PLANNING FOR INTEGRATING TRAMWAYS AND STREET ENVIRONMENT- A CASE OF KOLKATA

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF URBAN AND RURAL PLANNING

By

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CANDIDATE'S DECLARATION

I hereby declare that the work which has been presented in this dissertation entitled as **'PLANNING FOR INTEGRATING TRAMWAYS AND STREET ENVIRONMENT – A CASE OF KOLKATA'** in partial fulfillment of the requirement for the award of the postgraduate degree of **MASTER OF URBAN AND RURAL PLANNING**, submitted in the Department of Architecture and planning, Indian Institute of Technology, Roorkee, is an authentic record of my own work carried out by me during the period from August 2010 to June 2011 under the supervision and guidance of Prof. R Shankar.

The matter embodied in this dissertation has not been submitted by me anywhere else for the award of any other degree elsewhere.

Date: 27th June, 2011

Place: Roorkee

(RAHUL MAJUMDAR)

CERTIFICATE

This is to certify that the above statement made by the candidate **Rahul Majumdar** is correct to the best of my knowledge and belief.

Date: 27th June 2011

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Rahul Majumdar

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ACRONYMS

AC	Air Condition
ATM	Automated Teller Machine
B.B.D Bag	Binay Badal Dinesh Bag
CBD	Central Business District
CABE	Commission for Architecture and the Built Environment
CCTV	Closed Circuit Television
CDP	City Development Plan
CMP	Comprehensive Mobility Plan
CTC	Calcutta Tramways Co. Ltd.
DC	Direct Current
DTLR	Department for Transport, Local government and the Regions
ESI	Employees' State Insurance
EWS	Economically Weaker Section
Govt.	Government
HT Line	High Tension Line
KMA	Kolkata Metropolitan Area
KMC	Kolkata Municipal Corporation
KMDA	Kolkata Metropolitan Development Authority
Kmph	Kilometer per Hour
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LOS	Level of Service
LRT	Light Rail Transit
M.G Road	Mahatma Gandhi Road
MRT	Metro Rail Transit
NGO	Non Government Organization
ODPM	Office of the Deputy Prime Minister
PCU	Passenger Car Unit
PPP	Public Private Partnership
ROW	Right of Way
SAP	Survey, Analysis and Plan
S.P Mukherjee Road	Shyama Prasad Mukherjee Road
Sq.km	Square Kilometer
TfL	Transport for London
UDPFI	Urban Development Plan Formulation and implementation
UK	United Kingdom
ULB	Urban Local Body
USA	United States of America
USSR	Union of Soviet Socialist Republics
WB	West Bengal
w.r.t	With Respect To

EXECUTIVE SUMMARY

Tram is a mode of transport which is very much sustainable from the points of its low energy consumption, eco-friendly nature, low cost of construction as well as running cost, and its historical association with the city and its culture. Many of the developed countries have been trying to use tram as a mode of MRT. Many of them have been reintroduced tram into their transportation system after abandoning it in the past. In India, only Kolkata still has Tram which is fully functioning as a mode of public transport.

The study has been divided into seven chapters; the chapter 1 involves the brief history and the advantages of tram. Chapter 2 focus on the understanding the traffic and transportation scenario in Kolkata and the streetscape design practiced in the foreign country. Chapter 3 reviews the tramway system available in London and Hong Kong from where the inferences can be drawn on how they have managed to run the tram, what development policies they have taken for improvement of tramways. Chapter 4 broadly discuss the existing operational condition of Kolkata Tramways, Chapter 5 gives the information about the criteria on the basis of which the study area has been selected, Chapter 6 is the analysis stage where three road stretches have been intensively analyzed; the problems of traffic and transportation, streetscape design everything have been covered under this. Based on the issues and analysis, Chapter 7 aims to recommend some improvement possibilities for which plausible strategies, guidelines have been evolved.

This study aims to establish the fact that Kolkata is unique and fortunate that it is the only city showing its sensitivity to tramway which is part of architectural legacy. It needs to be revitalized and made to play a more important role in the life of the great city. Kolkata has the potentiality of making the tramway viable in terms of tourism, heritage, urban economy and environmental quality. It only requires positive approach, plausible development policies, and strict management to make it an attractive, viable and even profitable mode of transport.

1

INTRODUCTION

1.1. Introduction of tramways

A Tram, Tramcar (British English), streetcar or trolley car (American English) is a rail borne, electrically driven public transport vehicle that runs on rails let into the surface of the road, power usually being taken from an overhead wire [1]. It may also run between cities or towns (interurban, Tram-train), and/or partially grade separated (light rail or light rapid transit). Trams are usually lighter and shorter than conventional trains and rapid transit trains.

The tramway comprises of three distinctive parts, namely, 1) Tram car / vehicles, 2) Tram line / track and 3) Overhead electrical lines - the modern trams run either by 'Trolley system' or 'Pantograph system'[1]. Added to these are the appurtenant architectural components namely, 4) the tram stop, 5) the terminus and 6) the depot. These together make the tramway network. The streetscape which provides the setting for the tramway, together with the tramway network is Tramway Architecture.

1.2. Brief history of tramways [1] [2]

The very first tram was horse-drawn which started operating in South Wales in UK in 1807; it was horse-drawn at first, and later moved by steam and electric power. In 1883, Magnus Volk constructed his 2-ft gauge Volk's Electric Railway along the eastern seafront at Brighton, England. This 2-km line, re-gauged to 2 ft 9ins in 1884, remains in service to this day, and is the oldest operating electric tramway in the world. The first electric street tramway in Britain, the Blackpool Tramway, was opened on 29 September 1885 using conduit collection along Blackpool Promenade. Since the closure of the Glasgow Corporation Tramways 1962, this has been the only first-generation operational tramway in the UK. The first tram in Asia was introduced in Jakarta, Indonesia in 1869. Kolkata was the first Indian city to have tram introduced in 1873.

The Silesian Interurban in Poland and the Trams in Melbourne, Australia are claimed to be the largest tram networks in the world. Before its decline the BVG in Berlin operated a very large network with 634 km of route. During a while in the 1980s the world's largest tram system was in Leningrad, USSR, being included in Guinness World Records. The largest single tram line in the world is the Belgian Coast tram; which runs the entire length of the Belgian coast. Other large systems include Prague, Amsterdam, Basel, Zurich and Toronto. Until the system started to be converted to trolleybus (and later bus) in the 1930s, the first-

generation London network was also one of the world's largest, with 526 km (327 mi) of route in 1934. While the largest streetcar network in the world used to be located in Chicago, with over 850 km (530 miles) of track, all of which was converted to bus service by the late 1950s.

Tramways were common throughout the industrialised world in the late 19th and early 20th centuries but they had disappeared from most British, Canadian, French and U.S. cities by the mid-20th century. By contrast, trams in parts of continental Europe continued to be used by many cities, although there were contractions in some countries, including the Netherlands.

Since 1980 trams have returned to favour in many places, partly because their tendency to dominate the highway, formerly seen as a disadvantage, is now considered to be a merit. New systems have been built in the United States, Great Britain, Ireland, France and many other countries.

1.3. Tram in Asia

The countries in Asia [3] (Fig1) where the tram is still running as a mode of public transport is as listed below:

1. China
2. Hong Kong
3. India
4. Japan (Fig: 2)
5. Korea

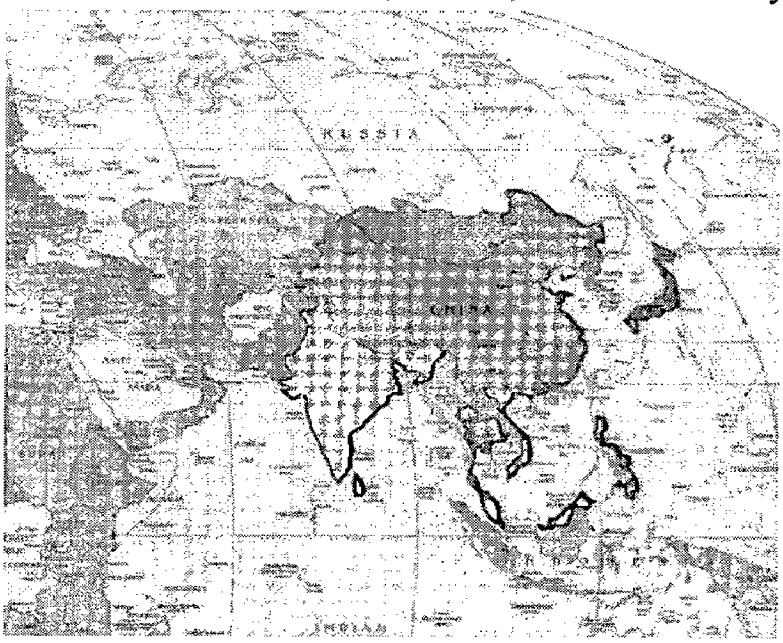


Figure 1 Map of the Asian countries where tram is used as a mode of public transport

Source: http://www.mapsofworld.com/asia-political-map

There were several other countries in Asia where tram was used as a mode public transport till 1990s, but after that due to various reasons it was abandoned or replaced by the LRT/MRT. But now, as in search of a sustainable transportation system, they are again thinking to reintroduce tram. Those countries are (Fig: 1):

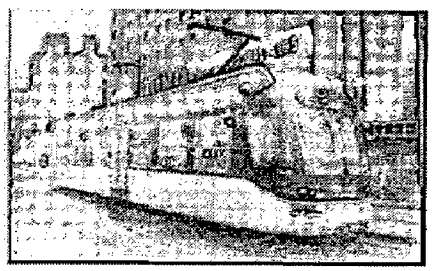


Figure 2 Toyoma Centram, Japan

1. Philippines 2. Malaysia 3. Sri Lanka 4. Thailand5. Vietnam

In India, Kolkata (Calcutta) has a tram network. Chennai (Madras), Kanpur, Delhi and Mumbai (Bombay) formerly had tram networks but these have been dismantled. Kolkata tram is the oldest operating electric tram in Asia, running since 1902.

1.4. Tram in America and Australia [1]

In some North American cities, streetcar lines were largely torn up in the mid-20th century except include New Orleans, Tampa, Newark, Seattle, Philadelphia, and San Francisco. Toronto currently has the largest streetcar system in the Americas in terms of track length and ridership (Fig: 3). Streetcars once existed in Edmonton and Calgary, but both cities have since converted their systems to support light rail vehicles instead. Some have restored their old streetcars and run them as a heritage feature for tourists, like the Vancouver Downtown Historic Railway.

Figure 3 Streetcar in Toronto, North America

Figure 4 A heritage H-Class model tram in Glenelg, Adelaide

Some American cities are now trying to rebuild or add streetcar systems after abandoning it mid 20th century; they are:

1. Tacoma 2. Washington D.C. 3. Portland 4. Seattle 5. Detroit

In Australasia, trams are used extensively only in Melbourne, and to a lesser extent, Adelaide, all other major cities having largely dismantled their networks by the 1970s. Sydney reintroduced its tram in 1997 as a modern system (Metro Light Rail), while Ballarat, Bendigo, Christchurch and Perth reintroduced their trams as heritage systems (Fig: 4).

Buenos Aires in Argentina had once one of the most extensive tramway networks in the world with over 857 km (535 mi) of track, most of it dismantled during the 1960s in favor of bus transportation. Now slowly coming back with the 2 km Puerto Madero Tramway, an artery that stretches for 15 kilometers by the River Plate (Fig: 5).

Figure 5 Puerto Madero Tramway in Buenos Aires

1.5. Tram in Europe [4] [5]

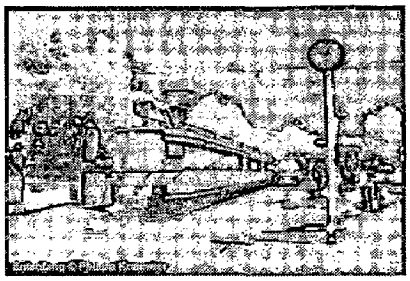


Figure 6 Tram-train in Karlsruhe, Germany

All the former communist countries of Central and Eastern Europe, excluding Lithuania, the Republic of Macedonia, Montenegro, Moldova and Slovenia, have extensive tram infrastructure. Globally, the whole of Europe stands out as a continent where all of thirty countries demonstrate successfully how sustainable tramway is as urban public transport. In recent decades, tram networks in countries including France, Germany, Spain and Portugal have grown considerably (Fig: 6). The Netherlands, which already makes extensive use of trams, has plans to expand trams. Instead of closing the tramway system that were carried out in other European countries, Germany retained the original tram networks in many countries and also in some places, tram networks have been added or expanded through the introduction of hybrid tram-train or Stadtbahn systems which may combine standard railway, on-street and underground operations. Notable examples include the systems in Cologne and Karlsruhe. The list of 117 cities in 28 countries of Europe (Fig: 7) where tram is still running as a mode of public transport is given in Annexure I.

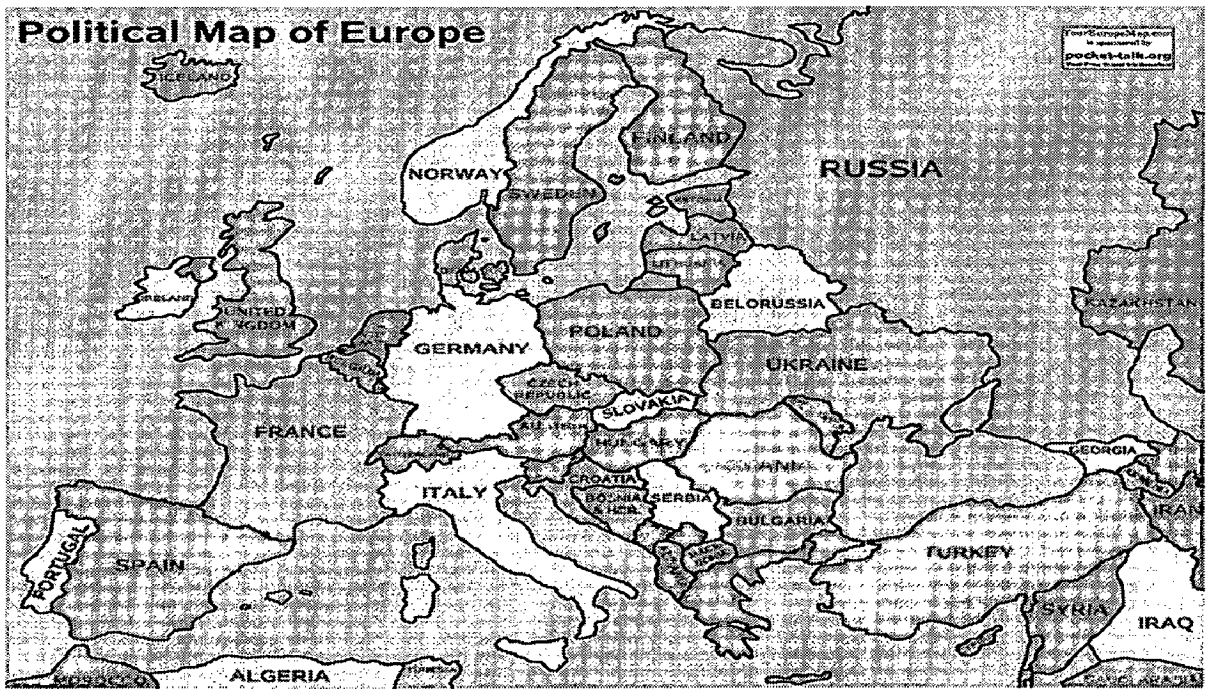


Figure 7 Map of the European countries where tram is used as a mode of public transport

Source: http://en.wikipedia.org/wiki/tram (Figure 2 to figure 6)
http://www.mapsofworld.com/europe-political-map (Figure 7)

1.6. Advantages of tram over the other modes of transport [1] [6] [7] [9] [10]

The tram is mostly favorable as a mode of public transport. In the developed countries it is introduced as a most sustainable mode of transport. Besides its eco-friendly qualities tram has other advantages too. It has many aspects by which it wins over the other modes of transport e.g. carrying more numbers of passengers, energy efficient, non pollutant, pedestrian friendly, reliable and above all it can be easily integrated with the city character. The advantages and attributes of tram are discussed below.

1.6.1 Passenger carrying capacity

1. Trams provide a higher capacity service than buses. They can move up to 18,000 people per hour along defined traffic corridors, effectively and efficiently;
2. Trams can adapt to the number of passengers by adding more cars during rush hour (and removing them during off-peak hours). No additional driver is then required for the trip in comparison to buses.

1.6.2 Energy source

3. They can use overhead wire set to be shared with trolleybuses (a three wire system).
4. Trams can run on renewable energy (compressed air, gas, battery) without the need for very expensive and short life batteries.
5. Trams can trackshare with mainline railways, servicing smaller towns without requiring special track as in Stadtbahn Karlsruhe - and at greater speed than buses.

1.6.3 Pollution free

6. Unlike buses, but like trolleybuses, (electric) trams give off no exhaust emissions at point of use.
7. Reduction in noise, pollution, vibration and dirt, thus improving the local environment for workers and shoppers;

1.6.4 Enhancing city character

8. The ability to return some city centre streets to the pedestrian and cyclist, yet penetrated by public transport;
9. Enhancement of the streets in which they operate by the use of sympathetic and decorative street furniture;

10. Rights-of-way for trams are narrower than for buses. This saves valuable space in cities with high population densities and/or narrow streets.

1.6.5 Reliability and comfort

11. Reliability and public confidence;
12. A quality ride in a comfortable and smooth vehicle - a key factor to persuade commuters to forsake cars;
13. A significant cutting of point-to-point journey times, reducing the stress of do-it-yourself driving and the potential of being a viable alternative to the dependence upon the car-culture.
14. The tram stops in the street are easily accessible - unlike stations of subways and commuter railways placed underground (with several escalators, stairways etc.) or in the outskirts of the city center.
15. Multiple entrances allow trams to load faster than suburban coaches, which tend to have a single entrance. This, combined with swifter acceleration and braking, lets trams maintain higher overall speeds than buses, if congestion allows.
16. Passenger comfort is normally superior to buses because of controlled acceleration and braking and curve easement.
17. Because the tracks are visible, it is easy for potential riders to know where the routes are.

1.6.6 Low maintenance cost

18. Opportunities for new business development and regeneration, through excellent links, of run-down areas;
19. Over the longer term, revitalization and expansion - they are a sign of confidence in the future of the city.
20. Construction and maintenance cost of the tram ways is less than the other mass transit system.

Consistent market research and experience over the last 50 years in Europe and North America shows that car commuters are willing to transfer some trips to rail-based public transport but not to buses. Typically light rail systems attract between 30 and 40% of their patronage from former car trips. Rapid transit bus systems attract less than 5% of trips from cars, less than the variability of traffic.

1.7. Need of the project

Considering all the advantages that the tram service has comparing to the fossil fuel based transport in the era of increasing carbon footprint, global warming, decreasing fossil fuel availability, it becomes significant to introduce tramways as an effective, viable and sustainable mode of transport in India. Since Kolkata is the only Indian city which has retained tramways, it is necessary to undertake a comprehensive study to understand and analyze the operative mechanism of the tram service and to plan for integrating it with the land-use and other aspects of urban system so as to make available sustainable model of tramways which can be adopted by other Indian cities. With these intentions the dissertation topic has been dealt with.

As Kolkata tramway has entered into its 3rd century, service started operating on 24th February 1873, this slow moving, electrical reptile in narrow and crowded streets completes the ultimate attraction of the city. Having glided down the rails as a historical witness, the tram has itself been turned into an immemorial heritage for which the all whole Kolkatans are proud of. This 137 years old tramways system in Kolkata is still functioning but it requires more attention to become a smart mode of transport like the other international cities.

The concept of improving the tramways is not only the improvement of the Level of Service (LOS) of the tramways. It is also for the urban revitalization which includes the road side development & urban design along the transport corridors. The problem of lack of adequate road space, transportation infrastructures is heavily responsible for the deterioration of LOS for tramways. It now operates in mixed traffic with all variety of vehicles competing for the same road space. The poor management, lack of future vision and unwillingness to use modern advanced techniques and technologies has further increased the challenges of Kolkata tramways as an effective mode of public transport.

So proper planning & methodology formulation is very much needed to cater the people of Kolkata, a comfortable, safe and reliable tram service with a pleasure of its heritage and nostalgic value by integrating the tramways with the street environment and city transportation system.

1.8. Aim

To prepare an improvement plan for integrating tramways with street environment in Kolkata

1.9. Objectives

The main objectives of this project to achieve the aim are as follows:

1. To do comprehensive literature survey on the international examples and best practices of tramways and tramway-street environment outside India, to derive useful guidelines.
2. To study the functioning of tramways in Kolkata in order to understand its efficiency, viability, role and problems and potentials.
3. To study the existing conditions and problems of the tramway-street environment of Kolkata.
4. To work out plan proposals and strategies for improving the service of Kolkata tramway to make it sustainable.
5. To work out plan proposals and strategies for integrating the tramways to the street environment of Kolkata.
6. To provide guidelines for other Indian cities for integrating tramways with street environment.

1.10. Methodology

The study has been carried out in different stages.

At first the background study on the importance of tram in transport scenario is done with the identification of need for the study and dissertation problem. The study helps in formulation of the aims and objectives of the thesis.

Next the literature review is done to focus on the understanding of the improvement of public transport system by integrating the tram system with the street environment. This study also includes the various aspects of urban development, e.g., the tram transport system in the foreign countries, the design and planning process of integration of urban design along with the transportation corridors in the foreign countries, the preset transportation scenario in India especially in Kolkata, the tramways system & the urban development in recent era in

Kolkata. Then the inferences and guidelines are to be drawn through analysis of literature study to frame the outline of the project.

The data collection on present condition of tramway-street environment in Kolkata has been done through primary survey based on the reconnaissance survey, user survey, direct observation and photo analysis, and the secondary survey based on the data acquired from Govt. offices, library, research paper, internet etc.

The data base is made with the variety of primary and secondary data. Preparation of guidelines, plan proposal, strategies & standards for the project's application is done by carrying a data analysis.

The methodology followed is shown in schematically in Fig 8.

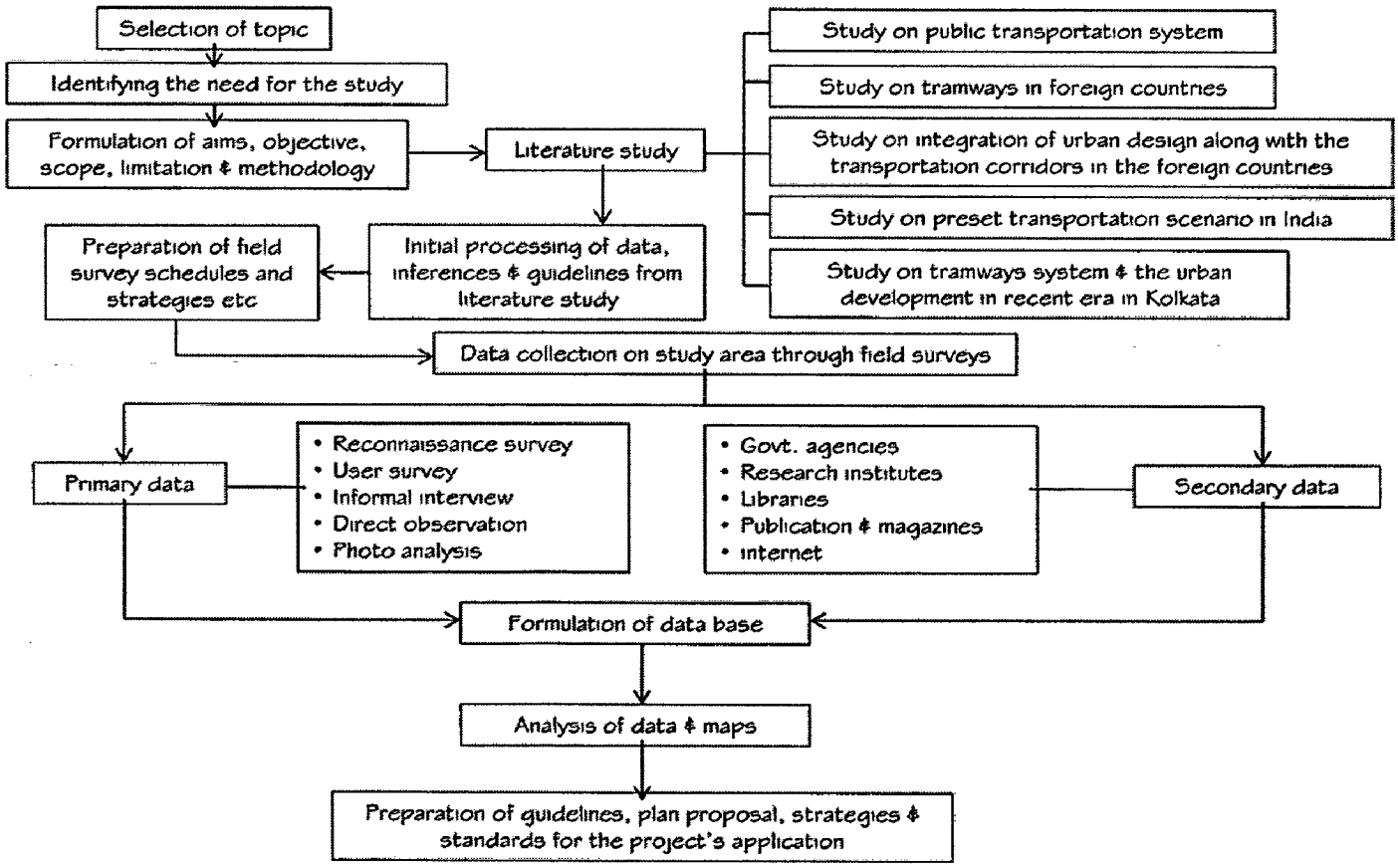


Figure 8 Methodology

1.11. Scope and limitation

1. Though the dissertation is related to the tramways but the findings and guidelines from it can be applied to the other LRT systems.

2. The dissertation proposals not only help the tramways but it can also help the other modes of transport to run smooth on the designed and planned tramway-streets.

3. The study area is limited only to Kolkata Municipal Corporation (KMC) area.

4. All the secondary data related to the various statistics of the tramways are all from The Calcutta Tram Company (CTC) which is five years old.

5. The accuracy, reliability and coverage of primary data are limited by the practical difficulties of field survey.

2

LITERATURE REVIEWS

This chapter focuses on the review of various literatures on the technical and operational details of tramway system and the streetscape design practiced in the foreign countries. These details of tramway system help us to know the overall system and also to find the possibilities of improving the services. The study also covers the standard dimensions and other factors regarding tramways which are helpful in evolving guidelines for the improvement of Kolkata tramways. The streetscape design guidelines of foreign countries help us know the nature and objectives of designing streetscape. It also tells us why a well designed streetscape is very much required to revive the city vitality. It is not only to uplift the city character but also to improve the street character by improving the road condition, pedestrian environments, street furnishing, plantation and proper lighting. These are all the key components for a better streetscape which not only provides a good aesthetic quality to the city but also helpful to provide security, safety and convenience to the people. The availability of the literature based on the tramways, specially Indian tramways, is very limited in number. The literature on streetscape design practiced in foreign countries is available in sufficient numbers but the review here is restricted to four.

The first section starts with the technical and operational details of tramways where it is again sub divided into five parts. The second section is on the book review and description of some points which are useful and related to my design. The third section is the summarization of book reviews of three books based on the streetscape design practiced in the foreign countries.

2.1. Technical and operational details of tramways

2.1.1 Main components of tramways

The tramway is comprised with mainly three components. They are:

1. Tram car / vehicles,
2. Overhead electrical lines
3. Tram line / track,

Besides this, it also has other components too. They are: Tram depots, tram terminal, and tram stoppage.

2.1.2 Types of tramcars [1] [2]

There are various types of tram cars available according to their construction techniques. All of them are same regarding the functionality, but slightly different regarding the exterior look, technical detailing, efficiency, cost of construction, energy consumption etc. Generally nine types' of different cars are available. They are named as:

1. A type
2. C type
3. D type
4. H type
5. L type
6. M type
7. S type
8. R type
9. N type

Besides these conventional tramcars, there are modern trams too which are made of totally different technologies and look wise also different from the older trams. Almost all the countries now emphasize running new tramcars instead of the older ones. All the new tram are made of almost same technologies that basically concentrate on reducing energy consumption and increasing speed, efficiency, passenger carrying capacity, passenger comfort. The general features of the above said tramcars are discussed in the following paragraphs.

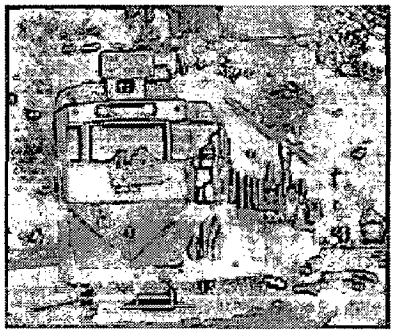


Figure 9 C Type Tram

- **C TYPE** (Fig: 9) and **D TYPE** (Fig: 10): These are of earlier stocks. Both stocks were double coached, two doors & four wheels under each coach, and no wheels between two coaches, but C TYPEs had no front iron net, and had front coach trolleypole, whereas D TYPEs had front iron net, and rear coach trolleypole. C TYPEs were the first double coach tram, introduced in Kolkata only (not in the Howrah). It was replaced by D TYPEs in all routes. D TYPE introduced much later on Bandhaghat, Kolkata line, and continued until its closure in 1971. After closing of Bandhaghat line, all D TYPEs started running on Kolkata side. D TYPE was continued until 1989.

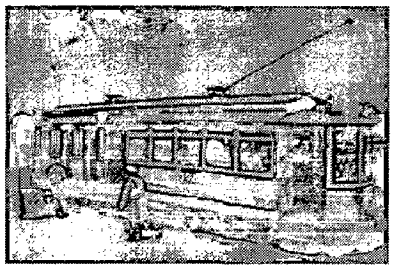


Figure 10 D Type Tram

Figure 9 L Type Tram

- **L TYPE** (Fig: 11) - The first double coach tram with wheels between two coaches, made in Nonapukur workshop, Kolkata. It is sometime called 'elephant car' by CTC, because its driver cab and backside is slightly slanted to

forward, and also narrow, just like the head of an elephant (without trunk). It was introduced as a higher speed tram, with improved motor, for running specially on reserved tracks and routes in Kolkata like Galiff Street, Baliganj, Tollyganj, Behala & Khidirpur (for so it was a little aerodynamic model mocked). It was also longer than D TYPE cars. This is the first tram with driver cab door. Although now decreased in number than before, L TYPE is still running proudly in city streets, mainly on south Kolkata routes. One tram was partly modified with front glass, and another with many glow sign boards (seems a moving billboard).

- **M TYPE** (Fig: 12) - This is a modified variation of L TYPE, and not so stylish like L TYPE, also made in Nonapukur workshop. The only difference is that it's front and back is not slanted, and is straight. It was also introduced as a higher speed tram, with improved motor, for running especially on reserved tracks and routes. Later, this type was also introduced on unreserved tracks and routes. M TYPE is also still running proudly in city streets, except Bidhannagar line due to high incline under Kankurgachhi Rail Bridge. Three cars are used as training cars.

Figure 10 M Type Tram

- **S TYPE** (Fig: 13) - This is a slightly changed variation of M TYPE, and not so stylish like M TYPE, also made in Nonapukur workshop. The only difference is that it's front and back is not narrow, and is wide. It had improved motor, for running especially on unreserved tracks and routes. Later, this type was running on reserved tracks and routes. Some early cars were highly maintained by government. S TYPE is also still running on city streets.

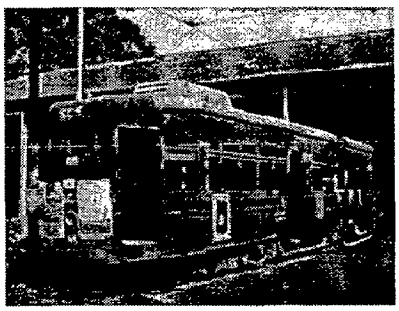


Figure 11 S Type Tram

- **R TYPE** (Fig: 14)- Many years after the introduction of D, L, M & S TYPE, a new type of rolling stock arrived in Kolkata, made by Burn Standard India Ltd. It is a renovated, stronger, heavier and speedier version than earlier types. It was introduced around 1982 changing the image of Kolkata trams. It was the first type, which started

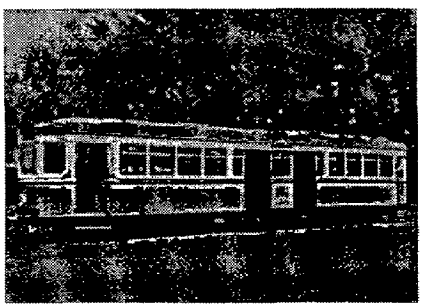


Figure 12 R type Tram

running throughout the city network in all routes. Some trams were partly modified with front glass; two trams were modified like the B class tram of Melbourne with fluorescent lights and back glass (similar to the double ended B class tram). These are the highest number of rolling stock of Kolkata tramways.

- **N TYPE** (Fig: 15) - This was the last original made new rolling stock, built by Jessop India Ltd. It was a variation of R TYPE. It was introduced around 1987. Some trams were partly modified with front glass; some were modified with fluorescent lights and FM radio. These are the second highest number of rolling stock of Kolkata tram. Three years after its introduction, closure of Kolkata tram was again thought by government, so no more new type of stock was introduced.

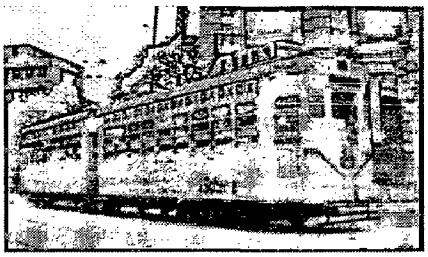


Figure 13 N Type Tram

2.1.3 Types of propulsion [1] [2]

The very first tram was drawn by animal i.e. horse driven tram. Gradually it shifted to the other modes of power supply system, e.g. steam, diesel, petrol, cable-pulled and electric. Besides all these conventional energy sources, in many foreign countries have adopted non-conventional energy sources to run the tram, i.e. compressed air, gas, batteries etc. but these are of limited numbers. Almost all countries in the world have trams powered by the overhead electric wire either by means of Trolleypole system or Pantograph system. The various sources of power supply system and the changes introduced in the tram technology are discussed below.

1. **Horse driven tram** (Fig: 16)**:** These early forms of public transport developed out of industrial haulage routes or from the omnibus that first ran on public streets in the 1820s, using the newly-invented iron or steel rail or 'tramway'. These were local versions of the stagecoach lines and picked up and dropped off passengers on a regular route, without the need to be pre-hired. Horsecars on tramlines were an improvement over the omnibus as the low rolling resistance of metal wheels on iron or steel rails (usually grooved from 1852 on), allowed the animals to haul a greater load for a given effort than the omnibus and gave a smoother

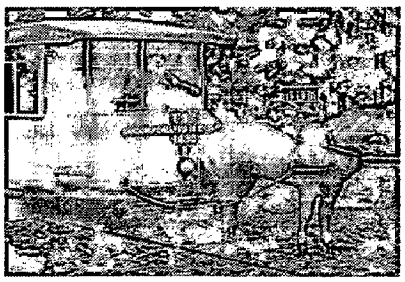


Figure 14 Life size model of a horse drawn tramcar in Kolkata

ride. The horse-drawn streetcar combined the low cost, flexibility, and safety of animal power with the efficiency, smoothness, and all-weather capability of a rail right-of-way.

2. **Steam powered tram** (Fig: 17)**:** The first mechanical trams were powered by steam. Generally, there were two types of steam tram. The first and most common had a small steam locomotive (called a tram engine in the UK) at the head of a line of one or more carriages, similar to a small train. Systems with such steam trams included Christchurch, New Zealand; Sydney, Australia; and other city systems in New South Wales. Steam tramways also were used on the suburban tramway lines around Milan; the last Gamba de Legn tramway ("Peg-Leg" in Milanese) ran on the Milan-Magenta-Castano Primo route in late 1958.

Figure 15 Steam trams in Rockhampton, Queensland

The other style of steam tram had the steam engine in the body of the tram, referred to as a tram engine or steam dummy. The most notable system to adopt such trams was in Paris. French-designed steam trams also operated in Rockhampton, in the Australian state of Queensland between 1909 and 1939. Stockholm, Sweden, had a steam tram line at the island of Södermalm between 1887 and 1901. A major drawback of this style of tram was the limited space for the engine, so that these trams were usually underpowered.

3. **Cable-pulled tram** (Fig: 18)**:** The next type of tram was the cable car, which sought to reduce labour costs and the hardship on animals. Cable cars are pulled along the track by a continuously moving cable running at a constant speed that individual cars grip and release to stop and start. The power to move the cable is provided at a site away from the actual operation. The first cable car line in the United States was tested in San Francisco, California, in 1873. The second city to operate cable trams was Dunedin in New Zealand, from 1881 to 1957.Cable Cars operated on Highgate Hill in North London and Kennington to Brixton Hill in South London.

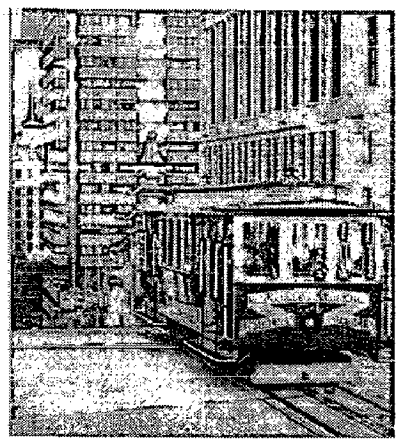


Figure 16 Cable car coming uphill from Chinatown in San Francisco, California

Cable cars suffered from high infrastructure costs, since an expensive system of cables, pulleys, stationary engines and vault structures between the rails had to be provided. They also require strength and skill to operate, to avoid obstructions and other cable cars. The cable had to be dropped at particular locations and the cars coast, for example when crossing another cable line. Breaks and frays in the cable, which occurred frequently, required the complete cessation of services over a cable route, while the cable was repaired. After the development of electrically powered trams, the more costly cable car systems declined rapidly. Cable cars were especially effective in hilly cities.

However, the most extensive cable system in the U.S. was in Chicago, a much flatter city. The largest cable system in the world, in the city of Melbourne, Victoria, Australia, had at its peak 592 trams running on 74 kilometers of track. The San Francisco cable cars, though significantly reduced in number, continue to perform a regular transportation function, in addition to being a tourist attraction. A single line also survives in Wellington, New Zealand (rebuilt in 1979 as a funicular but still called the "Wellington Cable Car").

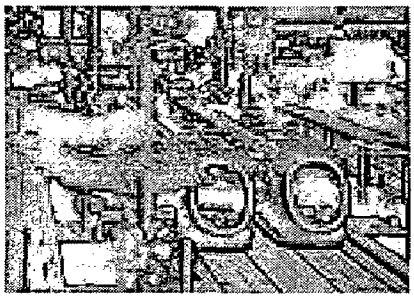


Figure 17 Electrical tram in Athens in Peace and Friendship terminal

4. **Electrical tram** (Fig: 19): Electric trams (trolley cars) were first successfully tested in service in Richmond, Virginia, in 1888, built by Frank J. Sprague. There were earlier commercial installations of electric streetcars, including one in Berlin as early as 1881 by Werner von Siemens and in Saint Petersburg, Russia, invented and tested by Fyodor Pirotsky in 1880. Another was by John Joseph Wright, in Toronto in 1883. The first commercial installation of an electric streetcar in the United States was built in 1884 in Cleveland, Ohio and operated for a period of one year.

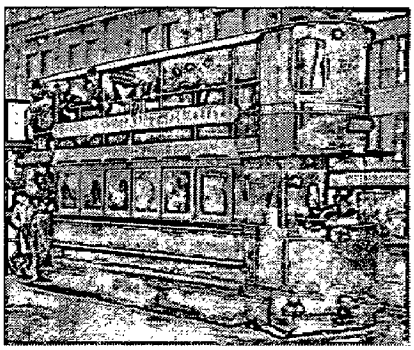


Figure 18 Mekarski tram in Paris during 1910

Earlier installations proved difficult or unreliable. Siemens' line, for example, provided power through a live rail and a return rail, like a model train, limiting the voltage that could be used, and providing electric shocks to people and animals crossing the tracks.

Siemens later designed his own method of current collection, from an overhead wire, called the bow collector, and Thorold, Ontario, opened in 1887, and was considered quite successful at the time. While this line proved quite versatile as one of the earliest fully functional electric streetcar installations, it required horse-drawn support while climbing the Niagara Escarpment and for two months of the winter when hydroelectricity was not available. It continued in service in its original form into the 1950s.

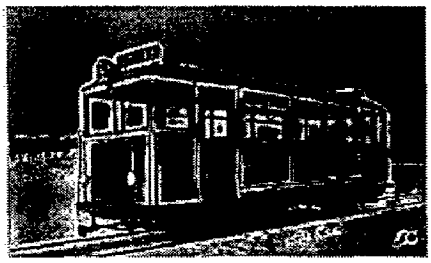


Figure 19 The only petrol-driven tram of Stockholms Spårvägar, on line 19 in the 1920s.

5. **Other power source** (Fig: 20, 21 and 22)**:** In some places, other forms of power were used to power the tram. Hastings and some other tramways, for example Stockholms Spårvägar in Sweden and some lines in Karachi, used petrol trams and Lytham St. Annes used gas trams. Paris operated trams that were powered by compressed air using the Mekarski system. In New York City some minor lines used storage batteries; a longer battery-operated tramway line ran from Milan to Bergamo (about 60 km) during the '50s. Galveston Island Trolley in Texas operates diesel trams due to the city's hurricane-prone location, which would result in frequent damage to an electrical supply system.

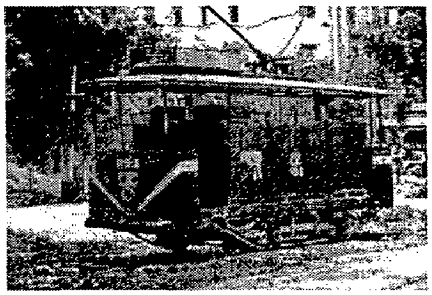


Figure 20 Diesel driven tram engine

2.1.4 Tramway track [1] [8]

Tramway track is used on tramways or light rail operations. Grooved rails (or girder rails) are often used in order to make street running feasible. Like standard rail tracks, tram tracks consist of two parallel steel rails. Tram rails can be placed in several surfaces, such as with standard rails on sleepers like railway tracks, or with grooved rails on concrete sleepers into street surfaces (pavement) for street running. Another environmentally-friendly or ecologically-friendly alternative is to lay tracks into grass turf surfaces (Fig: 23); this is known as grassed track (or track in a lawn), first used in Liverpool in 1924.

Figure 21 Grassed track on the Eusko Tran in Bilbao

The first tramways were laid in 1832 in New York by John Stephenson, to assist horses pulling buses through dirt roads, especially in wet weather when muddy. The evolution of street tramway tracks paralleled the development from horse power to mechanical, especially electric power. In a dirt road, the rails needed a foundation, usually a mass concrete raft. The first tramways had a rail projecting above the road surface, or a step set into the road, both of which were apt to catch the narrow tires of horse drawn carriages. The invention by Alphonse Loubat in 1852 of grooved rail enabled tramways to be laid without causing a nuisance to other road users, except unsuspecting cyclists, who could get their wheels caught in the groove (Fig: 24).

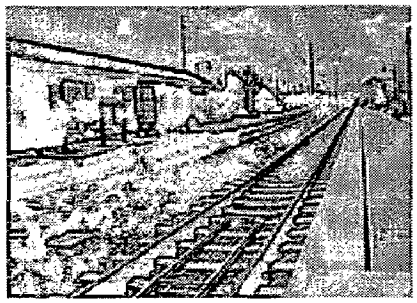


Figure 22 Light rail tracks with concrete railroad ties in Karlsruhe, Germany

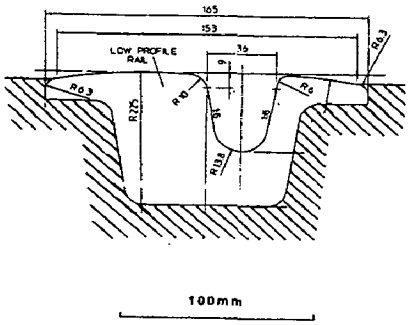


Figure 23 Detail of LR55 Tram track

A grooved rail, groove rail, or girder rail is a special rail designed for tramway or railway track in pavement or grassed surfaces (grassed track or track in a lawn). This was invented in 1852 by Alphonse Loubat, a French inventor who developed improvements in tram and rail equipment, and helped develop tram lines in New York City and Paris.

An alternative to the conventional girder profiled grooved track is the LR55 profile (Fig: 25). This is considerably cheaper and easier to install and maintain than conventional girder rail as it requires a smaller footprint foundation and existing utility services need not be disturbed.

The following figure shows the detail of a typical old London tram which has double Decker coaches and Trolley-pole propulsion system. This type of tram is used only for the tourism purpose in London (Fig: 26).

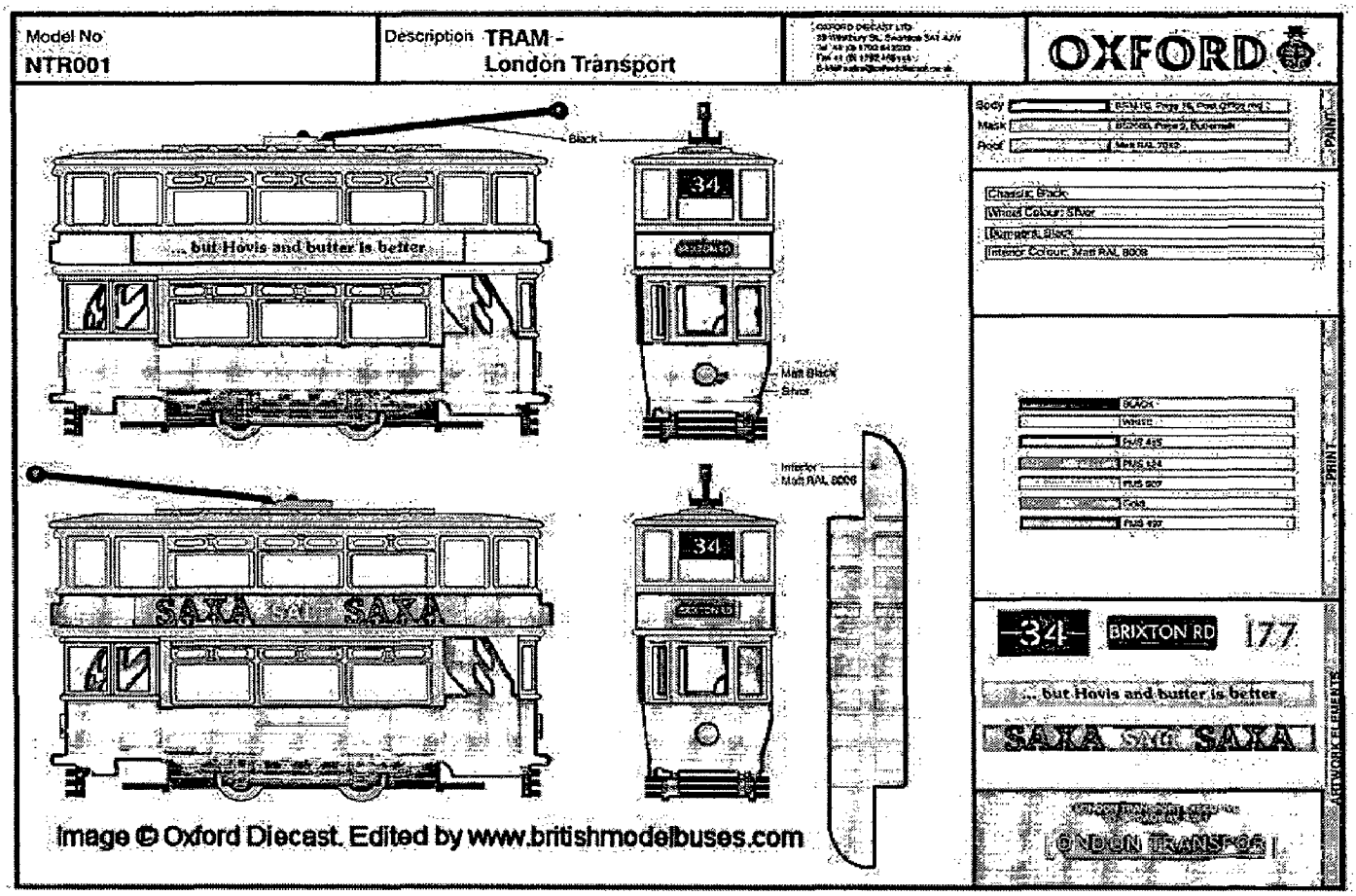


Figure 24 Detail of a tram in London (Model no NTR001)

Source: http://www.tramways.com/tram_types (Figure 9 to Figure 15)
http://en.wikipedia.org/wiki/tram (Figure 16 to figure 22)
http://en.wikipedia.org/wiki/tram_track (Figure 23and Figure 24)
http://www.trampower.co.uk/track.html (Figure 25)

2.1.5 Arguments against tramways [1] [6] [7] [9] [10]

Analyzing the pros & cons of travelling in the trams, the commuters would find it very hard to locate the negative aspects of tram travelling. However of late, the tramcars have lost much of its hype, sheer and luxury. Although it is true that their numbers have drastically come down in the era of luxurious cabs and bikes, still tram has managed to brave the odds and thrive in the roads with its same old promise of safe, luxurious and easy going life style.

Though tram has lots of advantages compared to other modes of public transport, it has some shortcomings because of which some people raise their voice against tram. They are listed below.

1. Tram infrastructure (such as island platforms) occupies urban space at ground-level, sometimes to the exclusion of other users, including cars.

2. The capital cost is higher than for buses, even if a tramcar usually has a much higher lifetime than a bus.

3. Trams can cause speed reduction for other transport modes (buses, cars) when tram stops in the middle of the road do not have pedestrian refuges. Passengers alighting from or boarding to tram can obstruct the traffic flow of other vehicles.

4. When operated in mixed traffic situations, trams are more likely to be delayed by disruptions in their lane. Buses, by contrast, can sometimes maneuver around obstacles. Opinions differ on whether the deference that drivers show to trams — a cultural issue that varies by country — is sufficient to counteract this disadvantage.

5. Tram tracks can be hazardous for cyclists, as bikes, particularly those with narrow tires, may get their wheels caught in the track grooves. It is possible to close the grooves of the tracks on critical sections by rubber profiles that are pressed down by the wheel flanges of the passing tram.

6. Steel wheel trams are noisier than rubber-wheeled buses or trolleybuses when cornering if there are no additional measures taken (e.g. greasing wheel flanges, which are standard in new-built systems). Tram wheels are fixed onto axles so they have to rotate together, but going around curves, one wheel or the other has to slip, and that causes loud

unpleasant squeals. A related improvement is rubber isolation between the wheel disc and the rim, as used on Boston (Massachusetts, USA) Green Line 3400 and 3600 series cars. These cars are much quieter than those with solid metal wheels. (This construction requires a flexible cable to electrically connect the tire to the wheel body.)

7. Light rail vehicles are often heavier per passenger carried than heavy rail and monorail cars, as they are designed with higher durability (which means more mass) to survive collisions, since they cannot swerve to avoid oncoming objects in emergencies.

8. Long-term conflicts between motorists and light rail operations can be alleviated by segregating their respective rights-of-way and installing appropriate signage and warning systems.

9. Rail transport can expose neighboring populations to moderate levels of low-frequency noise. However, transportation planners use noise mitigation strategies to minimize these effects. Most of all, the potential for decreased private motor vehicle operations along the trolley's service line because of the service provision could result in lower ambient noise levels than without.

10. In the event of a breakdown or accident, or even road works and maintenance, a whole section of the tram network can be blocked. Buses and trolleybuses can often get past minor blockages, although trolleybuses are restricted by how far they can go from the wires. Conventional buses can divert around major blockages as well, as can most modern trolleybuses that are fitted with auxiliary engines or traction batteries. The tram blockage problem can be mitigated by providing regular crossovers so that a tram can run on the opposite line to pass a blockage, although this can be more difficult when running on road sections shared with other road users. On extensive networks diversionary routes may be available depending on the location of the blockage. Breakdown related problems can be reduced by minimizing the situations where a tram would be stuck on route, as well as making it as simple as possible for another tram to rescue a failed one.

