



ROAD TRANSPORT NETWORK ANALYSIS OF HARYANA: A ZONAL STUDY

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ABSTRACT In the present research paper, an attempt has been made to analyze the road transport network in Haryana at zonal level. Keeping in view the physiographic conditions, the study area has been divided into two sub- zones: Eastern Sector and Western Sector and further into six micro zones. The nodes having minimum population of 10000 along with district and tahsil headquarters and settlements having three or more crossings of national highways, state highways and major district roads have been selected for the analysis. Structural indices like Cyclomatic number, Alpha, Beta and Gamma have been used. Aggregate Transport Scores have been calculated by the cumulative values of Alpha, Beta and Gamma indices. Western zone of the state is best connected followed by East- Central zone, North- Eastern zone, South- Eastern zone, South- Western zone whereas, West Central zone is the least connected zone by roads.

KEYWORDS : Road Network, Micro zones, Structural Indices, Aggregate Transport Score

Introduction

The term road network is considered as referring to spatial pattern of road transportation facilities in a region. **Robinson and Bamford (1978)** defined the connectivity of a network as 'degree of completeness of the links between nodes'. Greater degree of connectivity makes a transportation system more efficient. By measuring the degree of network connectivity, a transport geographer may institute comparisons of efficiency vis-a-vis different networks and also consider and elicit the reasons for differences between them.

In 1963, **Kansky** developed several descriptive indices for measuring the connectivity of transport network. **Mukerji (1974)** tried to seek correlation between road transport network and levels of urbanization in Rajasthan by using district level data with help of Aggregate Transportation Scores. **Saxena (2002)** examined the pattern of road transport connectivity in Rajasthan and observed that the better transport development was along the national highway no. 8, connecting the cities like Jaipur, Ajmer and Udaipur. **Subodh and Chamar (2016)** studied the levels of road connectivity in Haryana by calculating the aggregate transport scores and recorded that districts located in the western and central parts of the state were better connected by roads as compared to other districts. In the present research work, an attempt has been made to analyze the road transport network in Haryana at zonal level.

Study Area-Haryana

Haryana is an important state of North Western India which consists of 22 districts. Physiographically, the central part of Haryana is largely plain and featureless whereas the western part is traversed by numerous sand dunes. The total population of Haryana as per census 2011 is 2.53 crore in which male and female are 1.35 and 1.18 crore respectively. Haryana is having a well knit system of roadways. The state has 14 national highways, 31 state highways and 37 major district roads in 2011.

Source of Data and Research Methodology

The present study is based on 2011 census data. Keeping in view the physiography of state, the study area has been divided into two sub-zones i. e. (1) Eastern Sector (2) Western Sector and further into six micro zones [North- Eastern Zone (1Ai), East- Central Zone (1Aii), South- Eastern Zone (1Aiii), in the eastern sector and Western Zone (2Bi), West- Central zone (2Bii) and South-Western Zone (2Biii) in the western sector]. [Fig. 1]

The nodes have been identified on the basis of following criteria: (i) settlements having minimum population of 10000 persons (ii) all district headquarters and tahsil headquarters, and (iii) settlements having three or more crossings on national highways, state highways and major district roads. On the basis of above three criteria, 226 nodes and 359 edges in 2011 have been identified. [Table- 1]. After that, four indices: cyclomatic number, alpha, beta and gamma have been used to calculate the zone wise road connectivity. Further, aggregate transport scores have also been computed by adding the value of three relative indices i.e. alpha, beta and gamma. Arc-GIS (version 9.3) software has been used to prepare the maps.

Zone Wise Characteristics of Road Transport Network

From this exercise, regional variations in road transport network by different structural indices have been observed in the study area in 2011.

Cyclomatic Number

The cyclomatic number of a transport network is defined as the number of circuits in a network. A highly connected topological graph will have higher values of μ and vis-à-vis. Algebraically, the cyclomatic number can be computed by the following equation;

