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Spatial Variation in the Level of Development in Western Rajasthan

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Abstract

Spatial variation in development in India has remained static in spite of overall development efforts made during the plan periods. Not only had the vertical balance too showed distinct signs of deterioration. Regional disparities in relation to poverty income and unemployment have been increasing among the different regions of a state (vertical) and in the districts within the regions of the state (horizontal). Rajasthan is also characterized by economic imbalance. All the relative indicators indicate that the Eastern Plain Region occupies a balanced status followed by the Aravali Hills and Plateau regions. So far as the Western Desert Region is concerned it was at a disadvantageous position in terms of status of relative development. The economy of the study area being agrarian, Net Domestic Product is largely dependent on agriculture production, which is subjected to wide flections, depending on the monsoon conditions. There is a need of a suitable development strategy, an area specific planning approach based on proper and efficient use of resources and potentials to secure regional balance and final solutions to the problems of the economy of Western Rajasthan. There is no reason to believe that if so desired why desert state cannot touch the heights of development and make a place for itself in the galaxy of other developed states of this country? The raw data (Based on Census, 2011) have been converted into ratio or percentage according to the requirement of the analysis. The indicators used in the present paper have been divided in 4 groups i.e. demographic, agricultural, infrastructural and economic. By using composite index method development in each aspects have been find out. In this study the principal component method has been made to measure spatial variations in the level of development among the 12 Districts of Western Rajasthan. On the basis of composite index, these districts have been divided into 4 categories of level of development.

Key Words: *Spatial Variation, Western Desert Region, Principal Component Method, Level of Development*

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Introduction

India is a large federal nation and it is well known that there are widespread disparities in the levels of social and economic development between the different regions of the Indian nation. Balanced regional development has always been an essential component of the Indian development strategy in order to ensure the unity and integrity of the nation. The concept of spatial variation has been quintessential in all geographical thinking. Such variation in

terms of resource management and overall socio-economic progress reflect the levels of development in a country like India. On one hand there are large urban centers which are growing in size and are centres of materialistic culture and on other, there are vast rural areas where about eighty per cent of her people still remain backward and are devoid of even basic amenities like water supply, sanitation, education etc. Spatial imbalance has got accounted with the economic progress in the country. We do not mean imaginary equalization of all regions when we talk of balanced regional development. Such equalization is in fact not possible. Various factors are responsible for spatial variation in level of development like economic growth, political pressure, involvement of local people, skilled labour, irrigated land, industrial capital credit, infrastructural etc. The main objective of the present study is to identify level of development in the western Rajasthan.

The idea of analysis of spatial variation in the level of development is relevant for integrated area development because we cannot provide all services and development programmes for all settlement due to scarcity of resources. Hence, it is essential to identify the most suitable location for allocation of important services. There are widespread disparities in the levels of social and economic development between the regions and also within the region.

Raghuram Rajan Committee for Evolving a Composite Development Index of States Using Multi- Dimensional Index categorized Rajasthan as Least Developed state. The Western Rajasthan is at extreme backwardness, which is largely the result of peculiar physical feature of the area, a traditional society and a static economy in the years preceding. The state itself has remained much below the economic level attained in the rest of country. Against this backdrop, there is a need to identify the regions or areas which are backward, to find out the extent and nature of backwardness and to look into the dynamics of the regional backwardness over space and time. The present study is an attempt in this direction.

An attempt is made to trace the level of development in the social-economic structure in Western Rajasthan. Keeping the volatility of social infrastructure and amenities for the promotion of development in view, to study the existing infrastructure and social amenities of the area under study with the set objective to assess their impact on the exploitation of its physical and human resources. This in-depth analysis raises three basic questions, namely, why is there an enormous gap between differentially developed districts? Why is such a gap increasing? And why is development concentrated only in a few centers/areas? Answers to these questions are sought with the help of an analysis of dimensions of development and typology of backwardness. It is sought that this will highlight the major findings of the present study and also give valuable policy suggestions to all those who are interested in the development process of Western Rajasthan.

The study area

The Population of Rajasthan according to the 2011 census stands at about 68 million, making it the 8th most populated state in India. The state makes up about 5.6% of the country's population. The state is spread over an area of about **342,239** sq. km. making it the largest state in the country in terms of area. The Aravalli hill ranges, running from north- east to south-west, divides the state into the western arid and eastern semi-arid region. Rajasthan has been divided into four Physiographic regions, i.e., (Singh, R.L.1971)

Physiographic divisions of Rajasthan

1. The Western Sandy plain
2. The Aravalli Range & Hilly Region
3. The Eastern Plain
4. The south-Eastern Plateau

The study area 'Western Rajasthan' is situated in the western part of Rajasthan. (Fig.1). This region includes 12 western districts of Rajasthan, which covers an area of 208,746 sq. kms with a population of 27,115,542 persons as per census 2011. The study area makes up about 60.99 percent area and 39.51 percent population of the state.