2.2. Book review: "Paving the way-how we achieve clean, safe & attractive street" [11]

2.2.1 Overview of the book

The book is a research project commissioned in May 2001 by CABE and ODPM and produced by Alan Baxter & Associates in association with DTLR. In this book, CABE sets out a clear agenda to create a better designed, better managed streets, which satisfy the needs of all who use them. They set out the steps by which the Govt. can remove the inherent bias towards car users' interests in national design and regulatory guidelines and also show the process how the Govt. can get a grip on the many vested interests that screw up our streetscapes, including the utility companies and the advertising industry. The book contains five main chapters, of which chapter 1 gives the introduction of the book and Chapter 2 looks at why streets are important to everyone's life and well-being and how they are managed. Chapter 3 and 4 deal with the case studies, first by describing the methodology adopted in their selection and analysis, and then by reviewing the main issues which they raise. The recommendations presented in Chapter 5 cover many aspects of the existing procedures and activities by which streets are designed and managed. They are intentionally confined to recommendations that can be brought toward and implemented within a realistic time period. Streets are both the most central and the most multifarious aspect of the public realm, and it is the fragmentation of their treatment which is a major problem. The aim of the research is to show their treatment can be radically improved. Some important issues have been identified from this book and it is then summarized to get a overview of the book. They are discussed briefly in the following paragraphs.

2.2.2 Introduction to street

Whereas words such as Road (from the Anglo-Saxon ride) suggests movement from one place to another, the word Street (from Latin meaning to pave) suggests an area for public use but not exclusively devoted to circulation. The street is by definition, a multi functional space, providing enclosure and activity as well as movement. Its main functions are:

1. Circulation, for vehicles and pedestrians
2. Access to building and the provision of light and ventilations for buildings
3. A route for utilities
4. Storage space, especially for vehicles

5. Public space for human interaction and sociability; everything from parades and protests to chance encounters

Streets are the veins which allow places of every shape and size to function. They exist not just for movement, but as a space that everyone share. Streets are not just conduits for transport. Streets are where people meet each other. Streets define neighbourhoods. Each street has individual character and qualities. Streets are essential components in the urban fabric. They are places in themselves. They are the most immediate part of the public urban realm and we encounter them every day.

Local residents care passionately about the quality of their street environment to reap the social benefits, not least in terms of greater feelings of personal and community safety. Creating better street environment is, first and foremost, about changing attitudes and ways of working, so that people are put first. Improving streets is not simply a design issue. Enhancing streets addresses wider social issues, it is about achieving safer environments through promoting a personal and communal sense of security. A good balance of different function, well designed and safe for pedestrians, well cared for and free of unnecessary clutter – a good street is constituted with all of these features.

2.2.3 The quality of the street

The term 'streetscape' refers to the design quality of the street and its visual effect, particularly how the paved area (carriageway and footway) is laid out and treated. Obviously the buildings and other features which enclose the street are crucial to its character.

The main indicators of quality, which are the test of successful streetscape, can be listed under six headings:

1. Comfortable and safe for pedestrians and the disabled
2. A street designed to accommodate all sorts of functions, not dominated any one function
3. Visually simple, and free of clutter. Regardless of whether a street is a straightforward or complex space, what matters is the simplicity and clarity of its paving, street furniture, lighting and landscaping
4. Well cared for, and where utilities or 'extraneous' advertising are subordinate to all other street functions
5. Sympathetic to local character and activity context, in design and detail
6. Making appropriate ordered provision for access, deliveries and storage of vehicles

Historically, streets were the responsibility of the building owners along the street or the local parish. In some places separate Paving Commissions were set up to deal uniformly with streets in a particular area. With the growth of motor traffic in the 1920s, attention shifted to the free-flowing movements of vehicles as the main considerations in the design of streets. The growth of regulations and guidance also affects the design of street.

For the purpose of highway administration, it has been customary for the last 30 years or more to identify roads and streets through a hierarchical classification – artificial roads, district distributor, local distributor, access roads and shared surface roads. This classification system is intended to help priorities capital and maintenance spending and to guide development control and parking strategies. Some form of descriptive hierarchy, a different language is, of course necessary, based on their overall character and functions rather than their vehicle capacity could help point the way to a different kind of management regime.

The aim of this research has been to analyse the process for the design and management of streets and to discover how that process influence the production of quality streetscape. The efforts to improve the condition and appearance of our street in recent years have generally been beneficial compared to the previous decades and there is an increasing awareness of the need to improve the pedestrian environment and to strike a better balance between the different functions of the street.

The bias in official guidance and regulation in itself presents a fundamental problem in dealing with streets as multi-use environments. In contrast with car users, the claims of other users and other functions of the street are treated as secondary. The descriptive classification relied on makes no allowance for looking at the street as a total entity.

2.2.4 Design detail

The detail of the design should not be an afterthought, to be attended to as circumstances allow, but an integral part of the overall design process. There are number of examples which show how attention to detail can make all the difference to streetscape. There are four ways that quality can be compromised or eroded:

1. **Lack of a clear design ethos:** Street furniture and fittings and the design of paving, ideally, should be simple and consistent. At Dunstable in Bedfordshire, for example,

quite the opposite has happened. Some bollards and signage are historical pastiche, while other features, including seating, are modern. The colored patterns in the paving bear no relation to the street form and usage. The visual effect, after much effort and expenditure, is confusing and illogical.

2. **Conflicting design solutions:** Because of the varied functions of streets, their design has to answer many aims. Each function has been dealt with in isolation, resulting in a lack of coordinated design.

3. **Inappropriate signage:** The need for clear signage is an obvious aspect of street design. The use of a consistent graphic language of lettering and symbols contributes to the good appearance of the street and to public safety. But signs, however well designed, can cause immense harm to the character of the street if they are badly sited or of an inappropriate scale. They are sized on the basis of traffic speed to facilitate driver legibility. In historic core zones, the standard signage should be imaginatively adapted to suit the local context.

4. **Neglect of the local vernacular:** Streets, as much as buildings reflect local tradition in layout, materials and features, all of which merit respect in alterations and new design. Wherever the local distinctiveness is evident they should be acknowledged. The attempt should be made to create an effective layout using natural or more carefully blended materials, and to control the design and location of signage while implementing complex traffic management schemes. Every street is special, not just ones in historically significant areas, and that care of the streetscape should be given high priority.

2.2.5 Recommendations

The study shows that there is a widespread ambition to improve the quality of our streetscape, in places of every size and character. But this ambition has been impeded by numerous barriers to quality, with the result that what has been achieved generally falls short of the ideal. Even with the best intentions the quality of streetscape is often compromised by the rigid application of highway engineering solutions, the lack of a coordinated approach to design, and a failure of design detail. Here is some recommendations came out from the research which can be applied to deal with the problems.

1. Highway authorities should, under best value, establish an audit to trail for design decisions affecting the streetscape, to show how design guidance, people's needs and vehicle movements have been accommodated.
2. Local authorities should introduce cross-sectoral management control for the administration of streets, with the aim of establishing an integrated approach to the public realm.
3. Development Plans and Local Transport Plans should specific strategies aimed at the improvement and maintenance of streetscape.
4. Traffic Sign regulations and guidance should be revised so that local authorities can vary the size of signs according to local context as well as vehicle speed.
5. The principles of 'Lane rental' and 'overcharging' systems for utility works in the street are supported and should be extended nationally if pilot projects increase street quality and reduce disruption.
6. The Control of Advertising Regulations should be applied more considerately in streets themselves as well as to development fronting streets.
7. Involving the local community in the care of the streetscape should be encouraged through promoting local community trusts for the improvement and management of streets.
8. The Highway Code should be rewritten to place greater emphasis on the multiple use of streets, rather than mainly vehicle movement.

Except at time of crisis, we take our streets for granted. We use them relentlessly, and are furious when they let us down because of road work or congestion; we regard them as a utilitarian necessity, rather than as a positive pleasure. But there is now a growing realization that we cannot treat streets in such a casual manner, because they play a crucial role in our economic and social well-being .The aim of creating more sustainable society based on the husbanding of our resources depends on the quality of our streets. This means that conflicts over the use of the street have to be given a much greater priority. A well designed street is one which it is a pleasure to walk down and share with other users.

2.3. Streetscape design in foreign countries

2.3.1 Overview of the books

This is a compilation of three book reviews based on the streetscape design and the urban design related to streetscape. The books are –

1. Derck and Edson Associate, June 7, 2004.Streetscape Design Guidelines for the city of Lancaster, Pennsylvania.
2. Mayer, M. T., 1995, Urban Design Guidelines for city of Pittsburgh.
3. Parris, R. R, March 30, 2010. Lancaster Design Guidelines

The first book consists of five main chapters. The first two chapters are dealing with the introduction of streetscape, its features, objectives of streetscape design and effect of good streetscape design. The next two chapters reveal the broad discussion and the best application of each and every streetscape design features in Lancaster city, Pennsylvania. The last chapter ends with the conclusion and the recommendations for betterment of the existing streetscape design. It also tries to establish a guideline which can further be followed in future development.

The second book mainly concentrating over the urban design for the city of Pittsburgh throughout its three chapters. The first chapter started with the introduction of urban design, existing condition, the problems and its effect on the society. The next chapter focuses on the case studies on the selected places of Pittsburgh, its problems and analysis, and also the best possible proposals also be recommended. The last chapter deals with the conclusion where it is been discussed about the need of the good urban design, the general guidelines drawn from the recommendations from the case studies, their best possible application and the implementation methods.

The third book is a compilation of research study which shows the streetscape design of the Lancaster city, UK. The book has four main chapters among which the first chapter started with the introduction to the existing streetscape condition in the city of Lancaster. Then the next chapter is dealt with the case studies. The third chapter is mainly on the recommendations given both for the area covered under the case studies and for overall city. The last chapter ends with the conclusion, where it is shown which should not be done in a

good streetscape design, what should be the Govt. policies regarding the betterment of good streetscape and how the recommendations can be implemented in practical.

2.3.2 Introduction to Streetscape Design

- The term 'streetscape' typically refers to exterior public spaces located between street curbs and building facades. Inclusion of pedestrian crosswalks and traffic calming measures located within vehicular spaces are two exceptions to this definition [12].

- The primary goal of the Streetscape Design is as follows [12]

— To create a durable, safe, and attractive streetscape to withstand the test of time,
— To celebrate our unique heritage and distinctive neighborhoods,
— To reinforce a sense of place and economic vitality, and
— To promote visual continuity of quality streetscape components in an effort to enhance desirable destinations for visiting, working, playing and living.

- Revitalized streetscapes will assist with attracting new residents, businesses, and visitors to the richness of our urban landscape. With careful implementation, Streetscape Design Guidelines will help to advance this revitalization process, while creating more safe public spaces and generating a greater sense of community pride. This Streetscape Design do not address objects mounted to building facades such as signs, canopies, awnings, window boxes, railings, and other architectural features. Table 1 shows the basic components of streetscape design. [12]] [13]] [14]

Table 1 Basic components of Streetscape Design

Sl. nos.	Main components	Sub components
1	Paving	Side walks
		Accessible sidewalk ramps
		Cross walks
		Traffic calming measures
2	Planting	Street trees
		Other supplemental planting
		Container planting

3	Street furnishing	Banner
		Benches
		Bicycle bollards
		Bollards
		Bus stop
		Fences
		Litter & ash receptacles
		Movable table & chairs
		Sign poles
		Utility covers
4	Lighting	Street lighting
		Street illumination scheme
		Lighting fixtures

2.3.3 SIDEWALKS [12] [14]

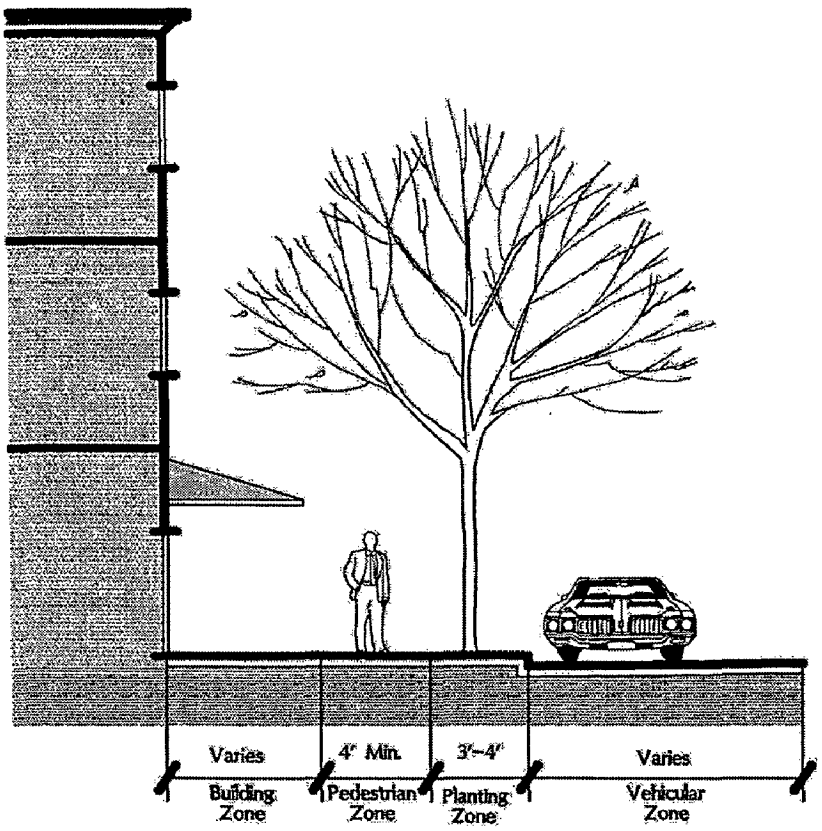


Figure 25 Detail cross section of sidewalks

The specified streetscape materials and furnishings identified in the following section of these Streetscape Design Guidelines require appropriate placement between street curbs and building facades. For the purpose of identifying appropriate locations, pedestrian areas immediately adjacent to the curb line will be defined as the Planting Zone. Progressing from the Planting Zone toward the building façade, the intermediate streetscape area will be referred to as the Pedestrian Zone. Finally, the streetscape area nearest the façade will be designated as the Building Zone (Fig 27). Typically, the Planting Zone extends 3' to 4' from the curb line to accommodate street trees

and pole-mounted site features, while the Pedestrian Zone shall be a minimum of 4' per City ordinance to permit safe, unimpeded circulation routes. Where additional sidewalk width exists within the remaining Building Zone, such spaces may accommodate seating areas.

2.3.4 PAVING [13] [14]

Brick has been used over the past centuries to pave our City's sidewalks. Its naturally warm, terra-cotta coloration produces paved surfaces which are in harmony with most adjacent structures. Furthermore, a standard brick's normal size (4" x 8"x 2 ¼") lends a human-scaled, textural design element to expansive areas of paving. Flexibility to create a variety of pleasing paving patterns is yet another benefit of this material (Fig: 28). Although durable and easy to maintain, concrete paving does not permit essential air and water to penetrate to the sub-surface root zones of street trees. Concrete is also a material which must be destroyed, thrown away, and replaced whenever access to underground utilities is required. Standard concrete can be an attractive material for sidewalks, street curbing, accessible ramps, and crosswalks when handled with a bit of creativity.

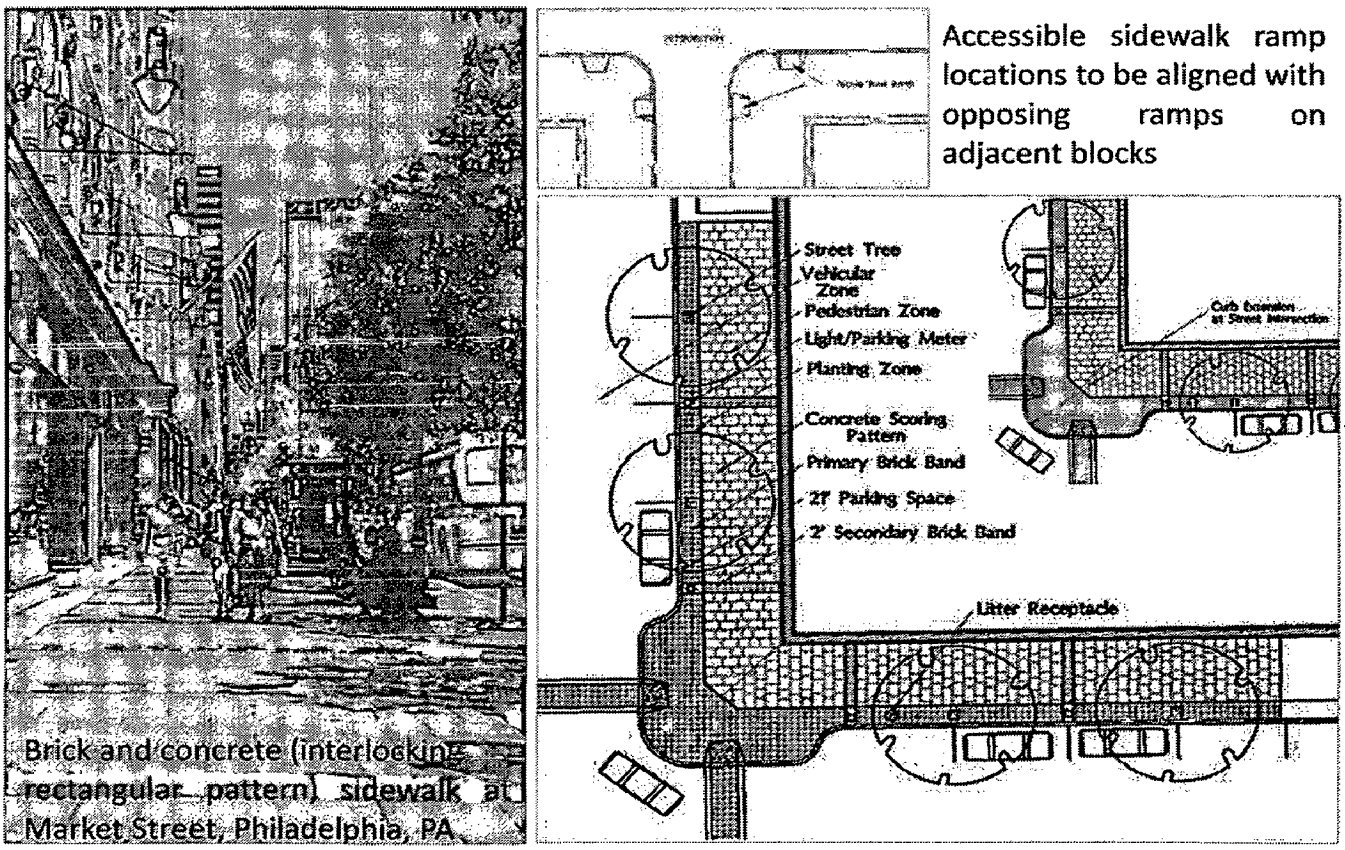


Figure 26 Streetscape Design - Paving

Simple, easily replicated, non-colored paving patterns must be utilized wherever textured paving is desired, but when the actual material replicated proves undesirable due to cost or durability. Selected paving patterns must be complementary to the overall streetscape, but must not be visually distracting.

2.3.5 CROSSWALKS [12] [13]

To further accommodate pedestrians and cyclists, crosswalks are to be placed at all street intersections, connecting opposing accessible ramps on street corners. Textured paving consisting of the same brick utilized within the Planting Zone, but installed on a reinforced concrete base is one preferred approach to addressing aesthetic and safety issues related to crosswalks.

There is a concern, however, that brick pavers installed for vehicular use may not withstand heavy truck traffic. Where significant truck turning movements do not occur, and where approved by the City's Department of Public Works, brick crosswalks are to be used. Such crosswalks are to be edged with flush concrete curb (7"width) to create a visual and functional transition between brick pavers and adjoining bituminous paving of Vehicular Zones. Brick crosswalk pavers are to be set in a herringbone paving pattern. Scored and reinforced concrete which replicates the interlocking rectangular appearance of proposed concrete sidewalks may provide a viable alternative to brick crosswalks where significant truck turning maneuvers do occur. Painted crosswalks are to be immediately re-striped whenever removal of bituminous paving and subsequent street patching occurs within painted crosswalk areas. Applied striping must permit the texture of the bituminous street base material to remain, allowing for a more slip resistant walking surface.

2.3.6 PLANTING [12] [14]

More than any other streetscape component, plantings enliven our public spaces, define an identifiable pedestrian scale, and herald the changing seasons with natural vibrancy. Spring and summer flowers are typically followed with brilliant autumn foliage and ornamental winter trees. In addition to this seasonal succession of landscape interest, plantings may be used to buffer undesirable views, reduce detrimental effects of wind and noise, provide comfortable shade, lower energy consumption and reduce carbon dioxide levels through the photosynthesis process. In short, plants make cities more livable (Fig: 29).

Figure 27 Streetscape Design - Planting

Many trees planted in an urban environment struggle to survive due to environmental stress from soil compaction (required for standard concrete sidewalk construction) and low soil fertility combined with inadequate soil moisture, low levels of oxygen near root zones, limited soil volume, detrimental de-icing salts, pet urine, air pollution, and excessive solar heat reflected from surrounding paving and structures. Basically, paved areas are unfriendly to trees. Add detrimental human forces such as vandalism and poor tree species selection to this list of environmental stresses and the relatively short life span of many urban street trees becomes more understandable.

As new development occurs and existing streetscapes are modified, it is imperative that proper consideration first be given to the protection and preservation of existing street trees. Factors to consider when evaluating existing street trees for preservation or removal from new streetscapes include a specific tree's age, health, size, and overall form. Once a determination to preserve an existing tree during construction is made, certain construction procedures must be followed. Tree protection fencing must be installed around existing trees. Storage of construction materials and/or machinery will not be permitted beneath any tree

canopy's drip line (edge of branch tips). Harmful construction runoff to root zones must also be avoided. When selecting new street trees for an entire block or for a more limited area, it is not essential to replicate the species of existing trees within the same area. It is imperative, however, that due consideration be given to the following Guidelines for correct tree species selection, size, placement, and planting practices.

2.3.7 STREET FURNISHING [12] [13]

Proposed street furnishings including benches, litter receptacles, bollards, bike racks, bus shelters, parking meters, fences and sign poles (excluding existing vehicular way-finding signs) are to be black, powder-coated metal to replicate the appearance of city's surviving ironwork. In addition to the previously noted site furnishings it includes recommendations for moveable tables and chairs, utility covers, banners, and planting containers. In order to create consistency in both quality and appearance for city's public spaces, some standardized options for these site furnishings are provided.

1. **Banners** (Fig: 30) – One colorful streetscape component is the pole-mounted banner. Banners mark seasonal changes, holidays, special events, local history, City gateways and unique neighborhood distinctions. Repeated throughout a specific neighborhood, colorful banners further add to the appearance of a well-planned and executed streetscape enhancement project. Banners and other seasonal decorations may be mounted to proposed light fixture poles. Their graphic designs must be clear and simple in order to quickly convey an intended message to both pedestrians and motorists. Any banners promoting particular events must be removed in a timely manner after the event occurs. By using an adopted background or border color established for each area, neighborhoods may form visual connections to a larger area, while leaving the design of the banner graphic flexible for each neighborhood's distinctive expression. Like some previously noted streetscape furnishings, banners provide excellent opportunities for local artists to create urban landscape enhancements unique to the city. While banners may not contain advertising,

Figure 28 Banners add distinction to major corridors in the city

they may note a specific sponsor or neighborhood association responsible for banner acquisition.' Banner mounting height must be at least 9' above sidewalk elevations and at least 13' above vehicular areas. No banners may block traffic signals, street lighting, and/or signage.

2. **Benches** (Fig: 31) – Provision of benches within streetscape areas encourages social interaction, and such interaction is the very foundation for successful neighborhoods and commercial areas. All benches should typically be located within the Building Zone and oriented toward the Pedestrian and Vehicular Zones of the adjacent street. They are best placed near street corners (but outside the established Clear Zones), mid-block spaces, bus stops, and other desirable resting locations. Locations in proximity to shade provided by street trees and buildings are also preferred. Bench locations must not create unsafe obstructions for such things as building entrances and fire hydrants. All benches located within public areas must be permanently mounted to sidewalk paving per the bench manufacturers' specifications. Use leveling hardware to compensate for sloping sidewalk conditions.

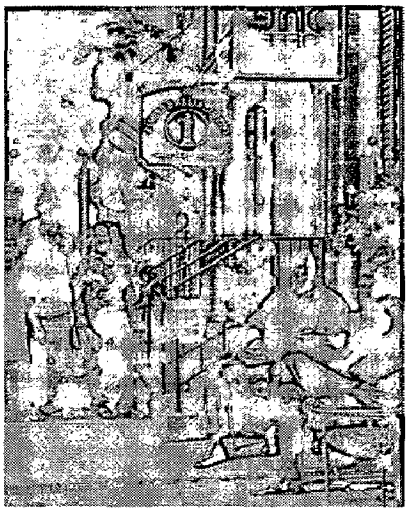


Figure 29 Existing moveable furnishings on North Duke Street

3. **Bicycle Bollard** (Fig: 32) – Providing opportunities for the safe storage of bicycles promotes an alternate means of urban transportation. It also supplies an amenity for couriers, shoppers, and commuters who bike to downtown from surrounding areas. Bollards provide a better alternative to chaining bicycles to trees, streetlights, and signposts. Typically, one bicycle bollard per block will likely be sufficient for current use, however, the City may determine that more or fewer bicycle bollards are warranted, depending upon specific streetscape locations.

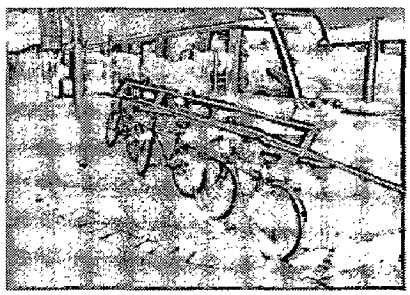


Figure 30 Bicycle bollard at tram stop

4. **Bollards** (Fig: 33) – Bollards intend to delineate secure Pedestrian and Vehicular Zones. Three alternative bollards can be provided. The more decorative bollard is to be utilized within public areas. The other type of bollard option may be used only within privately owned areas where views to bollard locations are intentionally buffered from public streetscapes by fences or plantings (e.g. loading areas, service drives).

Figure 31 Wrought iron bollard

5. **Bus Shelters** (Fig: 34) – Bus shelters must be located to avoid conflicts with existing street trees, street lights, utility poles, and other street furnishings. Shelters should also be placed with consideration of architectural features on adjacent building facades to avoid obstruction to building entrances. Ideally, shelter placement in front of existing structures should align with architectural features such as column locations, fenestration, or other façade treatments. Shelter locations must never be located within Clear Zones, nor interfere with any required sight distances intended to promote motorist and pedestrian safety. Lighted advertising displays which are integral to the specified bus shelter must be monitored by the Red Rose Transit Authority and/or the City of Lancaster to ensure that no objectionable displays are posted. In addition, all posted displays must be removed and replaced in a timely manner.

Figure 32 Typical bus shelter at Lancaster city

6. **Fencing** (Fig: 35) – Wherever fencing is used to separate adjacent site areas, wrought iron, steel, or aluminum fences with a black, powder coat finish should be used. Wooden fences, fences with barbed wire, and chains connecting wheel mounted posts, and metal guide rails are not to be used within any streetscape area. Chain-link fence may only be used if it has a black finish and its proposed location is first reviewed and approved by the City. Wherever spatial separation is required due to safety issues rather than a desire for a visual buffer, one of the previously noted bollard options should be employed. A delicate balance of adequate spatial

Figure 33 Iron railing at Lancaster's City Hall

separation and public surveillance must be met in order for proposed fencing to be beneficial. Fences and railings also present excellent opportunities to exhibit the work of city's many talented artists and artisans. Custom designed fences which serve utilitarian purposes while simultaneously adding public art to streetscape are encouraged. Such designs for fences visible from the public rights-of-way must be reviewed and approved by the City prior to construction.

7. **Litter & ash receptacles** (Fig: 36) – Together, the benches and litter receptacles, which are often located in close proximity to each other, will appear visually coordinated. All litter receptacles must be permanently mounted to sidewalk pavement per receptacle manufacturers' specifications. They must be located near street intersections (but outside the established Clear Zones), at mid-block crosswalks, and near proposed bench locations. Typically, two litter receptacles located on opposite corners of a street intersection will be sufficient. Unlike the bench locations typically located within Building Zones, litter and ash receptacles are to be placed within Planting Zones of all streetscapes.

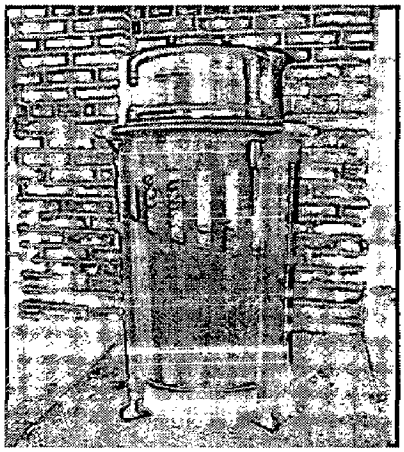


Figure 34 Litter and ash receptacles

8. **Movable table & chairs** (Fig: 37) – outdoor café spaces within the sidewalks spaces enhance the quality of the pedestrian experience, reinforce a vibrant sense of place, and add to the City's economic vitality. Typically, moveable tables and chairs serving these establishments are located within Building Zones. Moveable furnishings must not encroach into the adjoining Pedestrian Zones. Clear, accessible pedestrian routes must be maintained at all times, because the installation of all such improvements is considered temporary in nature, and subject to the aesthetic preferences of business owners. All moveable furnishings must, however, be made of safe, sturdy, and durable materials such as wood, steel, plastic, or wrought iron. They must also be of commercial grade and specifically manufactured for outdoor commercial use. Tables may be no larger than 2 ½' wide, and they should visually complement adjacent chairs. All

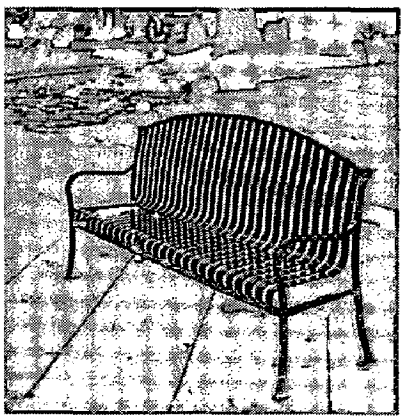


Figure 35 Movable table in Lancaster city

moveable furnishings must be regularly cleaned and maintained. They must be stored indoors and/or out of the public rights-of-way beyond hours of business operation. Neither moveable tables nor chairs may be secured to sidewalk pavement, street lights, trees, benches or other public street furnishings. The owner of moveable furnishings must also supply a specified litter/ash receptacle if such receptacles do not currently exist.

9. **Sign poles** (Fig: 38) – Some sign poles can be integrated with the other sign poles, e.g., 'No Parking' signs could be incorporated on pole-mounted street lights rather than on separate poles. Free-standing vehicular way finding signs will continue to be installed on the previously adopted standard white sign pole, while street name signs will be incorporated on traffic signal mast arms. Until new mast arms are installed existing traffic signal poles and extensions determined to be in a poor, rusty condition must be sanded, primed and covered with durable, black enamel paint. Future pedestrian way finding signs should either be added to the vehicular way-finding poles, or attached to street lights in an effort to reduce the total number of required poles.

Figure 36 Street name sign on mast arm

10. **Utility covers** (Fig: 39) – Perhaps the lowliest of streetscape components i.e. utility covers Where highly-visible covers exist within sidewalk areas or within crosswalks, their status could be elevated to the realm of public art with a bit of applied creativity. Any customized vault or manhole cover must meet all standards of existing manhole covers. Following City and utility company review and approval, covers may also include designs which celebrate city's distinctive history, or which make an artistic statement rather than simply proclaiming 'SEWER' or 'ELECTRIC' to passing pedestrians.

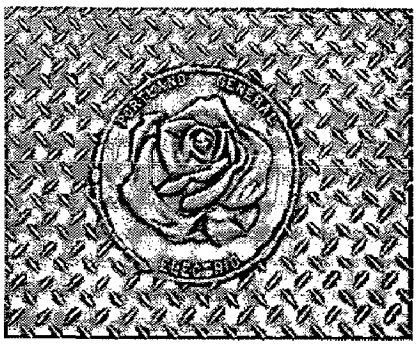


Figure 37 Portland's Rose City electric vault cove

2.3.8 LIGHTING [13] [14]

The basic objectives of street lighting can be grouped into four interrelated categories: safety, security, convenience, and aesthetics. Satisfaction of human needs in these four areas is the reason for the existence of lighting systems and the ultimate standard by which they should

be judged. Attainment of these objectives requires that the lighting design go far beyond the simple satisfaction of quantitative criteria for illumination. The qualitative aspects of the design, while difficult to quantify and prescribe, are typically the most important. The objectives of proper lighting in streetscape design are briefly described in the following paragraphs.

- **Physical safety**: Safety is the ability of users, both drivers and pedestrians, to reach their destination without causing inadvertent physical harm to themselves or others. There is never a guarantee of safety, only the ability to increase or decrease the safety of an environment. A well designed streetscape with the inclusion of a properly implemented lighting system can help increase the relative safety of public spaces. In combination with other streetscape elements, a lighting system must provide adequate visual information to allow users to avoid stumbling, loss of orientation, collisions (with vehicles, pedestrians, or inanimate objects), and other causes of accidental physical harm. In most instances, over-illuminating an area does not statistically increase one's physical safety (Fig 40).

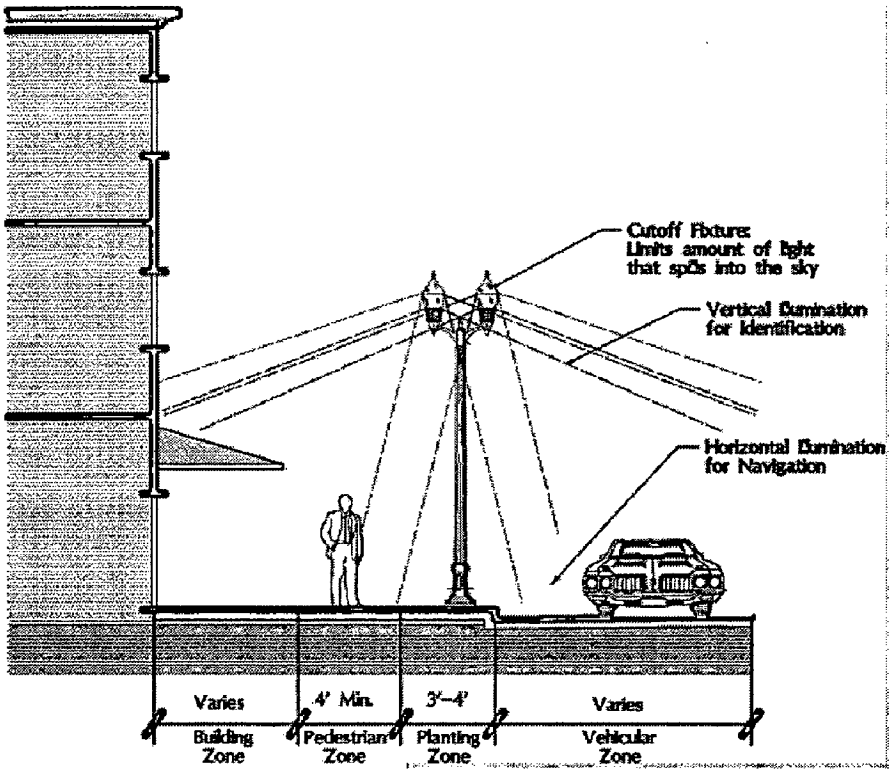


Figure 38 Illumination patterns of pole-mounted lighting fixtures

- **Security:** Security can be defined as perceived freedom from deliberate harm or threat by others. Unlike physical safety, security is primarily a subjective psychological matter, involving much more than the provision of adequate amounts of light. What needs to be created is really a *sense* of security, which may have only a secondary correlation to the actual likelihood of attack. The potential of being identified by key witnesses can be a major deterrent to many types of crime. Because of slower speeds and relative vulnerability, security is primarily a matter

of concern for pedestrians rather than motorists. While this seems obvious, it is common to find street lighting designed primarily for drivers. Fixtures that hang over driving lanes very commonly do not emit enough light to the adjacent pedestrian sidewalks. As with physical safety, over-illumination may not be the solution for security problems. Often, overly bright spaces are falsely perceived as high crime rate areas

- **Convenience** - Convenience relates to a degree of ease associated with a person's ability to perform desired tasks. In city streets, tasks for drivers include navigation, understanding driving lanes and organization of streets, identifying obstacles such as pedestrians at street crossings, and locating street names, buildings, and places to park. For pedestrians, tasks include locating streets and buildings, finding one's parked car and identifying approaching vehicles when crossing streets. The ease of accomplishing these visual tasks is not so much dependent on the quantity of illumination, but rather the quality of visual cues and information provided or enhanced by the configuration of the lighting system. Convenience also includes the ability of the City to easily maintain its street lighting system to ensure a continued high quality of light.

- **Aesthetics** - Probably the most difficult objective to quantify is visual pleasure or appeal. It is also the easiest objective to compromise or denigrate. Visual appeal implies not only the satisfaction of all the foregoing objectives, but also the creation of a strong and positive image of the City, both by day and by night. This image should be distinctive, recognizable, and memorable to city's residents and guests.

The general objectives previously outlined can be translated into a series of practical design guidelines or principles for the execution of future streetscape lighting designs. In formulating these principles, it is helpful to remember that a lighting system is a means to provide or transfer visual information. This information is the desired visual signal, and any factors which distract one's attention from this signal, making seeing more difficult, is considered to be visual noise. In general, design principles should lead to an enhancement of visual signals and to a reduction in visual noise.

- **Illumination** - Based upon specific use patterns and distinctive characteristics of various streets, a lighting system must provide enough illumination in the technical sense of footcandles measured at some reference surface. For example, illumination required for

safe driving is needed more on vertical surfaces such as potential vehicle obstructions and pedestrians than on horizontal paved surfaces. For pedestrian security, illumination of other pedestrians is of primary importance. Reflectance of target surfaces, such as the sidewalk or street, should also be considered, as surface brightness (the amount of light reflected from a surface) may be a more relevant criterion than the illumination (the amount of light striking a surface). What is important for good vision is not necessarily the absolute quantity of light, but rather uniformity and appropriate changes in light levels. It should be noted that the actual quantity of illumination required for adequate vision may be quite low. Raising illumination beyond modest basic levels may not result in much noticeable improvement. However, illumination is the easiest criterion to quantify. It is therefore commonly serried upon disproportionately to its importance in establishing lighting standards. Care must be taken not to over-light areas, as this may have negative affects crime implications, glare, etc (Fig: 41).

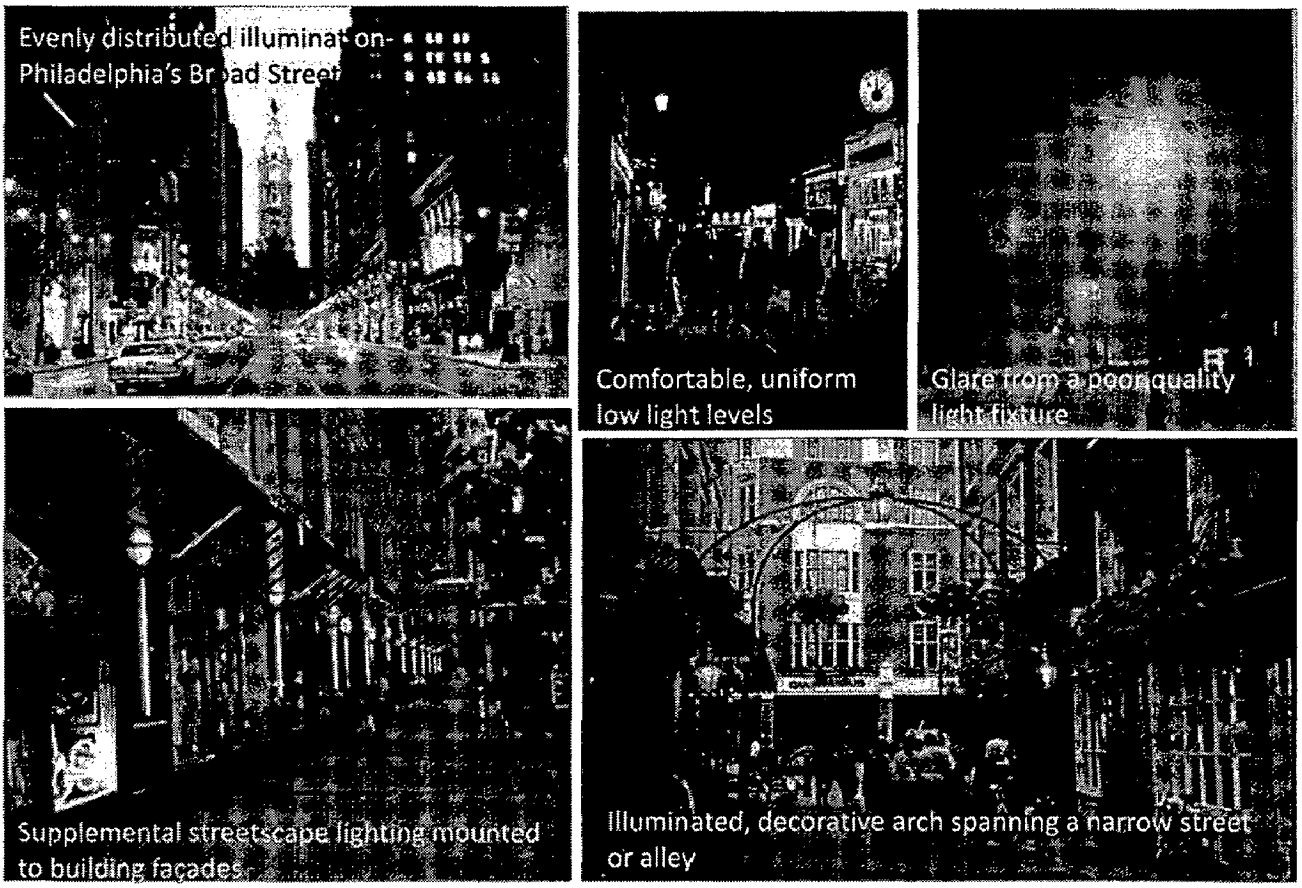


Figure 39 Streetscape Design - Lighting

- **Glare** - A common source of visual 'noise' is glare caused by luminaries with improper beam control. Independent of illumination level, glare makes the task of seeing more difficult, and produces a subtle sense of discomfort or annoyance. City's lighting system should be designed to minimize glare – a condition which often causes attention to be

drawn from the roadway to the lighting fixtures themselves. If a street or sidewalk surface is illuminated to required levels, yet light from overhead fixtures is shining directly into a person's eyes, he or she may be momentarily blinded, much like shining a flashlight into one's eyes while they are trying to read. Selecting fixtures which have a visually pleasing aesthetic value and an acceptable light distribution requires careful consideration to find an appropriate balance. This balance is achievable through the use of the suggested light fixtures proposed in these Guidelines.

- **Orientation** - Both drivers and pedestrians need quick and effective orientation to develop a visual sense of locations, destinations, and pathways. This is of clear importance for safety, security, and convenience. Highlighting of important features such as nodes, monuments, landmarks, paths, or edges can enhance nighttime orientation. In addition to drawing attention to other features, lighting can be a valuable source of visual cues, both by day and by night.

- **General Fixture Spacing and Location**: These general guidelines provide a starting point from which a lighting layout design may develop. As with any design, the entire scope of a streetscape enhancement project and all items therein should be taken into account. When considering specific placement of light fixtures and poles, the designer should address locations of existing or proposed trees, buildings, driveways, street furniture (benches, mailboxes, planters, etc.), roof overhangs, residential window heights, canopies over pedestrian areas, sub-street structures (vaults, manholes, gas and water valves, etc.), signs, and parking meters, among other items.

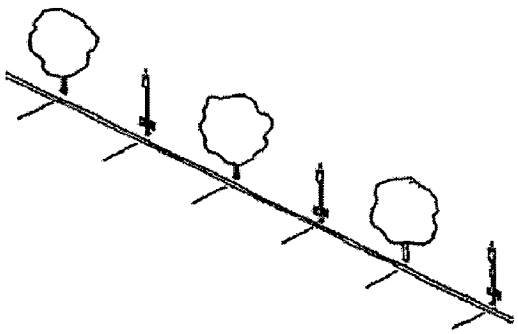


Figure 40 Light fixture relationship to street trees and on road parking spaces

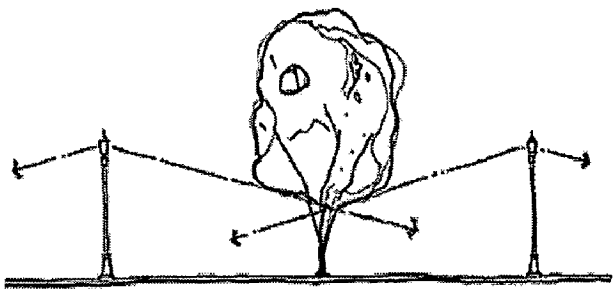


Figure 41 Light fixture spacing and light distribution under adjacent tree canopy

An effort should be made to space fixtures consistently based on the width of a given street and length of a given block. Incorporating existing or future trees into the light fixture spacing pattern is another important consideration. While most street trees are deciduous and lose their leaves in the winter, they produce foliage during the growing season which blocks light from inappropriately spaced fixtures (Fig: 42).

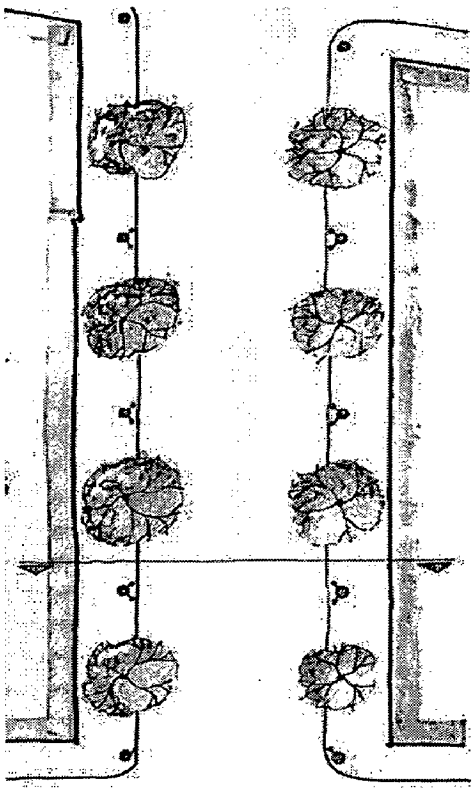


Figure 42 Plan view of typical tree and light fixture relationship on wide streets

The setback of each pole light from the curb edge must also be consistent to create visual alignment and to protect the poles from the bumpers of vehicles. Alignment of light poles with other streetscape elements, such as trees, must occur within the middle of the Planting Zone. Whenever possible, this alignment must be consistent along each street. Different poles may have different base sizes, but all can be centered along the same alignment. A minimum setback distance of 20" from curb face to pole center is required (Fig: 43).

Two standard layout methods are provided for arrangement of light fixtures on both sides of a street. The first method staggers fixtures on one street side with those on the opposite side of the street, such that each fixture falls in-between two on the opposing street side. This layout may generally be best for distributing the light evenly along the length of a narrow street. The second arrangement pairs fixtures on opposing street sides directly across from each other. This arrangement provides a better sense of symmetry, and should be used for wider streets. Wherever possible, light poles and street trees should be intentionally placed in relation to on-street parking delineation in an effort to prevent conflict with vehicular doors (Fig: 44).

2.4. Summary

After reviewing the available literature on the tramway service and the technical and operational details on tramway system it is been observed that the tramway has some unique detailing which makes it different from the other rail based transportation modes, though it

can share the track with the train (in Karlsruhe, Germany) and overhead wires with the trolley buses (in America). In every foreign country there are some modifications over the existing technology based on their climate, land contour, types of usage, places of usage and the energy resources. It is very much essential to know the new tram technologies occurring over the world so that we are ready to use it in our own context i.e. in Kolkata with the modification required as per its requirements. As an example we can change the Trolleypole system with the Pantograph system in Kolkata tramway because it is safer, energy efficient and of advanced technology. We can also think of alternative sources of energy instead of only depending on electricity. We can propose for the open roof type tram for tourism purpose (in Hong Kong) as it is attractive and enjoyable for the tourists. In Kolkata, we can propose for the cargo tram which can run specially in the purely commercial areas e.g. Barabazar, Sealdah, Boubazar area. In the stretches where educational and institutional services are facilitated a school special tram can be proposed. Thus the tram can be used for various types of activities just not as a mode of public transport. It will help to revive the system using the existing resources fully as well as to increase in revenue which will further help it to survive.

The streetscape design practiced in foreign countries helps us to understand the nature of extensive care taken to beautify a street and make it more attractive, more livable to the people. The main objective of the streetscape design is not only to beautify the street but also for increase of functionality of the street. A well designed street always acts as a public place rather than only a street. People feel more secure, and safe to use the street and thus it make the street more livable. Many activities can take place on the street which turn the street from a 'place' to 'space'. The streetscape design includes all the features, all the activities happening on it. It includes the street furnishing as well as the pedestrian environment too. So a good and well maintained street not only helps to uplift the city character but also confirms the safety and security both for the vehicle and the pedestrian traffic. In Kolkata, there are many stretches having potentiality for improvement of the streetscape only by taken care of existing elements by the means of conserving, modifying or preserving them. Many stretches have possibilities to introduce good streetscape as they have some particular architectural style, or some unique elements around the street. Kolkata, being a cultural city, is very needed to have good streetscape which can reflect the nature of the city. The examples mentioned in the literature reviews can be adopted but with modification according to our own climatic and other physical conditions in Kolkata.

2.5. Format for comparative analysis between Kolkata tram with foreign example

After doing the literature study on existing transportation scenario and development policies for Kolkata and the streetscape design in the foreign countries, it is possible to arrive at a comparative analysis format consisting of key variables and sub variables. Table 2 shows the format of the comparative analysis.

Table 2 Comparative analysis criteria

Sl. Nos.	Main Variables	Sub Variables
1	Fare System	Fare structures
		Fare comparison with other public transport
		Payment of ticket
		Penalty/concession
2	Travel time	Journey time
		Vehicle speed
		Frequency
		Reliability
3	Convenience	Availability
		Provision of facilities at stations
		Commercial services at station
		Information system
4	Accessibility	Location of station
		Access to station
		Distance between two stations
5	Safety and Security	Personal security
		Personal safety
		Quality of driving
6	Comfort	Comfort at stations
		Riding comfort
		Comfort inside the vehicle
7	Network	Length of network
		Directions to route / need for transfer
		Transfer integration with other modes
8	Operational Extent	Technical details
		Condition of vehicle
		Cleanliness of vehicle
		Overall maintenance of the system
		Effect of traffic congestion
		Effect of power failure
9	Functionality of Tramways	Type of usage
		Numbers of commuters using tram
		Type of the commuters
		Land use pattern along the tram corridors
		Quality of street environment
10	Management System	Development plan / policies
		Financial condition

3

CASE STUDIES

The main objective of the case studies included in this chapter is to know the operational and technological details of the tramways system practiced in foreign countries. This study is carried out to get the information about the system, development plans and policies by which the countries have made a successful move to make the tram a popular and a sustainable mode of transport rather than make it obsolete. London and Hong Kong Tramways have been selected as case studies to compare with the Kolkata Tramways. The countries have been selected based on their operational extent, level of Service, development criteria, and the criteria mentioned in the earlier chapter (Table 2).

