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THE METRO RAIL OF CALCUTTA : A STUDY

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ABSTRACT

While at the beginning the paper outlines the backdrop for introducing the metro rail - a rapid transit system - in the city of Calcutta, it has studied in detail, on the basis of a survey of the commuters, the users reaction to the service provided by the metro in the Tollygunge-Esplanade section, which has been opened to traffic since 1984.

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I. Introduction

Introduction of a Rapid Transit System in a Third World city signifies a major change in the state of existing technology. It symbolizes a big leap from the traditional bullock-cart to a high-tech, sophisticated, capital intensive system. The coexistence of the two, apparently an impossibility in the context of natural economic evolution, presents a picture of incongruity. The objective of this paper is to study the context in which the Metro Rail, the first of its kind in India, was introduced in Calcutta. This study also aims to inquire into some of the social aspects of its choice, e.g., the kind of people who avail this facility and their perception of this form of transport.

II. Need for transportation planning

The earliest mode of transport in Calcutta was the palanquin. The mode of transport became faster with the passage of time. Palanquin was followed by horse-drawn carriage, then by horse-drawn tram in 1880. The use of animate energy ended with the automobile in 1898; the electric tram appeared in 1902 heralding the era of public transport, taxi in 1909, bus in 1922, double decker bus in 1926 and minibus in 1972.

The inadequacy of mass transport facilities in Calcutta, and the need for developing efficient intra-and inter-urban connections were realized as early as in 1949. B.C. Roy, the Chief Minister of West Bengal at that time, appointed a French team of experts to recommend a grade

separated mass transit system for Calcutta. This team had recommended two alignments for an underground railway in Calcutta, but this suggestion was not based upon any detailed traffic study and, thereby, was unrelated to future urban growth.

Prior to the French study, the mass transportation problem of Calcutta was viewed only from the angle of commuters. The Terminal Facility Committee (TFC) in 1947 proposed plans for the extension of suburban railway line upto the central areas of the city. The recommendations of the TFC were examined and endorsed by subsequent committees in 1953 and 1956. It was only in the 1960s that CMPO demonstrated the need for a high capacity grade-separated rapid transit system on two principal travel corridors of the city. Since then, a number of individual experts and teams have furnished their reports. The list includes the Frieling Report in 1964, the Gurbutt Report in 1966 and a report by the Soviet Experts in 1971. The original work of CMPO provided the data base for all these studies.

The government of India eventually recognized the need for improving mass transportation facilities in the metropolitan cities and set up a committee in the Planning Commission to deal with the transportation system in those. Known as the Metropolitan Transport Team, this group of experts recommended that an engineering location survey for the Suburban Dispersal Line (SDL) as well as techno-economic feasibility study for the RTS be taken up for the regeneration of the mass transportation situation of Calcutta. A unit of the Railways, the Metropolitan Transport Project (MTP), was set up in Calcutta in order to perform this task.

SDL was proposed to be an extension of the main line from Dum Dum to Eden Gardens via Chitpur Yard and along Calcutta Port Commissioner's railway tracks. It was considered primarily for providing direct movement of the suburban passengers to the city core without any transhipment. RTS was proposed to be a grade separated facility running on two principal corridors crisscrossing the city : one from Dum Dum in the north to Tollygunge in the south, and the other from Sealdah in the east to Howrah in the west.

During the late 1970s the Central Inland Water Transport Corporation (CIWTC) suggested a plan for water transport in and around Calcutta. This circular waterway would be constructed through the canals and creeks of the city as well as by using the Hooghly river. Starting from the Kestopur Khal, it would stretch 16 km. from Chitpur to Kantatala on one side, and 26 km. from Hastings to Samukpota through Tolly Nala on the other side. The distance between Kantatala to Samukpota is about 6.5 km,, which would be joined by a creek to complete the circle. CIWTC also estimated the expenditure and time duration for the project, but did not receive the necessary approval from the Central Government.

It took quite some time for the necessity of transportation planning to dawn on the administrators, while only sporadic and piecemeal efforts were made. The number of surface transport modes was increased, until a point was reached when the inadequate width of roads began to pose a new problem - congestion - resulting the transport bottleneck. Among various solutions to this problem of congestion, the introduction of a Rapid Transit System gradually gained recognition.

