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SPATIAL ANALYSIS AND ASSESSMENT OF TRANSPORT NETWORK STRUCTURE USING GEO-INFORMATICS: A CASE STUDY OF MAHENDRAGARH DISTRICT, HARYANA

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Abstract: *It is a great challenge to provide all-weather road connectivity to all the habitations with better physical accessibility, quality, mileage, and safe public sustainable transport system in India. The Transportation System is a critical component of infrastructure development and lifeline of the area as well. It plays a key role in economic growth of the region and controls the movement of people, goods, services and the flow of resources. Network Analysis helps in identifying optimum locations for the services to be provided. A transportation network is a flow network representing the movement of people, vehicles or goods. There is urgent need to develop GIS based Road Information System (RIS). This will be capable to quick display of large scale real world geographical conditions of various information about the transport network structure. Geospatial technology has provided many types of networks and route analysis modules in various GIS packages to improve the movement of people, goods, services and the flow of resources. A case study approach was adopted to explore the existing spatial structure and patterns of the transportation network system discuss through in terms of surface gross accessibility, surface accessibility by mileage, by nodality and physical accessibility, road density of Mahendragarh district, Haryana. Present work was carried out to adopt an integrated approach of remote sensing and GIS. It can be more helpful to improve the movement of people, goods, services and the flow of resources for the better utilization, conservation, and management in sustainable manner.*

Keywords: Road Information System, Accessibility, Nodality, Mileage and Topology.

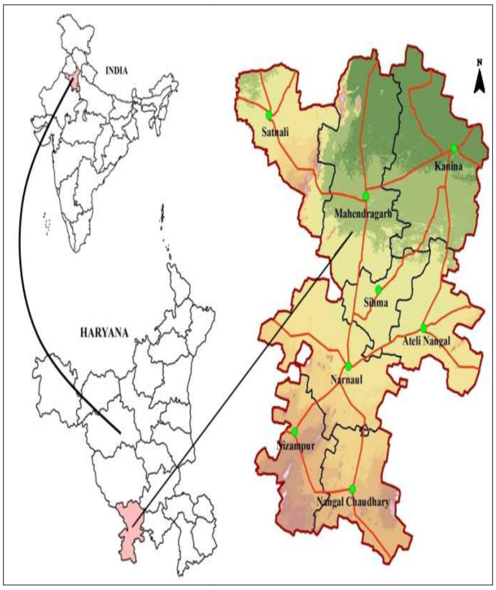
Introduction

It is a great challenge to provide all-weather road connectivity to all the habitations with better quality, mileage accessibility and safe public sustainable transport system in India. The Transportation System is a critical component of infrastructure development and lifeline of the area (Rai, et al., 2013). It plays a key role in economic growth of the region and controls the crime, movement of people, goods, services and the flow of resources. Network Analysis helps in identifying optimum locations for services to be provided. A transportation network is a flow network representing the movement of people, vehicles or goods (Bell and Iida, 1997). For any country to develop with right momentum modern and efficient Transport as a basic infrastructure is a must. It has been seen throughout the history of any nation that a proper, extensive and efficient Road Transport has played a major role. A well linked and coordinated system of transport plays an important role in the sustained economic growth of a country. Railways and roads are the dominant means of transport carrying more than 95% of total traffic generated in India (http://shodhganga.inflibnet.ac.in). Connectivity and mobility are the keys to reaching out and opening up new opportunities. With the construction of village roads, rural India is rapidly transforming. Wherever the roads network has come up, the rural economy and quality of life has improved. There is required to develop a comprehensive and reliable road inventory database for effective and efficient construction and maintenance management system. It should contain detailed information about the physical features of the roads along with identification number, geometric features, present condition, annual average daily traffic, rural market, social infrastructures (School, College, Religious places, Community Clinic, and Health Centre), and their controlling point on the road. Geospatial technology is capable to develop such type of comprehensive and reliable road inventory database .In recent times it has provided many types of network and route analysis modules in various GIS packages to improve the movement of people, goods, services and the flow of resources. Geographical Information System can be facilitate in understanding of spatial aspects of social and economic development by relating socio-economic variables to natural resources and the physical world, providing a tool for targeting interventions and monitoring impacts on various scales over wide areas (Rout, J. 2012). It can be more helpful for the better utilization, conservation, management and quick monitoring of natural and manmade resources in sustainable manner.

