

**“Analysis of Road Density, Connectivity and Tourism in Nashik District,
Maharashtra**

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Abstract:

The main objective of the present paper is to discuss the accessibility and road connectivity with respect to tourism development in Nashik District of Maharashtra State. Nashik District is located in the Northern part of Maharashtra State. Primary and secondary sources of data are used for the study. Primary data is collected from the field work (Dec.2022 to Jan.2023). Secondary data has been obtained from the Socio Economic abstract of Nashik District-2022. For analysis of road connectivity and accessibility, Road Density, Alpha Index, Beta Index and Gamma Index are calculated. QGIS software is used for explanations of results.

On the basis of the detailed study and observations of the study region, few problems are observed and seen related to tourism development in the study area. Such as lack of good road connectivity and accessibility, publicity of tourist places, inadequate accommodation facilities and lack of detailed information related to various tourists' places that are located within the study area. To develop good road connectivity by making a proper timetable for buses from concerned authorities (MTDC, ST. and Citilink etc.) that connect to all major tourist places in Nashik district is required Especially during the peak periods of winter and summer vacations.

There is also a need to start regular buses as Nashik Darshan from CBS, Nimani and Panchavati. In this regard MTDC and private travel agencies can initiate and arrange some AC and Non-AC buses for Nashik Darshan in cooperation with Citilink and Nashik S.T.Depot. There should be diversion of heavy vehicles, transport flows and commute flows to avoid burden on congested roads like Nashik-Trimbakeshwar, Nashik-Vani, Nashik-Nashikroad and Nasik-Ozar because these routes face traffic jam problems every day, especially during peak periods. City Link Bus Service of Nashik Municipal Corporation (NMC) and the Municipal Administration can reduce the frequency of school buses during vacation periods and increase the frequencies of buses towards major tourist places of the Nashik district. Especially at religious tourist places.

Key words: Road density, Accessibility, Connectivity, Alpha, Beta and Gamma Index.

1. Introduction:

Transportation is one of the most significant components of tourism. It is generally understood that the tourism industry grows more when there are better transportation frameworks. As a supporting factor, transportation is an important element of destination image that provides a base for the successful tourism industry. It is like the blood vessels of an area and is considered a determinant in developing a tourist destination (Ravinder Jangra & others, 2023). Transport is an integral part of the tourism industry. Tourism has expanded largely due to the improvement of transportation. Development of tourism in any region depends on development of the transport system (Virkar & Prita 2018). All tourists require convenient, cheap, comfortable and safe transport facilities.

Roads are the key to development of an economy of a country. A decent road network constitutes the basic infrastructure that drives the development process through connectivity and inaugurates trade and investment (Saparia & Pamnani 2018).

Tourism is all about travel and therefore the role of transportation is very important in the development of tourism. It is believed that any improvement in the transportation facilities like roads, railway, waterways and airways will ultimately affect the level of tourism development of a particular region. Development of roads and railways are playing an important role in the process of tourism development (Patil, 2014). Easy access is the most important factor in the development of tourist destinations. Road infrastructure and tourism represent positive implications for mutual relations and constraints. The development of road infrastructure in Tourism affects the mastery of long distances, reducing the duration of travel for tourist purposes (Mazrekaj, 2020).

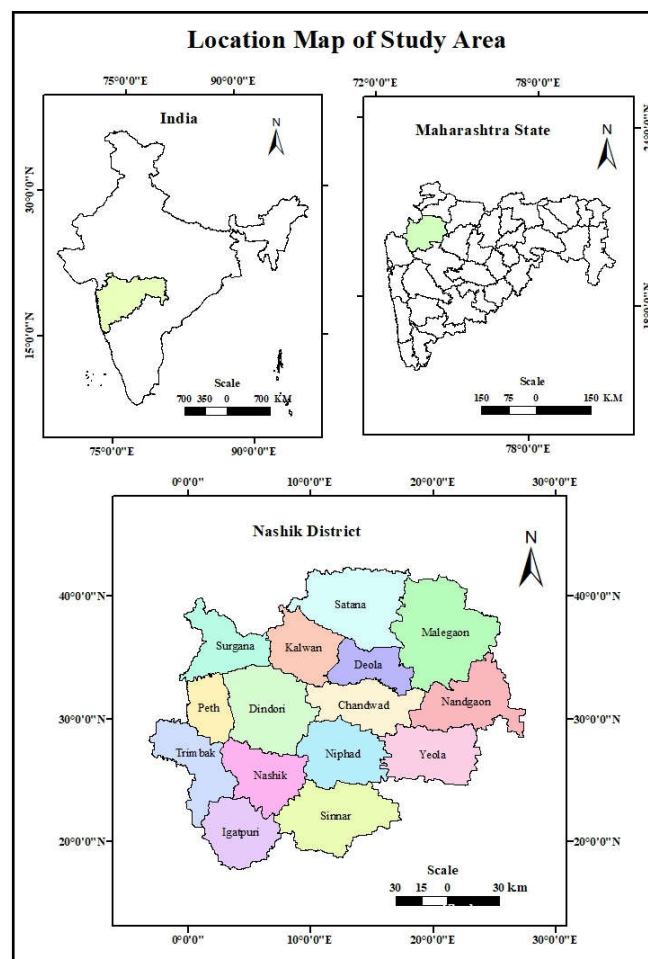
The study of road density, connectivity and accessibility is very important to determine the overall development of the transportation network of any region. If it is good then It will be very useful to the development of tourism in that particular region. If it is not then we can find out what problems are and how we can minimize the intensity of such problems to the development of tourism in that region. For this purpose, study of road density and connectivity is very useful. Nashik district has a lot of such potential. There is a lot of scope for tourism development.