Table 1 : Physiographic divisions of The Study Area

Region	Division	Sub-Division	Districts(12)
Western Rajasthan (**Western Sandy Plain**)	Sandy Arid Plain	**Marusthali**	Hanumangarh, Sriganganagar, Bikaner**,** Jaisalmer, Barmer, Jalore, Pali, Jodhpur, Nagaur, Churu, Sikar & Jhunjhunu
		Dune Free Tract	
	Semi-Arid Plain (Bangur Region)	**Ghaggar Plain**	
		Shekhawati	
		Naguri upland	
		Luni Basin	

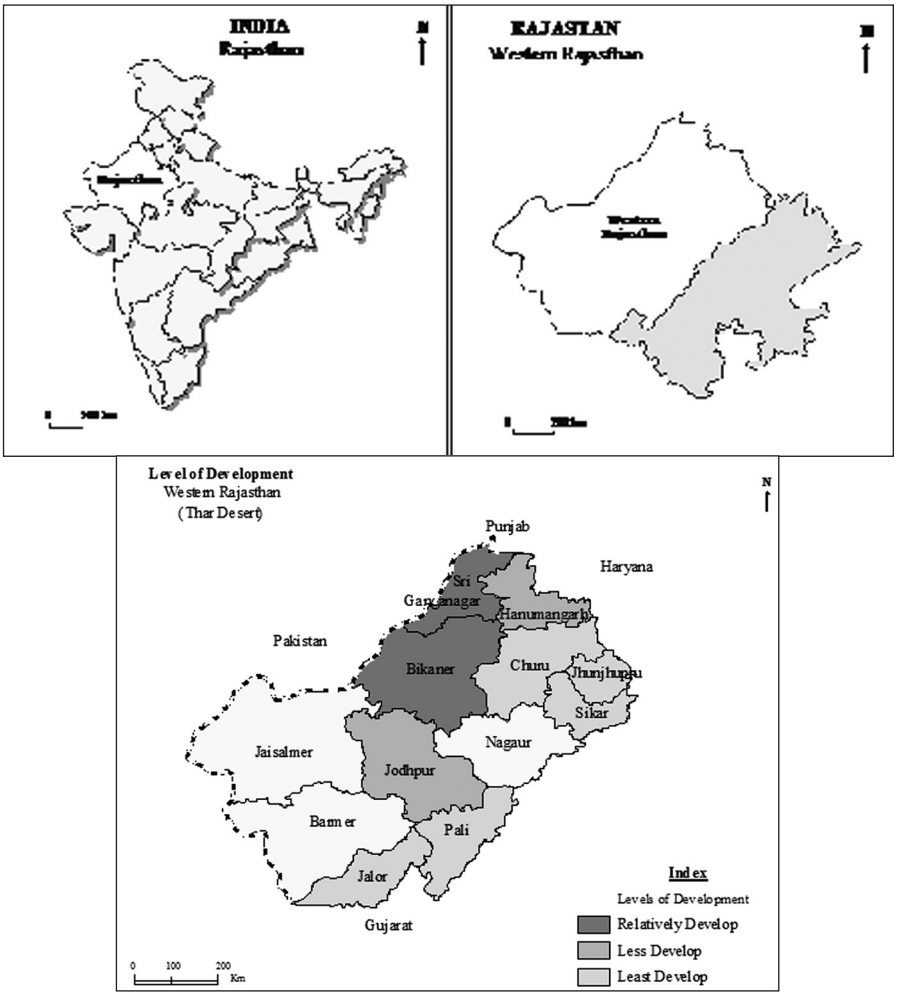

Fig. 1 : Location Map

The area is characterized by arid landscape with various types of sand dunes. It is dry and ill watered, unkind to all form of life, animal and plant. The study area has a desert climate characterized by extreme temperature and erratic rainfall. This area is lacking in water, biotic resources and infrastructure facilities with poor human development index. Due to scattered settlement and more spacing among them, it is difficult to provide all infrastructural facilities at village level because of lack of population threshold.

The Western Rajasthan is at extreme backwardness, which is largely the result of peculiar physical feature of the area, a traditional society and a static economy in the years preceding. Most of the villages of the Study area do not have even the basic necessities like Drinking water, Education,

Health, Transportation and other services. The study area has remained much below the economic level attained in the rest of state. There is no proper spatial distribution of services at the Micro – level due to scattered and more spacing among the settlement.

Objectives

The present study is intends to fulfil the following objectives:

1. To analyses the factors responsible for the inequalities in socio-economic development among the Districts.
2. To assess the natural and human resources and classify the districts into Backward region, least developed, less developed and relatively developed.
3. To make identification of the relatively backward areas within the study area and identify existing gaps and assess future demand for socio- economic infrastructure and prepare rational planning.

Database and Methodology

The present study is mainly based on secondary data obtained from census of India (2011) and statistical handbook of Rajasthan. Other relative data collected from various official sources such as publications of the Directorate of Economics and Statistics, the Revenue Board of Rajasthan, Departments of Agriculture, Department of Industry and Department of Environment and Forest. This research aims to measure the spatial variation in the level of development in Western Rajasthan at district level, with the help of multi-variable data analyzing methods based on a determined system of viewpoints. The presented model and the methodology based on it are suitable for making spatial variation measurable. Through this and with the help of statistical data, the spatial variation of any territorial unit of any level can be determined.

A number of methods have been used to study the spatial variation. Main work in this direction was done by Mitra, A. (1961). He used 35 indicators to highlight regional disparities through ranking method. The same method has been also used by Mahesh Chand and Puri, V.K. (1983), Roa & Puri (1971). Dasgupta (1971) and Pal, M. N. (1975) have used multiple factor analysis and the method of principal component analysis to study spatial variation in level of development. The method has been widely used by Sharma, K.L. (1975) Mandal, S.K. (1971) Hagood, M.S. (1977) and Mishra, R.P. (1978).

