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Road Accessibility and Level of Transport Development: Assessing Potential Accessibility of Minakhan CD Block in North 24 Parganas, West Bengal, India.

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Abstract: *Rural areas show significant variation in road accessibility, which plays a crucial role in shaping transport development as well as socio-economic development. This study focuses on evaluating road accessibility indices derived from metalled road networks to assess their influence on transport development of the Minakhan CD Block in North 24 Parganas, West Bengal, India. Using Open Street Map (OSM) data, the study identifies key measures such as the shimbel index, associate number, road length, road density, and detour index to evaluate accessibility in this northern deltaic region of the Indian Sundarbans.*

Each Gram Panchayat (GP) within the CD block has been ranked based on these accessibility measures. A composite score, referred to as the rank coefficient, was calculated for every GP to determine its transport development level. The analysis classified the GPs into three different zones of transport development: high (<15.00), medium (15.01–30.00), and low (>30.00). These classifications highlight the disparity in transport development and accessibility across the region. To understand geographic accessibility at the GP level, the study used a distance matrix to analyze how easily one location could be reached from others. By integrating this distance matrix with population data from each GP, the potential accessibility has been calculated. Based on the potential accessibility matrix, the "attractiveness" (The GP's ability to draw people and activities) and "emissiveness" (the ease with which people can travel out from a GP) have been assessed.

The findings reveal the clear spatial disparities in road accessibility and transport development across the Minakhan CD Block. This research underscores the importance of targeted infrastructure improvements in low-ranking GPs to enhance transport infrastructure, promote socio-economic development, and reduce regional disparities in accessibility and transport development.

Keywords: Road accessibility, Level of transport development, Composite score, Geographic accessibility, Potential accessibility.

1. INTRODUCTION

Worldwide road accessibility greatly impacts the economy and communication system, especially in rural and remote regions. About 14% of the global population lives more than 2 kilometers away from the nearest road (Wenz, 2020). In India, the construction of roads led to a rise in job opportunities, expanded avenues for self-employment, and boosted economic activities. It also enhanced farming employment by enabling a shift to higher-income cash crops and facilitating multiple cropping (Mahapatra et. al., 2007). The expert committee on doubling farmers' income, established by the Government of India, emphasized the importance of road infrastructure connecting farms directly. In its 2018 report, it recommended leveraging schemes under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and the Pradhan Mantri Gram Sadak Yojana (PMGSY) to achieve this goal (GoI, 2018). At the end of the 20th century, about 300 million people in rural India had limited connectivity because their villages lacked all-weather road access (World Bank, 2021). 70% of villages with a population of 1,500 or more are connected by road, connectivity is poor for villages with smaller populations (PMGSY). In West Bengal, Road accessibility has an impact on rural health, poverty, economy etc. The efficiency of road infrastructure in North 24 Parganas has ranked 15 out of all the districts of West Bengal (Chisti, 2015). Accessibility is defined as the measure of the capacity of a location to be reached by, or to reach different locations. Therefore, the capacity and the arrangement of transport infrastructure are key elements in the determination of accessibility (Rodrigues, 2013).

This study examines the Minakhan CD block, situated within the deltaic region of the Sundarbans, where residents face considerable difficulties in daily transportation and connectivity. The block's road infrastructure is sparse, forcing residents to depend heavily on ferry services as a primary mode of transport between various locations. For longer distances, residents must rely

on limited roadways and travel considerable distances to reach the nearest railway station, which is situated over 20 kilometres away, further isolating the community from more extensive transport networks.

The accessibility challenges are further compounded by the fact that only two of the eight Gram Panchayats (GPs) in Minakhan have direct access to State Highway (SH-03), a major road link. This lack of connectivity places a significant burden on residents of the remaining six GPs, as they have to navigate lesser roads, which are often shorter and poorly maintained, or rely on the district's narrow roadways to meet their transportation needs. These limited roadways are unable to accommodate heavy traffic, and the conditions are particularly challenging during the monsoon season when water levels rise, impacting ferry operations and making even the district roads less accessible.

This inadequate infrastructure creates challenges not only for regular commuting but also for accessing essential services such as healthcare, education, and employment, which often require travel outside the immediate locality. The region's low road density and minimal connectivity options result in prolonged travel times, isolating these rural communities even further. The study highlights the need for improved road development and solutions to transport problems to enhance the daily lives and economic prospects of Minakhan CD block, especially in more isolated GPs that lack direct access to SH-03.

This CD block was chosen for study because of its inadequate road network and prevalent communication issues. Most villages depend on boats to cross rivers, a situation that becomes especially difficult during the monsoon. Commuters face limited bus services on various routes, and some GPs are poorly connected to major roads, making them reliant on ferries. The duration of transport service is less in time, and in emergencies at night, residents struggle to find even minimal transport services due to the area's rural and remote location.

1.1. Study Area

The study area of Minakhan CD block of North 24 Parganas located between 22°23 ' 30 " N to 22°36 ' N and 88°38 ' E to 88°51 ' E, is bounded by Hasnabad CD Block in the east, Canning-II, Bhangar-I, and Bhangar-II CD Blocks of South 24 Parganas in the west, the Haroa CD block in the north and the Sandeshkhali-I CD Block is situated in the south. The study area situated as the northernmost part of the Indian Sundarban region covers an area of 158.82 Sq. Km. with 199084 population (2011). 1300 persons/sq. km., sex ratio 955 per 1000 males. The total literacy rate is 71.33% as per the census of India (2011).