Connectivity is referred to as the directness of travel between destinations. A well-connected network has many short links, numerous intersections and minimal dead-ends providing continuous and direct routes to the destinations (Sreelekha & others, 2012). Accessibility refers to the way in which a tourist accesses a destination. Along with

roads, railways and airways are also very useful to increase connectivity and accessibility of a particular region for tourism development. Railways are also very useful to increase the accessibility and connectivity of destinations. Air connectivity provides immediate benefits to those who utilize aviation services and larger benefits to the economy as a whole due to its positive effects on productivity and economic performance (Sharma & Ram, 2023). For considering overall connectivity and accessibility of transportation, railway and airway available in the study area is also considered in this study.

2. Study Area:

Nashik District is located in the western part of India and Northern part of Maharashtra State. It lies between $19^{\circ} 33'$ to $20^{\circ} 53'$ North latitude and $73^{\circ} 15'$ to $75^{\circ} 16'$ East longitude. Nashik District has an area of 15,530 Sq.k.m. Nashik District had a population of 61,071,877 as per the 2011 census. Nashik District is bounded by Dhule district in the north, Jalgaon to the east, Aurangabad districts in the south-east, Ahmednagar district in the south, and Thane and Palghar districts in the south-west and Dangs district of Gujarat state in the north-west. Location of the study area is showed in Map. No.1.



Map. No.1

The Western Ghats stretches from north to south across the western portion of the district. (Wikipedia, 2020). The Sahyadri mountain range is located in western part of the district. Physiographically, the district is divided into three divisions' viz. the hilly, Godavari basin and Girna basin. The elevation of the study area is varying between 300 M to 700 M from the sea level with lofty peaks. Salher (1567 M), Dhodap (1472 M), Mangi-Tungi (1331 M), Brahmagiri (1295 M) and Anjaneri (1280 M) are major peaks located in the district. The climate of the district is generally dry except during the monsoon season. The average annual rainfall of the district as a whole is 915.9 mm. (Socio-Eco. Abstract of Nashik District.2022). Ground water level is about 5 to 55 feet. The summer season is moderately hot and the temperature varies from 38° c to 42° c. The air is humid during the monsoon season and is generally dry during the rest of the year.

There are 114 tourist places in the Nashik District, Out of them 4 tourist places belong from 'B' grade category whereas 110 tourist places are graded as 'C' category. There are 325 hotels, 64 travel agencies, 600 restaurants and bars, 100 lodging, 38 wineries and about 100 forts located within the study area. It is very useful to boost tourism in the area.

3. Data and Methodology:

Present study is based on the primary and secondary source of data. Primary data are collected from the field work (Dec.2022 to Jan.2023) and interviews of 150 tourists through structural questionnaires from the tourist places of the Nashik District. Secondary data has been obtained from the Socio-Economic Abstract of Nashik District (2022) and research papers. Newspaper articles have been preferred. Internet sources have been referred for acquiring updated information related to the study. The data was systematically arranged, tabulated and presented with the help of a map. The degree of connectivity measures the completeness of the links between nodes. The connectivity and accessibility is measured by the Road Density, Beta Index, Alpha Index and Gamma Index. For calculating Road density and various index following formulas are used.

Road Density: $\frac{\text{Road Length}}{\text{Area Sq.K.M}}$

Beta Index (β) = $\frac{\text{Arcs}}{\text{Nodes}}$

Alpha Index (α): $\frac{(e-v+1)}{2v-5}$

$$\text{Gamma Index } (\gamma): \gamma = \frac{e}{3(v-2)}$$

Road density is defined as the length of road networks in a unit area of a particular region. Higher road density positively impacts on the overall development of tourism in the region. A higher value of Alpha, Beta and Gamma Index indicates more connectivity and efficiency.