The Principal Component Method of factor analysis was developed by H. Horelling (1933). The weights used in this case are the elements of the Eigen vector corresponding to the highest Eigen vector of the correlation matrix (R) are of the selected variables. Eigen vector has been used here as it gives relative importance to each variable, which is very important for the identification of level of development.

Primary work in this direction was done by Smailes (1944), Dickinson (1964), Berry (1968), Garison (1968) and Guttman (1969). An important work in this direction was done by Kim. (1999), Jeffrey (1965), Freeman C.(1987), Grossman G. and

Helpman E., (1991), Lundvall B. (1992), Nelson R., (1993), Anthony J. (2005), Elbers and Kenneth R. (2005), Venables. J. (2005), Pike A., Rodríguez-Pose A. and Tomaney J. (2006) etc.

In India the evolution of spatial variation in the level of development has been investigated by number of authors viz.. Agarwala, A.K. and Hazarika, P.L. (2002), Ahluwalia, Montek S. (2000), Arora, R.C. (1979), Debapriya, A. and Mohanty, M.K. (2006), Nagaraj, R, Aristomene Varoudakis and Marie-Ange Veganzones (1998), Nair K.R.G. (2004), Naseer, Y., Siddiqui, F.A. and Kazma Khan (2005), Rao, Hemlata, (1984), Shand, Ric and S. Bhide (2000), Singh R. (2006), L.K. Sen (1994), L.S. Bhatt, (1972), R.L. Singh(1971), .Pal(1975), R.P. Mishra (1978) etc. They have done pioneer work in the field of regional development, identified backward areas and suggested various impressive strategies for the balanced development of the region.

Present research aims to measure the spatial variation in the level of development in Western Rajasthan at district level, with the help of multi-variable data analyzing methods based on a determined system of viewpoints. The presented model and the methodology based on it are suitable for making spatial variation measurable. Through this and with the help of statistical data, the spatial variation of any territorial unit of any level can be determined.

In order to make the study comprehensive and more analytical both empirical and statistical methodologies have been adopted for the different aspects of the study. The indicators, which are used in the present study, have been divided into four groups, that is :

1. Demographic Indicators
2. Economic Indicators
3. Socio-Cultural Indicators
4. Infrastructural Indicators

The Principal Component Method of factor analysis was developed by H. Horelling (1933). The weights used in this case are the elements of the Eigen vector corresponding to the highest Eigen vector of the correlation matrix (R) are of the selected variables. Eigen vector has been used here as it gives relative importance to each variable, which is very important for the identification of level of development.

On the basis of Principal Component Analysis the districts will be classify into three categories i.e. least developed, less developed and relatively developed districts. After delineation of the development zone at district level I have tried to find out causes for its variation.

The identification of spatial variation and regional growth patterns is an important factor affecting policy formulation. Single indicator, usually GDP-based, approaches have revealed significant shortcomings. In present work, I have provided a new methodology and respective tools to analyze regional disparities and development patterns. Aiming at capturing the different aspects of development and quality of life my approach is multi-dimensional: I have, first, developed a composite index; then, apply multivariate clustering for identifying regions with similar socio-economic profiles.

Principal component is a linear combination of the standard scores of the given variable. The weights used in this case are the elements of the Eigen vector corresponding to the highest Eigen value of the correlation matrix R of the selected variables. The Eigen vector is also normalized to the highest Eigen value used. Eigen vector has been used here as it gives relative importance to each variable, which is very important for the identification of level of development. The following steps are involved to calculate first principal component.

1. Identification of development indicators for the analysis and columns.
2. For each column, sum of correlation as a_1, a_2, a_3 and ax are values of coefficient of each variables.
3. A normalization factor NF_1 is obtained by the square root of the sum of square of all the column sums of Ua_1 i.e.
4. Normalized factor Van is obtained by using formula $Va_1 = Ua_1/NF_1$
5. The elements of normalized column sums Va_1 are multiplied by their respective coefficients in various rows of the correlation matrix one by one sorting with the first row and ending with the last row of the matrix and the sum of these products put at the end of row. The resultant vector is referred to as Ua_2 with the help of Ua_z normalizing factor NF_2 is taken out.
6. To find first Principal Components various elements of vector Va_1 are multiplied by square root of normalization factor of vector Ua_2 i.e. NF_2. The product constitutes the elements in First Principal Component, F_1.
7. With the help of First Principal Components Eigen value has been worked out.
8. Eigen Vector has also been calculated as W corresponding to the Eigen value for each variable and with the help of the Eigen vector relative importance of each variable has been round. More the value of Eigen vector more the importance of that function.
9. Al last composite index value for each district can be calculated by summing standardized value of each variable multiplied by their Eigen vector.
10. Composite Index (C.I.), On the basis of composite index western Rajasthan has been divided into different level of development.

An attempt has been made in the measures of different level of development to construct a composite index by combining and grouping different indicators into four sectors, so that the composite indicator could be used to differentiate spatial units like districts for level of economic development. The study summarizes 24 indices identified for each of the four sectors which reflect the development characteristics (Table 2).