Study Area

Mahendragarh district is constituted by eight administrative blocks (Mahendragarh, Satnali, LKanina,Ateli, Nangal Chaudry, Shima, Narnaul and Nizampur) located between 27^0 47' 50" and 28^0 28' 00" North Latitudes and 75^0 54' 00" and 76^0 22' 11" East Longitudes (Fig. 1). It lies in Southern part of Haryana state covering an area of 1939 km^2 sq.km according to Survey of India Topographical maps. It is bounded by Bhiwani district in the north, by Rewari district in the east and by the state of Rajasthan in the southeast, south, southwest and west (Map - 1).Physiographical the district consists of flat level plain interrupted from place to place by clusters of sand dunes, isolated hillocks and rocky ridges. The leveled plain is spread in north, along the north-eastern boundary while the clusters of sand dunes, isolated hillocks and rocky ridges lying area covers the south, south central southeastern and western part of the district. In present time the district has 347 Gram Panchyats, 367 villages and 458 habitations. All the villages are connected with road transport network .Their quality, wide size and hierarchical levels are fully different.

Figure 1: Location of Study Area



Material and Methods

Open series topographical maps on 1:50,000 scales, obtained from Survey of India, Chandigarh have been used in the study. Data about road network hierarchy levels, their numbers were obtained from Public Works Department; Narnaul, Government of Haryana. IRS LISS III satellite data, March 2012, Google Earth data and other related data collected from various agencies and publications were also used in the study. A visual supervised classification technique is used for various type transport network features. All thematic layers were integrated and analyzed in a GIS environment. The overall results demonstrate that the use of remote sensing and GIS provide potentially powerful tools to study spatial analysis and assessment of transport network structure. This process also included collection of primary data such as site investigation and observation.

Objectives of the study

The main objectives of the study are as follows:

- ✓ Spatial Analysis of connectivity pattern,
- ✓ Thematic mapping of spatial structure of transport network,
- ✓ Identification and assessment of accessibility

Results and Discussion

It has been seen throughout the field work that most of villages have linked with transport network but not with efficient quality, wideness and monitoring system. Kanina block is leading stage followed by Narnaul, Mahendragarh and Shima block having lowest followed by Nizampur and Satnali blocks in term of total length of all hierarchical level transport network length. With the total length point of view, the other district road, major district road and state highway are the dominant factor in the whole transport network system in the study area (Table - 1).

Table 1: Block Wise Transport Network Length (in km)

Category	Satnali	Nizampur	N Chaudhry	M. Garh	Kanina	Shima	Narnaul	Atelli	Total
S.H	25.28	7.88	0.00	41.64	25.13	9.74	34.29	17.99	161.95
MDR	14.97	11.18	26.67	0.00	43.87	16.90	9.16	25.08	147.81
Rail Track	18.83	13.90	0.00	16.15	16.94	0.00	14.91	17.15	97.88
HSAMB	8.39	12.91	13.28	19.09	25.04	10.83	23.76	8.35	121.65
Panchayats	0.00	0.00	0.78	6.94	2.70	1.31	0.28	3.30	15.31
PMGSY	0.00	0.00	0.00	22.90	0.00	0.00	0.00	0.00	22.90
Others	58.02	81.80	106.97	115.76	116.68	49.20	140.90	56.14	725.47
Total	125.49	127.67	147.70	222.48	230.36	87.97	223.29	128.01	1292.97

Source: Calculated from IRS LISS III Satellite Image; March, 2012. SOI, Toposheets, & P. W. D. Narnaul