4. Objectives:

- 1) To find out the spatial pattern of road density in the study areas.
- 2) To determine the connectivity and accessibility of road networks in study areas.
- 3) To suggest measures to improve the road connectivity and accessibility of tourist centers for their development.

5. Review of literature:

Reviewing literature related to any research topic is very important because it helps to know what work has been done by various research scholars about the present topic. It also provides the interpretation of existing literature knowledge and relevancy of existing materials. Therefore, here attempt has been made to take review of some research works which has been carried out by some researchers and academicians related to the present topic.

Tijani Nasiru Olawale & Kukoyi Ibraheem Adesina (2013) have conducted the research work with aim to assessment of the Relationship between Road Network Connectivity and Tourists' Patronage in Lokoja Metropolis, Kogi State, Nigeria. They discovered that the result (7%) is too low to establish a strong relationship between variables. This therefore suggests that there are other factors that determine the level of tourists' patronage in Lokoja.

Patil P. T, Patil A.A & others (2014) have carried out research work on 'An Assessment of Accessibility and Connectivity of Some Important Places in Kolhapur City of Maharashtra: A Road Network Analysis'. After analyzing the accessibility and connectivity of the study area, easily accessible and shortest paths are also suggested by researchers in order to reach the important centers very easily in their research area.

Patil P. S. (2014), has published one important research paper on "Accessibility of Tourist Centers in Kolhapur District". In this research paper he concluded that tourist centers like Kolhapur have good accessibility and connectivity.

Virkar Anjali & Mallya Prita (2018) have published an important research article on “A Review of Dimensions of Tourism Transport Affecting Tourist Satisfaction. In this article they concluded that accessibility, service quality, perceived value, and destination image as dimensions of the transport system influencing tourist satisfaction.

Ramadan Mazrekaj (2020) has examined the Impact of Road Infrastructure on Tourism Development in Kosovo. He has observed in his study that the lack of roads, or the poor condition of the existing roads and due to the low level of road safety, in some tourist destinations there may be a decrease in traffic for tourist needs.

Shalvi Sharma & Sewa Ram (2023) have carried out an important research on “Investigation of Road Network Connectivity and Accessibility in Less Accessible Airport Regions: The Case of India”. They concluded that Airport accessibility and connectivity help to improve intraregional links as well as connectivity to other regions. Airports in an area are intended to improve connectivity on both a domestic and an international level.

6. Results and Discussion:

Tourist Places in the Study Region.

There are 114 tourist places in the Nashik District, Out of them 4 tourist places belong from ‘B’ grade category whereas 110 tourist places are graded as ‘C’ category. Tehsil-wise number of ‘B’ and ‘C’ Category tourist places are shown in Table No.1 and Map No.2. Every tehsil has few tourists’ places of ‘C’ category. Only Trimbakeshwar (Lord Shiva Jyotirlingas and Kushavart Tirtha), Chandwad (Renuka Mata Temple) and Kalwan (Vani, Saptashruni Mata Temple) tehsils have ‘B’ category tourist’s places. Maximum ‘C’ grades tourist places are located in Niphad (17), Nashik (14), Igatpuri (11) Malegaon (10) and Dindori (10) tehsils of the study area. Nandgaon and Sinnar tehsils have 6 places each and Surgana, Chandwad, Trambak and Yeola Tehasils have 5 tehsils each. Remaining Peth (04), Kalwan (02) and Deola (01) tehsils have less number of C graded tourist places in the study region.

