

Detour index of major road transport links of Rajasthan

Dr. Akhilesh Vaishnava

Lecturer of Geography

Abstract:

Rajasthan is the largest state in area in India. India has second largest road transport network after U.S.A. and Rajasthan also has second largest road transport network in country after U.P. It was very difficult to analyse the whole road transport network of the largest state which could mislead from the way of the object of study and could give flawed results. That is why only those major links are included which join the district headquarters to the capital of state. Detour index is an effective measure of the efficiency of transport network. It is a good indicator of the level of complexity of topology. A straight-line link is a route of minimum distance between two nodes. But these are found rarely in real world. Even the straight-line links also have deviation to some extent. These types of deviations are found due to physical barriers like mountains, rivers, ravines, plateaus, lakes, ponds etc.; which are measured by detour index.

Key Words: Straight link, Correlation, node, range, Standard Deviation, Coefficient of Variation, ω (omega; lower case), σ (sigma; lower case), γ (gamma; lower case).

➤ **INTRODUCTION:**

Detour index is an effective measure of the efficiency of transport network. It is a good indicator of the level of complexity of topology. A straight-line link is a route of minimum distance between two nodes. But these are found rarely in real world. Even the straight-line links also have deviation to some extent. These types of deviations are found due to physical barriers like mountains, rivers, ravines, plateaus, lakes, ponds etc.; which are measured by detour index.

➤ **STUDY AREA:**

Rajasthan is situated in the North-East part of Bharat among 23°3'N to 30°12'N and 69°30'E to 78°17'E in shape of irregular rhomboid and has 10.41% area of the country. It is five times larger than Sri Lanka, three times of Czechoslovakia, seventeen times of Israel, more than two times of England and little bit smaller to Japan.

Rajasthan can be divided into four physical divisions like Western desert, Aravali mountains, Eastern plains and South-eastern plateau, five climatic zones like wet, humid sub humid, semi-arid and arid, nine soil zones as Sandy soil, Brown sandy soil, Alluvial soil, Red-yellow soil, Medium black soil, Red-black soil, Red-loamy soil and Brown sandy alluvial soil. It is further divided into ten Agro-climatic zones.

Aravali mountain chain is dilated from south west to north east in the state. Chambal is ever flowing and Mahi, Luni, Banas, Kothari, Kali sindh, Jakham, Som, Ahu, Parvati, Banh ganga, Ghagghar, Western banas, Sukadi, Jojadi, Parvan, Khari, Rupangarh, Mendha etc. are seasonal rivers in the state. Lunkaransar, Sambhar, Pachbhadra, Degana, Parbatsar are saline and Jaysamand, Rajsamand, Talabsahi, Gebsagar, Annasagar, Kaylana, Kolayat, Foisagar, Narayansagar, Silisedh etc. are sweet water lakes scattered in the state. Only 1% underground water of the nation is found in Rajasthan.

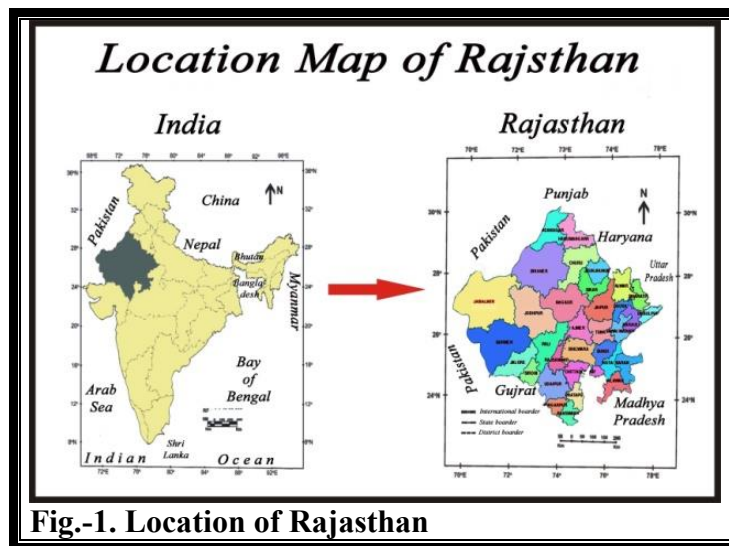


Fig.-1. Location of Rajasthan

Maximum average temperature of western Rajasthan is 36.1°C and 33.3°C in eastern part. Minimum average temperature is generally found between 17.7°C to 21.1°C. Average annual rainfall of the state is 57 cm. It is located in *BWhw* and *BShw* type climatic zones according to Koppen's climate classification. Land use of the state is as follows - net cultivated area is 51%, gross irrigated area is 43% out of which 67% area is irrigated by wells and tubewells. 17% land is uncultivated and 11.36% is fallow land. Average holding size in the state is 3.38 hectare and per capita available agriculture land is 0.49 hectare.

