ISSN: 2249-4316

eTraverse
GEOGRAPHICAL INSTITUTE

The Indian Journal of Spatial Science

Vol. III No. 1 — 2012

Article 3

Suburban Railway Network of Kolkata: A Geographical Appraisal

Teesta Dey

GEOGRAPHICAL INSTITUTE
1949–50

eTraverse
GEOGRAPHICAL INSTITUTE
The Indian Journal of Spatial Science

ISSN: 2249-4316

Vol. III No. 3 — 2012

Article 3
Suburban Railway Network of Kolkata: A Geographical Appraisal

Teesta Dey

Paper received on 10.12.2011
Paper accepted in revised form on 18.04.2012

Published by
Prof Ashis Sarkar

on behalf of
The Geographical Institute
Department of Geography
Presidency University (formerly College)
86/1 College Street, Kolkata 700073, India
etraverse.ijss@gmail.com
Ph. +91 33 2241 1960 Ext. 206

Typeset and layout by
Computer Club
ccprepress@gmail.com

Suburban Railway Network of Kolkata: A Geographical Appraisal

Teesta Dey

For the fulfillment of the post independence aim of the regional planners to fill up the existing gap between rural and urban areas, improvement of transport linkage system got priority. Hence, Kolkata adopts a multimodal transport system in which railways play an important role in the enhancement of regional linkage system between Kolkata and its suburbs. The surrounding districts of Kolkata are linked with the city through a well developed suburban railway network. It shows different levels of interaction as influenced by both spread effect and trickledown effect. The present study attempts to analyze the spatial pattern of the suburban railway network system, to identify the different suburban commuter zones around Kolkata, and finally to examine the role of suburban railway services in the regional development.

Introduction

Suburban railway has strongly influenced the morphology of the city region of Kolkata. Its emergence in the 19th century was the basic prerequisite for suburbanization. Today the suburban rail traffic accounts for over 17.38% of commuting into central Kolkata (CMDA Report, 2001) and is crucial for the city's global competition. In the near future, many new rail schemes are likely to come into operation; hence, the importance of exploring the impact of suburban railways on the urban morphology from geographical perspective.

The suburban railway region of Kolkata covers the nine districts of South Bengal viz. Burdwan, Nadia, Hooghly, Howrah, East and West Midnapur, North and South 24 Parganas including the Kolkata district itself (Fig.1). The network comprises two zones (eastern and south eastern) with a total of 320 railway stations located at an average interval of 2 to 2.5 km, and 27 terminal stations. The suburban services extend up to Burdwan, Katwa, Shantipur, Krishnanagar, Gede and Bongaon to the north, Diamond Harbour, Budge Budge, Namkhana, Canning to the south, Talpur via Tarakeshwar to the