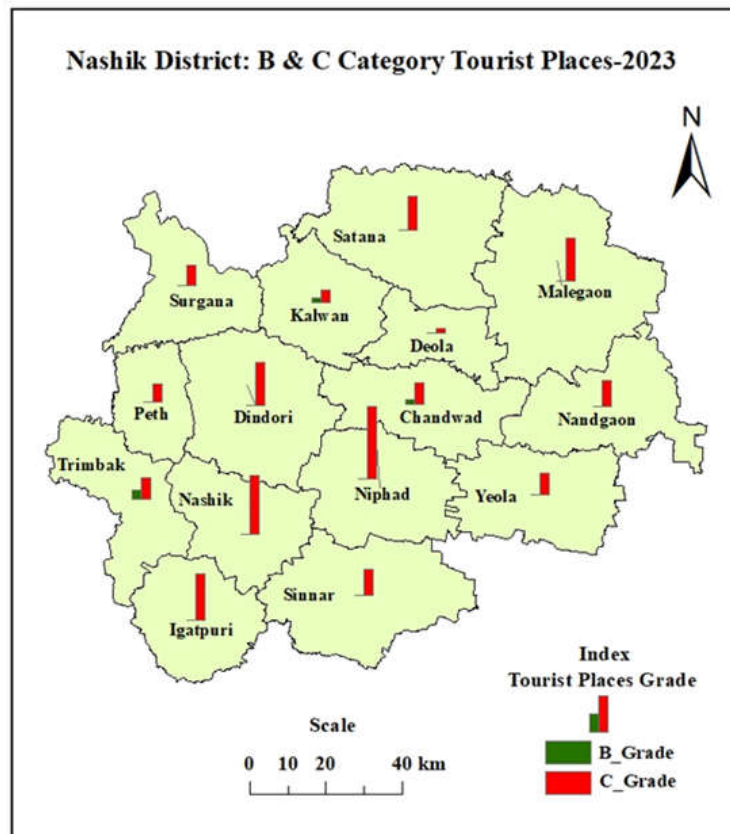
These places all have a lot of potential for development of tourism. The Strength of Nashik district tourism reflects in tourist places, Nashik city situated on the bank of Godavari River and it is a holy place for Hindu. It is famous for Kumbhamela. Ramkunda, Tapovan, Godaghat, Kalaram Temple, Sita Ghumpha, etc. are other places, which attract a lot of pilgrims. Therefore thousands of tourists visit every day to these places. The Money (Coin) Museum is situated in the peaceful surrounding near Anjaneri village on the Nashik Trimbakeshwar road. Nandur-Madhmeshwar Bird Sanctuary, Mamdapur Blackbuck

Conservation Reserve (Rajapur), Trimbakeshwar, Dhammagiri (Igatpuri), Museum of Mineral (Gargoti, Sinner), Pandav Leni (Near Ambad) and Chamber Leni (Mishrul) are very important tourist destinations that attracts tourists on a large scale. Other important tourist

Table No.1.Nashik District: Tehsilwise number of Tourist Places& Road Density-2022

Sr. No.	Name of Tahsil	Tourist B Grade Places	Tourist C Grade Places	Area Sq. K.M.	Total Road Length K.M.	Road Density (Per 100 Sq. K.M.)	National Highway K.M.
1	Surgana	-	05	821	1025.25	124.93	000
2	Kalwan	01	03	864	914.27	105.82	000
3	Deola	-	01	548	785.25	143.4	11.2
4	Satana	-	08	1453	1590.52	109.43	000
5	Malegaon	-	10	1818	2593.01	142.6	52.5
6	Nandgaon	-	06	1087	1265.99	116.43	000
7	Chandwad	01	05	953	1296.03	135.99	34.3
8	Dindori	-	10	1319	1738.75	131.85	1.5
9	Peth	-	04	557	807.81	145.12	000
10	Trambak	02	05	900	992.9	110.29	000
11	Nashik	-	14	891	2904.98	325.88	29
12	Igatpuri	-	11	867	856.48	98.78	63.5
13	Sinnar	-	06	1344	1698.33	126.38	63.2
14	Niphad	-	17	1,049	1824.82	174.02	24
15	Yeola	-	05	1059	1627.18	153.65	000
Total		04	110	15530	21921.57	141.16	279.2

Source: Socio-Economic Abstract of Nashik District.2022



Map No.2

places in the study area, Ramshej fort, Hatgad, Paithani Park of Yeola, Someshwr waterfall, Savarkar Memorial (Bhagur), Mangi-Tungi (Near Taharabad), Shri. Gondeshwar Temple (Sinner), Satimata Temple (Vadangali), Nasatanapur (Near Nandgaon), Ankai-Tankai forts (Near Manmad), Sarvtirth Taked and Kavnai (Near Igatpuri) etc. places also very important attractions for tourists to visit throughout the year. Wine Park was established at Vinchur by the Government of Maharashtra. Boating facilities are available at Gangapur dam, Someshwar and Ramkunda.

