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Significance of Road Transport Facilitating Regional Development: A Case Study in North Twenty Four Parganas District, West Bengal

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Abstract:
Background: Improvement in transport facilities along with road infrastructure boosts up socio-economic conditions of the inhabitants in the area under investigation by means of increased demand for transit of goods and people. Investment in transport infrastructure projects involves a wide range of direct and indirect effects, out of which the present research work aims to highlight spatial network analysis and influence of road network in urban development.
Materials and Methods: Spread and diameter of road network have been evaluated for five community development (C.D.) blocks representative from North, South, East, West and central part of North Twenty Four Parganas district respectively considered as study area on the basis of major roads. Space-potential map has been constructed on the basis of space-potential values derived at 12 urban centres throughout the district to assess the extent of regional accessibility. Again, it is of prime concern that the benefits of socio-economic facilities are not uniformly distributed over the study area and therefore categorical classification of two samples villages from each of the five C.D. blocks namely Bongaon, Barrackpore-I, Deganga, Basirhat-I and Minakhan has been determined.
Results: The study examines efficiency of connectedness between given nodes in each block. It also emphasizes on evaluation of accessibility of community services in rural areas. Importance of roads serving as a link between trans-metro city system and major urban centres has been highlighted with respect to employment opportunities and traffic of goods and vehicles.
Conclusion: The study concludes that regional planners should foresee strategies to ensure balanced development because development of road transport system embodies prosperity of national economy and social ethics at large.
Key Words: Transport, Road Network Diameter, Accessibility, Regional Development

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I. INTRODUCTION

Improvement in road infrastructure is regarded as one of the prime requisite for social and economic development of any region. It determines the capacity to achieve economic growth by decentralizing over accumulation of social and economic activities in large metropolitan centres and harnessing development potentials of secondary cities and their associated hinterland economies (European Commission, 2011). Dimension of available transport facilities exerts significant control on determining standard of living and landuse pattern.

Triaxial development of road network across North Twenty Four Parganas district, second urbanized district of West Bengal after Kolkata and endowed by existence of both rural and urban sector has encouraged to highlight the strategic role of road transport system in regional development (Kundu and Basu, 2015). Rapidly urbanizing countries often face scarcity of sufficient civic amenities to cope up tremendous pressure of population and hence arises the importance of decentralization of cityspace (Roberts, 2019). Dey (2013) proposes a perfect balance between spatial variation of public transport services and its regional demand pattern in the context of Howrah district to materialize the benefit of road transport in regional development. Kumar et.al. (2017) have emphasized that service of road network is influenced by factors such as frequency of nodes and interconnections, infrastructural condition like status of vehicular fleet, provisions of public and private transportation and elseother. The study of significance of road transport in regional development has become

crucial from the scientific point of view that rapid changes in landuse pattern in urban and semi-urban regions of India along with rest of the world intensify environmental complexes, such as constructing flyovers for easing movement of traffic shifts congestion from one part of the network to the other and regional connectivity can compensate this deficit as an objective of providing socially sustainable transport system. Socially sustainable transport (Boschmann and Kwan, 2008) advocates for transport-oriented environmental injustice and public health crises impacting different sections of citizens and suggests feasible solutions to relieve this problem. Again, interruption to pedestrian movement by motorized traffic flow constitutes another aspect to the present study and its effective management is of utmost importance. Transport has been identified to govern tourist flow in a variety of destinations (Peng et.al., 2015).

This paper aims to identify efficiency of linkages between places in different blocks of the study area, to visualize gravity measure of accessibility (attraction between two places accentuated by distance-decay function) by analyzing space-potential model (Kwan, 1998), to determine accessibility of community facilities in sample villages and to characterize growth of future townships, generation of employment opportunities and flow of goods and vehicles between trans-metro cities and major urban centres across the study area.

II. MATERIALS AND METHODS

Analytical part of the study has been organized with the help of primary survey results conducted in sample locations and villages of selected blocks of rural and urban areas of North Twenty Four Parganas district, and data collected from Census of India (2011), different reports and published research papers. Data collected about road network available in the district and daily average vehicular flow with special emphasis on commercial vehicles from Department of Road Traffic, Government of West Bengal and elseother. Maps have been constructed to illustrate spatial variation in the level of connectivity, to examine spatial differences in relative accessibility between different urban centres, to identify location of sample villages which are studied to examine accessibility of community facilities within villages and to represent distribution of trans-metro cities and major urban centres which anticipate progress as a consequence of regional transport development.

Study Design: Systematic and purposive sampling techniques have been employed for explaining different aspects of regional development served by road transport.

Study Location: Different localities belonging to urban and rural sector of the North Twenty Four Parganas district, and selected bus depots of the district have been surveyed.

Study Duration: July 2019 to February 2020

Sample size: Different sample sizes have been considered for different types of analysis. For calculation of Pi index and Eta index total length of road network, diameter (maximum distance between two arcs) and number of arcs consisting road network in each of the 22 community development (C.D.) blocks of the district have been considered. Again, for representation of space-potential model, 12 urban centres namely Bongaon, Sonatikiri, Nokpul, Guma, Halisahar, Panihati, Rekjuani, Deulia, Itinda, Mathurapur, Minakhan and Bankra, covering all of the North, South, East, West and Central part of the district have been studied. For analysis of accessibility of socio-economic services, Chanda and Adityapur village of Bongaon block, Mamudpur and Baliaghata village of Barrackpore-I block, Biswanathpur and Deganga village of Deganga block, Hariharpur and Nimdari village of Basirhat-I block, and Chaital and Malancha village of Minakhan block have been selected as sample because considerable variation is noticed in the existence of the facilities in sample villages. Frequency and convenience of bus services in intra and inter-district linkages have been assessed on the basis of average frequency of buses on-road, route length coverage and passenger compliance observed in ten bus depots across the district.