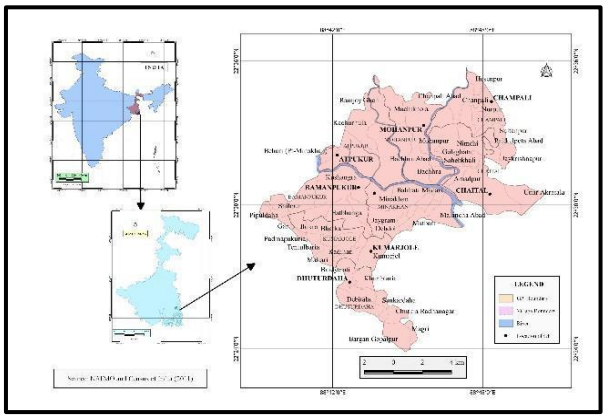

Fig.: 01. The study area.

In this CD Block, 12 originating/terminating bus routes are available as road transport services. The State Highway-03 (SH) passes through the middle part of the block. District roads are present in southern, northern and north-eastern parts of the block. In this study area, 07 ferry services are available as water transportation. The nearest railway station is situated 20 Km. away from the Minakhan.

Table No.: 01. Population characteristics and transport infrastructure of the study area.

Name of the GP(s)	Population	Area in Sq. Km.	Population Density in Km./Sq. Km.
Atpukur	20504	20.8518	983
Bamanpukur	24033	21.7017	1107
Chaital	26358	24.7686	1064
Champali	21377	17.3888	1229
Dhutrudaha	23573	15.0959	1562
Kumarjole	30332	16.6295	1824
Minakhan	35245	12.7109	2773
Mohanpur	21658	22.4398	965
Literacy and Poverty of Minakhan		**Religion of Minakhan**	
Total Literacy	71.33%	Hinduism	47.77%
Male Literacy	77.20%	Islam	51.60%
Female Literacy	65.17%	Christianity	0.52%
Rural Poverty Households.	38.42%	Others	0.11%
Transport Infrastructure of Minakhan			
Ferry Service			07
Originating/ Terminating Bus Route			12
Nearest Railway Station			20 Km.
Source: Census of India, 2011.			

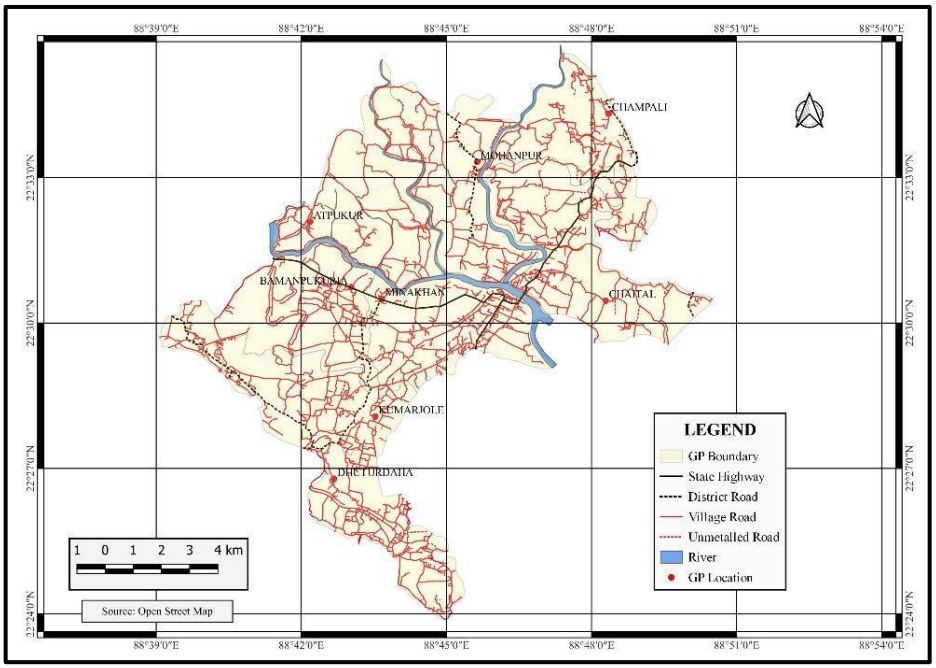

Fig.: 02. Road network of the study area.

1.2. Objectives of the Study

The main objectives of the study as follows:

i) To measure the different road accessibility indices at GP level and their spatial distribution based on metalled roads.
ii) To determine the level of transport development based on rank value of different accessibility measures.
iii) To examine the geographic accessibility and potential accessibility of the different GPs.

2. MATERIALS AND METHODS

This study has been carried out with the help of Open Street Map (OSM) for preparing different road maps and the Census of India (2011) data as a secondary source. Different methods and techniques have been incorporated to fulfill the objectives of the study.

To find out the accessibility, the following factors and formulae have been used for the metalled road (State Highway, District Road and Village Road) networks of the study area. With the help of edges and vertices of the road network, Gram Panchayat (GP) wise shortest path analysis, shimbel index, associate number, detour index and road density have been used to measure the road accessibility. The following formulae have been used to determine the different accessibility measures.

2.1. Associate Number: A metric of remoteness defined by the minimum number of connections required to access the farthest node in a graph.

Associate Number (AN) = Maximum number of vertices through the row for a node.

2.2. Shimbel Index: The highest value indicates as Shimbel index for a particular node or vertex into the road network. Shimbel index or shimbel distance, nodal accessibility, nodality. This measure of accessibility calculates the cumulative length of the shortest paths linking a given node to every other node within a graph. Its inverse, known as closeness centrality or distance centrality, provides an alternate perspective on accessibility.

Shimbel Index (SI) = Total number of vertices in each row.

2.3. Road Density: The total length of the roads in a per unit area. Based on GPs, road density has been calculated with the following formula:

Road Density (RD): Road Length in Km. / Area in Sq. Km.

2.4. Detour Index: The detour index measures the efficiency of a transport network by assessing how effectively it minimizes distance-related obstacles; a value closer to 1 indicates higher spatial efficiency in the network. The detour index is an important parameter that measures how efficient a transport network to reduce distance.

Detour Index (DI) = Actual Distance in Km. / Straight Distance in Km.