Table 2 : Development Indicators

S. No.	District	Population Growth (2001-2011)	% of net irrigated area of net cropped area	% of main workers to total workers 2011	% of villagers having electric facility	% of Urban population (2011)	No. of Livestock per 10000 population
1	Barmer	32.55	9.19	61.7	96.10	7.0	21179
2	Bikaner	24.48	16.64	76.3	98.71	33.9	15182
3	Churu	20.35	7.27	69.6	100	28.3	11099
4	Ganganagar	10.06	75.48	74.6	95.62	27.2	8016
5	Hanumangarh	17.24	44.54	76.9	97.3	19.7	8214
6	Jaisalmer	32.22	1396	60.7	78.21	13.3	48616
7	Jalore	26.31	41.09	73.7	99.12	8.3	12542
8	Jhunjhunu	11.81	52.69	66.3	100	22.9	6524
9	Jodhpur	27.69	19.37	70.9	100	34.3	1362
10	Nagaur	19.25	18.51	69.1	100	19.3	11694
11	Pali	11.99	18.45	71.9	100	22.6	15203
12	Sikar	17.04	45.10	69.4	100	23.7	7856
	X ˜	20.91	30.19	70.09	97.8	21.70	13957.25
	S.D. (σ)	4.57	5.49	6.28	5.44	11.51	8732.77

Development Indicators

S. No.	District	Number of Registered Vehicles/ 10000 population	Length of roads/ 10000 Sq.Km. (2011)	Literacy Rate (2011)	Number of beds in hospital & dispensary/ 10000 population (2011)	Agricultural output (Ton)/10000 Population (2011)	% of non-agriculture workers/ total workers (2011)
1	Barmer	380.70	1713.20	56.50	4	280.20	86.1
2	Bikaner	1240.18	1502.32	65.1	18	274.40	86.2
3	Churu	317.68	1755.18	66.8	8	351.70	89.1
4	Ganganagar	1741.32	1138.72	69.6	7	490.60	59.3
5	Hanumangarh	792.17	1540.80	67.1	5	697.10	78.1
6	Jaisalmer	298.75	826.73	57.2	6	227.7	78.8
7	Jalore	470.24	2877.15	54.9	3	284.9	77.1
8	Jhunjhunu	683.35	4354.12	74.1	9	384.60	92.2
9	Jodhpur	1456.16	2647.30	65.9	17	315.20	92.2
10	Nagaur	774.46	3183.62	62.8	5	360.20	75.4

11	Pali	823.60	3618.38	62.4	8	241.70	54.9
12	Sikar	647.92	3629.91	71.9	12	417.90	89.3
	X ˜	802.21	2405.62	64.53	8.5	360.51	78.39
	S.D. (σ)	435.30	1037.67	12.16	5.1	147.60	7.93

Development Indicators

S. No.	District	Number of Banks/ Lakh population (2011)	Deposits of banks per person (2011)	Credit of banks per person (2011)	No. of Primary schools to 10000 population	% of school going children to total children	% of double cropped area to total cultivated area (2011)
1	Barmer	6	2643	1018	18.11	80.01	6.42
2	Bikaner	12	8336	3278	9.17	79.30	23.52
3	Churu	9	4985	1632	6.86	82.42	4.72
4	Ganganagar	12	7761	4562	10.84	85.33	43.42
5	Hanumangarh	9	4389	2913	7.55	80.26	40.76
6	Jaisalmer	10	3910	1492	20.71	78.12	7.15
7	Jalore	6	2878	940	11.43	87.40	32.63
8	Jhunjhunu	7	6283	1469	9.64	97.40	9.67
9	Jodhpur	8	8481	3645	11.17	89.42	6.12
10	Nagaur	7	3734	946	10.45	87.88	14.75
11	Pali	8	53.18	1320	9.69	86.73	21.14
12	Sikar	9	6271	1530	9.96	91.32	11.38
	X ˜	8.58	5415.75	2062.08	11.29	85.52	18.47
	S.D. (σ)	1.72	3140.7	1855.88	3.63	6.84	9.35

Development Indicators

S. No.	District	% of college students to total student	Number of Education centres/ Sq.km. (2011)	Land Revenue per head of population (2011)	Postal Services per 100 sq.km.	Cooperative societies/ 1000 population (2011)	Total milk production in Kgs./1000 population (2011)
1	Barmer	8.62	0.05	4.86	2	0.32	129
2	Bikaner	17.29	0.09	2.78	1	0.67	226
3	Churu	14.72	0.19	2.86	3	0.41	120
4	Ganganagar	19.32	0.17	5.85	2	0.64	218
5	Hanumangarh	16.75	0.23	7.05	3	0.33	226
6	Jaisalmer	11.46	0.04	31.94	1	0.52	203
7	Jalore	13.59	0.18	7.85	3	0.39	175

8	Jhunjhunu	21.42	0.53	4.81	9	0.23	180
9	Jodhpur	8.74	0.21	7.10	2	0.50	192
10	Nagaur	13.15	0.24	5.25	4	0.24	113
11	Pali	14.72	0.20	11.35	4	0.45	154
12	Sikar	19.10	0.47	6.16	8	0.20	129
	X ˜	14.56	0.21	8.16	3.8	0.41	160.42
	S.D. (σ)	3.16	0.13	6.12	1.7	0.13	58.37

These 24 indices are firstly subtracted from their mean and then divided by their standard deviation separately for each district and thus we get standardized values for each district. These values of indices are grouped under each of the 4 sectors and are worked together under each sector to aggregate them into one. The sum of standardized values of each sector is then divided by the number of variables that have been chosen into each sector and composite index has been worked out (Table 3).

