

Chapter 4 – Transport Network System

The morphology and internal structure of the town is shaped and patterned by various aspects of transport. Such ideas have been confirmed by eminent geographers. Prof. Smailes (1958) designated the transportation arteries as the veins which supply life blood to the town. Dickinson (1956) suggested the topics dealing with morphology of the city should include the circulation which is the hydrology of the city. Garrison and Berry (1959) emphasised that the situation of CBD corresponds with points of maximum accessibility. Transport activity themselves constitute the single category of land use [Mayer, 1959]. Hence the studies related to transport has been dealt with in this chapter.

The definition of a transport system adopted by the Washington transportation plan is typical, "a set of facilities for the movement of goods and people, including highways, parking facilities and public transit". The definition may be acceptable as a definition of a physical system, but the transport system of any urban area is something more than a physical system. Its performance can have far reaching consequences for all individuals, business and other bodies relying on it. These consequences can be both long and short terms. In the short-term they influence the origin and destination, the time, the mode and route, of all trips made. In the long-term they can result in a change of location of activities in order to adjust to the transport system. [Bruton, 1985].

In modern times transport has assumed much more importance and many countries or regions cannot think of its agricultural, industrial and socio-cultural development unless it has an efficient and quick transport system. Transport is the focal point of all economic activity and busy transport nodes become sites for large cities and service centres. A well developed transport encourages not only cheap production but also an expansion of its market area. It not only distributes consumer goods to the doorsteps of consumers but enables them to cover long distance to purchase goods of their choice. The transport system also provides social advantage like high standard of living, attitudinal changes, dissemination of knowledge and new ideas, diffusion of innovations, developmental programmes, social welfare etc. Transport is an agency by which every part of the society is brought into relation with every other and interdependence, specialization, organization made possible. Modern society, with its high standard of living and high levels of consumption has created a high degree of spatial interaction, itself dependent upon a highly developed and complex transport system.

Extensive, efficient and economical means of transport and communication are indispensable for economic, social and cultural development of a region. These transport systems particularly the roadway and railway have profound impact on the nature of the regional economy catering demand and supply, developing social and political structure and improving interaction, connectivity and access so as to affect the very outlook of its people. Efficient transportation not only provides a more dependable supply service for large cities by increasing the number, the variety and the size of the areas supplying food and raw material, but it also allows these cities to sell their goods and services to larger areas. Hence, a thorough study of all aspects of transportation system is essential to assess its vital role in the development of the regional economy. Industrialization as a productive system is nourished by the arteries of transport to maintain its functional efficiency. Means of transport apart from being a locational factor, play a significant role in increasing the geometric efficiency of a certain place. They also play a significant role in providing geographical basis of industrialization to a certain place. They add "place utility" to the industrial raw material otherwise lying idle, and mobility to labour for its effective and efficient participation in industry.

In studying about the transport in a particular area it is necessary to assess the characteristics of the area i.e. the general economic development of the area, the spatial location of socio-economic activities and the technologies available, relative cost-structures; the interests, perceptions and preferences of the decision making groups. In addition the historical pattern developed in the area and the physical environment are also to be studied. A part of these studies have already been discussed in the previous chapters. The study of transport nodes, their morphology and their location are therefore a basic to the geography of transport.

To the land-use planner, planning of the total system is the aim, within which integrated traffic and transport is a part. First is the physical system containing several distinct elements: the land; other natural resources which are not only required in life (sun, air, wind), but also energy sources; the man-made buildings and surrounding places for living, working and recreation; the infrastructure for servicing those buildings and places (water sewerage, gas, electricity etc.); means of transport to convey people from various fixed points to other (home to work, home to school etc.) points and communication along wires or through the air;. Associated with these physical elements are corresponding social, economical and cultural activities. There is movement of people and goods by various transportation modes and their substitute, the non-face-to-face

linkages between people carrying out their various activity by use of communication rather than transport.

Transport is thus the active movement of people and goods along the various centres or zones of socio-economic activity. This is the essence of the land-use transport system. The traffic generated is thus a joint consequence of the land-use potential and the capability of the transport system to carry the traffic, both in terms of quality, categories, desired origins, destinations, desired times of travel, etc. The introduction of a transport capability will generate the possibility of socio-economic activity on land and the generation of such activity will stimulate the provision of transport capabilities. Traffic is a function of land use. The potential of a block of land to generate traffic is realised when activities take place on the land. Traffic generation of a block of land is a measure of the amount of traffic (number of people or vehicles, tones of freight) that visits during a specified time period (usually per day, or per hour). The amount of traffic generated is related to : a) the type of land use; and b) the scale or intensity of the activity taking place in the land. Traffic generated by each land-use category is a reflection of its role in the social and economic functioning of the economy.

A systematic approach to the study of transportation in the context of spatial interaction was ushered in by the following fundamental concepts developed by Ullman (1957): Complimentarity, Intervening opportunity; and Transferability.

The life-blood of a region circulates through its arteries of roads and railways. Since Kharagpur is land-locked both these networks play a significant role, morphologically and functionally. The evolution of the transport network systems is therefore concerned with that of road and rail. Within the historical development of the transport system the four interrelated items has already been considered- I) the location and pattern of the systems. II) the technological development (brought about by the railways) III). the institutional development. IV. the settlement and land use patterns. The Kharagpur village for a long period in the past was linked with the outside world via. Medinipur through the Jagannath (Puri) Road also known as the Ahalya Bai Road which was reconstructed in 1824 as a mettalled road. [Source : Jameson, 1918]. The modern Orissa Trunk Road is the successor of this Ahalya Bai Road. Here mention may also be made of the road from Kharagpur to Keshiary (Kasiary) which existed as a principal road under local management in 1871 (Hunter, 1876). Cart-traffic was considerable along the Mohanpur-Kharagpur Road calling for repeated repairs and remodeling. [Source:

Annual Administrative Report, 1902-03.]. The roads therefore preceded the railways which was opened towards the end of the nineteenth century. The evolution of rail network has already been discussed in chapter 2.

Railway Network

The Indian railway system, one of the largest in the world and the biggest public enterprise, provided the vital infra-structure and is an effective catalyst in the economy and social development of India. The railways have opened up many backward areas and have increased and speeded up the flow of trade and commerce and generated ever widening direct and indirect employment. At a glance it seems that the district of Medinipur is not well served by the rail network, but actually the alignment of these lines are so well planned that almost the entire area is tapped to a reasonable extent, the traffic being brought to the railways (mainly at the junction of Kharagpur) through several crossroads.

The railway network was initiated towards the end of the nineteenth century. The layout of a station calls for certain essential conditions. At important termini (as in the case of Kharagpur) the passenger or coaching work is kept apart from the goods work, a separate station or yard being provided for the latter. Waiting rooms for passengers, signal office, ticket booking office, officials' rest / retiring room, parcel office, goods yard along with its office, the office of the station-superintendent with its entire staff all these call for sufficient land. Sufficient land should be taken up to provide for expansion of traffic and when this is secured, other facilities can be provided as and when required. When the goods traffic is considerable, the passenger work is to be done on one side of the line and the goods work on the other, sufficient space being left between the goods shed and the passenger platforms for admission of the required sidings being laid. The goods shed side must be fixed with reference to the convenience of traders and if a large trading mart is on one side of the line the goods shed should be located on the same side [Finney, 1896]. The setting up of this station which later was formed into a junction station has already been discussed.

The Functioning of the Railway System

The Railway Board was established in 1905 at the head of the rail administration. With the expansion of the rail transport network the need for nationalisation was felt. The

policy of nationalisation started in 1925 and ^{was} completed in 1944 with the take-over of Bengal Nagpur Railway (BNR) the last major Rail Company. The rehabilitation of a war-battered railway system was taken over after independence. The Railway Board prepared a plan of regrouping of Indian Railways initially into six zonal systems. Vast development envisaged in the second five-year Plan coupled with the heavy workload of the combined Eastern Railway necessitated a reduction in the size of the combined eastern zone and so in 1955 the South Eastern Railway was constituted. The SE Railway from the administrative point of view is divided into seven administrative units or divisions of which Kharagpur division in West Bengal is the largest. The SE Railway accounts for only 12% of total rail lines of Indian Railways, but it carries over 30% of the total goods traffic on all the railway zones together and a large portion of this is dealt with at Kharagpur Rail Junction Station.

The Kharagpur Division covers the districts of Medinipur and Haora in West Bengal, Singhbhum in Bihar, Balasore and Mayurbhanj in Orissa. It occupies the pivotal position in regard to the passenger train operation on the SE Railway but its freight operation mainly consists of handling through traffic. However loading of oil tank from Haldia is an important feature on the small wagons loading spectrum of this division. The carriage and wagon depot at Nimpura is the most important wagon repair depot on the Kharagpur division. The staff of these departments look after the day to day maintenance problems in the formation and despatch of trains. The carriage shed attends to the maintenance of coaches based at Kharagpur. All coaching trains (with a few exceptions) are hauled by electric traction. The through goods operation on the main line is also under electric traction. An engine examination pit is located on the eastern end of Kharagpur where running attention to electric locomotion is carried out.

Since independence the growth in traffic has been more intense along the trunk routes. The massive increase in the demand for goods and passengers traffic was met very largely by increasing the capacity of the already existing routes through gauge conversion, doubling of track, traction modernisation and improvement of signaling and communication system. Workshop facilities were expanded in step with the increasing repairs and maintenance requirements. Until the beginning of the '60s, the classic steam locomotives had been the mainstay of the railway transport but thereafter there was a progressive extension of diesel and electric haulage of high volume; high density goods traffic and of long distance mail and express trains on the main trunk route (Indian

Railways, 1978). The introduction of diesel and electric traction, the adoption of the automatic buffer coupler, and measures taken to increase the trailing loads of trains led to the growth in traffic.

In the '50's passenger traffic in and around Calcutta had risen to 3 times the pre-war level. No further improvement in the condition of travel was possible under steam traction. This called for the electrification of the lines. The first phase of the electrification was sanctioned on 4th June 1954 based on reports conducted which brought out the increase of capacity following electrification as below:

Section	Goods Line Capacity Under Steam Traction (1954)		Increased Goods Line Capacity Under Electrical Traction	
	Up	Down	Up	Down
1. Haora-KGP	18	13	25	25
2. KGP-Tatanagar	9	9	11	11

Source: Bhandari,

The increased traffic density, heavier axle-loads and higher speeds necessitated a heavy track structure and improved methods of maintenance. Long welded rails in 1 Km long panels is now standard track on trunk routes. The use of concrete sleepers is being progressively introduced to cater to heavier axle-loads and higher speeds on main-line routes. The shortage of wooden, steel and iron sleepers make it incumbent on the railways to go in for pre-stressed concrete sleepers. The demand for faster trains and heavier density of traffic made the introduction of track-circuiting desirable for ensuring a higher standard of safety in station yards, on trunk routes and on busy suburban sections. The time-tabling of trains was extended to goods trains, as the means of communication and the instruments of effective control over goods movement improved.

The increased traffic calls for the opening of further lines besides their augmentation, the improvement in the signaling and route relay system and the usual technical procedures involved in the maintenance of lines. It also necessitates the construction of a *car-shed*, the shifting of the goods yard elsewhere. For opening of more lines along existing rail route the topography, the position of cables and economy to be achieved

are to be kept in mind. It is essential to utilise the provisions already existing to the maximum. As far as possible the entire alignment of the proposed new lines and allied constructions are to be kept confined within the existing railway boundaries.