Sample Size Calculation: The sample size is determined on the basis of single proportion design. It is assumed that confidence interval denotes 10% and confidence level rests at 95%.

Statistical Analysis

The following quantitative techniques have been employed for analysis of the available data:

- Pi index and Eta index (Bamford and Robinson, 1978) are evaluated to execute efficiency of linkages between different locations of the study area. The indices have been formulated as follows:

Pi index= Total Distance of Network ÷ Distance of Diameter (1)

Eta index= Total Network Distance ÷ Number of Arcs (2)

- Space-potential model (Tata, 1968) has been adopted to explain transport efficiency within the district. For this, 12 sample urban centres throughout the district have been selected to determine their population weightage and intervening distance acting as barrier in their interaction. Space-potential values have been calculated as per the formula:

$$\textbf{Space-potential } (V_i) = P_i + \sum P_j / D_{ij} \quad (3)$$

where, V_i= total population space-potential at urban centre i, P_i= population at urban centre i, P_j= population at urban centre j, D_{ij}= route distance between urban centre i and j, j is from 1^{st} term upto n^{th} term

- Accessibility of eighteen selected socio-economic services namely education centres (including schools and colleges), medical facilities, drinking water, post office, telephone, banks, agricultural credit societies, provisions for power supply, internet café, ATM, ration shop, market, Integrated Child Development Scheme (ICDS) centre, Accredited Social Health Activist (ASHA) centre, sports, recreation, newspaper and library within village located in two sample villages of each of the five C.D. blocks have been examined (Robinson, 1998) and on the basis of assignment of rank score categorical classification of each village has been determined.
- Co-efficient of Variations (C.V.) (Sarkar, 2008) for population size of different major urban centres and trans-metro city systems have been evaluated as per formula:

C.V.= (Standard Deviation ÷ Mean)*100% (4)

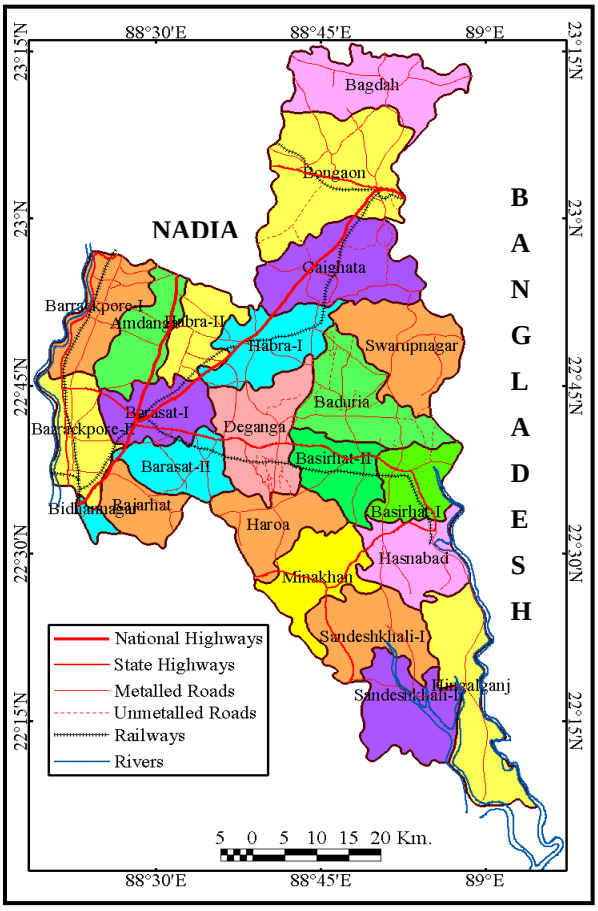
- Multiple regression analysis (Gaur and Gaur, 2009) has been executed on the basis of data collected from ten different bus depots to identify relationships between different aspects of bus service performance.

Requisite charts and graphs have been prepared to determine present scenario and future potential of employment, and condition of movement of goods and vehicles in the study area.

III. STUDY AREA

North Twenty Four Parganas district, second urbanized district of West Bengal with an urban population density of 9160 persons/sq Km (Census of India, 2011) lies between 22°11´6´´N. and 23°15´2´´N., and 88°20´E. and 89°05´E.. The district consists of five sub- divisions namely Bongaon, Basirhat, Barasat, Barrackpore and Bidhannagar, 22 C.D. blocks, 107 urban centres and 1527 villages (Micro, Small and Medium Enterprises [MSME], 2015).

Physiographically the region belongs to lower Gangetic deltaic plain drained principally by river Icchamati, Bidyadhari and their numerous tributaries and sub-tributaries. Soil composition is dominated by sandy to clay-loamy texture with some areas suffering from moderate to severe problems of waterlogging due to insufficient drainage condition. Suitable terrain condition has favoured development of extensive road network facilitated by intra and inter-district traffic movement.