Physical Accessibility

Accessibility refers to people's ability to reach goods, services and activities, which is the ultimate goal of most of the transport activities and therefore the time and money that people and businesses must devote to transportation. Many factors affect accessibility, including mobility (physical movement), the quality and affordability of transport options, transport system connectivity, mobility substitutes, and land use patterns. Generally, in transport network, physical accessibility refers to the minimum distance covered for reaching one node to another node. In study area 33.70 areas have high accessibility (< 2 km), 25.47 have moderate (2-4 km), 15.20 have low (4-6 km) and 25.20 are very low accessible areas (>6 km) shown in Table - 2. Spatial patterns of physical accessibility and gross accessibility are presented in figure - 2.

Table 2: Area under Physical Accessibility

Sr. No.	Distance (km)	Area (sq.km.)	In %
1	<2	639.87	33.70
2	2-4	483.63	25.47
3	4-6	296.96	15.64
4	> 6	478.54	25.20
Total		1899.00	100.00

Source: Calculated from IRS Satellite Image LISS III; March, 2012.

Gross Accessibility

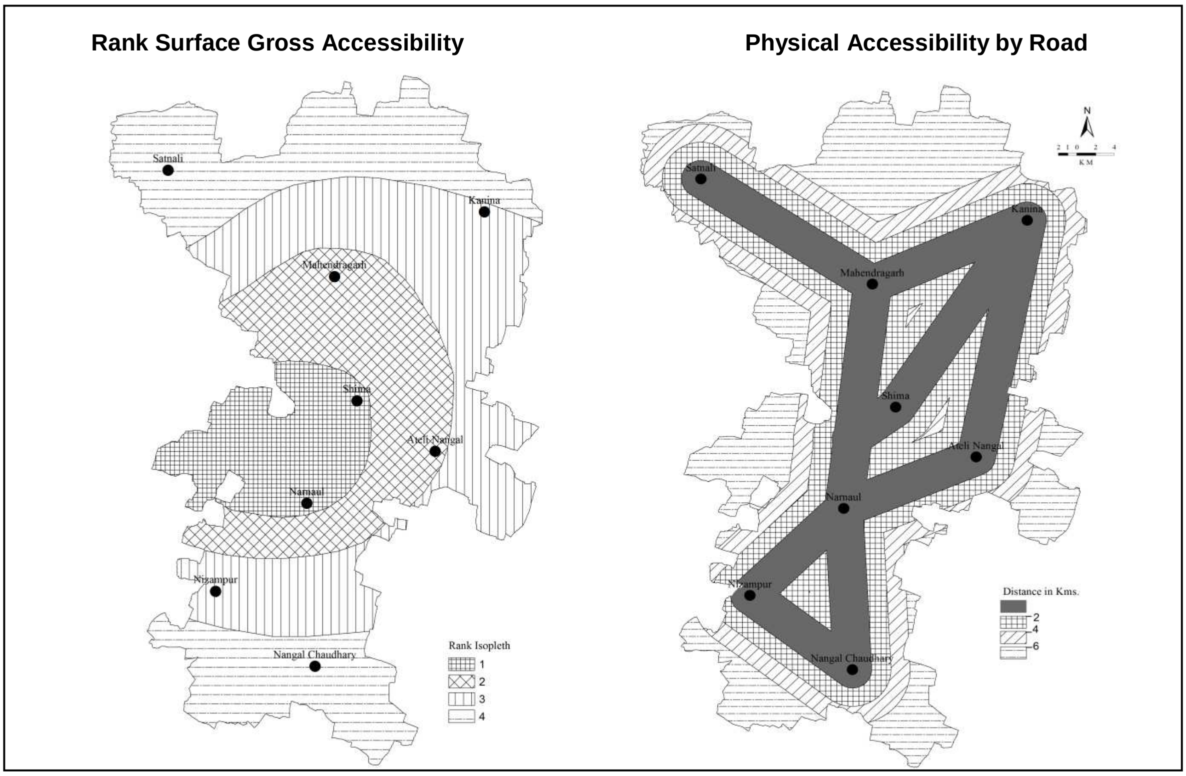
Accessibility is a product of mobility and proximity known as an indicator of the ability to efficiently reach one place to another place. Notably, it gives attention to alternative strategies for reducing traffic congestion and mitigating environmental problems, such as promoting efficient, resource conserving and land-use arrangements. Rank surface gross accessibility is the gravity based accessibility measurement indicator. Narnaul and Nizampur blocks are found as the highest accessible nodal points and Satnali and Kanina are the lowest accessible places in term of rank surface gross accessibility (Table – 3 & Figure - 2).