Table 3 : Value of composite index for various development sectors

S. No.	Districts	Demographic sector	Agriculture Sector	Economic Sector	Infrastructural Sector
1	Barmer	0.17	-0.67	-0.43	-0.19
2	Bikaner	1.05	-0.69	0.52	0.16
3	Churu	0.42	-0.39	-0.36	-0.65
4	Ganganagar	0.48	1.32	-0.18	-0.41
5	Hanumangarh	0.13	1.32	-0.03	-0.58
6	Jaisalmer	0.60	-1.53	1.24	-0.31
7	Jalore	-1.05	-0.81	-0.48	-0.04
8	Jhunjhunu	0.22	0.32	-0.61	0.15
9	Jodhpur	0.61	-0.39	-0.11	-0.01
10	Nagaur	-0.12	0.10	-0.14	-0.08
11	Pali	-0.55	0.72	-0.16	-0.11
12	Sikar	0.77	0.29	0.04	0.002

On the basis of composite index (Table 3) four categories/zones have been worked out for each sector.

1. Highly developed zone
2. Medium developed zone
3. Less developed zone
4. Very less developed zone

These zones have been grouped and analysed under the four sectors - demographic, agricultural, economic and infrastructural sector and are discussed as under -

Demographic Sector

This sector includes population growth (2001-2011), percentage of urban population to the total population and literacy rate according to census 2011. The districts of western Rajasthan have been grouped based on the level of development and shown in the map. The districts falling in highly demographic development zone are Bikaner, Jaisalmer, Jodhpur, and Sikar. They are developed in all demographic aspects, whereas Jaisalmer and Sikar are less developed in regard to urban population and Jodhpur has low literacy rate.

The districts like Barmer, Churu, Ganganagar, hanumangarh and Jhunjhunu comes in Medium developed zone. Here Churu, Ganganagar and Hanumangarh have less population growth but have good literacy rate while Barmer and Jhunjhunu has less percentage of urban population. The districts falling in less developed zone is Nagaur.

Lastly come the districts falling in very less developed zone, they are Jalore and Pali. These districts are very low in literacy rate.

Agricultural Sector

Agricultural sector constitutes give indices percentage in irrigated area to net cropped area, agricultural output per 1000 population, percentage of non-agricultural workers to total workers and percentage of double cropped area to total cultivated area. The level of agricultural development has been worked out and shown in map. Here Ganganagar and Hanumangarh districts fall in highly developed zone due to fertile plain. On the other hand Jhunjhunu and Sikar fall in medium developed zone.

The less developed zone, includes the districts like Churu, Jodhpur and Nagaur, where in these districts the percentage of irrigated area to net cropped area is less and has average condition in all the agricultural aspects except for percentage of non-agricultural workers which is quiet low. The districts falling in very less developed zone are Barmer, Jaiselmer, Jalore, Bikaner and Pali are those districts that have limitation of fertile soil due to large cover of sandy soil.

Economic Sector

Economic position of western Rajasthan was very dismal in the initial stage of planning. Only few districts of western Rajasthan show good position in economic profile while rest are even below average. The district Bikaner fall under highly developed zone.

The districts falling in medium developed zone are Jaisalmer, Nagaur, Ganganagar, Hanumangarh and jodhpur. The districts like Ganganagar, Hanumangarh, Jodhpur and Nagaur show good percentage of main workers to the total workers while Jaisalmer show good number of livestock. The districts falling in less developed zone are Baran, Barmer, Churu, Jalore, Pali and Sikar. In these district population is involved more in agriculture and is having low literacy rate thus these are less developed in all economic aspects, also the district Jhunjhunu fall in very less economic developed zone.

Infrastructural Sector

This sector plays vital role in the level of development and act as the main instrument without which the study of regional disparities is incomplete. The indices have

been selected for analysis namely road connectivity, electricity, educational centres, medical facilities, milk production and cooperative societies which indicates that may help in the identification of backward regions. The highly developed zone in this sector includes districts like Bikaner and Jhunjhunu. Thus these districts are well connected with other states through good transportation system, maximum educational and medical facilities and these districts have other high infrastructural facilities too. The district that fall in medium developed zone are Ganganagar, Hanumangarh, Sikar and Jodhpur. These districts show average conditions in infrastructural facilities. The less developed zone includes the districts like Chum, Jalore, Nagaur and Pali, while the very less developed zone includes Jaisalmer and Barmer.

All the above districts show less availability of infrastructure facilities and are sometimes nil in one or two indices with certain exceptions too. Due to the extremes of temperature, low fertility, less number or settlements connectivity and communication is less developed here.