As early as 1960 the railway board had desired to establish a rail link with the port of Haldia through Kharagpur. A survey was conducted on the proposed Jakpur-Haldia alignment in 1960 and it was then decided that the take off point should not be from Jakpur (8 kms away from Kharagpur) but from Panskura from the land acquisition-and engineering point of view. The line was finally opened for traffic in the mid-seventies. Thus the rail link in Kharagpur and Haldia port was established through Panskura.

Electric Multiple Unit (EMU) services were introduced in 1968 over Haora-KGP suburban section. This reduced the travelling time and troubles faced by the passengers in the long journey. Reduction in travel time caused an increase in the frequency of train services. The frequency of train services also increased with the construction of more rail lines. Through trains can pass along the middle line uninterrupted by movement of local trains. For the undelayed entry / exit of these fast long-distant trains several lines have been built near the Kharagpur station. Moreover separate platforms are allotted for them. Generally local trains are not allowed to halt at those platforms from where the fast trains pass, unless of course there is some emergency requirement (such as an accident or train derailment or some mechanical defect). The goods trains are not allowed to pass through the 8 platforms at Kharagpur station. They have entirely separate lines. During the pre-independence period there existed 4 platforms along with an over-bridge for the movement of passengers from one side of the station to the other. With the increase in trains particularly during the 70s (the decade of passenger explosion) the increasing pressure of the commuting population caused the Railway authorities to take the decision of constructing two new platforms particularly for the EMU Local train services to and from Medinipur as well as Passenger Trains along the Adra-Gomoh line. This along with the electrification of the Kharagpur-Medinipur line and henceforth the extension of the EMU services to Medinipur somewhat catered to the needs of the floating population. The older over-bridge was abandoned on the construction of a larger over-bridge close to it. Since Kharagpur is a big junction and it was not feasible to have an EMU car shed near this station and so this car shed has been constructed with 22.5 rakes holding capacity at Panskura, 45 Kms away to the

east. As it was centrally located Panskura had been chosen since it would be better suited to serve EMU services of Haora-Kharagpur as well as Panskura-Haldia.

It was decided in 1984 to increase the line capacity between Kharagpur and Rourkela which is an electrified route passing through the rich mineral belt. This required the splitting up of block sections, additions and alterations in the existing yards (including that of Nimpura) casing of grades and improvement in the signaling system. Care was also taken to avoid the lines at the junction points for through traffic [Source: Railway Project report, 1984]. It is also desired to link up Digha (in West Bengal) with Jaleswar (in Orissa) forming a loop to avoid congestion at Kharagpur (Nimpura) Yard for through traffic from Calcutta towards Chennai. This will be beneficial from commercial as well as operational point of view.

The Haora- Kharagpur line is the busiest consisting of 4 lines (upto 2 Kms from Haora) which converges into 3 lines upto Panskura (the 3rd line was constructed in 1968) and 2 lines upto Kharagpur. The two lines between Panskura and Kharagpur are provided with unidirectional automatic signaling in up and down directions. All these lines deal with local trains, Mail/Express, Passenger trains, through goods trains, shunting trains and other works trains. The lines between Kharagpur-Haora was doubled in the beginning of the century but this was not sufficient. A third line was constructed between Tikiapara and Panskura in 1968. With the growth of industrial and suburban traffic of this area, urgency was felt for augmenting the line capacity as well as terminal facilities for this section. Accordingly, a few surveys had been sanctioned by the Railway Board including the survey for the 4th line between Santragachi and Panskura and the third line between Panskura and Kharagpur. The entire alignment of the proposed new lines and allied construction have been kept confined within the existing railway boundaries and in conformity with the topography, position of cables and economy to be achieved by utilising the provisions already kept in the sub-structures for the 4th line on the Rupnarayan bridge and the Medinipur Canal Bridge.

The Kharagpur-Tatanagar section was electrified on 4th January 1963 resulting in a reduction in travel time. This reduction was more rapid after the introduction of the MEMU services in 1995. The MEMU services also caused an increase in frequency of trains as well as the extension upto Calcutta in the east and Asansol in the north. This extension train service halts at limited stations between Kharagpur and Haora but halts at all stations elsewhere.

The line towards the north is significant as it links up the city with the national capital. This line is, however, electrified upto the town of Medinipur and the line towards the southeast links up the city with southern India. Along the Haora-Kharagpur line the ruling gradient is 1 in 200 with a maximum degree of curvature of 7° while that along Kharagpur-Tata line it is 1 in 125 and 3° respectively and along Kharagpur-Bhadrak line it is 1 in 150 with a curvature of $3\frac{1}{2}^{\circ}$.

Passenger Traffic

To determine the passenger flow the inward-outward flow data has been collected and compiled. The outward passenger flow has been determined on the basis of train frequency per day, train frequency at peak hours and at non-peak hours; regular passenger flow based on point to point sale of seasonal (i.e. concessional) tickets from Kharagpur rail station and irregular passenger flow based on daily tickets sold from Kharagpur. The inward passenger flow towards Kharagpur involves the collection of such data from other stations with which this railway junction is linked. The passenger traffic density has been expressed in terms of number of passenger train per day taking into account both the up and down lines directions as depicted in fig no. 15.

Compared to the road network with its flexibility the railway network serves little as an intra-urban transport mode. However, the volume of long distant passenger traffic by rail exceeds that by road several times because of greater carrying capacity over a particular area and at a particular point of time, greater speed and hence lesser travel time, lesser inconveniences (caused due to bottlenecks / congestion, jerking, air and noise pollution).

Intra-urban movement by rail

There was a shuttle train service, known as "Nimpura Workmen's Train" meant solely for employees of the railway workshop residing in the western part of the city. The railway workshop runs on a shift system and based on this shift system the train used to run thirteen trips between the railway workshop and Nimpura in the west (during the peak hours). The time taken to cover the entire journey was 15 minutes and the train used to halt for 30 seconds near important railway settlements (New Settlement and Mathurakati Settlement) and near the wagon shop. This train service has however been discontinued as it was running at a loss.

The local MEMU (Modified Electrified Multiple Unit) trains and passenger trains coming from the west have an unmanned halting point (locally known as *Bara number*) near the railway settlement. This halting point with no ticket counter or any such railway service (platforms, electricity, tap-water) has become an unofficial halting point due to persistent chain-pulling by the passengers as the main rail station is quite far and there is no significant intra-urban bus service resulting in extra transport cost and wastage of time. As for the EMU and passenger trains heading northwards a halting platform known as *Giri Maidan* has been constructed with a ticket counter attached to it. This has been a great relief to the residents residing in the northern part of the city. This halting point in future may become a large suburban station of Kharagpur-Medinipur urban complex. Passenger trains heading for south have a halting station locally known as the Hiji station which are beneficial for those residing in the southern part of the city.

There is a significant pull towards the east generated by the metropolis of Calcutta for various purposes which accounts for a regular daily/weekly movement pattern of passengers from Kharagpur. It will result in wastage of time and money for these regular passengers to come all the way to the junction or leave it ^{via} ~~by~~ the cycle-rickshaw which is not only slow moving mode but also adding to the recurring expenditure incurred in movement. Another pull is exerted in the north by the district head quarters of Medinipur with its various institutional services. Those residing in the northeast and southeast avail the frequent regional bus services but those residing in the west would have to come to the bus terminal located near the rail station by *ricks*haw or personal vehicle. The halting station of *Giri Maidan* is therefore a great boon to them. So the halting points however poor in appearance they may be are of great significance for the residents of this city.

Inter-urban / regional Passenger Flow

The inter-urban passenger flow of Kharagpur by rail can be broadly classified into two types- the outward flow from Kharagpur and the inward flow to Kharagpur. Again both these may be culminating in a) regular flow pattern as determined by the point to point sale of seasonal (monthly) or quarterly tickets and b) An irregular flow pattern as determined on the basis of daily tickets sold.

The outward flow from Kharagpur is much more intense than the inward flow because of the obvious pull of the metropolis. In fact the overpowering pull of Calcutta is dominant in shaping the pattern of movement. As evident from figure no. 15, there is a significant

flow of passengers to the east with its several attractions – jobs, education, commercial and other institutional activities. EMU services were introduced on Haora (Calcutta) – Kharagpur section in 1968 and extended upto Medinipur in 1984. At present the number of EMU trains on this section is equal to 13. At present the service consist of 8 coaches EMU rakes with a crush load capacity of 1640 on an average. A survey team of railway observed that on an average a little more than 2700 passengers per train arrived at Haora during peak hours and 1150 passengers during the non-peak hours. This indicates the nature of overcrowding beyond the crush load capacity during the peak hours and also the “pull” exerted by the metropolis.

The inter-urban short distance local (suburban) services include the following:

- (1) Kharagpur ↔ Medinipur; Kharagpur ↔ Adra; Kharagpur ↔ Gomoh in the northern direction. Of these the Kharagpur ↔ Medinipur are EMU trains while the other two are non-EMU.
- (2) Kharagpur ↔ Haora (Calcutta) generating the maximum traffic particularly in the Down directions i.e. towards the east. Many of these EMU services have been extended upto Medinipur since the electrification of the line between Kharagpur and Medinipur in 1984.
- (3) In the western direction are Kharagpur ↔ Dhalbhumgarh (along Tatanagar route is a non-EMU train); Kharagpur ↔ Tatanagar; and Kharagpur ↔ Asansol via Tatanagar are the MEMU trains and passenger trains.
- (4) Towards the southeast is a local Kharagpur ↔ Bhadrak MEMU train service which generates the least traffic of all the four directions.

The commuters consist not only of residents of Kharagpur and the neighbouring areas, but hail from even far off towns and villages. Bus service to and from Medinipur town was quite frequent but travelling to the metropolis of Calcutta was preferred by trains. The train with a much greater loading capacity, an uninterrupted and hence quicker travel time lured many passengers to come by bus to Kharagpur railway station and then to board a train to reach their destination. This resulted in overcrowding of local trains. The demand was so great that besides passenger trains, through long distant Mail and Express trains were forced to halt at Kharagpur station for 30 seconds initially. The daily commuters started commuting by these trains too although seasonal ticket-holders are not legally permitted to do so. Short distant Express Trains like the Purulia

Express, The Steel Express, the Rourkela Ispat-Jarsugda Express, Bhagajatin Fast Passenger etc. - are the trains which daily commuters prefer to and from Calcutta ^{it} prefer over the local EMU trains as the travel time is shortened to even less than 2 hours.

These local train services connect the people of Kharagpur with all intermediate stations on the different routes and vice versa i.e. there is a closer knit spatial linkage established. Greater spatial linkage is established by means of several other short distance inter city train services originating from / destined at Haora. These are the various express and passenger trains whose first halt is at Kharagpur on departing Haora. Since these serve as through trains from Kharagpur towards Calcutta during the peak hours most of the daily commuters avail of these train facilities. Hence in determining the flow of passenger these train services have also been taken into account.

The crossing of major trunk lines makes the density higher than ^{it} what would actually have been otherwise. People avail of the train facility not only for short trips (daily) but also for occasional long distance trips to various parts of the country. A significant section of this passenger traffic is accounted for by persons residing outside this city. Since Kharagpur is the only important rail junction of the district, people wishing to travel to any part of the country do so by coming to Kharagpur for this purpose instead of going to Calcutta. In order to have the seats reserved for the pre-planned long journey the travellers are to purchase tickets in advance. So those residing beyond the city limits of Kharagpur prefer to do so by purchasing their tickets from the computerized rail reservation offices at Kharagpur instead of going all the way to Calcutta. This computerization has been a further advantage for the passengers. This is because there is an allocation of a fixed number of reserved seats for passengers boarding the train from Kharagpur. If the quota is already filled up, long distance purchase of tickets for the passengers has to be done from the metropolis of Calcutta which can be done through satellite links. The long journey trips are occasional ones, not forming a regular and constant feature of the passenger flow and hence has not been represented on a map.