3.1. LONDON TRAMWAYS

The first generation of trams in London started in 1860 when a horse tramway began operating along Victoria Street in Westminster. Horse tram lines soon opened all over London, typically using two horses to pull a 60-person car. They proved popular as they were cheaper, smoother, roomier, and safer than the competing Omnibus or Hackney carriages. They were replaced by electric vehicles from 1901 until the last were withdrawn during World War I. [15]

In 1891 a cable tram was introduced for Highgate Hill, the first cable tramway in Europe, which was followed by a second cable line to draw trams up Brixton Hill to Streatham. Both these systems were replaced within 15 years by electric trams. [16]

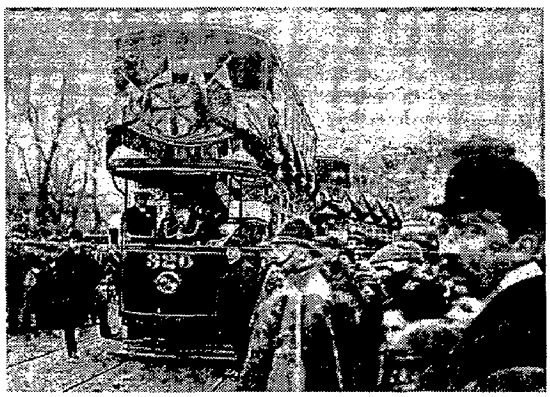


Figure 43 The first electric tram on Kingston Bridge, London, 1906

Source: http://wapedia.mobi/en/tram

In 1901 Croydon Corporation introduced the first fully operational electric tram services in the Greater London area, using power delivered from overhead wires (Fig: 45). [17]

In London the tramway was abandoned in 1952 and from 1952 to 2000 no tram ran at all in London. The next generation of trams started with the opening of Tramlink in 2000. Since it opened on 11 May 2000 the 38 km of track have been operated by FirstGroup on behalf of Transport for London on three routes across South London. [18] [19]

The operational and technological details of Tramlink service is broadly discussed in following paragraphs under the category of previously mentioned criteria.

3.1.1 Fare System [18] [20]

- **Fare structure**: Table 3 shows the fare structure and the concession charges for different type of users. There are mainly three categories i.e. student, 18+ student and the adults. Besides this several concessions are available for the old and handicapped persons also.

Table 3 Fare structure of tram in London

Adult							
Cash Single (In Rs.)		Oyster Single (In Rs.)		Tram Pass (in Rs.)			
				Weekly	Monthly	Yearly	
116	Valid for 90 minutes from time bought, including change of tram to reach destination	70	Valid for one single journey on tram boarded within 70 minutes.	963	3700	38512	Valid at all times on trams
18+ Student							
116		70		673	2587	26912	
Student							
116		35		481	1850	19256	
Free travelling for children below 15 years.							

Source: London Tramlink User Guide, 2010

- **Payment / ticket system:** The passengers buy their ticket before boarding from the ticket machine available at the stations. The passengers who are using the Oyster card, they must touch the Oyster card on the yellow reader on the platform before boarding the tram. Ticket checking machine is installed inside the vehicles.

- **Penalty:** Revenue inspectors make frequent checks. If anyone found without ticket or non-validated ticket they are liable for a Penalty fare of Rs. 2900 (reduced to Rs. 1450 if paid on the spot or within 21 days).

- **Concession:** Weekly, monthly and annually pass system is available. Freedom Passes is issued for the old and disabled persons for free journey at any time. Below and up to 15 years old people can travel free. 18+ Student Oyster photo-card needed for 30% discount. Any passenger in a wheelchair can travel free at any time on trams.

3.1.2 Travel Time [20]

- **Journey time:** It runs on the reserved tracks so it is very punctual like other modes. Generally it takes almost same time compared to other modes to reach the same distance by same route.

- **Vehicle Speed:** The maximum speed of the tram is 80 km/h. The average speed is 70 km/h.

- **Frequency:** The trams are available at time interval of 8-10 minutes on weekdays. On weekends and holidays the interval is 10-15 minutes.

- **Reliability:** It is very much punctual throughout the year. In severe cold season also, it maintain punctuality. It proves its reliability like other modes of transport.

3.1.3 Convenience [21] [22]

- **Availability:** It is available throughout the year. Service available from 4.50 AM to 12.40 AM on weekdays whereas on Sunday and holidays it is available from 7.20 AM to 1.00 AM.

- **Provisions of facilities at the stations:** Every tram stops have proper stations. Tram stops and trams are equipped with CCTV cameras. Most of the stations have cycle stand adjacent to it (Fig: 46). Every station has seating spaces for needed persons, first-aid kit, and emergency fire extinguishing System.

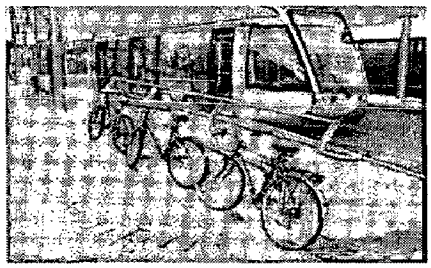


Figure 44 Cycle stand adjacent to tram stop

- **Commercial services at the stations:** No commercial services right at the stops. Many stations have small food stalls. Just outside the stations everywhere markets or shops are available (Fig: 47).

Figure 45 Tram stoppage at Central London

- **Information System:** Audio visual information system to mention the next stop, destination and interchange points at

the station as well as inside the tram. Proper traffic signs inside tram and at the stations. Every tram has the intercom services to speak to the driver in case of emergency.

3.1.4 Accessibility [19] [20] [22]

- **Location of tram stations:** Every tram stops at particular station. All the tram stations are located in a strategic location either from a commercial or transformational point of view.

- **Access to tram and stations:** All tram stops feature step-free access. All the stations have ramps from the street level for handicapped people. To assist blind and partially sighted passengers, each stop has a tactile strip along its entire length, a safe distance from the platform edge. Wheelchair & push chair users can easily board and alight. All doors have an opening & stop button at an accessible height. For less mobile and disabled people, or those with small children, there are priority seats in each section of the tram (Fig: 48).

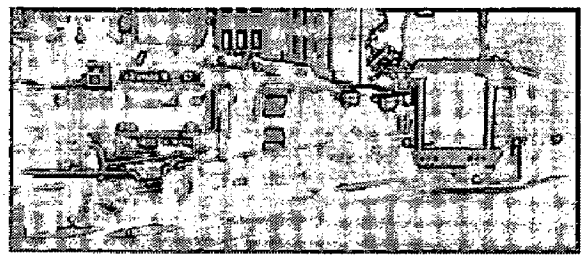


Figure 46 Universal accessibility to the tram stop

3.1.5 Safety and security [18] [19] [22]

- **Personal security:** Stress is given on security inside the tram. Every tram has CCTV, Fire extinguishing system, Emergency STOP button installed inside the car. Regular patrolling by the cops securing the inside security of the passengers.

- **Personal safety:** All doors are electronic sensor operated. Handrail at the door is installed for safe boarding or de-boarding. Handrail from the roof helping the standing passengers. Every tram car has the specific space to accommodate wheelchair (Fig: 49).

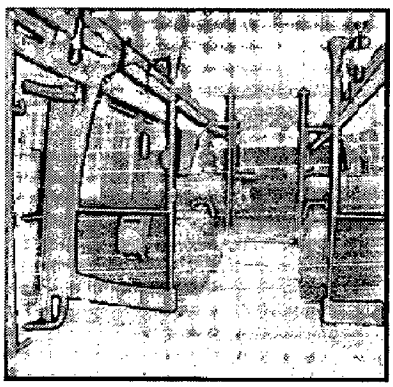


Figure 47 Ticket checking machine, handrail and the standing alley inside the tram

- **Quality of driving:** All the drivers are very much professional on their duty. They are very much strict on the punctuality. The drivers are given responsibility to the general surveillance inside the car.

3.1.6 Comfort [23] [24] [25]

- **Comfort at stations:** All the stations have seating places for needed people. As there is no thermal comfort in the station so it is very vulnerable to extreme weather specially in winter (Fig: 50).

Figure 48 A typical tram stop in London

- **Riding comfort:** Smooth running on the track gives comfort to the riders. No honking, overtaking with others makes the journey more pleasant. Public address system is in every tram car to give the information to the passengers. Anti jerking technology is installed for smooth travelling.

- **Comfort inside the tram:** AC system is in every tram. Seats have soft outfitting. There is enough space for standing passengers. Tinted glass helpful in summer. Floors and walls are well finished. Provision of natural light as well as with artificial light.

3.1.7 Network [22] [26]

- **Length of the network:** Tramlink is a 28 km tramway system with 24 trams on three lines providing a fast, frequent and reliable service connecting Croydon with Wimbledon, Beckenham, Elmers End and New Addington.

- **Transfer integration with other modes:** Wimbledon, Mitcham junction, Croydon, Addington- hese stations are well integrated with either tube rail or bus transport (Fig: 51). Tramlink itself has its own feeder bus services in some stations. Work continued across the transport network to improve access and interchange between services (Fig: 52).

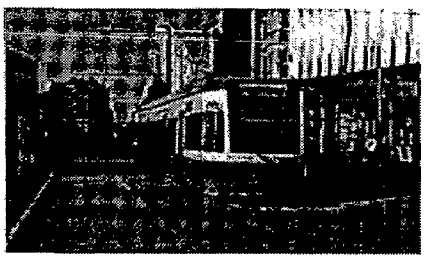


Figure 49 Tram running at Croydon

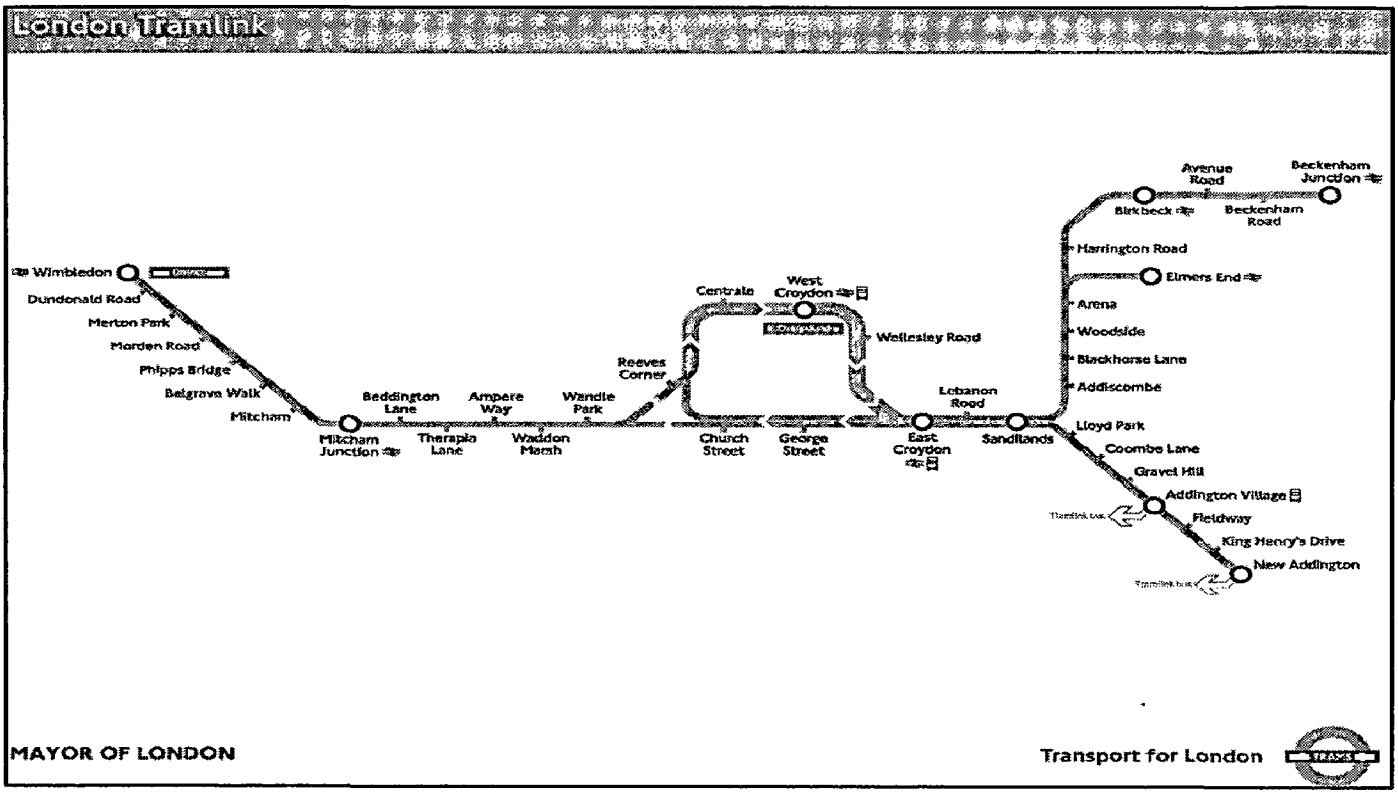


Figure 50 London Tramlink route map

3.1.8 Operational Extent

- **Technical details** [15] [16] [22]**:** technical detail of the tram are as shown below:
  - Length: 29 m (95.14 ft)
  - Width: 2.65 m (8.69 ft)
  - Capacity: Seating 80 (Standing 120)
  - Area/passengers: 0.4 Sq.km
  - Voltage: 750 volt DC power in overhead wires
  - Double ended car with 4 compartments.
  - Electric censored sliding doors of 1.3 m opening.
  - Software controlled magnetic rack brakes.
  - Low floor height of 300mm above track.

- **Condition of vehicle:** Every car is in good condition. Every vehicle is good looking, light weight (Fig: 53). Energy efficient (required 0.9 kwh / km)[23]

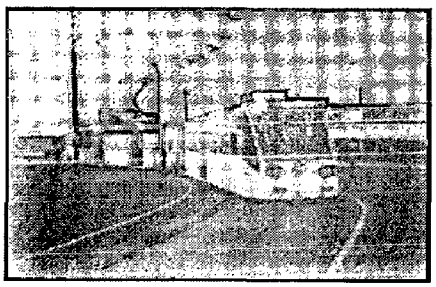


Figure 51 City Class Tram in London

- **Cleanliness of vehicle** [28] [29]**:** Strict on cleanliness of vehicles and stations. Overall maintenance of the system is divided into four parts i.e. daily, weekly, monthly and annually maintenance. The detail of the maintenance works are pointed in the Table 4.

Table 4 Detail of tramway system maintenance works

Daily	1. Screen wash bottles filled 2. Magnetic track brakes working 3. Air disc brakes working 4. Brake resistor fans working 5. Nose motor hatch firmly closed 6. Pantograph fully raised 7. Bogie side inspection panels closed 8. Battery Chargers working
Weekly	1. Wheel nuts tight 2. Drive shaft Universal Joints firm 3. Axle drive shaft oil seals 4. Air springs OK 5. Earth return bonds OK 6. Drain off Car A air tank 7. Download "Blackbox" Records
Monthly	1. Pantograph wear strips 2. Seat fixing bolts 3. Articulation steering links, under and over 4. Bogie king pin seating 5. State of battery 6. Wheel wear 7. King pin housing bolts
Annually	1. Heavy inspection and clean, especially of fans and air flow grills. 2. The bogie axle casings should be checked for oil 3. Overall inspection of the total system

- **Effect of traffic congestion** [23]: Most of the routes have reserved tracks. Priority is given to the tram than private vehicles, so there is no traffic jam due to the tram. Other vehicles don't block the tram routes.

3.1.9 Functionality of tramways

- **Type of usage** [27] [28]: Mainly use for mass transportation. In some occasions it offers some special services. The heritage tram is especially for in old areas. Chartered tram is also available.

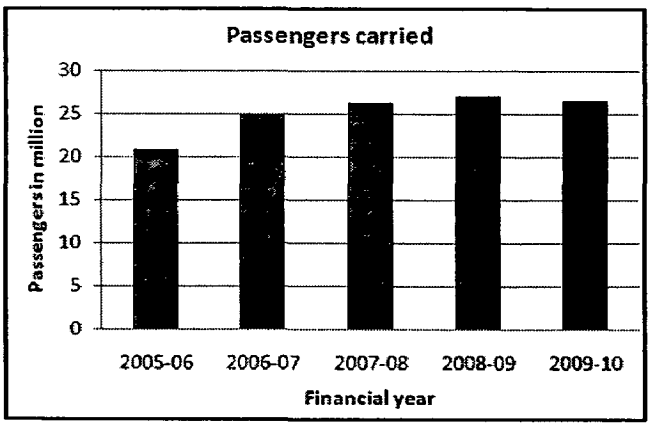


Figure 52 Annual passengers carried by London Tramlink

- **Nos. of commuters** [21]: Almost 0.7 lakhs people on each day i.e. 2.6 crores people use the tram annually. The passengers are increased by 27% within 5 years (Fig: 54).

- **Type of commuters** [25]: Maximum of the passengers is male. The numbers of student commuters are also increasing due to the govt. policies. Female passengers prefer to travel by tube rail than tram. Older people always prefer tram than other modes.

- **Landuse pattern along the tram corridors** [24] [27]: Most of the areas are of mixed land use. Many routes pass through the historical places. Many of the commercial areas also connected thro tram.

- **Quality of street environment** [18] [23] [26]: All the roads have controlled developments. The commercial areas have good street environment (Fig: 55). Emphasis on the passenger's safety. Stress is given to the proper lighting and traffic signage system. Residential areas also have safety measures from tram.

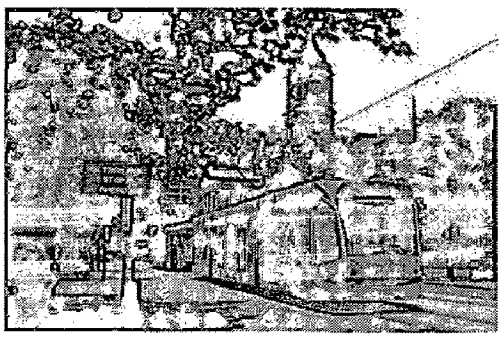


Figure 53 Beautiful streetscape integrated with tramway in London

3.1.10 Management system

- **Development plan/policies** [17] [18] [20] [21]: The necessity of expanding the electricity distribution system. Expansion of the cable system would be needed. Transport for London (TfL) is investing £28 m in a major programme of upgrades and maintenance on London's Tramlink network.

- **Financial condition** [29] [30]: The Figure 56 shows that the main source of revenue income is the fare (81%) and it then followed by the other method of income i.e. congestion charge income, rent and advertising etc. Operating expenditure on the Tram service increased by 3.5 % to £2,301m (Fig: 57). Net assets decreased by £2,174m between 31 March 2009 and 31 March 2010, Financing of the Business Plan is from:
  - Fares income and congestion charge income
  - Government grant and TfL borrowing
  - Secondary income such as advertising, sales of property and other assets
  - Third party funding for specific projects

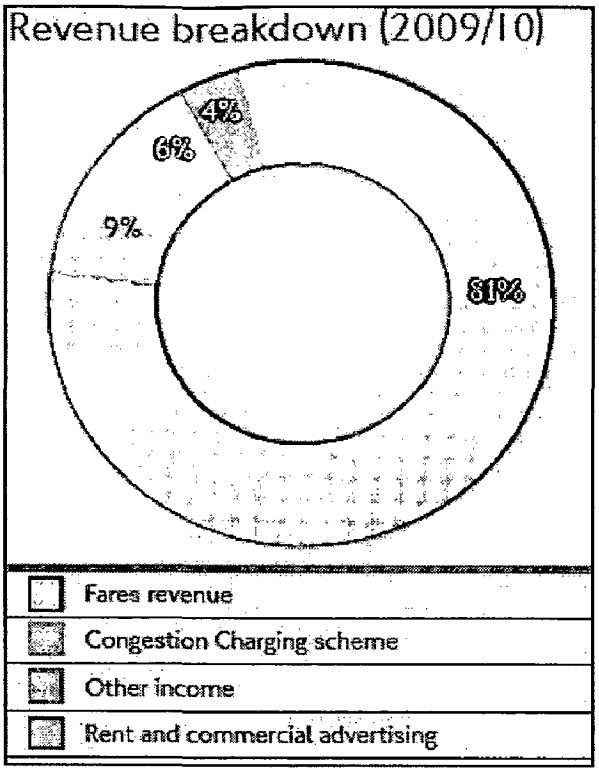


Figure 55 Revenue Breakdown for London Tramlink

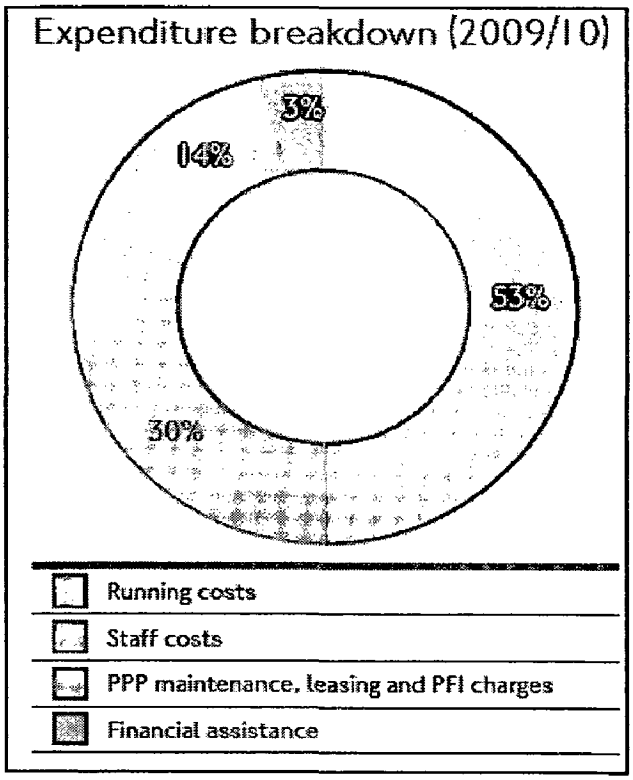


Figure 54 Expenditure breakdown for London Tramlink

Source: London Tramlink User Guide, 2010 (Figure 46 to Figure 57)

3.2. HONG KONG TRAMWAYS

Hong Kong Tramways Limited has been operating tram service in Hong Kong since 1904. Hong Kong Tramways is committed to providing passengers with a high level of service, with continuous enhancements in service quality and tram facilities. Hong Kong Tramways is a tram system in Hong Kong and one of the earliest forms of public transport in Hong Kong. Owned and operated by Veolia Transport, the tramway runs on Hong Kong Island in Hong Kong between Shau Kei Wan and Kennedy Town, with a branch circulating Happy Valley. [31]

Trams in Hong Kong have not only been a form of transport for over 100 years, but also a major tourist attraction and one of the most environmentally friendly mass transit systems. Hong Kong's tram system began directly as an electric tram. It has never run on horse or steam power. [31]

Owing to strong passenger demand, the first double-deck tramcar was introduced in 1912. The tramcar was open-top with garden seat design. The first class occupied the upper deck

and one third of the lower deck. Ten new tramcars were constructed. Due to passenger demand, a single deck trailer was introduced in 1965. The trailer was attached to the back of ordinary tramcar and designed to serve first class passengers only. The maximum capacity was 36 persons for each trailer. It is the world's largest fleet of double-deck tramcars still in operation, carrying an average of 230,000 passengers every day. [32]

As the tram tracks, east and west throughout the urban area of Hong Kong Island, the "Tram Road" has become an important urban area of Hong Kong Island, one of the symbols in the urban areas of Hong Kong Island. In the construction of the tram system, tramway was built along the waterfront road. However, after centuries of continued reclamation, now almost all the "Tram Road" has been away from the waterfront. [33]

The operational and technological details of Hong Kong Tramway service is broadly discussed in following paragraphs under the category of previously mentioned criteria.

3.2.1 Fare System [32] [34]

- **Fare structure:** Table 5 shows the fare structure for different category of users. There are mainly three categories i.e. adults, senior citizen and children.

Table 5 Fare structure of Hong Kong Tramways

Passenger category	Existing fare	New Fare (w.e.f 01.01.2011)
Adult	92	115
Children	46	60
Senior Citizen	46	51
Monthly Ticket	7820	9660

- **Payment / ticket system:** Passengers buy their tickets after boarding. Passengers can either use octopus card or place the coins into the drop-in box. Octopus reader and the coin box both located at the front exit of the tram.

- **Penalty:** Revenue inspectors make frequent checks. If anyone found without ticket or non-validated ticket they are liable for a Penalty fare of Rs. 7912.

3.2.2 Travel time [32] [34]

- **Journey time:** It runs on the reserved tracks so it is very punctual like other modes. Generally it takes almost same time compared to other modes to reach the same distance by same route.

- **Vehicle Speed:** The maximum speed of the tram is 70 km/h. The average speed is 50-60 km/h.

- **Frequency:** The tram is available at every 1.5 minutes during peak hours on average. Frequency on all routes will be adjusted to meet traffic's requirement.

- **Reliability:** It is very much punctual throughout the year. In severe monsoon also, it maintain punctuality. It proves its reliability like other modes of transport.

3.2.3 Convenience [32] [33] [34]

- **Availability:** It is available throughout the year. Service available from 5.30 AM to 12.30 AM on weekdays. Frequency is less on Sunday and holidays.

Figure 56 Typical tram stop in Hong Kong

- **Provisions of facilities at the stations:** Every tram stops have proper stations (Fig: 58). Every station has seating spaces for needed persons. Tram stops and trams are equipped with CCTV cameras.

- **Commercial services at the stations:** No commercial services right at the stations. Many stations have small food stalls. Just outside the stations everywhere markets or shops are available.

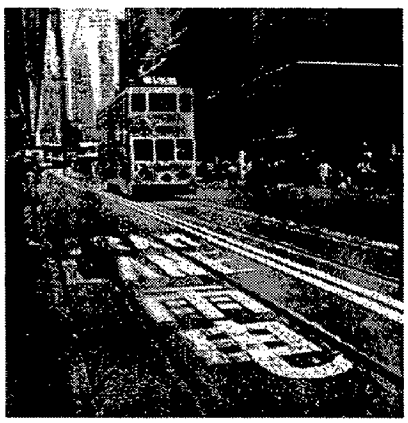


Figure 57 Reserved tram track in Hong Kong

- **Information System:** Audio visual information system to mention the next stop, destination and interchange points at the station as well as inside the tram. Proper traffic signage to guide the people (Fig: 59).

3.2.4 Accessibility [32] [34] [35]

- **Location of tram stations:** Every tram stops at particular station. Total 118 tram stops throughout the total route length. The avg. distance between two stations is 250 m.

- **Access to tram and stations:** All tram stops feature step-free access. Some of them have ramps from the street level. To assist blind and partially sighted passengers, each stop has a tactile strip along its entire length, a safe distance from the platform edge. Wheelchair & push chair users can easily board and alight. All doors have an opening & stop button at an accessible height. For less mobile and disabled people, or those with small children, there are priority seats in each section of the tram (Fig: 60).

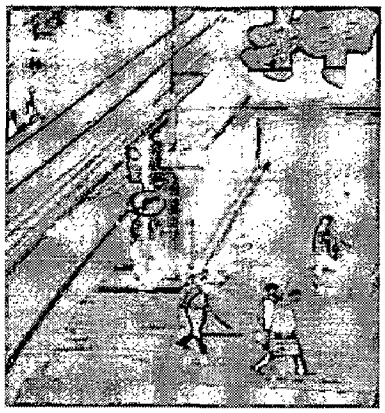


Figure 58 Access to the tram stop

3.2.5 Safety and security [31] [35] [36]

- **Personal security:** Stress is given on security inside the tram. Every tram has CCTV, Fire extinguishing system, Emergency STOP button installed inside the car. Regular patrolling by the cops securing the inside security of the passengers.

- **Personal safety:** Installation of censors operated doors with handrails, Driver's Vigilance Device, Programmable logic speed controller, automatic track switching control to increase the safety level of tram.

- **Quality of driving:** All the drivers are very much professional on their duty. They are very much strict on the punctuality. The drivers are given responsibility to the general surveillance inside the car.

3.2.6 Comfort [32] [36]

- **Comfort at stations:** All the stations have seating places for needed people. As there is no thermal comfort in the station so it is very vulnerable to extreme weather specially in monsoon and summer.

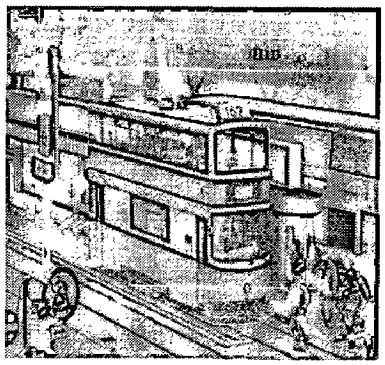


Figure 59 Glass covered open roof type tram

- **Riding comfort:** Smooth running on the track gives comfort to the riders. No honking, overtaking with others makes the journey more pleasant. Public address system is in every tram car to give the information to the passengers. Anti jerking technology is installed for smooth travelling.

- **Comfort inside the tram:** AC system is on testing. Seats have soft outfitting. Not enough space for standing passengers inside the car. Tinted glass helpful in summer. Floors and walls are well finished. Provision of natural light as well as with artificial light (Fig: 61 and 62).

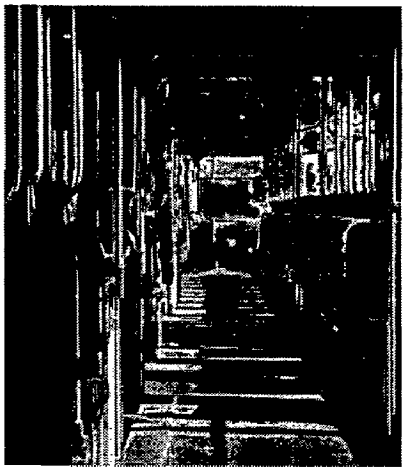


Figure 60 Interior view of the Hong Kong tram

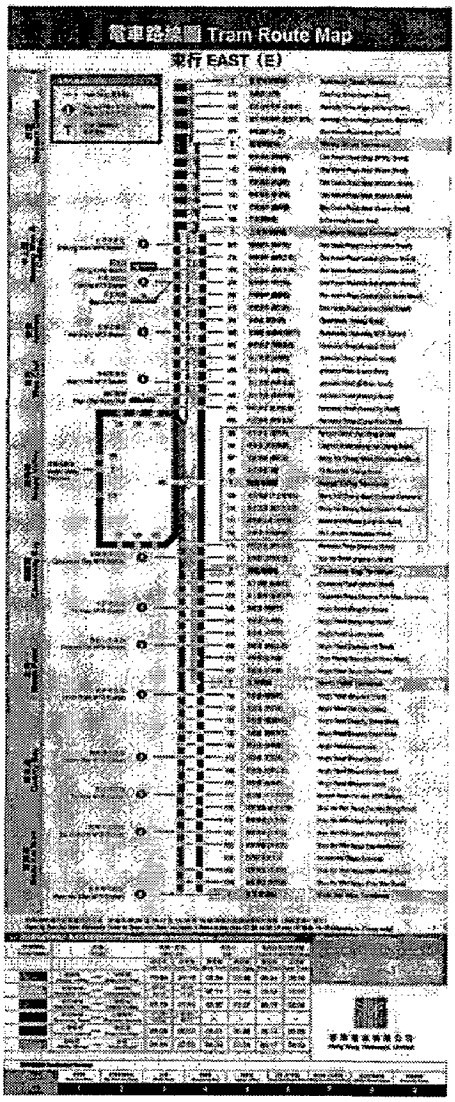
3.2.7 Network [32] [34] [35]

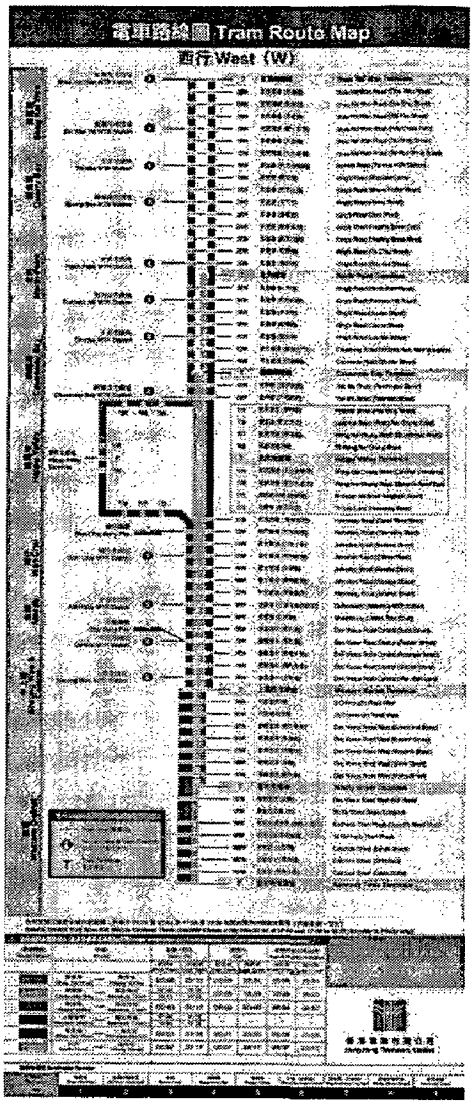
- **Length of the network:** There are total 163 tramcars which include 2 antique tramcars running on the track. Hong Kong Tramways operates 6 main routes running between Kennedy Town and Shau Kei Wan. At present the total route length is 30 km. Table 6 shows the six tram routes:

Table 6 Six main tram routes in Hong Kong

From	To
Shau Kei Wan	Western Market
Shau Kei Wan	Happy Valley
North Point	Whitty Street
Happy Valley	Kennedy Town
Causeway Bay	Kennedy Town
Western Market	Kennedy Town

Source: http://www.hktramways.com





e 61 Hong Kong tram route map (Eastern and western Bound)

Source: http://www.hktramways.com

- **Transfer integration with other modes:** Almost 12 metro rail terminals are connected with the tram stoppages. Hong Kong train station is connected with the tram route. Two Ferry piers are well connected to the tram route network. Work continued across the transport network to improve access and interchange between services (Fig: 63).

3.2.8 Operational Extent [31] [32] [36]

- **Technical details:** Technical details of the tram are as shown below:
  - Length: 19.8 m (65 ft)
  - Width: 1.90 m (6.23 ft)
  - Capacity: 115 persons
  - Area/passengers: 0.7 Sq.km

- Voltage: 550 volt DC power is used in overhead wires
- World's largest fleet of double ended double-deck tramcars with two compartments.
- Electric censored sliding doors of 1.5 m opening.
- Low smoke halogen free overhead power cable
- Main circuit breaker for over current protection

Figure 62 Seating arrangements in new tram

- **Condition of vehicle:** Every car is in good condition. Every vehicle is good looking, light weight. Modern trams are good looking even have open roof where the antique cars are preserved at their original looks (Fig: 64 and 65). Strict on cleanliness of vehicles and stations. Daily cleaning of vehicles.

Figure 63 Seating arrangements in old tram

- **Overall maintenance of the system:** Regular checking of tracks, the tram car especially the upper deck. Monthly checking of overhead power cables. Charging of heavy fines on spitting, polluting the car.

Figure 64 Traffic congestion due to the power failure

- **Effect of traffic congestion:** Most of the routes have reserved tracks. Priority is given to the tram than private vehicles. Other vehicles don't block the tram routes.

- **Effect of power failure:** Besides using normal power, it can also use a diesel motor for working. In a critical condition it causes the traffic jam but only for some time. The Maintenance or Service Tram use to move the tram from the track (Fig: 66).

3.2.9 Functionality of tramways [36] [37] [38]

- **Type of usage:** Mainly use for mass transportation for over100 yrs. The Antique cars are used for tourism purposes. Sometime in certain routes tram is used to carry goods. The open roof tram is mainly

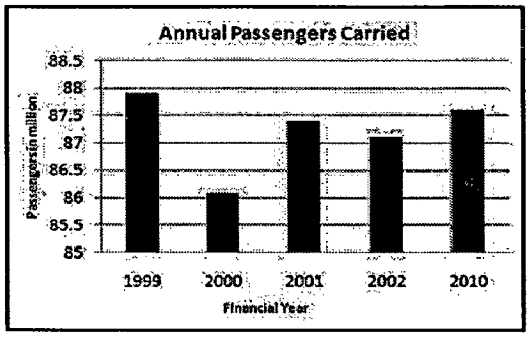


Figure 65 Annual passengers carried by Hong Kong tram

for tourism purpose. Tram usage is 92% of its total strength. Though the tram availability is 100%.

- **Nos. of commuters:** Each day 2.4 lakhs i.e. annually 8.76 crores residents of Hong Kong commute by tram. Passengers carrying increased only 2% by 10 years (Fig: 67).

- **Landuse pattern along the tram corridors:** Most of the areas are of mixed land use. Many are prominently residential. Stress on maximize the tram usage in commercial areas (Fig: 68). Many tram routes thro' the informal market areas (Fig: 69).

Figure 66 Tram running thro' a busy commercial street

- **Quality of street environment:** All the streets have controlled developments. No encroachment in the main vehicular road. Proper lighting and traffic signage in every street. Commercial roads are well decorated and maintained.

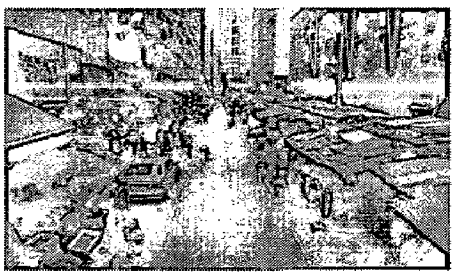


Figure 67 Tram running thro' a informal market area

3.2.10 Management system

- **Development plan/policies** [32] [37] [38] [39]: The Hong Kong Govt. has taken initiatives to improve the tram services. The improvement measures are as follows:

1. Revamping of track repair and maintenance methods;
2. Upgrading of emergency braking system;
3. Enhancement of passenger information system;
4. Improvement of tram body and interior design;
5. Provision of additional turnaround loops;
6. Use of new tools for traffic and staff scheduling;
7. Replacement of overhead span wire.
8. Synchronization with public traffic lights at selected road junctions;
9. Adoption of AC traction system.
10. Improve passenger comfort, facilitate passenger flows;
11. Achieve energy conservation by using LED lighting;
12. Enhance passengers safety on tram, such as adding more handrails;
13. Enhance motorman's working environment;

Source:http://www.tramways.com/tram_in_hongkong (Figure 58 to Figure 62)
http://www.discoverhongkong.com/tramguide/eng/ (Figure 64 to Figure 66, 68 and 69)

- **Newly designed tram car** [40]: The newly designed tram car has the following facilities and characteristics:

1. Full-sized screens at tram doors; and improved front and rear wind shields and windows (Fig: 70)
2. New seating arrangements having wooden seats with aluminum frame in both lower and upper decks.
3. Additional handles and railings with more ergonomic design for easier reaches by passengers (Fig: 71)
4. Improved headroom in both the lower and upper decks
5. Improved rear flap gate design and removal of turnstiles
6. Improved motorman compartment and motorman seat
7. Additional passenger information through station announcement and display of route map onboard the tram
8. Replacement of fluorescent lights by LED lighting inside the tram. Three LED displays on the external tram body to show the information like terminus, route, etc. (at the front, at the rear and on the left hand side of the tram body)

Figure 68 Exterior view of the new tram car

Figure 69 Safety features installed inside tram car

Figure 70 Advertisement on tramcar

- **Financial condition** [32] [39] [40]: Fare increase is the only realistic option for ensuring the financial stability. Revenue collected from advertising both in the car and the station (Fig: 72). New policies made to meet the growing expenditure of the tramways. By the year 2004 to 2010 Hong Kong tram way was successful to double up its profit. And it was also successful to increase its revenue and decrease its operation cost (Fig: 73).

Source: Hong Kong Transport Limited, 5th October, 2010. New Tram Design to Enhance Passengers Comfort and Achieve Energy Conservation (Figure 70 to Figure 72)

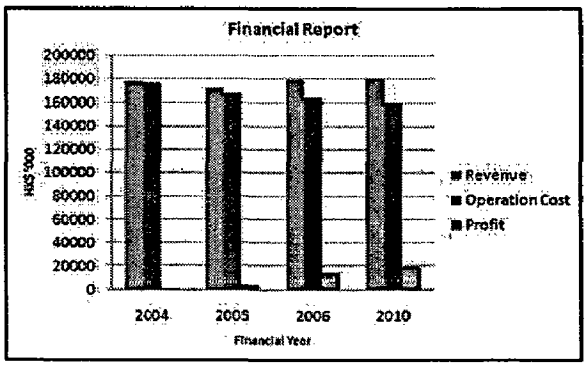


Figure 71 Financial condition of Hong Kong tramways

Hong Kong Transport Limited, Operational and financial information, 2004-06 (Figure 67 and 73)

3.3. Inferences

After reviewing the tramway service both in London and Hong Kong and analyzing the facts and figures, it is clearly visible that while both the countries take the tram service as a serious issue and strive to make it better and giving more stress to use it than the other mode of transport, Kolkata on the opposite hand is trying to abandon it instead of improving this sustainable mode of transport. Both London and Hong Kong adopted some common plan policies i.e. technical and technological up gradation, rational fare structure, passenger's comfort, universal accessibility to tram stoppage and tram, better transfer integration network with tram, betterment of tram-street environment and improvement of land use pattern along the tram routes, which makes the tram service reliable, convenient, safe, comfortable and profitable in both of these countries. The following paragraphs show some important aspects of their efforts to make the tram service so efficient and profitable in their own countries.

- **Fare system**: Both the countries have recently modified the tram fare structure to confirm the increase in revenue collection and to meet the expenses out from the income. Hong Kong has taken a very bold step than London regarding increasing of tram fare; fare rises of up to 30 % in its first fare adjustment in 12 years. The penalty charges are also high in both the countries just to decrease the numbers of without ticket passengers.

- **Convenience**: Tram service has been proved as convenient modes of transport to the passengers in both the countries. Regularity and punctuality, availability and frequency of tram, audio visual information system and facilities provided both in tram and the tram stoppages makes this service as convenient as the other modes of transport..

- **Accessibility**: In both the countries, the tram stops in the specific tram stoppage and each and every tram stoppage has step free and universal accessibility. Every tram stop and tram car have priority seats for the children, women and the old people. All trams are so designed that the wheel chair and the pull chair can be easily boarded direct from tram stop.

- **Safety and security**: Passengers safety and security is very much taken into consideration in both the countries. various measures have been adopted to ensure safety

and security e.g. CCTV, fire extinguishing system, medical kit, electronic sensor operated door, programmable logic speed controller, automatic track switching control device, driver's vigilance device etc.

- **Comfort**: Stress has been given to the passenger's comfort in both the countries. All the tram stations have been provided with seating spaces, music system, and audio visual information system. Efforts have also been given to the riding comfort by installing anti jerking technology, smoother journey over the track. Passenger's comfort inside the tram car has been secured by providing AC, soft seats outfitting, enough standing spaces, tinted glass for summer season, well finished floor and wall etc.

- **Network**: Both the countries have a well managed traffic network system which ensured the well integration of tram routes with the other modes of transport. Even the tram companies are also providing feeder bus service to some important tram stations in both the countries.

- **Operational extent**: New research is going on to invent more energy efficient, light weight, strong and efficient seating arrangement to accommodate more passengers. Research also going on to use alternative sources of energy instead of electricity and measures to overcome the situation in time of power failure.

- **Functionality of tramways**: In both the countries tram is used mainly for mass transportation but they have other kind of services also e.g. chartered tram, cargo tram, heritage tram, school special tram, tourist special tram etc. Care has been taken to improve the tram street environment and the betterment of streetscape. In both the countries, most of the areas along the tram routes have the mixed land use, some are pure commercial stretches. All the road stretches have controlled development and the Govt. is very much strict on the management of the roads.

- **Management system**: Future vision and the adoptability of the management make the tram service a profitable, convenient and reliable service in both the countries and as a result they both experienced the increase in tram passengers in last five years.

4

INTRODUCTION TO KOLKATA TRAMWAYS

This chapter deals with the introduction to the Kolkata, its chronological development, basic facts and figures to understand the profile of the city. Also the chapter focuses on the overall traffic and transport scenario in Kolkata Metropolitan Area (KMA). The main objective of this chapter is to introduce the exclusive operational and technical details of Kolkata tramways. The information about the Kolkata city helps to understand the city profile and its present condition and outlining the possibility of future development and improvement of tramways within the present road and traffic condition in Kolkata.

The chapter is sub divided into six sections. The first section is on the introduction to the Kolkata and its brief history. The next chapter tells the overall road traffic scenario in Kolkata. This chapter again sub divided into three sub-sections. The first sub-section discusses the facts and figures regarding the road network in Kolkata. The second sub-section gives the information on the public transport system issues in KMA and it is followed by the third sub-section which tries to make some recommendations for the issues discussed earlier chapter.

The third section tells the chronological development of Kolkata tramways. The fourth one is the main section where the detailed study on the Kolkata tramways is discussed. The fifth section tells the general problems of Kolkata tramways and it is followed by the sixth section where it is been discussed about the advantages of tramways in Kolkata.

4.1 Introduction to Kolkata

Modern Kolkata was founded in 1690 by British trader Job Charnock as a trading post of the English East India Company. In the mid -17th century the Portuguese had a trading outpost in the area at Sutanuti, followed by the Dutch, who constructed a diversion canal at the bank of the Hugli River, near the present Central Business District.

The city was recaptured by the British under Robert Clive in 1757. The English initially built an intricate transport network through the Hugli - Ganges water system, but it was the railroads, introduced in the 1850s, that successfully established connections with the hinterland and the rest of India. The city eventually had the largest concentration of trading establishments in India, and a Western-style business district evolved by the end of the 19th century.

Kolkata stands on the Eastern Bank of River Ganga. The tail end of river Ganga flows by the side of Kolkata before it reaches Bay of Bengal about 180 Km. downstream from Kolkata. Kolkata - The Jewel of the East remained the capital of India till 1911; Kolkata is now the capital of West Bengal, a state of India. The colonial city maintained a strict division between the crowded and ill-planned native quarters to the east and north of the Central Business District, and the spacious and well-planned quarters where the Europeans lived in the south and southeastern parts of the old city. After independence, the former European quarters were either turned into residences of the Indian rich or, as in the Park Street area, into commercial areas. Figure 74 is showing the growth of the Kolkata city i.e. KMA from 1973 to post 1856 and the Figure 75 shows the condition and the urban growth of the KMA in present era. [41]

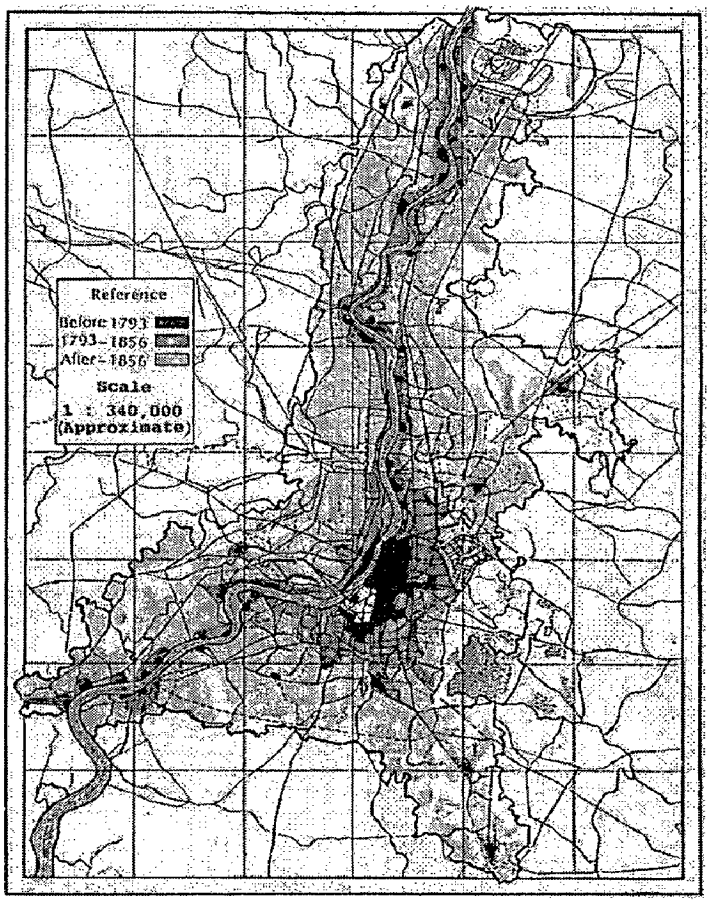


Figure 72 Growth of Kolkata from 1793 to post 1856

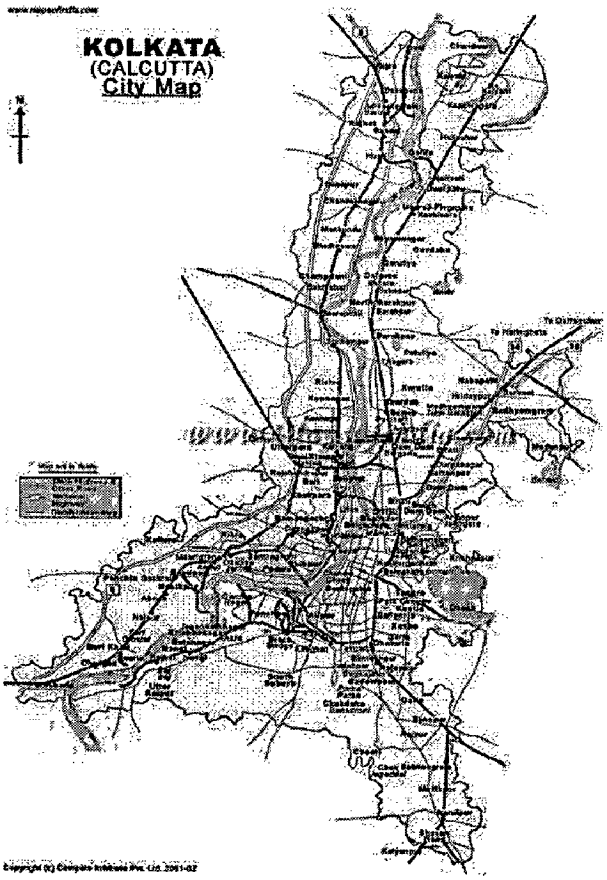


Figure 73 Present boundary map of KMA

Source: KMDA presentation, 2004. A Chronology of Planning & Development Activities in Kolkata (Figure 74)
http://www.mapsofindia.com/kolkata_map (Figure 75 and 76)

KMA is the oldest and second largest metropolis in India that now extends over 1,854 sq km area with a population of almost 15 million; it consists of three Municipal Corporation (Kolkata, Howrah, Chandannagar),38 Municipalities & 22 Panchayat Samities (Fig: 76). KMC is the biggest and most important ULB in the whole KMA. It is the main business center as well as the main tourist center of the KMA. Tram is running only in the KMC area and specifically in the core of the KMC area. KMC area is divided in 15 Boroughs. Each Borough again divided in several wards. There are total 141 wards in KMC area. Table 7 gives an overall idea of the KMC area regarding geographical location, area, climate, population, population density, vehicle population, road length etc. [41] [42] Detail of Boroughs and the respective ward are given in Table 36 in Appendix I.