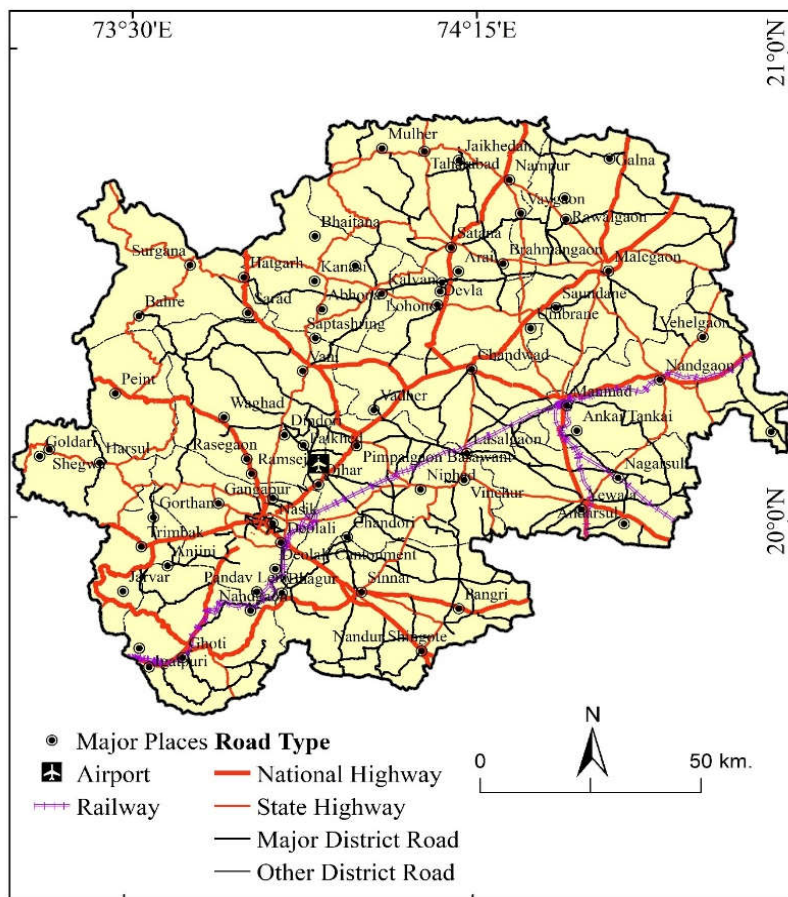
Transportation Network in the Study region:

Nashik district road, railway and air transportation is available. Total road length of the district is 21921 km and out of them 279 Km length is National highway. The length of State highway is 1763 Km, District Roads are 4421 Km and length of rural roads are 10013 Km. Nashik Road Railway Station is around 09 km from the central location of the city. Citylink bus service has started in Nashik city from 8 July 2021 in collaboration with the Municipal Corporation. It operates 45 routes with the help of 250 buses around Nashik and its suburban areas. It is also very useful for providing transportation facilities to Nashik city and nearby tourist places to tourists.

Table No.2 .Nashik District: Alpha, Beta & Gamma Index-2023

Sr. No.	Name of Tahsil	Alpha (α) Index	Beta (β) Index	Gamma (γ) Index
		$e-v=p/2v-5$	$e-v$	$e/3 (v-2)$
1	Surgana	0.03	1.00	0.37
2	Kalwan	0.11	1.14	0.42
3	Deola	0.14	1.21	0.44
4	Satana	0.08	1.10	0.40
5	Malegaon	0.29	1.36	0.56
6	Nandgaon	0.06	1.05	0.39
7	Chandwad	0.14	1.23	0.43
8	Dindori	0.24	1.41	0.51
9	Peth	0.00	0.75	0.50
10	Trambak	0.08	1.07	0.41
11	Nashik	0.31	1.58	0.54
12	Igatpuri	0.20	1.27	0.49
13	Sinnar	0.14	1.21	0.44
14	Niphad	0.47	1.81	0.65
15	Yeola	0.24	1.35	0.51

Source: Computed by Researcher, 2023



Map No.3.Nashik District: Transportation Network

Table No.3 Nashik District: Rail station and Their Grade-2022

Sr. No.	Station Name	Station Code	Grade	No. of Platforms	No. of Trains Passing
1	Manmad Jn.	(MMR)	A+	06	203
2	Nasik Road	(NK)	A	03	135
3	Igatpuri	(IGP)	A	04	102
4	Lasalgaon	(LS)	C	03	22
5	Devlali	(DVL)	C	03	38
6	Nagarsol	(NSL)	C	02	30
7	Sangmeshwar	(SGR)	C	02	46
8	Nandgaon	(NGN)	D	03	19
9	Yeola	(YL)	D	02	03
10	Niphad	(NR)	D	03	12
11	Ankai	(ANK)	E	03	02
12	Taru.	(TR)	E	01	02
13	Pimpar Khed	(PKE)	O	02	00
14	Panjhan	(PJN)	O	02	00
15	Naydongri	(NI)	O	02	00
Total				41	614

Source: <https://www.railyatiri.in/districts/nashik> (2023)

There are other 13 Bus Depot located in Nashik district run by Maharashtra State Road Transport Corporation and more than 250 buses providing transportation facilities especially in rural areas of the study region. This bus service is also useful to tourist travel in all parts of Nashik District.