Based on: Ghosh (2013)

Figure 1: Location map of North Twenty Four Parganas district

IV. RESULT

Efficiency of Road Connectivity in Different Blocks of North Twenty Four Parganas District

Connectivity measures evaluate the possibility of maintaining linkages between road segments (Qian et.al., 2012). A well-developed transport network is characterized by many short links, numerous intersections and minimal dead ends providing continuous, direct routes to destinations. Pi index describes average mileage of any transport network per diametric arc, and diameter considers number of arcs connecting shortest possible path between two nodes located farthest apart. Pi (π) index and Eta (η) index evaluating level of connectivity for all blocks (except Bidhannagar sub-division because of unavailability of data) have been tabulated in table 1.

Table No 1: Pi Index and Eta Index in Different Blocks of North Twenty Four Parganas District

Blocks	Total Network Distance (Km.)	Diameter of Network	Number of Arcs (e)	π index	η index
Bagdah	619.1	5	10	123.82	61.91
Bongaon	1023.91	5	24	204.78	42.66
Gaighata	881.69	4	13	220.42	67.82
Barrackpore-I	496.25	6	21	82.71	23.63
Amdanga	311.5	6	12	51.92	25.96
Habra-I	249.2	7	21	35.6	11.87
Habra-II	191	5	9	38.2	21.22
Baduria	390	6	16	65	24.38
Swarupnagar	458.02	3	5	152.67	91.6
Barrackpore-II	168.7	4	13	42.18	12.98
Barasat-I	401.77	3	12	133.92	33.48
Barasat-II	288.75	14	6	20.63	48.13
Rajarhat	321.9	5	8	64.38	40.24
Deganga	378.33	5	12	75.67	31.53
Basirhat-I	122.6	3	11	40.87	11.15
Basirhat-II	201.2	3	6	67.07	33.53
Haroa	160.41	3	6	53.47	26.74
Hasnabad	128	3	10	42.67	12.8
Minakhan	180.5	3	5	60.17	36.1
Sandeshkhali-I	579.8	5	7	115.96	82.83
Sandeshkhali-II	203	2	3	101.5	67.67
Hingalganj	991.22	2	3	495.61	330.41

Source: www.north24parganas.gov.in (accessed on 17.11.2019) and Google Earth (accessed on 17.04.2020)

Table 1 shows that blocks of Habra-I, Habra-II, Basirhat-I, Barasat-II, Barrackpore-II and Hasnabad have a Pi index score less than 50, signifying less road length in addition to less diametric length. Many areas are left unconnected by any type of roads and road construction process is still in progress because of emerging economic importance. Blocks of Gaighata, Bongaon and Hingalganj have a Pi index score above 200 which may be attributed to achievement of stability in road development process. Hingalganj exceptionally shows a higher Pi value because traffic intersection is very much less compared to other areas.

Eta index implies the spread or extent of road network by the ratio of total mileage of network to total number of arcs contained in the network. Table 1 explains that except Hingalganj, all other blocks are identified with a very low (less than 25) to moderately high score (75-100) of index value which are less spread and more intensive and subject to more traffic congestion and associated externalities.

Network efficiency is defined by reciprocal of the distance between two places or nodes, so if the network length becomes higher with respect to diameter or frequency of connecting arcs, possibility of traffic movement tends to be optimum and where this is reversed, chances of traffic accidents and traffic congestion are higher.

Road Transport Efficiency through Space-Potential Model

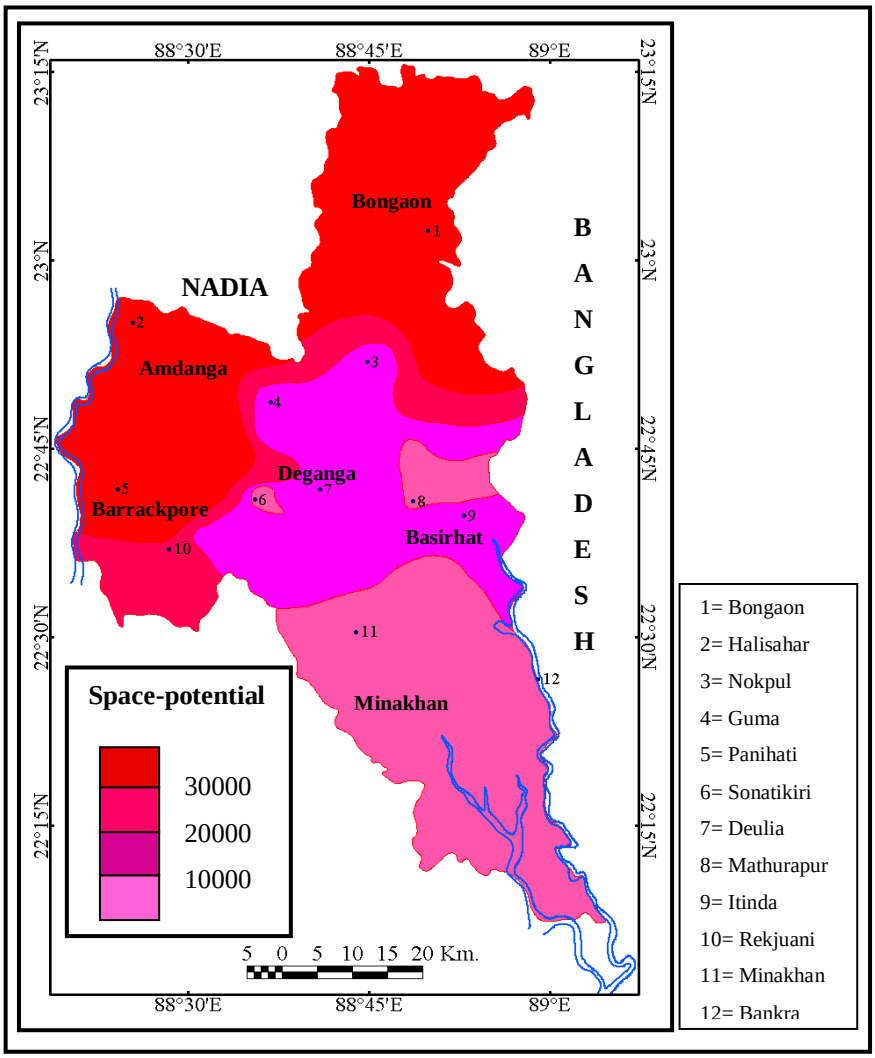
Space-potential, incorporating mutual influence of the factors of population of growth centres and intervening distance between these centres, measures relative strength of various nodal points in a transport network for assembling all masses of population in a region. Friction of distance serves as a barrier in the

