
Research Papers



Road Density and Levels of Development in West Bengal

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Abstract

The present paper is an attempt to analyse the spatial patterns of road density, variations in the level of development and casual relationship between road density (dependent variable) and selected variables of socio-economic development (independent variables) among the districts of the state of West Bengal. The entire research work is based on secondary sources of data, collected from Census of India publications (2001), New Delhi and Bureau of Applied Economics and Statistics, West Bengal state Govt. publications (2002-03), Kolkata. The boundary of the district has been taken as a smallest unit of the study.

The present study discloses that the level of road density is either high or medium in most of the districts of West Bengal excluding the districts of Koch Behar and Uttar Dinajpur lying in the north and Bankura located in the eastern part of the state where the road density is low. The level of development is high or medium in the southern and northern districts of the state, while; the districts having low level of development form a linear region in the central part of the state. The t-test explains that the road density has a high level of positive association with educational facilities, health and medical amenities, urbanization, industrialization, and infrastructural facilities, and it indicates that the spatial variations in the road density in the state may have been mainly due to variations in the level of these variables of development.

Key Words: Road Density, Development, Region, District, State, West Bengal

Introduction

Transportation plays an important role in the political, economic and social development of the society, whether, it is rural or urban; transportation forms the main path through which different parts of the society are connected together. As a society grows in terms of population and functions, the need for interaction among its various components also grows thereby requiring quality and effective transportation systems (Aderamo and Magaji, 2010: 171-179), therefore, during the last three decades, the transport geography has shared with other aspects of the discipline in a general swing towards the geography of relevance (Williams, 1981: 22).

Transport refers to the carriage of goods and passengers from one place to the other (NCRET, 2003: 83). Transport network is a set of geographic locations inter connected in a system by a number of routes (Kansky, 1963: 1). The connectivity of a network may be defined as the

degree of completeness of links between nodes (Robinson & Bamford, 1978: 430). Any geographical perception on developmental issue pays attention to the accessibility of a unit, that is, its ease of access to or from somewhere else. It is difficult to determine that accessibility affects most development processes, but its specific role and importance are hard to resolve from available evidence (Wilbanks, 1972: 427-436). On the other hand, Hailey (1957) observed that there are no any other types of development which can effect so rapidly a change in the economic and social conditions of backward nations except transport. According to Ali and Magalmani (2006) the transportation is the base for the development of the any country. It helps in the agricultural, industrial, trade, and administration & defense development. It changes the outlook of the society. So it is assumed that if agriculture and industry are the body and bones of a national organism, transport and communication are its nerves.

However, among various modes of land transport, the road transport is very much significant for the development of society because increased connectivity can decrease traffic on arterial streets, reduce travel time, create shorter travel distances & reduce the number of vehicle miles traveled, provide continuous and more direct routes for travel by walking and biking, facilitate greater emergency vehicle access and reduced response time, present improved utility connections, easier maintenance, and more efficient trash and recycling pick up, lower speeds and reduce accident severity and better accommodate transit use (OKI's Community Choices, 2007: 1-27).

Road transport is relatively economic mode of transport for short and medium distance because it transports perishable goods at a faster speed by road carriers, it helps people to travel and carry goods from one place to another, even in remote and inaccessible areas where other means of transport do not exist, like hilly, tribal, desert, forest, border and backward areas, it provides frequent loading and unloading at any destination and it prevents the pilferages and wastage of the produce (Mamoria & Goel, 1979: 492). Road transport offers more flexibility, reliability, choice of routes and deliver door-to-door service (NCRET, 2003: 84), and it also links villages with markets, processing towns, administrative and cultural centers and thus to national mainstream than any other mode of transport (Gautam, 2012: 625 and Ahir, 1999: 569).

The growth and intensity of road transport and level of socio-economic development in an area or region are interconnected and interdependent. No doubt, the road connectivity is the harbinger of development in a region because it not only helps the people of the remote and backward areas in the development and optimum utilization of natural endowments but also brings momentum in the mutation of workers from primary to secondary and secondary to tertiary economic activities. As a result, the income level of the people of the backward areas is enhanced and that, in the long run, helps in bringing to minimise the regional disparities in the level of socio-economic development in a country. The increasing level of development further attracts the infrastructure of transport especially roads in a region and, in this way, they get nourished by each other.