Principal Component Method

In the present study the method "First Principal Component Method" has been used to measure regional disparities in western Rajasthan. It is a method of factor analysis and was developed by H. Hotelling (1933) Principal Component analysis is an empirical technique of "Breaking down" a correlation or covariance matrix into set of orthogonal components or axes equal in number with that of original variates. In the present study First Principal Component method has been used as it happens to be the linear combination of variates having the maximum sum of squares of the correlation coefficients with the variable. The first principle component is a linear combination (weighted sum) of the standard scores of the given variables. The weights used in this case are the elements of the eigen vector corresponding to the highest eigen value of correlation matrix R of the selected 24 variables. Thus this method is found more convenient and reliable to measure the extent of regional disparities in each sector in comparison to the other methods discussed above as this method gives importance to each variable.

In this method firstly mean and standard deviation of each variable on the basis of 12 districts of western Rajasthan are evaluated and then a correlation matrix (R) is worked out on the basis of above 24 variables, the analysis is shown in the table.

Correlation Matrix

For each column, sum of correlation is obtained. The vector of column sums is referee to as :-$Ua_1 = \Sigma a_1 + a_2 + a_3 + ... + a_k$

Where a_1, a_2, a_3 and a_k are value of coefficient of each variable.

After the above step normalization factor NF1 is obtained by the square root of the sum of squares of all the column sums of Ua_1 i.e.

$NF_1 = \sqrt{}$ [(Σcolumn 1)^2 + (Σcolumn 2)^2 + ... (Σcolumn n)^2

Normalized vector Va_1 is obtained by using the formula : $Va_1 = Ua_1/NF_1$

Table 4 Correlation Matrix (R)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
X_1	1.00	-0.07	0.15	-0.23	-0.08	-0.15	0.08	-0.09	0.02	0.02	-0.09	-0.20
X_2	-0.07	1.00	-0.02	-0.04	0.09	-0.57	0.13	0.07	0.32	-0.15	0.63	0.21
X_3	0.15	0.02	1.00	-0.01	0.38	0.07	0.41	-0.33	0.01	0.23	-0.02	-0.09
X_4	-0.23	-0.04	-0.01	1.00	0.30	0.03	0.15	0.39	0.09	0.22	0.05	0.01
X_5	-0.08	0.09	0.38	0.31	1.00	-0.16	0.56	-0.25	0.50	0.72	0.03	0.07
X_6	-0.15	0.57	0.07	0.03	0.16	1.00	-0.17	-0.18	-0.44	0.02	-0.46	-0.42
X_7	0.08	0.13	0.41	0.15	0.56	-0.17	1.00	-0.17	0.04	0.60	-0.14	0.17
X_8	0.09	0.07	-0.33	0.39	-0.25	-0.18	-0.17	1.00	-0.13	-0.28	0.11	-0.05
X_9	0.02	0.32	0.01	0.09	0.50	-0.44	0.04	-0.13	1.00	0.21	0.38	0.39
X_{10}	0.02	-0.15	0.23	0.22	0.72	0.02	0.60	-0.28	0.21	1.00	-0.34	-0.06
X_{11}	-0.09	0.63	-0.02	0.05	0.03	-0.46	0.14	0.11	0.38	-0.34	1.00	0.11
X_{12}	-0.20	0.21	-0.09	0.01	0.07	-0.42	0.17	-0.05	0.39	-0.06	0.11	1.00
X_{13}	0.03	0.05	0.38	0.04	0.55	0.21	0.60	-0.50	-0.01	0.59	-0.28	0.10
X_{14}	-0.16	0.0	0.15	0.26	0.49	0.02	0.53	-0.06	0.36	0.44	-0.22	0.35
X_{15}	0.07	0.29	0.30	0.08	0.67	0.23	0.77	-0.28	0.35	0.65	0.16	0.18
X_{16}	0.06	-0.28	-0.23	0.27	-0.74	0.35	-0.29	-0.86	-0.67	0.31	-0.24	-0.14
X_{17}	-0.01	-0.28	-0.38	-0.33	-0.71	0.49	-0.36	0.02	0.65	-0.37	-0.26	-0.26
X_{18}	-0.11	0.44	0.21	0.20	0.56	-0.41	0.40	-0.14	0.61	0.32	0.29	0.44
X_{19}	-0.15	0.89	-0.11	0.02	-0.07	-0.57	0.03	0.14	0.35	-0.19	0.58	0.33
X_{20}	-0.18	0.32	-0.31	0.31	-0.35	-0.47	-0.13	0.72	0.03	-0.28	0.29	0.21
X_{21}	-0.02	0.25	0.24	0.05	0.12	-0.06	0.28	-0.12	-0.23	0.26	-0.26	-0.12
X_{22}	-0.26	0.26	-0.33	0.40	0.25	-0.42	-0.17	0.72	0.09	-0.22	0.22	0.15
X_{23}	0.15	-0.05	0.45	-0.06	0.50	0.19	0.52	-0.39	-0.09	-0.06	-0.06	-0.34
X_{24}	0.15	0.12	0.17	-0.03	0.10	0.16	-0.02	0.01	0.06	0.13	0.14	-0.15
Ua_1	0.11	4.79	2.32	3.14	4.58	1.11	5.10	0.65	2.59	4.08	1.62	1.89