promotion of interaction, whereas weightage of population encourages communication being directly correlated. For analysis of transport efficiency of North Twenty Four Parganas district, 12 census towns and municipalities have been studied as shown in table 2.

Table No 2: Evaluation of Space-potential For Selected Urban Centres in North Twenty Four Parganas District

Town (i)	Population (P_i)	$\sum P_i/d$	Space-potential= $P_i+\sum P_i/d$
Bongaon	108864	23160.8	132024.8
Sonatikiri	6919	2813.78	9732.78
Nokpul	7737	2595.48	10332.48
Guma	12025	4382.49	16407.49
Halisahar	124939	28472.07	153411.07
Panihati	377347	117383.02	494730.02
Rekjuani	16553	5206.53	21759.53
Deulia	9663	4408.7	14071.7
Itinda	8679	3361.21	12040.21
Mathurapur	6803	2980.82	9783.82
Minakhan	3474	898.91	4372.91
Bankra	6897	1345.75	8242.75

Source: Primary survey (2019)



Based on: Table 2

Figure 2: Distribution of space-potentiality between selected urban centres of North Twenty Four Parganas district

Table 2 and figure 2 illustrate that out of 12 sample urban centres selected for the model, about 40% of the area located in the rural sector of the district and is characterized by a space-potential value less than 10000. This implies that the region experiences much less intra and inter-district movement of people and traffic. Regional inertia such as agriculture based activities, small businesses or school teachers in local academic centres restrict frequent transit. Space-potentiality is quite improved at Itinda, Deulia, Nokpul and Guma which are served by local markets and multifarious business transactions.

Maximum space-potentiality is identified in the western and northern parts of the district because these are highly connected by frequent freight and passenger transit and being located in the vicinity of state highways and national highways. These areas are also recognized as hinterland of Rajarhat satellite township and Barasat-Barrackpore sub-region.

Categorical Classification of Selected Villages on the Basis of Accessibility of Community Facilities within Villages in Different Blocks of North Twenty Four Parganas District

Accessibility of road transport, when it is applied to examine availability of civic and socio-economic facilities, determines the opportunity for individuals to marginalize the costs involved (travel time, travel cost and physical constraints), in order to enjoy services rendered in an area (Miller, 2018). North Twenty Four Parganas district, by its physical existence, holds a considerable area under rural sector and therefore analysis of community facilities connected by road infrastructure is quite contextual.

Table 3 records gross rank value for two villages in each of the five C.D. blocks of Bongaon, Barrackpore-I, Deganga, Basirhat-I and Minakhan having specific amenities mentioned in the methodology and on the basis of gross rank value category of each village is identified.

Table No 3: Hierarchy of Sample Villages in Selected Blocks of North Twenty Four Parganas District

Block	Villages	Gross Score on the Basis of Availability of Community Facilities	Class/Category
Bongaon	Chanda	8	III
	Adityapur	8	III
Barrackpore-I	Mamudpur	13	II
	Baliaghata	12	II
Deganga	Bishwanathpur	12	II
	Deganga	17	I
Basirhat-I	Hariharpur	12	II
	Nimdari	10	III
Minakhan	Chaital	6	III
	Malancha	12	II

Source: Primary survey (2019-2020)

Among different facilities mentioned, provisions for academic achievement and hygienic lifestyle constitute backbone of progress of an area, based on which development of other facilities depends. Therefore, development of schools, colleges and universities, provisions for clinical help and safe drinking water rest in priority list followed by development of communication medium, customer service centres and financial institutions. Villages are classified into three categories with gross score above 15 belonging to class I, gross score between 10 and 15 belonging to class II and gross score less than 10 belonging to class III.

Table 3 interprets that out of ten sample villages, only Deganga village belongs to category I where all facilities are available within the village except Post office. Improvised road transport system in addition to local demand of inhabitants has recognized the village almost a self-sufficient one. Rest of the villages which belong to either category II or category III are characterized by limited extent of schools, colleges, dispensaries, hospitals, markets or elseother due to locational constraints. The condition of Chaital village under present study units is most critical because inhabitants travel 5-10 Km. apart from villages for most of the amenities.