RTS could be of two types elevated or underground, of which the latter was preferred. London was the pioneer in introducing an underground railway in the year 1863, along a stretch of 3.25 miles. New York followed in 1867, Budapest in 1896, Vienna in 1898 and Rome in 1955. Today, as many as 50 cities in the world have underground railways in operation, and in quite a few others such railways are under construction. India entered the 'metro age' in 1972, when the foundation stone was laid by the Prime Minister, on December 27, in Calcutta.

The CMPO investigated the existing mass transport facilities as well as the pros and cons of introducing a rapid transit service. It also discussed the merits and demerits of two types of RTS, i.e., underground and elevated, in its Traffic and Transportation Plan for the CMD. The underground system was found to be aesthetically more desirable than the elevated one, apart from registering an absolute minimal level of noise generation.

Despite the aesthetic advantages, there are, however, several serious limitations to the development of an underground system. Some of them are general, while others are specific to Calcutta. Capital expenditure, for example, is very high as it depends on considerable imports of equipments and other materials, thereby entailing heavy foreign exchange outlay. The construction of underground systems is also time-consuming. The Plan mentioned that, particularly in the case of Calcutta, the underground RTS would involve an appreciable disturbance and relocation of the surface traffic as well as the moribund sewer system. The high water content of Calcutta's subsoil, it noted, was prone to encourage direct flooding of the channels during the monsoons. Furthermore, the sultry Calcutta climate necessitated efficient ventilation and air-conditioning.

The elevated rapid transit system, on the other hand, was considered by the CMPO to be more appropriate in Calcutta than the underground system. An elevated system had the same passenger-movement capacity but involved only a fraction of the cost of the equivalent underground system. It also eliminated the problems related to construction. Its demerits, as mentioned by the report, were: deficiency of light and air through the route, noise nuisance and greater space requirements which were bound to create problems for the surface mass transport.

Having assessed the relative merits and demerits, CMPO decided in favour of the elevated system. The Metropolitan Transport Project (Railway) Authority, however, using CMPO's survey results, prepared a voluminous report in favour of an underground railway and presented it to the Soviet expert team. In the absence of a comparative study of the two systems, the Soviet experts ultimately approved the MTP's plan to construct the underground RTS in Calcutta.

The Calcutta Mass Transit Study (1970-71), in its report, introduced a number of arguments in favour of the Metro Railway at Calcutta. It argued that the elevated system of rapid transit was not suitable for the city core of Calcutta because of excessive congestion. The alignment that was chosen for the underground system was mostly along the existing roads, requiring a minimum of land acquisition. A minimum width of 18 metres was found sufficient for running tunnel sections and 26 metres for stations, whereas for elevated structures a 50 metre-wide strip of land had to be acquired. Other existing modes of transport were also considered for improvement, but were found to be unsuitable. The circular railway, for example could literally touch only the fringe of the problem as it

could not serve the inner city traffic. Further widening of the roads was also thought to be an impossible task, whereas increasing the capacity of different modes of transport, particularly buses, would have only aggravated the traffic congestion and a high level of pollution. Though trams were a non-pollutant mode of transport, they moved very slowly and, thus, contributed to traffic jams, especially when there was a breakdown.

Therefore, the Metro Railway Authority found that the only answer to the problem was an underground RTS. Technological advances around this time also made the construction of such a railway feasible either by 'shield tunnelling' or by the 'cut and cover' method. It was argued that the number of people that needed to be moved could not be moved by any other means at a reasonable level of comfort even if the number of vehicles was increased. The comparative carrying capacities of different modes of transport were estimated as follows (in terms of numbers of passengers moved in an hour in a single lane) :

Mode	No. of passengers
Private Cars	1,000 - 1,500
Buses	11,000 - 4,500
Railways	60,000 - 67,000

III. The Metro Rail of Calcutta

On the basis of the MTP Plan, Metro construction work started in 1973, The plan had originally proposed two alignments, but financial limitations restricted the construction work to the north-south corridor for the present.

There are 17 stations (figure 1) along the Metro route. The stations at the two extermities are elevated, while the rest are underground. The total distance between

Dum Dum and Tollygunge is 16.43 kilometres, and will be covered in 33 minutes. The average distance between two consecutive stations is 1.02 kilometres. Trains usually stop at a station for 30 seconds and leave the termini at an interval of 2.5 minutes. The carrying capacity of a train is 2500 passengers while the maximum speed is 80 kilometres per hour with an average speed of 30 kilometres per hour. The total power requirement is 53 mw, collected through the third rail.