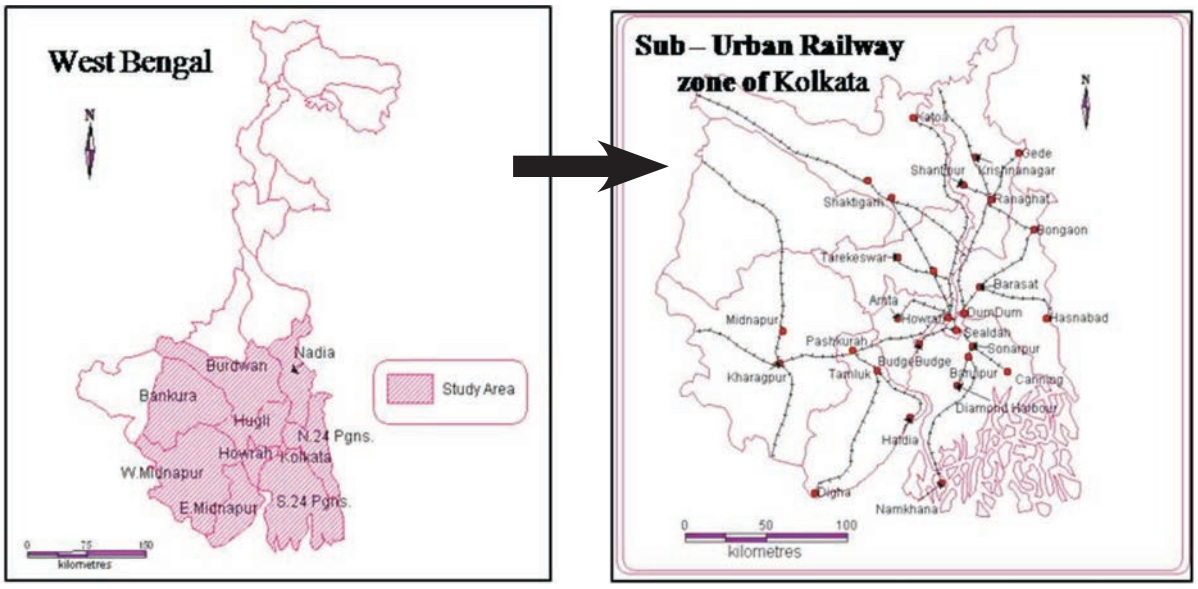

Fig. 1: Location Map of the Study Area (*Source:* NATMO, 2010)

West, Haldia, Kharagpur, Midnapur to the southwest, and Hasnabad to the East. The two most important passenger terminals are Sealdah and Howrah. Apart from the major terminal stations, there are 21 junction stations, viz., Ballygunge, Sonarpur, Baruipur, Dumdum, Barasat, Bongaon, Ranaghat, Shantipur, Krishnanagar, Kalyani, Naihati, Dankuni, Shaktigarh, Panshkura, Santragachhi, Tamluk, Kharagpur, Kamarkundu, Seoraphuli, Bandel and Barddhaman. The Howrah – Kharagpur section belongs to SE Railway while the remaining to the Eastern Railway. The suburban services of the Eastern Railway operate both from the Sealdah, Kolkata and the Howrah stations (Table 1).

Table 1: Suburban Rail Services

Railway Sub-Division	Terminals	Route Description	Total Time Taken	No. of Trains/day	No. of Stations
Eastern Railway	Sealdah	Sealdah South – Budge Budge	0 hr 50 min.	60	12
		Sealdah South – Diamond Harbour	1 hr 45 min	46	25
		Sealdah South – Namkhana	2 hr 47 min	26	33
		Sealdah South – Canning	1 hr 20 min	54	18
		Sealdah North - Krishnanagar	2 hr 53 min	34	30
		Sealdah North - Bongaon	2 hr 08 min	58	24
		Sealdah North - Hasnabad	2hr 07 min	32	30
		Sealdah North - Gede	3 hr 03 min	32	36
		Sealdah North - Shantipur	2 hr 20 min	32	29
		Ranaghat Jn - Bongaon	1 hr 03 min	22	8
		Sealdah North - Dankuni	1 hr 02 min	20	9
	Howrah	Howrah – Barddhaman (Main line)	2 hr 21 min	118	35
		Howrah – Barddhaman (Chord line)	2 hr 05 min	48	30
		Howrah – Katwa	3 hr 20 min	38	45
		Howrah – Tarakeswar	2 hr 09 min	48	21
		Bandel Jn – Naihati Jn	0 hr 50 min	46	4
South Eastern Railway		Howrah - Midnapur	3 hr 23 min	22	36
		Howrah - Haldia	3 hr 07 min	4	38
		Howrah - Amta	1 hr 35 min	8	20
		Santragachhi - Shalimar	0 hr 13 min	4	3

Methodology

Data have been collected from the Divisional Railway Manager (DRM) Offices of Sealdah, Howrah and Kharagpur Railway Stations. The study area has been delineated based on the maximum extent of suburban railway lines. Nodal strength, frequency of trains and passenger pressure at a station per day have been measured in relation to the degree of connectivity of all the major railway stations. Both physical and time accessibility have been computed for a clear understanding of the situation. The degree of interaction between and among the stations has been shown by analyzing its district level variation, physical and time distance variation, variation in terms of accessibility, by identifying the influence zone of Kolkata and local influence zones of the suburban railways, and by estimating the future growth potentials of all the

stations. Correlations have been drawn between passenger density and number of stations, and also between passenger density and railway density in each district. The degree of interaction between and among Kolkata and other suburban railway stations has been measured as follows —