Figure 74 KMA map showing the administrative boundaries

Table 7 General information about KMC area

Geographical Location	Kolkata, located at 22°30′ North latitude, 88°30′ East longitude
Climate	Humid during summer and pleasant in winter(Max. 40°C, Min. 20°C)
Area	185 sq. km (1480 sq.km is of total KMA)
Population :	4.52million (14.72 millions in KMA) as per 2001 Census
Density	24,429 persons/sq. km (9946 persons/sq.km in KMA)
Urban Population	3.98million (88% of total population in KMC area)as per 2001 Census
Floating Population	6 million per day
Category of ULB	Municipal Corporation
Vehicular Population	1.05 million
Buildings	1 million, out of which 79.23% are reinforced, cement concrete structures
Total Road Length	1416 km
Employees in KMC	38,252 up to 01.01.2005
Water Supply	300 million gallons per day
Solid Waste Generation & Disposal	2,500 metric tonnes (average)/per day
Slum Pockets	5600 nos.
Slum Population	1,49,810 as per 2001 Census
No. of KMC Parks	300

Source: http://www.kolkatamycity.com

Figure 77 is showing the administrative boundary of KMC in the KMA and the population density of KMC area. It has an population density of 24,429 persons/sq.km which is the highest among the Indian metropolitan cities. In the ward wise population density map it can be observed that the South Kolkata i.e. the Borough nos. XII to XV, has the low population density ranging from 4,000 to 44, 000 persons/sq.km. Central Kolkata i.e. Borough nos. VII to XI, has the medium density population ranging from 44, 000 to 64,000 persons/sq.km. North Kolkata i.e. the Borough nos. I to VI, has the maximum population density ranging from 64,000 to 1, 44, 000 persons/sq.km. [41] [42]

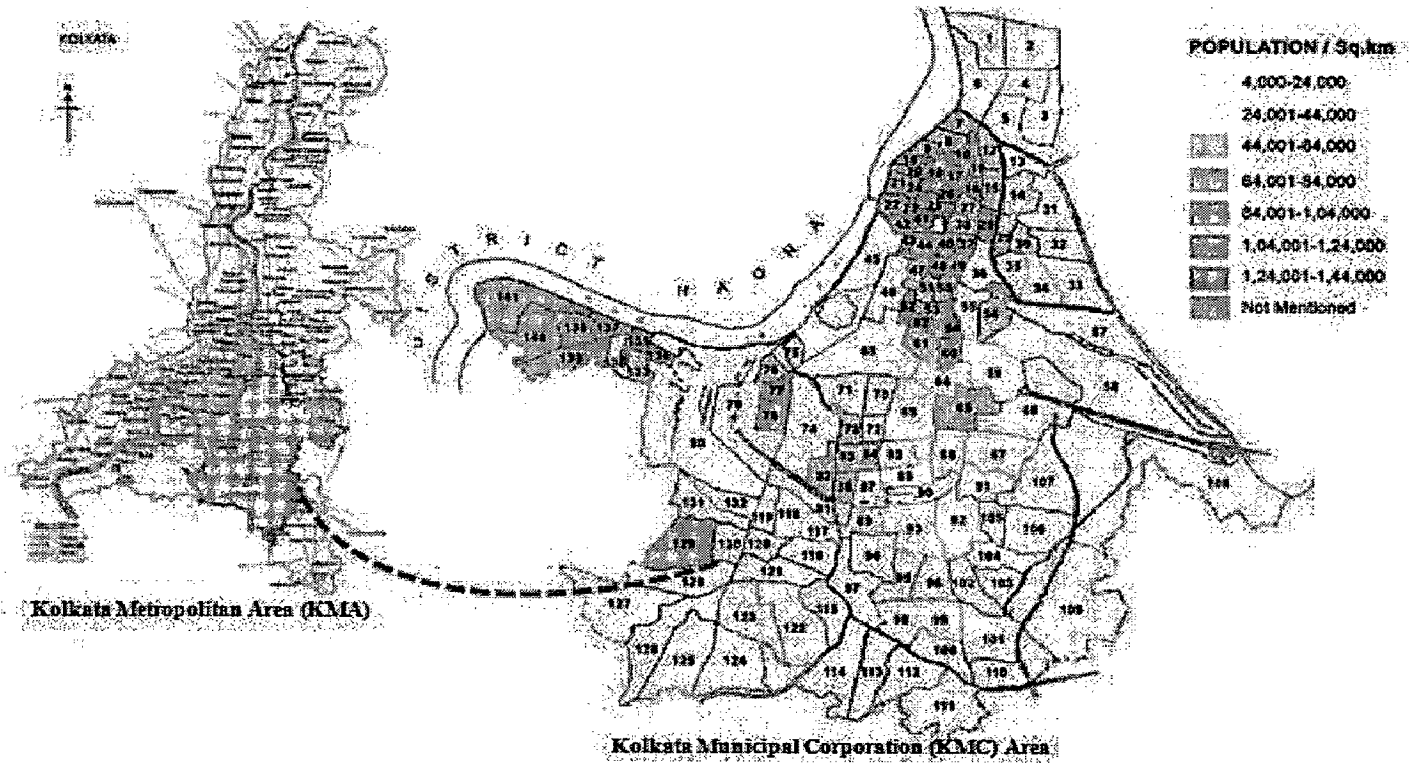


Figure 75 Maps of KMA and KMC area (with population density)

Source: http://www.kolkatamycity.com, http://www.kmdaonline.org

From 1698 onwards there was a gradual conversion of residential village to offices around the fort in Dalhousie square area. From 1700 onwards the British Govt. started to make planned residential development in Chowringhee and Park Street areas. From 1773 Kolkata grew linearly in North-South direction with Salt Water basin on the east & Sunderbans on the South, Chitpur Road served as the oldest N-S spine connecting the Kalighat Temple Area. Because of this urban growth there was a need to make the city beautiful

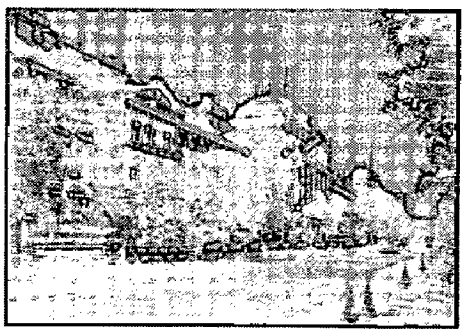


Figure 76 Old Secretariat building of Kolkata - Writers' Building

and as a result in 1803 Govt. started the transformation from the city of mercantile complex to the city of colonial buildings, Monuments, Halls, Gardens and 33 Bathing Ghats viz. St. John's Church, Raj Bhavan, Ochterlony Monument, Town Hall, Metcalfe Hall, St. Pauls' Cathedral, Royal Exchange and Botanical Gardens. 1870 to 1920 was the golden period of architecture in Kolkata when there was an improvement of establishments, institutions, edifices & mansions were built in Chowringhee / Dalhousie Areas viz. GPO, High Court, Renovated Writers' Building (Fig: 78), New Market, Indian Museum and Victoria Memorial. Figure 79 shows the development and the growth of the KMC area from its inception i.e. from 1726. [41] [42] [43]

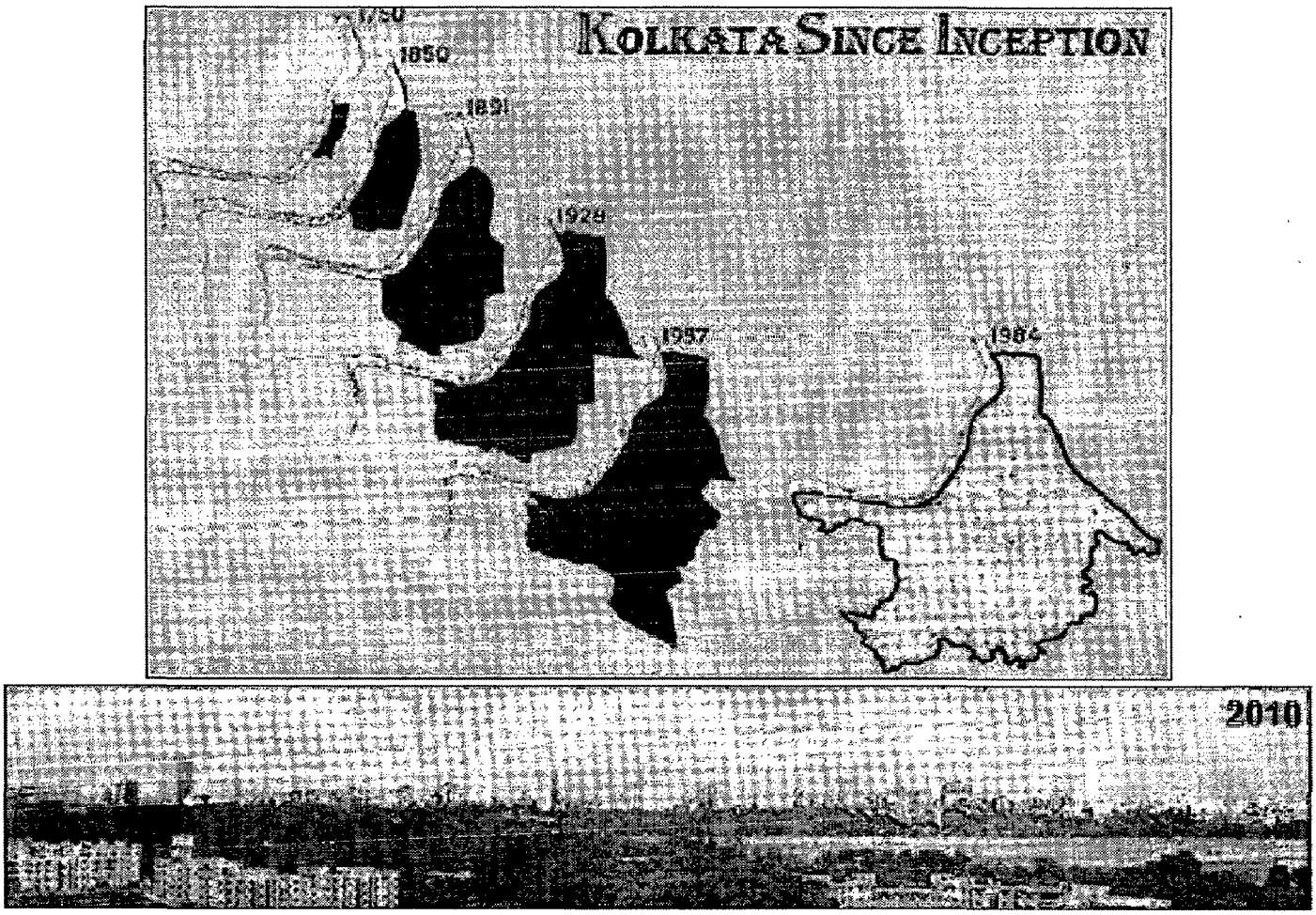


Figure 77 Growth of KMC from its inception

Source: KMDA presentation, 2004. A Chronology of Planning & Development Activities in Kolkata

4.2. Overall transport scenario in Kolkata [43] [44] [45] [46]

The transportation infrastructure of Kolkata consists of various modes ranging from the original ferries to metro rail, hand driven rickshaws, trams, buses and trains which currently share the same right of way. Historically, the core city of Kolkata was based on mobility by

ferries, hand rickshaws and trams, complemented by the pedestrian movement. The use of trams and non-motorized modes of transport suited the narrow streets and offered the required maneuverability. Technological advancement has led to the same roads being confiscated by high speed motorized modes. This has been also due to no major capital investment in the mass transportation system for the last several decades. The ferry system and tram system have been totally neglected as evidenced by the drop of ridership on the tram from a million riders in 1976 to less than 70,000 per day. This is in total contradiction to what is happening in the mega cities around the world that are shifting from car based societies to mass transit.

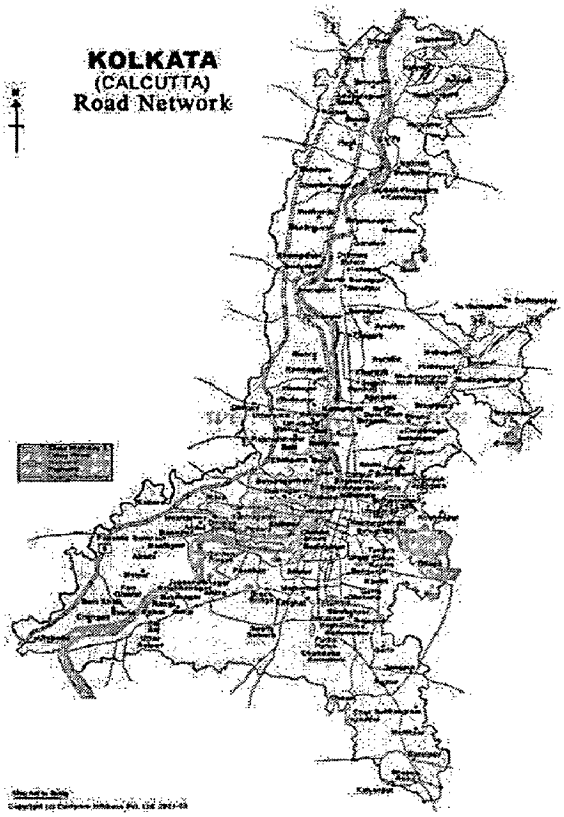


Figure 78 Existing road network in Kolkata

The standard guidelines for determining transportation improvement projects will be difficult to adhere to in Kolkata because of the nature of the city. During the evolution of the city the founding fathers had planned the city based on river / canal as the main transport system which was later augmented by the rail based tram system. The current nature of determining the need for transportation based on UDPFI guidelines projects is difficult to apply (which proposes a minimum of 15-18% of land use for transportation) where as Kolkata has a mere 6% of land under transport use, with a whole gamut of modes from hand pulled carts to tractor trailer trucks sharing the same carriageway.

The transportation movement within the study area is determined by various activities. By mandating the freight movement of trucks into / out of the city during the off peak hours of the night to early morning greatly helps in reducing the congestion during the AM and PM peaks when the office / school commuters are of paramount importance. Kolkata has several peculiar issues associated with urban transport infrastructure low road density, mixed traffic, inadequate public transport system, and limited road maintenance and insufficient traffic control/measures.

4.2.1 Road network [45] [46] [47] [48] [49]

The road network in KMA (Fig 80) consists of regional roads including National and State Highways, arterial roads, inner arterial and sub-arterial network. Table 8 shows the total road length by road type and Table 9 shows the road density comparison with the other Indian metropolis.

Table 8 Road network in KMA

Road Type	Road Length (Km)
National Highways	107
Regional Roads	242
Major Arterial Roads	443

Table 9 Comparison of road density with the other Indian metropolis

City	Road length (Km)	Land area (Sq.km)	Road density (Km/km²)
Delhi	30949	1483	20.87
Chennai	1800	174	10.34
Kolkata	1416	187	7.56
Mumbai	1900	438	4.34

Source: Pilot study for project formation for urban transport development in the KMA, 2007

Figure 81 presents the overall composition of traffic in KMA. Of the total traffic passing through major corridors, private cars and taxis have a share of 44 % followed by auto with 12 % and two wheelers with 6 %. The share of public transport vehicle is 29 %. National highways, state highways and other arterial roads exhibit similar characteristics in their respective groups.

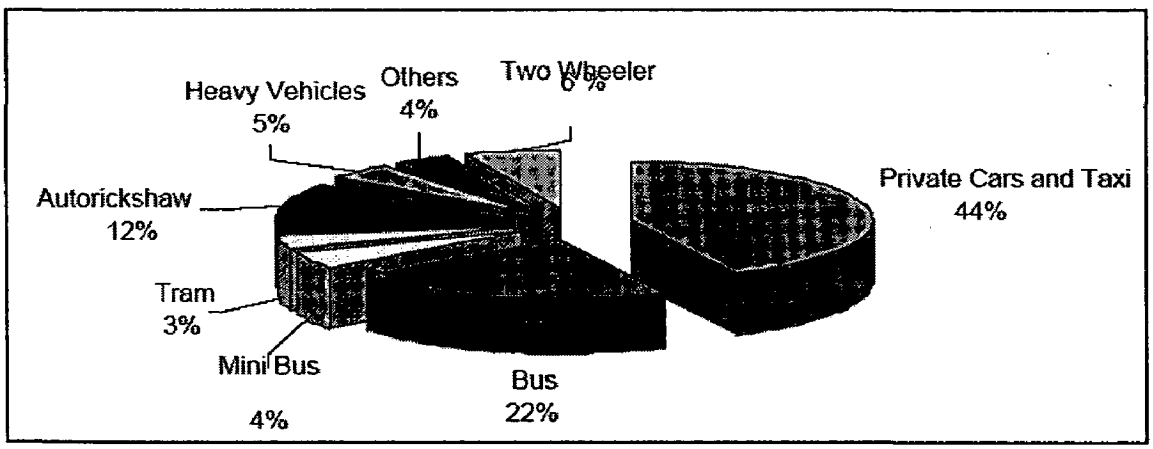


Figure 79 Traffic composition on major roads in KMA

Source: Comprehensive Mobility Plan for KMA, 2008

Table 10 shows the growth of transit passengers in KMA, from where it is clearly visible that the share of trams in 1980 was 15 % and has come down alarmingly to 2 % (2007). The bus system owned by the government has decreased from 15 % in 1980 to 11 % in 2007. The private and mini buses have decreased the share of other public transport modes.

Table 10 Growth of transit passengers in KMA (on an average weekday; in lakhs)

Mode of Transport	1980		1998		2007	
	Trips	%	Trips	%	Trips	%
Public Buses, CSTC, CTC, WBSTC, etc.	9.4	15	12	11	12.5	11
Private buses	41.5	67	80	72	85	73
Trams	9	15	1.6	1	2	2
Mini Buses	1.5	2	12	11	12.5	11
Chartered Buses	0	0	2.2	2	2.7	2
Ferry Services	0.4	1	2.5	2	2.4	2
Total	61.8	100	110.3	100	117.1	100

Source: Comprehensive Mobility Plan for KMA, 2008

Table 11 shows that the number of vehicles registered in each of the six constituent administrative units of the KMA in the last eight years shows that the average annual growth of different vehicle types varies from 14 % to 1.2 %. From the following table it is well observed that the average annual growth of all vehicles till 2006 is 7%. A rise in the number of private buses shows that the increased demand is catered by the public transport. A significant increase in the number of two wheelers and auto rickshaw is a major area of concern as they add to congestion along with increased environment degradation.

Table 11 Total numbers of registered vehicles in KMA

Year	Goods Vehicles	Motor car	Motorised Two Wheelers	Taxi/ Cont. Carriage	Auto Rickshaw	Mini bus	Bus	Trailer/ Tractor	Total
2000	1,37,567	3,16,372	5,55,613	38,708	24,613	3,046	15,719	10,622	92,708
2001	1,3,0704	3,45,075	5,81,767	42,816	17,700	3,145	16,865	11,125	91,651
2002	1,58,674	3,72,396	6,51,878	45,411	32,607	3,209	17,729	11,128	1,10,084
2003	1,61,862	3,99,120	7,37,673	52,700	38,461	3,599	19,006	11,270	1,25,036
2004	1,69,492	4,02,623	8,16,378	57,207	32,346	3,974	18,477	11,621	1,23,625
2005	1,52,910	4,34,626	7,94,599	50,611	49,567	2,872	17,842	10,447	1,31,339
2006	1,60,753	4,44,257	8,69,954	52,467	35,961	3,824	27,240	12,091	1,31,583
Average Annual Growth	3.08	5.9	7.9	5.6	14	5.5	11	2.5	7.0

Source: Master Plan for Traffic and Transport in Kolkata Metropolitan Area (for 2001-2025)

Travel speed is an indicator of the quality of flow and traffic load on a particular corridor. Table 12 clearly indicates that 1 % of the total road length, the travel speed is less than 5 kmph. 72 % of the total road length, the travel speed is below 20 kmph. 13 % of the total arterial roads in KMA are observed to have travel speed of more than 25 kmph, which is much below the mandated speed (40 to 50 kmph).

Table 12 Lanes-Speed profile

No. of Lanes	Speed (in Kmph)							
	0 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40
2	2.0	4.8	36.8	23.6	1.3	2.5	0.0	0.0
3	0.0	0.4	16.1	3.3	1.6	4.2	0.0	0.0
4	0.0	12.6	44.3	40.2	24	6.6	5.1	6.5
6	0.0	3.1	9.2	16.8	12.2	10.3	3.8	0.0
Total length (Km)	2.0	20.9	106.4	83.9	39.1	23.6	8.9	6.5
Percentage	0.69	7.17	36.53	28.8	13.42	8.1	3.06	2.23

Source: Pilot study for project formation for urban transport development in the KMA, 2007

4.2.2 Public transport system issues in KMA [46] [47] [48]

Kolkata has the lowest road length compared to the other metropolitan cities. In addition to low road length there are other problems too which cause slow traffic movement, increase in road accident, traffic jam etc. The main issues of the public transportation system in KMA are as follows:

1. LOS (frequencies, reliability and comfort) of bus/rail system is not enough to encourage modal shift from private cars to public transport.
2. Rail/ bus system do not have adequate access facilities, feeder system, and modal interchange facilities.
3. Inappropriate regulatory framework (concession of bus routes etc.)
4. Fare/ticketing system require integration.
5. Old transport infrastructures
6. Poor infrastructures at the terminal or stations.
7. Operating losses by public transport operators.
8. Inadequate level of traffic management, focus on transport supply management not transport demand management.
9. Inadequate designed and maintained carriageways and intersections, lack of traffic facilities, and insufficient U-turn system.
10. Inadequate and poorly managed pedestrian environment.

11. Road user behavior is poor and road user education is unfocused.
12. Poor enforcement of traffic laws (Illegal license issuing, under age driving)
13. Lack of public awareness relating to road traffic and use of roads,
14. Manually operated traffic signals; need for up gradation of traffic management.
15. Narrow roads with poor geometrics and closely spaced intersections,
16. Improper bus stops locations.
17. Poor surface condition of road and paving.
18. Inadequate capacity of existing roads.
19. Location of manhole covers in the center of the carriageway.

4.3 Chronological development of Kolkata tramways [50] [51]

After the premature experiment in 1873, a horse tram system opened in January 1881, and a steam tramway line in 1882 in Kolkata. Electric trams began running on March 27, 1902 and by 1921 there were 56 kilometers of track and 512 cars in service. Since the beginning, the Calcutta Tramways Co. Ltd. (CTC) is the operating agency which was established 22nd December of 1880. After India's independence, the government of West Bengal passed the Calcutta Tramways Company Act, and took over the management on 19th July, 1967.

Ever since the first tram which rolled out in the tracks way back in Feb 24th 1873 this sturdy built electrically driven carriage has gone through the wears & tears with the ravages of time, carving out our golden phases of history. Braving out the illustrious moments of our Indian freedom struggle, World wars, Kolkata tram had come a long way and still its wheel continue to pave its way as a rail witness of the present era and hopefully for the future too.

1873:- The attempt to run a tramways service between Sealdah and Armenian Ghat Street of route length 2.4 mile was made on Feb 24 The service was not adequately patronised and was wound up on Nov 20.

1880:- The Calcutta Tramways co ltd was formed and registered in London on 22nd Dec, Meter -gauge horse-drawn tram track between Sealdah to Armenian Ghat via Bowbazar Street, Dalhousie Sq. Customs House and Strand Road was laid. The route was inaugurated on 1st November 1880.

1882:- Steam locomotives were deployed experimentally to haul tramcars. By the end of the nineteenth century the Company owned 186 tramcars, 1000 horses, 7 steam locomotives and 19 miles of tram tracks.

1900:- Electrification of Tramways and simultaneous reconstruction of tracks to the standard gauge (4'-8½") was taken up. By the end of 1905 the entire system was converted to an electric traction.

1905:- Howrah station to Bandhaghat section for tramways was opened in June. Lines to Sibpur via G.T. Road were made ready in 1908.

1907:- The first electric tram was on the road on 27th March of 1907.

1943:- The Calcutta system was connected with Howrah section through the new Howrah Bridge in Feb with this extension, the total track length reached 42.09 miles (67.73Kms).

1951:-The Govt. of West Bengal entered into an agreement with the Calcutta Tramways Co and the Calcutta Tramways Act, 1951 was enacted. The Govt. took over all rights with regard to Tramways and reserved the right to purchase the system on 1st Jan, 1972 or any time thereafter giving two years notice.

1967:- The Govt. of West Bengal passed the Calcutta Tramways Company (Taking over of Management) Act, 1967 and took over the management on 19th July 1967

1970:-The Howrah sections were closed down in Oct 1970 and Dec 1971/1973 NimtalaGhat route was closed down in May 1973. The total track length was reduced to 38.58 miles (62.08kms).

1976:-On November 8th, 1976 the Calcutta Tramways (Acquisition of Undertaking) Ordinance, was promulgated under which the Company with all its assets vested with the government.

1985:-On April 17, extension of track was completed connecting Maniktala to Ultadanga Station via Maniktala Main road (3.7 km). This is the first Tramways extension since 1947.

1986:- On Dec 31 further extension of tram track from Behala to Joka was completed.

1992:- CTC has taken a new venture by introducing Bus services from 4th November 1992 initially with a fleet of 40 buses.

4.4 Detailed study on Kolkata Tramways

4.4.1 Fare System [52]

- **Fare structure:** Table 13 shows the compartment wise fare structure of tram. There are two compartments namely First class and second class.

Table 13 Fare structure of tram in both of its compartments

Route Stage	First class	Second class
1st route stage	Rs. 4.00	Rs. 3.50
For every subsequent stages	Extra Rs. 0.50	Extra Rs. 0.50
	Max. Rs. 5.00	Max. Rs. 4.50

Source: http://www.calcuttatramways.com

- **Fare Comparison with Other Public Transport:** Table 14 shows the comparison of fare structure between tram and the other modes of public transport. From the table it is clearly visible that the tram has the lowest fare charges compare to all the other modes. And contradictory to the fact that the Govt. bus charges the higher fare than the private bus and mini bus whereas it should be the reverse one.

Table 14 fare structure comparison with various modes of public transport

Modes of transport	Min. fare	Max. fare (For a route length of 20 km.)
Suburban Rail	5.00	8.00
Metro Rail	4.00	12.00
Tram	3.50	4.50
Govt. Bus	6.00	10.00
Private Bus	5.00	7.00
Mini Bus	6.00	8.00
Taxi	20.00	100.00
Shared Auto (6-8 seats)	4.00	10.00

Source: Field survey by author

- **Payment / ticket system:** The passengers get the ticket from the collector/conductor after boarding into the tram (Fig 82).

- **Penalty:** A sudden checking by the officials/inspectors from CTC at the stations or travelling. Penalty charge is Rs.100 in case of without ticket.

Figure 80 Conductors issuing ticket inside the tram

- **Concession:** Zone wise, route wise and the all route monthly tickets are available. No ticket is required for the children up to 5yrs of age. There is a concession for the old people and the student. No concession is for the handicapped people.

Figure 81 Esplanade tram terminus

6.4.1. Travel time [52]

- **Journey time:** Generally it takes 8-10 minutes more than bus to reach the same distance by same route.

- **Vehicle Speed:** The maximum speed of the tram is 50 -60 km/h. The average speed is 25 km/h. whereas the bus has the maximum speed of 80 km/h & average of 40-50 km/h.

Figure 82 Non-regulated commercial service

- **Frequency:** Available at time interval of 15-20 minutes on weekdays. On weekends and holidays the interval is 20-25 minutes. Whereas bus are available at the interval of 3-5 minutes for all days.

- **Reliability:** It is almost reliable in the view of punctuality. It is very much reliable in the monsoon and winter seasons but not in summer due to frequent power cut.

6.4.2. Convenience [52] [53]

- **Availability:** It is available throughout the year. Service available from 5 AM to 11 PM daily. The frequency is less in holidays.

- **Provisions of facilities at the stations:** There is no station at all. Only the depots & terminals have stations. Stations are covered with asbestos sheet. No seating places for the needed people (Fig: 83).

- **Commercial services at the stations:** Non regulated commercial services. Mainly encroached by the hawkers. Most of them are food stalls & cigarette shops (Fig: 84).

Figure 83 Waiting spaces are far from the main tram routes

- **Information System:** Neither written nor audio-visual information system is available either in station or in tram.

6.4.3. Accessibility [53]

- **Location of tram stations:** Stations are only at terminals or depots. Waiting area is far from the tram lines (Fig: 85). There is no prominent stoppage for boarding. Few locations have prominent stoppage by clearly indicating with on-road signs "TRAM".

- **Access to tram and stations:** Very challenging for the disabled, old people & the children. The stations are not properly designed (Fig 86).

Figure 84 People boarding to the running tram

- **Distance between two stations:** There are no proper measured distances between stations. Anywhere on the road the tram can stops. The passengers can board or de-board from anywhere in between the route.

Figure 85 Old tram car

6.4.4. Safety & Security [53] [54]

- **Personal security:** There is no security guaranteed by authority. There is no security guard therefore no security on pick pocket, theft etc.

- **Personal safety:** No safety measures are there for the passengers. The old tram, having no doors makes it unsafe to travel when it is fully loaded (Fig: 87). In the new tram the above problem has been solved but still there is no audio visual alarming or information system (Fig: 88).

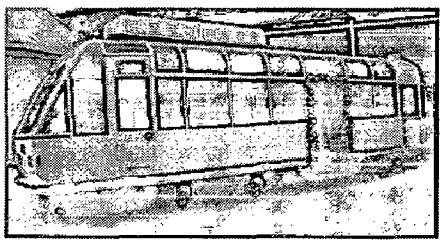


Figure 86 New tram car

- **Quality of driving:** No hustle or reckless driving. Much smoother journey than bus, auto etc. Low speed makes it easy to accessible to women, child and old people.

6.4.5. Comfort [54]

- **Comfort at stations:** there are no facilities at the stations. No seating places for the needed people. Uncomfortable at rainy seasons. The stations area is mostly encroached by the hawkers or vagabond.

Figure 87 Seating arrangements in new tram

- **Riding comfort:** Smooth running on track, no honking, overtaking with others. Not depend on the bad road condition.

- **Comfort inside the tram:** No AC system both in old and new tram. 2nd class compartment even don't have fans. Seats are not comfortable (Fig: 89). Standing space is not enough in new tram. No special provisions for the handicapped people. The glass covering in new tram makes it uncomfortable in summer (Fig 90).

Figure 88 Inadequate standing spaces inside the tram

6.4.6. Network [52] [54] [55]

- **Length of the network:** There are 29 tram routes stretched over 60 km route length. The longest distance between two depots is 26 km. The shortest distance between two depots is 10 km.

- **Direction to route/need to transfer:** Maximum routes are through commercial areas and main business areas. Least break journey and efficient in some places where one way vehicle movement is allowed. It is very well connected with institutional places.

- **Transfer integration with other modes:** Well integrated with the other modes. It is connected with the main bus depots, and rail stations. Figure 91 shows the location of tram network w.r.t the KMA which shows that the tram is only in operation within the core of the KMC area. The map also shows the administrative boundaries of the wards of KMC. So that it can be easily identified the places thro' which the tram is running on.

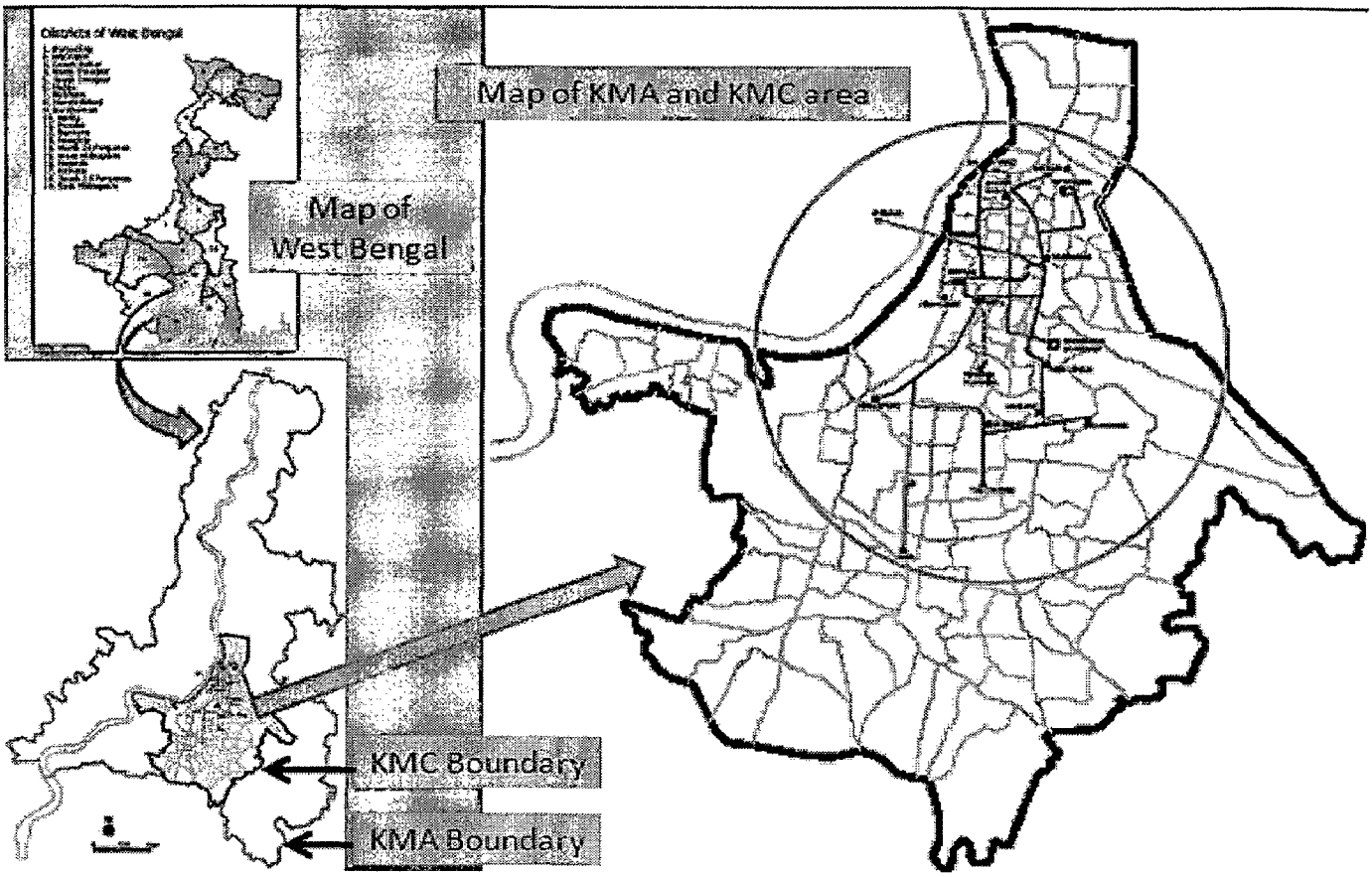


Figure 89 Tram network in KMC area

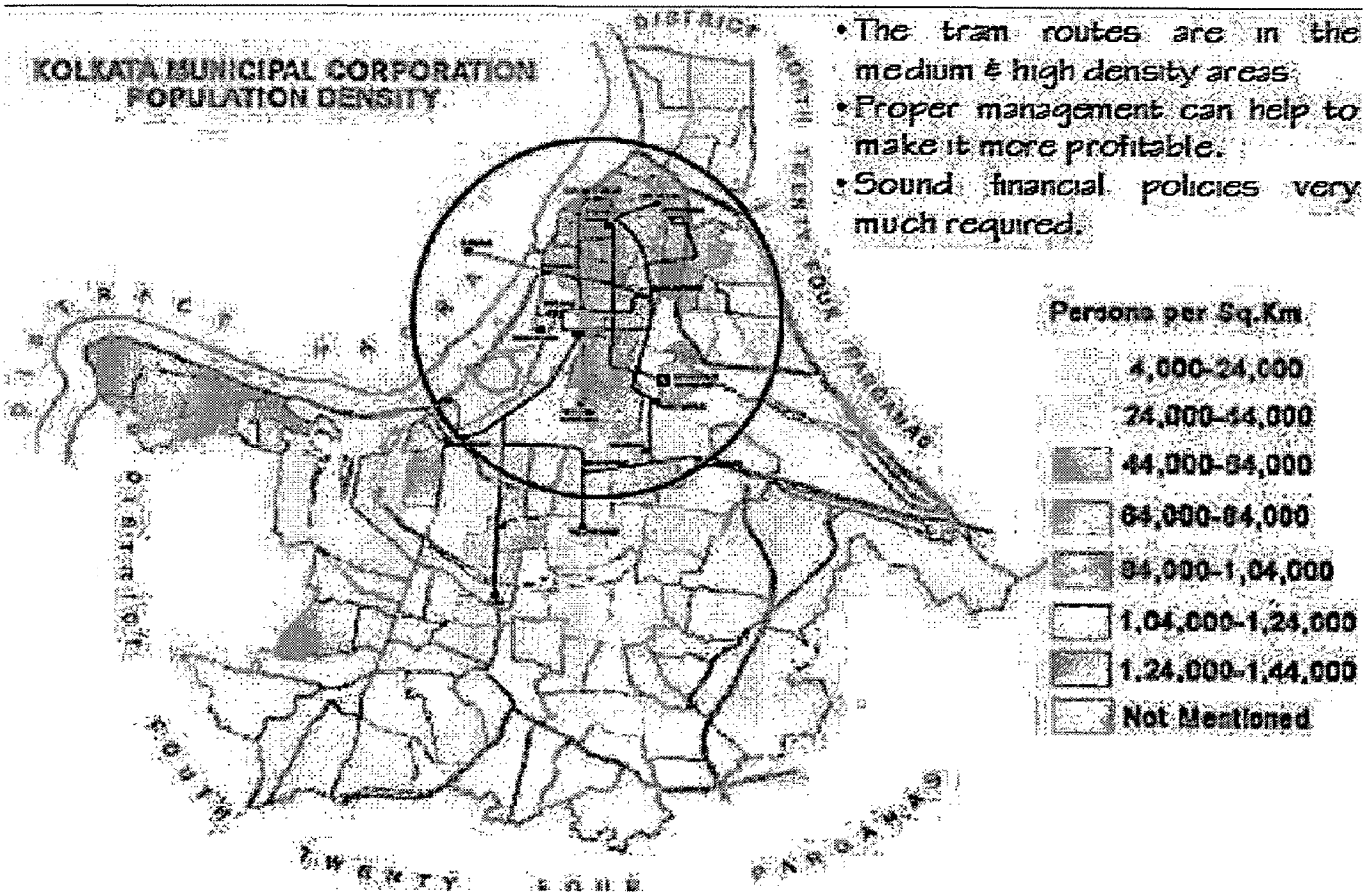


Figure 90 Tram network and population density map of KMA

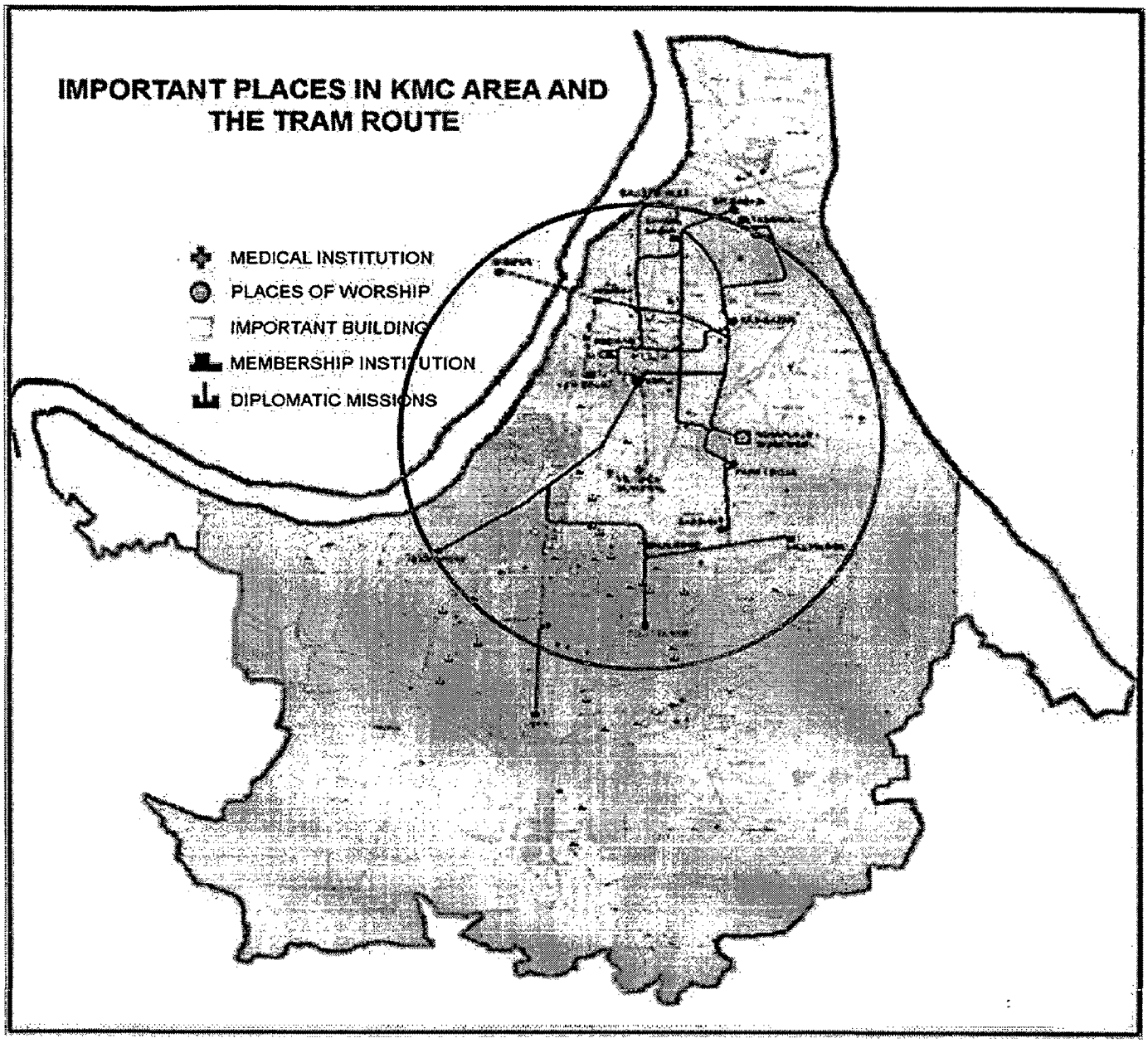


Figure 91 Tram network and important places in KMC

Figure 92 is showing the tram network with respect to the population density in KMC area [50]. From that map it is clearly observed that the maximum part of the total network is running thro' the medium and high density area. So it is the proper planning and policies which is required to gain the advantages from these populated areas and help to increase the revenue of the tramways.

Figure 93 shows the interrelationship of the tram network and the important places in KMC area [51]. From the map it is being observed that Almost 50% (21 nos.) of the total (43 nos.) medical institutions in KMC area are directly accessible by the tram routes. Almost 30% (6 nos.) of the total (18 nos.) places of worship is well connected with the tram routes. Almost 40% (8 nos.) of the total (20 nos.) important buildings stand just beside the tram routes.

Almost 50% (8 nos.) of the total (16 nos.) diplomatic missions are directly connected with the tram route. So it is clearly understandable that there is a high scope to redevelop the tram network and its integration with the other modes of transport.

Figure 94 shows the tram network including the depots, terminal and workshop. A workshop for construction & major repair of tram is located at Nonapukur. There are 7 tram depots in Kolkata at the locations below. These are generally used for night parking & minor maintenance.

1. Belgachia
2. Gariahat
3. Kalighat
4. Kiderrpore
5. Park Circus
6. Rajabazar
7. Tollygunge

There are 9 terminuses with turn-around facilities. Those are:

1. Ballygunge
2. B.B.D Bag
3. Esplanade
4. Gallif Street
5. High Court
6. Howrah Station
7. Joka
8. Shyambazar
9. Ultadanga

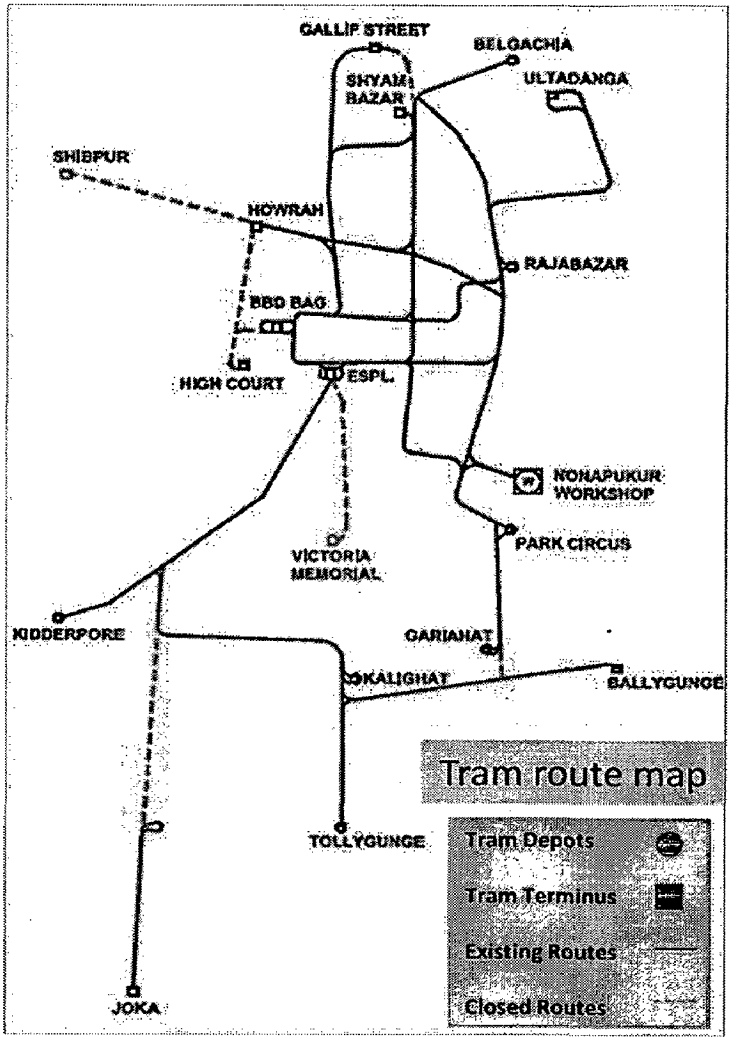


Figure 92 Tram network showing the routes, depots & terminus

6.4.7. Operational extent [50] [51] [52] [53]

- **Technical details:** Technical details of the tram are as shown below:
  - Length: 17.5 m (57.4 ft)
  - Width: 2.1 m (6.9 ft)
  - Capacity: seating 60 per car (1st class: 28 nos., 2nd class: 32 nos.)
  - Area/passengers: 0.6 Sq.km
  - Voltage: 550 volt DC power in overhead wires
  - Single ended car, no vestibule, no door shutter, currently drawn by trollypole.

- **Condition of vehicle:** The old trams required maintenance. The external faces of old trams are not attractive. The new ones are good looking, light weight (Fig: 95).

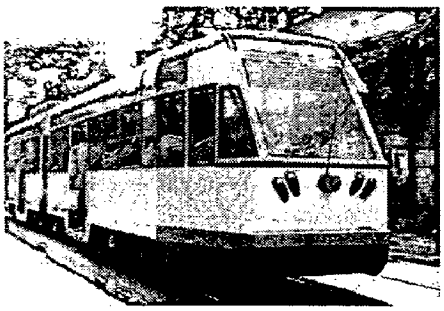


Figure 93 Well maintained tram car

- **Cleanliness of vehicle:** No regular cleaning of vehicles. Lack of awareness of people regarding cleanliness. External faces also not cleaned properly.

- **Overall maintenance of the system:** The old vehicle needs more maintenance. The tracks and the overhead wires are well maintained (Fig: 96).

Figure 94 Well maintained OHE wire

- **Effect of traffic congestion:** Non presence of reserved track affects the tram. Its slow movement responsible for traffic jams. Less priority given to it when congestion is there. The traffic police set the frequency of 15 minutes between two trams.

Figure 95 Traffic jams due to the power failure

- **Effect of power failure:** Absence of back-up system makes the tram to stand still on road until power come. Crane move out the vehicles to run the traffic. The system is heavily affected at monsoon and in summer (Fig: 97).

6.4.8. Functionality of tramways

- **Type of usage:** Mainly use for mass transportation. In some occasions it offers some special services. The heritage part is very much ignored.

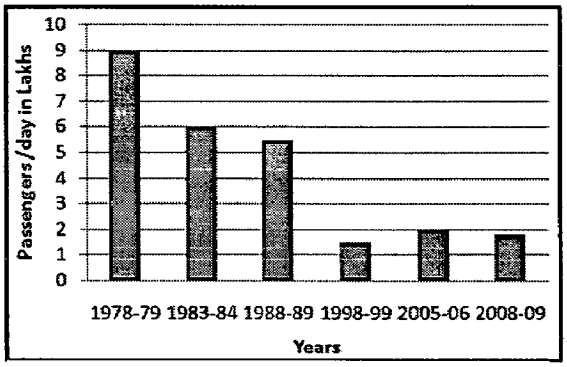


Figure 96 Annual passengers carried

- **Nos. of commuters** [52] [54] [55]**:** In last year it carried 1.80 lakhs passengers per day, i.e., 6.6 crores passengers in a year but due to the poor management the numbers are decreasing (Fig: 98).

- **Type of commuters:** Most of the commuters are of LIG people. About 20% are women and children, 20% are of 25-30 yrs old people. 50% are of 30-50 yrs old people. 10% are from >50yrs age group people. Most of the people use it to reach to their work area. Have fewer interests for a leisure trip by tram. Preferable for carrying bulky luggage.

Figure 97 Controlled development at Bidhan Nagar road

- **Landuse pattern along the tram corridors:** Most of the areas are of mixed land use. Many are prominently residential. Many stretches have unauthorized slums. One or two stretches are purely institutional.

Figure 98 Filthy condition at Ultadanga Tram Terminus entry

- **Quality of street environment** [55] [56]**:** Many of the stretches have good controlled development (Fig: 99). Some of the routes are really in poor condition due to presence of garbage, slums, and congested market areas (Fig: 100). The routes are not properly merged with the places of interests. Most of the routes suffered from the uncontrolled developments, encroachment of footpath.

6.4.9. Management system [52] [55] [56] [57]

- **Development plan/policies:** No future development plans by the authority. Proposals for introducing AC in some trams. No plans for changing the "Trolley pole system" to "pantograph system" regarding power supply. Proposals for two new routes. Proposals of adding a goods compartment in some routes.

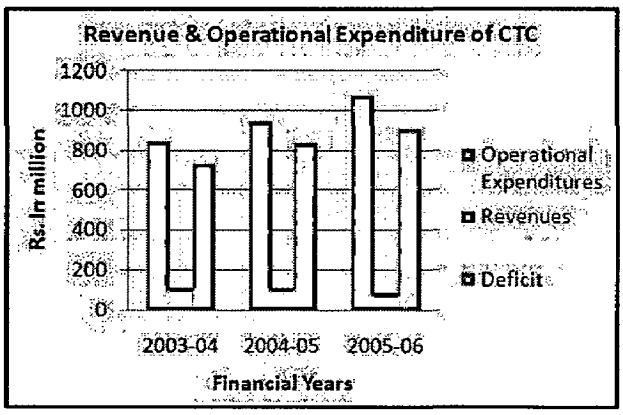


Figure 99 Financial detail of CTC

- **Financial condition:** CTC, which employs 7,000 people and had accumulated losses of at least Rs. 500 crores in 2006-07, is dependent on state government subsidies to stay afloat. The tram service is almost 80% subsidized by West Bengal Govt. Revenue also coming from the advertisement outside the vehicle. Due to poor management, lack of

future development plans, back dated thinking force the tram service to run in loss (Fig: 101). The numbers of employees are also decreasing from 8900 in 1990-91 to 5058 in 2004-05. Table 15 shows the service characteristics by CTC including the total numbers of available fleet, its utilization and productivity, staff productivity.

Table 15 Service characteristics by CTC

Items	Vehicle	2003-04	2004-05
Number of units purchased	Tram	-	-
	Bus	-	60
Utilization (% of vehicles on road to average fleet held)	Tram	45	42
	Bus	61	60
Vehicle productivity (kms per vehicle/day on average fleet held)	Tram	37	35
	Bus	131	129
Staff per vehicle (on average fleet operated)	Tram	36	37
	Bus	11.5	11.31
Staff productivity (km/worker/day)	Tram	2.3	2.19
	Bus	18.74	19.08

Source: KMDA, Pilot study for project formation for urban transport development in KMA, 2007, http://www.calcuttatramways.com

Source: http://www.kolkatamycity.com and http://www.calcuttatramways.com (Figure 91)
http://www.mapsofindia.com and http://www.calcuttatramways.com (Figure 92)
http://www.kolkatamycity.com, http://www.mapsofindia.com
and http://www.calcutttramways.com (Figure 93)
http://www.calcuttatramways.com (Figure 94, 98 and 101)
By author (Figure 82 to Figure 90, Figure 95 to Figure 97, Figure 99 and100)

4.5 Advantages of Kolkata Tramways

After analyzing the pros & cons of travelling in the trams, it is very hard not to be in favor of use of tramway as public transport. However it is true that due to the irrational competition with the other modes of transport and discriminating behavior of Govt. against tram service, tramways have lost much of its hype, sheer and popularity. Though their numbers have drastically come down in the era of luxurious cabs and bikes, tram cars has managed to brave the odds and thrive on the roads with its same old promise of safe, affordable and harmonious life style. Though the Kolkata tramway has some lacuna, it has a lot of advantages compared to other modes of transport. They are as follows:

1. Trams can have greater passenger capacity of 300 persons as compared to only 60 in buses.

2. Trams are quite friendly to children, ladies and the elderly person with great comfort & ease to board in its low platform.

3. These sturdy trams are much disciplined, since they run on tracks & also provide utmost safety.

4. Tram can be regarded as the cheapest mode of transport and with better management it can be run profitably.

5. Trams are undoubtedly pollution free and environment friendly. In this polluted city, trams provide the ultimate healthy travel for young & old.

6. Segregation of tram line and priority of tram can help in avoiding traffic congestion.

7. No violent movements vertically, laterally, or backwards /forwards make the journey a very smooth & safe journey.

8. Compatible with pedestrians in pedestrianised areas.

9. It is a versatile mode of transport as it can run at high speeds on segregated way and can penetrate narrow historic centers.

