauri Garhwal, Champawat and Tehri Garhwal. On basis of the above analysis it is observed that inter-district has not widened during the study period. A majority of less developed districts are due to inadequate availability of infrastrucutural facilities. The Districts of Pithoragarh, Chamoli, Uttarkashi, Rudrapryag, Pauri Garhwal, Champawat and Tehri Garhwal are infrastructurally backward particularly abalabiliuty of roads, banking facilities, communications facities, avavalabilty of primary agricultural cooperative socities and availability of educational and health facilities. The present analysis, the districts, which have experienced a low level of infastrastructure developmen, should be given first priority in the process for implementing the developmental plans. But, the districts attaining the high levels of development should not be ignored in the matter of the implementation of development plans, i.e. the natural pace of development should not be disturb in any context but should not be given top priority compared to that in retarded districts. It is important that the development gap prevailing between the retarded and the developed districts should be systematically and judiciously alleviated in order to achieve an optimal spatial Infastructure development. Therefore it suggeated area specific programme for socio-economic infrastructure development.

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