A consistent correlation between the growth of population and growth of rail passenger traffic has not been noticed at Kharagpur. This is perhaps due to continuance of significant level of dissatisfied demands. This is evident from the fact that out of the total

EMU trains running between Haora and Kharagpur – Medinipur only 29% originate / terminate on the Panskura-Kharagpur-Medinipur section.

Goods traffic By Rail

The spatial interaction at the national level is best displayed by the mode of rail as the trains can cover much longer distances with a greater quantity of goods than roads. Inter-regional trade in a number of commodities like food products, raw materials and manufactured goods gets stimulated within the national economy due to the existence of a common currency and transport network and also due to the absence of tariff barriers. The exchange of goods between the producing and consuming centres results in a regular pattern wherein the commodity flows get linked with one another.

Kharagpur being a junction point also acts as an originating / terminating / as well as a transshipment point through which this spatial interaction takes place not only at the regional level but also at the national level. The role of Kharagpur as a transshipment point was significant since its initiation. This is indicated by the fact that passenger work (i.e. maintenance of lines dealing with passenger trains) was done on one side of the line and the goods work on the other side. Sufficient space was left between the goods shed and passenger station (platforms) for admission of the required sidings being laid. The goods shed side was fixed with reference to the convenience of traders i.e. it was located on the same side of the line as that of the large trading mart of Kharagpur- the Gole Bazar.

A proper working of goods trains involve shunting and securing of vehicles; working of ballast trains, train lighting, maintenance of lines and inspection of permanent way (on foot). The time taken by goods in transit between stations is so slow as seriously to interfere with the proper development of traffic. The delays are permitted to occur at starting, at intermediate and at engine changing stations and junctions en route. Arrangements are not made for loading consignments for one station in the same wagon or wagons for the same point i.e. for junctions, terminals for given point and stations beyond, so as to avoid further delay in shunting and finding loads at intermediate stations. To avoid the delay in transit and increase in the service of train for goods (as well as passengers) was felt essential. Such a service increase was made possible with the opening / extension / augmentation of the rail lines along with automatic signaling system and conversion to concrete slippers.

With the conversion of wooden sleepers into concrete cemented ones, electrification of lines along with the augmentation of lines, the line capacity increased tremendously. This along with the rising population (hence demand-supply) led to an increase in spatial interaction. This resulted in tremendous increase in volume of both goods and passenger trains which in turn led to the shift of the goods yard from the Kharagpur railway station complex to Nimpura, 6.5 kms away to the west of Kharagpur. The one which exists at present in the station area deals with a much larger fraction of goods brought by rail transport to Kharagpur. The sprawling Nimpura yard plays the vital role for the freight operation of Kharagpur Division.

The Marshalling Yard receives and despatches thousands of wagons daily. It has been mechanised to increase the handling capacity and reducing the incidence of damage to wagons and their contents. This Marshalling Yard covering an area of 22,01,260 sq.m and stretches from east to west between Kharagpur-Kalaikunda stations over a length of 5.6 Kms. It is one of the major yards of the South Eastern Railway. It is Hump Yard of Uni-flow design consisting of the following subsidiary yards: Reception Yard, Classification Yard, Departure Yard, Through Yard.

The Marshalling Yard was mechanised in October, 1969 utilising Kyosen retarders. The equipment has been designed for a maximum humping capacity of 4,600 wagons a day and to cater for 7 Classification grids. The hump tower is provided with a panel depicting the layout of the Reception and Classification Yards. The equipment provides for sorting of five consecutive cuts at a time. The Hump Yard consists of two master (primary) retarders and 4 group (secondary) retarders. Each group retarder controls 6 lines. All points are electro-pneumatically operated in the Classification Yard. Fullness of the sorting lines is recorded at the panel by means of axle counters provided on each classification lines. Paging and talk-back facilities have been provided in Reception and Classification Yards for inter-communication.

Three-phase local power supply is available at the hump tower withstands - by a diesel generator set. A three-phase power supply from Workshops has also been provided to eliminate dislocation to humping operations. Three compressors are available out of which one is driven by a stand-by diesel engine. Only one compressor is required at a time.

Reception and despatch of trains as also the inter-yard movements are so oriented that cross-movements are reduced to the minimum. A special feature of the Nimpura yard is the provision of six fly-overs in order to ensure uninterrupted movement on the main entry and the exit routes.

The Reception Yard consists of ten reception lines, one engine run-round line and four dead-end sidings. Trains can be directly received from all the four directions into the Reception Yard. The natural forward entry into the Reception Yard is from Tata (west) and Adra (north) sides. Trains coming from Bhadrak (south east) travel on the southern periphery of the Through Yard over the Fly-over across the Tata trunk routes and Adra Goods Reception and Departure lines, for isolated uninterrupted movement. Similarly trains from Howrah-Shalimar section (i.e. east) move from Kharagpur fly-over. Engines of all trains have their exit in the forward direction from the Reception Yard. However, generally, release of engines obstructs humping of trains, but humping can continue uninterrupted from the North grid while an engine from the South grid is released to go to the shed.

The Master Plan of the Classification Yard consists of grids with 42 lines of which only 27 lines are commissioned in 5 grids. Nimpura Marshalling Yard forms and despatches solid blocks for Calcutta, Shalimar, Tata, Bondamunda, Haldia, Waltair, Khurda Road. Classification lines are accordingly nominated. Rest of the lines in the Classification Yard are utilised for collection of the local wagons including POH wagons for the shops, and empties.

There are 11 lines in the Departure Yard inclusive of an engine line. Facilities have been provided keeping in with working of a Uni-flow Yard, for despatch in various directions without cross-movements. In the Departure Yard lines 1,2 and 3 are un-wired. Line Nos. 4 and 9 are fully wired, Line Nos. 5 and 6 are top-wired at Tata and line nos. 7 and 8 are top-wired at both the ends for facility of despatch in both UP and Down directions. With the help of Fly-over No. 2 departure towards Tata and towards the east coast has been isolated from the Tata-Kharagpur Down Mail Line. Departure towards Kharagpur is, however, direct in the Down direction.

The through Yard is situated south of the Marshalling Yard with suitable connection for reception and despatch in all directions. This yard is meant for reception and despatch of through blocks loads in both Up and Down directions which are not required to be dealt with at Nimpura Marshalling Yard except for change of staff or if necessary for change of traction. [Source: An inspection report of Kharagpur complex, SE Railway, 1980].

Of all the flows, the commodity flows may be considered to be the most important links amongst the regions by means of which any region can avail itself of the natural advantage of its region and can compete with those of other regions in disposal of their products in several regional markets. Kharagpur is an important rail junction and so goods arrive into the city from different directions both by passenger trains (in small lots) and goods trains (larger quantity). This city is well linked with all the four major metropolitan cities as well as other urban centres of the country.

The basic data on commodity flows have been aggregated at different levels particularly the point to point flows. The analysis has been done mostly in terms of weights and not in terms of monetary value because the range of prices for each commodity is very large and the prices often fluctuate; the average price calculation would not always give the true picture.

Commodities originate from the areas of production and terminate in the areas which are either points of intermediate consumption, final demand or are the points of transshipment. Both the outward and inward freight consist of two categories –the light goods (mainly perishables) and the heavy goods and hence separate graphs have been shown on the basis of the data compiled from the Parcel office, the Goods Shed (within the station) and the Goods Yard for at least a period of 1 year (1995). With the help of the "comparative statement sheets obtained for 6 years i.e. 1990 to 1995 a graphical representation has been done year wise taking the help of computer (software- MS Excel) as the statistical representation of the varied volume of data would be next to impossible manually. Where the data range was very high the graphs have been represented with the help of the log scale. All the different aspects of goods traffic have been also graphically represented

Fig No.16 : Inward Traffic of Light Perishable Food Items of Kharagpur (1990-1995)

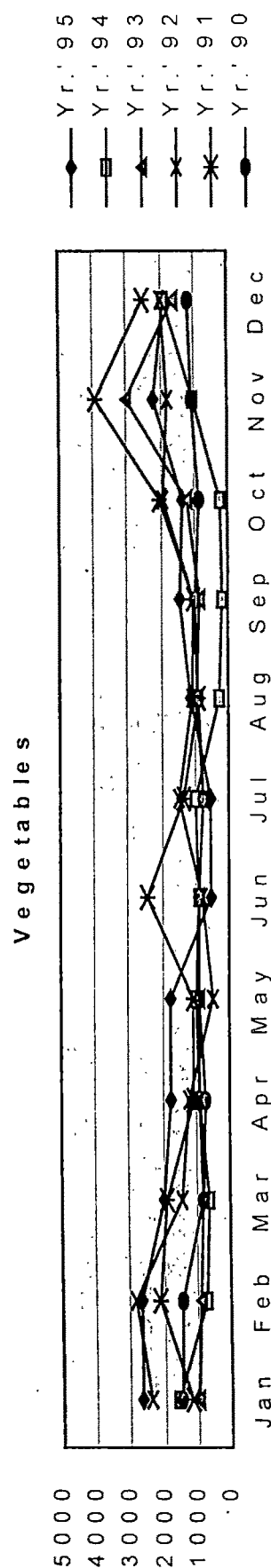
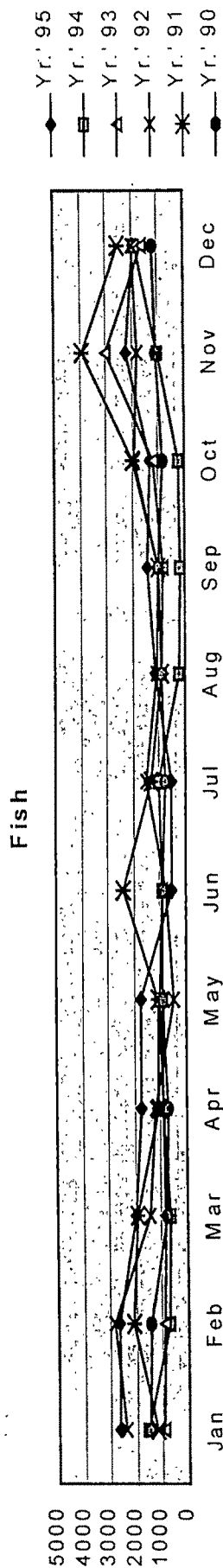
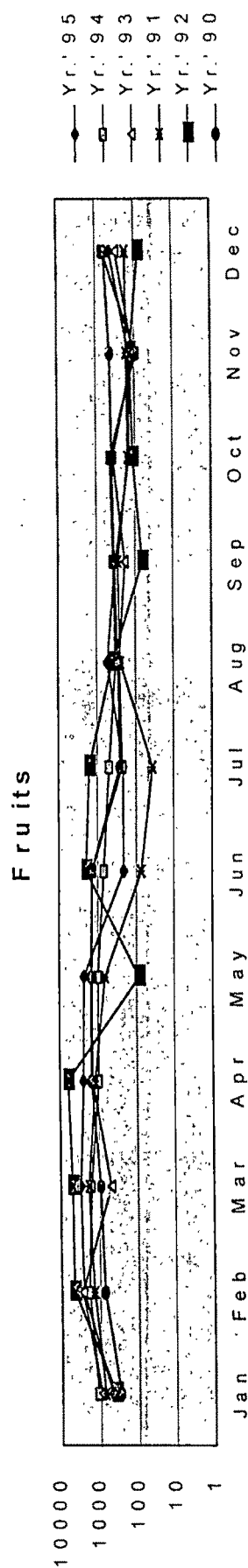