Correlation Matrix

	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}	X_{24}
X_1	0.03	-0.16	0.07	0.06	-0.01	-0.11	-0.15	-0.18	-0.02	-0.26	0.15	0.15
X_2	0.05	0.00	0.29	-0.28	-0.28	0.44	0.89	0.32	0.25	0.26	-0.05	0.12
X_3	0.38	0.15	0.30	-0.23	-0.38	0.21	-0.11	-0.31	0.24	-0.33	0.45	0.17
X_4	0.04	0.26	0.08	0.27	-0.33	0.20	-0.02	0.31	0.05	0.40	-0.06	-0.03
X_5	0.55	0.49	0.67	-0.74	-0.71	0.56	-0.07	-0.35	0.12	0.25	0.50	0.10
X_6	0.21	0.02	0.23	0.35	0.49	-0.41	-0.57	-0.47	-0.06	-0.42	0.19	0.16
X_7	0.60	0.53	0.77	-0.29	-0.36	0.40	0.03	-0.13	0.28	-0.17	0.52	-0.02
X_8	-0.50	-0.06	-0.28	-0.86	0.02	-0.14	0.14	0.72-	-0.12	0.72	-0.39	0.01

X_9	-0.01	0.36	0.35	-0.67	-0.65	0.61	0.35	0.03	-0.23	0.09	-0.09	0.06
X_{10}	0.59	0.44	0.65	0.31	-0.37	0.32	-0.19	-0.28	0.26	-0.22	0.51	-0.13
X_{11}	-0.28	-0.22	0.16	-0.24	-0.26	0.29	0.58	0.29	-0.26	0.22	-0.06	0.14
X_{12}	0.10	0.35	0.18	-0.14	-0.26	0.44	0.33	0.21	-0.12	0.15	-0.34	-0.15
X_{13}	1.00	0.61	0.69	-0.27	-0.22	0.40	-0.10	-0.46	0.33	-0.47	0.61	0.02
X_{14}	0.61	1.00	0.54	-0.43	-0.44	0.69	0.04	0.02	0.05	0.10	0.11	-0.08
X_{15}	0.69	0.54	1.00	-0.45	-0.43	0.53	0.16	-0.17	0.29	-0.23	0.55	0.13
X_{16}	-0.27	-0.43	-0.45	1.00	0.81	-0.66	-0.15	0.15	0.17	-0.01	-0.17	-0.25
X_{17}	-0.22	-0.44	-0.43	0.81	1.00	-0.76	-0.25	-0.03	0.07	-0.10	-0.13	-0.26
X_{18}	0.40	0.69	0.53	-0.66	-0.76	1.00	0.44	0.18	-0.02	0.22	0.07	0.08
X_{19}	-0.10	0.04	0.16	-0.15	-0.25	0.44	1.00	0.57	0.15	0.41	-0.22	-0.03
X_{20}	-0.46	0.02	-0.17	0.15	-0.03	0.18	0.57	1.00	0.06	0.93	-0.47	-0.14
X_{21}	0.33	0.05	0.29	0.17	0.07	-0.02	0.15	0.06	1.00	-0.02	0.07	-0.04
X_{22}	-0.47	0.10	-0.23	-0.01	-0.10	0.22	0.41	0.93	-0.02	1.00	-0.31	-0.14
X_{23}	0.61	0.11	0.55	-0.17	-0.13	0.07	0.22	-0.47	0.07	-0.31	1.00	0.33
X_{24}	0.02	-0.08	0.13	-0.25	-0.26	0.08	-0.03	-0.14	-0.04	-0.14	0.33	1.00
Ua_1	3.90	4.37	6.88	3.34	3.85	4.98	3.23	1.80	2.50	2.07	2.77	1.20

The elements of normalized column sums (Va_1) are then multiplied by their respective coefficient in various rows of the correlation matrix one by one sorting with the first row and ending with the last row of the matrix and the sum of these products put at the end of the row. The resultant vector is referred to as Ua_2 (Table 5) and with the help of Ua2 normalizing factor NF_2 (i.e. 1.99) is calculated.

Table 5 : Extraction of First Principal Component

Variable	Va_1		Normalized Factor of Ua_2 or $\sqrt{1.99073}$	First Principal component (F_1)	Eigen Vector (W)
X_1	0.003	X	1.411	0.0042	0.0583
X_2	0.132	X	1.411	0.1863	2.5875
X_3	0.064	X	1.411	0.0903	1.2542
X_4	0.087	X	1.411	0.1228	1.7056
X_5	0.0126	X	1.411	0.1779	2.4708
X_6	0.047	X	1.411	0.0663	0.9208
X_7	0.140	X	1.411	0.1975	2.7431
X_8	0.018	X	1.411	0.0254	0.3528

X_9	0.071	X	1.411	0.1002	1.3917
X_{10}	0.112	X	1.411	0.1580	2.1944
X_{11}	0.045	X	1.411	0.0635	0.8819
X_{12}	0.052	X	1.411	0.0734	1.0194
X_{13}	0.107	X	1.411	0.1510	2.0972
X_{14}	0.120	X	1.411	0.1693	2.3514
X_{15}	0.190	X	1.411	0.02681	3.7236
X_{16}	0.092	X	1.411	0.1298	1.8028
X_{17}	0.106	X	1.411	0.1496	2.0778
X_{18}	0.137	X	1.411	0.1933	2.6847
X_{19}	0.089	X	1.411	0.1256	1.7445
X_{20}	0.050	X	1.411	0.0701	0.9736
X_{21}	0.069	X	1.411	0.0974	1.3528
X_{22}	0.058	X	1.411	0.0818	1.1361
X_{23}	0.076	X	1.411	0.1072	1.4889
X_{24}	0.033	X	1.411	0.0466	0.6472
Eigen Value				0.6258	

First Principle Component is extracted when various elements of vector Va_1 are multiplied by square root of NF_2 and the products thus constitute the elements of First Principle component F_1.