In this study, the detour index has been made out from the Minakhan GP to every GPs location but in the case of Minkhan GP, the detour index is computed with the nearest urban centre or sub-divisional headquarter (HQ) i.e. Basirhat. The value of detour index is hardly ever found 1.00 when the straight distance and actual distance are the same.

2.5. Transport Development: The level of transport development has been determined using different indicators of road accessibility. The indicators are the associate number, shimble index, road length in km., road density, and detour index. The ranking coefficient of Kendell's method has been incorporated to determine the level of transport development.

The value of these five indicators of accessibility has been computed and ranked for every GP. Getting the rank of GPs, the composite score of transport development has been computed to sum all the ranks of five indicators of accessibility.

Ranking Co-efficient (Composite Score) = Summation of individual ranks of the different indicators (the higher score indicates the lower level of development and vice-versa).

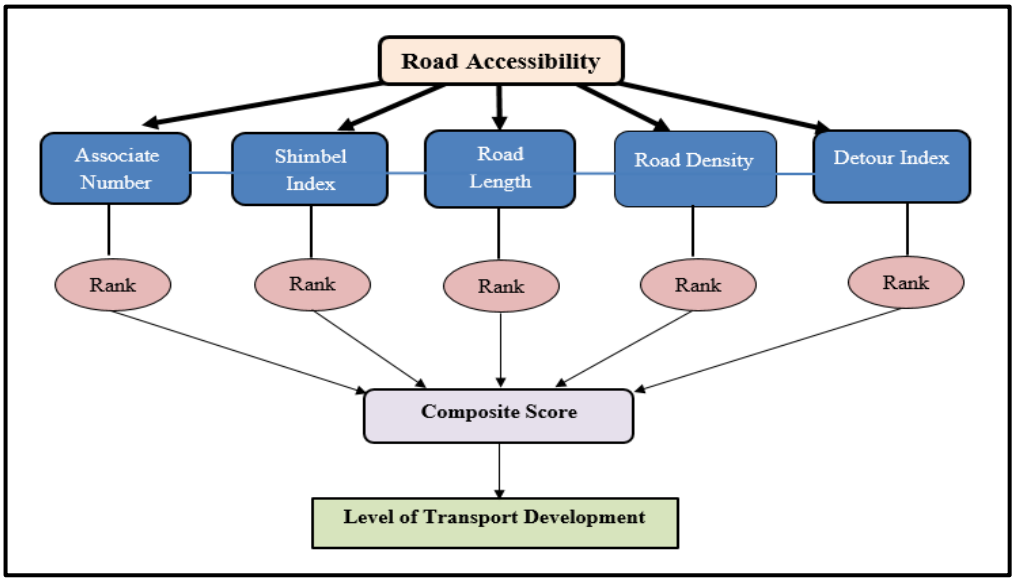

Fig.: 03. Flow charts of the methods.

2.6. Geographic Accessibility: The geographic accessibility is a highly practical measure. In simpler terms, geographic accessibility measures how easy to reach a particular location from other places. It is calculated by adding up the distances from this location to all other locations and then dividing by the total number of locations. If the average distance is smaller, it means that the location is more accessible, or easier to reach, from other places.

Geographic Accessibility (GA) = Σ Road Distance in Km. / N

Where, N= Total number of places (or Vertices)

2.7. Potential Accessibility: By considering the value matrix of the shortest road distance and population matrix, the potential accessibility matrix can be calculated. The higher value means more accessibility.

Potential Accessibility (PA) = Pj / Dij

Where, Dij = Distance between place i and j (Derived from shortest road distance matrix)

Pj = Attributes of place j (Population)

Attractiveness is represented by the sum of values in a column of the potential accessibility matrix. It measures the ability or likelihood of a location to receive flows or be interacted with by other locations. *Emissiveness* is represented by the sum of values in a row of the potential accessibility matrix. It refers to how likely or able a location is to send flows or interact with other locations.

3. RESULTS AND DISCUSSION

3.1. Associate Number: Three zones of accessibility have been identified based on the associate numbers (Table No. 02), where higher values indicate lower accessibility. Mohanpur GP and Dhuturdaha GP have the highest associate numbers (23), marking them as low-accessibility areas. Moderate accessibility is found in Atpukur GP (18), Chaital GP (17), Champali GP (18), and Kumarjole GP (18), while the highest accessibility is in Bamanpukur GP (14) and Minakhan GP (12).

The higher accessibility in Minakhan GP and Bamanpukur GP is due to the State Highway (SH-03) passing through these areas, facilitating better connectivity. In contrast, Dhuturdaha GP and Mohanpur GP are more isolated, as they require a greater number of connections to reach other GPs and are farther from SH-03. Atpukur, Chaital, Champali, and Kumarjole GPs have moderate accessibility, needing more links to connect other GPs compared to Dhuturdaha and Mohanpur.

Table No.: 02. Calculation for shimbel index and associate number (shortest path analysis).

CD Block	Name of the GP(s)	V1	V2	V3	V4	V5	V6	V7	V8	Shimbel Index	Associate Number
Minakhan	Atpukur (V1)	0	5	12	18	10	10	7	9	**71**	**18**
	Bamanpukur (V2)	5	0	10	14	8	7	1	14	**59**	**14**
	Chaital (V3)	12	10	0	6	17	15	8	12	**80**	**17**
	Champali (V4)	18	14	6	0	15	13	10	6	**82**	**18**
	Dhutrudaha (V5)	10	8	17	15	0	8	8	23	**89**	**23**
	Kumarjole (V6)	10	7	15	13	8	0	5	18	**76**	**18**
	Minakhan (V7)	7	1	8	10	8	5	0	12	**51**	**12**
	Mohanpur (V8)	9	14	12	6	23	18	12	0	**94**	**23**

Source: Computed by Authors.