Table 3: Block Wise Gross Matrix

Block Name	Node	Node Rank	Assumed Distance	Milege	Total	Rank
Satnali	A	8	10	394	474	8
M.Garh	B	4	10	234	274	3
Kanina	C	2	10	300	320	6
Shima	D	5	10	210	260	2
Atelli	E	2	10	280	300	4
Narnaul	F	1	10	200	210	1
Nizampur	G	5	10	269	319	5
N. Chaudhary	H	5	10	311	361	7

Source: Calculated from IRS LISS III Satellite Image; March, 2012. SOI, Toposheets, 1: 50,000

Figure 2: Accessibility Year - 2014



Source: IRS LISS III Satellite Image; 2012. Google Earth Image, SOI, Toposheets, 1: 50,000.

Nodality

Geographically, nodality refers to the spatial arrangement and geometrical linkage of nodes in transport network. It represents the nodal centrality and direct relation of number of nodes within network. In the study area node F (Narnaul) having highest linkage and place of centrality (Figure - 2) with compression of others nodal points followed by E (Ateli), C (Kanina) and node A (Satnali) has lowest linkage followed by node D (Shima) and G (Nizampur). It is clear that the node F is most accessible and A is least accessible node in the district (Table - 4).

Table 4: Node Wise Nodality Matrix

Block Name	Node	A	B	C	D	E	F	G	H	TOTAL	RANK
Satnali	A	0	0	1	2	3	2	3	3	14	8
M.Garh	B	0	0	0	1	2	1	2	2	8	4
Kanina	C	1	0	0	0	0	1	2	2	6	2
Shima	D	2	1	0	0	2	1	2	2	10	5
Ateli	E	2	1	0	1	0	0	1	1	6	2
Narnaul	F	2	1	1	1	0	0	0	0	5	1
Nizampur	G	3	2	2	2	1	0	0	0	10	5
N. Chaudhary	H	3	2	2	2	1	0	0	0	10	5

Source: Calculated from IRS LISS III Satellite Image; March, 2012. SOI, Toposheets, 1: 50,000

