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Road transport network in purbamedinipur district of West Bengal: A geographical appraisal

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Abstract
Based on the research progress in related fields and the distribution characteristics of road networks in PurbaMedinipur, the complex network model of a city road network is established to study its connectivity reliability. Purba Medinipur as the example, several parameters of the complex network abstracted from the road network are calculated and the practical meanings of them are described, respectively. The detailed investigation of connectivity reliability of PurbaMedinipur district road network is done by analyzing the curves' tendency. Finally, we find that the network of a valley city has a poor connection and has a lot of dead ends. Besides, the average length of the roads is very long and the holistic connectivity reliability is at a lower level; these are suitable to the group-type distribution of road network, and the connectivity reliability of the road network is stronger under random attacks than that under intentional attacks.

Keywords: road networks, connectivity, reliability, model

Introduction

In order to facilitate the movement of man and matter in one point of concentration (rather spoken as a knot) to another across space, some defined Transport channels are needed. Obviously, these channels must consist of nodes and paths connecting the nodes. Therefore, the structure of the transmission network can be considered as referring to the spatial configuration of transport facilities in a given region. The Web the description implies the description of the repository of nodes and their interrelationships with 1-link rows and distributions so that they can be used as effective indicators of economic development. As Fitzgerald 2 puts it, "variations in characteristics the network can be seen as representing some spatial aspects of the system. "The regional development of any country depends on three Networks, such as: irrigation, electricity and transport, in which transport plays a role fundamental role in the process of regional and economic development 3. It is presumed, founded on logical observation and contemplation, which in all developed countries development of the transport network, the level of economic development is higher and there is a positive correlation between the two. The transport network is therefore one of the most important determinants of economic prosperity. It is with the above observation and context that the various measures of The efficiency and effectiveness of the transport network were examined, highlighting the previous correlation. The most logical technique for this spatial analysis is the graph theoretical measures widely supported by various researchers in developed countries and developing countries of the world.