10. It is easily adaptable as it can cope with steep gradients and tight curves.

11. The Kolkata tramway has become a part of city and national heritage.

5

ANALYSIS OF THE STUDY STRETCHES

This chapter is completely dealing with the analysis of the study stretches. At first it was discussed about the criteria for selecting the areas, among the whole KMC area where tram is running, which have some kind of importance in terms of heritage, services, tourism etc. After selecting the areas, particular roads from those areas have been selected based on some conditions. Then some stretches have been selected from those road sections. The stretches have been selected in such a manner that it reflects the character of the total road section in a nut shell. The length of the road stretches is limited to 500 m and it is also taken into account that the stretches should be from one junction to another junction. After selecting the road stretches the analysis parts have been started. First the problems have been identified by the primary survey and the information has been processed for the analysis. Analyzing the present conditions and the problems, the possible solutions for each of the problem has been chalked down. Then all of the three road stretches have been compared to each other to identify whether a common solution can be applied to all of these three stretches for any common problem.

5.1. Criteria to select site areas:

Three areas have been selected where the scope of improving the tramways as well as the streetscape is higher than the other areas. All the three areas are totally different by nature, activity pattern, traffic volume, places of interests, road characteristics, land use pattern etc., but they have some common features too i.e. vibrant informal sector activity, problems of traffic, high pedestrian volume, existence of highly important places, poor streetscape, heritage buildings etc. These three road stretches have been selected to redesign it so that it can work more efficiently and make it a place of public attraction instead of making only a pure transportation corridor or a commercial center.

The selected three areas are: College Street, Sealdah and Kalighat (Fig: 102 to 105).

All of the three areas have some potentialities which are listed below:

1. They have three different major activity patterns.
2. Land use patterns are almost same in these three different areas.
3. All of the three areas have some important institutional, educational, religious buildings, cultural center, commercial areas & transportation corridor.
4. Tram route usage is relatively more among the total tram route network.
5. High density population spread over all of the three areas.

6. Tram route is better integrated with the other transportation network than the other areas in KMC.
7. There is a scope of work for betterment of tramways and its integration with the streetscape.

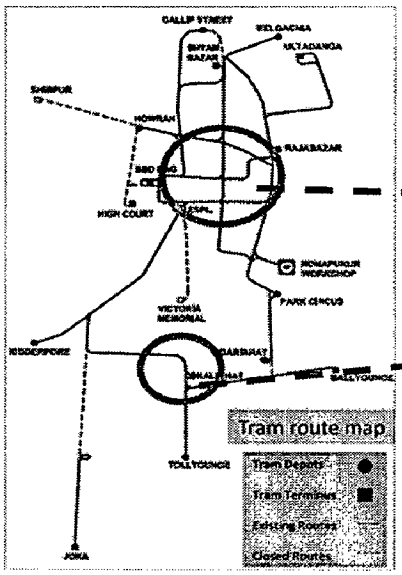


Figure 101 Tram network map

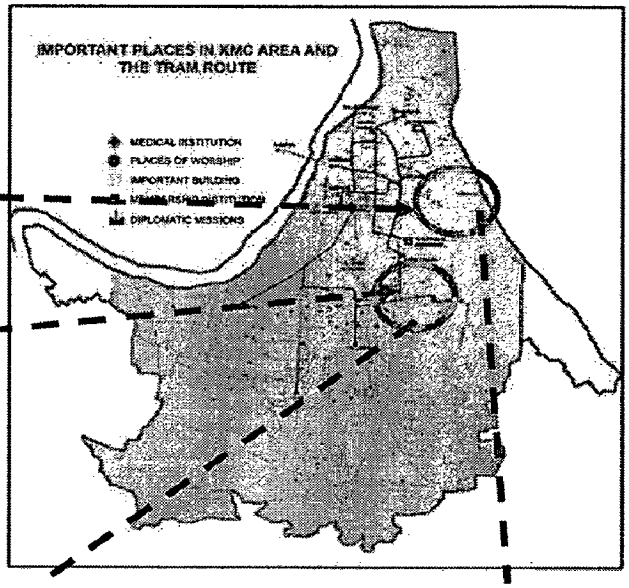


Figure 100 Tram network and important placed in KMC

Figure 102 Kalighat area

Figure 103 Esplanade, College street and Sealdah area

5.2. Criteria to select road stretches:

Three roads stretches having a length of 500 m from the selected areas mentioned earlier have been selected which are as follows:

- **College Street Road (College Street)** – Surya Sen Street & College Street Road Junction to M. G Road & College Street Road Junction

- **State Highway 1 (Sealdah)** – Maharani Sarnamoyee Road & State Highway Junction to Surya Sen Street & State Highway Junction

- **S.P Mukherjee Road (Kalighat)** – ManaharPukur Road & S.P Mukherjee Road Junction to Kali Temple Road & S.P Mukherjee Road Junction

The criteria of selecting the particular three road stretches are as follows:

1. All the three stretches are most important and busiest one.
2. All the three stretches comprises with some important places either of educational, commercial, institutional, religious or transportation.
3. All of the three stretches have high pedestrian count as well as vehicular traffic count.
4. All of them have same kind of land use pattern surrounding the stretches.
5. All of them have vibrant informal sector activity but required rearrangement.
6. Quality of road is good in all of them but the streetscape is very much unimpressive
7. All of the three stretches are suffering from lack of public amenities, pedestrian comfort, tramway architecture, parking, & public utilities
8. All of these three stretches have a better scope to improve the LOS of tramway & its integration with streetscape.

5.3. Criteria to analyze the select road stretch:

The road stretches is being further observed in detail by means of its potentiality, detail site plan, road section, the existing problems etc. the problems are identified through primary survey based on the Reconnaissance survey, user survey, traffic survey, direct observation and photo analysis. Then the problems are analyzed and the plausible solutions are proposed to solve the existing problems. Every road stretches have some existing street furnishing which is either ignored or ill-maintained which can be taken care and used in streetscape design.

The features on which the each stretch is being analyzed are as follows:

1 Site potentiality
2 Detail site plan of the selected road stretch
3 Cross section of the selected road stretch
4 Existing problems along the stretch
5 Existing street furnishing along the stretch
6 Problems analysis and the intent of solution
7 Traffic survey & its analysis

5.4. COLLEGE STREET ROAD (COLLEGE STREET):

5.4.1 Site potentiality

The site is well comprised with a number of institutional buildings as it is named as "College Para". The selected road stretch from Surya Sen road & College Street Road Junction to M G Road & College Street Road Junction is a important transport corridor. The road stretch has four oldest educational institutes beside it namely Calcutta University, Presidency College, Hare School and Hindu School and one medical institution named Calcutta Medical College & Hospital. Above all, along the total length of the road there is the biggest book market of India named College Street book market. The road has one famous square, College Square, used for the various cultural and religious programmes. The stretch has two nearest metro stations, Central Metro Station and M G Road Metro Station. The stretch is the major transport link to a good numbers of schools and colleges, markets, parks, hospitals and other important place surrounding of it. The important places in surrounding 1 km area of the selected road stretch are listed below (Table 16, Fig: 106 to 108):

Table 16 Important places surrounding 1 km area of the road stretch

Sl. Nos.	Places of importance	Total nos. of places
1	School	10
2	College	10
3	Hospital	7
4	Metro Station	2
5	Temple	5
6	Mosque	1
7	Park	4
8	Palace	1
9	Library	1
10	Post office	1
11	Police Head quarter	1
12	Bank	13
13	Hotel	4

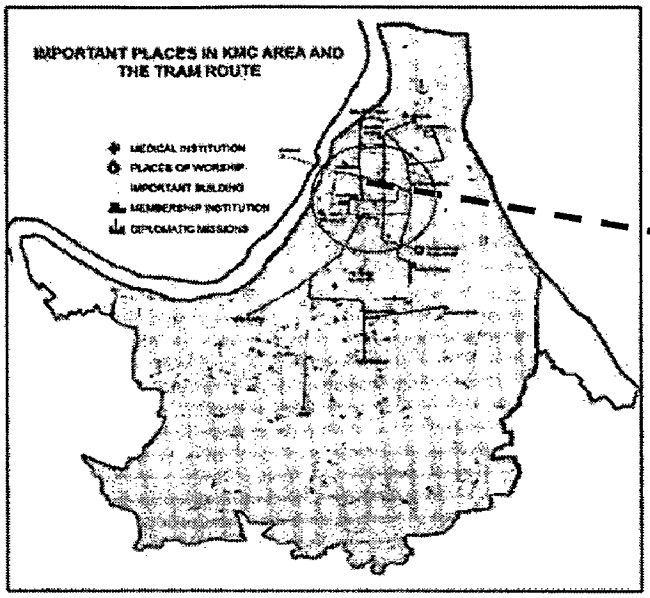


Figure 105 Important places in KMC area & tram route map

Figure 104 500m Road stretch & the surrounding 1km areas

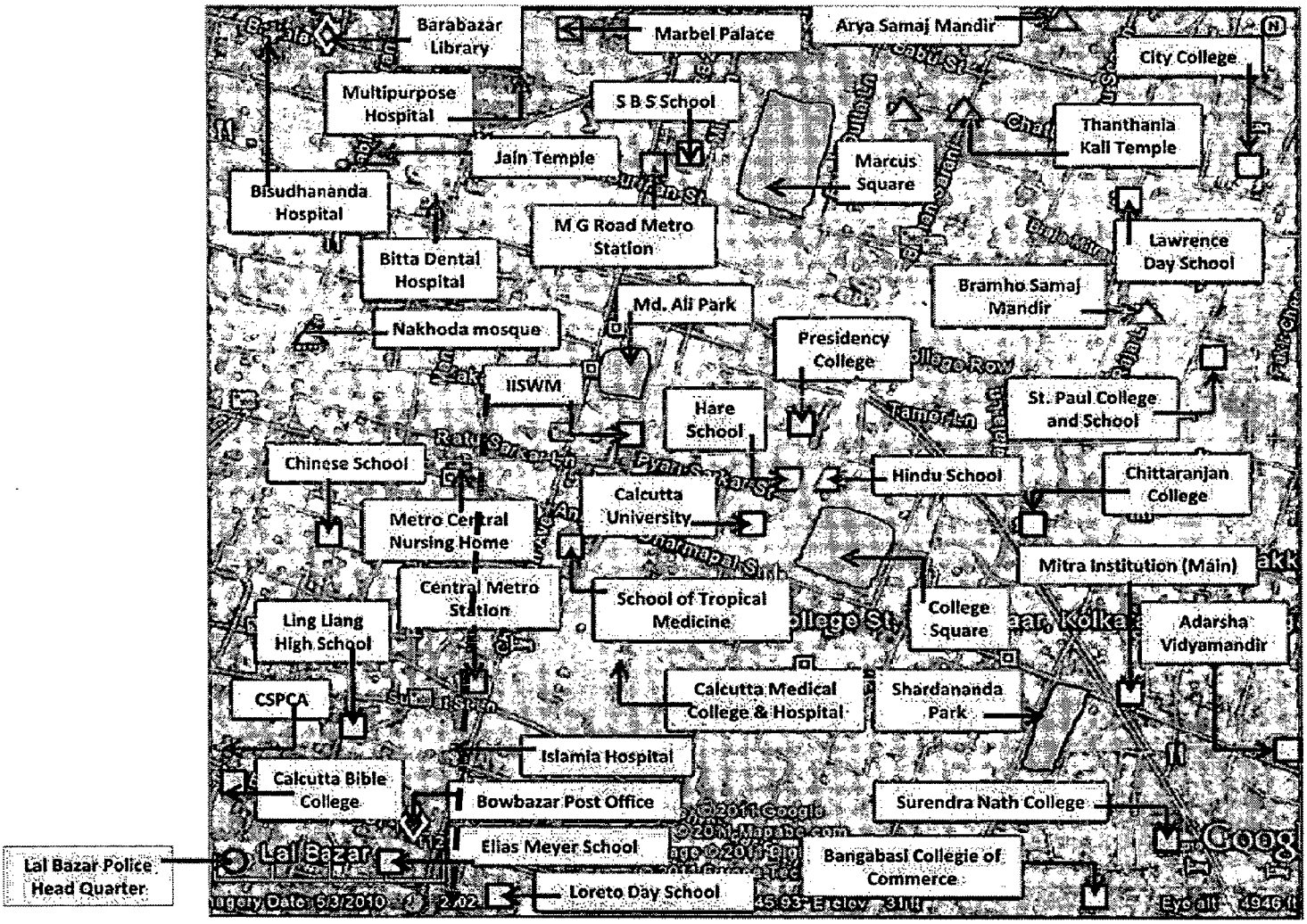


Figure 106 Important places in surrounding 1 km area of the stretch

5.4.2 Site plan of the selected road stretch

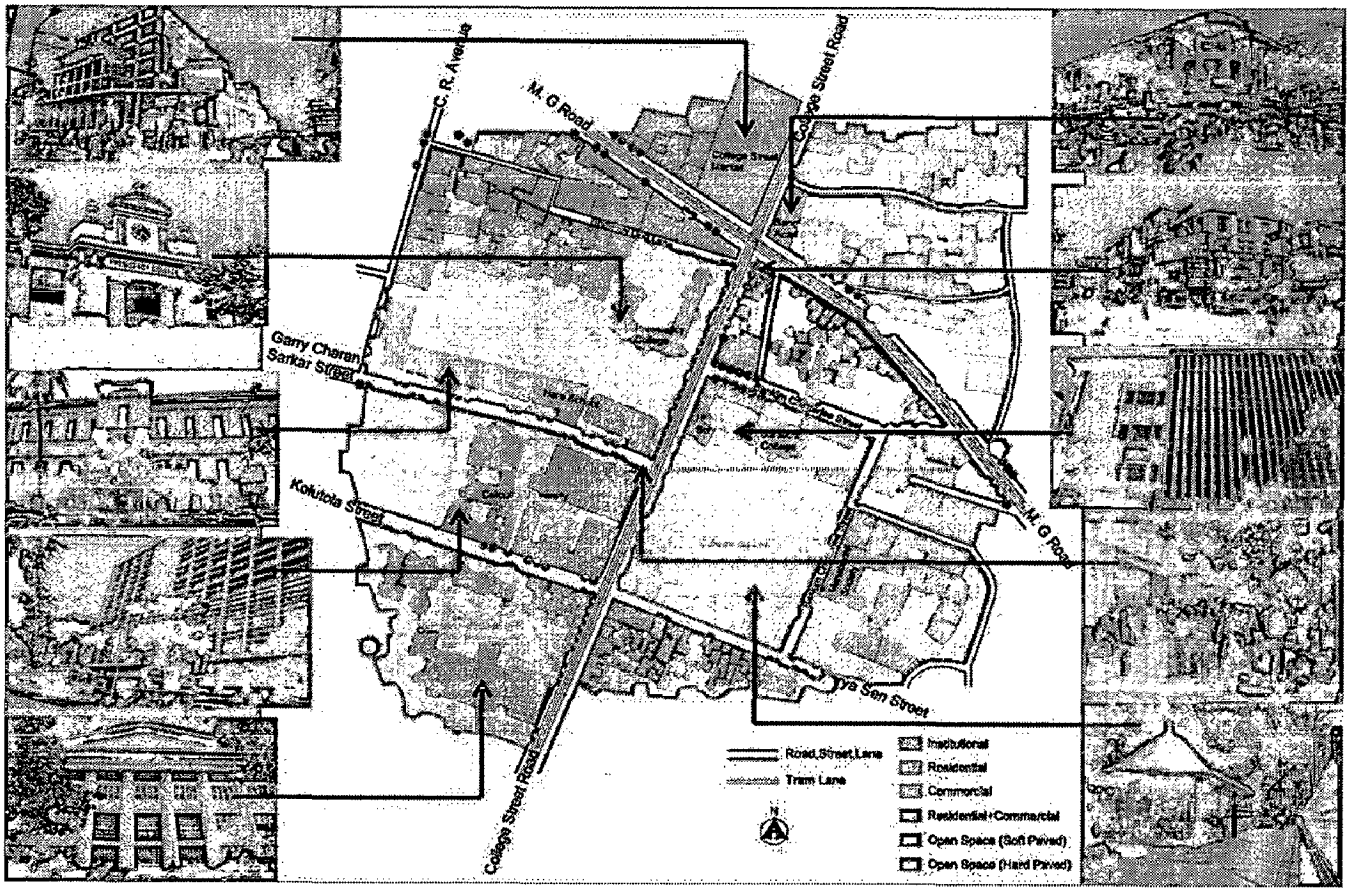


Figure 107 Site plan surrounding the road stretch

The road stretch is lined up with all the educational institutions. On the west side of the road there are Calcutta University, Hare School and Presidency College. On the east side there is Hindu School. At the south-west corner there is Calcutta Medical College and Hospital. College Street market is situated at the north-west corner of the road. At the north-east corner there is one cultural center named Bangla Sahitya Academy. At the east side of the road there is an open area named College Square. Besides these landmarks there is the book market lining thro' the whole stretch of the road (Fig: 109).

5.4.3 Cross section of the selected road stretch

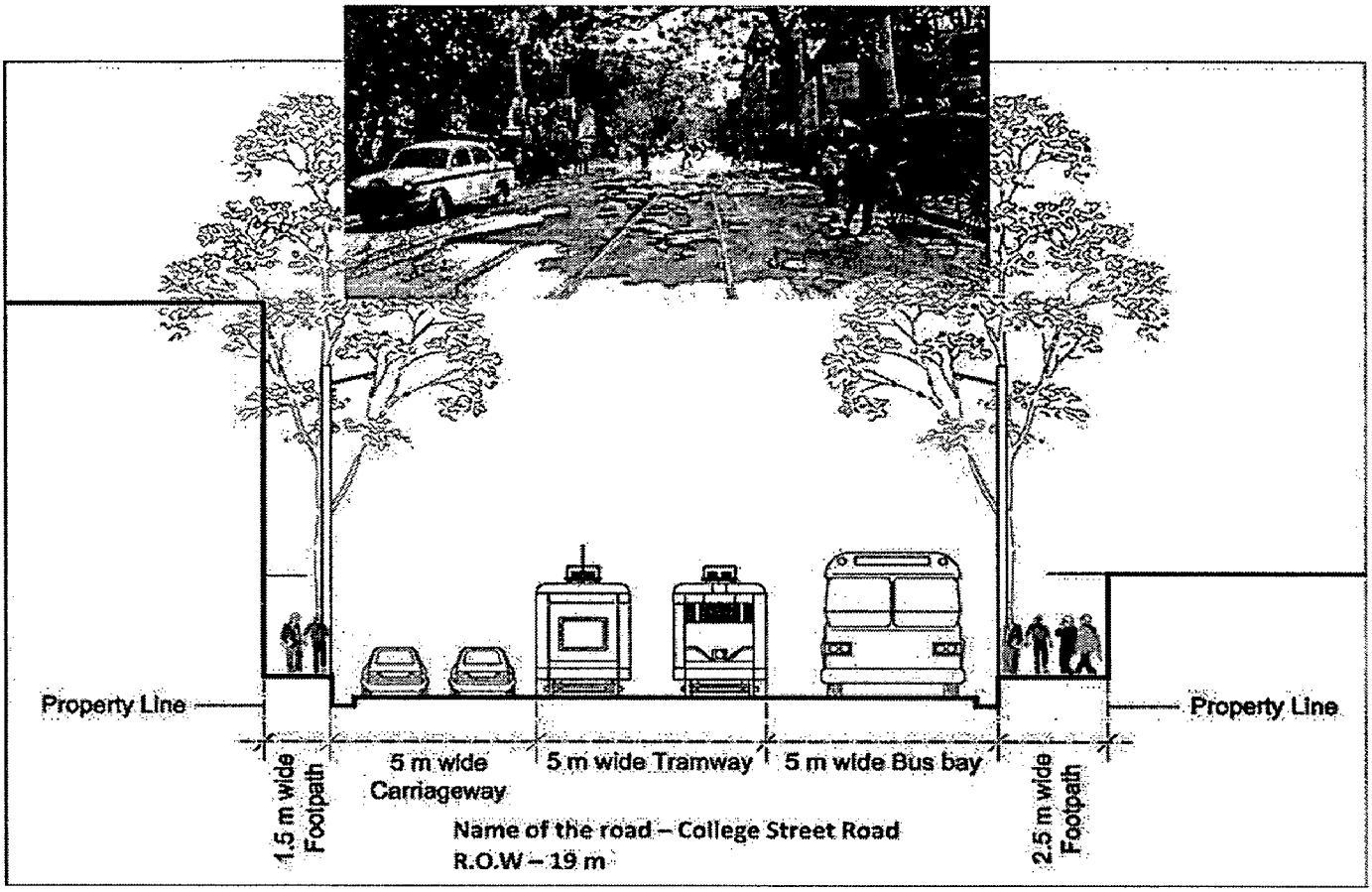


Figure 108 Cross section of the road stretch

Right of Way (ROW) of the road is 19 m. The road has the tram line running thro' the middle of the road. The road has the carriage way width of 15 m with 2m wide footpath at right side and 1.5m wide footpath at left side of the road. It is a 3 lanes undivided one way road. The bus movement is restricted into one way direction where as the other modes of public transport is running in two ways direction. Both side of the footpath is well shaded by either the building or trees. The road has the problem of water logging in the monsoon seasons though it has the drains on both sides. The footpath is narrowed down by the encroachment of the hawkers or the storage of goods by the shopkeepers which results the people to walk on the vehicular road. In some portions both sides of the footpath is being obstructed by the trees grown at middle of it. The tram stops at the middle of the road which being risky for the passengers. The bus also stops not in a particular stoppage but anywhere in between the road (Fig 110).

5.4.4 Existing problems along the stretch

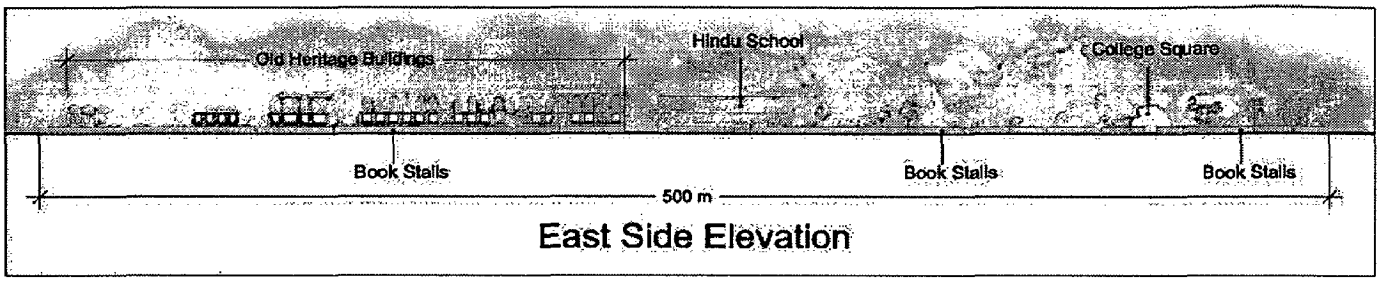
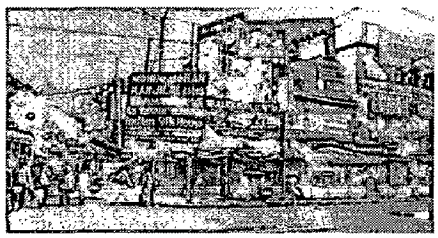


Figure 109 East side elevation of the stretch

The problems which are been identified through the survey in the east side of this road stretch are discussed in Table 17:

Table 17 Existing problems on east side of the stretch

Sl. Nos.	Problems	Visuals
1	▪ The building face is totally covered by the hording. ▪ Indiscriminate use of hording, banner creates poor visual appearance.	
2	▪ Walkable space is hardly 0.7 m. ▪ Maximum space of footpath is forcefully acquired by the shop keepers. ▪ The whole area is very much prone to fire hazard.	
3	▪ The road beside the Hindu school is very much congested due to both high vehicular & pedestrian volume. ▪ Absence of zebra crossing ▪ Narrow footpath.	

4	▪ Waiting space for the guardian of the schools surrounding it. ▪ The college square is famous for its historical & cultural background.	
5	▪ Very much congested stretch of footpath which has only 0.5 m walkable space. ▪ Having risk of pick pocket, molestation due to these unmanaged populations.	
6	▪ Inward looking book stalls make a blank façade through the road and also narrowing the footpath. ▪ Illegal on road parking consumes the half of the carriageway.	
7	▪ A good number of signage helps the tourist to move around the area. ▪ Unorganized vehicle stoppage, pedestrian movement along this certain stretch of the road	
8	▪ A comparatively well maintained road. ▪ Problem of mix traffic including the hand pulled rickshaw on the vehicular road. ▪ Lack of pedestrian crossing though the pedestrian count is very high through the whole day.	

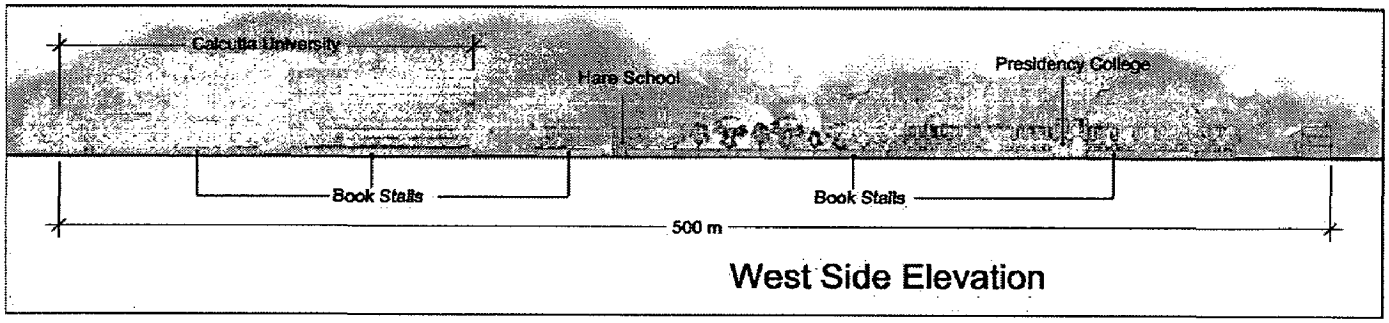
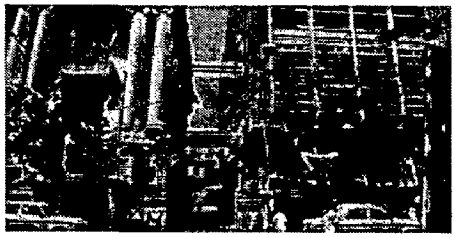
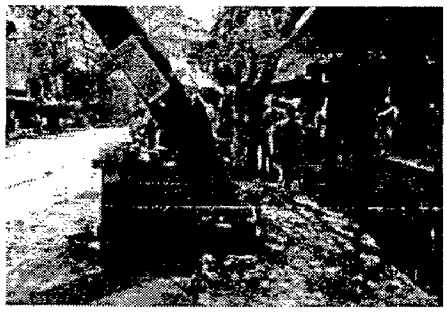


Figure 110 West side elevation of the stretch

The problems which are been identified through the survey in the west side of this road stretch are discussed in Table 18:

Table 18 Existing problems on the west side of the stretch

Sl. Nos.	Problems	Visuals
1	▪ Unauthorized book stalls up to the middle of footpath. ▪ Goods stored on the footpath. ▪ Unclean footpath.	
2	▪ Well maintained vehicular road. ▪ The biggest book market of India is stretched over both sides of this road.	
3	▪ Only tram has double way movement thro this road whereas the bus goes on single way. ▪ A good number of passengers are carried by tram on both peak & lean hours.	
4	▪ The buildings with colonial architecture with the dense plantation on both sides of the road are feast of eyes. ▪ People prefer to have a leisure walk on this road at night.	

5	▪ Visually highly contradiction between old and new building architecture. ▪ The 154 yrs old university is losing its visual charm due to the bookstalls, extensive use of banners, advertisements outside of this building.	
6	▪ People have to ride on the running tram due to the non existence of exact tram stop. ▪ For the above reason some time, especially in peak hours the other traffic got affected.	
7	▪ The maximum space of the narrow footpath (1.5 m) is taken by the shop keepers and the rest of the space is hardly enough for two persons to walk side by side.	
8	▪ The food stall is right on the vehicular road. ▪ Storage, trees and lamp post at middle of footpath make it narrower than the actual.	

5.4.5 Existing street furnishing along the stretch

The following photographs are showing the available street furnishing which is very much neglected but they can be conserved or even copied in new constructions. These features are well in harmony with the existing building architecture of this area. All of these features belong to the British era. But still these can be merged with the modern architecture and the streetscape design (Fig: 113). The existing street furnishing elements are shown below:

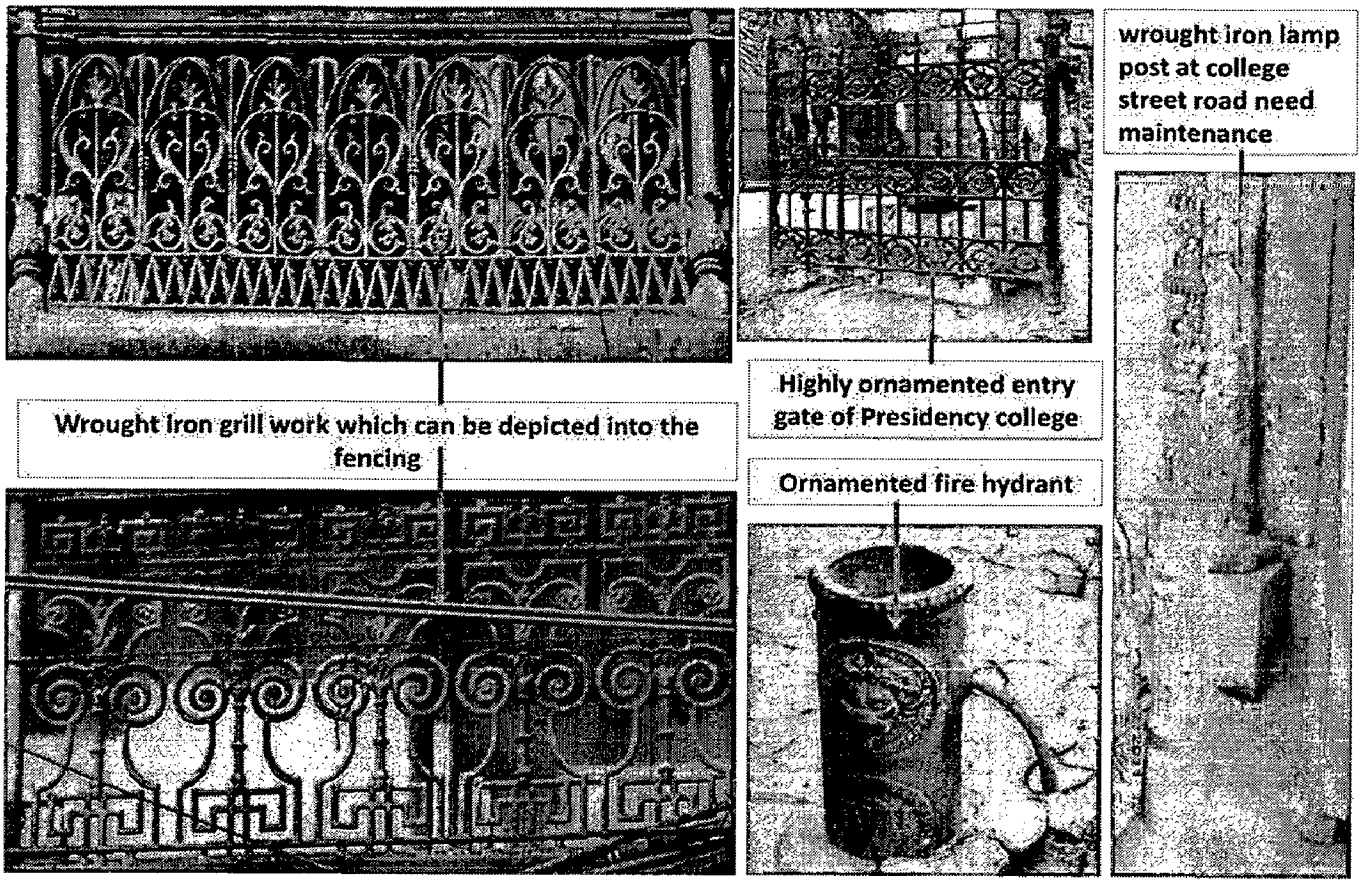


Figure 111 Existing street furnishing along the stretch

5.4.6 Problem analysis and the intent of solution

The existing problems have been observed and it is being analyzed to get the solutions. The problems are further categorized into broad head headings and summarized. The categories or components for analysis are as follows:

1. Road condition
2. Parking
3. Pedestrian sidewalks
4. Activity pattern
5. Building architecture
6. Landmarks
7. Public amenities
8. Utilities
9. Informal sector
10. Street furnishing

The following figure is showing the matrix of street environment quality and the requirement or proposals for improving the quality or eradicates the problems. The matrix is showing the correlation between the problems intensity and the proposals needed. From this matrix we can easily understand the present condition of that street and then the proposal can be prepared as per the requirements (Fig: 114).

Sl. Nos.	components	Quality				Requirements/proposal				
		Very Good	Good	Un-satisfactory	Bad	Conserve	Improve	Renew	Remove	Construct /add
1	Road condition									
2	Parking									
3	Pedestrian sidewalks									
4	Activity pattern									
5	Building architecture									
6	Landmarks									
7	Public amenities									
8	Utilities									
9	Informal sector									
10	Street furnishing									

Figure 112 Street environment quality Vs proposal matrix

After analyzing the problems on the both side of the road stretches it is now easy to summarize those problems. This will help to understand the nature of problems and their intensity and also to identify the common problems existed on both sides of the road stretch. From the analysis it is found that the problems on both sides of the road are same in nature so it is possible to find out a common solution. The problems are grouped together and the possible recommendations are given for those problems. Table 19 shows the summarization of problems, their analysis and the intent of solutions.

Table 19 Summarization of problems, their analysis and the intent of solution

Sl. Nos.	Components	Observation	Intent of solution
1	Road condition	• Overall stretch is quite in good condition • Regular maintenance is taken place	• Emphasis can be given on traffic management. • Stress on the traffic calming measures.
2	Parking	• On road illegal parking • Creating traffic jam in peak hours • Increase the nos. of accidents	• Adequate, multiple and flexible parking solutions need to be worked out. • Strict on removing illegal parking.
3	Pedestrian sidewalks	• Lack of cross walks, pedestrian signals at crossing, street furniture & street lighting. • Footpath thro' the whole stretch is totally unfriendly for walking due to the heavy congestion • Unhealthy condition due to the food vendors • Absence of pedestrian comfort & security	• This space need to be designed for physiological and psychological comfort of the pedestrian with adequate shade, diverse plantations, comfortable street furniture and lighting. • In addition adequate traffic calming strategies with installation of pedestrian signals at crossings need to be incorporated.
4	Activity pattern	• This is a total educational stretch along with the book market. • Always busy with the customers among which maximum are the students. • High pedestrian count on holidays.	• Priority should be given to mix land use development instead of totally commercial developments. • Pedestrian should always be given priority at school time. • Proposal to reduce the vehicular traffic by bypassing them thro' another road.

5	Building Architecture	• Both sides of the road comprised with a good number of heritage buildings. • The building facades are badly covered up by the posters, banners, hording etc. • Visual contradiction between old and new building architecture. • Entries are often blocked by the book stalls	• New structure should be in harmony with the old ones. • Proposals for conserving the old heritage buildings. • The advertisement should be in such a manner which will balance the ambiance. • All the building entries should be prominent and make them impressive.
6	Landmarks	• Four educational buildings & one hospital are the main landmarks of this stretch. • The book market is also a famous commercial landmark • The college square itself a cultural landmark. • It has a major crossing named M G road & college street road crossing.	• All the landmark details should be well documented & make it available for the tourist to create interest. • If required then proposals for modifying the building bye-laws for the new construction & to conserve the old structures can be given. • Proposals for getting benefit out of these landmarks can be given
7	Public amenities	• Lack public toilets, information kiosks, seating in the public realm • Less number of ATMs & public telephones • Non adequate lighting make the public realm unfriendly to people.	• Planning for introduction of better public amenities at proper location. • These have to be established as non negotiable features of the street. • Make the maximum commercial use of available resources.

8	Utilities	• There is also no proper garbage disposal system or storm water drains. • Utilities are randomly located on the setback spaces and on the sidewalks. • Electric posts, HT pylons and transformers are located right on the footpath.	• The overhead HT lines are the single most disturbing feature in the visual landscape of the street, the city will have to invest in laying these underground. • A proper garbage recycling program needs to be introduced by the municipality.
9	Informal sector	• Encroachments in the left over spaces, vacant land by hawkers and vendors are a common sight. • Vibrant informal sector activity. • Scattered location creates nuisance. • Due to absence of service lanes to serve the Industries, loading & unloading happens right on the streets.	• Spaces to accommodate an orderly organization of informal sector commercial activities. • Plazas can also incorporate stalls and kiosks to cater to this sector and also liven up the public realm. • Proper loading unloading system without hampering the main traffic flow
10	Street furnishing	• Lack of sitting space, proper signage • The fencing is not matching with the surrounding architecture. • The natural trees cater shades to the road thus it soothing in summer time. • Indiscriminate use of banner, poster creating poor visual appearance.	• Provision of adequate sitting spaces. • Proper signage having the details of road, building, landmarks etc. • Stress on diverse plantation to break monotony • Managed use of advertisement hording, banners to create a pleasant streetscape.

5.4.7 Traffic survey and its analysis

5.4.7.1 Traffic survey

The traffic was done to understand the traffic pattern, traffic volume, and the impact of traffic count on the local area or activities. The traffic survey is also required to analyze the activity pattern and the future scope for developing the area as per the traffic intensity and the traffic pattern. Traffic survey gives an idea whether the surrounding area is efficiently planned to get the full benefit out of the existing traffic corridor and if it is not then the plausible policies can be evolved to change the land use pattern to maximize the benefit. From the traffic survey it also can be understand whether it is possible to divert the traffic to another road if the road is suffering from heavy traffic volume at peak hours.

Thus the traffic survey was carried on during 4 time intervals. In the morning session (8.00 – 9.00 AM), noon session (12.00 – 1.00 PM), evening session (5.00 – 6.00 PM) and the night session (8.00 – 9.00 PM). It helps to understand the traffic flow and pattern in various time of the day. The result of the traffic survey is given below (Table 20 and 21, Fig: 115).

Table 20 Categorized traffic count in different time interval

Time interval	Traffic count/% over total nos. of vehicle/Equivalent PCU Factors									
	Fast moving vehicle					Slow moving vehicle			Cycle	Pedestrian
	Tram	Bus	Taxi	4 wheeler	2 wheeler	Auto Rickshaw	Mini van	Rickshaw	Cycle	Pedestrian
8.00 – 9.00 AM	10 (2%) 40	53 (9%) 116.6	205 (32%) 205	91 (15%) 91	96 (16%) 48	103 (17%) 123.6	12 (2%) 16.8	20 (3%) 40	23 (4%) 9.2	305
12.00– 1.00 PM	8 (2%) 32	32 (8%) 70.4	102 (25%) 102	58 (14%) 58	44 (11%) 22	70 (17%) 84	18 (4%) 25.2	44 (11%) 88	34 (8%) 13.6	200
5.00 – 6.00 PM	9 (2%) 36	55 (9%) 121	195 (34%) 195	95 (16%) 95	89 (15%) 44.5	95 (16%) 114	8 (1%) 11.2	18 (3%) 36	21 (4%) 8.4	289
8.00 – 9.00 PM	7 (2%) 28	42 (9%) 92.4	110 (24%) 110	60 (13%) 60	67 (15%) 33.5	73 (16%) 87.6	30 (6%) 42	41 (9%) 82	30 (6%) 12	165

Table 21 Total traffic count in different time interval

Time interval	Traffic count/Equivalent PCU Factors				
	Fast moving vehicle	Slow moving vehicle	Cycle	Total	pedestrian
8.00 – 9.00 AM	455 (500.6)	135 (180.4)	23 (9.2)	613 (690.2)	305
12.00 – 1.00 PM	244 (284.4)	132 (197.2)	34(13.6)	410 (495.2)	200
5.00 – 6.00 PM	443 (491.5)	121 (161.2)	21 (8.4)	585 (661.1)	289
8.00 – 9.00 PM	286 (323.9)	144 (211.6)	30 (12)	460 (547.5)	165

5.4.7.2 Survey analysis

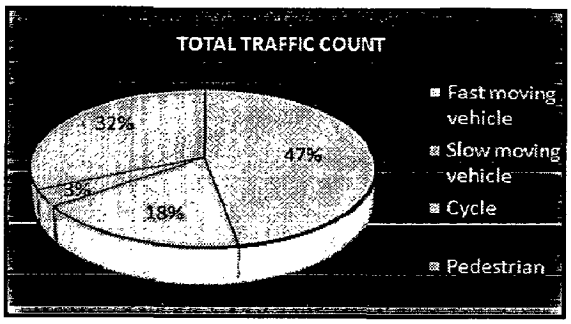


Figure 113 Transportation modal split in the stretch

1. Tram accounts 2% over the total fast moving vehicular traffic.
2. Vehicular traffic volume is doubled in peak hours from the lean hours.
3. Fast moving vehicular traffic accounts 47% over the total traffic volume.
4. Among the total fast moving vehicular traffic taxi 29%, 4-wheeler accounts 15%, 2-wheeler 14% & whereas bus accounts only 9%.
5. The fast moving vehicle traffic volume is doubled in peak hours from lean hours.
6. Considerable nos. of slow moving traffic (18%) causes the reduction of on road speed.
7. The stretch is suffering from the rapid increase of auto rickshaw as it has 17% share on total traffic count and its unmanageable parking problems.
8. Pedestrian traffic accounts 32% over the total traffic volume.
9. As the pedestrian traffic is high in the morning time so priority should be given to them.
10. Design Service Volume is 598.5 which is very low from the recommended value i.e. 2900 for 3 lanes undivided (one way), still it suffers traffic congestion. So it is the question of efficient traffic management.
11. Proposal to increase the tram service as it has such kind of potentiality.
12. Proper routing of vehicular traffic and signal prioritization are very much needed to control over the traffic jam.
13. Proposal for by passing of slow moving traffic to another road which will increase the average on road speed of the fast moving traffic.

5.5. STATE HIGHWAY 1 (SEALDAH):

5.5.1 Site potentiality

The site is very much known for its importance as a main transportation corridor. It is one of the busiest roads in KMC area. The stretch is the main link to the Sealdah rail terminus. There is one of the main ESI hospitals i.e. Sealdah ESI hospitals beside this road. This stretch is also the major transport link to a good numbers of schools and colleges, markets, parks, hospitals and other important place surrounding of it. The important places in surrounding 1 km area of the selected road stretch are listed below (Table 22, Fig: 116 to 118):

Table 22Important places surrounding 1 km area of the road stretch

Sl. Nos.	Places of importance	Total nos. of places
1	School	8
2	College	6
3	Hospital	5
4	Rail Station	1
5	Church	2
6	Park	1
7	Palace	1
8	Market	1
9	Bank	2
10	Hotel	2

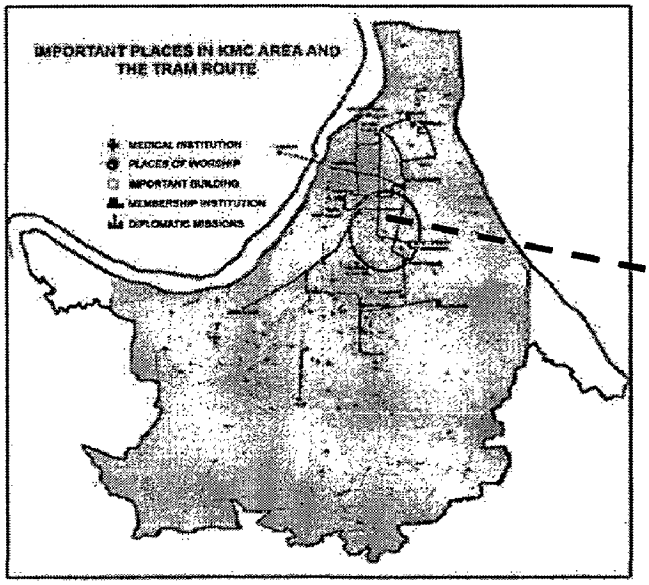


Figure 115 Important places in KMC area & tram route map

Figure 114 500m Road stretch & the surrounding 1km areas

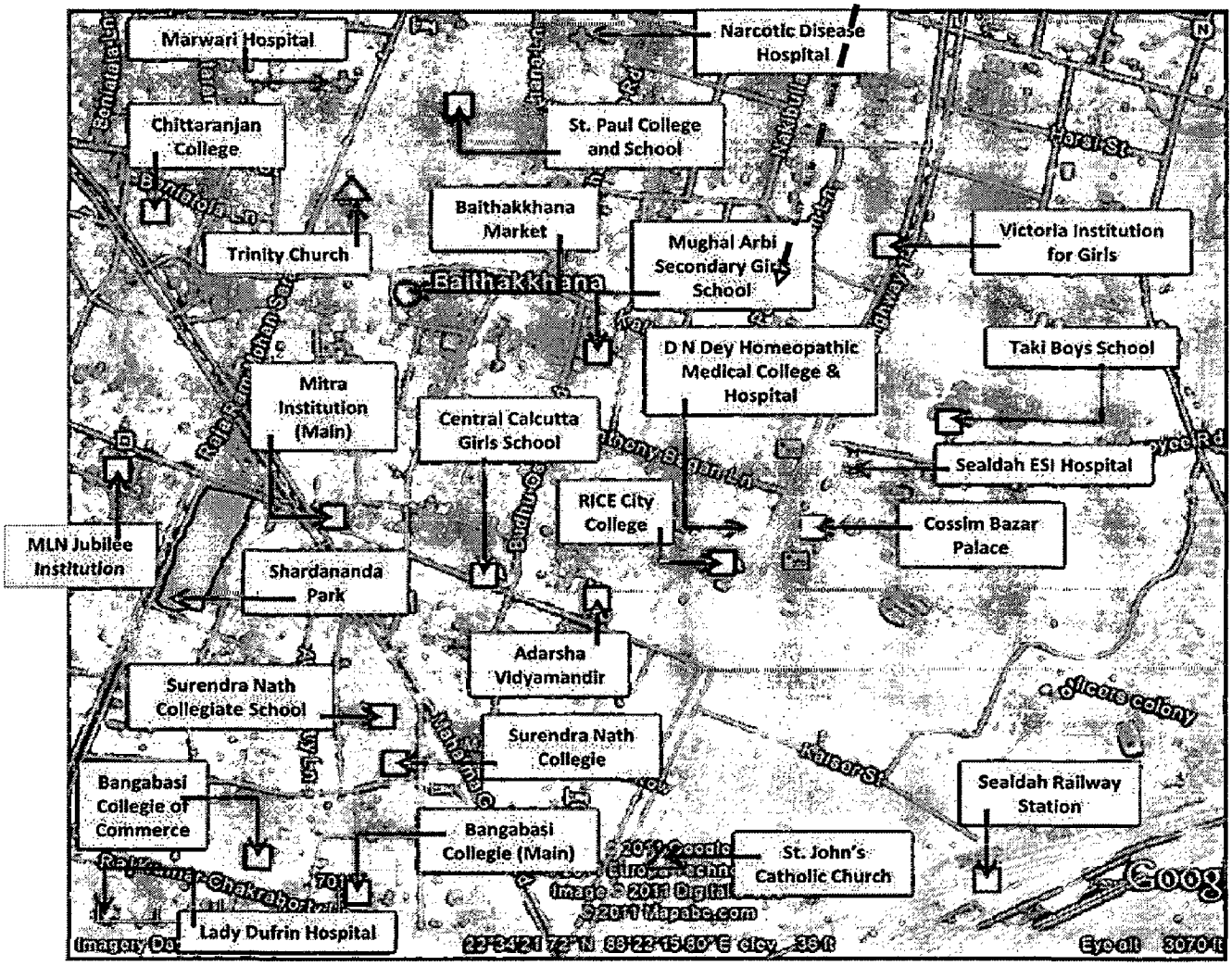


Figure 116Important places in surrounding 1 km area of the stretch

5.5.2 Site plan of the selected road stretch

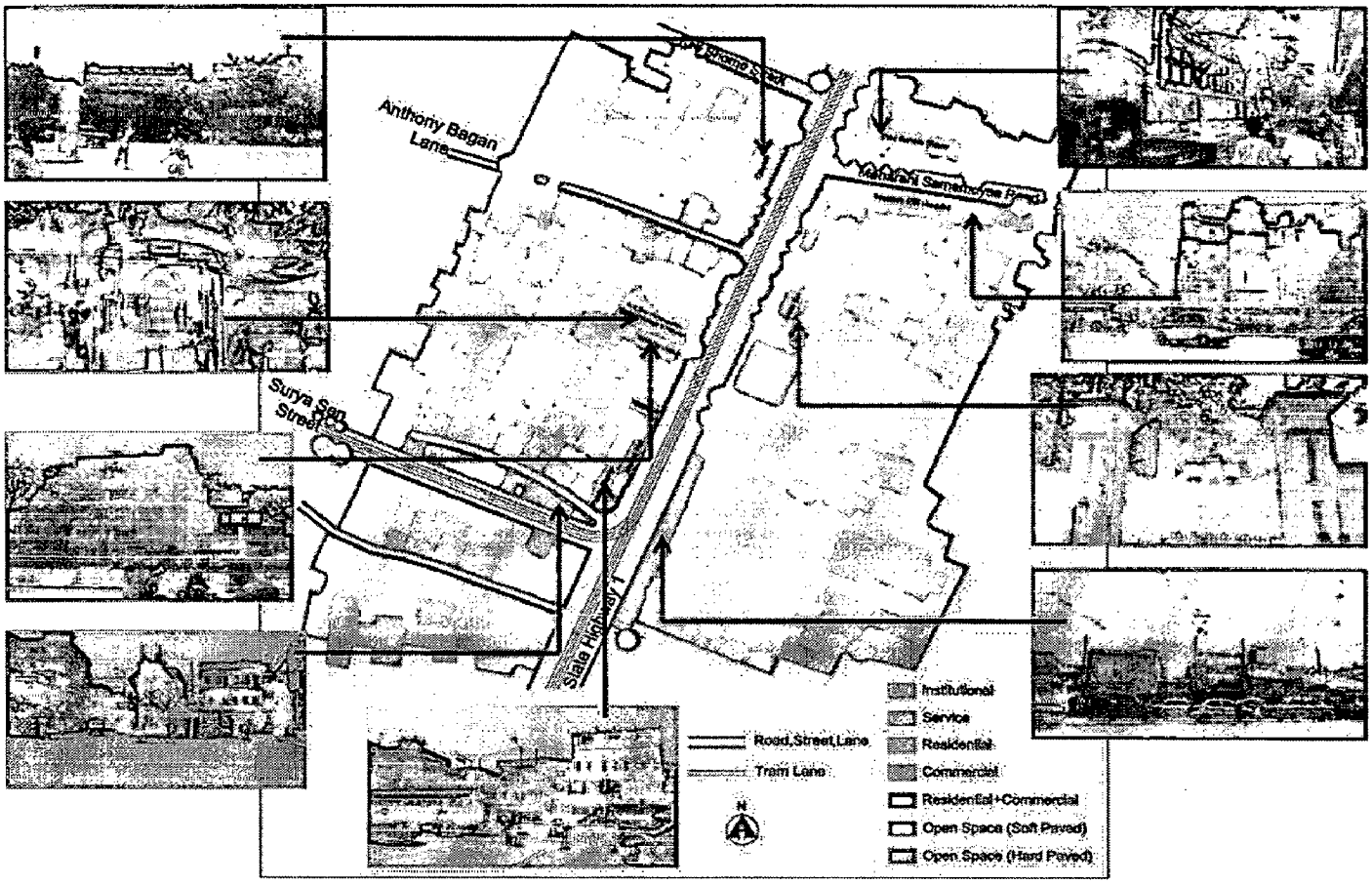


Figure 117Site plan surrounding the road stretch

The road stretch is lined up with maximum residential buildings which have commercial activity at the ground floor. The ESI hospital is on the north-east corner which is the main landmark of this area. Sealdah railway station is on the south-east corner. On west side there is another hospital named D.N Dey homoeopathic medical college and hospital. One important boy's school named Taki Boys School is on the east side. The stretch has a vibrant informal sector activity lined up thro' the whole stretch of the road. There is also a palace named Cossimbazar palace on the east side of the road (Fig: 119).