Fig No. 17 : Outward Traffic Of Light Goods from Kharagpur (1990-1995)

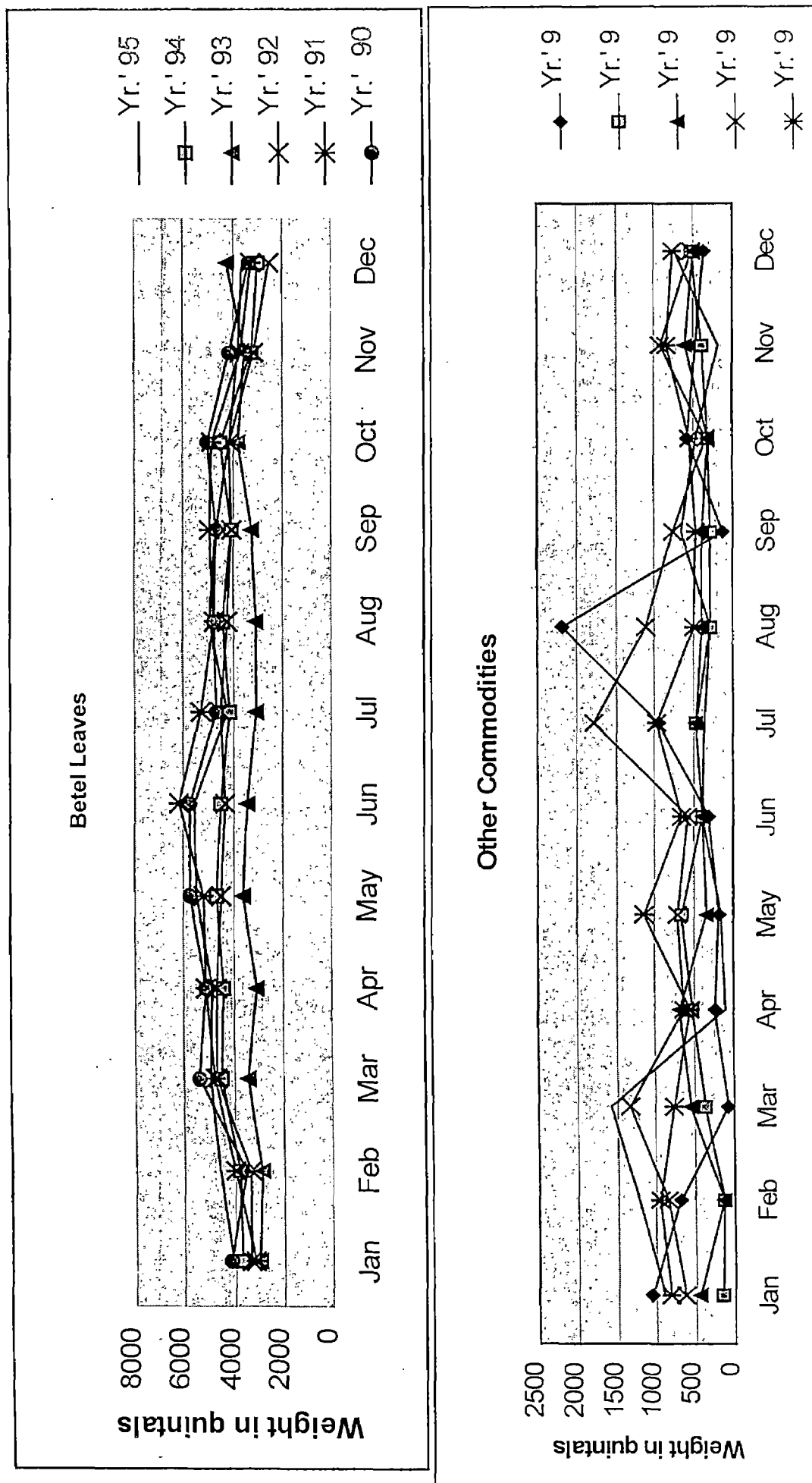
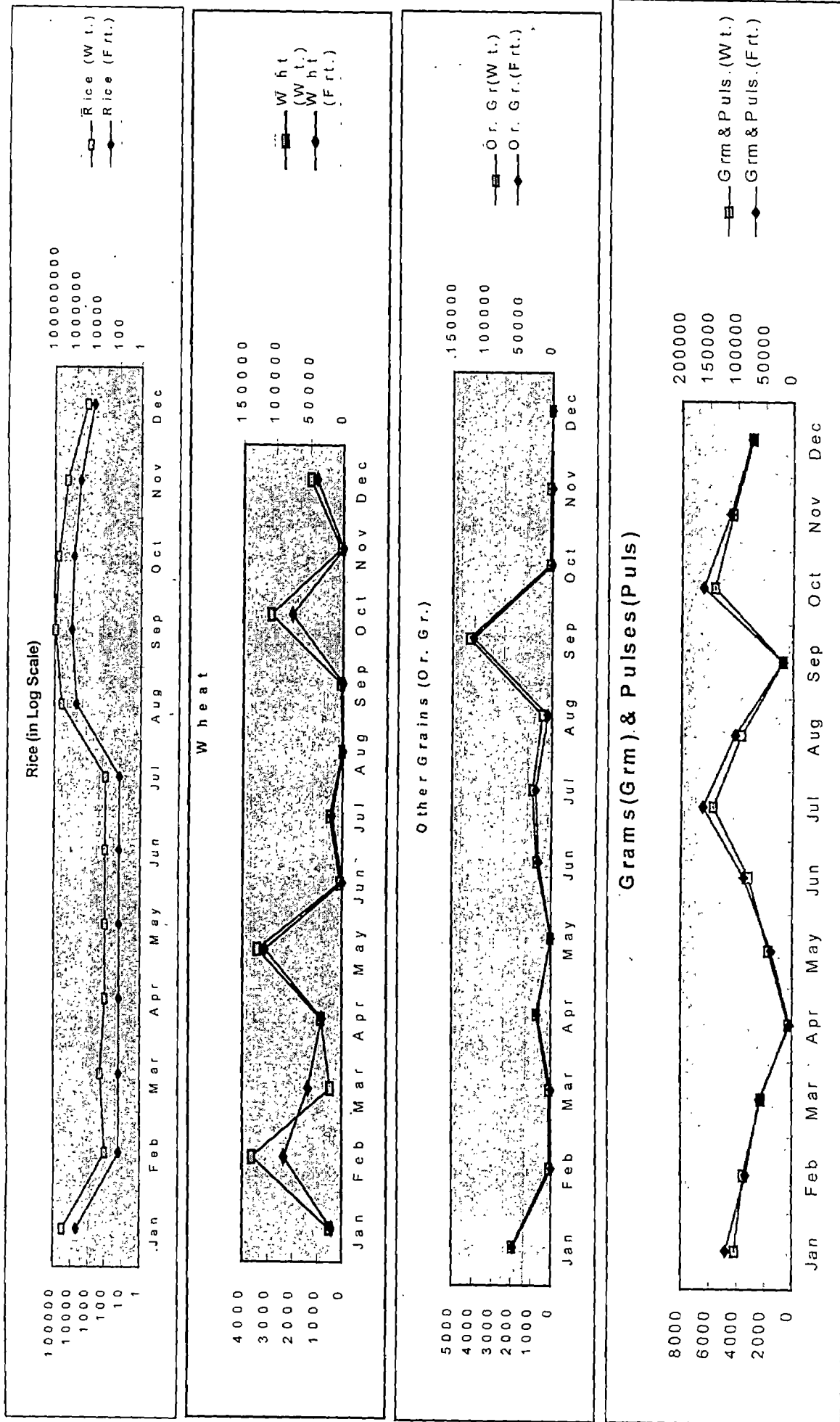


Fig No. 18 : Inward Traffic Of Heavy Goods at Kharagpur (1991)



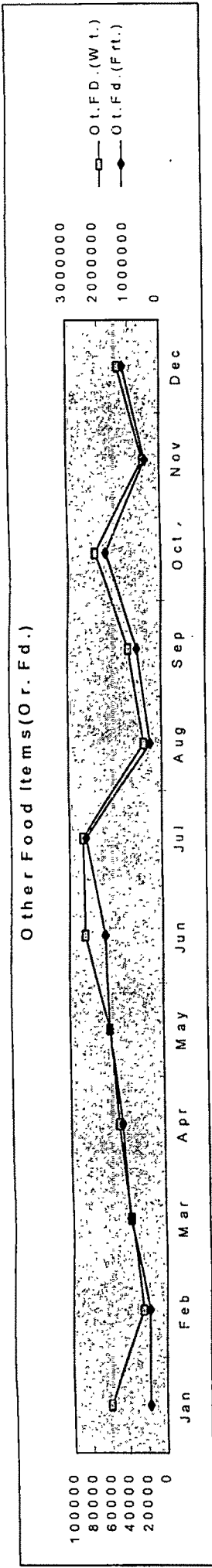
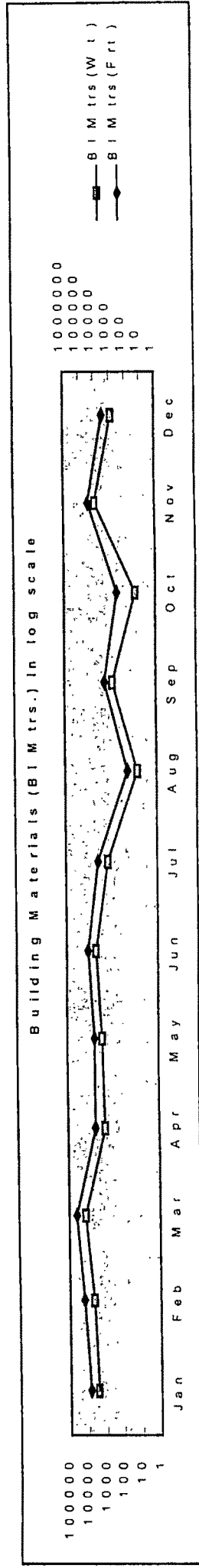
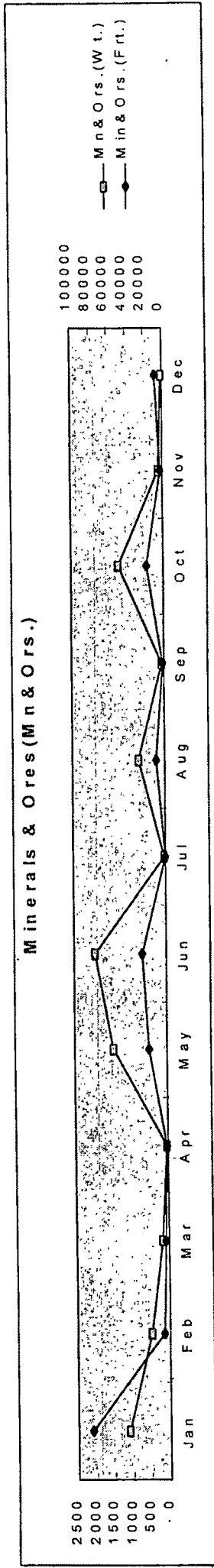
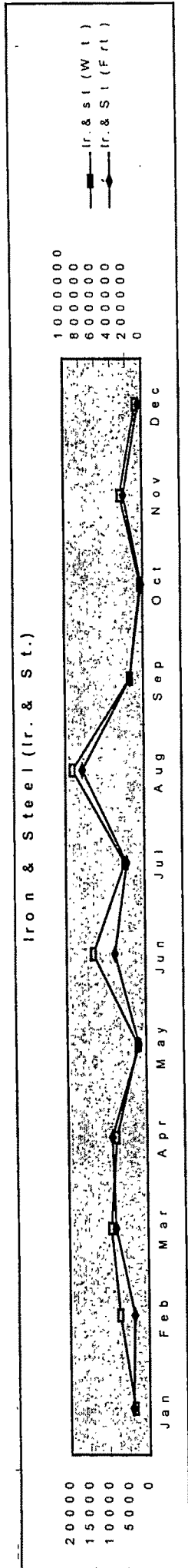
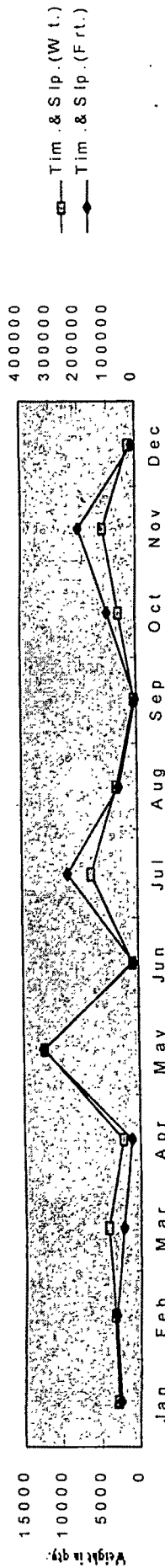