Location of the study area

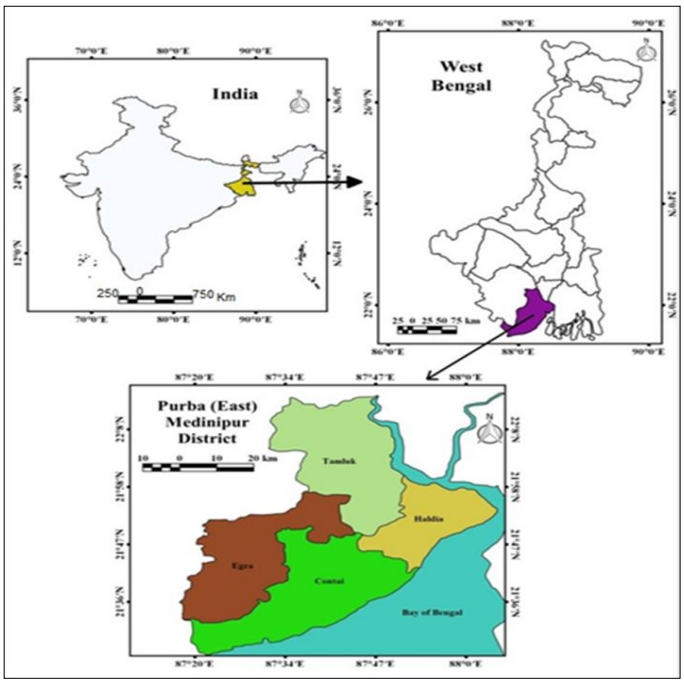

Fig1: Location Map of the study area

The erstwhile Medinipur district was divided into Paschim Mednipur and Purba Mednipur in 2002. Purba Medinipur district is a funnel-shaped district in layout, with its eastern part penetrating into Bay of Bengal extends through 21° 36' 35"N - 22° 02' 23"N and 87° 22' 48"E - 88° 01' 12"E latitudes and longitudes respectively. The district is well connected with Kolkata, Bhuneshwar, Ranchi, Bankura and Burdwan by a network of roads and railways. It is about 75 km away from the estuary of Hoogly River. Physiographically this district is a plain land with slopping towards the east.-southeast and the southeastern part of district is bounded by Bay of Bengal. Howrah district lies to the east-norheast, Paschim Medinipur in the west, and south 24 Parganas in the east. Spreading over an area of 4,093.94 km^2, it consists of 3,028 Mauzas, 223 Gram panchayats, 25 CD Blocks, 4 Subdivisions and the disict is inhabited by 50,95,875 people, and the the density of population is 1,186 persons per km.

Review of literature

Krishnamurthy (2015) studied to an attempt has been made to analyse the road network connectivity and spatial pattern existing in Calicut city in India, and hence to determine if the network connectivity can explain significant variance in the spatial pattern of the network structure.

Dr. Jabir Hasan Khan and Shamshad (2012) analysed the spatial patterns of road density, variations in the level of development and casual relationship between road density (dependent variable) and selected variables of socio-economic development (independent variables) among the districts of the state of West Bengal.

Hong-Xia Kang (2012) Studied on the Road Network Connectivity Reliability of Valley City Based on Complex Network.

Erik Jenelius (2010) studied the influence of the regional location and travel patterns and development of the road network.

Jacoby (2000) 48 suggested that roads play a central role in rural development. The empirical analysis, using data from Nepal, revealed that among other benefits from extending roads into remote rural areas, rural roads provided cheaper access to both markets for agricultural output and for modem inputs, schools and health facilities and, more generally to a greater variety of consumer goods.

Majumdar (2002) on the basis of regression analysis of the state level cross section data for each of the years from 1971 to 1995 indicated that among various physical infrastructures, it was the transport infrastructure that significantly affected the agricultural output level and the agricultural development index.

Mohanan, Srivastava and Rao (2002) soexplained that rural road connectivity is an extremely important aspect of rural development Inadequate rural connectivity and lack of mobility pose serious constraints to accelerate rural development.

Singh, Nagesh (2006) in an analysis of incidence of poverty across Indian states indicated that poverty is very closely linked to the absence of economic and social infrastructure. Investment in rural infrastructure has been reported to have a significant impact on increase in economic activities in the area and consequent reduction in poverty. It was also observed that availability of infrastructure goes a long way in redressing the issues of regional imbalance.

Objectives of the research

Aims and objectives of this research are as follows:

- to studied graph theory
- to analysis the graph theory and its application to the study area
- To explained the connectivity of road networks and measures of connectivity in the study area

Data Base

This work is based on both secondary and primary data. Secondary are collected from the published work; as for example, Census Report. Record of implementation of poverty alleviation programmes by the government Primary data has been generated in the field using prepared data table in appropriate manner. People's perception on various aspects relating to poverty and its alleviation programmes have been recorded upon systematically design questionnaires.

Research methodology

The research methodology, followed in this research work, is as follows:

a. Base work

- A bibliography of sources of information has been prepared at the outset.
- Necessary information on the Geographical environment of the area under study has been collected.
- The sources of information including the respective sectors where they are available have been identified.
- Map of the location has been collected.
- A pilot survey was conducted prior of the field work.

b. Field Work

- Secondary data have been collected from the respective offices and institutions in the study area.
- Primary data have been generated through questionnaire survey among the people.
- Necessary and relevant photographs have been taken in the field.

c. Post Field Work

- The information collected in the forms of primary and secondary data have been categorized on priority basis.
- Both primary and secondary data have been processed using appropriate statistical techniques.
- Processed data then have been analyzed and interpreted.
- The thesis has been complied on the basis of analyzed data.