1. To measure the direct interaction between Kolkata (including both Howrah and Sealdah Stations) and other major suburban railway junctions, 'breaking points' have been identified by Reilly's method, as follows —
   BP = 1 + (Distance between A and B) / √(Passenger at A / Passenger at B)
   where, A = the Metro railway station, B = any other railway junction or terminal station linked with A
2. To measure the level of interaction among the selected junctions and terminal stations, the 'gravity potential model' of Zipf has been applied, as follows —
   $$I_{ij} = M_i M_j / D_{ij}$$
   where, I_{ij} = central potential value, M_i = passenger of i^{th} station, M_j = passenger of j^{th} station, and D_{ij} = distance between i and j
3. To determine the future potentials of passenger growth, 'spread effect analysis' has been conducted based on the last ten years' passenger data in each of the 320 stations, as follows —
   Index of Spread Effect = $(PG_H / PG_M) \times 100\%$
   where, PG_H = annual rate of passenger growth in the hinterland, and PG_M = annual rate of passenger growth in the Metro city.

Network Analysis

The relative location and strength of major suburban railway stations influence the degree of inter-district commuter linkage pattern specifically with the Kolkata city. The station wise variation of availability of trains in each station per day is observed in relation to the existing passenger pressure per station per day (Fig. 2 and 3). A detailed passenger and train strength analysis of selected 27 major suburban railway stations shows that maximum passenger pressure lies within the Kolkata Metropolitan Area (KMA) boundary. Although there is a positive relation between the availability of trains and passenger pressure, there are 11 stations within the suburban railway zone of Kolkata where frequency of trains must be increased to manage the existing passenger pressure (Fig. 4), viz., Shantipur, Ballygunge, Baruipur, Sonarpur, Krishnanagar, Ranaghat, Budge Budge, Diamond Harbour, Canning, Tarakeswar and Burdwan.