With the help of First Principle Component Eigen value is calculated which the sum of square of factor loading is relating to a factor. Eigen Vector W corresponding to Eigen value 0.6258 for each variable is calculated. With the help of Eigen vector relative importance of each variable can be known and more the value of Eigen vector more is the importance of that function.

The last stage composite index value for each district is worked out by taking total score of standardized value of each variable multiplied by their eigen vector (Table 5).

i.e. Composite Index (C.I.) = $[(X_1-X_1)/\sigma_1.XW_1] + [(X_2-X_2)/\sigma_2. XW_2] + ... = [(X_n - X_n)/\sigma_n. XW_n]$

Where $(X1 - \bar{X}1)/ \sigma_1$ is the standardized value and W is eigen vector.

Table 6 Final Composite Index Value

S.No.	Districts	Standard Value
1	Barmer	- 0.83
2	Bikaner	0.55
3	Churu	-0.27
4	Ganganagar	0.75
5	Hanumangarh	0.14
6	Jaisalmer	-0.51
7	Jalore	-0.01
8	Jhunjhunu	-0.13
9	Jodhpur	0.25
10	Nagaur	-0.51
11	Pali	-0.28
12	Sikar	-0.16

Spatial Variation in Western Rajasthan

On the basis of composite index, 12 districts of Western Rajasthan have been divided into 4 categories of level of development shown in the table. Higher value of composite index show higher level of development and vice versa.

Table 7 Level of Development

S. No.	Composite Index Value	Level of Development	Name of the district
1	Above + 0.30	Relatively Developed	Ganganagar, Bikaner
2	0.0 to 0.30	Less Developed	Jodhpur, Hanumangarh
3	-0.30 to 0.0	Least Developed	Churu, Jalore, Jhunjhunu, Sikar, Pali
4	Less than -0.30	Backward Regions	Nagaur, Jaisalmer, Barmer

I. Relatively Developed

The districts having composite index value more than 0.30 have been assigned with relatively developed zone. The districts falling in this category are Ganganagar and Bikaner. Ganganagar is at the top position with a composite index value of 0.75 in terms of level of development. The Ganganagar district has rich agricultural potential and in the stage of development due to the existence of Indira Gandhi Canal Project. The district has also average condition in urban population and non SC-ST population. Bikaner district has better condition in number of livestock and has average condition in transportation system and education.

2. Lass Developed Zone

This zone constitutes composite index value between 0 to +0.3 and the districts include in this category are Jodhpur and Hanumangarh. Hanumangarh has rich agricultural potential but have average conditions in totla urban population and literacy rate.

3. Least Developed Zone

This zone includes 5 districts of western Rajasthan, they are Churu, Jalore, Jhunjhunu, Sikar and Pali with a composite index between -0.3 to 0.0. Here Churu stands at good position in terms of sex ratio, literacy rate (both male & female) but is less developed in terms of economic and infrastructural development. Districts Jhunjhunu has good percentage of net cropped area and has second rank in literacy. Jalore stands at good position regarding the occupation and livestock but has the lowest female literacy rate and maximum

percentage of rural population i.e. more than 90 percent. Sikar has also high literacy rate i.e. more than 70 percent of the total population but is less developed in terms of economic development, because of semi arid conditions.

4. Backward Region

The district having a composite index value less then -0.3 fall in the category of backward region and the district falling in the category are Nagaur, Jaisalmer and Barmer. District Jaisalmer and Barmer are situated in the Thar Desert where maximum land is under sand dunes and the area is lacking in infrastructural facilities like transportation, education and medical. Due to scattered settlement and more spacing among them it is difficult to provide infrastructure facilities at villages level because of lack of population and areal threshold. These districts are less developed in agriculture and percentage or urban population as well as literacy rate is also poor in these districts. Although having rich potential of mineral and power resources, these districts are unable to exploit these resources and utilize these to their maximum.

It may, therefore, be concluded from the above analysis that in western Rajasthan the general level of development is poor. Out of the total 12 districts, more than 65 percent numbering district fall under less developed or backward region. Only two districts are comparatively highly developed. This situation therefore demands process to be undertaken giving special attention and allocation of funds for development of lagging areas.

Conclusion

The main challenge of regional economic development is undoubtedly to increase the living standard and welfare of local people. Usually the state of development of regions and sub-regions within one country significantly differs. In Rajasthan, the eastern part is emerging, and the western part, mostly the ones by the boarder are lagging behind. Economic development should not be executed homogeneously, one should take into consideration the attributes and starting conditions of that certain area. The variety of starting conditions requires different interventions and strategies of economic development from region to region. Due to their different conditions they cannot be developed by the same action plans. This research helps to analysis dimensions of development and typology of backwardness and also useful to formulate a future Plan for the balanced regional development and a relevant strategy to minimize spatial variation in the level of development at micro-level.

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