Results and discussion

1. Graph Theory

The study of the network in the topological sense began with Euler (1736) 4 and contained with the Cay Lay card coloring problem, but the first full treatment has been done Konig. (5) Graph theory as a branch of combinatorial topology provides us with appropriate tools suitable for the measurement and analysis of structural aspects of transport the Web. However, the underlying assumption is that any given network can be reduced to a structure made up of points that can be connected by a set of lines or segments, These graphics allow us to see the entire transport network, as well as its parts in theme of the set. The term "graphic"

used here should be distinguished from the term more familiar graph, on which coordinate positions are plotted. Chart in the new direction and The network is not completely interchangeable, but they are considered similar here.

Many social scientists have studied the structure of transport networks using graphics theoretical techniques. Lalanne (1863) 6 analyzed the density and configuration of the railway mainland France network. He observed the regular use of the rail network and suggested a hierarchical relationship between the network and political divisions France. Particular attention can be drawn to certain recent studies which have Taking into account the spatial configuration of the transport system, they form the theoretical point of the graph of view. Garrison (1960) applied some of the techniques of graph theory to analyze the Connectivity of the US interstate road network for 1957.You have pointed out the usefulness as well as some of the limitations when The methodologies of graph theory are applied to the analysis of the transport network. Garrison and Marble (1961.) 8 developed a set of measures based on the concepts of Theory of graphical diagrams. These measurements relate to theoretical and empirical surveys of what has been called the structure of the transport network. Nystuen and Dacey (1961) analyzed the functional connections between the central place on the basis of communication follow in a network using graphic theoretical measurements to the regional road. Kansky (1963) carried out an in-depth empirical analysis of the transport network structure and suggested a series of measures to analyze complex transport network structures. Kissling reviewed (1969) (U) the regional road network for the province of Nova Scotia and used it to identify likely growth points systems and more specifically to identify existing bottlenecks where improvement this would generate greater benefits for the region. V.L. Singh, D. k. Singh and J.K. Rautray, 12 years old H. Ramehandran (1973) and M. Raza (1980) also studied graph theory measures related to India's transportation system and suggested analysis-based development measures for improving transport efficiency, especially in properly connected areas of the country. These studies claim the applicability of the analytical approach and graph theory techniques to analysis of the transport network.

2. Graph theory and itts application to the study area.

One of the simplest applications of graph theory has been its use in comparing sets of networks.

a. By reducing the networks to a topological graph.
b. By selecting three basic measures, and
c. By manipulating the three measures in a series of ingenious indices, we can form some common yardsticks for network comparison.

The three basic parameters on which the indices based are:

1. The number of separate (i. e. non- connecting) sub graphs in the network (G)
2. The number of edges (links) in the network (E).
3. The number of vertices (V).

Measures of network structure are measures of relative quantity. After closer insight into
the said work, two general classes of measures will be dealt in the present study. These are.

1. Measures of the transportation network in their entirety and
2. Measures of individual elements of the transport network.

The measures of transportation network structure derived from graph theoretical concepts
may be broadly classified into two groups.

1. Non-ratio measures.
2. Ratio measures.

The measures describing transportation network in their entirety are considered predominantly as ratio between the whole system and its individual elements. Only two measures are abstracted directly form graph theory: - (a) the cyclomatic number (p) and (b) diameter of the network are non-ratio measures.

The idea behind each of the analytical techniques is to apply some kind of measurement to a network in order to provide a numerical value which can be used, (i) to describe that network quantitatively and (ii) to compare exactly the network with another one.

At the present stage of development of the network analysis, however, there are two points to this.

The approach followed here is to look first simple indices that can be developed from an initial appraisal of graph structure and subsequently to consider the extra structural information that can be derived via matrix analysis. Following this process first the high value indices are considered then low value indices are taken in to account.

At the time of calculating different structural indices, the spatially identified nodes of Purba Medinipur district have been considered. The nodes are selected on the basis of-

- The points where two roads have joined.
- The points of originating and terminating centres for conveyances.
- Major distributing centres of goods and services.
- Block headquarters.
- The villages in each block which are moderate to well populate and

where some significant economic activities take place.