5.5.3 Cross section of the selected road stretch

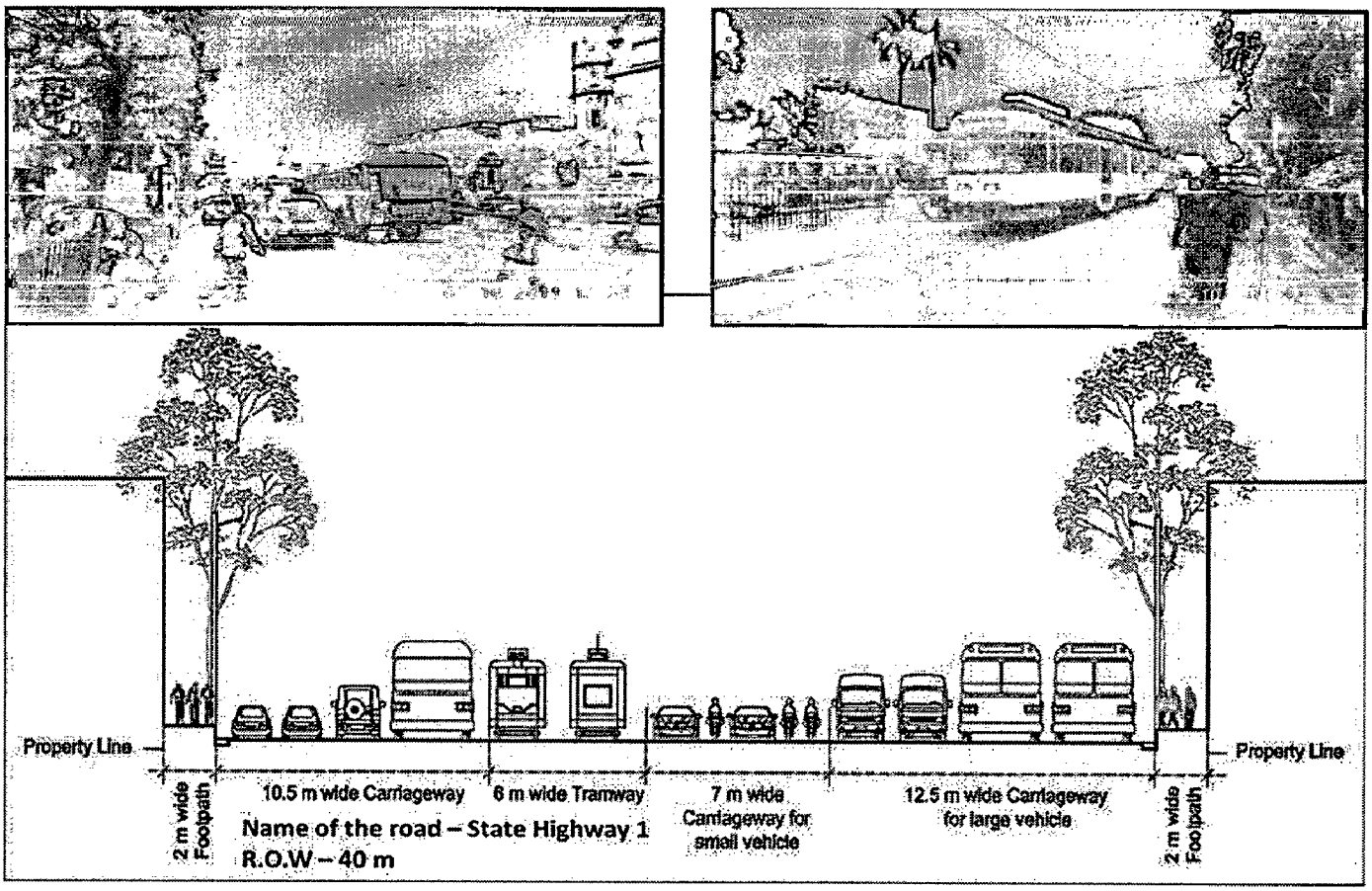


Figure 118 Cross section of the road stretch

It is one of the important and busiest roads in KMC area. Right of Way (ROW) of the road is 40 m. The road has the undivided two way traffic movements. The left side carriageway is 3m less wide than the right side carriageway. The tram lines are running thro' the left side of the road. The road has the carriageway width of 36 m with 2m wide footpath on both side of the road. It is a 6 lanes undivided two way road. The road has a clear traffic division. On the right side it has 7 m wide carriageway for the small vehicle and the rest of the road i.e. 12.5 m is reserved for the large vehicle. The divisions are made by fencing. People are restricted to cross the main road except the Zebra crossing. Due to the poor traffic management road accidents are happened very often on this busy road (Fig: 120).

5.5.4 Exsting problems along the stretch

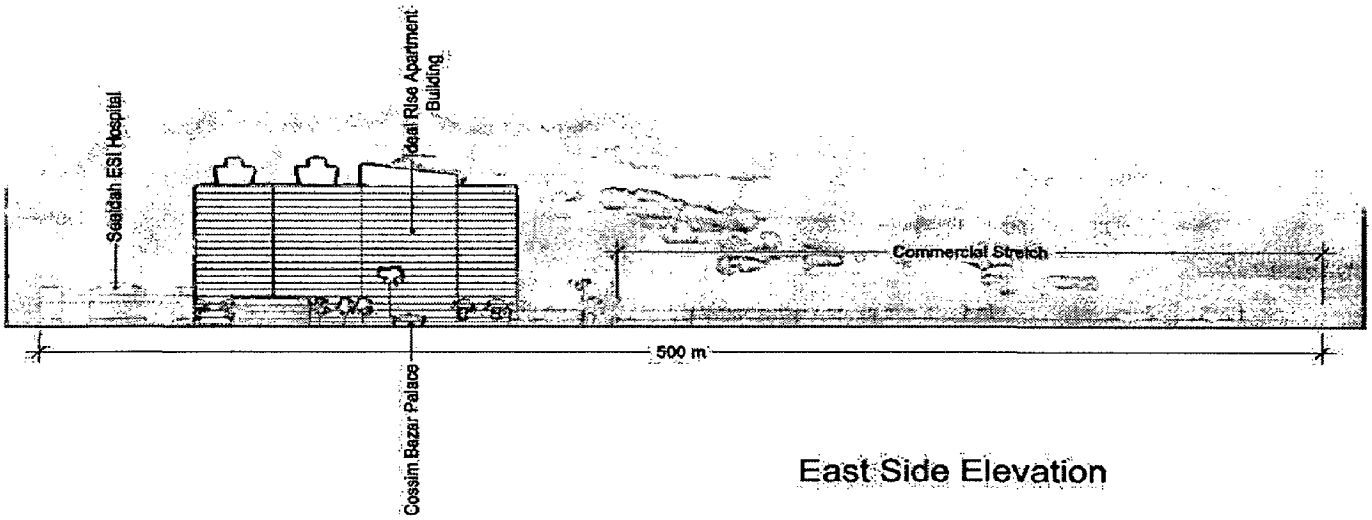


Figure 119 East side elevation of the stretch

The problems which are been identified through the survey in the east side of this road stretch are discussed in Table 23:

Table 23 Existing problems on east side of the stretch

Sl. Nos.	Problems	Visuals
1	• Lack of footpath force the people to walk on the road • Footpath along the school is not being used by the public.	
2	• Unauthorized structure at middle of footpath makes it inaccessible for the people. • Poor maintenance of the fencing.	
3	• Footpath is totally encroached by the shop keepers. • No street light along the footpath.	

4	• Poor display of advertisement causes bad streetscape. • Lack of zebra crossing. • Old & hazardous buildings which required maintenance.	
5	• Visual contradiction between new and old developments • Uncontrolled developments along the road	
6	• Mixed traffic movement. • No provision of bus stop. • Encroachment of the footpath by the shop keepers. • People are forced to walk on the vehicular road.	
7	• High pedestrian count on the working hours. • No waiting place for the disabled & the old people. • Lack of proper maintenance of the street.	
8	• Lack of strict Govt. action leads to the encroachment of the road as well as footpath. • People have to pass by the filthy squatter developments. • Lack of security.	

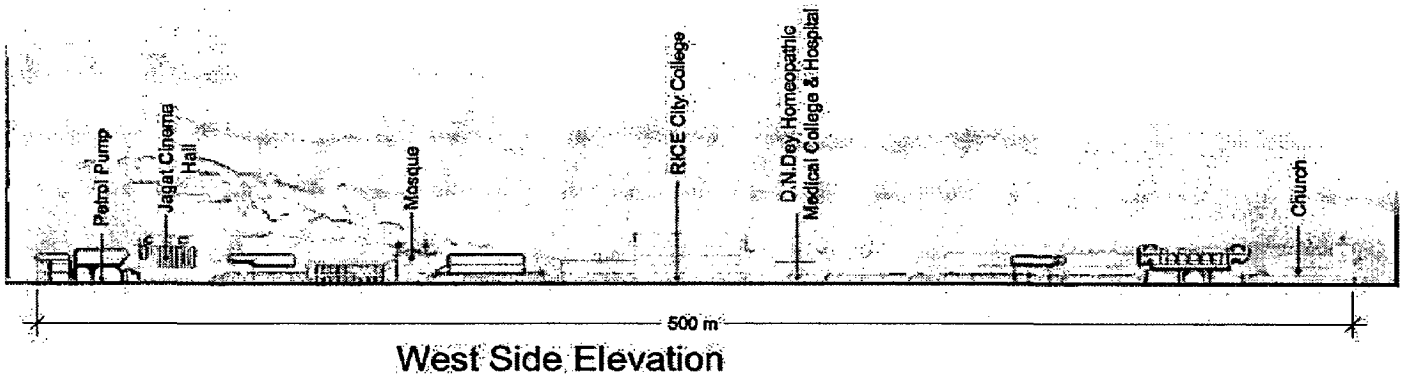
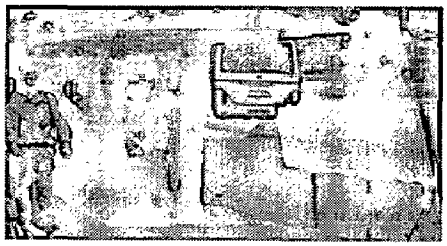
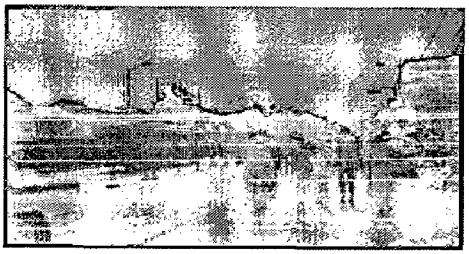


Figure 120West side elevation of the stretch

The problems which are been identified through the survey in the west side of this road stretch are discussed in Table 24:

Table 24 Existing problems on the west side of the stretch

Sl. Nos.	Problems	Visuals
1	• Traffic police kiosk at the middle of the road. • People waiting at the traffic kiosk make it impossible for the police to control traffic. • No control on pedestrian crossing.	
2	• A well maintained stretch of the road. • Tram routes, bus routes & 4-wheeler carriagewayare separatedby fencing. • Strict restriction on pedestrian crossing in between the road through the fencing.	
3	• 3 m wide footpath but the usable space is only 1.5 to 2 m. • The poor people & beggars have started to live right on the footpath. • Often causes the security problems.	

4	• Vibrant informal sector activities thro' the whole stretch of the road. • Lack of proper management of this sector often creates nuisance for the people.	
5	• The bus stand has no provision for the disabled and the old persons. • Road side news paper cum notice board helps people to pass the time and get informed about some important notices.	
6	• Unimpressive entry for the hospital. • Lack of proper signage, street light & security. • The entry is often blocked by the hand-pulled rickshaws.	
7	• Illegal parking, storing of goods on the road reduces the effective carriageway width. • Narrow footpath makes people bound to walk on the vehicular road. • Low density development fails to extract the full benefit from this busy and important road from the commercial point of view.	

5.5.5 Exsting street furnishing along the stretch

The following photographs are showing the available street furnishing which is very much neglected but they can be conserved or even copied in new constructions. These features are well in harmony with the existing building architecture of this area. All of these features belong to the British era. But still these can be merged with the modern architecture and the streetscape design. Though this stretch is not comprised with a good number of design elements like the other two stretches but still it has some kind of potentiality to revive the

street environment by using the existing elements (Fig: 123). The existing street furnishing elements are shown below:

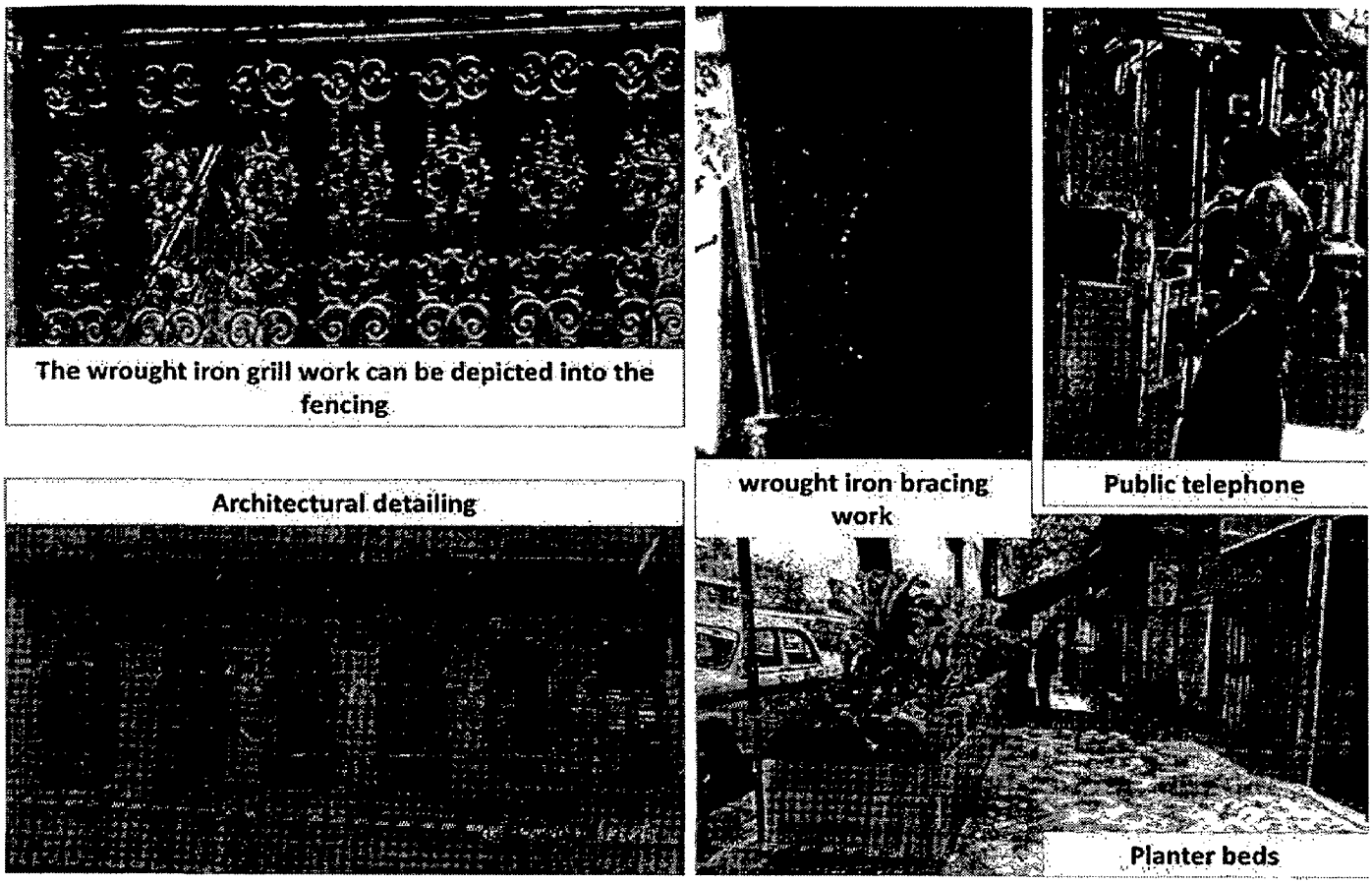


Figure 121 Existing street furnishing along the stretch

5.5.6 Problems analysis and the intent of solution

Problems have been observed and it is being analyzed to get the solutions. The problems are further categorized into broad head headings and summarized. The categories or components for analysis are as follows:

1. Road condition
2. Parking
3. Pedestrian sidewalks
4. Activity pattern
5. Building architecture
6. Landmarks
7. Public amenities
8. Utilities
9. Informal sector
10. Street furnishing

The following figure is showing the matrix of street environment quality and the requirement or proposals for improving the quality or eradicates the problems. The matrix is showing the correlation between the problems intensity and the proposals needed. From this matrix we

can easily understand the present condition of that street and then the proposal can be prepared as per the requirements (Fig: 124).

Sl. Nos	components	Quality				Requirements/proposal				
		Very Good	Good	Un-satisfactory	Bad	Conserve	Improve	Renew	Remove	Construct /add
1	Road condition									
2	Parking									
3	Pedestrian sidewalks									
4	Activity pattern									
5	Building architecture									
6	Landmarks									
7	Public amenities									
8	Utilities									
9	Informal sector									
10	Street furnishing									

Figure 122 Street environment quality Vs proposal matrix

After analyzing the problems on the both side of the road stretches it is now easy to summarize those problems. This will help to understand the nature of problems and their intensity and also to identify the common problems existed on both sides of the road stretch. From the analysis it is found that the problems on both sides of the road are quite different in nature so it is obvious to find out the solution for each of the problem and if there are some common problems then the common design guidelines can be applied to both. The problems are grouped together and the possible recommendations are given for those problems. Table 25 shows the summarization of problems, their analysis and the intent of solutions.

Table 25Summarization of problems, their analysis and the intent of solution

Sl. Nos.	Components	Observation	Intent of solution
1	Road condition	• Main vehicular stretch is quite in good condition • Regular maintenance is taken place • Separation of vehicular traffic	• Traffic management & traffic calming measures are very badly needed.
2	Parking	• Both sides of the road have illegal on road parking. • Repairing of damaged vehicles is also done right on the main vehicular road.	• Adequate, multiple and flexible parking solutions need to be worked out. • Strict on removing illegal parking.
3	Pedestrian sidewalks	• Lack of cross walks, pedestrian signals at crossing, street furniture & street lighting. • Hospital side footpath is totally blocked by the squatter development. • Strict in cross walking in between the road. • A footbridge is required by the people.	• This space need to be designed for physiological and psychological comfort of the pedestrian with adequate shade, diverse plantations, comfortable street furniture and lighting. • Total eviction of the squatter development. • Proposal of footbridge can be given after feasibility analysis
4	Activity pattern	• Highly busy and most important road. • High traffic count due to the presence of hospital and rail station. • Predominantly commercial area. • Intense pedestrian volume on	• Priority should be given to mix land use development instead of totally commercial developments. • To manage pedestrian volume to avoid the spillover on the road.

		the day of release of new movie because of the presence of two cinema halls.	
5	Building Architecture	• No prominent architectural style. • Visual contradiction between new and old buildings. • Low density development besides the road. • Building facades are not such impressive.	• New structure should be in harmony with the old ones. • Proposal for compact development to get the full use of such a important road. • Proposal for the beautification of the building facades
6	Landmarks	• Sealdah railway station and the ESI hospital are the main landmarks. • Within 500 m distance there are 6 famous colleges, 8 schools & 2 churches. • Two important markets are also within 300 m distance.	• All the landmark details should be well documented & make it available for the tourist to create interest. • Proposals for getting benefit out of these landmarks can be given
7	Public amenities	• Lack public toilets, information kiosks, seating in the public realm • Less number of ATMs & public telephones • Non adequate lighting make the public realm unfriendly to people. • High risk of security due to the squatter development. • Lack of parks or open spaces.	• Planning for introduction of better public amenities at proper location. • Make the maximum commercial use of available resources. • To maximize the security by designing the road itself.
8	Utilities	• There is also no proper garbage disposal system or storm water drains.	• The overhead HT lines are the single most disturbing feature in the visual landscape of the

		• Utilities are randomly located on the setback spaces and on the sidewalks. • Electric posts, HT pylons and transformers are located right on the footpath. • Lack of running water taps. • Filthy and unhealthy condition.	street, the city will have to invest in laying these underground. • A proper garbage recycling program needs to be introduced by the municipality. • Proposal for better arrangement of the public utilities.
9	Informal sector	• Encroachments in the left over spaces, vacant land by hawkers and vendors are a common sight. • Vibrant informal sector activity. • Scattered location creates nuisance. • Due to absence of service lanes to serve the Industries, loading & unloading happens on the streets.	• Spaces to accommodate an orderly organization of informal sector commercial activities. • Plazas can also incorporate stalls and kiosks to cater to this sector and also liven up the public realm. • Proper loading unloading system without hampering main traffic flow
10	Street furnishing	• Lack of sitting space, proper signage • The natural trees cater shades to the road thus it soothing in summer time. • Indiscriminate use of banner, poster creating poor visual appearance.	• Provision of adequate sitting spaces. • Proper signage having the details of road, building, landmarks etc. • High stress on better streetscape design. • Managed use of advertisement hording, banners to create a pleasant streetscape.

5.5.7 Traffic survey and its analysis

5.5.7.1 Traffic survey

The traffic was done to understand the traffic pattern, traffic volume, and the impact of traffic count on the local area or activities. The traffic survey is also required to analyze the activity pattern and the future scope for developing the area as per the traffic intensity and the traffic pattern. Traffic survey gives an idea whether the surrounding area is efficiently planned to get the full benefit out of the existing traffic corridor and if it is not then the plausible policies can be evolved to change the land use pattern to maximize the benefit. From the traffic survey it also can be understand whether it is possible to divert the traffic to another road if the road is suffering from heavy traffic volume at peak hours.

Thus the traffic survey was carried on during 4 time intervals. In the morning session (8.00 – 9.00 AM), noon session (12.00 – 1.00 PM), evening session (5.00 – 6.00 PM) and the night session (8.00 – 9.00 PM). It helps to understand the traffic flow and pattern in various time of the day. The result of the traffic survey is given below (Table 26 and 28, Fig: 125).

Table 26 Categorized traffic count in different time interval

Time interval	Traffic count/% over total nos. of vehicle/Equivalent PCU Factors								
	Fast moving vehicle					Slow moving vehicle		Cycle	Pedestrian
	Tram	Bus	Taxi	4 wheeler	2 wheeler	Mini van	Rickshaw	Cycle	Pedestrian
8.00 – 9.00 AM	12 (1%) 48	325 (27%) 715	275 (23%) 275	365 (31%) 365	116 (10%) 58	38 (3%) 53.2	20 (2%) 40	40 (3%) 16	965
12.00–1.00 PM	10 (1%) 40	150 (17%) 330	260 (29%) 260	221 (25%) 221	110 (12%) 55	59 (7%) 82.6	25 (3%) 50	55 (6%) 22	850
5.00 – 6.00 PM	12 (1%) 48	321 (27%) 706.2	270 (22%) 270	360 (30%) 360	135 (11%) 67.5	48 (4%) 67.2	20 (2%) 40	45 (3%) 18	942
8.00 – 9.00 PM	10 (1%) 40	185 (21%) 407	255 (28%) 255	200 (22%) 200	126 (14%) 63	50 (6%) 70	20 (2%) 40	55 (6%) 22	900

Table 27 Total traffic count in different time interval

Time interval	Traffic count/Equivalent PCU Factors				
	Fast moving vehicle	Slow moving vehicle	Cycle	Total	Pedestrian
8.00 – 9.00 AM	1093 (1461)	58 (93.2)	40 (16)	1191 (1570.2)	965
12.00 – 1.00 PM	751 (906)	84 (132.6)	55 (22)	890 (1060.6)	850
5.00 – 6.00 PM	1098 (1451.7)	68 (107.2)	45 (18)	1211 (1576.9)	942
8.00 – 9.00 PM	776 (965)	70 (110)	55 (22)	901 (1097)	900

5.5.7.2 Survey analysis

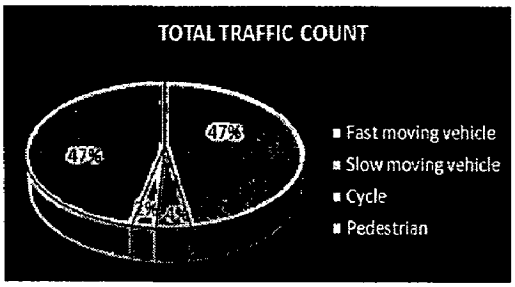


Figure 123 Transportation modal split in the stretch

1. Tram accounts 1% over the total fast moving vehicular traffic.
2. Vehicular traffic volume is almost equal both in fast and lean hours.
3. Fast moving vehicular traffic accounts 47% over the total traffic volume.
4. Among the total fast moving vehicular traffic 4-wheeler accounts 27%, taxi 26%, and bus 23%, whereas the 2-wheeler accounts 12% which is low than the other two stretches.
5. Slow moving traffic has only 4% contribution over total traffic volume.
6. No auto rickshaw is allowed on this road.
7. Pedestrian traffic is very high (47% over the total traffic volume) than the other two stretches
8. As the pedestrian traffic is always high so it should be taken into concern.
9. Design Service Volume is 1048.25 which is very low from the recommended value i.e. 4800 for 6 lanes undivided (two way), still it suffers traffic congestion. So it is the question of efficient traffic management.
10. Proposal to increase the tram service as it has such kind of potentiality.
11. Proper routing of vehicular traffic and signal prioritization are very much needed to control over the traffic jam.
12. Proposal for by passing of slow moving traffic to another road which will increase the avg. on road speed of the fast moving traffic.

5.6. S. P MUKHERJEE ROAD (KALIGHAT)

5.6.1 Site potentiality

The site is very much known for the kali temple named Kalighat Kali temple being a tourist spot. It is also famous for the residence of the Indian rail minister, Ms. Mamata Banerjee. This road is the main linkage to the Alopore central Jail which is on the south side of this road. Besides this, the stretch is also the major transport link to a good numbers of schools and colleges, markets, parks, hospitals and other important place. The road connects to one cancer hospital named Chittaranjan national cancer hospital. It also gives an access to one of the big cremation center named Keoratala cremation ground. This road also the main vehicular way to get an access to a big market named Bhawanipur market. The area has one old church and several old temples which can be explored as the places of tourist interests. The important places in surrounding 1 km area of the selected road stretch are listed below (Table 29, Fig: 126 to 128).

Table 28Important places surrounding 1 km area of the road stretch

Sl. Nos.	Places of importance	Total nos. of places
1	School	10
2	College	6
3	Other institution	3
4	Hospital	3
5	Metro Station	2
6	Temple	4
7	Park	3
8	Bank	9
9	Hotel	5

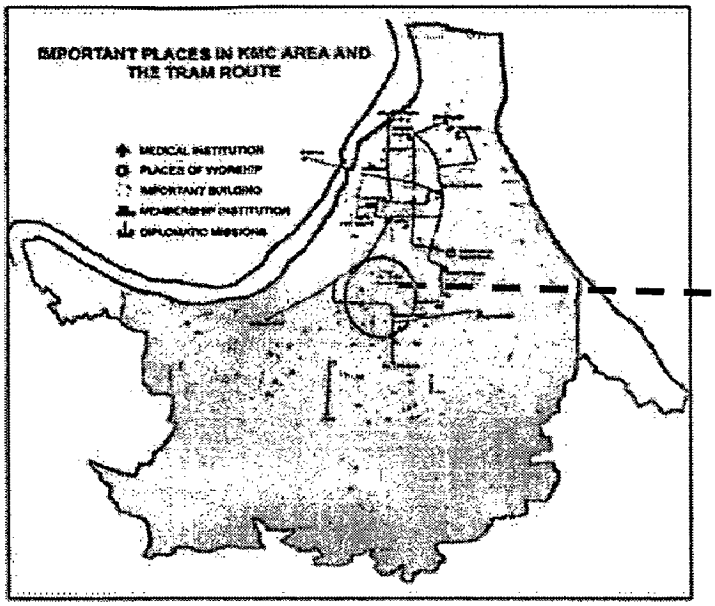


Figure 124 Important places in KMC area & tram route map

Figure 125 500m Road stretch & the surrounding 1km areas

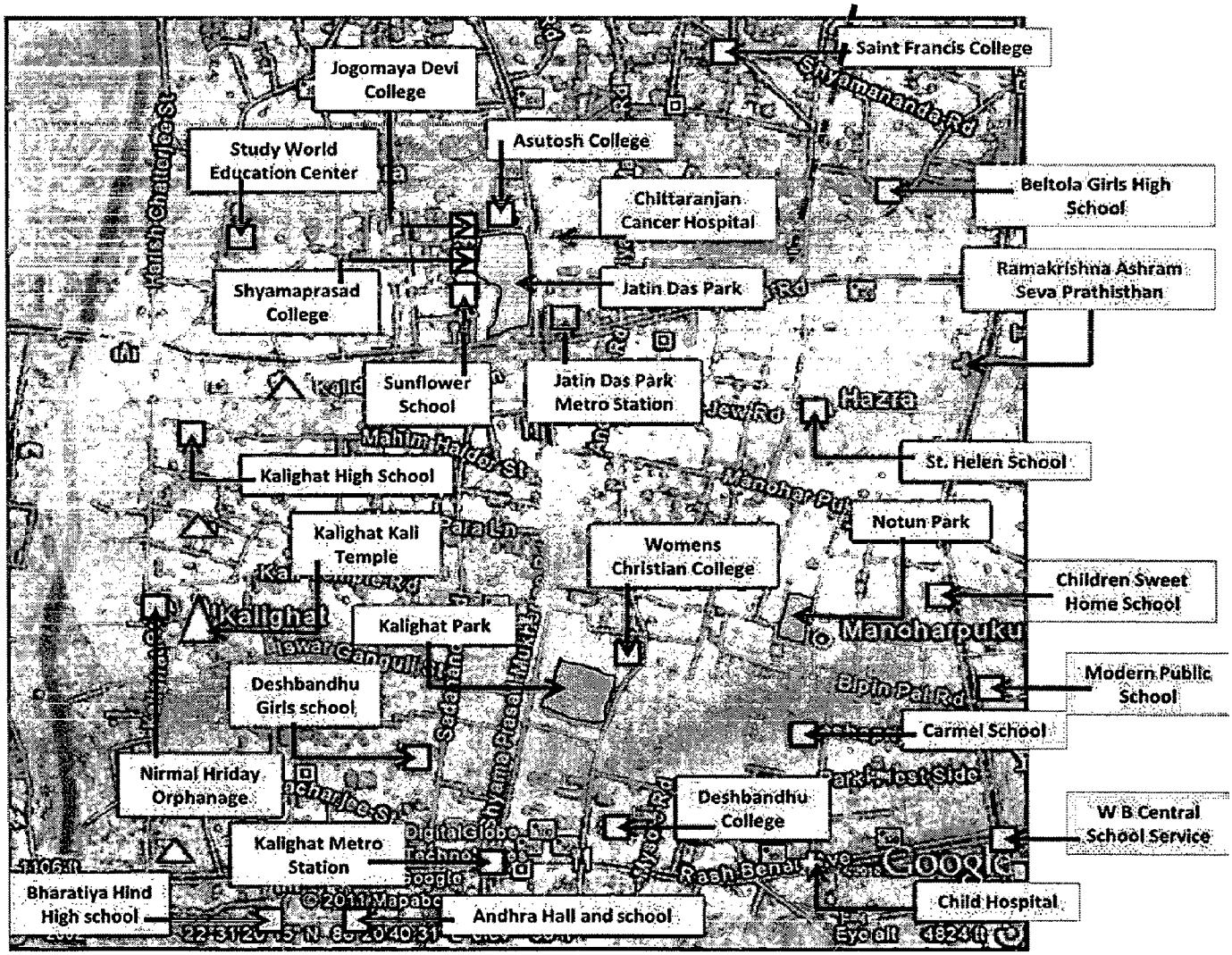


Figure 126Important places in surrounding 1 km area of the stretch

5.6.2 Site plan of the selected road stretch

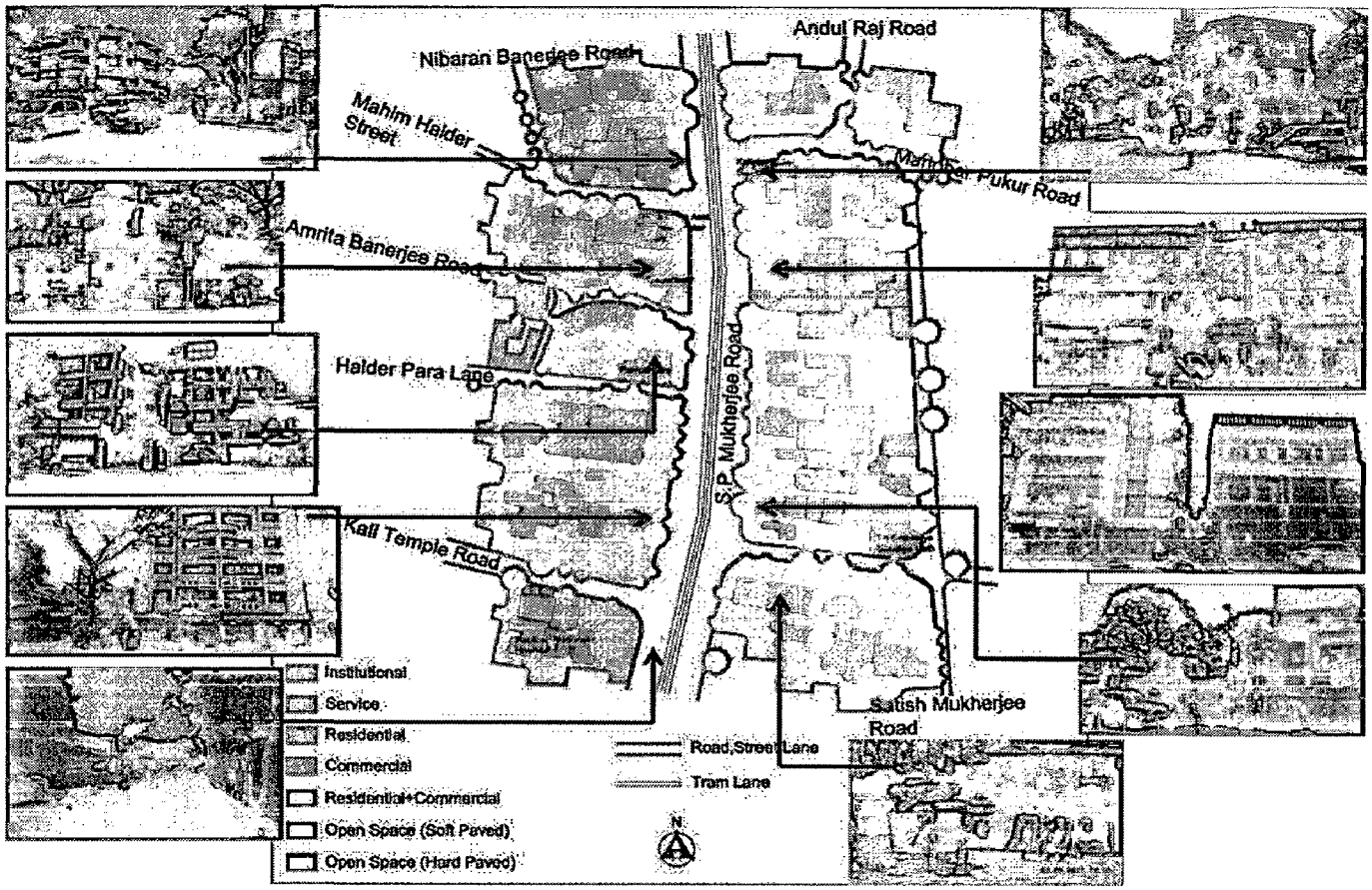


Figure 127 Site plan surrounding the road stretch

The road stretch is lined up with maximum residential buildings which have commercial activity at the ground floor. Maximum buildings are of 4-5 storied. There are a good numbers of old buildings along this stretch. There is one fire station named Kalighat fire station is on the east side of the road. On the same side there is one religious building named Sri ChaitanyaGaudiya Math. There is one hospital named Asutosh national hospital is on the south side of the road. The famous Kalighat kali temple is on the south-west side of the road. Besides this there is one prostitute colony is on the south-west corner of the road (Fig: 129).

5.6.3 Cross section of the selected road stretch

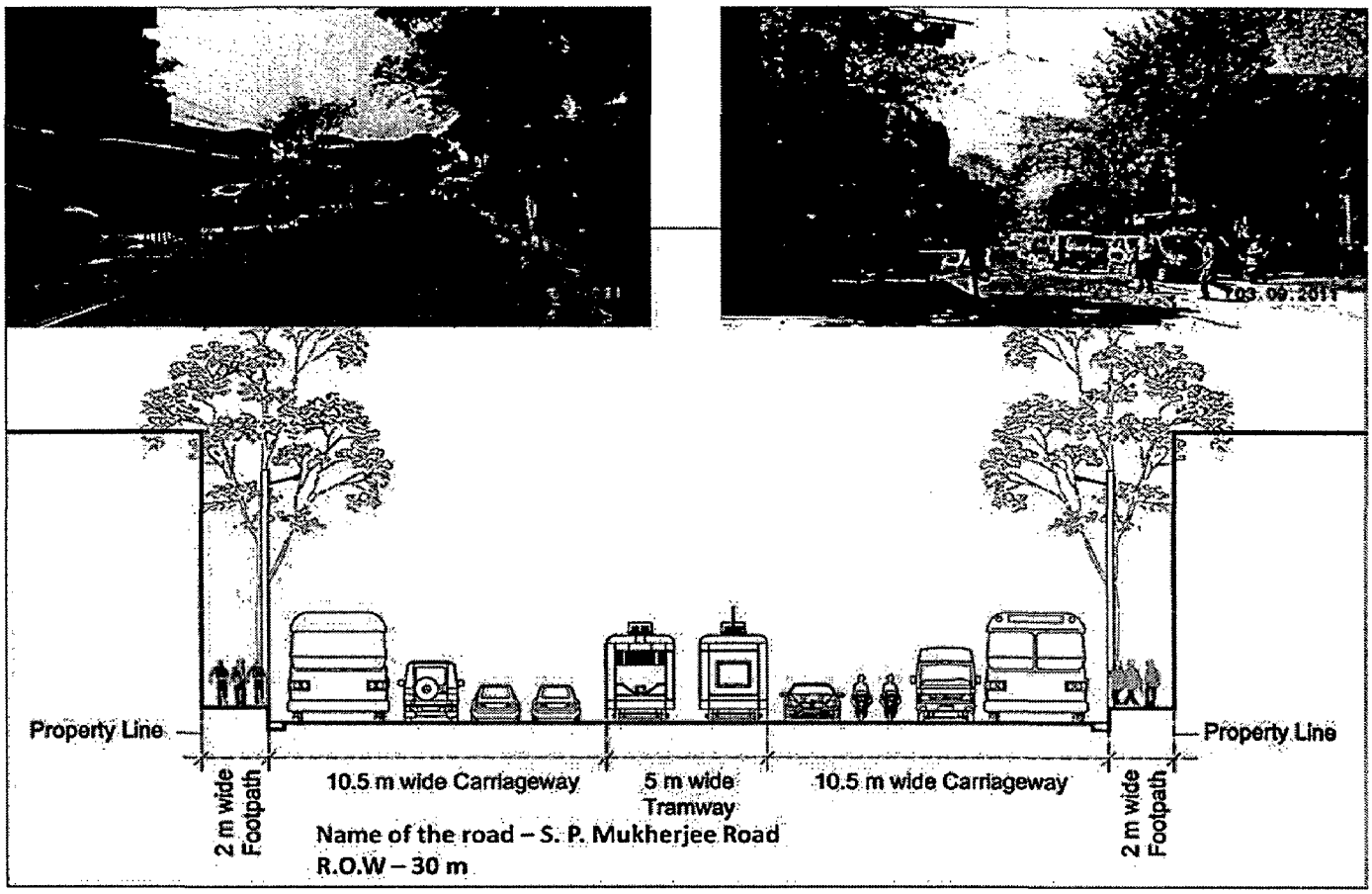


Figure 128 Cross section of the road stretch

It is also an important road in KMC area not only because of its connectivity but also the political importance.. Right of Way (ROW) of the road is 30 m. The road has the undivided two way traffic movements. Both sides have 10.5m wide carriageway. The tram lines are running thro' the middle of the road. The road has the carriageway width of 16 m with 2m wide footpath on both side of the road. It is a 4 lanes undivided two way road. Though the road hasn't a clear traffic division but the tram line itself divides the road. People are restricted to cross the main road except the Zebra crossing. Due to the poor traffic management road accidents are happened very often on this busy road (Fig: 130).

5.6.4 Existing problems along the stretch

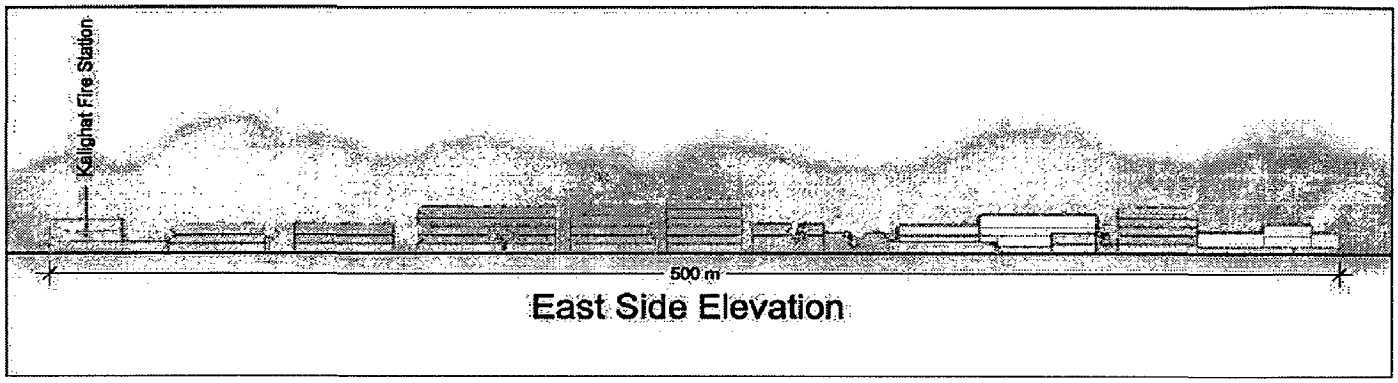
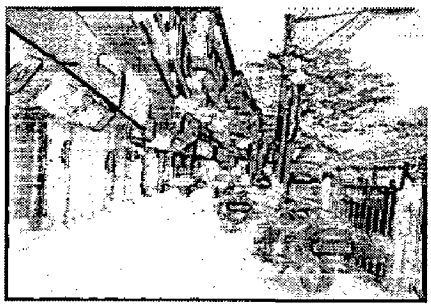


Figure 129 East side elevation of the stretch

The problems which are been identified through the survey in the east side of this road stretch are discussed in Table 29:

Table 29Existing problems on the east side of the stretch

Sl. Nos.	Problems	Visuals
1	• Wide footpath helps to accommodate people in rush hours. • Proper street light, fencing ensures safety & security. • No intermediate bye-pass for the people.	
2	• The footpath is shaded by the alongside buildings. • Proper signage helps people • Taking care of new plants. • Controlled developments.	
3	• Controlled traffic movement. • Total stretch of the road is well shaded by either building or trees. • Well maintained road with traffic signal, crossing, & signage.	

4	• People like to walk thro' the shaded footpath. • Mixed traffic reduces the average speed of the vehicle • Heavy traffic jams in peak hours.	
5	• Footpath is used as storage space by the shop keepers. • The footpath is certainly narrowed in some places. • It is hardly possible to walk in this narrow (1 m) footpath. • Trees are being cut by the shop keepers for their own sake.	
6	• The traffic police kiosk is totally covered by the advertisements. • People used to park their vehicle right on the corner of the road. • Signage having the street name is hardly visible.	
7	• Poor streetscape due to the old and deteriorated structures along the road. • Low density development along the road. • Improper arrangement of banner, hording create poor visual ambiance.	

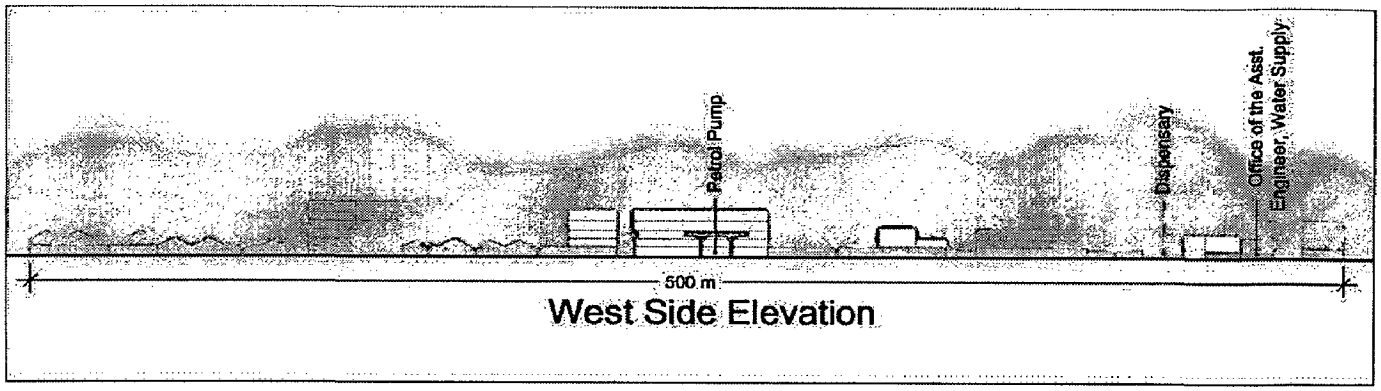
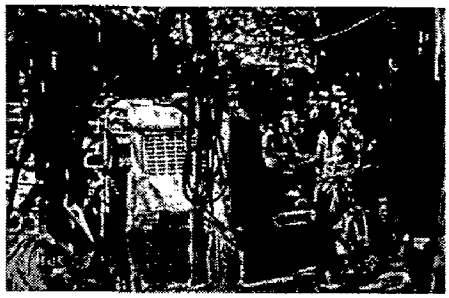


Figure 130West side elevation of the stretch

The problems which are been identified through the survey in the east side of this road stretch are discussed in Table 30:

Table 30 Existing problems on the west side of the stretch

Sl. Nos.	Problems	Visuals
1	• Provision of tube-well & trees helps people in summer. • The base of the trees is used for sitting purpose. • People often cross the road in between because of the absence of fencing.	
2	• The abandoned milk booth totally blocked the footpath. • For that milk booth, almost 50 m stretch of the footpath is not being used.	
3	• The signage indicating tram stop is far from the tram line. • The traffic signage is not proper visible due to its improper position.	

4	• The structure having shrine inside totally blocked the footpath. • People used to avoid the certain stretch of this footpath.	
5	• The letter box, electrical power boxes everything is on the footpath. • The building edge line illegally came over the footpath.	
6	• Tough boarding and de-boarding to the bus because of no proper bus stop. • From the footpath it is hardly accessible.	
7	• Controlled traffic movement. • Tram route is well segregated from the other vehicle by the divider. • No proper stoppage for tram creating problems for the people.	

5.6.5 Existing street furnishing along the stretch

The following photographs are showing the available street furnishing which is very much neglected but they can be conserved or even copied in new constructions. These features are well in harmony with the existing building architecture of this area. All of these features belong to the British era. But still these can be merged with the modern architecture and the streetscape design. Though this stretch is not comprised with a good number of design elements like the other two stretches but still it has some kind of potentiality to revive the street environment by using the existing elements (Fig: 133). The existing street furnishing elements are shown below.

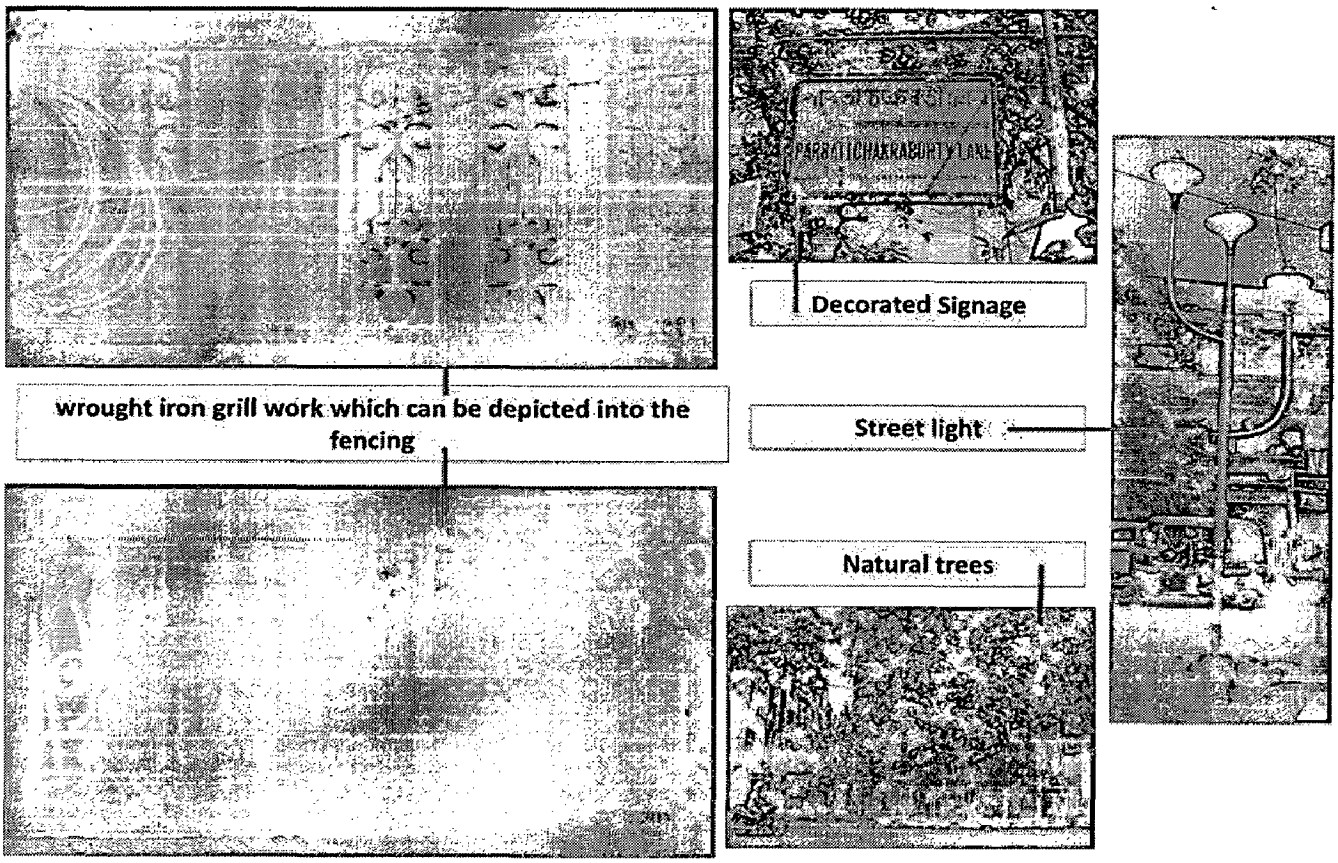


Figure 131 Existing street furnishing along the stretch

5.6.6 Problem analysis and the intent of solution

Problems have been observed and it is being analyzed to get the solutions. The problems are further categorized into broad head headings and summarized. The categories or components for analysis are as follows:

1. Road condition
2. Parking
6. Landmarks
7. Public amenities

3. Pedestrian sidewalks
4. Activity pattern
5. Building architecture
8. Utilities
9. Informal sector
10. Street furnishing

The following figure is showing the matrix of street environment quality and the requirement or proposals for improving the quality or eradicates the problems. The matrix is showing the correlation between the problems intensity and the proposals needed. From this matrix we can easily understand the present condition of that street and then the proposal can be prepared as per the requirements (Fig: 134).

Sl. Nos.	components	Quality				Requirements/proposal				
		Very Good	Good	Un-satisfactory	Bad	Conserve	Improve	Renew	Remove	Construct /add
1	Road condition									
2	Parking									
3	Pedestrian sidewalks									
4	Activity pattern									
5	Building architecture									
6	Landmarks									
7	Public amenities									
8	Utilities									
9	Informal sector									
10	Street furnishing									

Figure 132 Street environment quality Vs proposal matrix

After analyzing the problems on the both side of the road stretches it is now easy to summarize those problems. This will help to understand the nature of problems and their intensity and also to identify the common problems existed on both sides of the road stretch. From the analysis it is found that the problems on both sides of the road are same in nature so it is possible to find out a common solution. The problems are grouped together and the possible recommendations are given for those problems. Table 32 shows the summarization of problems, their analysis and the intent of solutions.