In some parts of Nashik District railway facilities are available, which is useful to increase connectivity of tourist places in the study region. The total length of the railway route is 271 k.m. in the study area. Nashik Road station falls on the Mumbai-Bhusawal route of the Central Railways. Therefore it is well connected with many major cities in India like Agra, New Delhi, Mumbai, Kolkata, Nagpur, Guwahati, Kanpur, Patana, Bhopal etc. Table No.3 indicates the details about various railway stations and their platforms and numbers of trains passing from each railway station. Manmad, Igatpuri and Nashik are the major railway stations which play an important role in providing transportation facilities to tourists in the study region.

Road Connectivity in the Study region: The road connectivity of the study region is determined with the help of Alpha, Beta and Gamma Index, which are given here.

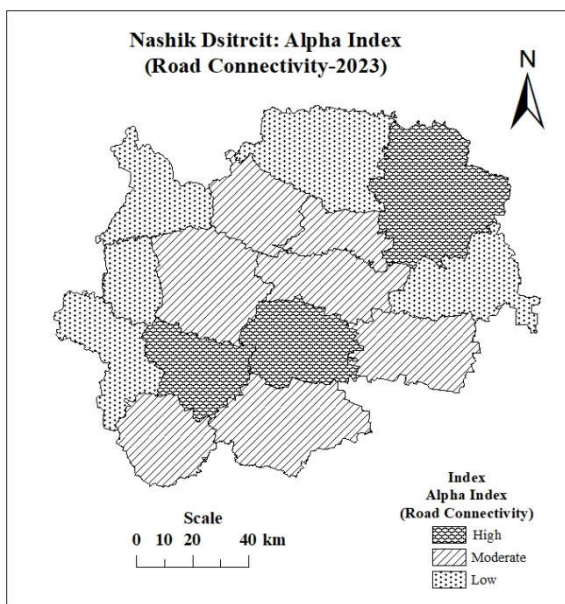
Alpha Index (α):

Alpha Index is a very useful measure of the connectivity of a network. The higher value of this index indicates more connectivity and efficiency. It gives the range values from 0 to 1.00. The higher the index, the greater is the degree of connectivity in the network. The study area has been classified into three classes on the basis of Alpha values (Table 4, Map 4). First class of high road connectivity having value more than 0.25 and it includes Niphad, Nashik & Malegaon Tehsils, where road density and development is good. Whereas, seven tehsils, namely Dindori, Yeola, Igatpuri, Deola, Sinnar, Chandwad & Kalwan belong to the moderate road connectivity with values ranging from 0.10 to 0.25 in the study region. Low road connectivity is observed in last class having values less than 0.10.it includes tehsils such as Satana, Trambak, Nandgaon, Surgana & Peth, where development is less and most part is covered by hilly areas.

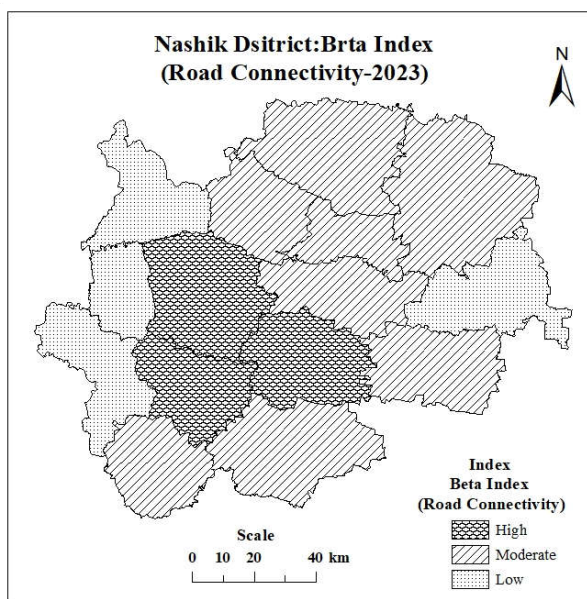
Table No.4.Nashik District Alpha(α) Index-2023

Sr. No.	Category (Road Connectivity)	Range	Name of Tahsils
1	High	More than 0.25	Niphad, Nashik & Malegaon
2	Moderate	0.10-0.25	Dindori, Yeola, Igatpuri, Deola, Sinnar, Chandwad & Kalwan
3	Low	0.00-0.10	Satana, Trambak, Nandgaon, Surgana & Peth

Source: Computed by Researcher, 2023



Map No.4



Map No.5

Beta Index (β)

Beta Index is another measure of connectivity, which is calculated by dividing the total number of arcs in a network by the total number of nodes. The beta index ranges from 0.0 for networks, which consist just of nodes with no arcs, through 1.0 and greater where networks are well connected. The Study area has been classified into three classes on the basis of beta values (Table 5, Map 5).