3.2. Shimbel Index: The highest and lowest values of the Shimbel index are observed in Mohanpur GP (94) and Minakhan GP (51), respectively, resulting in a significant range of 43. Minakhan GP (51) and Bamanpukur GP (59) form the lower Shimbel index zone, indicating high accessibility. Moderate accessibility, based on the Shimbel index, is found in Atpukur GP (71), Chaital GP (80), and Kumarjole GP (76). Meanwhile, Champali GP (82), Dhuturdaha GP (89), and Mohanpur GP (94) fall into the low-accessibility zone.

Due to the presence of SH-03 and district roads, Minakhan GP and Bamanpukur GP achieve high accessibility, requiring fewer connections to reach other GPs. In contrast, Champali GP, Dhuturdaha GP, and Mohanpur GP, lacking sufficient SH and district road coverage, require more connections to access other GPs.

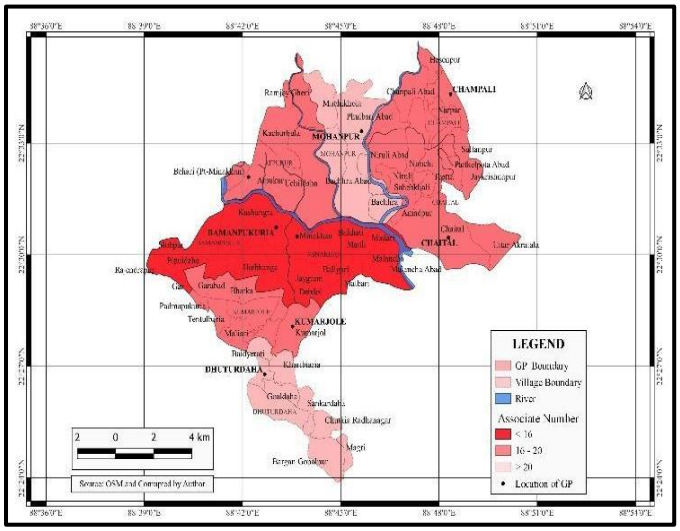

Fig.:04. Spatial distribution of associate number.

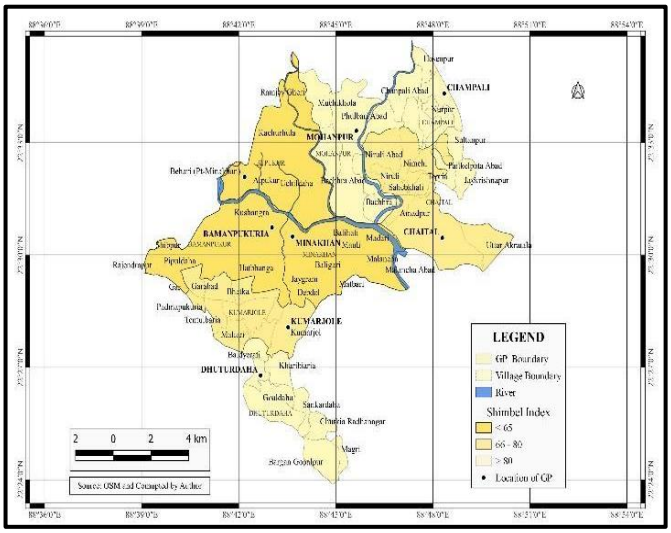

Fig.: 05. Spatial distribution of shimble index .

3.3. Road Length and Road Density: In this study area, State Highway-03, district roads, and village roads all are different kinds of metalled roads. The maximum length of metalled road is in Minakhan GP (62.86 km.) and Champali GP (44.57 km.) has the minimum length of a metalled road as per the OSM.

The road density in the area ranges from 2.30 to 4.95, with a variation of 2.65. Minakhan GP, with a density of 4.95, falls in the high road density zone. Dhuturdaha GP, at 3.03, has moderate road density. The remaining GPs, including Atpukur GP (2.41), Bamanpukur GP (2.69), Chaital GP (2.31), Champali GP (2.56), Kumarjole GP (2.89), and Mohanpur GP (2.44), falls into the low road density category.

Due to the presence of different administrative offices in this CD block, Minkahan GP has the maximum length of roads with a minimum area. Because of this reason, Minakhan GP has the highest road density in this CD block. In the case of other GPs, they have moderate to low road densities because the road length is medium to low and GPs have covered medium to high geographic areas.

Table No.: 03. Measures of road density

CD Block	Name of the GP(s)	Road Length in Km. (Metalled)	Area in Sq. Km.	Road Density in Km./Sq. Km.
Minakhan	Atpukur	50.29	20.8518	**2.41**
	Bamanpukur	58.28	21.7017	**2.69**
	Chaital	57.14	24.7686	**2.31**
	Champali	44.57	17.3888	**2.56**
	Dhutrudaha	45.71	15.0959	**3.03**
	Kumarjole	48.00	16.6295	**2.89**
	Minakhan	62.86	12.7109	**4.95**
	Mohanpur	54.86	22.4398	**2.44**
Source: OSM and Computed by Authors.				

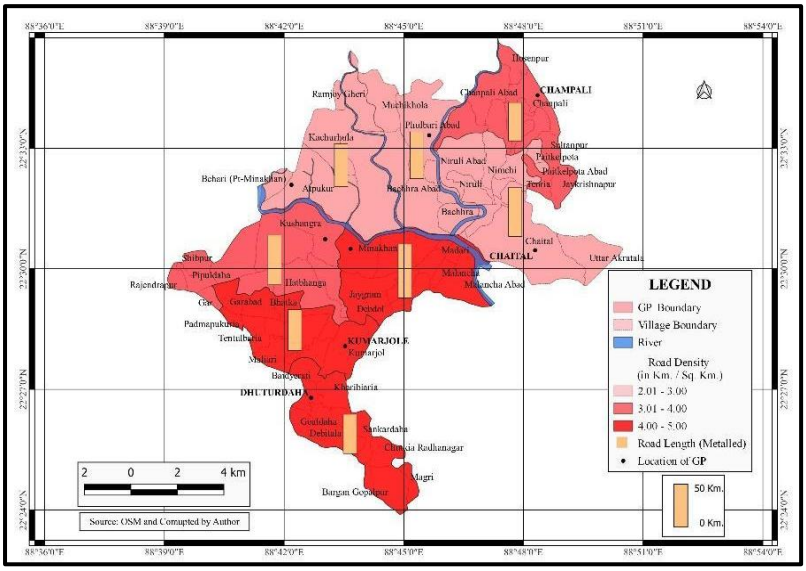

Fig.: 06. Spatial distribution of road density with metalled road length.