Table 31 Summarization of problems, their analysis and the intent of solution

Sl. Nos.	Components	Observation	Intent of solution
1	Road condition	• Overall stretch is quite in good condition • Regular maintenance is taken place	• Emphasis can be given on traffic management. • Stress on the traffic calming measures.
2	Parking	• On road illegal parking • Hand-pulled rickshaw parking often create traffic jam • 2- wheeler counts are more.	• Adequate, multiple and flexible parking solutions need to be worked out. • Strict on removing illegal parking.
3	Pedestrian sidewalks	• Lack of cross walks, pedestrian signals at crossing, street furniture. • Footpaths on both sides are well shaded by either trees or buildings & have sufficient street lights. • Fencing in footpath restricts people to cross the road in between. • In some portion the walkable parts of footpath are consumed by the goods storage.	• The space is needed maintenance. • Introduction of cross walks, pedestrian signals and street furniture. • Provision of proper bus stops and the connection with the footpath
4	Activity pattern	• This is a prominent residential area. • Maximum buildings have shops at ground floor which serve the locality. • Busy in holiday because of the Kalighat temple.	• Priority should be given to mix land use development instead of totally commercial developments. • Proposal to reduce the vehicular traffic by bypassing them thro' another road.

5	Building Architecture	• Both sides of the road comprised with buildings having 5 stories on average. • Often entries are blocked by the shopkeepers • The old buildings are hazardous for living. • Having no particular architectural style but having some old architectural details.	• New structure should be in harmony with the old ones. • Proposals for conserving or adaptive re use of the old buildings. • All the building entries should be prominent and make them impressive.
6	Landmarks	• Kalighat fire station is the main landmark of this stretch. • The area is very much popular for the residence of Mamata Banerjee, the Indian rail minster. • Within the 500 m distance there iskalighat temple, three important colleges, church and two metro stations.	• All the landmark details should be well documented & make it available for the tourist to create interest. • If required then proposals for modifying the building bye-laws for the new construction & to conserve the old structures can be given.
7	Public amenities	• Lack public toilets, information kiosks, seating in the public realm • Less number of ATMs & public telephones. • People feel unsecure at night due to the presence of one prostitution colony just beside this road. • Lack of running water taps in this stretch.	• Planning for introduction of better public amenities at proper location. • Proposals for the shifting or re-planning the colony for the sake of other people.

8	Utilities	• There is also no proper garbage disposal system or storm water drains. • Utilities are randomly located on the setback spaces and on the sidewalks. • Electric posts, HT pylons and transformers are located right on the footpath.	• The overhead HT lines are the single most disturbing feature in the visual landscape of the street, the city will have to invest in laying these underground. • A proper garbage recycling program needs to be introduced by the municipality.
9	Informal sector	• Encroachments in the left over spaces, vacant land by hawkers and vendors are a common sight. • Vibrant informal sector activity. • Due to absence of service lanes to serve the Industries, loading & unloading happens right on the streets.	• Spaces to accommodate an orderly organization of informal sector commercial activities. • Plazas can also incorporate stalls and kiosks to cater to this sector and also liven up the public realm. • Proper loading unloading system without hampering the main traffic flow
10	Street furnishing	• Lack of sitting space, proper signage • The natural trees cater shades to the road thus it soothing in summer time. • Indiscriminate use of banner, poster creating poor visual appearance. • The street has adequate nos. of street light and the natural trees.	• Provision of sitting spaces in between. • Proper signage having the details of road, building, landmarks etc. • Stress on diverse plantation to break monotony • High stress on better streetscape design. • Managed use of advertisement hording, banners to create a pleasant streetscape.

5.6.7 Traffic problems and its analysis

5.6.7.1 Traffic survey

The traffic was done to understand the traffic pattern, traffic volume, and the impact of traffic count on the local area or activities. The traffic survey is also required to analyze the activity pattern and the future scope for developing the area as per the traffic intensity and the traffic pattern. Traffic survey gives an idea whether the surrounding area is efficiently planned to get the full benefit out of the existing traffic corridor and if it is not then the plausible policies can be evolved to change the land use pattern to maximize the benefit. From the traffic survey it also can be understand whether it is possible to divert the traffic to another road if the road is suffering from heavy traffic volume at peak hours.

Thus the traffic survey was carried on during 4 time intervals. In the morning session (8.00 – 9.00 AM), noon session (12.00 – 1.00 PM), evening session (5.00 – 6.00 PM) and the night session (8.00 – 9.00 PM). It helps to understand the traffic flow and pattern in various time of the day. The result of the traffic survey is given below (Table 32 and 33, Fig: 135)

Table 32 Categorized traffic count in different time interval

ime interval	Traffic count/% over total nos. of vehicle/Equivalent PCU Factors									
	Fast moving vehicle					Slow moving vehicle			Cycle	Pedestrian
	Tram	Bus	Taxi	4 wheeler	2 wheeler	Auto Rickshaw	Mini van	Rickshaw	Cycle	Pedestrian
8.00 – 9.00 AM	-	81 (6%) 178.2	235 (18%) 235	450 (34%) 450	256 (20%) 128	188 (14%) 225.6	6 (1%) 8.4	15 (1%) 30	80 (6%) 32	789
12.00– 1.00 PM	-	66 (9%) 145.2	144 (19%) 144	222 (29%) 222	114 (15%) 57	102 (13%) 122.4	12 (2%) 16.8	25 (3%) 50	72 (10%) 28.8	450
5.00 – 6.00 PM	-	79 (6%) 173.8	210 (16%) 210	376 (28%) 376	359 (27%) 179.5	200 (15%) 240	7 (1%) 9.8	9 (1%) 18	86 (6%) 34.4	389
8.00 – 9.00 PM	-	53 (7%) 116.6	121 (17%) 121	189 (27%) 189	114 (16%) 57	100 (14%) 120	23 (3%) 32.2	30 (4%) 60	79 (12%) 31.6	135

Table 33 Total traffic count in different time interval

Time interval	Traffic count/Equivalent PCU Factors				
	Fast moving vehicle	Slow moving vehicle	Cycle	Total	Pedestrian
8.00 – 9.00 AM	1022 (991.2)	209 (264)	80 (32)	1311 (1287.2)	789
12.00 – 1.00 PM	546 (568.2)	139 (189.2)	72 (28.8)	757 (786.2)	450
5.00 – 6.00 PM	1024 (939.3)	216 (267.8)	86 (34.4)	1326 (1241.5)	389
8.00 – 9.00 PM	477 (483.6)	153 (212.2)	79 (31.6)	709 (727.4)	135

5.6.7.2 Survey analysis

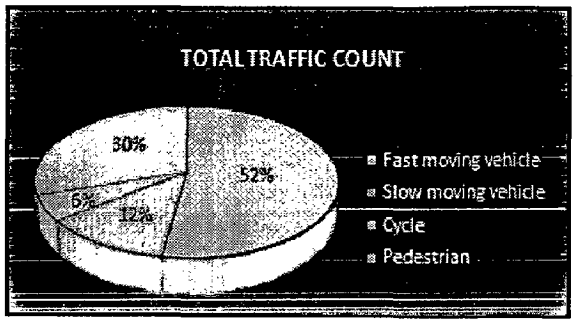


Figure 133 Transportation modal split in the stretch

1. The tram service is temporarily stopped working due to the maintenance work of the route.
2. Vehicular traffic volume is very high at peak hours (8.00 – 9.00 AM & 5.00 - 6.00 PM)
3. Fast moving vehicular traffic accounts 52% over the total traffic volume.
4. Among the total fast moving 4-wheeler accounts 30%, 2-wheeler 20% & taxi 18% whereas bus accounts only 7%.
5. The fast moving vehicle traffic volume is doubled in peak hours from lean hours.
6. The stretch is suffering from the rapid increase of auto rickshaw as it has 14% share on total traffic count and its unmanageable parking problems.
7. Pedestrian traffic accounts 30% over the total traffic volume.
8. Pedestrian traffic reduces drastically (789 to 135) at night due to the lack of security.
9. As the pedestrian traffic is very high in the morning time so priority should be given to them.
10. Recommended Design Service Volume for 4 lanes undivided (two way) is 2400 whereas here the avg. value is 1008.08, still it suffers traffic congestion. So it is the question of efficient traffic management.
11. Proper routing of vehicular traffic and signal prioritization are very much needed to control over the traffic jam.
12. Proposal for by passing of slow moving traffic to another road which will increase the avg. on road speed of the fast moving traffic.

5.7. Comparative analysis between three stretches

After doing the detail analysis of each of the three stretches it is required to have comparative analysis between there of them. It helps to understand the varieties of problems, their intensity, the impact of the problems, and it also helps to chalk down the idea where most concentration is needed and where less. The potentiality of each stretch is also then cross checked by doing this comparative analysis. This analysis helps to get an overview of plausible proposals. If the stretches have some common problems then the same proposals can be applied. All of the three stretches have some common problems like encroachment of

footpath, narrow footpath, obstruction in the footpath, the problems of traffic jam, poor traffic management, high pedestrian as well as vehicular traffic, less importance to the pedestrian traffic, non signal prioritization both for tram and the pedestrian traffic, poor street furnishing, absence of public amenities, bad arrangement of utilities, un-efficient use of the public parks and gardens, indiscriminate use of banners, posters, hording etc. So proper design guidelines should be formulated to overcome these obstacles. Table 34 shows the comparative analysis between the three selected stretches.

Table 34 Comparative analysis between three stretches

College Street Road	State Highway 1	S.P Mukherjee Road
1. Road condition		
• As the overall road condition of the main vehicular road is quite in good condition so only improvement and the regular maintenance is required. • Traffic bypassing is very much required at school time. • Scope of by passing is possible due to the other parallel roads.	• The road is already in a good condition. • It only requires the traffic management and the signal prioritization. • The junction are required much attention than the main road.	• It is also a maintained road. • The traffic should be bypassed during the festival and the holidays. • Lane separation and traffic management is required. • Proper signaling system is needed to be installed.
2. Parking		
• On road illegal parking should be removed. • New parking spaces can be planned. • Limited entry for the vehicle at peak hours.	• On road illegal parking should be removed. • Repairing on the road should be banned • New parking lot can be proposed.	• On road illegal parking should be removed. • Parking arrangement for the hand pulled rickshaw should be proposed • 2 wheeler parking should be planned as its count is more in the peak hours.

3. Pedestrian sidewalks		
• Physiological and psychological comfort of the pedestrian with adequate shade, diverse plantations, comfortable street furniture and lighting. • In addition adequate traffic calming strategies with installation of pedestrian signals at crossings need to be incorporated.	• This space need to be designed for physiological and psychological comfort of the pedestrian with adequate shade, diverse plantations, comfortable street furniture and lighting. • Total eviction of the squatter development. • Proposal of footbridge can be given after feasibility analysis	• The space is needed maintenance. • Introduction of cross walks, pedestrian signals and street furniture. • Provision of proper bus stops and the connection with the footpath • The condition of footpath is comparatively better than the rest of the two stretches.
4. Activity pattern		
• Pedestrian should always be given priority at school time. • Proposal to reduce the vehicular traffic by bypassing them thro' another road. • Emphasize on educational and recreational activity rather than highly commercial activity	• As commercial and transportation activity is predominant so proposal for mixed land use with compact development can be given. • Special traffic management is required for the hospital vehicle.	• As it is a prominent residential area with the commercial activity within the building, so priority should be given to mix land use development instead of totally commercial developments. • Proposal to reduce the vehicular traffic by bypassing them thro' another road on the holidays.
5. Building architecture		
• New structure should be in harmony with the old ones.	• Proposal for compact developments to get the full benefit of such important	• New structure should be in harmony with the old ones.

• Proposals for conserving the old heritage buildings. • The advertisement should be in such a manner which will balance the ambiance. • All the building entries should be prominent and make them impressive. • Scope of street beautification is much more than the rest of two stretches.	road. • Proposal for the beautification of the building facades	• Proposals for conserving or adaptive re use of the old buildings. • All the building entries should be prominent and make them impressive.
6. Landmarks		
• All the landmark details should be well documented & make it available for the tourist to create interest. • Proposals for modifying the building bye-laws if it is required. • Proposals for getting benefit out of these landmarks can be given.	• All the landmark details should be well documented & make it available for the tourist to create interest. • Proposals for getting benefit out of these landmarks can be given. • The transportation corridor can be well utilized to explore the available resources.	• All the landmark details should be well documented & make it available for the tourist to create interest. • If required then proposals for modifying the building bye-laws for the new construction & to conserve the old structures can be given.

7. Public amenities		
• Planning for introduction of better public amenities at proper location. • These have to be established as non negotiable features of the street. • Make the maximum commercial use of available resources.	• Planning for introduction of better public amenities at proper location. • Make the maximum commercial use of available resources. • To maximize the security by designing the road itself. • Better scope for improving the condition of public amenities as it already has some existing features.	• Planning for introduction of better public amenities at proper location. • Proposals for the shifting or re-planning the prostitute colony. • Total new construction of public amenities.
8. Utilities		
• The overhead HT lines are the single most disturbing feature in the visual landscape of the street, the city will have to invest in laying these underground. • A proper garbage recycling program needs to be introduced by the municipality. • Old building are vulnerable to damage so proper care is to be taken for the fresh construction or laying out of utilities.	• The overhead HT lines are the single most disturbing feature in the visual landscape of the street, the city will have to invest in laying these underground. • A proper garbage recycling program needs to be introduced by the municipality. • Proposal for better arrangement of the public utilities	• The overhead HT lines are the single most disturbing feature in the visual landscape of the street, the city will have to invest in laying these underground. • A proper garbage recycling program needs to be introduced by the municipality.

9. Informal sector		
• Spaces to accommodate an orderly organization of informal sector commercial activities. • Plazas can also incorporate stalls and kiosks to cater to this sector and also liven up the public realm. • Proper loading unloading system without hampering the main traffic flow • The number of informal sector & the intensity of it is less than the other two stretches.	• Spaces to accommodate an orderly organization of informal sector commercial activities. • Plazas can also incorporate stalls and kiosks to cater to this sector and also liven up the public realm. • Proper loading unloading system without hampering the main traffic flow. • The intensity of the informal sector activity is highest among the three stretches.	• Spaces to accommodate an orderly organization of informal sector commercial activities. • Plazas can also incorporate stalls and kiosks to cater to this sector and also liven up the public realm. • Proper loading unloading system without hampering the main traffic flow.
10. Street furnishing		
• Provision of adequate sitting spaces. • Proper signage having the details of road, building, landmarks etc. • Stress on diverse plantation to break monotony • Managed use of advertisement hording, banners to create a pleasant streetscape.	• Provision of adequate sitting spaces. • Proper signage having the details of road, building, landmarks etc. • High stress on better streetscape design. • Managed use of advertisement hording, banners to create a pleasant streetscape.	• Provision of sitting spaces in between. • Proper signage having the details of road, building, landmarks etc. • Stress on diverse plantation to break monotony • Managed use of advertisement hording, banners to create a pleasant streetscape.

5.8. General problems of tramways in the stretches

All of the three stretches have some common problems regarding tramways. The street nature, the activity pattern, land use pattern, traffic volume all are different from each other but still the problems of tramways are almost common to all of them. So the planning and design guidelines can be evolved as matter of common fact which can be applied to all of these three stretches. The features responsible for the poor service and failure of the system are:

1. Low fare structure causing the subsidization of tramways by the Govt.
2. Tram takes more time to travel the same distance than bus.
3. Actual speed on the road is very low (20 km/h).
4. Unimpressive external face of old tram.
5. New tram is looking good but uncomfortable in summer time.
6. The seat arrangement is not efficient.
7. Absence of safety and security features inside the tram.
8. No information system is available.
9. No backup power supply system in case of power failure.
10. No thermal comfort inside the tram.
11. No proper tram stops resulting the challenging boarding & alighting from the tram.
12. Lack of universal accessibility in the tram terminal and depots.
13. Poor condition of tram depots and terminals.
14. Unreserved tram line causing traffic jam in peak hours.
15. Lack of signal prioritization for tram.
16. Absence of revenue earning commercial activity in the terminus.
17. Encroachment of tramway property.
18. Poor integration with other modes of traffic.
19. Lack of willingness of CTC to introduce modern technology to improve the tramways.
20. Lack of integration with the tourist spots and other important places.
21. Poor operational management.
22. Lack of Govt. willingness to promote travel by tram among people.

6

PROPOSAL

6.1. Recommendations to improve the tramway system

The Govt. of W.B and the CTC are responsible to carry out a detail research study on each and every aspect related to tramway service and set development guidelines and plan proposal to improve the service as tramway provides vastly better public transport: faster, smoother, quieter, and more reliable, a predictable journey time, a pleasant, comfortable ride in a level floored vehicle with no steps and fully accessible to wheelchairs and buggies. It also helps to revitalize our town centers by bringing in more people, encouraging businesses to invest and improving the image of the area. If the tramway system will properly be planned and managed then it can increase employment and reduce deprivation and social exclusion - a real problem in Kolkata.

Kolkata has the potentiality of making the tramway viable in terms of tourism, heritage, urban economy and environmental quality. It only requires positive approach, plausible development policies, and strict management to make it an attractive, viable and even profitable mode of transport and then it can prove to be an enjoyable, interesting, convenient and profitable mode of transport like that of London, Hong Kong or other European cities. Here are some recommendations including policies, planning guidelines and design norms, proposed for the improvement of tramway service.

6.1.1 Accessibility: The topmost priority should be given to introduce a designated tram stop lacking in Kolkata. The stop should be positioned in such a way that it is easily and safely accessible by all. The stop should have some minimum requirements i.e. roofing, audio visual information sysytem, medical and emergency fire extinguishing kit, CCTV etc. The tram stop should have step free access and the ramped access from the road and the footpath also. One connector should be made rom the footpath to the tram entries as tram in Kolkata runs in the middle of the road. The connector should have some specific safety measures to assist the handicaped persons. It should have specific covering material approved for the wheelchair users and the blind persons. To assist blind and partially sighted passengers, each such connector should have a tactile strip along its entire length, a safe distance from the platform length (Fig: 137).

Figure 136 is the proposed view of a tram-road stretch. It shows the proper tram stoppage having roof covered with the translucent material which allows natural light and also it is a light weight material. The footpath is improved with introduction of more street light, trees, bollard, trafic signages and landscaped area. The connector with enhanced paving pattern is constructed at the tram stoppage from the footpath level. Public amenities such as information kiosk, public telephone booth, toilet, ATM are also introduced on the footpath. Controlled vehicular traffic and the signal prioritization for tram and pedestrian when passengers alight to or deboard from the tram.

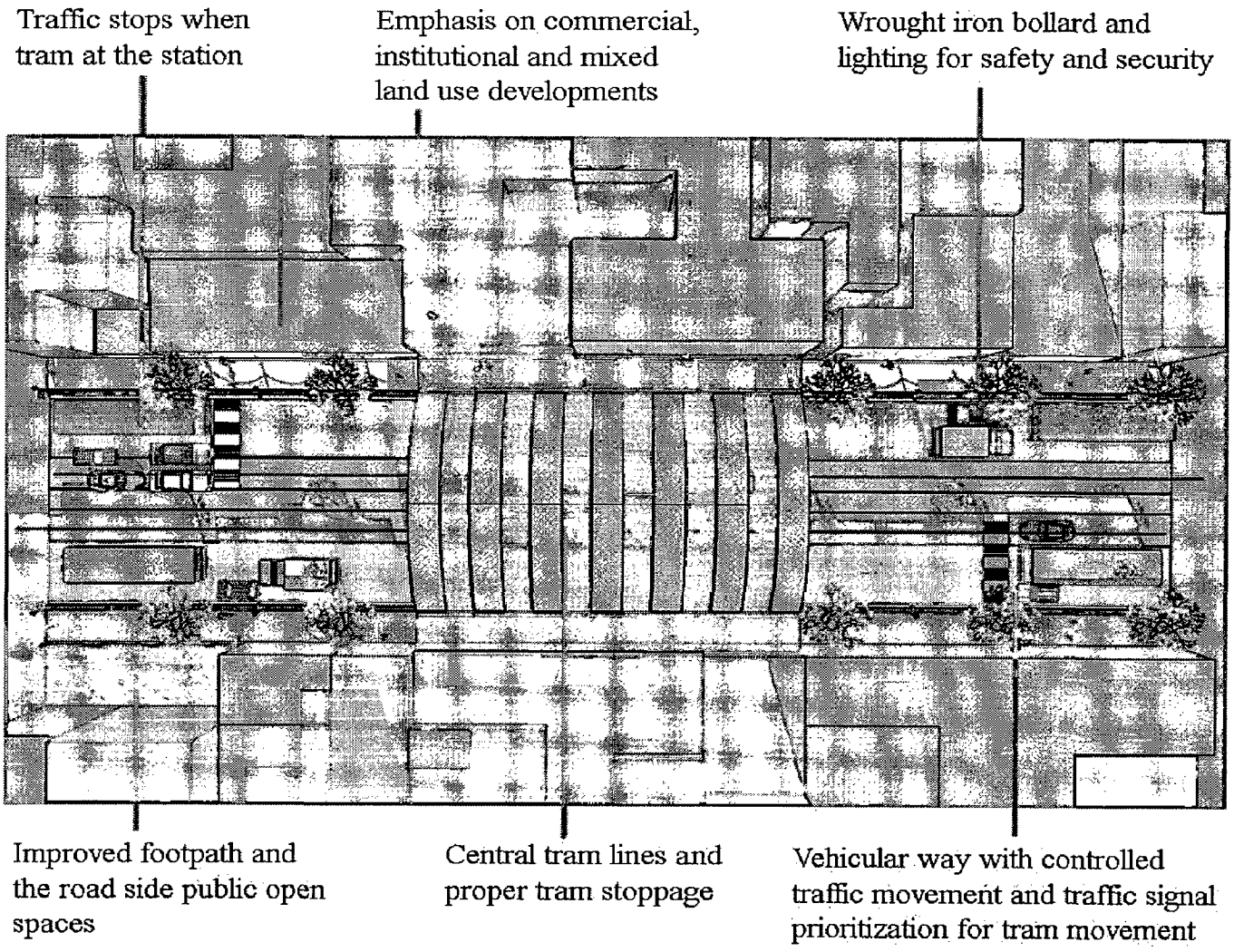


Figure 134 Proposed road stretch with improved tram-road environment

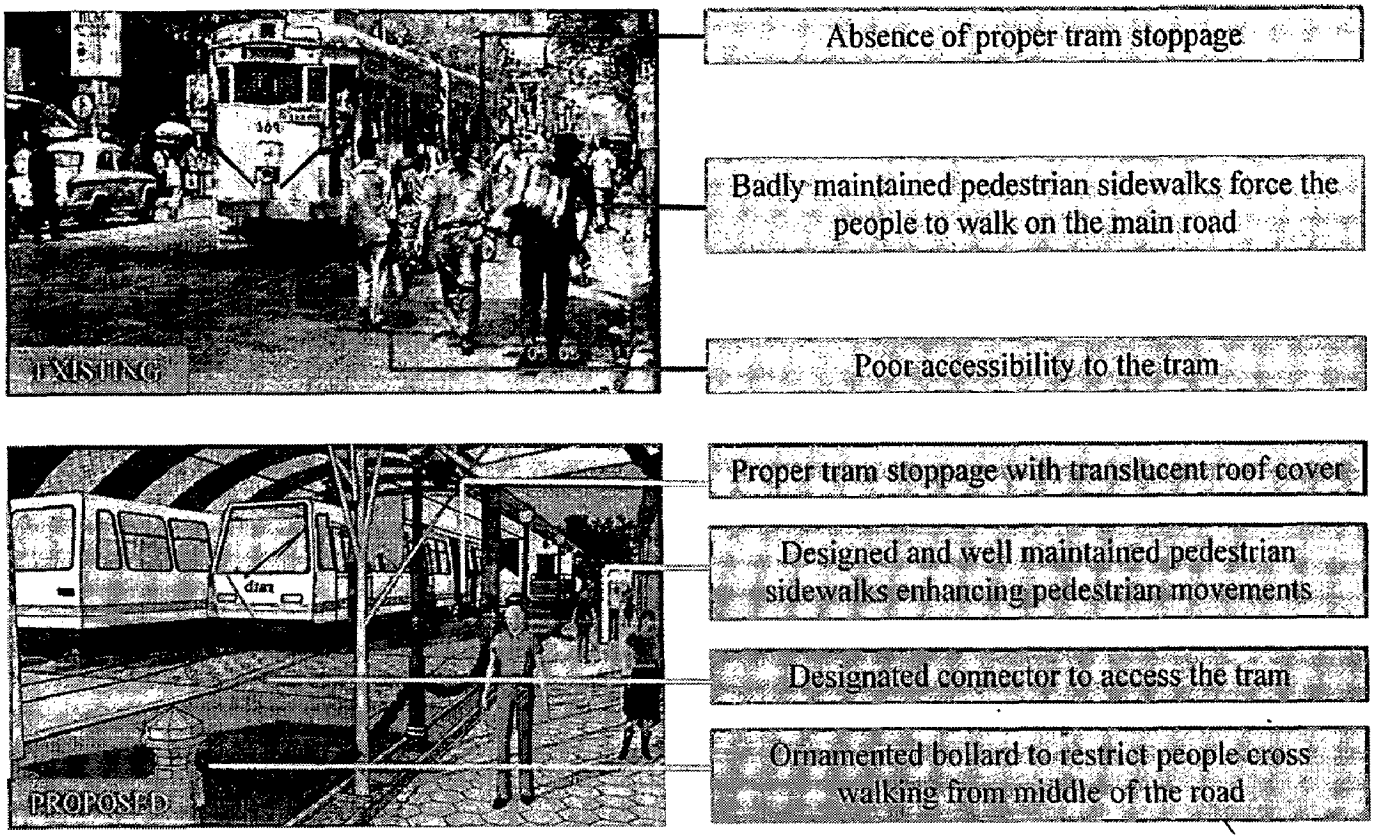


Figure 135 Proposed tram stoppage to access the tram

The vehicle should be stopped when people boarding to or aloghting from the tram. For that traffic management and signal prioritazation should be done. It can managed by lane wise i.e. when the tram stops on the stoppage in the down lane the other traffic should be stopped on that particular lane while the up lane is then free for the traffic and vice versa for the up lane also. When the tram will start then the other traffic on that lane will be signaled to move.

6.1.2 Fare system: The second most important if not equal, planning priority is on the modification of tram system because the prevailing low fare structure makes the Kolkata tramway non viable from the economic point of view. Fare increase is the only realistic option for ensuring the financial stability. New rational fare structure shall be introduced for different catagories of users for different time period for different route stretches. The penalty charge for travelling without ticket should be high to avoid and minimise the intension of passengers to travel without ticket.

A thorough cost benefit analysis shoud be carried out to set the rational as well as economical tariff system for the tram. The increase in fare is also required to make the tramway service self sustainable i.e. all the expences to the tramway service

should be carried out by the revenue collected from the fare and the other methods of earnings so that no subcidies then required to run the service.

The fare atructure should be set in such a way so that it can be affordable to all section of the people. Smart Card or Single Ticket system can also be a proposal for the betterment of the service as it helps to ease the passengers' commutation by the different modes of transport and it is easily maintainable for the transport department also. At present there is no concession for the EWS and handicapped people, so proposal can be given to introduce the concession ticketing system for them.

6.1.3 Network: Another improvement should be on the transfer integration with the other modes of transport. The tram routes should be integrated with the other transport modes so that people can access them without much problems. The tram service should also be managed in such a way that it connects most of the important places i.e. market places, school and colleges, commercial area, other institutional services, places of tourist interest etc so that it can earn the maximum revenue out of available resources. The routes and stoppages should be designed in such a way that being connected with the heritage buildings, parks, important places, places of worships etc., itself can attract more passengers. It is also to be required to revitalize the areas suffering from the problems such as encroachments, squatter development, filthy road condition etc. It is recommended to list down those areas and start to make new mixed use development and also concentrate on the improvement of the infrastructure i.e. road and drainage, garbage disposal etc. and the beautification of areas (Fig: 138).

The detailed study should be carried out to find out the possibilities and feasibilities of reopening the abandoned tram routes. It is advisable to connect the closed routed to make the tramway service more efficient in terms of connectivity, accessibility, passengers' carrying capacity, time and revenue generation. Another analysis also to be carried out to find the possibilities of running tram in the other areas of Kolkata. There is an opportunity to introduce the tram service in Salt Lake and Rajarhat New Town area as these are planned area and the numbers of public transport are also less in these areas. A detailed project should be made to find such possible areas to extend the tramway network.

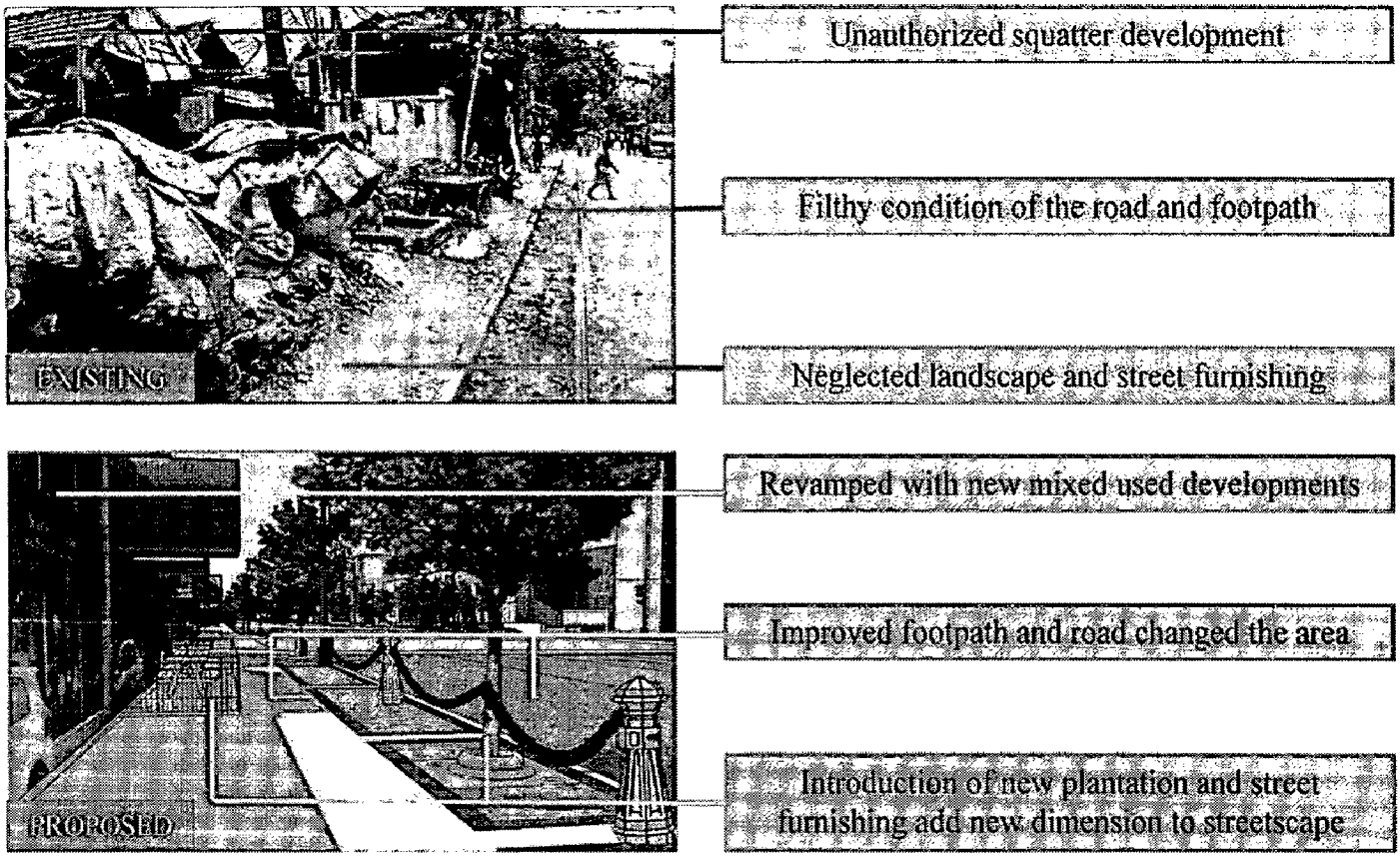


Figure 136 Proposed new development at the encroached sites

6.1.4 Convenience: The importance should also be given to the convenience of the passengers. The tram stoppages should be located in strategic places so that it is easily accessible convenient to the passengers. Proper planning for the tram stoppage and its location with all the emergency facilities is very much required. The improved passengers information system, safety ans security measures, other facilities provided for the passengers are also required to make the service convenient to the users.

The tram stoppage should not be allowed to have commercial facilities as it creates problem if it is not properly managed. The frequency should be more to make the service more effective. The punctuality of the service is another key factor to make it convenient and reliable. It depends on the availability of rolling stocks and how better the integration and management of the traffic is. The audio visual information system showing the arrival and departure time and the route map should be there both inside the tram and in the stoppage.

6.1.5 Safety and security: A total renovation is needed for safety and security lacking in the Kolkata tramway. All the tram stoppage and the tram car should be equipped with some security measures i.e. CCTV, passengers alert system, fire extinguishing system, medical kits, phone for emergency services etc. Tram cars should have censor monitored double sliding doors to ease the passengers movement, as at present the old tram cars in Kolkata have no doors which is very much vulnerable for the passengers when it is fully loaded (Fig: 139).

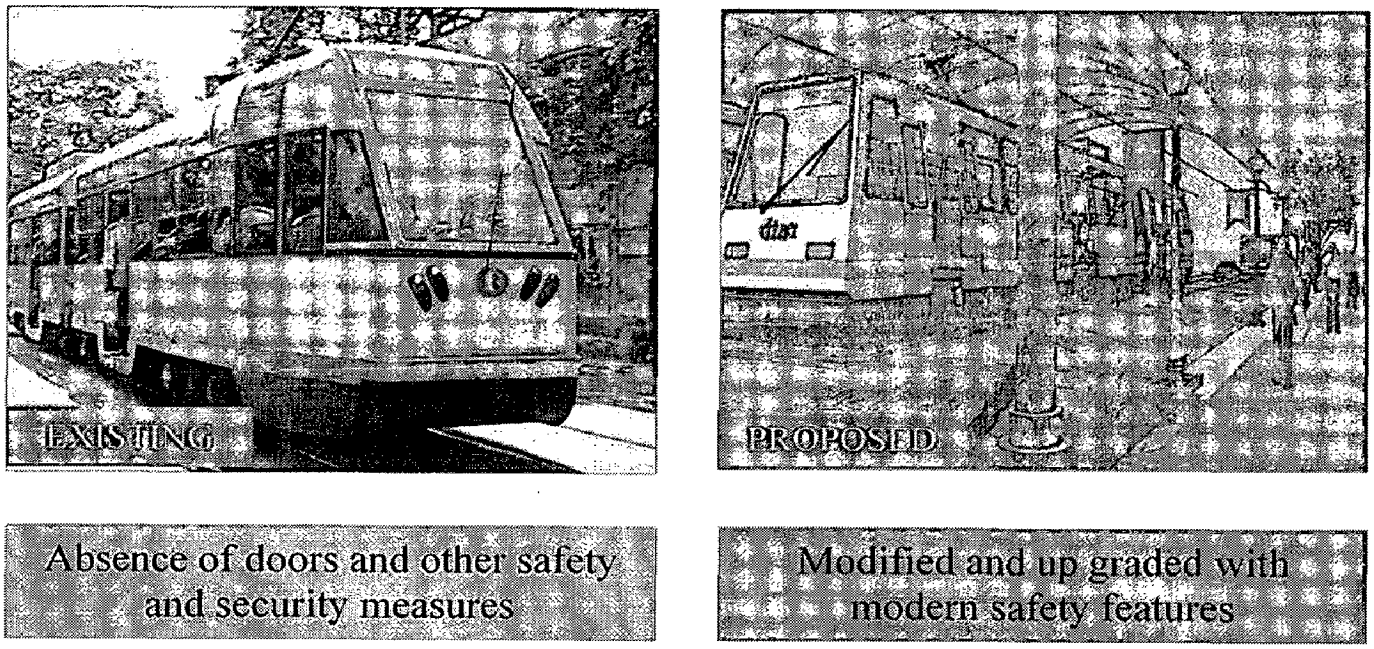


Figure 137 Modified with modern technologies to ensure passenger safety and security

Improvement of the overall system with high and modern technology should be done. Some new technology can be adopted to increase the safety and security, such as installation of driver vigilance device inside the tram car, programmable logic speed controller device, automatic track switching control device, low smoke halogen free overhead power cable, LR55 tram track, emergency STOP button inside the tram car and additional handles and railings with more ergonomic design for easier reaches by passengers.

6.1.6 Comfort: Improved passengers comfort can be ensured by providing AC system inside the tram car, larger satnding bay, proper ventilation system, proper seating arrangement etc. The riding comfort can be assured by installing anti jerking technology. It can be also possible to design and introduce tram with adjustable open roof which can be used in winter but the roof can be covered during summer and monsoon seasons. This type of tram is very much helpful for tourism purpose as the

whole city can be seen from the open roof tram. The seating layout should be modified to increase the passengers capacity. At present the total seating capacity is 60 persons including both compartments. But the proposed seating srrangement can accommodate 72 seatings and accordingly the standing space also be increased. The present seating arrangement is not comfortable either. The wooden seat has to be covered with the soft outfit to ensure the passenger comfort (Fig: 140).

Figure 138 Modified seating layout to increase the seating spaces

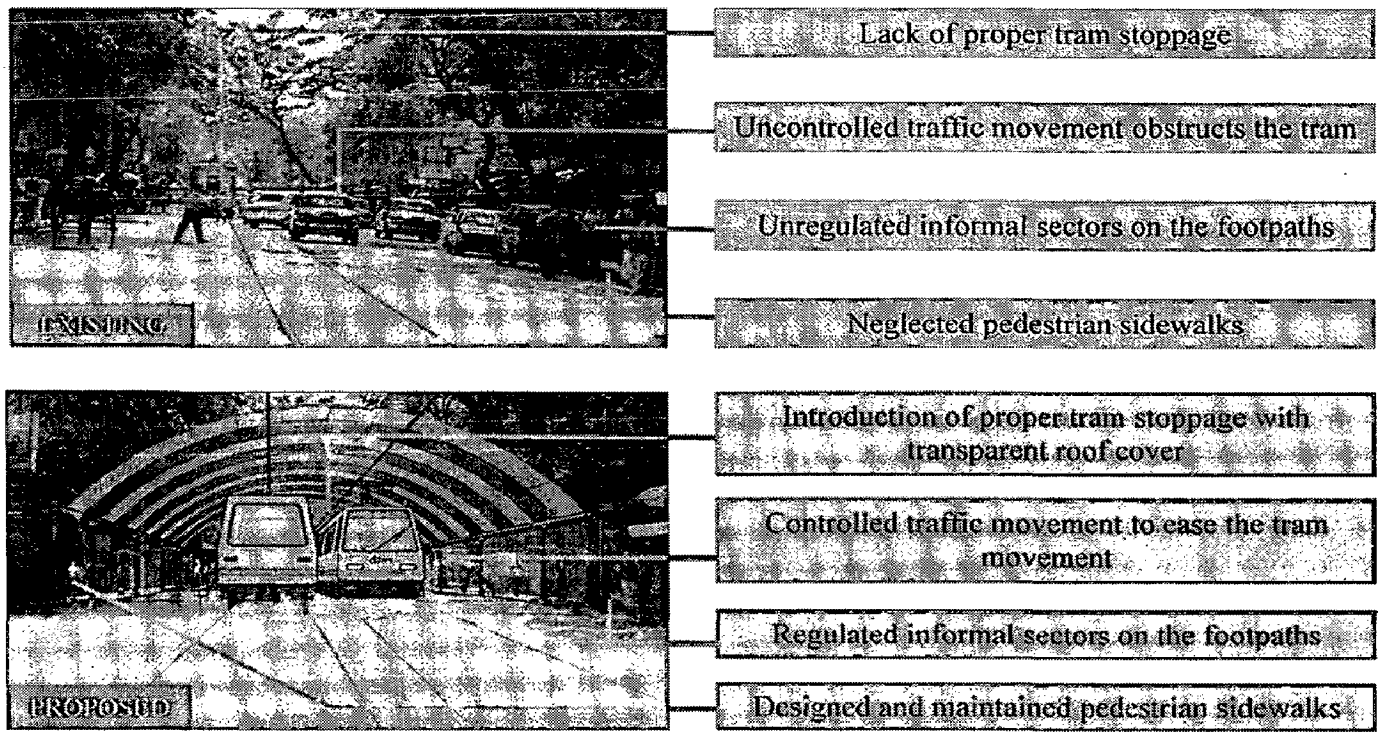


Figure 139 Proposal of proper tram stoppage and the other facilities

The tram stoppages should have roofing to its entire length because Kolkata has hot and humid climate so it is to ensure the passengers should have minimum exposure to the sun while they are waiting for the tram, alighting to or boarding from the tram (Fig: 141). Each and every tram car should be maintained properly to ensure its cleanliness, neatness of its seat outfittings, floor and wall furnishing etc. The more it will be maintained the more it will run efficiently and also increase the passenger comfort.

6.1.7 Functionality of tramways: Development plan policies should be made to increase the functionality of the tramway system. First off all there should be diversities in the usage pattern of tram. At present it is mainly used for the public transport, but it should be used for the other purposes too. Cargo tram can be used in the commercial areas like Barabajar, Posta, Bhawanipur market, Baithakhana Bazar, Kole market etc., which will not only help to ease the goods transportation but will also reduce the goods traffic pressure from the road on the peak hours. Proper planning and management can make the tramway service faster, cheaper and reliable and then it will automatically attract the businessman to transport their goods by tram which will in return earn more revenue. School special tram can be used for safe, secured and comfortable transport of the children to and from the school. Heritage and tourist special tram can also be the key for revenue generation (Fig: 142).

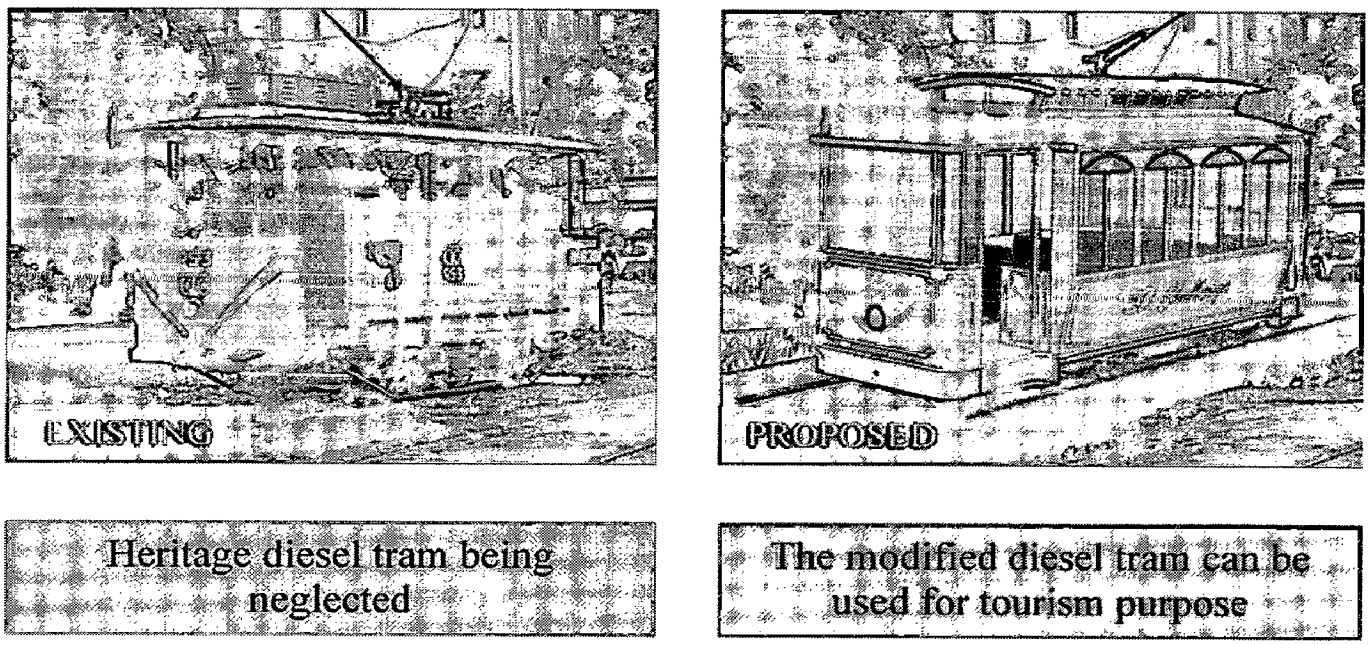


Figure 140 Modification and re-use of the old trams

The policies should also be developed to increase the numbers of passengers. It can be done by modifying the tram routes and networks, better integration with the other transport network, increasing availability and punctuality of tram, decreasing journey time with the help of traffic control and management system and traffic signal prioritization for tram, diversities in tram usages, increasing passengers comfort and increasing the public awareness to use tram.

6.1.8 Management system: Kolkata tramway is in a badly need of a good management system. The present management system of CTC is not so interested to improve the tramway service as no future development plan policies for the tramway have been taken so far. The total tramway system requires an immediate up gradation in terms of technology, accessibility, reliability, convenience, comfort, safety and security.

For the technical modification and improvement some factors should be considered i.e. revamping the tram track and overhead wire system, provision of additional turn around loops, methods for energy conservation, use of alternative energy instead of only electric, introducing modern technology to improve the efficiency etc. Traffic signals and traffic management should be redesigned to incorporate the prioritization of the tram movement instead of private vehicle (Fig: 143). The proper and scientific traffic management thus can help to reduce the traffic congestion. The emphasis sholud also be given to the ehancement of motorman's working environment, enhancement of passenger information system, facilitate passengers flow, facelifting of old trams etc.

Investment is much required for the up gradation, revival and maintenance of the whole system. For this, sound financial policies should be taken which should cover the introduction of feasible fare structures, various methods of revenue earning, methods of decreasing operational cost, improvement of service efficiency etc. Financing the business plan can be from increasing the fare, congestion charge income, income from advertisement both on the tram car and in the stoppages, renting out of CTC's properties, introducing PPP model in some projects, Govt. grant or bank loan.

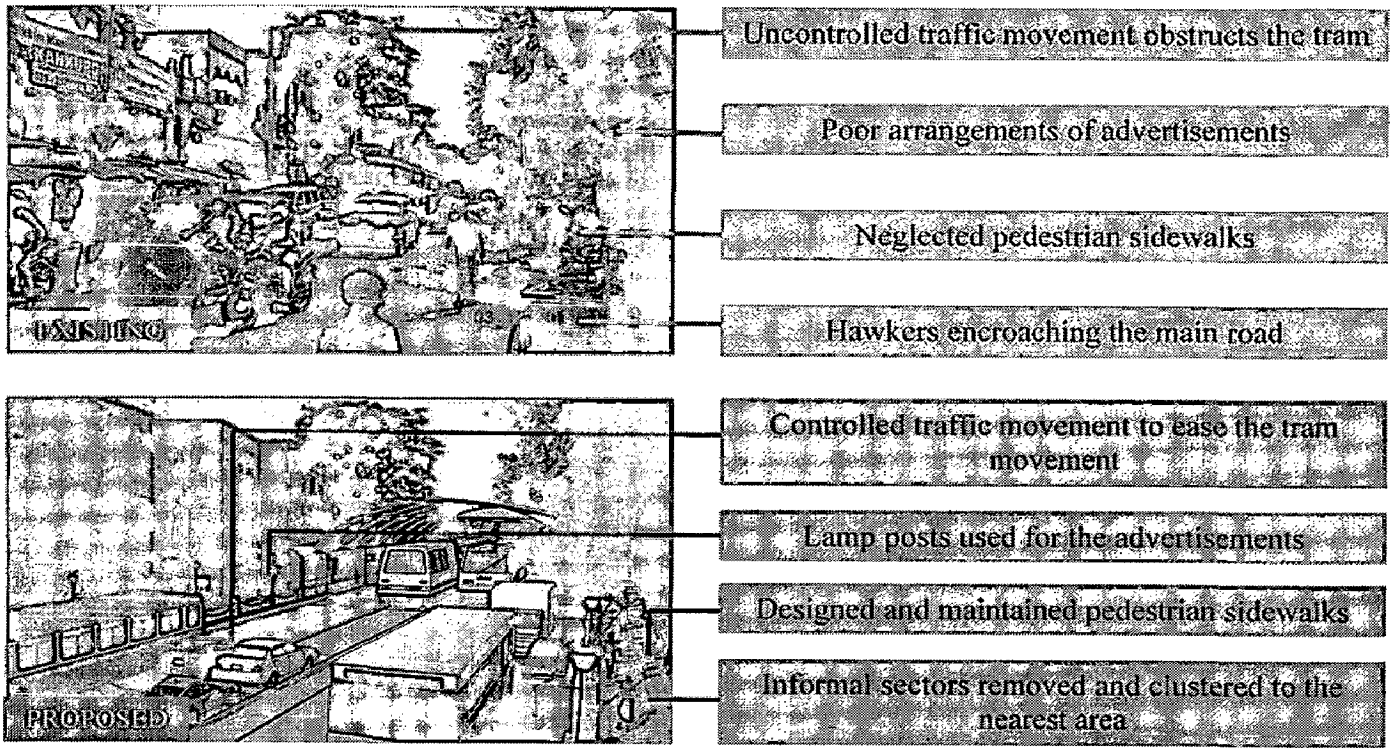


Figure 141 Traffic management and signal prioritization for tram

The building planning and management system should also be incorporated and integrated with the tramway system, because for betterment or conserving the street environment or building architecture along the area the change or modification in building by laws is required. Modification in land use pattern is also needed to get the maximum benefit out of the improved tramway network. Redevelopment of landuse including dense mixed landuse integrated with the tram routes should be adopted.

6.2 Recommendations to improve the streetscape

Being an integral part of a city character, a well maintained streetscape always gets first preference while enhancing the city beautification. The improvement of tramways will not get success unless it will have a better integration with a good quality of streetscape and tram street architecture. Once it had great street environment which includes covered pedestrian ways, proper garbage disposal system, ornamented street furniture, statue, monuments, obelisk, plaza, open spaces and public gathering spaces, but presently they are all gradually vanishing due to the negligence and lack of awareness. As a first step and integral part of revitalization process, the Kolkata streetscape along the tram routes, particularly of the central areas of mixed land use and architectural heritage interests, should be improved with addition, improvement and substitution of streetscape elements.

Enhancing street environment is not only the improvement of street furnishing, betterment of urban art, landscaping or making of parks and public gardens, it also includes the improvement the pedestrian environment, both vehicular and pedestrian traffic management, betterment of accessibility both for pedestrian and vehicular traffic, proper lighting system, traffic calming measures, improvement of signaling system, solving parking problem, modification or controlling of building facades and provision of public amenities. Here are some recommendations which can be adopted to improve and integrate the streetscape with the tramways in Kolkata.

6.2.1 Traffic management: The standard guidelines for determining transportation improvement projects will be difficult to adhere to in Kolkata because of the nature of the city. The current nature of determining the need for transportation based on UDPFI guidelines projects is difficult to apply (which proposes a minimum of 15-18% of land use for transportation) where as Kolkata has a mere 6% of land under transport use with a pressure of rapidly increasing traffic volume. So what required is the scientific traffic management to minimize the traffic jam, improvement of traffic flows and the efficient usages of available road spaces.

Traffic management consists of several factors such as by passing of traffic in some special days or in peak hours; lane separation system, advanced traffic signaling system, signal prioritization for the pedestrian and public transport rather than the private cars, using the same road for one-way and two-way traffic in some specific time span (two-way in peak hours and one-way in lean hours), by passing of slow moving vehicular traffic to the other alternative routes to reduce the pressure on the main busy road, and restriction of speed according to spaces (low speed in the residential and institutional areas) and the nature of road (low speed in the arterial, sub-arterial road and the link roads) (Fig: 144). Besides these, action should be taken to the breaching of traffic rules and illegal parking by setting a high amount of penalty charges. Public awareness programmes on rules and regulations for road usages and road safety should be carried out regularly.