Block-wise name of the nodes considered are given in appendix No- (i). About 677 links or road connections of different categories (like N.H., S.H., M.D.R., O.D.R., and V.R. including roads constructed under PMGSY) are identified in the base map of the district. So, all 503 nodes and 677 links (edges) are considered in the graph theoretic analysis of the study area (Fig.2).

3. Connectivity of road networks and measures of connectivity

Connectivity of networks can be defined as the degree of completeness of the links between nodes. Greater degree of connectivity within a transport network obviously indicates the more efficient system. K.J. Kansky, an American Geographer who has developed several descriptive indices for measuring the connectivity of networks like Beta, Alpha, Gama, Cyclomatic number
and Eta indices. The indices used for measuring the connectivity of road network of Purba Medinipur district are discussed below.

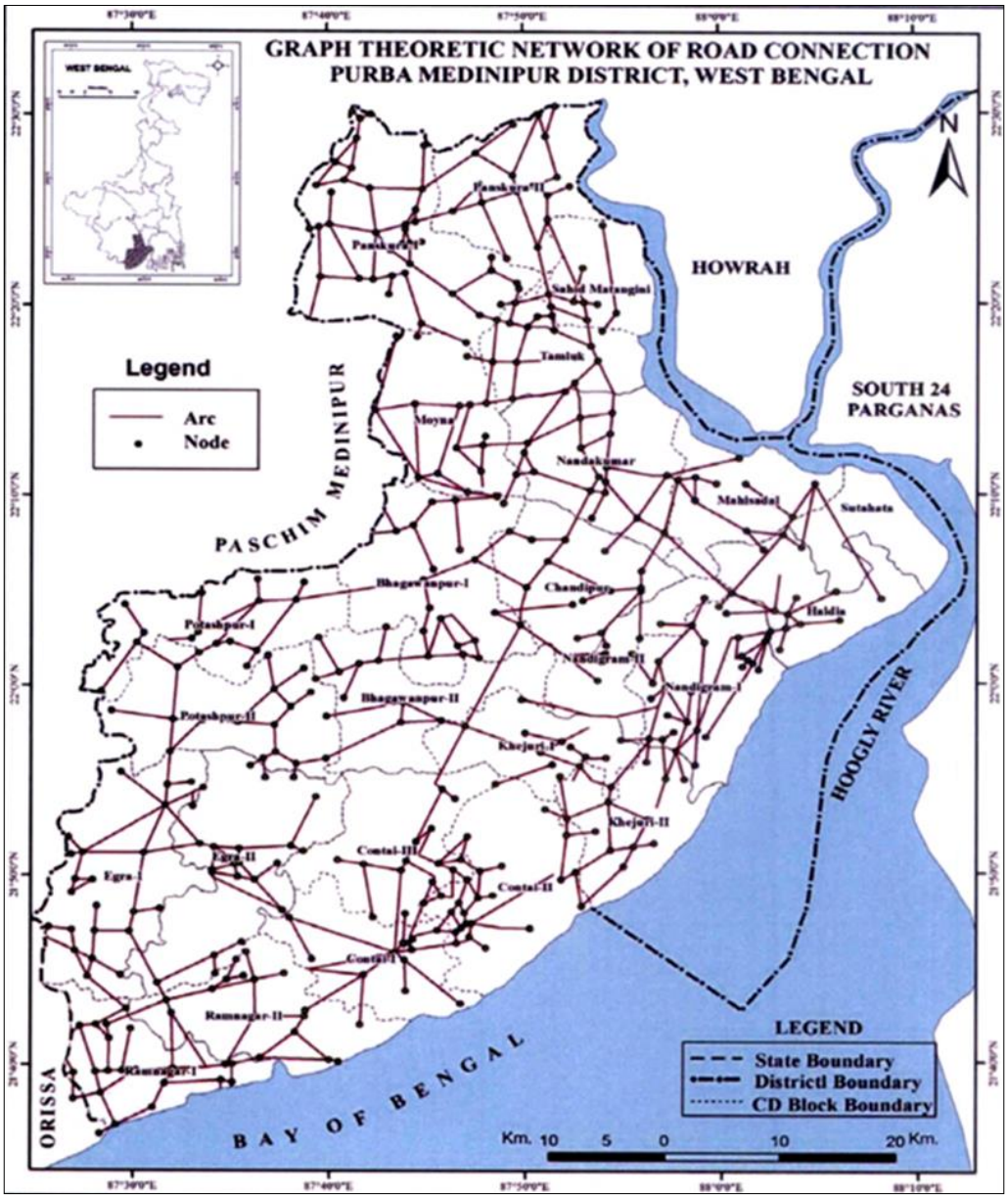

Fig 2: Graph Theoretic Network of Road connection in Purba Medinipur

3.1 Road density

Road density is the ratio between the total road length and the area of the region. The higher the value indicates the well-developed network or well connectivity of the area or the region. It can be calculated by using the following formula.

Road density = Total Road length of the area in km/ the area of the region

Form the calculated and tabulated value of road density of Purba Medinipur district it is found that Sutahata (130.46), Nandakumar (128.16) having high road density, while Bhagabanpur-I, Moyna, Panskura-I have very low density which clearly reveals the direct control of physical factors as well as agglomeration of population which generate and support construction of roads. Blocks