3.4. Detour Index: The detour index value is found as lowest in Bamanpukur (1.25) and the highest value found in Mohanpur GP (1.89). From the detour index value (Table No. 04) three different zones have been prepared. Atpukur (1.40), Bamanpukur (1.25), Chaital (1.32) and Minakhan (1.42) GPs have high Detour Index value which falls under the high-efficiency road network. Moderate efficiency is found in Champali (1.57) and Kumarjole (1.48) GPs whereas, Dhuturdaha (1.66) and Mohanpur (01.89) GPs have low efficiency as per the detour index value.

The Atpukur GP, Bamanpukur GP and Chaital GP have high accessibility as per detour index value due to the presence of SH-03 and district road which are well connected to the block HQ i.e. Minakhan and the situation of GPs are nearer to the SH-03 and district road. In case of Dhturdaha GP and Mohanpur GP have faced the lack of major roads to well connect the block HQ. Champali GP and Kumarjole GP are well connected to block HQ through SH-03 and district roads but distances are higher. The Minakhan GP has moderate efficiency because its detour index has been determined with the nearest urban centre (Basirhat).

Table No.: 04. Calculation for detour index

CD Block	Name of the GP(s)	Actual Distance in Km.	Straight Distance in Km.	Detour Index
Minakhan	Atpukur	05.38	03.85	**1.40**
	Bamanpukur	01.25	01.00	**1.25**
	Chaital	10.77	08.15	**1.32**
	Champali	16.46	10.46	**1.57**
	Dhutrudaha	11.23	06.77	**1.66**
	Kumarjole	06.15	04.15	**1.48**
	Minakhan	30.00	21.08	**1.42**
	Mohanpur	11.08	05.85	**1.89**
Source: OSM and Computed by Authors.				

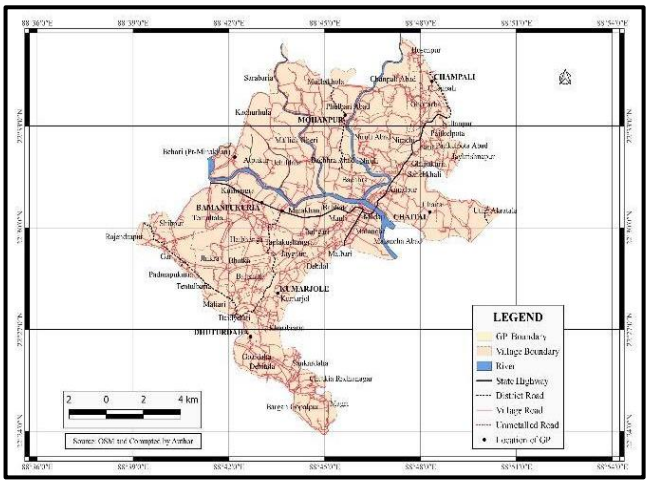

Fig.: 07. Spatial distribution of road network.

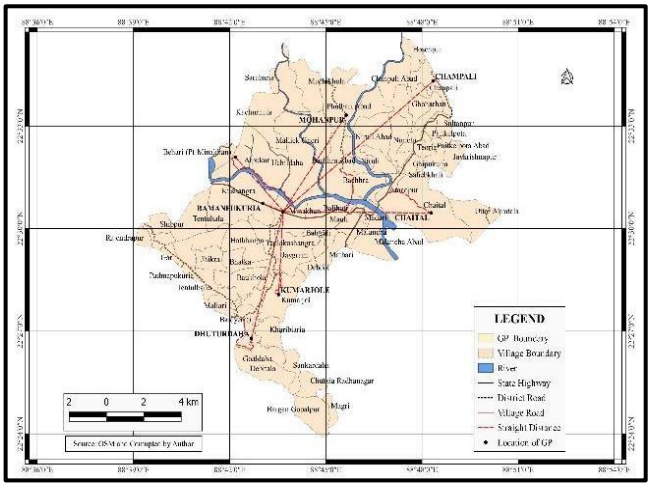

Fig.: 08. Straight line distance and actual distance.

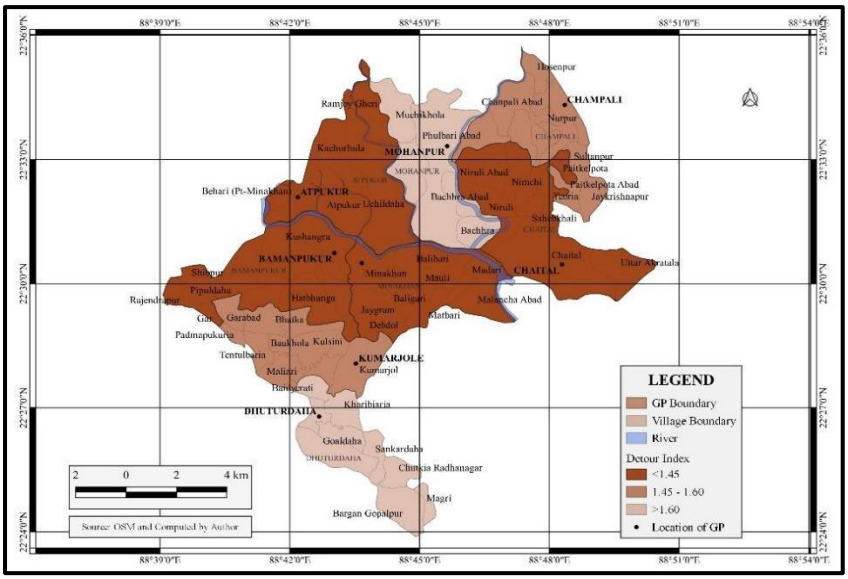

Fig.: 09. Spatial distribution of detour index.