Niphad, Nashik & Dindori tehsils have the high road connectivity having value more than 1.40 in the study region. Second class of Moderate road connectivity having value range from 1.10 to 1.40. In this class 8 tehsils from the study region are included. They are Malegaon, Yeola, Igatpuri, Chandwad, Deola, Sinnar, Kalwan & Satana. Third class of low road connectivity have value range less than 1.10 and Trambak, Nandgaon, Surgana & Peth tehsils are included in this class. It is due to rugged topography and steep slope at various places, which is not suitable for construction of road and development of the region.

Table No.5. Nashik District Beta(β) Index-2023

Sr. No.	Category	Range	Name of Tahsils
1	High	More than 1.40	Niphad, Nashik & Dindori
2	Moderate	1.10-1.40	Malegaon, Yeola, Igatpuri, Chandwad, Deola, Sinnar, Kalwan & Satana
3	Low	0.00-1.10	Trambak, Nandgaon, Surgana & Peth

Source: Computed by Researcher, 2023

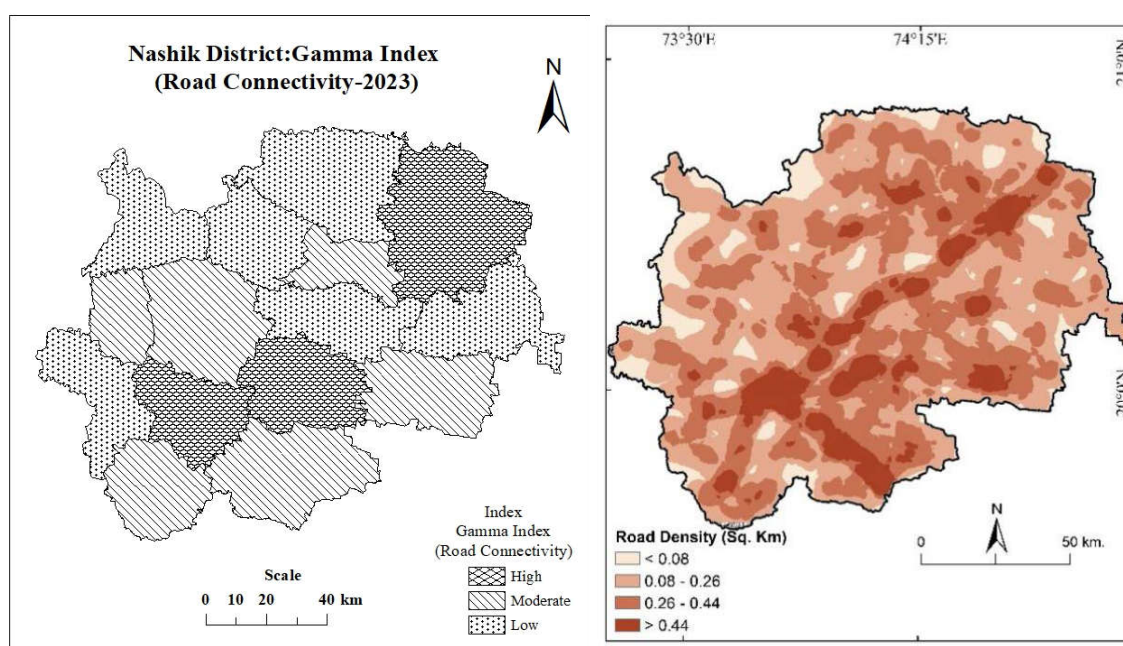
Gamma Index (γ):

The connectivity of the network is evaluated in terms of the degree to which the network deviates from an unconnected graph and approximates a maximally connected one. The value for the gamma index is between 0 and 1. The gamma index is a ratio between the observed number of edges and nodes of a network. A higher value indicates good connectivity and efficiency. The study area has been classified into three classes on the basis of gamma values. (Table 6, Map 6) Three tehsils, namely Niphad, Malegaon & Nashik belong to the high road connectivity class having value of connectivity more than 0.54. On the other hand, six tehsils, namely Yeola, Dindori, Peth, Igatpuri, Deola & Sinnar belong to the moderate road connectivity class, while remaining 6 tehsils are included in this class. They are Chandwad, Kalwan, Trambak, Satana, Nandgaon & Surgana.