The development is a multi-dimensional phenomenon. Some of its major dimensions include: the level of economic growth, level of education, level of health services, degree of modernization, status of women, level of nutrition, quality of housing, distribution of goods and services, and access to communication (Das, 1999: 313-345). Midgley (1995) conceives social development as a process of planned social change designed to promote the well-being of the population as a whole in conjunction with a dynamic process of economic development. Economic development is a broad and complex phenomenon. In fact, there is no clear agreed definition of development, but still economic development along with qualitative change in the social, economic and institutional realness of a society is generally considered as the key element of development (Rao 1984: 18-21). According to Drewnowski, (1966) development is a process of qualitative change and quantitative growth of the social and economic reality which we call either society or economy because of the close interrelation of economic and social elements. No purely social or purely economic development is possible; consequently, it is better not to speak of social development separately. It is a single process which is best called simply development.

Objectives of the Study

The present study has been under taken with the following objectives:

- i. to inspect the spatial patterns of road density in West Bengal,
- ii. to analyse the regional variations of level of development in state and

iii. to detect relationship between road density (dependent variable) and selected indicators of development (independent variables) in the state.

Database and Methodology

The present research work is entirely based on secondary sources of data collected from Census of India publications (2001), New Delhi, and district wise indicators of development collected from Bureau of Applied Economics and Statistics, Govt. of West Bengal publications (2002-03), Kolkata. In the present analysis, a set of thirty five socio-economic indicators of various sectors have been taken into account to determine the levels of development in the eighteen districts of state of West Bengal. These indicators fall into ten categories like population characteristics, education, literacy, agriculture, industry, health, power, transport & communication, per capita income and banking facilities. In the first step, the raw data for each variable which determines the areal variations of surface road density and level of development have been computed into standard score, it is generally known as Z value or Z-Score. The score quantify the departure of individual observations, expressed in a comparable form. This means it becomes a linear transformation of the original data (Smith, 1973: 85). It may be expressed as:

$$Z_{ij} = \frac{X_{ij} - \bar{X}_i}{\sigma_i}$$

Where, Z_{ij} = Standardized value of the variable i in district j .

X_{ij} = Actual value of variable i in district j .

$\bar{X}_i$ = Mean value of variable i in all districts.

σ_i = Standard deviation of variable i in all districts.

In the second step, the Z-Scores of all variables have been added district wise and the average has taken out for these variables which may be called as Composite Score (CS) for each district and it may be algebraically expressed as:

$$CS = \frac{\sum Z_{ij}}{N}$$

Where, CS stands for composite score.

N refers to the number of variables.

$\sum Z_{ij}$ indicates Z-Scores of all variables i in district j .

The positive values relating to the district's Z-Score explain high level of road density and development and negative values show the low level of road density and socio-economic development in the study area. The correlation co-

efficient is worked out between dependent variable (road density) and independent variables (selected variables of development) and student t-test technique is applied to find out the determinants which are significant at 1 per cent and 5 per cent levels. The correlation co-efficient has been computed on the basis of the Karl Pearson's correlation co-efficient (r) method which is as follows:

$$r = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\sum x^2 - \frac{(\sum x)^2}{n}} \sqrt{\sum y^2 - \frac{(\sum y)^2}{n}}}$$

Where, r is the co-efficient of correlation.

x, y are the two given variables.

n is the number of observation.

To find out the computed 't' value, student t-test technique is used which is given below:

$$t = r \sqrt{\frac{(n-2)}{1-r^2}}$$

Where, t is the calculated value of 't' in the test of significance.

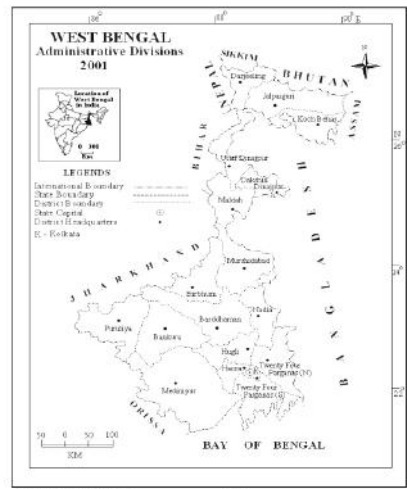
n is the number of observation.

r is the computed value of co-efficient of correlation.