$$\mu = e - v + p(i)$$

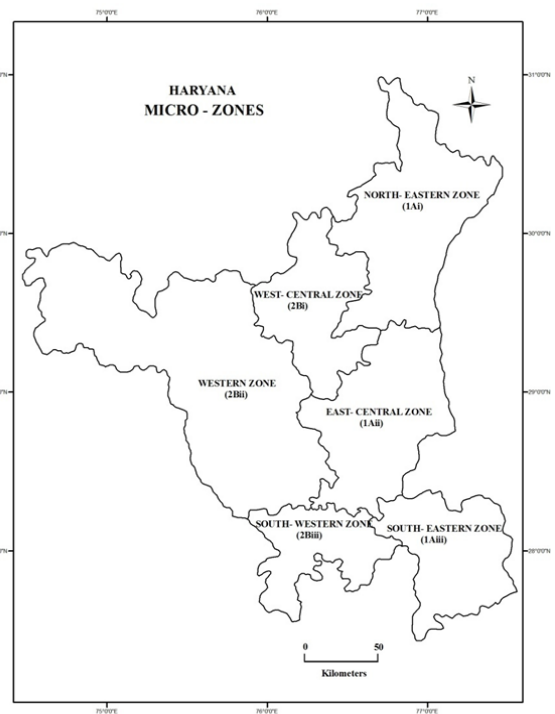


FIG. 1

Table- 1, Micro Zones: Attributes of Road Connectivity in Haryana, 2011.

Attribute s	Eastern sector		Western sector		Haryana				
	1Ai	1Aii	1Aiii	Sector	2Bi	2Bii	2Biii	Sector	
	2011	2011	2011	2011	2011	2011	2011	2011	2011
Total Edges	72	80	68	212	109	57	20	174	359
Total Nodes	52	56	51	147	71	45	16	115	226
Cyc. Number	21	25	13	66	39	13	5	60	134

Alpha Index	0.02	0.02	0.01	0.01	0.02	0.01	0.05	0.01	0.01
Beta Index	1.38	1.43	1.33	1.44	1.54	1.27	1.25	1.51	1.59
Gamma Index	0.49	0.49	0.46	0.49	0.53	0.44	0.48	0.78	0.53
ATS	1.89	1.94	1.80	1.94	2.09	1.72	1.78	2.30	2.13

Source: Compiled by Author.

Here μ = cyclomatic number, e = number of edges, v = vertices (nodes) and p = non connected sub-graphs.

The zone-wise scores of cyclomatic number in 2011 are calculated and presented in Table-1. The maximum value (39) of cyclomatic number is recorded in Western zone and minimum (5) in South-western zone. Cyclomatic number is higher in the eastern sector (66) as compared to western sector (60). The highest cyclomatic number is observed in Western Zone (39) followed by East-Central zone (25), North-Eastern zone (21), West Central zone (13) and South-Eastern zone (5) whereas South-Western zone (2) has the lowest cyclomatic number. The lower values of cyclomatic number are mainly observed in zones comprising the peripheral southern parts of the study area.

Alpha index

This index is an adjusted form of cyclomatic number. It is the ratio between the number of circuits in a network system and the total possible circuits in a network. It is measured as:

$$\text{Alpha} = e - v + 1 / \frac{1}{2}(v^2 - v) - (v - 1)$$

The state average of alpha index is 0.01 (Table- 1) which indicates that the state does not have a well connected network by alpha index. It is observed that value of alpha index is same in the both eastern and western sectors i.e. 0.01. It is also recorded that there is a little variation found in the values of six micro zones. The highest alpha index is observed in the South-western zone (0.05) followed by North-Eastern zone (0.02), East-Central zone (0.02), Western Zone (0.01), South-Western zone (0.01) and West-Central zone (0.01).

Beta Index

The beta index is a simple index which gives the average number of edges available per vertex. It is mathematically expressed as:

$$\text{Beta} = e / v$$

Beta index varies between 1.25 and 1.54 recorded by South-western zone and Western zone respectively [Table- 1]. It is observed that value of beta index is higher in the western sector (1.51) as compared to eastern sector (1.44). Among all the six micro zones, the highest beta index is observed in the Western Zone (1.54) followed by East-Central zone (1.43), North-Eastern zone (1.38), South-Eastern zone (1.33), and West Central zone (1.27) and whereas South-Western zone (1.25) has the lowest beta index.

Gamma Index

It is a relative index of network connectivity expressed as a ratio of actual number of edges to the total number of edges possible in the network. The numerical range for the gamma index varies between 0 and 1. It is calculated as:

$$\text{Gamma} = e / 3(v - 2)$$

It is observed from the Table- 1 that values of gamma index in the state in 2011 ranges between 0.44 and 0.53 recorded by West-central and Western zones respectively. The value of gamma index is higher in the western sector (0.78) as compared to eastern sector (0.49). Among all the six micro zones, the highest gamma index is observed in the Western Zone (0.53) followed by East-Central zone (0.49), North-Eastern zone (0.49), South-Western zone (0.48) and South-Eastern zone (0.46) whereas West Central zone (0.44) has the lowest gamma index.