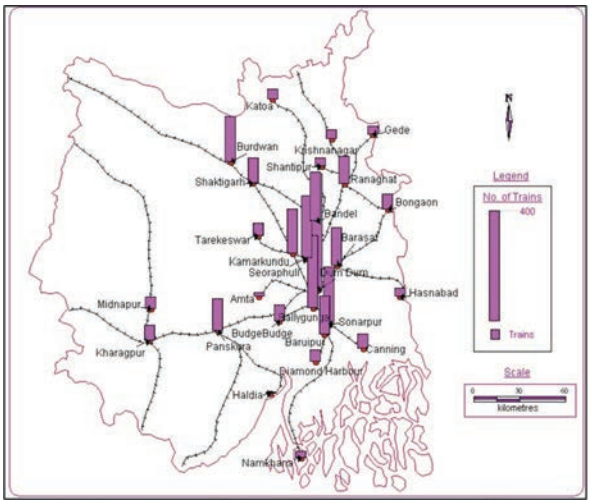

Fig. 2: Train Availability at a Station/Day

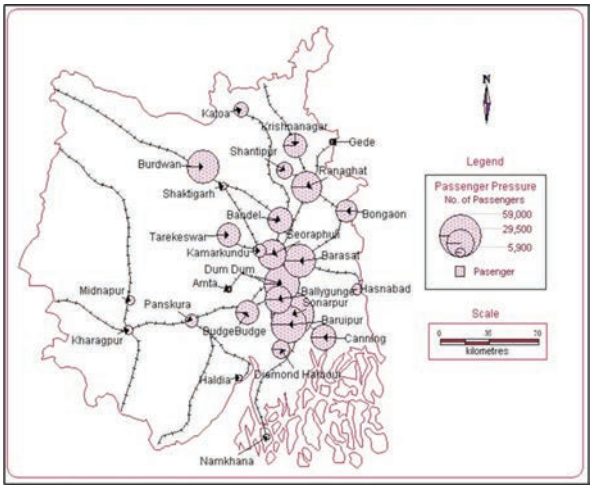

Fig. 3: Passenger Pressure at a Station/Day

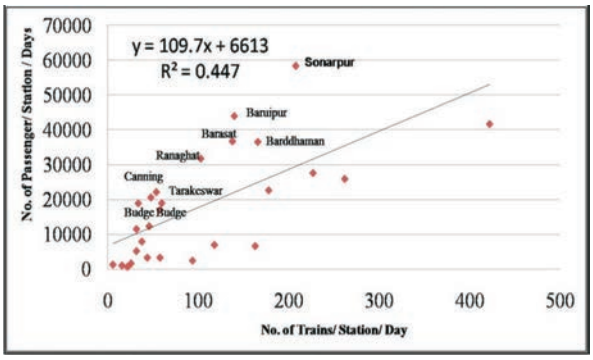

Fig. 4: Passenger Pressure in relation to Train Availability

Network Topology and Connectivity

The intensity of daily commutation to Kolkata is mainly governed by the 'degree of connectivity' of major suburban stations, i.e., the number of links originating from a particular station. The most central nodes are those with the highest nodal degree. The binary model describes the topology of the network: *which nodes are connected by railway services and which nodes are not* (Fig. 5 and 6).The network shows a polarized pattern in terms of nodal degree: *highly centralized stations face marginalized endpoints*. The central stations with a large number of adjacent lines are the main interchanges which show high accessibility but suffers from heavy pressure. They also have the shortest nodal distance to other nodes. This does not only result from their central location, but also from their large number of direct links.

The degree of connectivity of each station determines the relative intensity of passenger pressure on that station. Accordingly Dum Dum and Ranaghat (linked with Sealdah) have maximum nodal degree. Dum Dum is the main junction to Kolkata, having all the different five routes in north, south, east, west and south west direction. Ranaghat has its main route towards Sealdah and is bifurcated into four directions towards Shantipur, Krishnanagar, Gede and Bongaon. In the next level Bally, Bandel, Kamarkundu and Santragachhi have four different routes bifurcated from each of these stations. Of these only Santragachhi belong to the SER division. Baruipur, Kalyani, Barasat, Sonarpur, Ballygunge, Seoraphuli and Panshkura have three bifurcations, while Bongaon and Kharagpur each have only two routes. The terminal stations or endpoints have only one nodal degree.

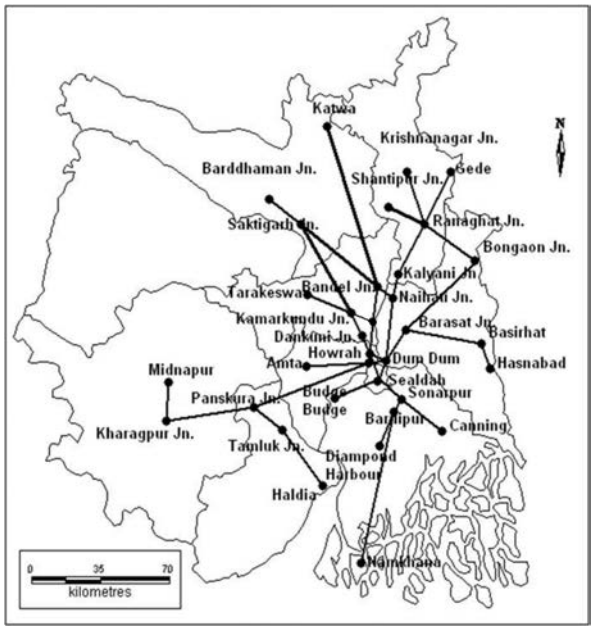

Fig. 5: Topological Map

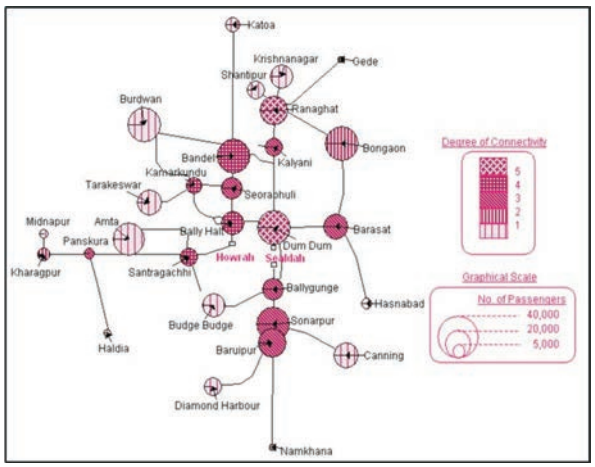

Fig. 6: Degree of Connectivity

Railway Flow Analysis

The strength and importance of a particular route is judged by the service frequency, i.e., the number of trains running between two stations in one direction per day. Within the network, the radial lines are the strongest ones while the orbital links are significantly weaker (Fig. 7). As distance from Kolkata increases, the strength of the railway service