According to administrative point of view state is divided into 7 zones, 41 districts, 355 panchayat samities, 343 tehsils and 255 urban bodies (8 municipal corporations, 34 municipal councils and 213 municipalities).

➤ **METHODOLOGY:**

following methods are used to find out the detour index and to analyse the detour values of the links of the capital of state Jaipur with other 40 district headquarters.

1. **Detour Index: -**

$$\omega = \frac{\text{Actual length of link}}{\text{Straight line distance of link}} \times 100$$

2. **Correlation: -** To find out the relation between actual length of links and straight-line distance of links Spearman's rank correlation coefficient is used.

$$\gamma = 1 - \frac{6\sum D^2}{N(N^2 - 1)}$$

Where,

$$D^2 = (R_1 - R_2)^2$$

N = number of items

γ = correlation coefficient

R_1 = Rank of 1st series

R_2 = Rank of 2nd series

3. **Standard Deviation: -** to find out the variability of different detour values of the set standard deviation has been used.

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{N}}$$

Where,

Σ = Capital sigma (sum of)

X = Variable

$\bar{x}$ = Arithmetic Mean

N = Number of items

4. **Coefficient of variation:** - It is also being used to measure the range of data of series.

$$C. \text{ of } V. = \frac{\sigma}{\bar{x}} \times 100$$

5. **Range:** - It is also a measure of dispersion which is calculated by the difference between largest and smallest value of the series.

$$\text{Range} = L - S$$

➤ **DETOUR INDEX:**

In present days there are 41 districts in the state. Jaipur is not only a district headquarter but capital of state too. The actual distances and straight linear distances of the links from different district headquarters to state capital are mentioned in the 'Table-1'. And detour index is also written in that table after calculating with the formula. Jaipur - Baran link has the highest detour value of 132.56% among the variables of series; by which we can come to know that this path is very snaky and is highly deviated from its straight linear route. While, Jaipur - Bharatpur Route is deviated all time low among the 40 links, has the value of 104.05%. It means Jaipur - Bharatpur Link is closest to

Table - 1. Detour Index of Different Routes of the State of Rajasthan

S.No.	Name of Both Nodes	Actual Distance	Straight Line Distance	Detour Index	Rank
1	Jaipur - Shri Ganga Nagar	465	380	122.37	14
2	Jaipur - Hanumangarh	400	327	122.32	15
3	Jaipur - Bikaner	338	275	122.91	12
4	Jaipur - Falaudi	397	342	116.08	32
5	Jaipur - Jaisalmer	563	484	116.32	30
6	Jaipur - Balotra	446	376	118.62	24
7	Jaipur - Barmer	535	456	117.32	28
8	Jaipur - Jalore	409	359	113.93	33
9	Jaipur - Sirohi	420	370	113.51	34
10	Jaipur - Jodhpur	330	284	116.20	31
11	Jaipur - Pali	304	276	110.14	37
12	Jaipur - Beawar	191	172	111.05	36
13	Jaipur - Nagaur	240	204	117.65	26
14	Jaipur - Deedwana	164	131	125.19	9
15	Jaipur - Churu	208	173	120.23	21
16	Jaipur - Sikar	118	101	116.83	29
17	Jaipur - Jhunjhunu	183	141	129.79	2
18	Jaipur - Kotputli	106	97	109.28	39
19	Jaipur - Khairthal	158	131	120.61	19
20	Jaipur - Alwar	134	111	120.72	18
21	Jaipur - Deeg	194	165	117.58	27
22	Jaipur - Dausa	58	52	111.54	35
23	Jaipur - Bharatpur	180	173	104.05	40
24	Jaipur - Dholpur	254	211	120.38	20
25	Jaipur - Karouli	158	126	125.40	8
26	Jaipur - Sawaimadhopur	147	115	127.83	5
27	Jaipur - Ajmer	143	130	110.00	38
28	Jaipur - Tonk	99	83	119.28	22
29	Jaipur - Rajsamand	339	280	121.07	17
30	Jaipur - Bhilwara	247	209	118.18	25