Aggregated Transportation Scores

A consolidate picture of the levels of road connectivity has been presented by applying the technique of Aggregate Transport Scores. As cyclomatic number is an absolute value and other three indices have relative values, therefore only the values of Alpha, Beta and Gamma

indices have been considered to calculate the Aggregate Transport Scores in the present study.

Table- 1 represents the value of aggregate transport scores in the state in 2011, which varies from minimum of 1.72 in west-central zone to maximum of 2.09 in Western zone. The value of ATS is higher in the western sector (2.30) as compared to eastern sector (1.94). It is observed that among all the six micro zones, the Western zone (2.09) of the state is better connected followed by East-Central zone (1.94), North-Eastern zone (1.89), South-Eastern zone (1.80), South-Western zone (1.78) whereas, West Central zone (1.72) is the least connected zone by roads.

Levels of Road Network Connectivity

On the basis of above analysis, 3 zones of road connectivity have been identified in Haryana. Western and East-central zones have the high level of road connectivity North-Eastern and South-Western zones are moderately connected by roads and South Eastern and West Central zones having large number but small size of rural settlements, low capital investments and lack of infrastructural facilities are the least connected zones of the state.

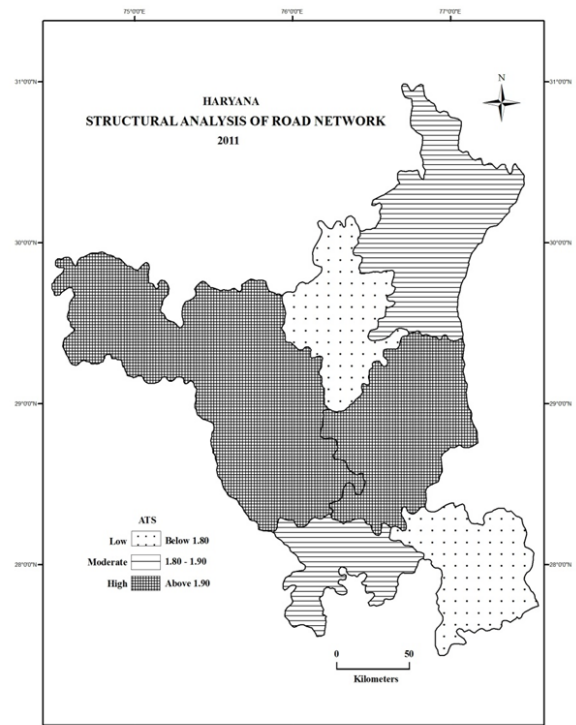


FIG. 2

Table- 2, Levels of Road Connectivity in Haryana, 2011.

Micro Zones	Districts	Rank
1Aii. East-Central	Panipat, Sonipat, Rohtak, Jhajjar	II (1.94)
1Ai. North-Eastern	Panchkula, Ambala, Yamunanagar, K.shetra, Karnal	III (1.89)
1Aiii. South-Eastern	Gurgaon, Faridabad, Mewat, Palwal	IV (1.80)
2Bi. Western	Sirsa, Fatehabad, Hisar, Bhiwani	I (2.09)
2Bii. West-Central	Jind, Kaithal	VI (1.72)
2Biii. South-Western	Mahendergarh, Rewari	V (1.78)

Source: Compiled by Author.

Conclusion

The study concludes that western Sector (2.30) has better road connectivity as compared to Eastern Sector (1.94). Zones comprising the districts namely Bhiwani, Hisar, Karnal, Sonipat, Rohtak and Jhajjar are well connected by roads due to plain with fertile land for ideal location. On the other hand, zones comprising the districts like Kaithal, Jind, Mahendergarh, Rewari, Mewat and Palwal in west central and southern parts are the least connected zones in Haryana, as they are located in the hilly and unfertile soil areas and have lack of infrastructural facilities. Finally, it is suggested that more emphasis

should be laid on the urbanization and development processes in South- Eastern, South- Western and West- Central Zones for the creation of new nodes to stimulate the connectivity of roads in the study region for balanced development.

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