Table No.: 05. Determination of (rank coefficient) composite score.

CD Block	Name of the GP(s)	S I	Rank	A N	Rank	R L	Rank	R D	Rank	D I	Rank	(Rank Coefficient) Composite Score
Minakhan	Atpukur	71	3	18	5	50.29	5	2.41	7	1.40	3	**23.00**
	Bamanpukur	59	2	14	2	58.28	2	2.69	4	1.25	1	**11.00**
	Chaital	80	5	17	3	57.14	7	2.31	8	1.32	2	**25.00**
	Champali	82	6	18	5	44.57	8	2.56	5	1.57	6	**29.00**
	Dhutrudaha	89	7	23	7.5	45.71	7	3.03	2	1.66	7	**30.50**
	Kumarjole	76	4	18	5	48.00	6	2.89	3	1.48	5	**23.00**
	Minakhan	51	1	12	1	62.86	1	4.95	1	1.42	4	**08.00**
	Mohanpur	94	8	23	7.5	54.86	4	2.44	6	1.89	8	**33.50**
*SI= Shimbel Index, AN= Associate Number, RL=Road Length, RD=Road Density, DI=Detour Index												
Source: Computed by Authors.												

3.5. Level of Transport Development: The level of transport development was carried out based on a composite score. The highest and lowest values of (Rank Coefficient) composite scores are found in Mohanpur GP (33.50) and Minakhan GP (8.00) respectively. So, the range of composite score is 25.50. Based on the composite score three categories of level of transport development have been computed. In the first category (<15.00), the Minakhan GP (8.00) and Bamanpukur GP (11.00) fall under this category which is high-level transport development zone. The second category (15.01 – 30.00) is found in Atpukur GP (23.00), Chaital GP (25.00), Champali GP (29.00) and Kumarjole (23.00) as a moderate level of transport development. Lastly, the third category (>30.00) is observed in Dhuturdaha GP (30.50) and Mohanpur GP (33.50) as a low level of transport development. The higher composite score indicates a lower level of transport development and vice versa.

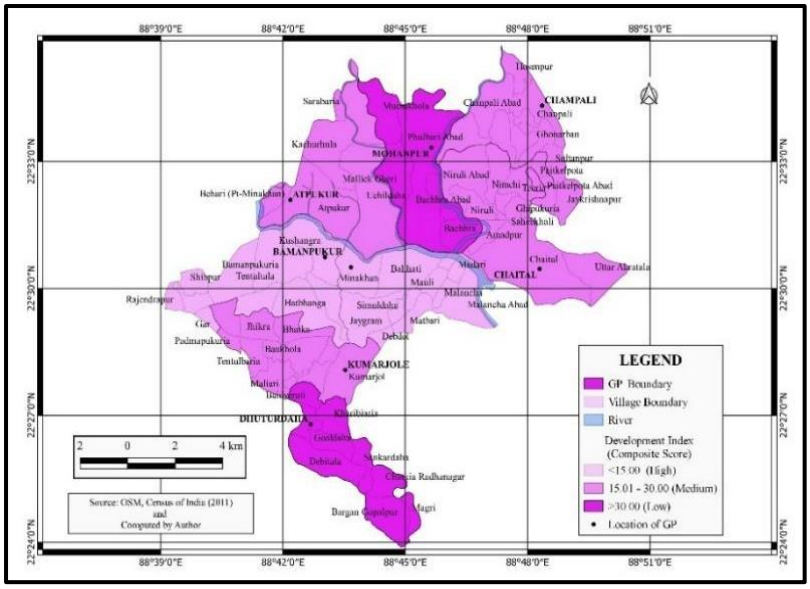

Fig.: 10. Different zones of level of transport development.

3.6. Geographic Accessibility: The geographic accessibility has been measured with road distance in kilometers between every node to every node (GP) and a value matrix has been prepared. The lower the value, the location is more accessible and vice versa. Based on the value matrix (Table No. 06), it has been found that the maximum value is 14.29 and the minimum value is 7.79 in Champali GP and Minakhan GP respectively. From the value matrix table, geographic accessibility has been classified into three categories e.g. High accessibility (<10.00), Moderate accessibility (10.01 - 12.00) and low accessibility (>12.00). The high accessibility is found in Minakhan GP (7.79) and Bamanpukur GP (8.66). Whereas, moderate geographic accessibility is observed in Atpukur (10.17), Chaital (11.98), Kumarjole (10.22) and Mohanpur (11.85). Low geographic accessibility is present in Champali GP (13.51) and Dhuturdaha GP (14.29).

Table No.: 06. Value matrix of shortest road distance.

CD Block	Name of the GP(s)	Atpukur	Bamanpukur	Chaital	Champali	Dhutrudaha	Kumarjole	Minakhan	Mohanpur	Σ/N
Minakhan	Atpukur	0	6.05	16.15	18.63	12.41	11.53	05.38	11.20	**10.17**
	Bamanpukur	6.05	0	12.02	17.71	12.48	7.40	01.25	12.33	**8.66**
	Chaital	16.15	12.02	0	11.53	18.13	13.05	10.77	14.15	**11.98**
	Champali	18.63	17.71	11.53	0	23.82	18.74	16.46	7.43	**14.29**
	Dhutrudaha	12.41	12.48	18.13	23.82	0	8.14	11.23	21.84	**13.51**
	Kumarjole	11.53	7.40	13.05	18.74	8.14	0	06.15	16.76	**10.22**
	Minakhan	05.38	01.25	10.77	16.46	11.23	06.15	0	11.08	**7.79**
	Mohanpur	11.20	12.33	14.15	7.43	21.84	16.76	11.08	0	**11.85**
	Σ/N	**10.17**	**8.66**	**11.98**	**14.29**	**13.51**	**10.22**	**7.79**	**11.85**	

Source: OSM and Computed by Authors.