like Panskura-II. Sahid Matangani, Haldia, Tamluk. Chandipur, Contai-I, have moderately high road density and remaining blocks of the district have moderate to low road density A choropleth map of road density is drawn on the basis of calculated data also gives a clear visual impression about the road density of the district. Block wise study alsoreveals that block situated in the western part of the district have low road density because of frequent flood, structure of soil, and economically less developed area where as the block situated in the North- East, North and Eastern parts having high road density because of concentration of more settlements and economic activities. Although rural roads constructed under Prime Minister Gram Sarak Yoyona (PMGSY) Scheme started form 2001 on w'ards have changed the scenario of the connectivity of the so-called backward blocks and it is observed during the survey that some of the blocks have acquired more connectivity than the known developed blocks. So to have a clear idea about the actual condition of the road transport network at present in the Purba Medinipur district, the block wise number of major settlement connected by any category of road
and the block wise total road length have taken into consideration (table no 4.2) which gives a detail idea of the nature of linkages of each block in the district which will further help to plan the development strategy.

Table 1: Block wise Road Density of Purba Medinipur District in 2009-2010

Serial No.	Road Density per 100sq km. (2009-2010)
1	64.94
2	49.57
3	87.00
4	93.95
5	37.46
6	99.99
7	35.69
8	56.54
9	48.29
10	64.80
11	53.32
12	55.87
13	33.99
14	81.00
15	130.46
16	55.32
17	107.02
18	89.14
19	94.62
20	77.29
21	78.49
22	58.34
23	45.91
24	128.16
25	124.96