Besides, advanced statistical techniques, SPSS (Version 16.00) & R (Version 2.12.2) software have been used to analyse the statistical data, and GIS-Arc view programme (Version 3.2a) has been applied to show the regional disparities of road density and levels of development among the districts of the state through maps.

Study Area

The state of West Bengal has been selected as a study area which is located between 21°25' to 26°50' north latitudes and 86°30' to 89°58' east longitudes with three international boundaries i.e., Bangladesh, Nepal and Bhutan. It occupies a geographical area of about 88,752 sq. km. (2.70 per cent of the India's total geographical area) and extends from the Himalayas in the north to the Bay of Bengal in the south. It is surrounded by Sikkim and Bhutan in the north, Assam and



Bangladesh in the east, the Bay of Bengal in the south and Orissa, Jharkhand, Bihar and Nepal in the west. According to 2001 Census its total population is 80,176,197

(7.79 per cent of India's total population), density is 904 persons per sq. km. (in terms of population density West Bengal is on the top among the Indian states). Total female literacy rate in the state is 54.10 per cent, while, in India as a whole it is 59.61 per cent. In 2001, the state is divided into eighteen districts (Fig.1).

Regional Analysis of Road Density

Table 1 visualizes the district wise Z-Score values of road density in West Bengal and shows that there is a wide range of variations in road density among the districts of the state, which varies from the lowest -0.41 score in Bankura district to the highest 1.04 score in Kolkata

Table 1: District Wise Distribution of Road Density and Levels of Development in West Bengal, 2001

Districts	Z-Score of Road Density	Composite Mean Z-Score of Development	Road Density vis-a-vis Development
Darjeeling	-0.29	0.17	RTC ₂ D ₁
Alipour	-0.35	-0.02	RTC ₃ D ₂
Koch Behar	-0.37	0.10	RTC ₃ D ₂
Uttar Dinajpur	-0.39	-0.30	RTC ₃ D ₃
Dakshin Dinajpur	-0.35	0.10	RTC ₃ D ₂
Maldah	-0.34	-0.16	RTC ₃ D ₃
Murshidabad	-0.29	-0.31	RTC ₃ D ₃
Birbhum	-0.27	-0.04	RTC ₃ D ₂
Bardhaman	-0.27	0.06	RTC ₃ D ₂
Nadia	-0.18	0.07	RTC ₃ D ₂
Twenty Four Parganas (N)	0.16	0.06	RTC ₃ D ₂
Hugli	0.38	0.21	RTC ₁ D ₁
Bankura	-0.41	0.12	RTC ₃ D ₂
Puruliya	-0.4	-0.20	RTC ₃ D ₃
Medinipur	-0.35	0.13	RTC ₃ D ₂
Haora	0.08	0.06	RTC ₃ D ₂
Kolkata	1.04	0.46	RTC ₁ D ₁
Twenty Four Parganas (S)	-0.28	-0.14	RTC ₃ D ₃

Source: Calculation is based on District Level Published data, Census of India, 2001 and Statistical Abstract, Govt. of West Bengal, 2002-2003.

Note: RTC 1= High Level of Road Density, RTC 2= Medium Level of Road Density, RTC 3= Low Level of Road Density, D1= High Level of Development, D2= Medium Level of Development and D3=Low Level of Development.

district. This whole ranges of spatial variations may be arranged into three categories such as, high (above 0.36 score), medium (0.36 to -0.36 score) and low (below -0.36 score) as given in Table 2.

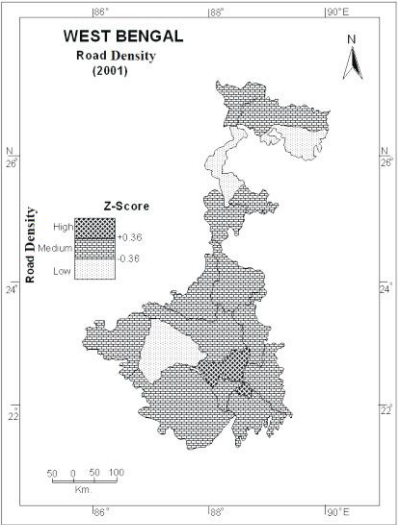
Table 2 indicates that there are only two districts (Kolkata and Hugli) of the state that have high level (above 0.36 score) of road density and they form a very small region in the centre of southern part of the state. The thirteen districts of the state which fall under the medium grade (0.36 to -0.36 score) of road density, constitute two distinct regions in the state. First one region lying in the northern part of the state comprises only two districts namely, Darjeeling and Jalpaiguri, while, second region much more widespread and contiguous located in the southern parts of the study area includes the districts of Dakshin Dinajpur, Maldah, Murshidabad, Birbhum, Bardhaman, Nadia, Twenty Four Parganas (North), Puruliya Medinipur Haora, and Twenty Four Parganas (South) (Fig. 2).