The 'cut and cover' construction method has been adopted under the roads, while, under the densely developed areas, the 'driven shield tunnelling' method has been adopted. In the open areas, the construction is on elevated trestles. The first method of construction needs diversion of most of the surface traffic into other parallel roads and was possible only in the southern section from Esplanade to Tollygunge. It is not feasible for the northern section from Esplanade to Shyambazar along Chittaranjan Avenue, which is still under construction, due to lack of sufficient road width. A modified cut and cover method is, therefore, being applied in this section. It keeps traffic flowing on the surface, using deckings while the construction work goes on underneath. This method requires large scale mechanization and certain special equipments and expertise.

Driven shield tunnelling has been adopted between the Chitpur Railway Yard at Belgachhia and the Shyambazar five point crossing in the north section, where the tunnels pass under densely populated areas, old and dilapidated buildings and a canal.

Metro construction requires the application of several new technologies in the fields of civil, electrical, signalling and telecommunication engineering. Thus, while constructing the Metro, the Indian engineers have adopted advanced technologies, for the first time in the country,

in the following fields:

(i) cut and cover method of construction, using diaphragm walls and sheet piles;

(ii) use of extensive decking for keeping the traffic flowing over the cut, while construction is in progress underneath;

(iii) shield tunnelling, using compressed air and air-locks;

(iv) ballastless tracks, using elastic fastenings rubber pads, epoxy mortar, nylon inserts;

(v) air-conditioning and ventilation systems for environmental control of stations and tunnels;

(vi) third rail electric current collection system for trains;

(vii) underground sub-stations with dry type transformers and vacuum circuit breakers;

(viii) continuous automatic train protection system with cab signalling;

(ix) tunnel train UHF radio communication system;

(x) micro-processor - based train control and supervisory remote control system for sub-stations.

Though the construction work began more than 15 years ago, it is yet to be completed. The metro is now operating only along two short stretchers of the north-south corridor. The Metro Rail has been having several problems since its inception.

Foremost is the inadequacy of financial resources. The work started during 1972-73 with a budget of only Rs. 23.4 millions. Since then the Union Government budgeted very measly amounts till 1977-78. This resulted in a chronic shortage of capital due to which the Authority were forced to cancel many approved tenders. With the

stepping up of budgetary support in the past few financial years, the Metro Rail authority are hoping that the work would be completed by 1995-96, involving a total expenditure of at least Rs. 8000 millions.

The second problem arises from the traffic congestion created by the construction work. To minimise this, construction has to be phased in a way that allows for movement of vehicular traffic.

The third major problem of construction has been land acquisition. Whereas the Metro Rail is under the Central Government, the land acquisition facilities are with the State Government. The latter has been faced with a variety of legal problems in undertaking such acquisition, from those having legal rights over such land. To avoid long-drawn court-battles the Metro authority prompted the Parliament to enact the 'Metro Railway Construction of Works Act 1978'. Despite this the problem has not yet been solved, since 90 per cent of the suits had been filed before 1978. Therefore, the more expensive and time-consuming tunnelling method was adopted in the densely built-up section between Belgachhia and Shyambazar five-point crossing to avoid such land acquisition problems.

The haphazardly laid service lines of Calcutta also cause severe construction problems. In 1980, seepage of water through the diaphragm wall of the Metro Rail took place near the Kalighat Tram Depot, when the sanitary pipeline gave way. This caused damage to at least forty buildings, while the building of Ashutosh College, an old and important institution, tilted towards the Metro ditch and the nearby Tollygunge Bridge became weakened. Though none of the damages was very serious, these led to strong public criticism of the Metro Authority.

Moving sand present in the sub-surface is also dangerous. In Belgachhia area, for example, a small factory subsided under such sand and was later untraceable. The geological characteristics of Calcutta, particularly its soft soil, created many such problems of construction; Japanese and Italian expertise was sought to meet such problems of subsidence.

Now that the Metro is operating, a new problem regarding the maintenance of the Metro Rail is emerging. Neither the state, nor the central government, wishes to take the responsibility of the huge losses that the Metro is incurring. After the completion of the entire tunnel, 1.7 million passengers can be moved daily, but this would involve an yearly loss to the tune of Rs. 120 million. The Metro Authority do not favour the idea of its separation from the Indian Railways, because such a decision would only limit the scope of Metro operations, while the railway personnel are averse to being transferred to the Metro.