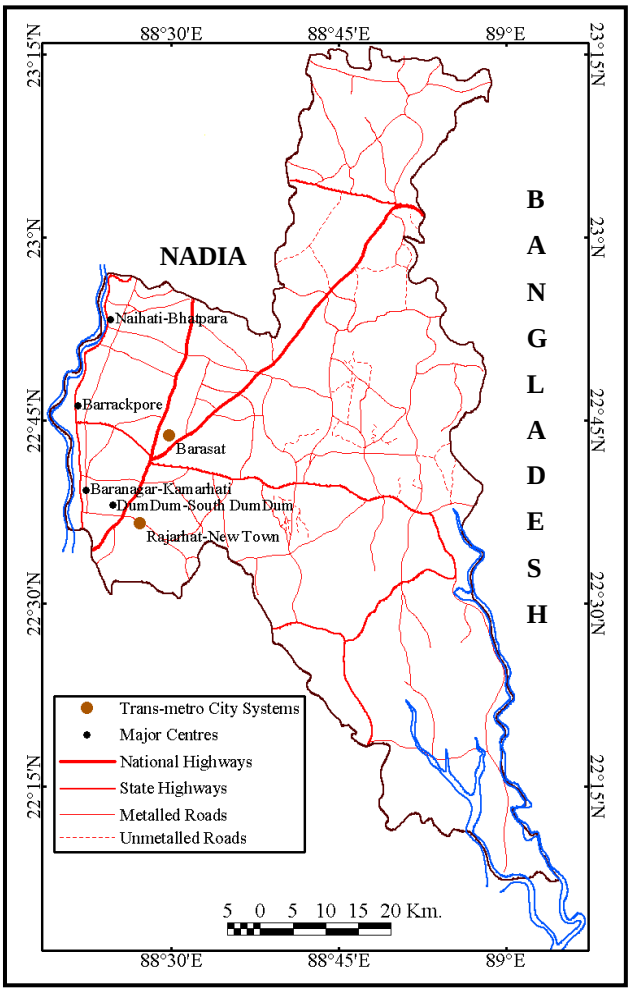
Development of Townships

North Twenty Four Parganas district as a constituent part of Kolkata Metropolitan Area (KMA) exerts considerable influence in determining growth of townships, expansion of industrial potential and promotion of traffic movement. High density of population in Kolkata, Haora and Chandannagar Municipal Corporations, availability of land in reasonable prices, facilities for suburban rail network and convenient bus transport system through the newly developed corridors have necessitated dispersal of settlement away from metropolitan core area for the last two or three decades. Table 4 demonstrates population size of trans-metro cities and major centres of North Twenty Four Parganas district.

Table No 4: Population Size of Trans-metro City Systems and Major Urban Centres in North Twenty Four Parganas District

City Systems	Name	Population	Statistical Analysis For City Systems		
			Mean	Standard Deviation	Coefficient of Variation (C.V.)
Major Centres	Naihati-Bhatpara	603919	463682	179580	38.73
	Barrackpore	157283			
	Baranagar-Kamarhati	575424			
	Dum Dum-South Dum Dum	518102			
Trans-metro Cities	Rajarhat-New Town	402844	407043	4198.5	1.03
	Barasat-Barrackpore Sub Region	411241			

Source: www.westbengalstat.com (accessed on 22.07.2020)



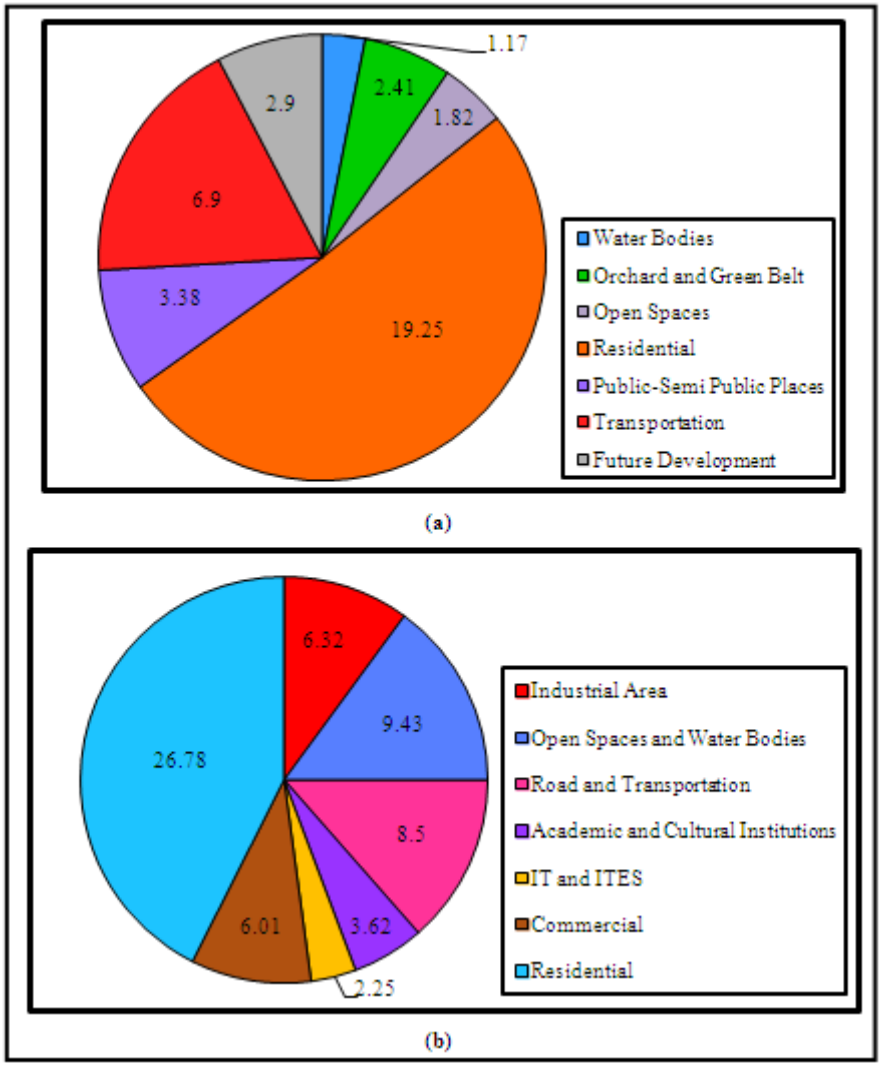
Source: KMDA (2011)