Spatial Dimension of Mileage

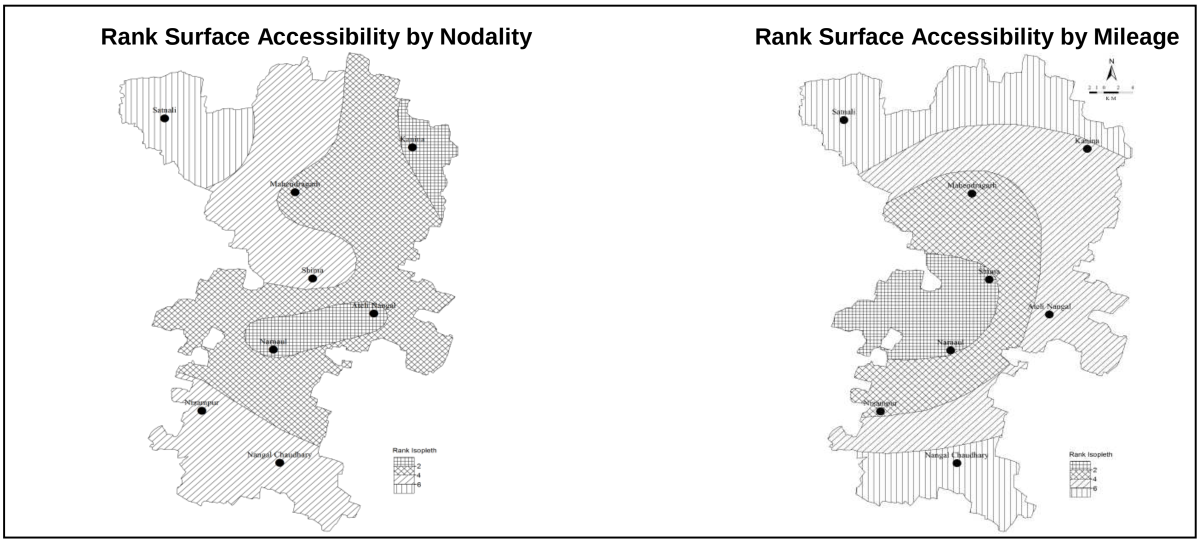
In the study area node F (Narnaul) have higher accessible by mileage (Figure - 2) with compression of others nodal points followed by D (Shima), and B (Mahendragarh) while on the other side, node A (Satnali) has least accessible followed by node H (Nangal Chaudhry) and C (Kanina). It is clear that the node F is most accessible and A is least accessible node in the district (Table - 5).

Table 5: Node Wise Mileage Matrix

Block Name	Node	A	B	C	D	E	F	G	H	TOTAL	RANK
Satnali	A	0	26	44	50	75	54	69	76	394	8
M.Garh	B	26	0	18	24	45	28	43	50	234	3
Kanina	C	44	18	0	30	27	48	63	70	300	6
Shima	D	50	24	30	0	33	12	27	34	210	2
Atelli	E	75	45	27	33	0	21	36	43	280	5
Narnaul	F	54	28	48	12	21	0	15	22	200	1
Nizampur	G	69	43	63	27	36	15	0	16	269	4
N. Chaudhary	H	76	50	70	34	43	22	16	0	311	7

Source: Calculated from IRS LISS III Satellite Image; March, 2012. SOI, Toposheets, 1: 50,000

Figure 2: Accessibility by Nodality & Mileage Year – 2014



Source: IRS LISS III Satellite Image; 2012. Google Earth Image, SOI, Toposheets, 1: 50,000.

Road Density

Road density is representing the total length of roads per square kilometer area (Figure - 3). In the study area block Narnaul have high road density in compression to others blocks followed by Nizampur and Nangal Chaudhry and on other side, the Satnali has lowest followed by Mahendragarh and Kanina.