IV. Public responses to Metro

Let us now take a look at the human side of the Metro Rail of Calcutta. Who uses the Metro? Why? and what does that person feel about it?

We used two questionnaire schedules for this purpose. A simple method of quota sampling was adopted for survey. The survey was spread over a period of over eight months to avoid any seasonal bias. Further, we interviewed the users at various times of the day so that the view of no particular group became predominant in the outcome. We also took interviews along the whole length of the route so as to include the users of all stations. We questioned, in all, 400 respondents, a summary of whose replies is given below

Metro users

The first questionnaire deals with the characteristics of the users of the Metro.

The respondents were divided, according to their average monthly income, into the following five groups :

(i) Rs. 750 and below
(ii) Rs. 751 - Rs. 1500
(iii) Rs. 1501 - Rs. 2500
(iv) Rs. 2501 - Rs. 5000
(v) Rs. 5000+

While the highest number of respondents (208) had an average monthly income between Rs. 2501 and 5000, the lowest number of respondents (20) came from the lowest income group, having an income of less than Rs. 750.

It is noticeable from Table 1 that the usage of this mode of transportation is largely availed of by the middle income groups, Rs. 1501 - Rs. 2500 and Rs. 2501 - Rs. 5000 categories and, to a lesser extent, by the lower middle income group, Rs. 751 - Rs. 1500. The table gives the percentages as well as the absolute numbers of respondents in various income categories.

In the national economy too it is the upper and middle income groups who constitute the bulk of the tax payers and account for most of the saving.

The age-gender structure of the Metro users reveals a very interesting pattern. Under the age-group of 11-20, the numbers of male and female passengers are more or less equal; males forming 7 per cent and females constituting 6 per cent of the total. The main users of the Metro belong to the age-groups of 21-30 and 31-40. In both of these two age-groups male users dominate. Of the 39 per cent users of the age-group 21-30, 25 percent are male. The extraordinary feature is that, in the age-grou

of 51-60, there is not a single female moving by the metro. Again, only one per cent of females in the highest age-group (> 61) used the metro during our survey. It is evident that the Metro rail has largely benefitted the people in working age-groups, while the dependents, particularly the older age-groups, prefer to use other, mostly slower, modes of transport (Table 2).

We also enquired about the frequency of use of the Metro. A five-point scale was used to determine this. It was expected that clear picture on the 'Metro habit' would emerge from the responses. Table 3 illustrates the findings.

Interestingly, it is found that the two extremities of the scale account for 69 per cent of the respondents. As is evident from the figures, the highest number of respondents use the Metro daily. The next category are the 'once a week' users. These are probably the shoppers and 'holiday crowd'.

The efficacy of the Metro can be assessed better if we take a look at the frequency of use of other modes of transport. Table 4 illustrates this. It is observed from the data that 81 per cent of the users of the Metro are multiple users, that is use other modes of transport as well.

The reason is that the Metro is still incomplete as it only traverses the central corridor of the city from the south to the north. It is expected that, once the alignment to Dum Dum is completed, there would be more exclusive users of the Metro.

In Table 5 we find that the majority (61 per cent) of commuters use both the Metro as well as other modes of transport while another large group (28 per cent) also use other modes of transport in addition to the Metro within the operating hours of the Metro. Only a small segment (11 per cent) of the metro-users use other modes of transport when the Metro is unavailable. This may be the segment whose residence and work place are along the Metro corridor or those who travel very early in the morning or very late in the evening, that is after the Metro hours.

The number of passengers in October, 1984, the starting year of the Metro (from Esplanade to Bhowanipur) was only 5,000 for 36 trains daily. Today, with the opening of the services upto Tollygunge, the number of users exceeds 60,000 with 116 trains operating daily at an interval of 12 minutes. With the completion and opening of the whole stretch upto Dum Dum, these figures are expected to show a quantum jump.

From Table 1 it was also observed that the majority of users were in the income group Rs. 2500 or more per month. We will now focus attention on them to ascertain the purposes for which they use the Metro.

Table 6 shows that the majority of commuters use the Metro for non-formal purposes. Whereas those using the Metro exclusively for going about their office, school or college routine constitute 44.55 per cent of the respondents, the percentage of users using the services for going for shopping, to movies or other purposes is 55.45. Thus, the Metro has not become an essential mode of transport for the vast majority as yet. Of the 55.45 per cent using the Metro for other purposes, 43.45 per cent were using the same exclusively for other purposes, while 12 per cent were mixed users.