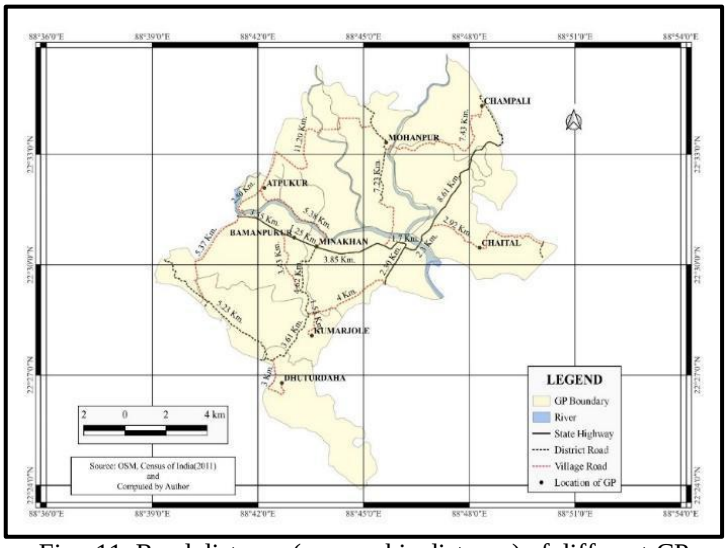

Fig.: 11. Road distance (geographic distance) of different GPs.

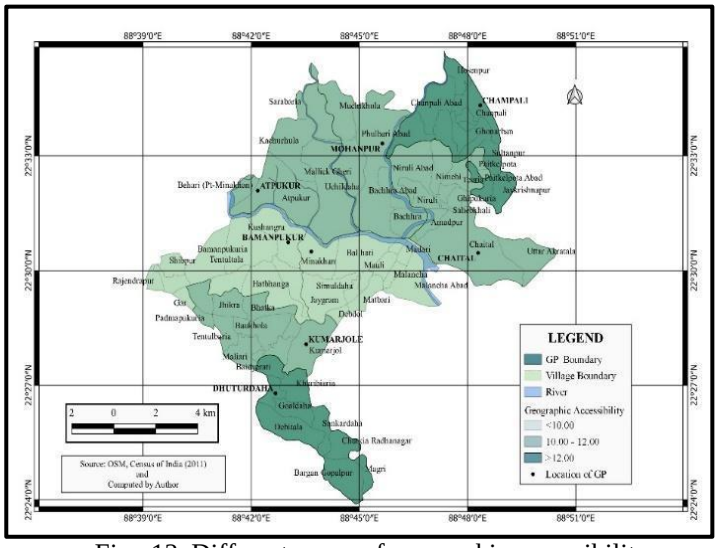

Fig.: 12. Different zones of geographic accessibility.

The higher geographic accessibility observed in Minakhan GP and Bamanpukur GP, due to its location in this CD block as well as the presence of SH-03, which passes through these GPs. In the moderate geographic accessibility, where the absence and distances of SH, district roads and large road distances among different GPs. The Low geographic accessibility observed in Champali GP and Dhuturdaha GP due to its location as far away from the headquarter of the block and lack of major roads.

3.7. Potential Accessibility: From the potential accessibility matrix (Table No.: 07), the highest value found in Minakhan for emissiveness (87456.21) and attractiveness (71044.45). The lowest value found in Champali for emissiveness (31799.54) and attractiveness (33788.05). So, Minkhan GP has more emissiveness than attractiveness and inverse in Champali GP. The emissiveness are higher in respect to attractiveness found in Chaital GP (40285.67 verses 39908.68), Kumarjole GP (51472.59 verses 48437.59) and Minakhan GP (87456.21 verses 71044.45). The attractiveness is higher in respect to emissiveness observed in Atpukur GP (40271.01 verses 35335.68), Bamanpukur GP (66762.31 verses 57710.82), Champali GP (33788.05 verses 31799.54), Dhturdaha GP (37358.64 verses 35725.64) and Mohanpur GP (36247.84 verses 34032.42).

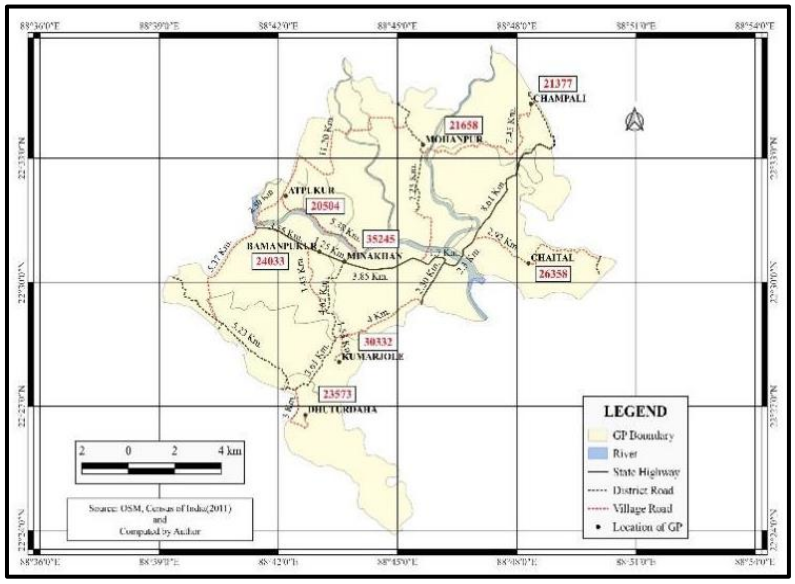

Fig.: 13. Road distance with population of GPs.