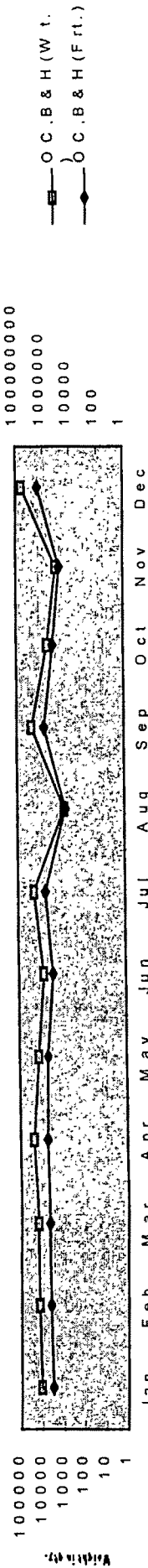
Fig No. 19 : Heavy Goods Traffic of Non-Food Items (1991)



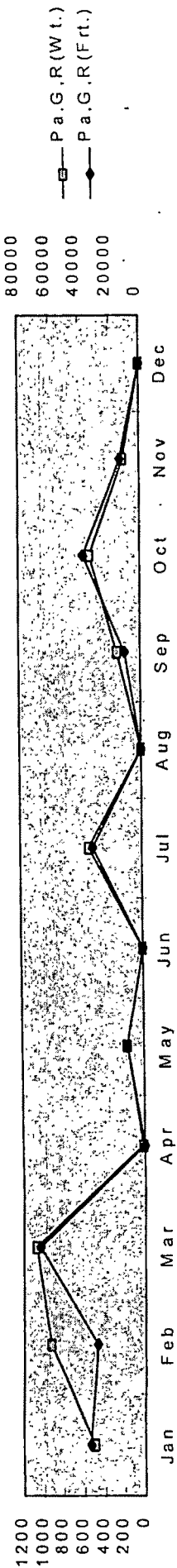
Timbers & Sleepers (Tim & Slip.)



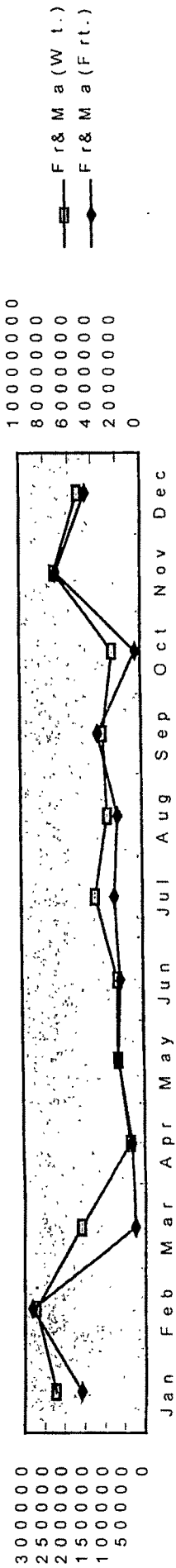
Oilcake, Bran and Husk (OC, B & H) in log scale



Paper, Grass, Copra, Sabairope (Pa,G,R)



Fertiliser and Manure (FR & Ma)



Different areas depending upon their economic base, tend to have different participation rates in the flows of different commodities. The movement of food products depends upon the agricultural situation during a particular year. The relative concentration of originating and terminating freight in the case of food grains is high because of the extent of population concentration as well as due to the regional specialisation.

There is a significant variation in the production of goods (agricultural ; non-agricultural) in different parts of the country. Wheat is grown in western part of India while paddy in the eastern part. So more of wheat is imported than rice as indicated by the fig number/8 Betel leaves are produced in significant quantities in the district of Medinipur and the neighbouring districts of Orissa and therefore arrives into this junction from two directions- one is from different stations on the Haora-Kharagpur route in the east and the other is from different stations in the south east particularly from Orissa. Since betel leaves have a huge demand all over India, on their arrival they are despatched either along the western route heading for Mumbai or along northern route heading for Lucknow, Allahabad and Delhi. Fish forms another outward(parcel)traffic- the fish from Orissa is sent to Haora to meet the needs of the metropolis. The outward traffic has been represented graphically (fig. no 17.).

Food products move from the surplus areas to deficit areas and there are wide annual fluctuations (as depicted in the graphs) depending upon the agricultural situations in the country. As in all urban centres Kharagpur too has a significant amount of inward traffic (terminating) compared to the outward traffic. The inward traffic of food-items (specially perishable items comes from various parts of the neighbouring states by rail as well as by road. Here the inward flow (by rail) has been depicted graphically (fig. nos.18-19...).

According to the seasonal production of the green vegetable there is a seasonal variation in the arrival of these items due to the strong role played by the demand-supply mechanism in the market. The volume of items reached in small lots varies from day to day and all different types of green vegetable arriving in any one particular day does not arrive daily. Hence the exact volume per vegetable type is difficult to ascertain and therefore their average volume per vegetable type item wise per basket per bag has been determined after random sampling of the data obtained from the Parcel office of Kharagpur rail station. Vegetables like green chilli, ginger, potato, onion (potato and onion are mostly brought by trucks plying on the roadways) and fruits like banana arrive daily as they are consumed daily by the people. Vegetables like lady's finger, drumstick,

"parbar", gourd and pumpkin and fruits like mango, jackfruit, grapes, cucumbers, water melons arrive in summer while items like radish, carrot, cauliflower, cabbage, coriander leaves, brinjal, bean and tomato and oranges arrive in winter. The number of items and consequently their volume falls in ^{the} rainy season because of their perishable nature as there is a greater risk of rotting and also because paddy cultivation is carried on and less vegetables are produced. As for fish the demand is high and forms a daily item. Fish is essential item required by the Bengalees daily as a source of high quality protein (100 gms of fish consumed produces more protein in the body than same quantity of pulses consumed) and so it arrives daily (one container having more than 50 Kgs weight. Fresh fish arriving from a shorter distance are brought in large aluminium container, the water being changed frequently at the stations enroute where the train halts. Living fish arrives into the city mostly through local trains from the east and south-east where there are vending facilities –separate vendors bogie being allotted – one near the front part of the train and the other near the rear. It comes from Jakpur, Madpur, Haur, Panskura, Mecheda, Kolaghat (all in West Bengal) in the east and from Balasore, Puri, Bhadrak, Bhubaneshwar, Rourkela in Orissa. The fish which comes from a longer distance particularly Andhra Pradesh (Rajmundry) are preserved with the help of ice blocks and salt. Fresh green vegetable coming as small lots by trains crossing this junction vary in their weight according to the number of gunny bags / baskets. Generally one bag / basket can hold 50 kgs (in the case of radish; green chili; fruits, beans, drumstick, peas); 60 kgs in the case of ginger, brinjal); 70 kgs (in the case of potato, lady's finger) but only 10 kgs in the case of betel leaves and 30 kgs (in the case of cauliflower). Coriander leaves and tomato besides being perishable are fragile requiring spacious airy packing while cauliflower is a space occupier because of its size. The green vegetables besides coming by road also arrive by rail from the neighbouring states of Bihar (Ranchi noted for cauliflower and ginger), Orissa (Palasa noted for drumstick). The tropical fruits like mango, jackfruit, guava arrive from the neighbouring areas while sub-tropical fruits like grapes come from different parts of the country like Chennai, Secundrabad etc. and oranges come from Nagpur, Hyderabad etc..

Chickens are brought from Orissa (Khurda, Cuttack, Bhubaneshwar). They arrive in caged airy compartments and the eggs arrive in cardboard compartments. A distinct distance decay factor is noticed in the case of the arrival of the perishable items. The fact that large volume of traffic terminates over short distances testifies to the operation

of the “friction of distance” and to the consequent realization of the economies of scale at several locations.

At Kharagpur perishable food items normally arrive in small lots and are booked as *parcels* from different stations on passenger trains while non-perishable food items as well as other non-food items arrive by goods train, some of it for serving the city but most of it is despatched elsewhere thus meeting of the demands of different areas of the district as well. This is done through the *arat* at Gole Bazar the only wholesale market of the district. Non-perishable food items which arrive into the city consist of major food-grains (rice, wheat), other food grains (less significant), grams and pulses (fig no.18.). The quantity arriving daily by rail is however much lesser than that arriving by roads. This is because of the inordinate delay in the settlement of claims. It is not always possible for an entire wagon to be booked by one person.

The SE Railway accounts for only 12% of total rail lines of Indian Railways, but it carries over 30% of the total goods traffic on all the railway zones together and a large portion of this is dealt with at Kharagpur Rail Junction Station. Although the originating loading of the Kharagpur Division is quite small as compared to the total originating loading of this Railway, efforts are being made whenever possible to lift whatever tonnage could be offered from any quarter. The available evidence on commodity flows therefore indicates a weak involvement of the city in the production system of the country and is thus a centre of consumption (due to its high population) rather than of production as revealed by the receipts and shipments. The receipts are linked with the consumption and shipments with production. It is also evident that the requirements of food products increase in direct proportion to the increase in population size.

The rail junction is not only an originating station but also a destination station; the latter being more conspicuous through the inward pattern of traffic compared to the outward pattern as depicted by the graphs also by the number of loaded wagons originating (25.7 on an average and having no rakes) & terminating (8.69 on an average with rakes) at Kharagpur. The monthly average figure has been derived from the statistics available (for the year 1995) at the operating Department, Goods Yard, Kharagpur. The average traffic density in terms of gross metric tonnes / annum along Kharagpur-Panskura line in the east is 18.28; along Kharagpur-Tata line in the west is 12.80 and along Kharagpur-Bhadrak line in the south east is 10.66.