As a corollary, we asked the respondents to what extent they had benefitted from this new facility. 52 per cent of the respondents said, they had highly benefitted; 33 per cent took the view that they had benefitted partly; and 15 per cent thought that they had benefitted only slightly (Table 7). Most of the respondents in the last category were from the northern section which is barely operational at present.

Next, the intensity of use of various sections was determined on the Tollygunge-Esplanade section. The terminus-to-terminus passenger group accounted for most of the users on the outward journey from Tollygunge to Esplanade. Other important stations were Park Street and Rabindra Sadan. Jatin Das Park was the least important one as only one passenger disembarked there. On the return journey too, a majority of passengers boarded from Esplanade and disembarked at Tollygunge.

About 73 per cent of the respondents felt that the number of Metro stations was adequate. Those who were in favour of a lesser number of stations constituted more or less the same proportion as those who were in favour or of a greater number of stations.

The respondents, however, expressed doubt on the efficacy of Metro Rail in solving Calcutta's traffic and transport problem. As many as 70 per cent of them believed that the Metro had solved the problem only partially. Another 27 per cent were very enthusiastic in their opinion about the Metro expressing, the feeling that it had been able to solve the problem to a large extent. Only 3 per cent of the respondents believed that the Metro Rail had entirely failed. The respondents were also asked if the time schedule of the Metro was right. There was a general feeling that,

due to financial and maintenance constraints, the present timing, which mainly caters to the peak hour need, would have to be adhered to.

To measure the respondents' feelings about the Metro rail, a five point semantic differential scale was adopted. While one end of the scale consisted of the negative aspects, viz., dirty, noisy, etc., the other end took care of the positive sides viz., clean, quiet.

Once the questionnaires were completed, a matrix was prepared. Individual scores were multiplied by the number of respondents at that score. Then the individual scores were added and divided by the sample size to test the average attitudes of the user, i.e., whether they differed significantly from the neutral point (Table 8).

From this attitude survey we find that seven attributes are highly appreciated by the respondents. These are: comfortable, on time, modern, convenient, enjoyable, clean and fast. Nine others are also more or less appreciated. The users have a positive attitude towards the Metro in general and are proud of it. They are quite comfortable in a Metro train in spite of the fact that the seats are not cushioned.

There is some amount of crowding during the peak office hours, though this is tolerated by the users (average opinion on this is nearly neutral, 2.61).

There is a slight inclination towards a negative feeling for the attribute 'within walking distance' (2.77). This is, probably, the reason why the elderly people avoid the Metro. It is considered 'inexpensive' and quite safe, by the majority, though, in the latter case, the score

was no more than 4 (four). With a few exceptions, the train generally move on time, and that is reflected in the average score on this (4.77).

TABLE - 1

MONTHLY AVERAGE INCOME OF THE METRO USERS

Income group	Per cent of respondents	No. of respondents
Rs. 750 and below	5	20
Rs. 751 - Rs. 1500	12	48
Rs. 1501 - Rs. 2500	20	80
Rs. 2501 - Rs. 5000	52	208
Rs. 5001 and above	11	44
Total	100	400

TABLE - 2

AGE-SEX STRUCTURE OF THE METRO USERS (PERCENTAGE)

Age group	Male	Female
11 - 20	7 (28)	6 (24)
21 - 30	25 (100)	14 (56)
31 - 40	20 (80)	8 (32)
41 - 50	8 (32)	4 (16)
51 - 60	6 (24)	-
61 and above	1 (4)	1 (4)
Total	67 (268)φ	33 (132)φ

φ Figures in brackets are absolute numbers.

TABLE - 3

FREQUENCY OF METRO USE

Frequency	% of respondents	No. of respondents
Occasionally	33	132
Once a month	6	24
Once a fortnight	6	24
Once a week	19	76
Daily	36	144
Total	100	400

TABLE - 4

FREQUENCY OF USE OF OTHER MODES OF TRANSPORT

Frequency	% of respondents	No. of respondents
Occasionally	14	56
Once a month	3	12
Once a fortnight	1	4
Once a week	1	4
Daily	81	324
Total	100	400

TABLE - 6

PATTERN OF USE OF OTHER MODES OF TRANSPORT (%)

Mostly within Metro timings	28 (112)
Outside Metro timings	11 (44)
Both	61 (244)
Total	100 (400)