Table 6: Block Wise Road Density Year- 2014

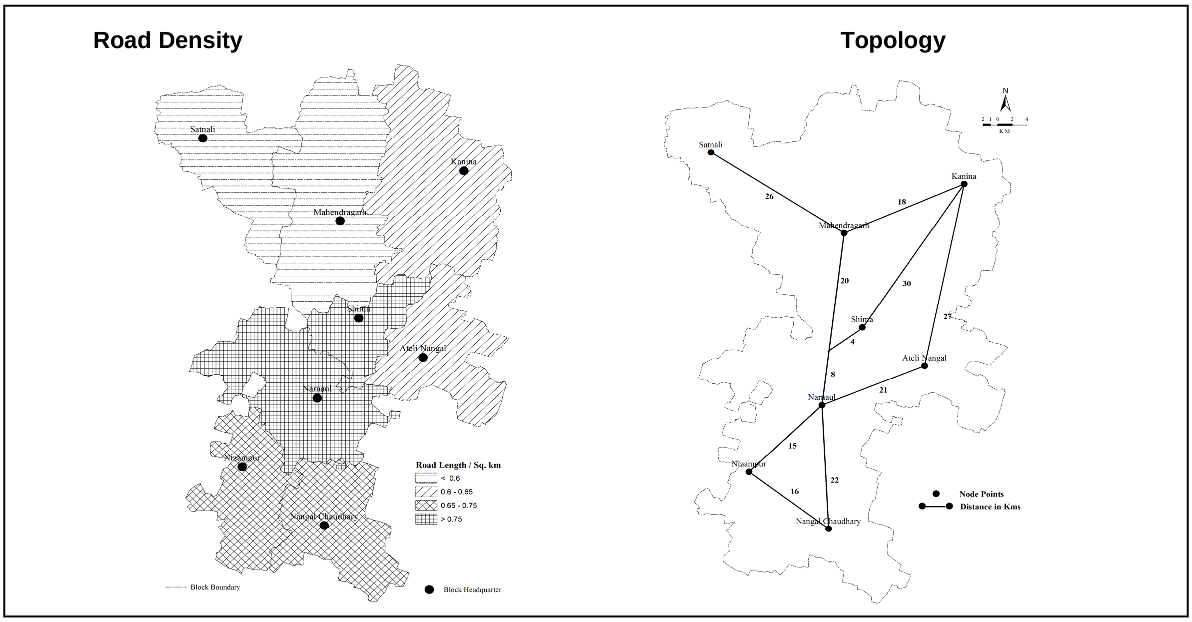
Block Name	Road Length (Km)	Area (Sq. Km)	Density
Satnali	125.49	226.53	0.55
Nizampur	127.67	172.34	0.74
Nangal Chaudhary	147.70	193.99	0.76
Mahendragarh	222.48	366.13	0.61
Kanina	230.36	352.28	0.65
Shima	87.97	110.66	0.79
Narnaul	223.29	279.34	0.80
Ateli	128.01	197.70	0.65
Total	1292.97	1899.00	0.68

Source: Calculated from IRS LISS III Satellite Image; March, 2012. SOI, Toposheets, 1: 50,000

Topology

Topology refers to the spatial relationship between the links and the nodes with their physical distance for separating two nodes in network. It specify the direction of movement of goods, peoples and other resources. Study area topological view and road density is represented in figure - 3.

Figure 3: Road Density & Topology Year – 2014



Source: IRS LISS III Satellite Image; 2012. Google Earth Image, SOI, Toposheets, 1: 50,000.

Conclusion

The accurate high resolution spatial information may be provides a solid foundation in selecting the area for road building, alignment, accessibility measurement or for upgrading these. In the coming years, it will be useful for planning and monitoring the roads for a maintenance check and a assured environmentally sustainable transport network system. In Mahendragarh district a well linked and coordinated system of transport playing an important role in the sustained economic growth. Narnaul have highest accessible central place and Satnali and Kanina least accessible place in term of mileage and physical accessibility. Narnaul block have leading position and Satnali block has lowest level in term of road density. During the field checking, time it was observed that few roads have efficient quality while rest of the roads have low levels quality in term of wideness, build-up materials and monitoring system in all over the district. There is urgent need of large scale investments in the whole transport network system to boost the local economic growth for assured environmentally sustainable development. It will be more helpful for rational utilization of land resources to sustain the transport network system of the study area.

References

1. Rout, J. et. al. (2012) GIS for Rural Development and Spatial Planning System. Geo-spatial world.
2. Rai, P. et al., (2013) Network Analysis Using GIS, International Journal of Emerging
3. Technologies in Computational and Applied Sciences, vol. 13,pp. 289-292.
4. Bell, M. et. al., Y.(1997) Transportation Network Analysis, John Wiley and Sons, Chichester
5. Sikdar, P. K. et.al. GIS Based Planning and Implementation of Rural Roads Programme in India: http://128.40.111.250/cupum/searchpapers/papers/paper421.pdf
6. http://webspace.ship.edu
7. http://nptel.ac.in
8. http://shodhganga.inflibnet.ac.in
9. http://www.its.berkeley.edu