The standard wagon on Broad Gauge was evolved as a 10.31 tonne tare 4-wheeler with a maximum leading capacity of 22.19 tonnes. A large number of new long-distance trains were introduced in the '70s – the decade of passenger explosion. In the '50s passenger traffic in and around Calcutta had risen to 3 times the pre-war level. Haora and Sealdah stations along with surrounding sub-urban stations had reached saturation and no further improvement in condition of travel was possible under steam traction. Electrification reduced the travelling time. As the burden of carrying additional freight for the new steel plants at Bhilai, Rourkela, Durgapur, the expansion of steel plants TISCO and IISCO and increase in coal production in Bengal and Bihar fields, developed mainly on eastern and SE Railway, the main and heavy mineral lines in these areas were electrified.

Marshalling Yard receive and despatch thousands of wagons daily. The Marshalling Yard has been mechanised to increase the handling capacity and reduce the incidence of damage to wagons and their contents. The Kharagpur work-shops have been modernised to cope the increasing maintenance demands of new additions (phase I & II) to the rolling stock fleet.

There was not only an increase in passenger traffic but also an increase in goods traffic as well. Kharagpur junction became an important transshipment point besides inflow traffic. The outflow of goods and parcels were much lesser than the volume of inflow. Nearby stations like Panskura, Mecheda sent large volume of betel leaves daily to Kharagpur to be transshipped to different parts of the country through the different railway routes diverting from here. Local trains provided for monthly vendor facilities which the poor farmers and fishermen found advantageous. They brought their produce daily from Jakpur, Madpur, Haur, Panskura Bhogpur, Gomoh, etc. to sell it at the Gole Bazar *arat* either directly to the consumers or indirectly through agents. Traders of consumer articles purchased their goods from Calcutta to sell them at Kharagpur at an increased rate. They usually come to Calcutta on Thursday (the day when shops remain closed at Kharagpur) and purchase weekly goods, though some come even on other days. This is evident if one goes from Calcutta to Kharagpur on Thursday particularly in the evening by the Purulia Express and the Steel Express –a greater rush with larger number of bags and articles causing inconvenience to all passengers of those trains.

Maximum line capacity utilisation of goods train from Kharagpur is seen along the south east of 90%, followed by the western line of 87%, northern line of 85%, eastern line of

75%. The Nimpura to Gokulpur line has been utilised the minimum i.e. only 24% and so calls for greater utilisation in future to ease the traffic towards the north [Source: Inspection of Government Report, 1992]. In regard to freight operation the major role of Kharagpur Division of the SE Railway therefore lies in handling through traffic besides supplying empties to Chakradharpur Division (in Bihar).

It was considered necessary to aggregate the commodities into a number of internally homogeneous groups. Food products are classified into food-grains and non-food-grains. Rice and wheat, being the major food grains have been considered separately while all other food-grains have been grouped under a third category of other food-grains. Gram and pulses have been considered as a separate group. These commodities are generally collected in the *mandis* and then stored in godowns and are shipped to different deficit parts of the country. The food-grains arrive either in jute gunny bags or in synthetic bags. Fresh vegetables and fruits are shipped from nearby railway stations from the producing areas in small lots to a large number of destinations in different parts of the country and the gunny packets which are booked for Kharagpur are received by the department of Parcel Office situated in between two platforms of the station complex. Fish and poultry and dairy products also arrive in a similar manner. The (poultry item) arrive in caged airy compartments and the eggs in cardboard compartments.

Mention must be made of betel leaves which are produced in the district of Medinipur and brought into the city of Kharagpur by rail from Panskura, Bhogpur and Mecheda. It also arrives from the rail stations of Jaleswar and Dantun in Orissa in baskets (numbering 55 on an average daily) only to be transshipped to other parts of the country. The requirement of the city is met through the vendors each bringing 1-2 baskets weighing 10-20 kgs. utilising the local train service.

The Kharagpur division is therefore the main artery of the SE Railway through which the traffic for entire Calcutta area flows and the empties feed to steel and mineral belt for back loading. This division also serves a portion of the mineral belt of Bihar and the fertile agricultural zone of Orissa. The network of easy communication gave rise to movement of population from one region to another. This changed the pattern of demand for goods and services and the old patterns of traffic. With the improvement in transport the local markets too started coming into the fold of freight movement.

Kharagpur is an important converging-diverging junctions. Goods coming from different directions to Kharagpur are again sent to other places, making Kharagpur an important transshipment junction. The traffic from central, western, southern and some parts of eastern India converge at Kharagpur to feed Calcutta area and ports of Calcutta and Haldia. Based on the traffic surveys conducted on this route by the rail authorities it is estimated that the number of goods trains would increase to 35 eachway from 24 on Kharagpur-Panskura section and to 38 upto Haora (Calcutta) by 2020-21. So further augmentation of line capacity is essential on this route in addition to provision of extra coaches. Since the Kharagpur Division serves important industries and covers a major section of the mineral belt in India it has a huge potentiality and this potentiality is to be utilised to the maximum.

Road Network System

Roads are the blood streams of civilization and progress. In the words of Bentham, "roads are the veins and arteries of a country through which channels every improvement circulates". Road are used by various means of transport. Road transport is cheaper than others and it is transferable. There is complete freedom for the owner of a means of road transport (e.g. car, scooter) to ply it on any road or to transfer it from one road to another according to his need and convenience. Economy in time- for short distance road transport saves time of passengers. Diversity of interests- Maintenance and development of roads depend upon the Government and taxpayers. For this purpose carriages are taxed and the Government has to bear the responsibility of constructing modern types of roads. Road transport is flexible- Road vehicles may be diverted to any street or lane. Sometimes they reach the very door of the passengers which the railways cannot do. At the pioneering stage all that is needed is to clear a tract through the natural vegetation and to provide a few culverts over nullahs / streams. As traffic builds up, first a gravel surface can be provided and then tar-sealing. At the same time the culverts and bridges can be strengthened to allow larger and heavier vehicles.

Classification

Roads are classified according to their functions into five categories for administration purposes: NH, SH, Major District Roads (MDR), Other District Roads (ODR) and Village Roads (VR). National Highway constitutes the arterial routes through the length and

breadth of the country; connecting the state capitals and ports. They include roads of strategic importance. The NH6 establishes linkages of Kharagpur with eastern (i.e. Calcutta) and western (i.e. Mumbai) part of India. The SH are main traffic routes of states which would be the main arteries of transport within a state. The SH NO. 5 passes through Kharagpur. The District Roads (D.R.) are main branches from the NH or SH and take traffic into the interior parts of each district. MDR connects areas of production and markets between two neighbouring districts. ODR mainly function as interlinking roads between blocks/*taluks* within the district. The Kharagpur-Keshiary road and the Kharagpur-Malancho road (fig no 14) are included within the broad category of district roads. VR are roads linking villages with a higher categories of roads and urban centres. They are farm tracks, cart tracks, *kutcha* roads or metalled roads.

After the Nagpur Plan (1943), the next landmark in the history of road development in India was the Chief Engineers Plan 1961-81. A 20-Yr Road Development Plan was drawn up in the year 1961 by the Chief Engineers of the Statistical and Central Government. According to this plan every village in a developed and agricultural area should be within 6 km from metropolitan road and 2.5 km from any other road. Another 20-Yr Road Development Plan was drawn up for the period 1981-2000 and the follow up by the Government of West Bengal includes expansion of the NH and SH system which is being done by connecting new routes with the existing NH system (e.g. Sonamukhi to Kuli via the NH at Kharagpur) and by converting MDR into SH (e.g. Kharagpur-Keshiary road). Besides these, widening and upgrading of existing roads; providing road side amenities, constructing over bridges, footbridges, fly-overs are included within this plan.

The alignment of all the roads in the city is in an east-west direction. Most of the intra-city traffic to the urban core is brought by the OT and Keshiary road. Other important roads are the Malancho road, the Mosque road, the Keshpal road and the Jhargram road.

Within the railway and IIT area the rectangular pattern of the roads are a result of preplanned approach while in the Municipal area the road system does not follow any particular pattern. The roads geometrics forces the few automated vehicles in this part of the city to move at lower speeds. In the municipal area the growth was sudden and premeditated and hence the paths became roads which have developed without regard

to the requirement of the buildings and convenient allotment. This natural ^{average -} alignment has no distinct pattern.

Vehicular Traffic

To control and coordinate the motor traffic through out India, the Motor Vehicles Act was passed in 1939. It stated that motor vehicles are to run under a permit system, the permits being used by the Regional Transport Authority located at the district headquarters. Speed and volume (passenger and goods) restriction^s were also laid down [Srivastava. S.K].

Passenger traffic

According to the traffic census survey reports of 1937 it is learn^{ed} that on an average 1190 foot passengers and 230 cattle were seen moving on the OT Road daily while the fast moving vehicular traffic consisted of loaded/unloaded lorries (plying only during the day time); buses; 28-29 cars/taxi and 4-5 motor cycles. Traffic was significantly of greater volume during daytime than at night. The non-motor traffic consisted of four-wheeled carts, hackney carriages, bullock carts dealing with goods traffic and the *rickshaws* and cycles with passengers traffic; more than 670 such vehicles consisted of the latter type. The average weight of all traffic (motor; non-motor) was approximately 323.47 tonnes daily. Tangra a similar significant spot on the Kharagpur-Kesriary route was a large cattle mart where the average weight of goods traffic was 350.40 tonnes daily. However the fact that only 1 lorry and 5-6 buses^{es} were noticed here ^{indicate} passenger traffic was more or less of the same volume as that on the OT road. In the 70s the Kharagpur-Digha route resulted in a significant amount of traffic in view of the fact that Digha is an important tourist spot. At present different centres of the district of Medinipur establish good road linkage with the city of Kharagpur through the district headquarters. The fig no. 20-21 indicates the flow of passenger traffic on the roadways

Selection of Transport Mode and Route

When interaction between two land uses takes place a traveller will patronise the transport mode (or combination of modes) and route which takes the shortest travel time or costs the least from origin to destination. The choice is based on the desire to minimise the friction in overcoming distance.

The main purpose of roads are to cater for the demand of passengers and as such roads work as an important transport network through which most public transport

move. In India the ownership of car^s is very low so people generally depends on mass transportation system. In the study area important mass transport systems are bus and mini buses. Buses are mainly long distance^{fe} and very few of them are available for all parts of the city. Minibus routes cover a well distributed network. In this study in most of the cases the minibus routes have been considered to calculate various aspects of transport.

A network is formed by linking points in one or two dimensional space. A topological map or graph is generally developed to meet the need for convenient representation of a network. A topological map reduces a transport network to its simplest form and such simplicity help us more easily to understand the characteristics of transportation network. Topology is a form of geometry which is concerned with the positions and relationships between points and lines not with the distance between points, but the straightness of lines. In topological map contiguity or positional relationship are preserved even though distance and directions may not be true.

Connectivity :the connectivity of a network is defined as the degree of completeness of the links between various nodes. The greater the degree of connectivity within a transport network the more efficient will be the system.

The beta (β) index is a very simple measure of connectivity i.e.

$$= \text{arcs} / \text{nodes} ,$$

The beta index ranges from 0.0 for networks which consist just of nodes with no arcs, though 1.00 and greater where networks are well connected. The beta index is of less value for complex networks than for simple ones.

One of the most useful and perhaps the best measure of connectivity of a network particularly a fair complex network is the alpha (α) index. This consists of the ratio of the number of fundamental circuits to the maximum possible number of circuits which may exist in a network i.e.

$$\alpha = (a-n+1) / (2n-5),$$

The alpha index gives the range values possible: from 0 to 1. The higher the index, the greater is the degree of connectivity in the network. A network with an alpha index value of 1 implies that a network has the highest possible number of arcs and fundamental circuits and hence possesses the maximum degree of connectivity.