TABLE - 6

PURPOSE OF USE OF METRO

Purpose	No. of respondents	
Going to office	97	
Goint to school/college	32	44.55 %
Going for business/official purpose	59	
Going to movies	76	
Going for shopping	103	55.45 %
Other purposes	55	

(Multiple response)

TABLE - 7

ASSESSMENT OF BENEFIT

Degree	% of respondent
Highly	52
Partly	35
Slightly	15

TABLE - 8

AVERAGE FEELINGS OF THE RESPONDENTS ABOUT METRO RAIL

Attribute	Score	Attribute	Score
Uncomfortable	1 2 3 4 5	Comfortable	4.50
Late	1 2 3 4 5	On time	4.77
Complicated fare structure	1 2 3 4 5	Simple fare structure	4.20
Dangerous	1 2 3 4 5	Safe	3.78
Old fashioned	1 2 3 4 5	Modern	4.89
Feel ashamed	1 2 3 4 5	Feel proud	4.10
Inconvenient	1 2 3 4 5	Convenient	4.62
Expensive	1 2 3 4 5	Inexpensive	4.10
Unenjoyable	1 2 3 4 5	Enjoyable	4.58
Unreliable	1 2 3 4 5	Reliable	3.84
Crowded	1 2 3 4 5	Uncrowded	2.61
Dirty	1 2 3 4 5	Clean	4.97
Long walk to metro station	1 2 3 4 5	Short walk to metro station	2.77
Noisy	1 2 3 4 5	Quiet	3.75
Unsuitable routes	1 2 3 4 5	Suitable routes	3.93
Staff unhelpful	1 2 3 4 5	Staff helpful	3.69
Slow	1 2 3 4 5	Fast	4.83