Table No.6.Nashik District Gamma(γ) Index-2023

Sr. No.	Category	Range	Name of Tahsils
1	High	More than 0.54	Niphad, Malegaon & Nashik
2	Moderate	0.44-0.54	Yeola, Dindori, Peth, Igatpuri, Deola & Sinnar
3	Low	0.00-0.44	Chandwad, Kalwan, Trambak, Satana, Nandgaon & Surgana

Source: Computed by Researcher, 2023



Map No.6**Map No.7****Road Density in the study area:**

Nashik city is 180 km from Mumbai and 205 km from Pune. Nashik is easily accessible by road from Gujarat, Madhya Pradesh and Karnataka. The road density of the total district is 141 in per 100 Sq.K.M. area, which is shown in Table No.6. The highest density of road network in per unit area is recorded in Nashik (326) tahsil. Nashik city is the main place located in this tehsil, which is well connected with each other's tehsils of the study area therefore here road density is the highest in the study area. Niphad (174) and Yeola (154) tehsils also have good density of road network in per 100 Sq.K.M area. Most of the areas of these tehsils are located along the major state highways which are passing through these tehsils. The Lowest road density is found in Igatpuri tehsil (99) due to rugged topography and steep slope. Tehsilwise road density is shown in the map No.7. The road network is yet not fully developed all over the district, which is the main problem in accessibility of the study area.

Ozar Airport is located 22 km northeast from the city Nashik city. Ahmedabad, Nagpur, Indore, Hyderabad & Goa have daily flights therefore connectivity of Nashik is available with these all places and shortly a number of flights will be available for other major 20 cities of India. It will be very beneficial to outside tourists to connect with Nashik District.

7. Conclusion and Suggestions:

On the basis of the detailed study and observations of the study region it is concluded that road density and connectivity is good in Nashik, Niphad & Malegaon tehsils of the study region. These three tehsils are comparatively developed with respect to industries and agriculture. Another important reason for development of road connectivity of these regions is that most part of these three tehsils is connected with national and state highways which are passing through these tehsils. In other hand low road density and connectivity is mainly observed in Trimbak, Peth, Sargana, Nandgaon and Kalwan tehsils, where most part is covered by undulating topography, steep slope and comparatively less developed with respect to industries and agriculture occupation.

Most of the respondents faced problems about road connectivity (22.12 %), lack of detailed information of tourist places (17.52 %), accommodation (15.50 %), parking problem (12.10 %) and availability of S.T. buses (9.50 %). It means the major problem is a

lack of good road connectivity and accessibility, publicity of tourist places, inadequate accommodation facilities and lack of detailed information related to various tourists' places that are located within the study area. Nashik district have too much potential for developing tourism but for that purpose MTDC (Maharashtra Tourism Development Corporation), Travel Agents Association of Nashik (TAAN) Nashik Municipal Corporations (NMC), Maharashtra State Road Transport Corporation (MSRT) and Citylink Bus Authority of Nashik City have to take collective efforts to develop good road connectivity by making proper timetable for buses that connect to all major tourist places in Nashik district. Especially during the peak periods of winter and summer vacations.

There is also need to starts regular some buses as Nashik Darshan from CBS, Nimani and Panchavati. Some year ago such facility was available but now it is closed. In this regards MTDC and private travel agencies can initiate and arranged some AC and Non-AC buses for Nashik Darshan in corporation with Citilink and Nashik S.T. Depot. There should be diversion of heavy vehicles transport flows and commute flows to avoid burden on congested roads like Nashik-Trimbakeshwar, Nashik-Vani, Nashik-Nashikroad and Nasik-Ozar because these routes face traffic jam problems every day, especially during peak periods. City Link Bus Service of Nashik Municipal Corporation (NMC) and the Municipal Administration can reduce the frequency of school buses during vacation periods and increase the frequencies of buses towards major tourist places of the Nashik district. Especially at religious tourist places. It will be beneficial to Citylink bus authority and tourists for traveling at tourist places.

It is suggested that more rural access roads should be constructed and even earth roads upgraded to pave way for easy travelling of tourists in the study area. Therefore, it would suggest that there is a need to improve the connectivity and accessibility of those tourist places yet not connected properly with major places of the district. They should connect with roads for the future growth and development of tourism in the study area. Nashik city must have a Toll free Number for tourists, which will work 24*7, so tourists can be contacted and enquire about traveling information and related problems. To start tourist information centers and booths at major places like railway stations and bus stops within the district. It will give wide publicity to these tourism destinations. There is also a need to display a big wall map about the location and route network related to all tourist places at major railway stations.

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