Accessibility of a node can also be measured with the help of accessibility matrix. In this matrix direct connection between two nodes is given 1 point. It indicates the direct connection of each node with all other nodes. In this case higher value indicates greater accessibility.

Mode of transport : Bus

The different bus routes plying through the city (intra-urban; inter-regional) converge at the terminal situated close to the railway-junction. This terminal is in the form of a number of "stands" each used by a group of routes, without shelters, scattered at various points. There is however common "covered" shelter for all the passengers and there is no indication of the route allotted for each of the "stands" with the help of any sign board nor is there any proper ticket counter.

In Kharagpur exclusive intra-city bus service is provided by the mini-bus and it traverses through the heart of the city from the bus terminal near the railway station to Nimpura in the northwest. The regional bus-services whose feasibility depend on regional passenger movement attract a part of the local trips which otherwise would have to depend on slow-moving vehicles. The IIT however has its own bus service to serve employees along with their family members particularly for trips to the rail station; to Gole Bazar and to schools situated outside its premises.

Another feature which needs to be mentioned is that buses ~~too~~ were overcrowded causing an increase in bus services since the late 70s; the old bus stand could not cope with this because of lack of space. The over congestion resulted often in accidents and delay in reaching the station platform. So the Railway authorities decided to shift the bus stand to the other side where more land was available.

Bus route index: A bus route index for each bus stop has been calculated in the following manner. In this case both the long distant bus and short distant mini-bus routes have been considered. Both bus and minibus starting points get more point than its presence as through traffic route. The origin point of bus have been allotted 4 points because the nodes having this facility allow its population to move inter-state level. The areas where buses pass through get 2 points. In case of minibus original points get 2 points while other gets 1 point.

The frequency of bus and minibuses in each of these nodes have been calculated and multiplied by their allotted points. All the points of each node have been added to get an

index for frequency of rapid transit system of that node. Then mean and standard deviation of all these indices are calculated to get seven ranges.

A flow map has been made to get an idea of the intra-urban transport (fig no. ^{23 & 24}...) attached with the pouch.

Main findings: Transport networks of the study area shows that the area is more or less well connected except extreme southwestern part. Minibus routes are extended upto Kesiary in the south and Medinipur in the north. Buses mainly pass through the NH 6 and the OT road connecting the rail station in particular. Buses originate from important urban centres and those plying through Kharagpur aim at providing feeder services to the rail-station.

Accessibility:

Accessibility is the concept which combines the geographical arrangements of land use and the transport that serves these land uses. Accessibility is a description of how conveniently land uses are located in relation to each other, and how easy or difficult it is to reach them via the transport network. When many land-use activities are located close together and the transport connections are good, high accessibility is achieved. Conversely, when activities are located far apart and the transport connections are poor, low accessibility results. Different geographical locations do not have the same accessibility because land-use activities are distributed unevenly and transport is neither of uniform coverage nor quality. Some land uses have a dispersed pattern in the fringes. It also provides a measure of the performance of the land-use transport system. Residents are primarily interested in accessibility of job opportunities, schools, shops, health services, leisure and recreation activities. Retailers are concerned about accessibility to labour markets and to suppliers of materials.

As traffic increases on a mode or route the difficulty in getting about also increases, especially when traffic approaches the fixed capacity of the transport facility. Crowded buses mean waiting in queues; congested roads mean stop-start conditions for motorists; and crowded footpaths force pedestrians to shuffle along at a pace slower than normal walking speed.

Measurement of levels of accessibility

A complete account of accessibility patterns would require as many maps as there are locations, for each mode. Isochrone or isocost maps can show important aspects of

accessibility between locations or to facilitate but, without ^{availability-} ~~an~~ municipality of such maps, they cannot show all aspects of accessibility patterns. Another ^{disadvantage} of isochrone maps is that they do not show the number of people affected. Because of these difficulties with isocost maps, attempts have been made to devise numerical accessibility indices. The accessibility index for a particular zone is usually defined as the weighted sum of the attractions of all zones, where the weights reflects the costs of travelling from the particular zone to other zones. So the attractions of all zones are taken into account (not just those of a central area or the nearest facility) with the weighted attractiveness of possible destination being reduced according to the cost of getting there. Separate indices are required for each zone, each journey purpose and each mode of travel. Accessibility indices for individual zones do not by themselves reflect the number of persons affected in each zone. In principle one could calculate an overall index for a city with the indices for each zone weighted by its resident population (or travelers of a particular type).

Accessibility Matrix (table no 9) and fig no. 14 shows that the Inda more is most accessible and it is followed by the More at Kausalya and Malancha (table no 9). A large portion of the study area is not accessible by minibüs. This indicates that most of the nodes have low accessibility. The western and southwestern parts of the study area is least accessible while the eastern (northeastern and southeastern) and northwestern is more accessible. Influence of Kharagpur rail junction in the road transport network indicates its prominence ~~of~~ in the district.

Goods Transport /commodity flow through road network

Next to railways the road transport plays an important role in carrying commodities in India. Road traffic has acquired great significance in view of its reliability, efficiency and economies for short distance movement. Road traffic can operate on steep gradients. Roads of widely differing capacity, quality and investment outlay can be built according to expected traffic density. Road transport has an advantage in delivery as loads can be picked up even in "small" from consignors. Where there is no railway siding on a consignee's premises, long local transfer hauls are required, buttressing expenses and involving loss of time. Road transport cannot only pick up and deliver small items expeditiously but move a full lorry-load without waiting for any subsidiary transshipment help. The superiority of road transport over railways lies in the reduced handling, faster services, door-to door carriage, less risk of loss and damage, low costs of packing, more

flexible timings and avoidance of transshipment. The roads have a higher employer potential and their construction needs little or no foreign exchange. Moreover, roads are absolutely essential for supplying traffic to the railways and thus make rail construction worthwhile. In certain spheres the road transport is better equipped than railways for emergency services, movement of perishable and fragile goods because of flexibility of road services, freedom of movement, low capital investment, economy of time and above all for its changing character. There is no need for elaborate packing. Many big marketing concerns send their products by road over long distance because goods are picked up from the factory premises and delivered at the destinations points. Bookings by road are often available more easily and without delay for far off places. Over short distance between two urban centres and the surrounding rural land where there is surety for return loads to the towns the motor transport has effectively competed with the railways because of fast service. A modern roadway can pass three times, or more the tonnage of the traffic a railway can handle due mainly to the latter's handicap of not being permitted to admit more than one train at a time on a block section. Roads generate seven times as much employment as the railways for the same amount of capital invested. This indicates that the road transport industry is highly labour intensive.

However, road vehicles are less reliable regarding punctuality. Road transport is less safe. Precise data on the nature and volume of freight traffic covered by road transport particularly by trucks is not available. This is mainly because of the fact that goods transport by road remains largely a private sector field. At various weigh bridges, sales tax and octroi and other check posts the innumerable checks lead to delays.

So the estimates of road freight are to be based on interpolations, by taking into account the number of trucks, their capacity and utilisation indices etc. or small sample studies [Raza M. & Aggarwal, 1986].

Characteristic feature of slow-moving vehicles in Kharagpur for goods

The road geometric within the Municipal area forces the few automated vehicles to move at lower speeds, thereby reducing the perils of travelling by slow moving vehicles where there is a mixed traffic. The ease with which a slow moving vehicle can manoeuvre itself, makes it accessible to almost all parts of the city.



5. Varied modes of transit



6. The unplanned bus stand at Kharagpur



7. The Marshalling yard revealing the role of Kharagpur as a transshipment point



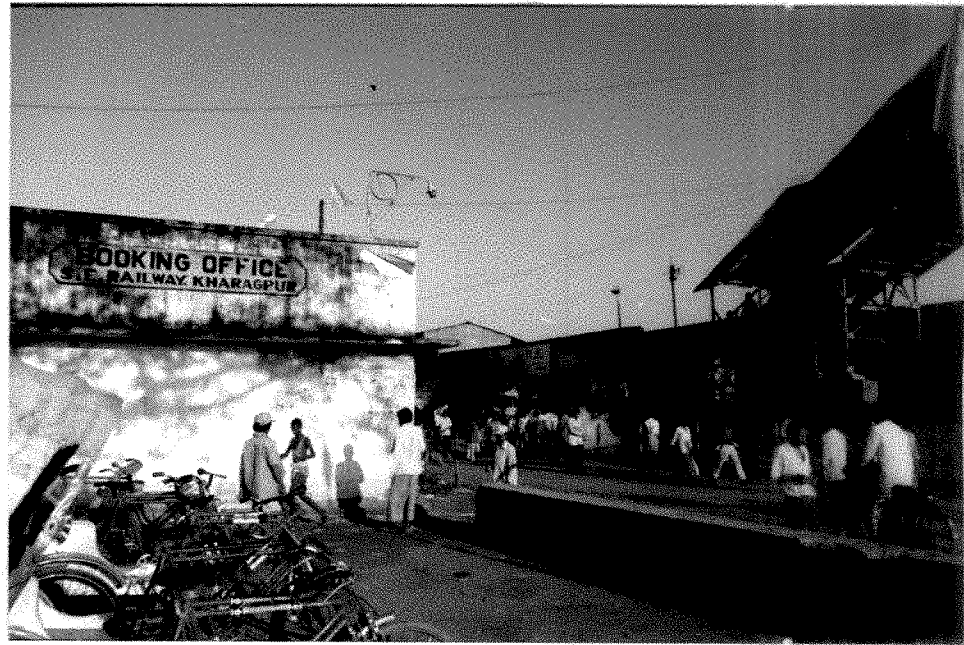
8. Trucks: the major mode of goods transport on roadways



9. Passenger traffic at Kharagpur rail station



10. Newly introduced MEMU train services for quicker transport



11. The Rail station - Bus stand linkage vide the overbridge



12. An overcrowded long-distant bus heading towards the Rail station



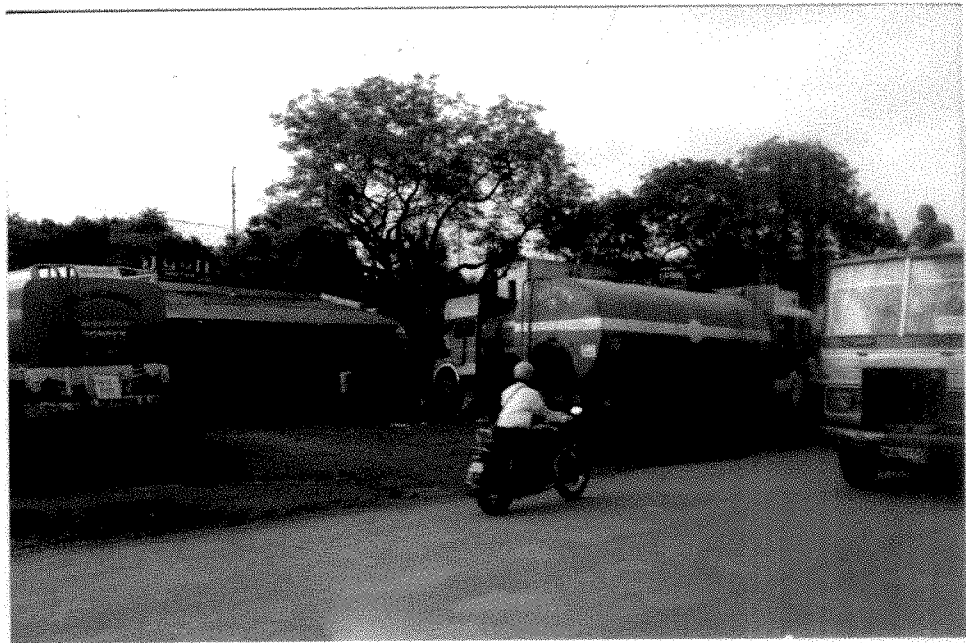
3. Slow-moving vehicles : the lion's share of vehicular movement



14. ^aL₁oding-unlkoading process on the road



15. Cycle stand



16. Manufacturing - cum repairing activity

Manufacturers and building material suppliers located in different parts of the city use slow moving vehicle due to lower rates for transporting their goods within the city, specially when consignment size is within the capacity of these vehicles.