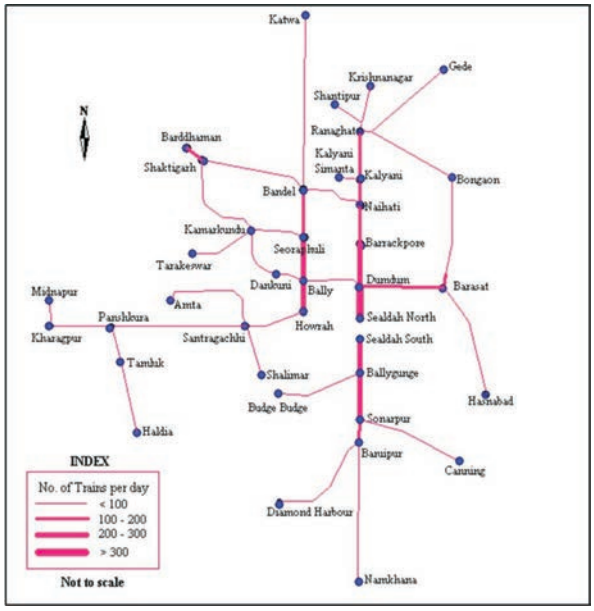

Fig. 7: Flow Network Map

decreases. The number of train services also affects the centrality of a specific station. The nodal degree corresponds to the number of incoming trains. Most of the suburban railway stations have nodal degree more than two, representing maximum flow strength of routes connecting that station. Maximum flow strength is observed in the two parallel railway lines, one is originating from Sealdah and connecting North 24 Parganas and Nadia in the north and South 24 Parganas in the south. The other originates from Howrah connecting Hooghly and Barddhaman in the north. Extreme eastern and western parts are comparatively weaker zones revealing a fragile commuter linkage pattern. This produced a north – south oriented commuter linkage pattern between Kolkata and its hinterland, the shape of which broadly corresponds to that of the Kolkata Metropolitan Area (KMA).

Delineation of Commuter Zones

District Level Analysis

The suburban railway network connects eight districts of South Bengal with Kolkata. Each district has a certain length of railways and a certain number of stations, the importance of which vary according to the local economic and social factors (Fig. 8 and 9). Passenger pressure is a dominant factor for analyzing the level of interaction of any district with Kolkata through suburban railway services. Among the eight districts, maximum interaction is found in case of Howrah and North 24 Parganas whereas the passenger pressure gradually decreases in the cases of Hooghly and Nadia. Relatively low passenger pressure is observed in Burdwan and South 24 Parganas; it is lowest in East and West Midnapur districts, mainly due to low frequency of local trains in the South Eastern division (Fig.10).