Table No.: 07. Potential accessibility matrix.

Name of the GP(s)	Atpukur	Bamanpukur	Chaital	Champali	Dhutrudaha	Kumarjole	Minakhan	Mohanpur	**Emissiveness**
Atpukur	**20504**	3389.09	1269.60	1100.59	1652.22	1778.32	3811.15	1830.71	**35335.68**
Bamanpukur	3972.40	**24033**	1999.42	1357.03	1925.72	3247.70	19226.4	1949.15	**57710.82**
Chaital	1632.07	2192.85	**26358**	2289.04	1453.83	2019.77	2477.35	1862.76	**40285.67**
Champali	1147.45	1207.06	1854.03	**21377**	897.44	1140.72	1298.72	2877.12	**31799.54**
Dhutrudaha	1899.52	1888.86	1300.22	989.63	**23573**	2895.95	2099.11	1079.35	**35725.64**
Kumarjole	2630.70	4098.92	2324.29	1618.57	3726.29	**30332**	4932.03	1809.79	**51472.59**
Minakhan	6551.12	28196	3272.52	2141.25	3138.47	5730.89	**35245**	3180.96	**87456.21**
Mohanpur	1933.75	1756.53	1530.60	2914.94	991.67	1292.24	1954.69	**21658**	**34032.42**
Attractiveness	**40271.01**	**66762.31**	**39908.68**	**33788.05**	**37358.64**	**48437.59**	**71044.45**	**36247.84**	

Source: Census of India (2011) and Computed by Authors.

Attractiveness is the ability to reach a particular location where the value is higher and emissiveness is the capacity to leave a particular location. In this study area, due to the presence of different roads (SH-03, District Road, Village Road) and the location of Atpukur GP, Bamanpur GP, Champali GP, Dhuturdaha GP and Mohanpur GP have more attractiveness but emissiveness are also higher in Chaital GP, Kumarjole GP and Minakhan GP. So, the potential accessibility is higher in Bamanpukur GP, Minakhan GP and Kumarjole GP.

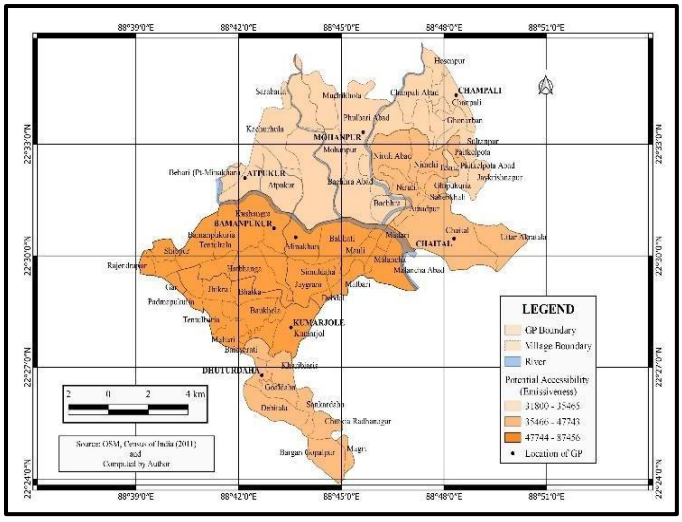

Fig.: 14. Different zones of potential accessibility (emissiveness).

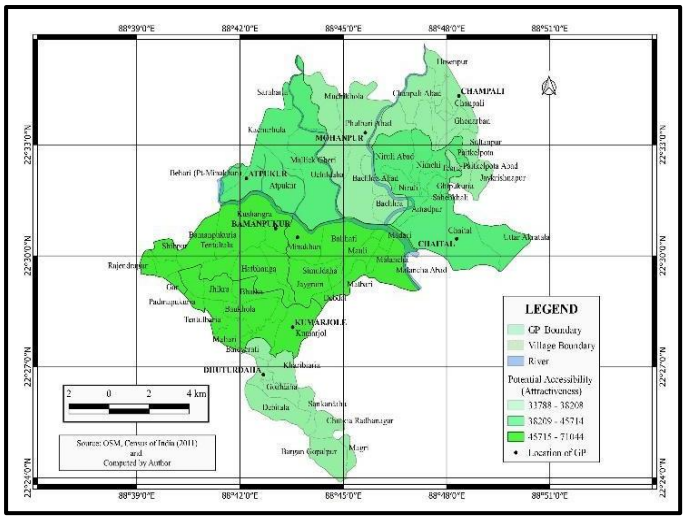

Fig.: 15. Different zones of potential accessibility (attractiveness).

4. CONCLUSION

The study found that the accessibility indices values vary across different GPs due to several factors, including the length and quality of road infrastructure, population distribution, area coverage, communication facilities, and geographical location. These variations influence the ease with which residents can travel to and from their villages.

For instance, GPs such as Minakhan and Bamanpukur have benefited from better road networks, including the SH-03 and district roads, providing higher accessibility. In contrast, areas like Mohanpur GP and Dhuturdaha GP face challenges due to limited road infrastructure and longer travel times to reach other locations. These GPs also lack sufficient road density, which further hampers connectivity and increases the difficulty of accessing essential services.

To improve transport and accessibility in this deltaic region of Indian Sundarbans, priority should be given to developing the road networks in Mohanpur GP and Dhuturdaha GP. Expanding road lengths and upgrading infrastructure in these areas would significantly reduce travel times and enhance connectivity for the local population. This would not only address existing disparities in accessibility but also promote overall socio-economic development by enabling easier movement of people and goods, improving access to education and healthcare, and fostering economic opportunities.

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