The flow of commodities signify spatial interaction. It has been a common mistake in the past to regard urban areas as fixed, static places within which transport arrangements must be provided. Commodities with very little intra-state flows are fruits and vegetables, tea, cotton, tobacco, edible oils, textiles. The proportion of intra-state flows vary from one commodity to other and to a large extent depend upon its production consumption cycle. Commodities with large intra-state linkages are rice and other food grains. The proportion of intra-regional flows also tends to be large.

Normally the freight per interaction tends to be high for inter-state flows than intra-state flows. This is because on the average the long distance interactions, though less in number, tend to be of bulk character as compared to the short distance interactions. For most of the commodities intra-regional flows and spatial interactions tend to be significant as compared to the total freight. So to bring out the complexities of the intra-regional flow phenomenon the inter-regional flows have to be considered.

The distance impact is strongest in the case of inputs into agriculture and construction materials and is the least in the flow of industrial products.

One of the new arteries planned to be developed following the growth of Haldia is the Kharagpur – Mahisadal expressway of 35 kms. length, of 2x2 lane, carriageway. This will establish a rapid link system between Kharagpur and Haldia [Source: Economic Times dated 12.8.97].

Conclusion

The transportation studies have been categorised under three general heads:

1. The study of transport networks;
2. The study of flows on the networks; and
3. The study of networks and flows in relation to each other and to the spatial organisation of the economy.

Railways are the major instrument of long distance movement. It may be observed that while a large proportion of the industrial raw materials are moved by railways, high rated freight is usually carried through roadways.

Kharagpur is a city where tertiary activity is predominant, people engaged in secondary activity is lesser and hence the industrial production is also lesser and primary production is still lesser. So the outward traffic is significantly lesser in quantity as well as in number of items and therefore renders lesser earnings to the railways.

The railways have little to do with the internal circulation. They figure in helping long distance travel. The opening of rail network not only led to an easy movement of people but led to a change in the pattern of demand for goods and services and the old patterns of traffic. The railways brought about the end of laissez-faireⁱⁿ India. They also provided new employment, specially for the humbler classes and their creation of new artisan class transformed society. Hence they brought about greater social interaction by making the population more mobile.

With the increase in frequency^{of} train services along with reduced travel time there has been a considerable increase in feeder road traffic. With the shift from public to private transport congestion on the highway and streets have resulted.

The intra urban road transit system is so poor that the railways contribute partially to the movement of passengers. Considering the size of the city the trains meant for long distance inter-urban journeys play a role similar to the suburban train services present in any large city the only difference being in the volume of traffic (both passenger and goods) and quality of service facilities available at the halting points. So the train (mode) serves the dual purposes of the passengers for the city for [A] movement within the city for (1) work trips (2) recreational trips (3) educational trips (particularly to the college) (4) shopping trips. [B] movement beyond the city limits through the rail junction, bus terminal. The former is a result of trips generated by different functional activities prevalent within the city and the latter the pull exerted by other cities which may be a regular (daily/weekly) pattern or of an irregular (occasional) pattern.

Since all urban centres are to depend on the rural areas for food based items the volume of inward traffic of agricultural and agriculture related products is huge and the same is applicable to this city as well as indicated in fig number 16.18 ?

The main reason for traffic congestion on roads at peak hours are :

1. Personal vehicles (especially cycles are used for different trips particularly journey to work and shopping
2. Too many jobs in too few locations

3. Work starting and shopping times not spread out.
4. Through traffic using the main road (particularly the OT road) system.
5. Inadequate roads and inadequate^t road junctions.
6. Lack of subways/bridges at the numerous crossings found scattered
7. Bad road conditions resulting in slow traffic speed
8. Insufficient parking space

Heavy "tidal" traffic is concentrated on only a few roads and in front of some establishments. The peak hour flow was about 60% of the work journey tidal and the heaviest traffic was during the return journey from work. Another peak hour flow is related with the arrival/departure of trains and regional buses as Kharagpur has a significant floating population.

In highly populated urban and industrial areas there are usually a dense pattern of transport lines. A set of transport lines or routes which may and frequently do, join and cross at junctions form a transport network and serves to link locations together though its main function is distribution. The network changes with time. They become more complex and change their functions. The features, characteristics and patterns of transportation network are capable of investigation and analysis and a number of techniques have been recently applied by geographers for those purposes.

Viewed like this, the system of inter-settlement interactions gets enmeshed into the system of inter-regional trade. The inter-meshing of these two operates within the national space economy, which is bound by tariff barriers, a common currency and an integrated transport network. It is through these processes that a loosely knit and weakly connected system of settlements gets transformed into a highly differentiated and well integrated field of a unified home market in national space. Thus, the interdependencies of various sectors of the economy forms the basis of spatial interaction and result in commercial exchange within the regions, which in its turn contribute to the development of a sense of nationhood [Smith, 1970].

The space economy responds to the requirements of intra and inter-sectoral relationships through bi-lateral and multi-lateral commodity flows, occurring^{Fe} over a range of varying distances from a discrete node to another in the network of an interactive system and not along spatial continuum as is the case of surface flows in a stream.

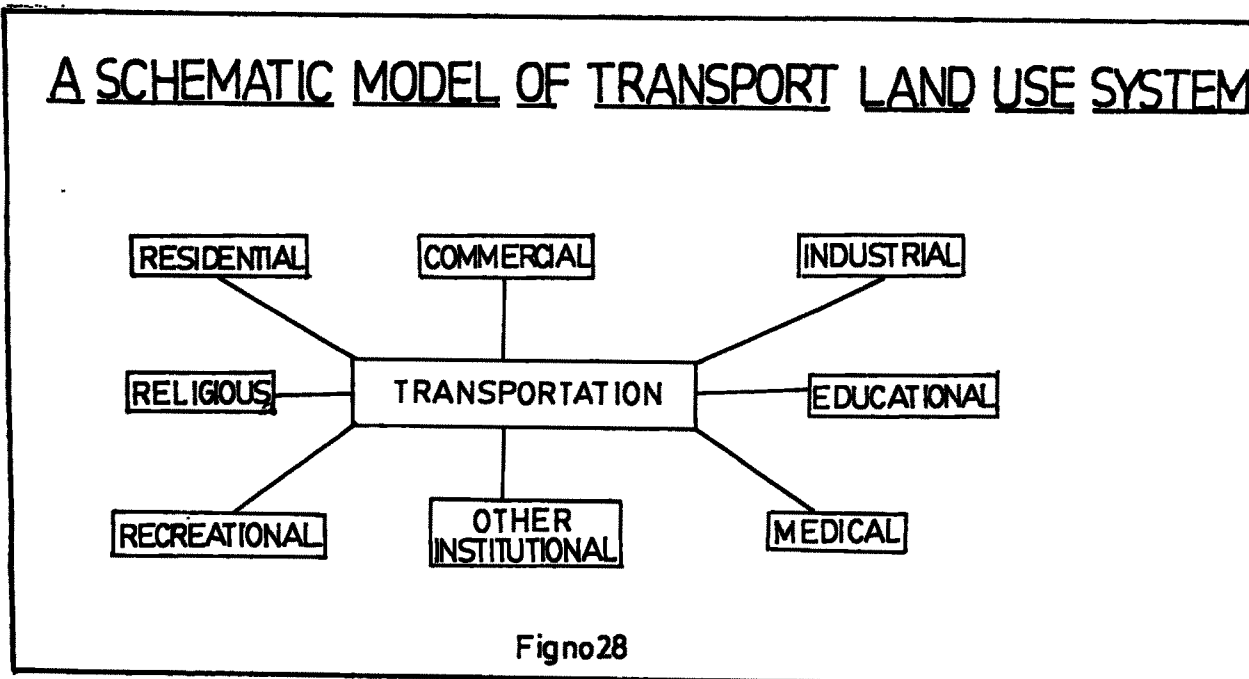
The flows of goods, people and ideas stem from the socio-economic structures of generators and absorbers of these flows, on the one hand and from the network efficiency on the other. These flows take place along defined channels; and their spatial arrangements provide the basis for more complex system of interactions which integrate the space economy.

The urban and rural settlements that constitute the space economy interact with each other through the exchange of their produce among other media of interaction. At natural and regional level, it is through the urban centres that the space economy is organised.

The biggest hurdle for achieving the desired mobility for urban areas is probably the availability of adequate funds. In a developing economy, optimisation of the existing resources becomes of prime importance. Softer options like optimising the existing bus systems will have to be adopted before launching capital-intensive schemes like a grade-separated railway, etc. Bus transport would continue to be the key mode of a passenger transport for the urban poor and it would be the responsibility of every operator of this transport system to ensure that urban bus transport is optimised with a view to obtaining the maximum carrying capacity from the available fleet, so that the bus transport is economical, efficient and effective. The carrying capacity can be maximised by operating the maximum number of seat-kilometers in a particular time span. The operation of seats would depend upon a number of seats which would be kept moving in a certain period and these in turn would be largely governed by the internal factors such as fleet-utilisation obtainable, route-planning, bus-scheduling, staff-scheduling etc. The speed with which the vehicles can move, however, is largely governed by external factors such as street congestion, road traffic management, etc., traffic management plays an important role in ensuring optimum utilisation of urban bus transportation. It should be the aim to optimise the speed of buses so that not only the operational costs are minimised but also the carrying capacity of the system is maximised. It would, therefore be necessary to give priority to passenger buses on streets in Kharagpur particularly as resources are hardly available for providing a powerful mode like the metropolitan railway as the basic system.

There is overlap or competition between the modes and technical change is tending to increase that overlap and competition. It has been a common mistake in the past to regard urban areas as fixed, static places within which transport arrangements must be

provided. There is a relationship among the transport system and also with the whole



Transportation involves movement of goods and people while communication involves movement of ideas and information through several media like television, radio, telephone, telegraph etc. With the improvement in the electronic system the communication network has widely expanded both in the public and private sector. The computerisation of the railway reservation office at Kharagpur establish quicker linkage with the rest of the country. The TV with its multimedia channels have already entered into the drawing rooms of many residents. Faster communication has been made possible through the STD, ISD, public booths. This telephone network centre was initially located near the Kharagpur railway station but rapid increase in consumer demand has resulted in setting up of several sub units. These include: one at Nimpura (with 2000 subscribers, Hijli (with 3000 subscribers), Malancha (with 2000 subscribers). This is known as the Kharagpur remote subunit. Some neighbouring villages like Benapur, Rupnarayan, Madpur are also having telephonic connections through antenna known as Marr connections. A proposal has been put forth for the opening of another telephone exchange at Inda. The expansion of the communication network is a necessity as it results in quicker spatial interaction and spread of ideas and information over a wider area.

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