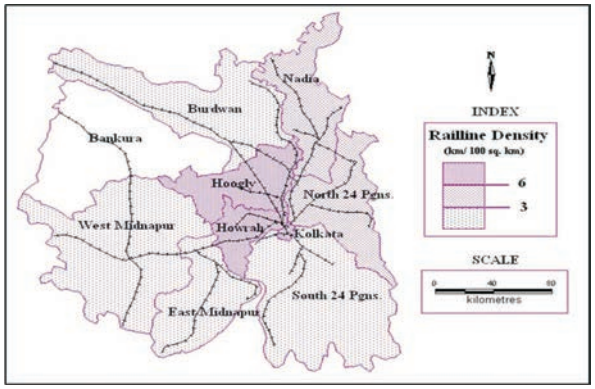

Fig. 8: Railway Density Map

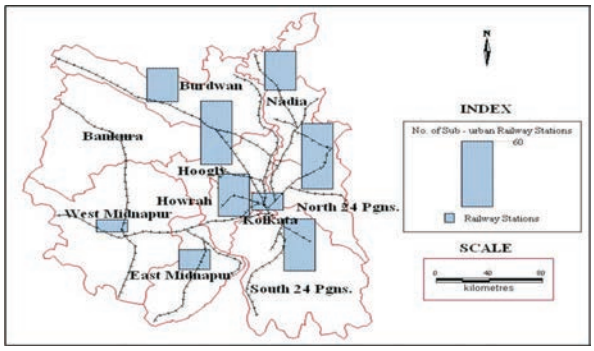

Fig. 9: Distribution of Suburban Railway Stations

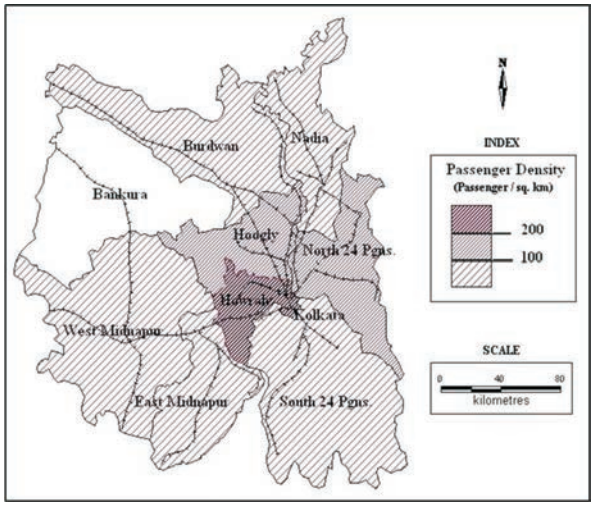

Fig. 10: Passenger Pressure Map

Degree of Accessibility

Development of railways significantly decreased the travel time, thereby shrinking the geographical space of entire south Bengal that ultimately leads to huge daily commutation of near about 32.50 lakh passengers into the city core (CMDA Report, 2001). The route distances of suburban railway line extends up to 140 km which take near about 4 hours of travel. But most of the passengers come from 60 km zone from the city core which takes about 2 hours of travel. This is because the quality of suburban railway services decline with increasing distance from Kolkata.

The isodromes of 30, 60, 90 and 120 km divide the entire area into five spatial zones and the isochrones of 1, 2 and 3 hours delineate four travel time zones (Fig. 11 & 12). Each of these spatial and time zones has distinct passenger pressure in accordance with the number of stations located there. Maximum stations are located within 60 km from the city core and 2 hours of travel

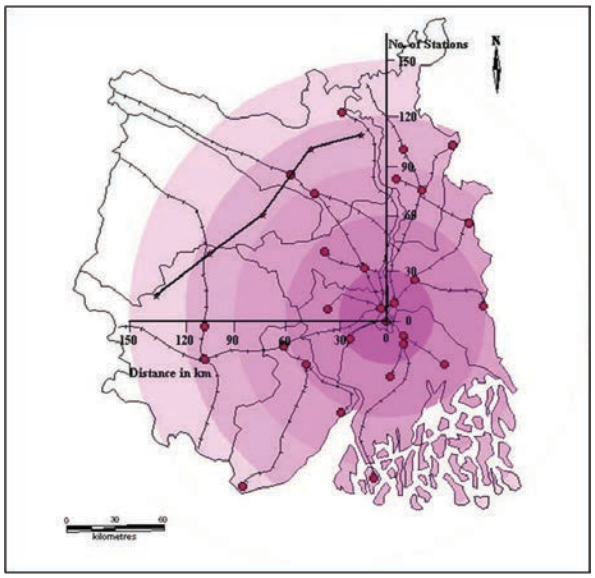

Fig. 11: Distance Zones of Suburban Railway Services from Kolkata

Table 2

Distance Zones (km)	Passenger Pressure	No. of Stations
0–30	14,96,962	108
30–60	7,53,894	99
60–90	2,78,221	60
90–120	1,12,551	39
120–150	16,879	14
Total	26,58,507	320

Fig. 12: Travel Time Zones of Suburban Railway Services from Kolkata

Table 3

Travel Time Zones (hrs.)	Passenger Pressure	No. of Stations
0–1	17,75,722	131
1–2	7,07,864	124
2–3	1,58,668	57
3–4	16,263	8
Total	26,58,507	320

time zone (Kolkata, Howrah, North 24 and South 24 Parganas) that holds near about 84.67 % of total passenger. The major terminal stations like Midnapur, Haldia, Burdwan, Katwa, Namkhana etc are located more that 90 km away from the city core and take 3 to 4 hours to reach there have comparatively low passenger pressure mainly due to distance factor (Table 2 and 3). The orientation and location of towns in South Bengal exhibit linear development mainly along the suburban railway lines. Thus urban development becomes less significant with increasing distance from Kolkata and from the railway networks.