31	Jaipur - Bundi	214	165	129.70	3
32	Jaipur - Kota	250	194	128.87	4
33	Jaipur - Baran	285	215	132.56	1
34	Jaipur - Jhalawar	322	261	123.37	11
35	Jaipur - Udaipur	394	331	119.03	23
36	Jaipur - Chittorgarh	310	254	122.05	16
37	Jaipur - Salumber	435	354	122.88	13
38	Jaipur - Dungarpur	504	398	126.63	7
39	Jaipur - Pratapgarh	417	335	124.48	10
40	Jaipur - Banswara	505	397	127.20	6
Total		11564	9638	4793.15	-
Mean		289.1	240.95	119.828	-
1	Correlation Coefficient	0.992			
2	Standard Deviation	6.284			
3	Coefficient of Variation	5.24%			

its straight linear route among rest edges. The ranks of detour index of all links are also shown in the 'table - 1'.

➤ **CORRELATION:**

Correlation is calculated between the series of actual distances of links and straight-line distances of routes from Jaipur to other 40 district headquarters; Which is found +0.992 (high positive correlation). It means actual distance increases as well as the straight line distance and vice versa.

Table 2- Calculation of Correlation

S. No.	Actual Distance	R ₁	Straight Line Distance	R ₂	D	D ²
1	465	5	380	5	0	0
2	400	11	327	13	-2	4
3	338	15	275	17	-2	4
4	397	12	342	10	2	4
5	563	1	484	1	0	0
6	446	6	376	6	0	0
7	535	2	456	2	0	0
8	409	10	359	8	2	4
9	420	8	370	7	1	1
10	330	16	284	14	2	4
11	304	19	276	16	3	9
12	191	28	172	27	1	1
13	240	24	204	23	1	1
14	164	31	131	31	0	0
15	208	26	173	25	1	1
16	118	37	101	37	0	0
17	183	29	141	30	-1	1
18	106	38	97	38	0	0
19	158	32	131	32	0	0
20	134	36	111	36	0	0
21	194	27	165	28	-1	1

S. No.	Actual Distance	R ₁	Straight Line Distance	R ₂	D	D ²
22	58	40	52	40	0	0
23	180	30	173	26	4	16
24	254	21	211	21	0	0
25	158	33	126	34	-1	1
26	147	34	115	35	-1	1
27	143	35	130	33	2	4
28	99	39	83	39	0	0
29	339	14	280	15	-1	1
30	247	23	209	22	1	1
31	214	25	165	29	-4	16
32	250	22	194	24	-2	4
33	285	20	215	20	0	0
34	322	17	261	18	-1	1
35	394	13	331	12	1	1
36	310	18	254	19	-1	1
37	435	7	354	9	-2	4
38	504	4	398	3	1	1
39	417	9	335	11	-2	4
40	505	3	397	4	-1	1
						92
						ΣD ²

$$\gamma = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$

$$\gamma = 1 - \frac{6 \times 92}{40(40^2 - 1)}$$

$$\gamma = 1 - \frac{552}{40(1600 - 1)}$$

$$\gamma = 1 - \frac{552}{40 \times 1599}$$

$$\gamma = 1 - \frac{63960}{552}$$

$$\gamma = 1 - 0.008$$

$$\gamma = 0.992$$

➤ **RANGE:**

The highest value of detour index is 132.56 and lowest value is 104 .05 and the range is as below

$$\begin{aligned}\text{Range} &= L - S \\ &= 132.56 - 104.05 \\ &= 28.51\end{aligned}$$

➤ **STANDARD DEVIATION:**

Standard Division is used to calculate the deviation of series of the values of datour index of 40 links which is found 6.284. This value is very low in comparison of range (28.51). It means all the values of datour index do not have a major difference. It shows that there is very low deviation between the actual distances and straight linear distances of the major routes of the state.