Figure 3: Spatial distribution of future township growth in North Twenty Four Parganas district

In North Twenty Four Parganas district, there are four major urban centres and two trans-metro city systems which are expected to accommodate 0.5-0.75 million population by 2025 (Kolkata Metropolitan Development Authority [KMDA], 2000). These intermediary cities usually develop clustered secondary city structure system, wherein trans-metro cities behave as metropolitan urban centres and major centres and new settlement areas develop on the periphery of trans-metro-cities and serve as crucial linkage and transformative role between metropolitan regions and smaller regional towns and cities.

Very good linkages through National Highway (NH)-34 and NH-35, Barrackpore Trunk Road, VIP Road, Rajarhat road, Biswa Bangla *Sarani* and Kalyani Expressway in addition to regular railway services within the district, with districts of Kolkata, Haora, Hugli, Nadia and South Twenty Four Parganas and beyond

the domain of KMA, centralization of information technology (IT) industry across Saltlake Sector V, availability of cheap land in addition to future development proposal for metro corridor and other favourable factors have surfaced development of trans-metro city systems in Barasat-Barrackpore sub region (BBSR) and Rajarhat-New Town area. Table 4 shows that population size of trans-metro cities in Rajarhat-New Town and BBSR is more consistent (C.V.=1.03) compared to population size of four major centres mentioned (C.V.=38.73).



Note: IT and ITES= Information Technology and Information Technology Enabled Services

Source: Development and Planning Department (2005) and WBHIDCO (2012)

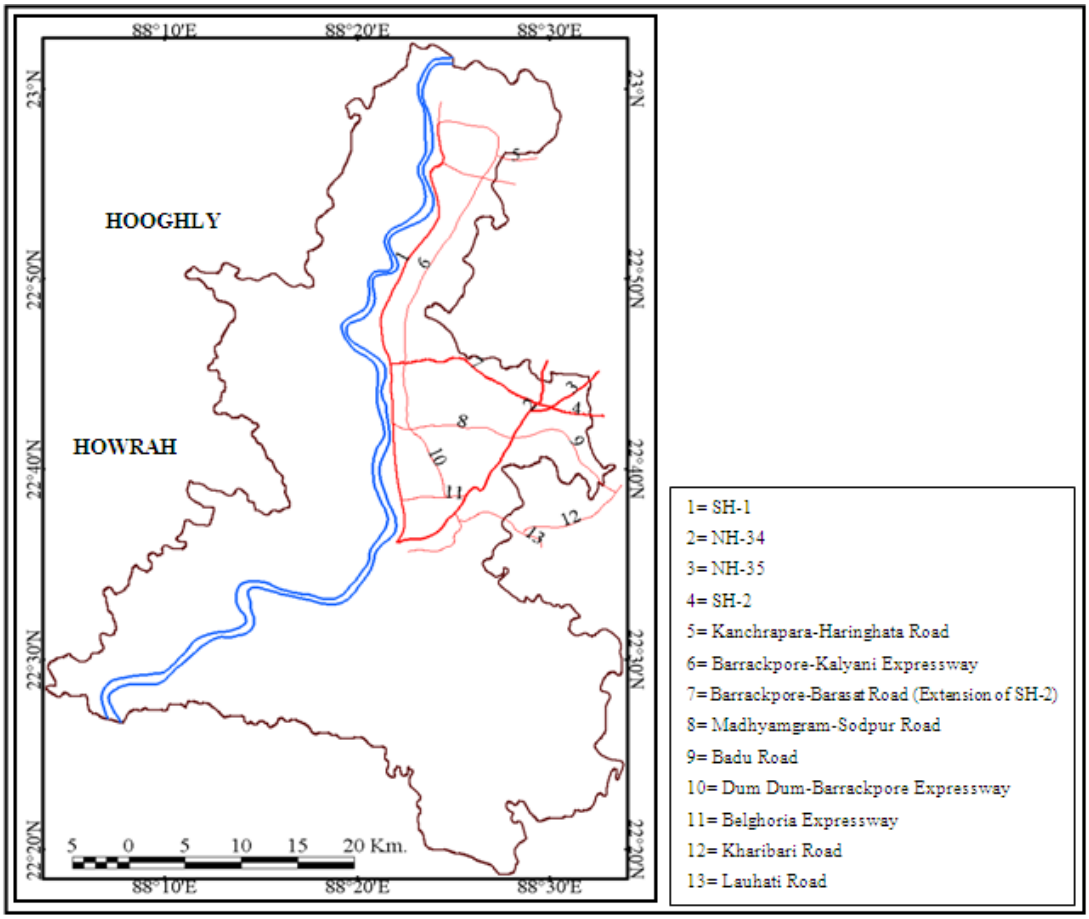
Figure 4: Percentage share of different types of landuse in trans-metro city systems; (a) BBSR (b) Rajarhat-New Town area

Improvement of Road Traffic

Improvement in road traffic system incorporates development of different types of roads and associated infrastructures, and increase in the frequency of public and private vehicular movement.