Table 2: Road Density in West Bengal, 2001

Category	Z-Score	No. of Districts	Percent of Total Districts	Districts
High	Above 0.36	2	11.11	Kolkata and Hugli
Medium	0.36 to -0.36	13	72.22	Darjeeling, Jalpaiguri, Dakshin Dinajpur, Maldah, Murshidabad, Birbhum, Bardhaman, Nadia, Twenty Four Parganas (North), Puruliya Medinipur Haora, and Twenty Four Parganas (South)
Low	Below -0.36	3	16.66	Koch Behar, Uttar Dinajpur and Bankura
Total		18	100.00	-

Source: Based on Table 1.

Remaining three districts of the state experience the low level (below -0.36 score) of road density and these districts form three small distinct separate regions in the state. The districts of Uttar Dinajpur and Koch Behar make two separate regions in the northern part of the state of West Bengal, while, the district of Bankura makes another third region of this category in the south-western part of the state (Fig. 2).



The geographical analysis of the Figure 2 reveals that the majority of the districts of the state have medium and high level of road density and these districts are concentrated in the whole southern part and northern tip of the state of West Bengal.

Spatial Analysis of Development

Table 1 shows the district wise composite mean Z-Score values of development. There is a large range of variations in the level of development among the districts of the state, which varies from the lowest -0.30 score in Murshidabad district to the highest 0.46 score in Kolkata district. This range of variations in socio-economic development may be grouped into three grades i.e. high (above 0.12 score), medium (0.12 to -0.12 score) and low (below -0.12 score) (Table 3 and Fig. 3).

Table 3: Levels of Development in West Bengal, 2001

Category	Z-Score	No. of Districts	Percent of Total Districts	Districts
High	Above 0.12	4	22.22	Kolkata, Hugli, Darjeeling and Medinipur
Medium	0.12 to -0.12	9	50.00	Jalpaiguri, Koch Behar, Dakshin Dinajpur, Birbhum, Barddhaman, Nadia, Twenty Four Parganas (North), Bankura and Haora
Low	Below -0.12	5	27.78	Uttar Dinajpur, Maldah, Murshidabad, Twenty Four parganas (South) and Puruliya
Total		18	100.00	-

Source: Based on Table 1.

Table 3 and Figure 3 depict that the high level (above 0.12 score) of development is witnessed only in four districts of the state i.e. Kolkata (0.46 score), Hugli (0.21 score), Darjeeling (0.17 score) and Medinipur (0.13 score), and seventy five per cent districts of them constitute a prominent region in the southern part of the state. The medium category (0.12 to -0.12 score) of development is found in nine districts of the state, nearly seventy eight per cent districts of this category i.e. Birbhum (-0.04 score), Barddhaman (0.06 score), Nadia (0.07 score), Twenty Four Parganas (North) (0.06 score), Bankura (0.12 score) and Haora (0.06 score) constitute a dominant contiguous region extending from central to south-

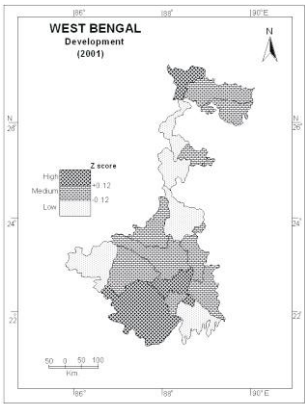
eastern parts of the state and other two districts of the same grade namely, Jalpaiguri (-0.02 score) and Koch Behar (0.10 score) make a small region in north-eastern part of the state.