Degree of Interaction

The 'breaking point analysis' clearly reveals that Kolkata has maximum linkage with the northern and north western parts based on Sealdah to Ranaghat, Howrah to Bandel, Barddhaman, Tarakeswar and Amta lines (Fig.13). In most of the cases the degree of direct influence is the outcome of the economic

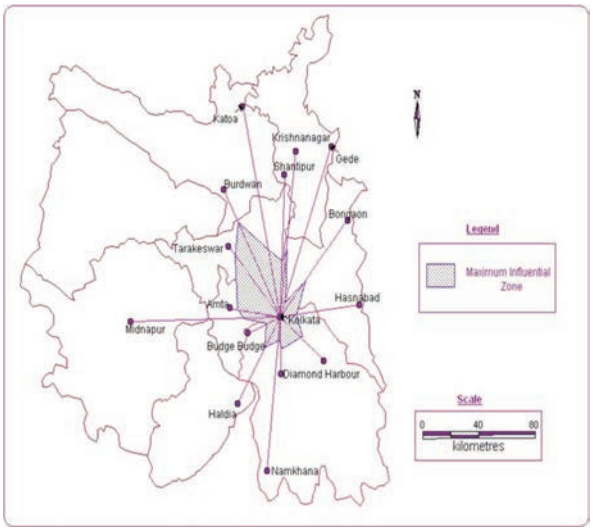

Fig. 13: Area of Influence of Kolkata in the Suburban Railway zone

pattern, although sometimes locally the social and religious factors also govern the pattern.

The 'central potential values', on the other hand reveals that maximum influence lies in the immediate zone of Kolkata covering Barasat to Budge Budge. Bongaon, Amta, Diamond Harbour all are intensively interrelated with Kolkata through daily commutation. Level of interaction gradually declines with increasing distance from the core area. Hence, minimum commutation is found between Kolkata and Katwa, Midnapur, Haldia, Namkhana and Hasnabad (Fig. 14).

The 'spread effect analysis' of each sub – urban railway station shows that among the 320 suburban stations, only 29 have maximum potentials for future growth (Fig. 15). It is estimated that in 291 stations, passenger growth exceeds that of Kolkata, while 25 stations reveal negative growth mainly due to local factors. However, the opening up of new occupational sectors not only in the city core but also in other important towns and municipalities, make it a new factor to attract people from surrounding regions. Hence commutation pattern has been gradually changing connecting new physically remote areas.