Expansion of Highways, Arterial Roads and Secondary Roads

There are three national highways (NH) NH-2, NH-34 and NH-35, three state highways (SH) of SH-1, SH-2 and SH-3 along with other surfaced and unsurfaced roads with a total length of 100.94 Km, 178 Km, 5281.26 Km and 3465.59 Km respectively (Government of India[GoI], 2016). These play significant role in maintaining intra-district and inter-district, even inter-state mobility, and many of these roads have been undertaken by government for widening and strengthening to accommodate increasing volume of traffic with years passing.



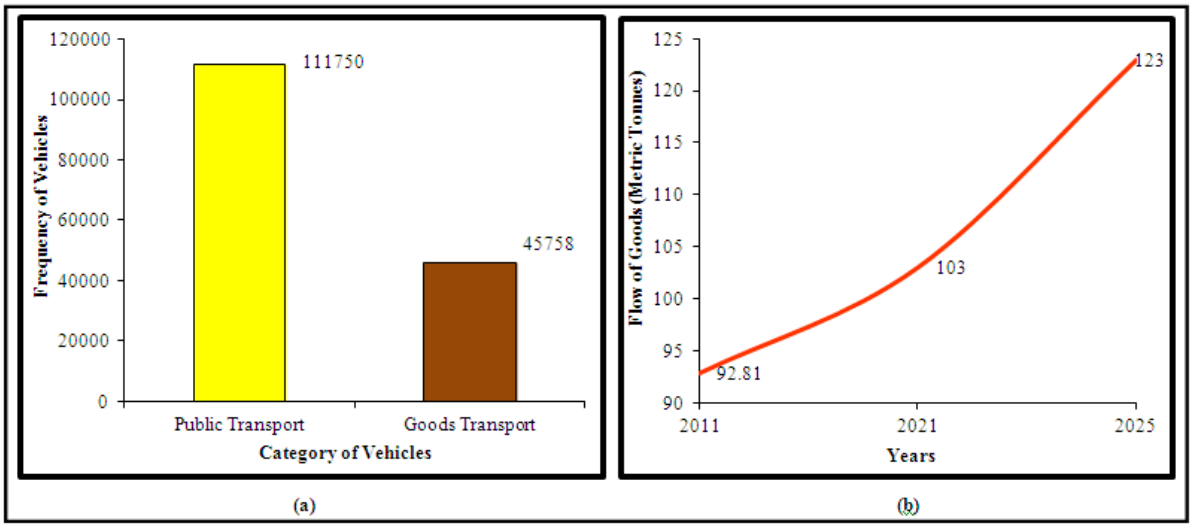
Note: NH= National Highway, SH= State Highway

Source: Primary survey (2019)

Figure 5: Selected highways and arterial roads connecting KMA in North Twenty Four Parganas district

Movement of Commodities and Vehicles

Flow of goods and vehicular transit determines the dimension of commercial activities and economy to a large extent. North Twenty Four Parganas district as part of KMA has experienced considerable flow of goods and vehicular movement represented in figure 6.



Source: NABARD (2018)

Figure 6: Selected aspects of traffic and transportation in North Twenty Four Parganas district; (a) vehicular movement in 2016-17 (b) temporal growth of flow of goods

Figure 6(a) presents that volume of goods transport vehicles comprises 40.95% of the public transport vehicles which is characterized by buses, autos and contract carriages. On the other hand, existence of truck terminals in different parts of the district serve as origin and destination points of commercial products. Fig. 6(b) demonstrates that during the period of 15 years starting from 2011 and ending in 2025 flow of goods in the roads of KMA increased 32.52% which is an indicator to economic progress.

Performance of Bus Services

Bus transport service provided by government undertakings like West Bengal Surface Transport Corporation (WBSTC), Calcutta State Transport Corporation (CSTC) etc. and private sectors like Bengal Bus Syndicate Association, Chartered Bus services etc. play most important role in intra and inter-district linkages. A multiple regression analysis has been dealt with on the basis of data collected from ten bus depots across the district (table 5) to understand the relationship between average number of buses put on road per day, considered as dependent variable and total route length (Km) run daily and passengers served per day regarded as independent variable. The results of multiple regression analysis are provided in table 5(a) and table 5(b).

Table No 5: Performance Parameters of Selected Bus Depots in North Twenty Four Parganas District

Bus Depot	Average Number of Buses Put on Road Per Day	Total Route Length (Km) Run Daily	Passengers Served Per Day
Bongaon Motiganj market	23	306	2747
Barrackpore Nilgunge	40	183	7442
Barasat Titumir Bus Stand	283	2114	22586
Deganga Berachampa crossing	17	167.2	4668
Basirhat Itinda *Ghat*	12	148	2334
Airport Gate No. One	103	840	25556
Rajarhat Four-lane crossing	21	168	6386
Bidhannagar Karunamoyee crossing	238	1782	27259
Minakhan Malancha market	7	156	1786
Sandeshkhali Nyazat	14	216	6774

Source: Primary survey (2020)

Table No 5(a): Model Summary

Model	r	r Square	Adjusted r Square	Standard Error of the Estimate
1	0.996[a]	0.992	0.989	10.616

a. Predictors: (Constant), Passengers served per day, Total route length (Km) run daily

Based on: Table 5

Table 5(a) describes that adjusted r square value here 0.989 comprises two independent variables in the present study account for 98.9% variance in dependent variable, i.e., average number of buses put on road per day. Parameters selected here almost perfectly match.