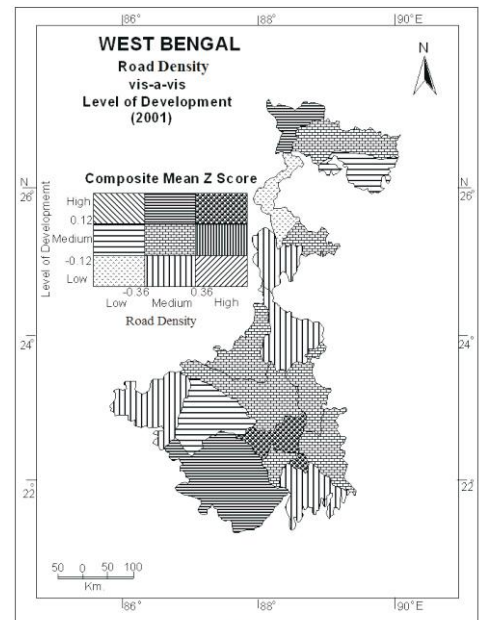
Five districts of the state come under the low level (below -0.12 score) of socio-economic development and sixty per cent of them form a longitudinal region in the north-central part of the state, involving the districts of Uttar Dinajpur (-0.30 score), Maldah (-0.16 score) and Murshidabad (-0.31 score). Rest two districts of the same grade are sparsely distributed in the state of West Bengal (Fig. 3). The composite mean Z-Score values of socio-economic indicators demonstrate that the level of development is either high or medium in the southern and northern districts of the state while the districts having low level of development form a linear region in the central part of the state. It may be attributed to, in the southern districts, the high levels of industrial, infrastructural, urban development, and educational and health facilities than the central and northern districts of the state.

Relationship between Road Density and Levels of Development

The relationship between road density and level of development among the districts of the state is dimensionally shown in Figure 4. The abscissa shows the level of road density and ordinate represents the level of development. The districts with reference to Z-Score of road density may be categorized into three groups i.e. High (above 0.36 score), Medium (0.36 to -0.36 score) and Low (below -0.36 score) and the composite mean Z-score of development may also be grouped into three grades of high (above 0.12 score), medium (0.12 to -0.12 score) and low (below -0.12 score).

Figure 4 exhibits that two districts (Kolkata and Hugli) of the state have both high level of road density and level of development and they are forming a small region in the mid of the southern part of the study area. The medium grade of road density is witnessed in thirteen districts of the state from the Table 2, in which, seven (about fifty four per cent) districts of the state also have medium level of development, out of them, five districts





(Birbhum, Bardhaman, Nadia, Twenty Four Parganas (North) and Haora) constitute a remarkable region in the central-eastern of the southern part of the state, ranging from the district Birbhum in the north-west to the district Twenty Four Parganas (North) in east, whereas, the two districts (Jalpaiguri and Dakshin Dinajpur) form two separate very small regions in the northern part of the study area. The districts of Darjeeling and Medinipur experienced medium level of road density and high level of development but they make two separate small regions in the northern and southern parts of the state respectively. The remaining four districts (Maldah, Murshidabad, Puruliya, and Twenty Four Parganas (South)) have low level of development, wherein, the districts of Maldah and Murshidabad make an identifiable region in the central, Puruliya in south-west and Twenty Four Parganas (South) in the south-eastern parts of West Bengal (Fig. 4).

There are three districts which have low level of road density these districts Koch Behar, Uttar Dinajpur and Bankura, in which, the district of Uttar Dinajpur underwent with the low level of development but the districts of Koch Behar and Bankura witnessed the medium level of development but all these districts failed to make contiguous region with any other districts of the state.

Correlation between Road Density and Selected Variables of Development

The analysis of simple correlation between road density (dependent variable) and selected socio-economic variables (independent variables) has been listed in Table 4. Out of thirty five independent variables, the coefficient of

correlation of twenty variables (X1, X2, X3, X4, X5, X8, X9, X11, X13, X14, X15, X22, X24, X25, X27, X29, X30, X31, X32 and X34) has a higher level of significant relationship with the road density. Among these twenty variables, fourteen variables (X1, X2, X3, X4, X13, X14, X15, X24, X25, X27, X29, X30, X31, and X34) are significant at the confidence level of 99 per cent, in which, five variables (X1, X3, X24, X25 and X30,) are negatively, and remaining nine variables (X2, X4, X13, X14, X15, X27, X29, X31, and X34) are positively correlated with the road density. Whereas, six variables (X5, X8, X9, X11, X22 and

Table 4: Result of Correlation (r) between Road Density and other Selected Variables of Development in West Bengal, 2001