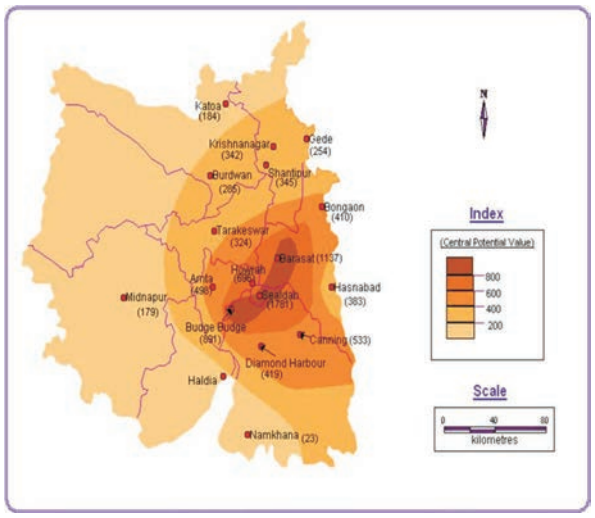

Fig. 14: The Influence Zones of the Suburban Railways of Kolkata

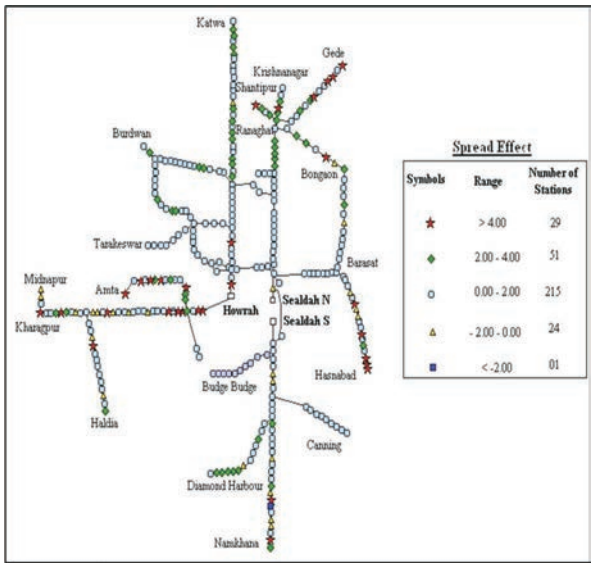

Fig. 15: Future Growth Potentials of Suburban Railway Stations

Conclusion

The suburban railway network reveals the spatial polarization between highly accessible and less favoured places and supports the concept of 'network urbanism'. The combination of topologic factor and the flow factor determines the relative importance of railway stations in terms of passenger pressure. Thus, a spatial model is most precise as it takes into account spatial and nonspatial factors as well as the traditional geography of locations and the geography of relations corresponding to the space of Flow (Castells, 1998). The spread effect analysis of each station effectively identifies the future pattern of growth potentials of different stations that is likely to change the commuter linkage pattern. In order to increase the level of interaction between Kolkata and its surrounding regions, some parameters can be suggested as follows —

1. Faster and more frequent railway connections: *it will encourage modal shift from road to rail, thereby making the distant places more attractive for commuters.*
2. The higher nodal centrality: *it will improve the importance of the stations within the network.*
3. The new schemes: *quality of service will improve, as well as new areas of commutation will develop.*

Source

1. Combined Suburban Time Table of Eastern and South Eastern Railway, DRM Office, Sealdah, 2010
2. DRM Office of Howrah, Sealdah and Kharagpur
3. NATMO

References

1. Bhaduri, S (1992): Transport and Regional Development, A Case Study of Road Transport of West Bengal, Concept Publishing Company, New Delhi, pp. 121 – 131
2. Chakraborty, S. C.(1995): The Growth of Calcutta in the Twentieth Century, Chaudhuri, Sukanta (ed.), Calcutta – The Living City, Volume – II, The Present and the Future, OUP, India, pp. 2 - 6
3. Chiaradia, A., Moreau, E., Raford N., (2005): Configurational Exploration of Public Transport Movement Network: A Case Study – The London Underground, A.van Nes (ed.), Proceedings, 5th International Space Syntax Symposium, Delft, Techno Press, London.
4. Government of West Bengal (1967): Traffic and Transportation Plan for the Calcutta Metropolitan District (1966 – 1986), CMPO, Kolkata, pp. 43 – 48
5. Government of West Bengal (2001): Master Plan for Traffic and Transportation in Calcutta Metropolitan Area (2001-2025), KMDA, Kolkata.
6. Government of West Bengal (2008): District Statistical Handbooks of Kolkata, Bankura, Burdwan, East Medinipur, West Medinipur, Howrah, Hooghly, Nadia, North 24 Parganas, South 24 Parganas, Bureau of Applied Economics and Statistics, Kolkata.
7. Halder, D (2006): Urban Transport in India: Crisis and Cure, Book Well, New Delhi, pp119 – 149.
8. Mukhopadhyay, T (2003): Railway Transport Network in India, in Vaidya, B.C. (ed.), Geography of Transport Development of India, Concept Publishing Company, New Delhi, pp. 1 – 18.
9. Ramanathan, R (2004): Indian Transport towards the New Millennium: Performance, Analysis and Policy, Concept Publishing Company, New Delhi, India, pp. 36 – 42.
10. Turton B., Black W. R. (2001): Inter Urban Transport, in Hoyle B. and Knowles R. (ed.), Modern Transport Geography, John Wiley and Sons, pp. 162 – 163.

Teesta Dey

Junior Research Fellow (UGC), Department of Geography, University of Calcutta
teestadey08@yahoo.co.in