Source: Author calculation

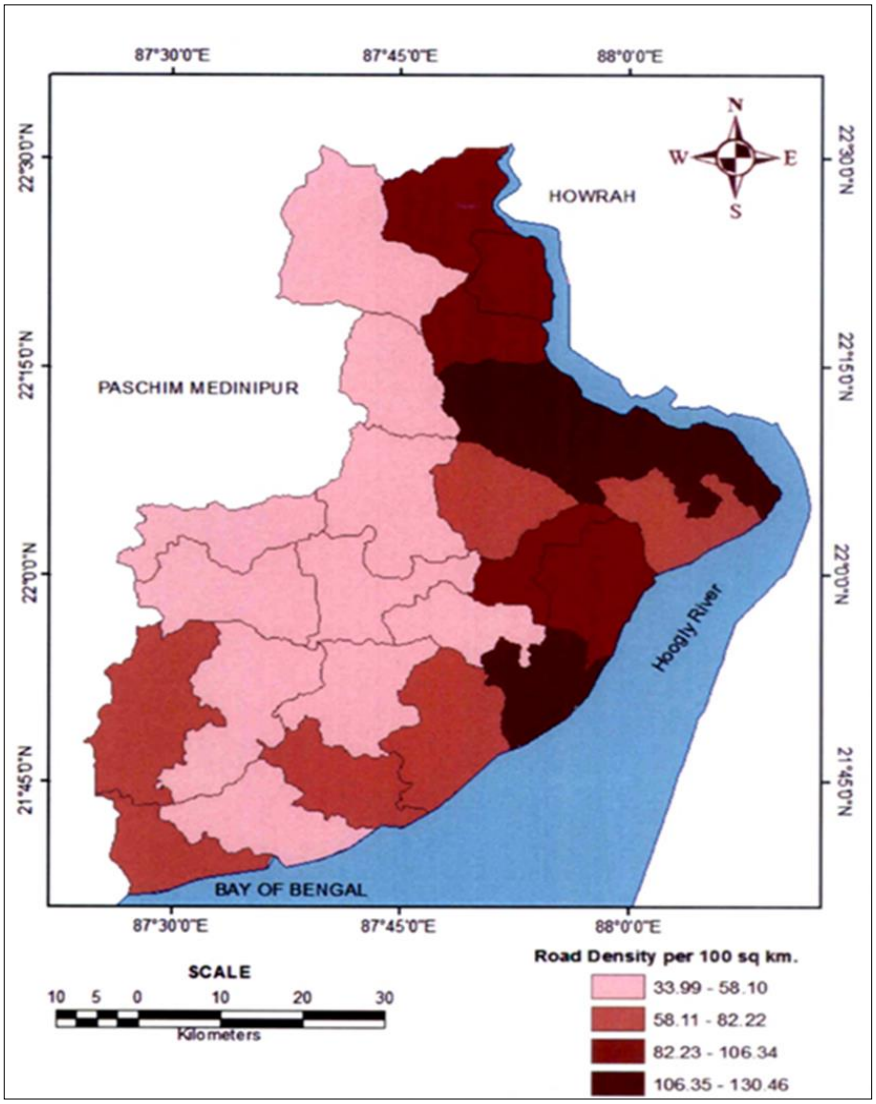

Fig 3: Road Density Map

The spatial organization of road transport system where the indices of connectivity are used to measure the degree of connectivity in the road network of the district. Graph theoretic technique is applied to convert the road network to a straight-line graph and road dencityare calculated taking 776 connected settlements (Nodes) and 855 links into consideration (based on field observation and information collected). The maximal-minimal connectivity with degree of development in road network and the pie index are also used to have detailed idea of magnitude variation in the connectivity. Maps are drawn to give visual representation of the actual position. The connectivity indices and related maps provide a logical inference that the road network in Purba Medinipur district, as far as connectivity concerned is fairly or moderately developed. It is observed that Khejuri-1 and Khejuri-II recorded maximum degree of connectivity having well connected network Other blocks like Sahid Matangani having fairly good degree of connectivity. Ramnagar-I, Ramnagar-II, Panskura-II), Sutahata, Moyna, Nandigram-I, Nandigram-II, Chandipur are having fairly good connectivity. On the other hand remaining 15 blocks having low connectivity where the inter- block connectivity is poor. The blocks having high degree of connectivity attracted moderate to higher degree of population concentration with inter-block as well as block to district service point linkages and also concentration to other big urban centers of greater status of economic activities. Rural areas are still unconnected with metalled roads resulting poor inaccessibility and above all lack of proper maintenance of these roads by the administrative machinery.

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