Variables	Definition of Variables	Road Density (Y ₁)
X ₁	Population Growth (1991-2001)	-.629*
X ₂	Population Density	-.993*
X ₃	Sex-Ratio (Number of females per thousand males)	-.926*
X ₄	Percentage of Urban Population to Total Population	.868*
X ₅	Percentage of SCs and STs Population to Total Population	-.563**
X ₆	Literacy Rate	0.385
X ₇	Male Literacy Rate	0.347
X ₈	Female Literacy Rate	.555**
X ₉	Rural Literacy Rate	.536**
X ₁₀	Urban Literacy Rate	0.093
X ₁₁	Number of Primary Schools per lakh of Population	-.488**
X ₁₂	Number of Middle Schools per lakh of Population	-0.133
X ₁₃	Number of High and Higher Secondary Schools per lakh of Population	.673*
X ₁₄	Number of Colleges per lakh of Population	.884*
X ₁₅	Number of Students per School	.662*
X ₁₆	Number of Students per Teacher	-0.261
X ₁₇	Percentage of Net Area Sown to Total Reporting Area	0.143
X ₁₈	Intensity of Cropping	0.322
X ₁₉	Percentage of Irrigated Area to Net Sown Area	0.04
X ₂₀	Agricultural Productivity	-0.324
X ₂₁	Employment Rate	-0.108
X ₂₂	Male Employment Rate	.500**
X ₂₃	Female Employment Rate	-0.369
X ₂₄	Percentage of Workers engaged in Cultivation	-.604*
X ₂₅	Percentage of Workers engaged in Agriculture Labour	-.611*
X ₂₆	Percentage of Workers engaged in Households Industry	-0.205
X ₂₇	Percentage of Workers engaged in Other Works	.657*
X ₂₈	Percentage of Workers engaged in Registered Factories	0.043
X ₂₉	Number of Registered Factories per 100 sq. km. of Area	.963*
X ₃₀	Number of Hospitals & Primary Health Centers per lakh of population	-.777*
X ₃₁	Number of Beds in Hospitals per lakh of Population	.903*
X ₃₂	Percentage of Electrified Village to Total Villages	.561**
X ₃₃	Density of Surface Road per sq.km. of Area	1.000
X ₃₄	Number of Motor Vehicles on Road per lakh of Population	.949*
X ₃₅	Per capita Income (in Rs.)	-0.308

Source: Calculation is based on District Level Published data, Census of India, 2001 and Statistical Abstract, Govt. of West Bengal, 2002-2003.

* Significance at 1 per cent level, ** Significance at 5 per cent level.

X32) are significant at the confidence level of 95 per cent, in which, two variables (X5 and X11) are negatively and rest four variables (X8, X9, X22 and X32) are positively correlated with the road density. Instead of one star and double stars variables of socio-economic development, other variables of development are also correlated with road density but not up to a significant level.

Therefore, it may be inferred from the analysis of Table 4 that the spatial variations in the road density in the study area have been mainly determined by population characteristics (population growth, population density, sex -ratio, percentage of urban population to total population, etc.), educational facilities (female literacy rate, rural literacy rate, number of primary schools per lakh of population, number of high and higher secondary schools per lakh of population, number

of colleges per lakh of population and number of students per school), employment opportunities (male employment rate, percentage of workers engaged in cultivation, percentage of workers engaged in agriculture labour and percentage of workers engaged in other works), health and medical facilities (number of hospitals & primary health centers per lakh of population and number of beds in hospitals per lakh of population), industry (number of registered factories per 100 sq. km. of area), infrastructural facilities (percentage of electrified village to total villages and number of motor vehicles on road per lakh of population), etc.

Conclusion

The spatial analysis of road density, levels of development and their relationship obviously states that there is a wide range of variations among the districts of the study area. The spatial patterns of road density show that the level of road density is either high or medium in most of the districts of West Bengal excluding the districts of Koch Behar and Uttar Dinajpur lying in the north and Bankura located in the eastern part of the state where the road density is low. The level of development is high or medium in the southern and northern districts of the state, while; the districts having low level of development form a linear region in the central part of the state. However, the relationship between road density and level of development discloses that about fifty six percent districts of the state have perfect positive relationship, while; all other remaining districts of the state are moderately associated in terms of road density and level of development. The investigation of t-test explains that the educational facilities, health and medical amenities, urbanization, industrialization, and infrastructural facilities are the major variables of development affecting spatial patterns of road density in the state.

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