BIBLIOGRAPHY

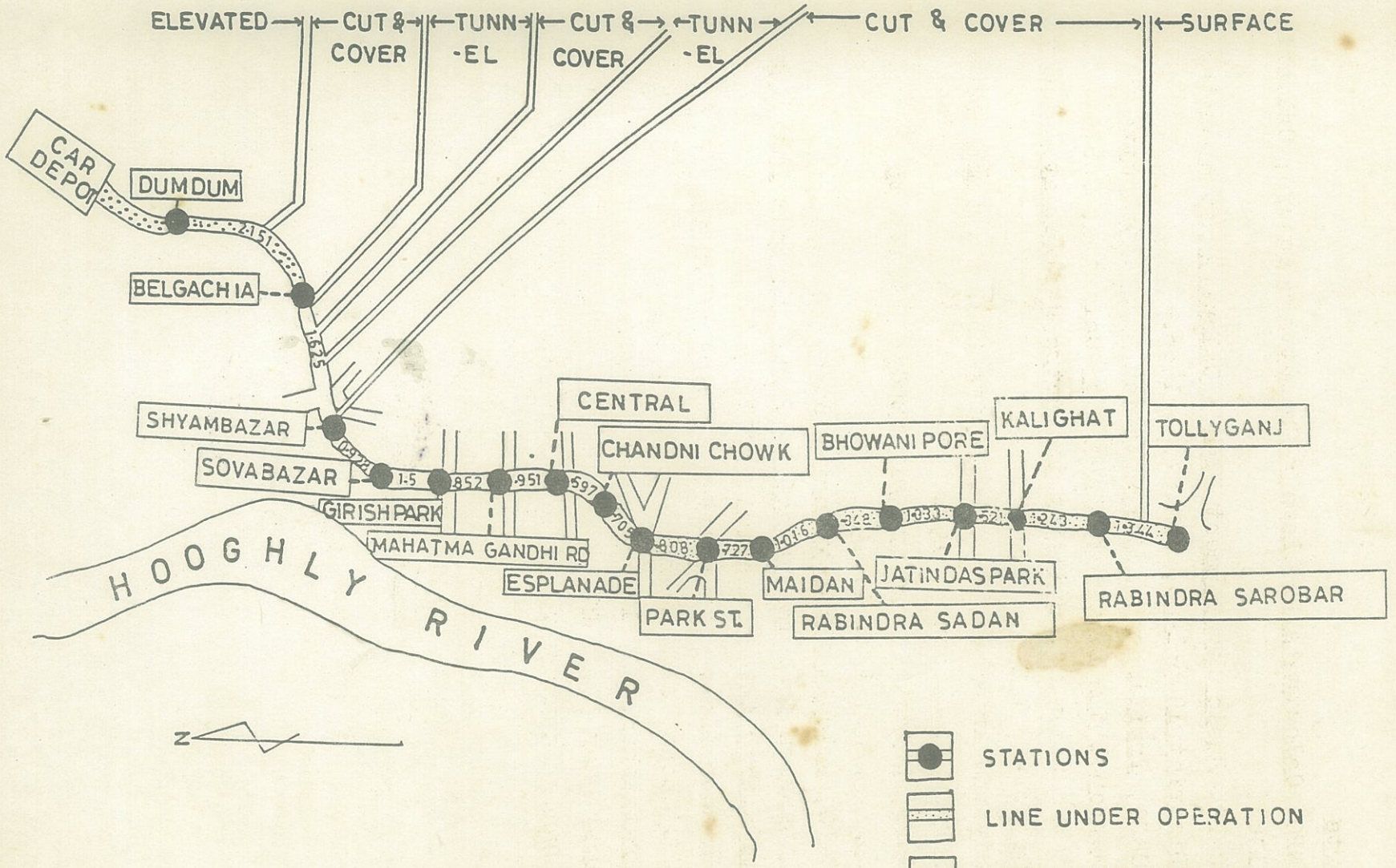
Books

1. Banerjee, P., Calcutta and its Hinterland, Calcutta, 1975.
2. Beaumont, J.R. and S.W. Williams, Project Work in in Geography Curriculum : An Advanced Level Primer, London, 1983.
3. Bhattacharyya, K., Kolkatar Patal Rail : Ekti Samiksha, (in Bengali), Anyamane, Calcutta, 1973.
4. Bose, N.K., Calcutta 1964 : A Social Survey, Delhi, 1968.
5. Bruton, M.J., Introduction to Transportation Planning, 1985.
6. Burgess, J.A., Image and Identity : A Study of Urban and Regional Perception with Particular Reference to Kingston Upon Hull, University of Hull, Occasional Papers in Geography No. 23, 1978.
7. Casley, D.J. and D.A. Lury, Data Collection in Developing Countries, Oxford, 1981.
8. Chaudhury, P. and Abhijit Mukhopadhyay, Calcutta : People and Empore, India Book Exchange, Calcutta, 1975.
9. Ghosh, Binoy, Kalkata Shaharer Itibritta (in Bengali), Calcutta, 1975.
10. Ghosh, Murari, Alok K. Dutta and Biswanath Ray, Calcutta : A Study in Urban Growth Dynamics, Calcutta, 1972.
11. Lubell, Harold, Calcutta : Its Urban Development and Employment Prospects, International Labour Office, Geneva, 1974.
12. Mitra, Asoke, Calcutta : India's City, Calcutta, 1963.
13. Moser, C.A. and G. Kalton, Survey Methods in Social Investigation, 1971.
14. Munsi, S.K., Calcutta Metropolitan Explosion : Its Nature and Roots, New Delhi, 1975.
15. Roy, Nishith Ranjan, Prasanga : Kolkata (in Bengali), Calcutta, 1986.
16. Sur, Atul, Kolkata : EK Purnanga Itihas (in Bengali), Calcutta, 1981.

Reports

1. CMPO, Calcutta's Problems - Calcutta's Future, Calcutta, 1965.
2. CMPO, Basic Development Plan : Calcutta Metropolitan District 1966-1986, Calcutta, 1966.
3. CMPO, Traffic and Transportation Plan : Calcutta Metropolitan District 1966-1986, Calcutta, 1967.
4. Metro Railways, Building the Metro Railway at Calcutta, Calcutta, 1983.
5. Sivaramakrishnan, K.C., Calcutta 2001 : Triumph by Survival, Calcutta, 1984.
6. CMPO, Calcutta Mass Transit Study: Dum Dum to Tollygunge, Vol. I, 1971.
7. CMPO, Calcutta Mass Transity Study Phase II, Vol. I, Extension from Tollygunge to Garia and Salt Lake City to Ramrajatala, Calcutta, 1975.
8. Manzoor Alam, Metropolitan Systems of India, (Report of a UGC Sponsored Research Project), 1980.
9. Pratikshan, May 17 - June 15, 1987.
10. Desh, May 30, 1987.
11. Ananda Bazar Patrika, December 23, 1987.

PLAN OF METRO RAIL, CALCUTTA



NOT TO SCALE

FIGURE-1