Table No 5(b): Coefficients[a]

Parameters	Unstandardized Coefficients		Standard Coefficients Beta	t	Significance	Collinearity Statistics	
	B	Standard Error				Tolerance	Variance Inflation Factor
(Constant)	-8.276	5.072		-1.632	0.147		
Total Route Length (Km.) Run Daily	0.134	0.01	0.975	14.069	0	0.252	3.965
Passengers Served Per Day	0	0.001	0.024	0.353	0.735	0.252	3.965

a. Dependent variable: Average number of buses put on road per day

Based on: Table 5

The ordinary least square equation for predicting daily bus services is:

Average number of buses put on road per day= -8.276 + 0.134 (Total route length run daily) + 0 (5)

Table 5(b) points out p-value for beta coefficient of total route length run daily is 0, and the same for passengers served per day is 0.735 which signifies there is no relation between the chosen dependent variable

and total route length, whereas dependent variable is positively related with passengers availing bus service daily.

Acceleration of Employment Opportunities

Availability of cheaper land, provisions for regular power supply and communication channels in addition to development of social infrastructures like entrepreneurship, financial institutions etc. has expanded demand horizon of local and inter-regional population which encouraged supply chains and retaining of labour forces. Different types of large and medium scale, and micro and small scale industries have been cropped up in North Twenty Four Parganas district the study of comparative prospects of those industries is quite contextual.

Table 6 explains that although number of micro and small scale industries of diversified items is nearly double to that of transport related industries dominated by motor vehicle and equipment manufacturing; capital investment is only 2% in small industries with respect to the road transport industries, and registered employees is only half in small industries with respect to the transport industry. North Twenty Four Parganas district endows vast resources of agricultural products, handlooms, handicrafts and many other things which need to be promoted for balanced regional development.

Table No 6: Different Prospects of Transport Related Large and Medium Scale Industry and Other Micro and Small Scale Industries

Industrial Sector	Prospects		
	Frequency of Factory	Frequency of Registered Employees	Capital Invested (Lakh)
Transport	55	2378	64445
Micro and Small	101	1147	1398.13

Based on: District Industrial Corporation (2016)

The industrial estates for chemical and engineering industries, jewellery items, agro based products, information technology services, garment manufacturing and elseother are concentrated in different parts of the district such as Bongaon, Basirhat, Barasat, Barrackpore etc. and their command zones are extended in the districts of Nadia, Hugli, Haora, Kolkata, South Twenty Four Parganas inside KMA and beyond its boundary. The command zones of each identified industrial estates coalesce near Barasat area which characterizes concentration of all administrative and economic activities.

V. DISCUSSION

Road transport serves multidimensional role in augmenting regional connectivity and consequent regional development. Results of the present study summarize that blocks of Swarupnagar, Bongaon, Gaighata and Hingalganj which observe π index above 150 interpret high road network length compared to diametric length. On the other hand, blocks of Barasat, Habra, Deganga, Barrackpore and Rajarhat area which are characterized by less spread of road network, existence of frequent traffic intersections impedes network efficiency.

Blocks of northern and western part of the district are identified with a space-potentiality above 30000 which implies very intensive mass movement and commercial transactions. Southern blocks of Sunderbans area having space-potentiality less than 10000 are much dependent on local economy. Regional disparity is also implicit in terms of ease of access to community facilities enjoyed by rural people and penetration of roads by linking disconnected areas can alleviate this problem.

Population size of trans-metro cities is much consistent compared to population size of major centres as C.V. of both studied in table 4. These trans-metro cities will exert pull effect on their hinterlands and will augment new employment avenues.

VI. CONCLUSION

Transport improvement energizes performance of economic sectors and therefore it is imperative of maintaining balanced mobility of concerned road transport system. Analysis of Pi index and Eta index shows that a considerable part of road network in Bongaon, Sandeshkhali, Swarupnagar and Hingalganj areas are still left unutilized which requires better connection with urban areas. Capacity of road network in the blocks of Barasat, Barrackpore, Habra and Deganga has almost been optimally utilized where volume of traffic has to be relaxed through alternate communication channels.

Multimodal services with greater emphasis on intra- and inter-district bus movement through highways, arterial roads and ring roads play significant role in having linkages with surrounding districts of Nadia, Hugli, Kolkata etc. and with other districts of West Bengal and other states of India. Adjusted r square value of 0.989 in table 5(a) admits that performance of bus service is greatly dependent on fleet strength,

mileage and coverage of beneficial passengers. The district of North Twenty Four Parganas as part of KMA will experience 32.52% increase in flow of goods which indicates progressive mercantile economy.

North Twenty Four Parganas district endows a vast reserve of agro-based resources and diversified items, and the benefits micro and small industries based on these resources will be rationally distributed followed by proportional development of road infrastructure. Growth of townships will then facilitate as trickle-down effect of economic prosperity.

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