$$\sigma = \sqrt{\frac{\Sigma(x - \bar{x})^2}{N}}$$

$$\sigma = \sqrt{\frac{1579.72687}{40}}$$

$$\sigma = \sqrt{39.4931}$$

$$\sigma = 6.284$$

Table 3 - Calculation of Standard Deviation

S. No.	Detour Index	X	$(x - \bar{x})$	$(x - \bar{x})^2$	S. No.	Detour Index	X	$(x - \bar{x})$	$(x - \bar{x})^2$
1	122.37	119.828	2.540	6.4515555	22	111.54	119.828	-8.290	68.72357
2	122.32	119.828	2.496	6.2286643	23	104.05	119.828	-15.782	249.0774
3	122.91	119.828	3.081	9.4904728	24	120.38	119.828	0.551	0.303289
4	116.08	119.828	-3.747	14.0367	25	125.40	119.828	5.568	31.00703
5	116.32	119.828	-3.506	12.292848	26	127.83	119.828	7.998	63.96252
6	118.62	119.828	-1.211	1.4675106	27	110.00	119.828	-9.828	96.59803
7	117.32	119.828	-2.504	6.269357	28	119.28	119.828	-0.551	0.303955
8	113.93	119.828	-5.901	34.820069	29	121.07	119.828	1.243	1.545046
9	113.51	119.828	-6.315	39.878168	30	118.18	119.828	-1.647	2.71133
10	116.20	119.828	-3.631	13.185953	31	129.70	119.828	9.869	97.38808
11	110.14	119.828	-9.684	93.770216	32	128.87	119.828	9.038	81.6773
12	111.05	119.828	-8.782	77.122087	33	132.56	119.828	12.730	162.0455

13	117.65	119.828	-2.181	4.7583794	34	123.37	119.828	3.543	12.55439
14	125.19	119.828	5.362	28.75544	35	119.03	119.828	-0.795	0.632339
15	120.23	119.828	0.403	0.162235	36	122.05	119.828	2.219	4.923137
16	116.83	119.828	-2.997	8.9804904	37	122.88	119.828	3.053	9.320358
17	129.79	119.828	9.959	99.177782	38	126.63	119.828	6.805	46.30443
18	109.28	119.828	-10.550	111.30417	39	124.48	119.828	4.649	21.61489
19	120.61	119.828	0.782	0.6119263	40	127.20	119.828	7.376	54.39948
20	120.72	119.828	0.892	0.7961831	1579.72687 $\Sigma(x - \bar{x})^2$				
21	117.58	119.828	-2.253	5.0745322					

➤ **COEFFICIENT OF VARIATION:**

5.24% Value is found after calculating the coefficient of variation, which shows that there is a very low deviation in the value of Detour index.

$$C. of V. = \frac{\sigma}{\bar{x}} \times 100$$

$$= \frac{6.284}{119.828} \times 100$$

$$= 5.24$$

➤ **CONCLUSION:**

Rajasthan is the largest state in area in India. India has second largest road transport network after U.S.A. and Rajasthan also has second largest road transport network in country after U.P. It was very difficult to analyse the whole road transport network of the largest state which could mislead from the way of the object of study and could give flawed results. That is why only those major links are included which join the district headquarters to the capital of state. These following conclusions are extracted from this research study-

1. Jaipur - Baran link has the highest detour index (132.56) which shows the highest deviation from its straight-line route.
2. Jaipur - Junjhunu link follows it with the value of 129.79.
3. The third largest value of detour index is 129.7, it is calculated of Jaipur - Bundi link.
4. Jaipur - Bharatpur link has the lowest value 104.05 of detour index, which shows the minimum deviation from its straight linear route.
5. Standard deviation and coefficient of variation values of these all 40 links show that these all have approximate equal nature. That is, these all links have approximated equal deviation.

BIBLIOGRAPHY:

1. Vaishnava, A., 'Parivahan Bhugol' Rajasthan Hindi Granth Academy, Jaipur, 2nd addition, 2024.
2. Ullman, E.L., 'Transportation Geography' in James, P.E. and Jones, C.F. (Ed.) American Geography : Inventory and Prospects, Syracuse Press, Syracuse, 1954.
3. Taffee, E.J. and Gauthier, H.L., 'Geography of Transportation', Prentice Hall, London, 1973.
4. Gauld, P.R., 'The Development of Transportation Pattern in Ghana', North – Western University, Studies in Geography, 5, 1960.
5. Rodridgue, J.P., Slack, B. and Comtois C, 'The Geography of Transportation System,' Routledge Publication, Newyork, 2006.