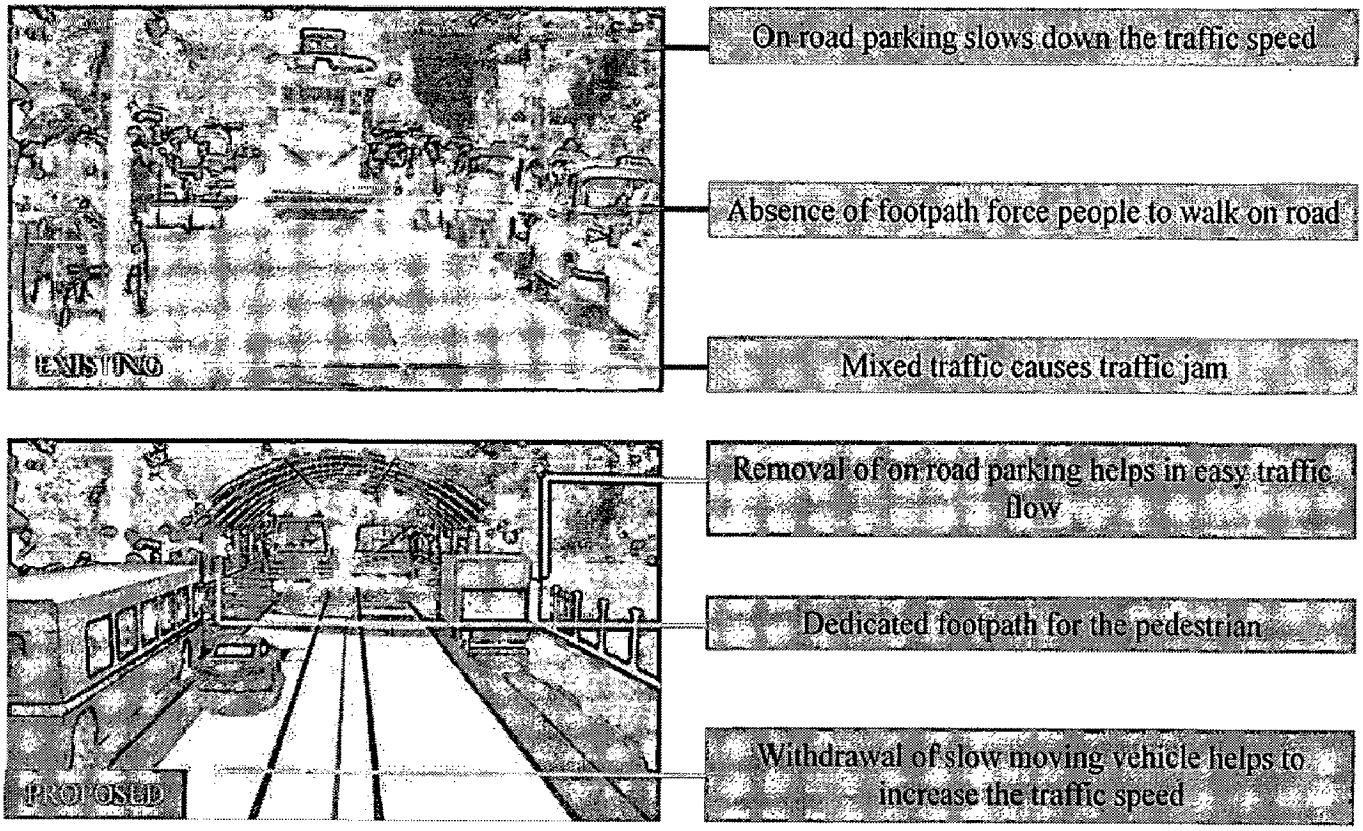


Figure 142 Removal of on-road parking and slow moving vehicle for easy traffic flow

6.2.2 Parking: Parking is one of the major problems in Kolkata. It is often in Kolkata to see a number of cars are parked on the main vehicular road and the vehicular traffic flow is getting obstructed for this. Adequate, multiple and flexible parking solutions need to be worked out. Restriction should be imposed on road side parking, breaching of this rule should be led to heavy penalty charges. New parking arrangements should be made in form of basement parking, multi-level car parking and time specific surface parking. The service vehicle should not be allowed to enter on the road in the peak hours and their loading, unloading works should be specified if the service road is not available.

6.2.3 Pedestrian environment: The improvement of pedestrian environment is badly needed in Kolkata. The areas which have been mentioned earlier have the potentiality to improve the pedestrian environment but it is neglected. Each of the selected area witnesses high pedestrian traffic volume both in peak and lean hours. The pedestrian environment includes the footpath, crosswalks, road crossing, paving, public information system, traffic signal and signage, accessibility to bus and tram stoppage, traffic calming measures, lighting, environmental factors, safety, security and comfort.

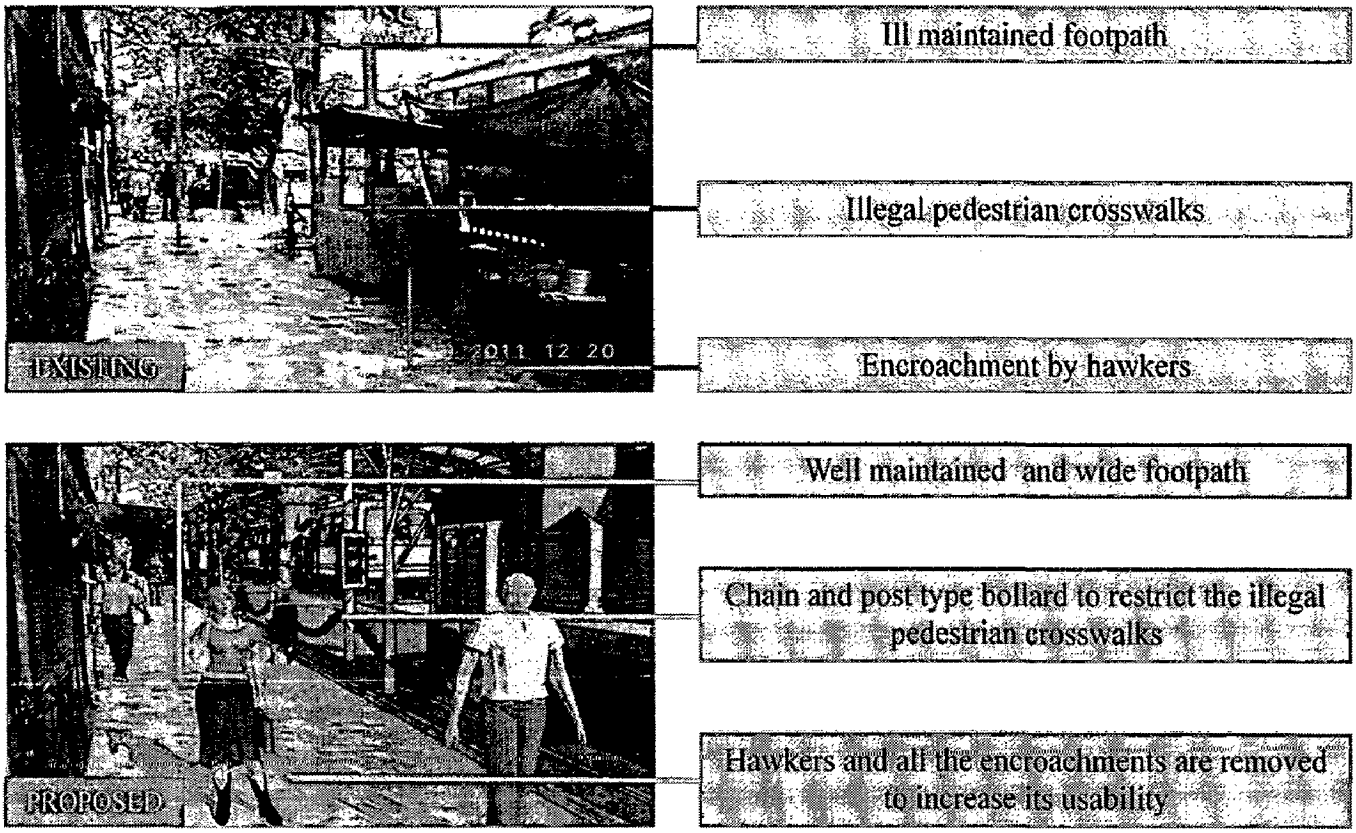


Figure 143 Improvement of pedestrian sidewalks

First off all the encroachment on the footpaths should be evacuated immediately to make the footpath free for the pedestrian movement. If possible, then the narrow footpaths should be widened to increase the carrying capacity of pedestrian traffic (Fig: 145). The footpath should have universal accessibility i.e. it should have ramped access from the road level, the paving should have tactile material to assist the visually impaired people, and proper railing or bollard should be there throughout its entire length to assist the older people and children. In addition to street intersection locations, accessible ramps are to be provided at all access drives, alleys, and any other locations where sidewalks intersect with vehicular zones and where existing grades require the use of ramps to maintain accessible routes. Ramps at intersections are to be aligned with existing or future opposing ramp located on adjacent blocks.

Combinations of paving enhancements and curb extensions are proposed at street intersection to slow vehicle approach and turning speeds, while creating shorter crosswalks and more prominent staging areas for pedestrians preparing to cross our city's streets (Fig: 146). These extensions are commonly referred to as 'bump-outs" or "bulb-outs". Essentially, well-designed curb extensions effectively narrow the vehicular cartway and reduce vehicular turning radii in an effort to slow motorists'

travel speed at street intersections. Space lost to vehicular use is gained for pedestrian use at street corners, and the pedestrian crossing distance at busy street intersections is minimized. Maintaining adequate curb radii is essential to provide larger vehicles with ample turning space without encroachment into designated pedestrian areas.

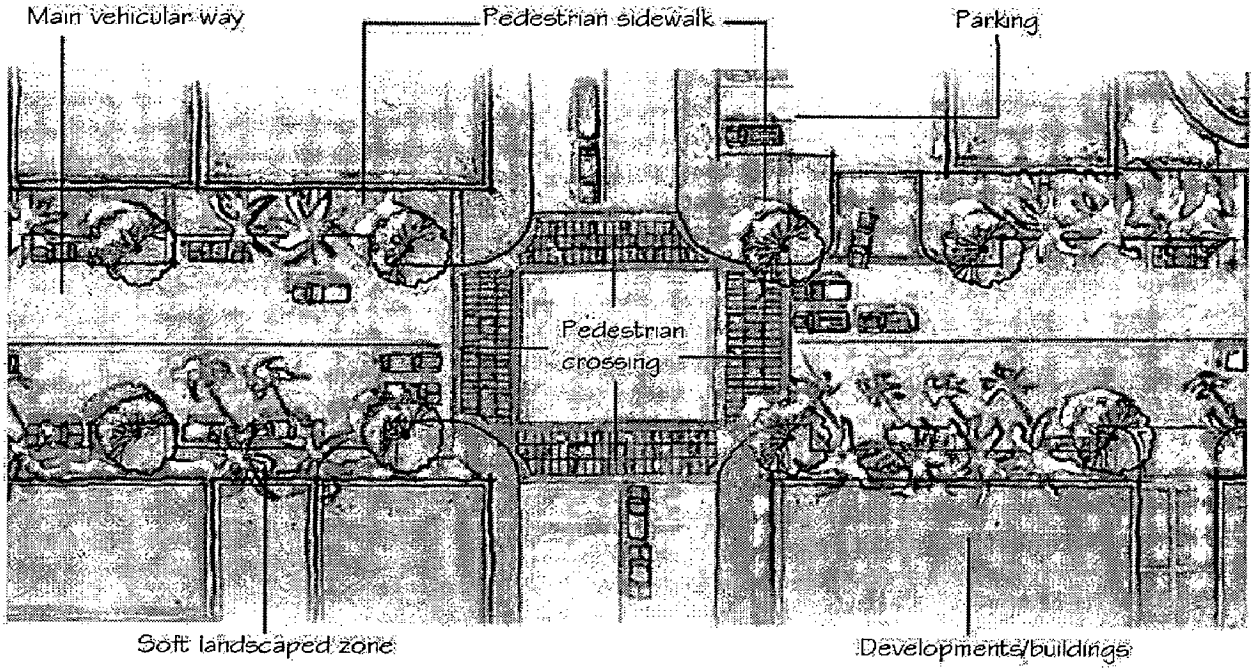


Figure 144 Enhanced paved pedestrian cross walks at the major junctions

Instead of zebra crossing, footbridge or subway should be made on the major roads to minimize the road accident and to continue the vehicular flow. Where the zebra crossing is present, pedestrian signal prioritization should be ensured at that crossing. Adequate public information system should be there to make people convenient to the road traffic. Legible traffic signage should be installed at all the critical or important locations of all roads specially in the junctions or main crossings to ensure the peoples' safety and smooth the traffic flow.

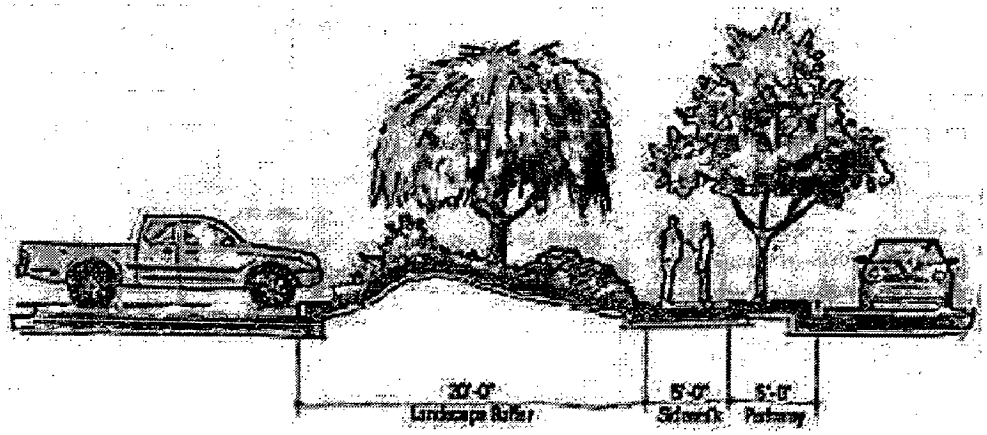


Figure 145 Shaded pedestrian sidewalks and the landscape buffer

The bus and tram should stop at specific stoppage instead of stopping in the middle of the road. All those stoppages should be properly designed to ensure the accessibility for all kind of people. These types of controlled vehicular stopping will greatly help to reduce the traffic jam and also to minimize the road accidents. It is advisable to construct covered or semi covered pedestrian sidewalks to protect them from sun and rain. If it is not possible to construct the covered footpath then it is mandatory to plant trees to cast shadow on the footpath (Fig: 147). The selection of trees should be decided after consulting the landscape architect. If all of these will be adopted, then automatically it will help to improve the pedestrian environment and also enhance the pedestrian comfort.

6.2.4 Landscape: A well designed streetscape is always best integrated with a well designed landscape. Landscape includes the open spaces, plants and trees and supplementary planting. The open spaces should not be designed in isolation; it should be designed according to the site, road character, nature of usages, users' behavioral pattern, climatic condition and the site surroundings. It should be designed in such a fashion that it can be visible from the road and people can easily access to the space. It will then create interest among the people and it will be fully utilized. The space can accommodate parents while they are waiting for their children at school hours for a short period of time but still it can act as a social space. It can be a rendezvous for the young college students and the morning walkers if it is designed carefully (Fig: 148).

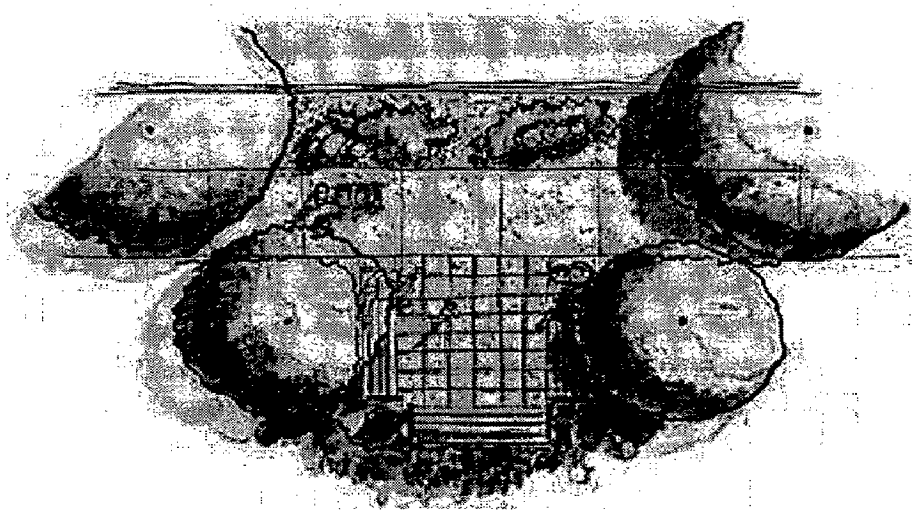


Figure 146 Public open spaces visible and accessible from the road and sidewalks

More than any other streetscape component, plantings enliven our public spaces, define an identifiable pedestrian scale, and herald the changing seasons with natural vibrancy. In addition to this, plantings may be used to buffer undesirable views, reduce detrimental effects of wind and noise, provide comfortable shade, lower energy consumption and reduce carbon dioxide levels through the photosynthesis process. In short, plants make cities more livable. It is imperative that proper consideration first be given to the protection and preservation of existing street trees. Factors to consider when evaluating existing street trees for preservation or removal from new streetscapes include a specific tree's age, health, size, and overall form.

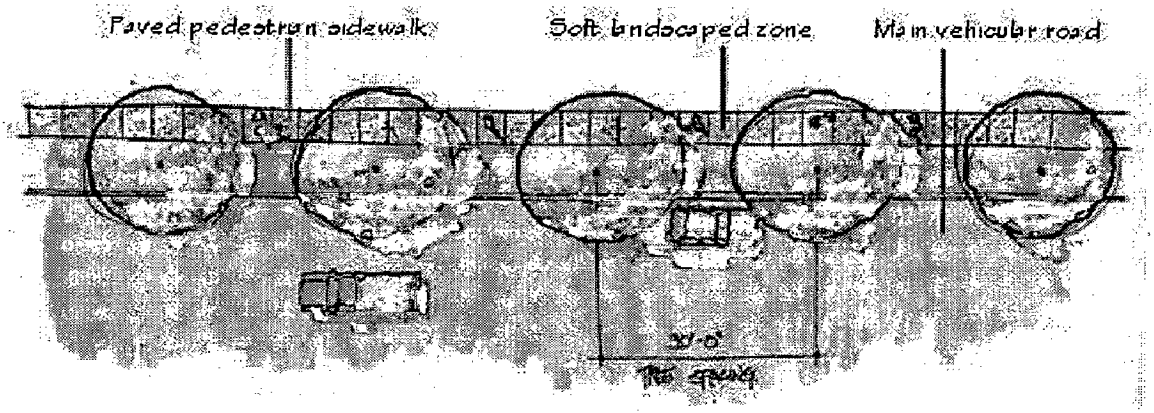


Figure 147 Position of trees on the sidewalks

Once a determination to preserve an existing tree during construction is made, certain construction procedures must be followed. Tree protection fencing must be installed around existing trees. Storage of construction materials and/or machinery will not be permitted beneath any tree canopy's drip line (edge of branch tips). Harmful construction runoff to root zones must also be avoided.

When selecting new street trees for an entire block or for a more limited area, it is not essential to replicate the species of existing trees within the same area. To partially offset the numerous environmental stresses imposed upon city street trees, appropriate species selection for tolerance of urban conditions and ability to grow within confined areas (overhead utilities, nearby building facades, limited root zones) is essential when choosing a tree species. The position of the new plantation is also an important factor because it is associated with the position of lamp posts, traffic signals, other utilities features etc. It is recommended to plant new trees with the distance of 30' from each other (Fig: 149).

Consideration must also be given to a site's specific micro-climate resulting from the effects of shade and wind. Select tree species with mature heights less than 30' where trees could potentially conflict with overhead utility lines or building overhangs. Wherever feasible, overhead utilities located along key corridors should be relocated underground, or to adjacent alleys which parallel these key routes in an effort to reduce visual 'clutter' and to permit the use of larger, canopy producing trees.

Following careful species selection, tree size must be the next important consideration. To comply with city ordinances and to minimize conflicts of lower tree limbs with vehicular and pedestrian zones, bottom tree branches shall be at least 9' above adjacent sidewalk elevations and at least 13' above vehicular circulation areas at the time of tree installation. No street tree shall be smaller than a 2" caliper size (the diameter of the trunk measured 4' above grade) at the time of tree installation.

Where adequate support structures such as fencing or blank, feature-less building facades exist, vines may also be used as supplemental plantings intended to make city 'greener,' while requiring only limited growing area. Again, specific site conditions and available support structures must be carefully considered when selecting the best vine for a specific growing location. One of the greatest successes to improve our city's streetscapes would be the container planting. Seasonal annuals, bulbs, vines, and shrubs to be used in container plantings must be selected for drought tolerance and specific micro-climatic conditions such as wind and shade. Where intense, seasonal color is not desired, containers may be planted with more permanent installations of evergreen materials with proven root hardiness and an ability to survive in containers through the winter months. Such permanent plantings are especially warranted on streets where extensive underground utilities and vaults render street tree plantings impossible.

6.2.5 Street furnishing: Proposed site furnishings include benches, litter receptacles, bollards, bus and tram stoppage, fences, sign poles, banners and utility covers. A detailed study should be carried out to make the database of existing streetscape elements, their present condition and the level of requirement. As per the database, the necessary action should be taken. All the three road stretches, selected in this

dissertation, have a sufficient numbers of street furnishing elements. Ornamented wrought iron jali works, decorated lamp post, Doric and Corinthian style columns, ornamented benches - these great architectural details are available in those areas, but it is due to the negligence and awareness they are going to deteriorate and gradually vanishing from the city.

The street existing elements should be conserved and then improved. According to the level of deterioration, they may need to be renewed or removed. After removal of the elements, it is also required to place it back at the previous position by constructing new one which should be harmonious and almost similar to the existing elements. As an example, the elements used in College Street Road cannot be copied to the other stretches as the nature of traffic; characteristics of roads and site are totally different from one another. Modern elements can be used In State Highway, Sealdah as it has modern developments surrounding of the road, but the same elements cannot be used in Kalighat or College Street as they are fully surrounded with colonial style architecture. In that case the surrounding architecture should be reflected in the newly added elements.

The banners, hording, posters and any kind of advertisements which seemed to be the obstruction of a pleasant streetscape should be immediately removed and a managed way of advertisement should be adopted. The advertisement can be done in such a way so that it can be a feast of eyes. Design clearly visible and consistently sited signs, allowing readers to easily locate information. Integrate signs into its surroundings in such a way that the message is clear, but does not dominate other architectural features. Properly install and maintain signs on quality mountings so that the intended alignment and orientation are sustained. Avoid unnecessary and unsightly clutter of multiple signs that result in information confusion. Design signs using appropriate scale, height, and color that integrate consistently with the development. Position signs so as not to obstruct or obscure views of oncoming traffic for motorists entering and exiting the premises. Coordinate signage with other street furniture.

The visual appearance of the city can be up-lifted by introducing urban art, sculptures or any monuments harmonious to the site. All the landmark details should be well documented & make it available for the tourist to create interest. Instead of using simple iron railing, the chain and post bollard can be introduced which will create a feeling of less physical bounding lacking in the continuous iron railing. The movable tables and chairs should be placed in a planned manner so that it should not affect the pedestrian and the other activity (Fig: 150).

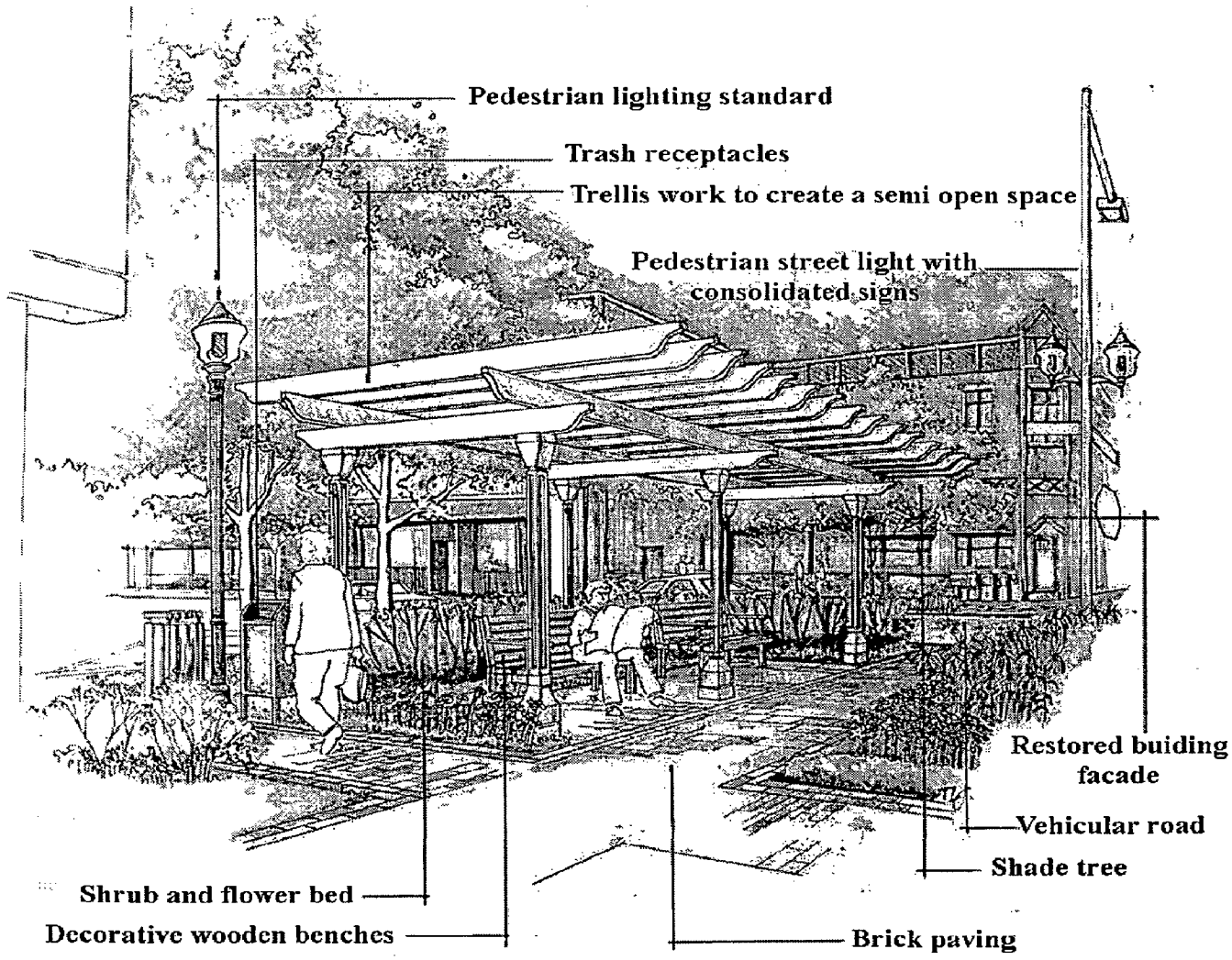


Figure 148 Detailed design of the road side public open space with street furnishing

6.2.6 Lighting: Design the placement of lighting and utilities on buildings and the project site in a manner that promotes safety and an overall positive effect on appearance and use. Provide attractive lighting consistent with building style, materials, finishes and colors. Incorporate ground-level, overhead, and building mounted lighting throughout the project area. Use up-lighting (under trees), diffused lighting, and low level walkway lights within landscaped areas. Utilize accent lighting to highlight key

features in the community. Choose lighting sources and light levels to provide optimum illumination and to reduce light pollution. Only light areas required for safety and comfort. Provide sufficient lighting for safety and use. Prevent over-illumination, light spillage trespass and glare, and avoid insufficient or uneven illumination, especially in areas where pedestrian and vehicular movements coincide. Use down-shielded or low-pressure sodium lighting as close to the ground as possible, in some situations, such as residential transitions to commercial uses. Use metal-halide sources in pedestrian areas, streets and parking areas, for the visual comfort of pedestrians. Overlap light sources at about 7 feet to give even coverage and visual recognition of pedestrians in areas and crosswalks where pedestrian and vehicular movements coincide. Highly encourages compliance with Leadership in Energy and Environmental Design (LEED) site performance standards (Fig: 151).

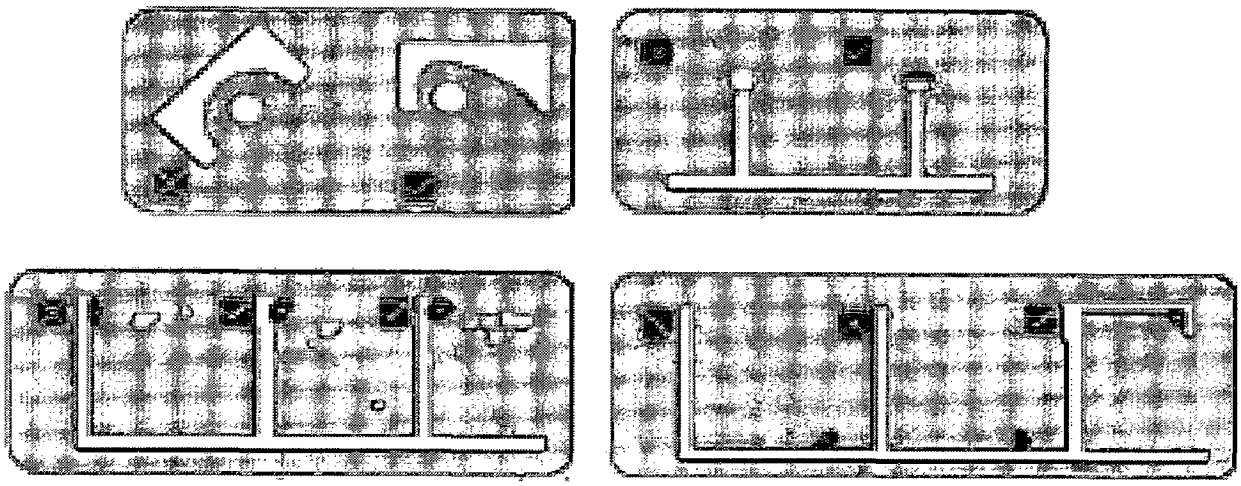


Figure 149 Correct and incorrect lighting angles to consider in designing for reduced glare and sky glow

6.2.7 Building architecture: Streets are strongly defined by the "street-walls" of buildings that are built up to the edge of the sidewalk to form consistent spatial corridors. There are only a few significant "holes" in the continuous fabric of buildings that define the streets. It is advisable to encourage a high quality and visually interesting roof horizon to lessen the mass of the building and to add visual appeal. Proposals can be given to provide a variety of roof lines and plane lines, especially where building heights exceed 20'. Vary roof lines of large buildings to reduce apparent scale and mass. Using of three-dimensional cornice treatments, parapet wall details, overhanging eaves, etc. to enhance the architectural character of the roof. Encourage should be given to deep roof overhangs, articulated eaves, and parapets to create pedestrian arcades and verandas. Provide articulation of all building

façades and include variation in massing, roof form and wall planes to reinforce the concept of 360° architecture and high quality façades at the rear and sides of new buildings through careful design and detailing, in keeping with the architectural design and theme style of the front façade (Fig: 152 and 153).

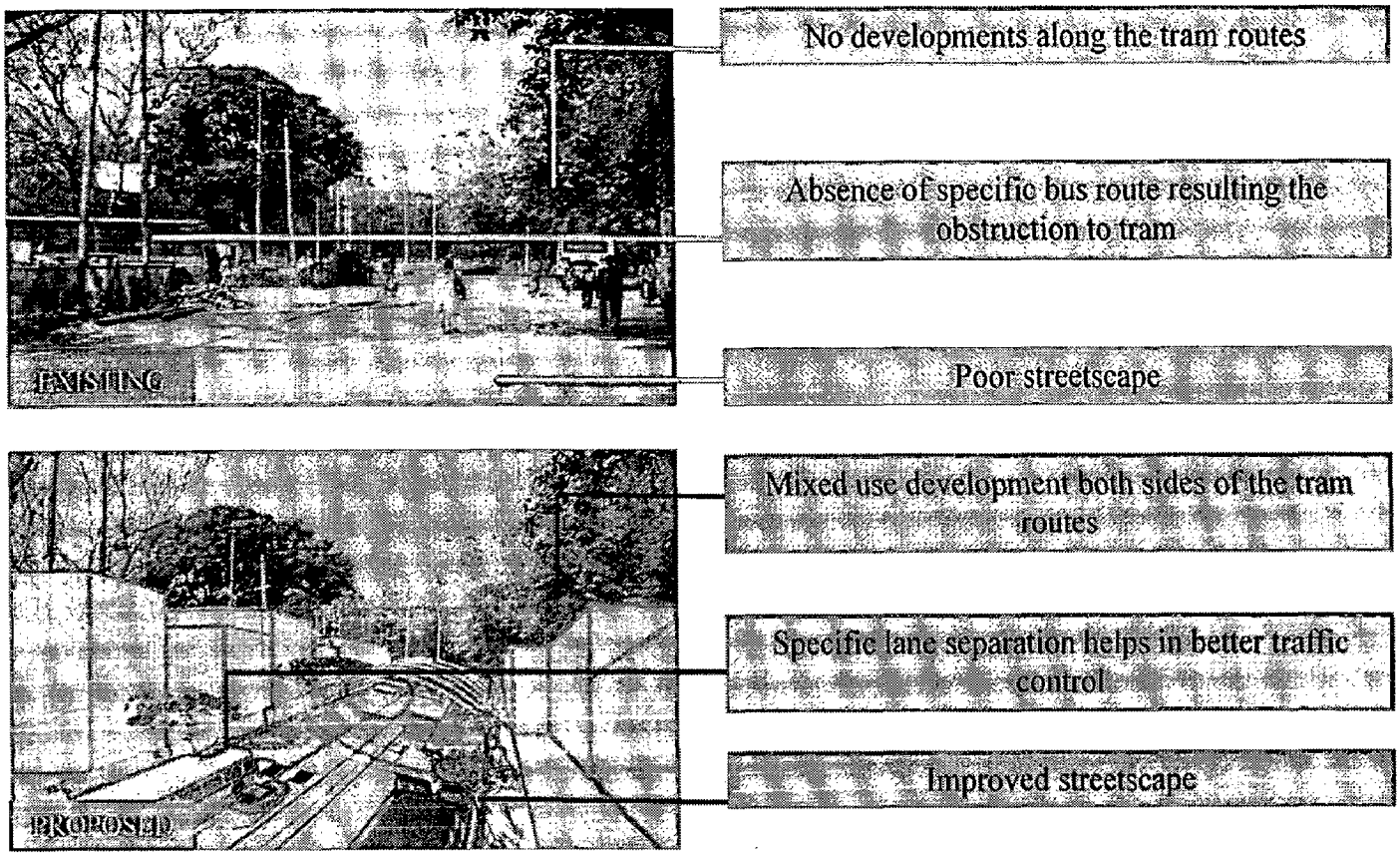


Figure 150 New developments along the tram routes

To create visual interest in building façades use a combination of the following design elements and guidelines:

1) Avoid blank walls.
2) Provide the highest level of articulation on the front façade and all other façades visible from the street.
3) Articulate walls using details such as insets, canopies, wing walls, trellis features, arcades, and colonnades.
4) Incorporate similar and complementary massing materials and details into side and rear yards.
5) Place murals, espaliers/trellises and vines on large wall expanses.
6) Use lighting and fixtures that are complimentary to the intended style/theme for the project.

7) Use materials, colors, fenestration, scale and massing consistent with the intended architectural style or theme for the project or project area.
8) Use materials in a manner that carry through to all façades, consistent with the architectural style of the project.
9) Break down building wall mass into smaller massing of colonnades to provide a more intimate, human-scaled environment.
10) Create shadow lines in massing section and fenestration.
11) An expression of architectural or structural bays through a change in plane no less than 12" in width, such as an offset, reveal or projecting rib.
12) Create virtual boundaries by a change of level, material, texture, and color.
13) Create a contextual fit-strong massing, horizontal division (base, middle, top)

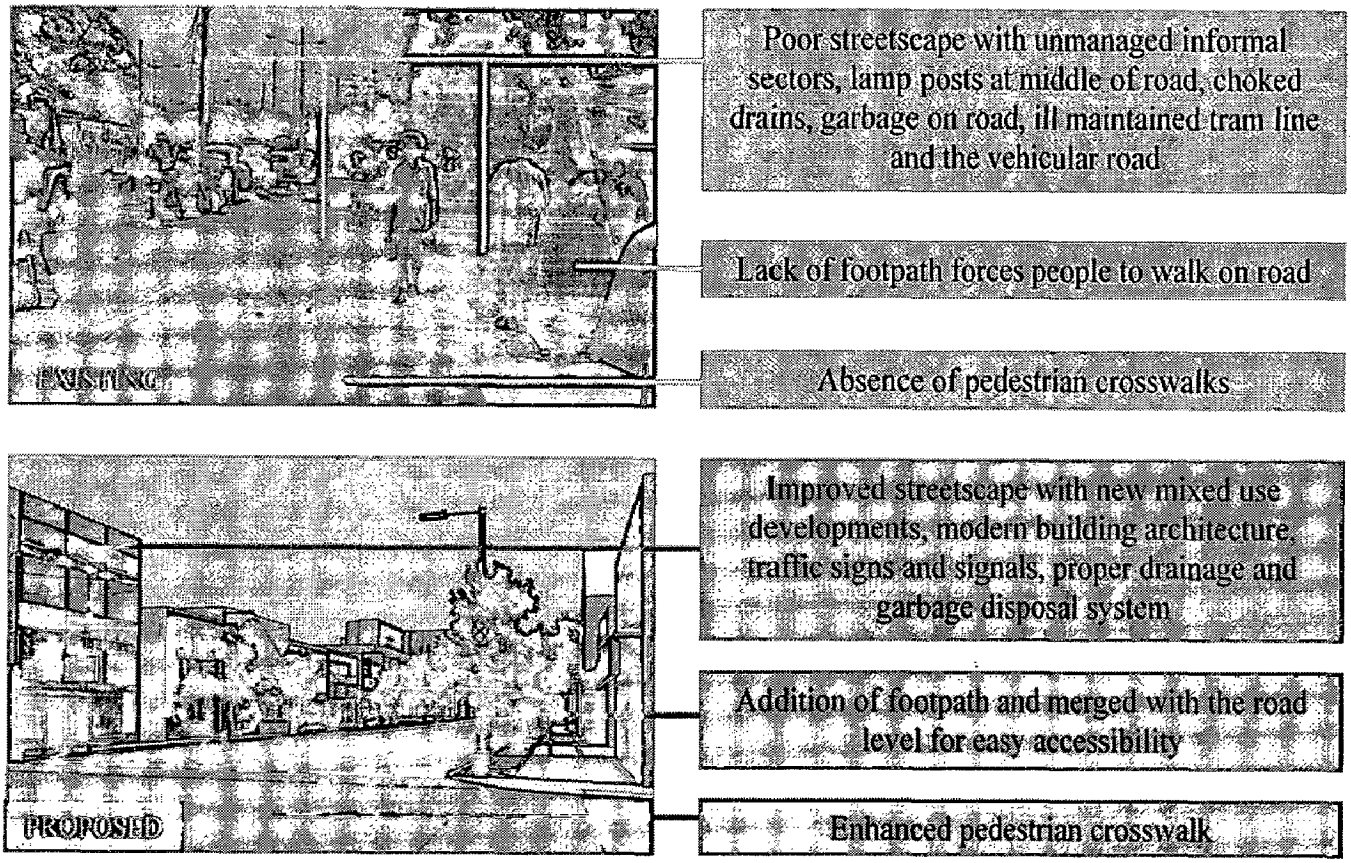


Figure 151 Proposed streetscape by improving building architecture

6.2.8 Activity patterns: Kolkata is a walking city with a continuing tradition of street-level retail and well-designed building facades that present a welcoming public face to the buildings. The sidewalks remain the principle place of pedestrian movement and casual social interaction. They are the continuing focus of retail activity and are the principal venues for casual public interaction. The relationship between public

open spaces and the activity of the surrounding pedestrian streets is crucial to their success. In general, the most successful urban open spaces are those with direct physical and visual access to the adjacent streets. Presently all the footpaths are lined with varieties of shops which make the spaces more livable. It is better to have some kind of activities on the footpaths rather been deserted; it helps to increase the social interaction, safety and security of the users. The proposed activity patterns should follow the existing patterns so that easily mingled with the site characters. The informal activities should be controlled in a proper way by giving them a specific space near that area instead of allowing it to sprawl to the whole area (Fig: 154).

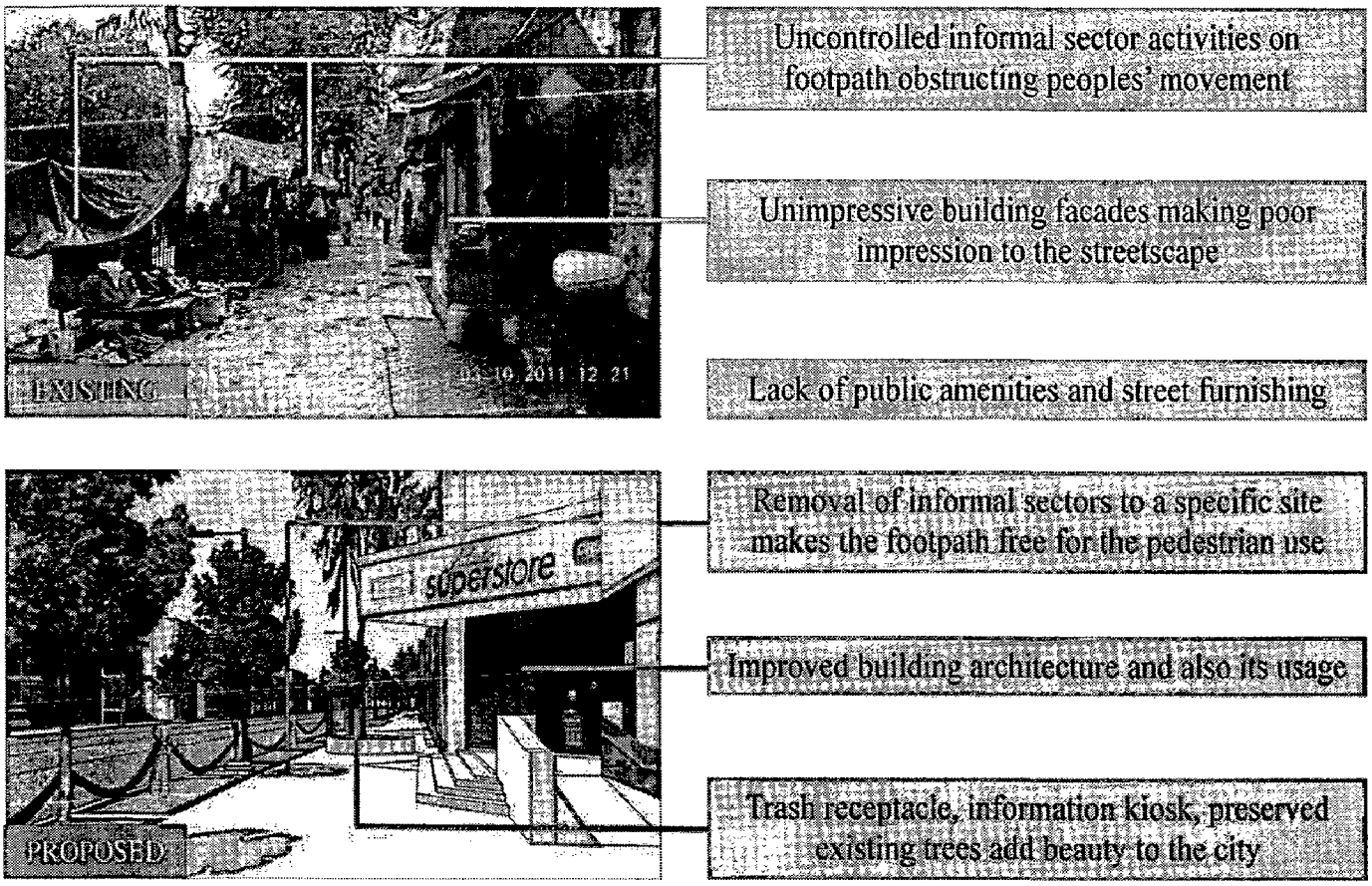


Figure 152 Removal of informal sectors and improvement of building architecture

It is always advisable to go for the mixed use development instead of only residential or commercial development. It helps people to have their basic necessities within the walking distance and also the city govt. to have control over the development. The mixed-use development guideline section is intended to combine residential uses with one or more of the following uses: office, retail, entertainment, and restaurant or community facilities. Generally, developers are encouraged to implement a vertical mixed-use typology, such as multi-family residential use above a retail use. The

ground floors of buildings should be encouraged to contain public or semi-public uses such as retail or entertainment uses with direct entry from the street. Retail activities within buildings should be oriented towards the street and have direct access from sidewalks through storefront entries. Internal, vertically organized retail malls are discouraged. Ground floor storefront restaurants are strongly encouraged to have French doors, operable storefront windows and sidewalk cafes to increase the connection between the interior and exterior environments (Fig:155).

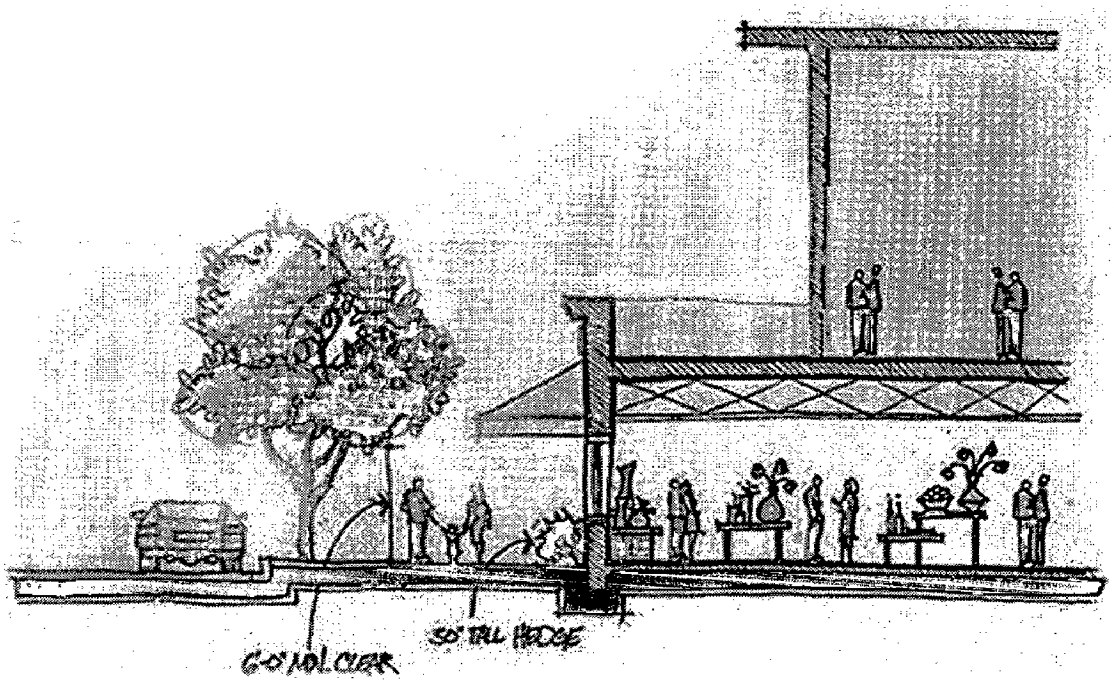


Figure 153 Pleasant pedestrian environment with sidewalks cafes and other activities

Mixed-use development plays a vital role in creating neighborhoods where people can walk between home, work, shopping, and recreation. The primary design issue related to mixed-use projects is the need to successfully balance the requirements of residential uses, such as the need for privacy and security, with the needs of commercial uses for access, visibility, parking, loading, and possibly extended hours of operation. Urban design and the continuity of shop-fronts are to be developed in accordance with 'main street' design principles, characterized by continuous building frontages adjacent to, and with awnings over, the footpath. Mixed-use development should result in the formation of a focal point for retail, office, entertainment, recreational, and community related activities for the immediate area (Fig: 156).

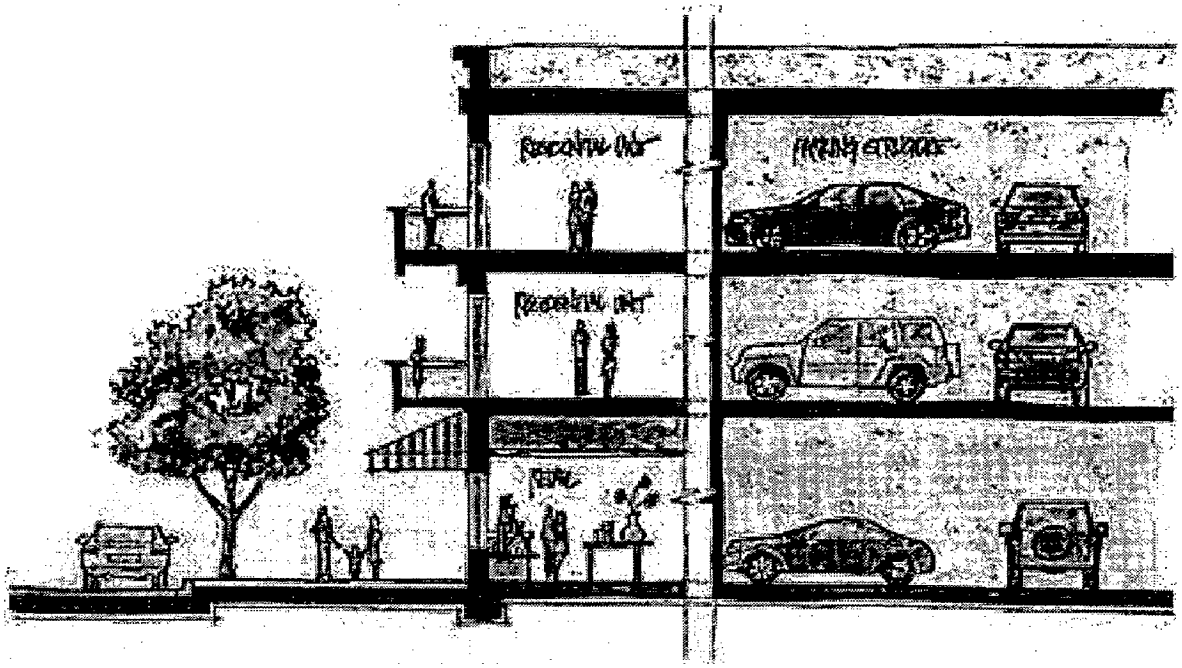


Figure 154 Proposed mixed land use development

To provide quality mixed-use developments consider following elements and the guidelines in the overall design of mixed-use developments.

1) Allow both vertical and horizontal integration of uses in mixed-use development, with an emphasis on tying the uses together with appropriate pedestrian linkages.
2) Design into the project adequate open space amenities to create a pedestrian-scaled environment.
3) Incorporate elements of building scale and architectural massing for reasonable transitions to adjacent developments.
4) Utilize consistent form for the entire mixed-use development.
5) Break up building façades with a high level of articulation, including window features, recessed elements, transparent storefronts, awnings, and entrance canopies, especially at the ground level.
6) For developments over two stories high, recess portions of the upper stories from the front façade to reduce the overall massing of the building.
7) In general, build mixed-use and commercial buildings to property lines or other publicly accessible areas, to define the street frontage and pedestrian areas.

6.2.9 Utilities: Carefully design, locate and integrate utilitarian aspects. Where screening is required, use a combination of elements, including solid masonry walls, berms, and landscaping as follows:

1) Screen all utilities from public view by incorporating it into the overall architecture. Development must comply with all utility company requirements for access, service, and ownership.
2) Provide roof access from the interior of the building. Exterior roof access ladders are not appropriate;
3) Locate mailboxes in alcoves away from streetscape for Commercial, Industrial and Multiple Family uses;
4) Provide decorative gutters on the exterior of the building, and integrate the gutters, overflow scuppers and downspouts with the design of the building façade. Conceal downspouts within the structure, where practical;
5) Design trash enclosures with similar finishes, materials and details of the primary building;
6) Locate enclosures away from view, from primary entrance drives or streets; Design enclosures with a non-combustible, overhanging trellis or roof cover;
7) Locate unsightly and noise generating elements such as, loading zones, service bay doors, and trash enclosures, so they can be screened from public right-of-way and adjacent properties;
8) Prohibit exterior vending machines or create alcoves for their placement.
9) The overhead HT lines are the single most disturbing feature in the visual landscape of the street, the city will have to invest in laying these underground (Fig: 157).
10) A proper garbage recycling program needs to be introduced by the municipality.

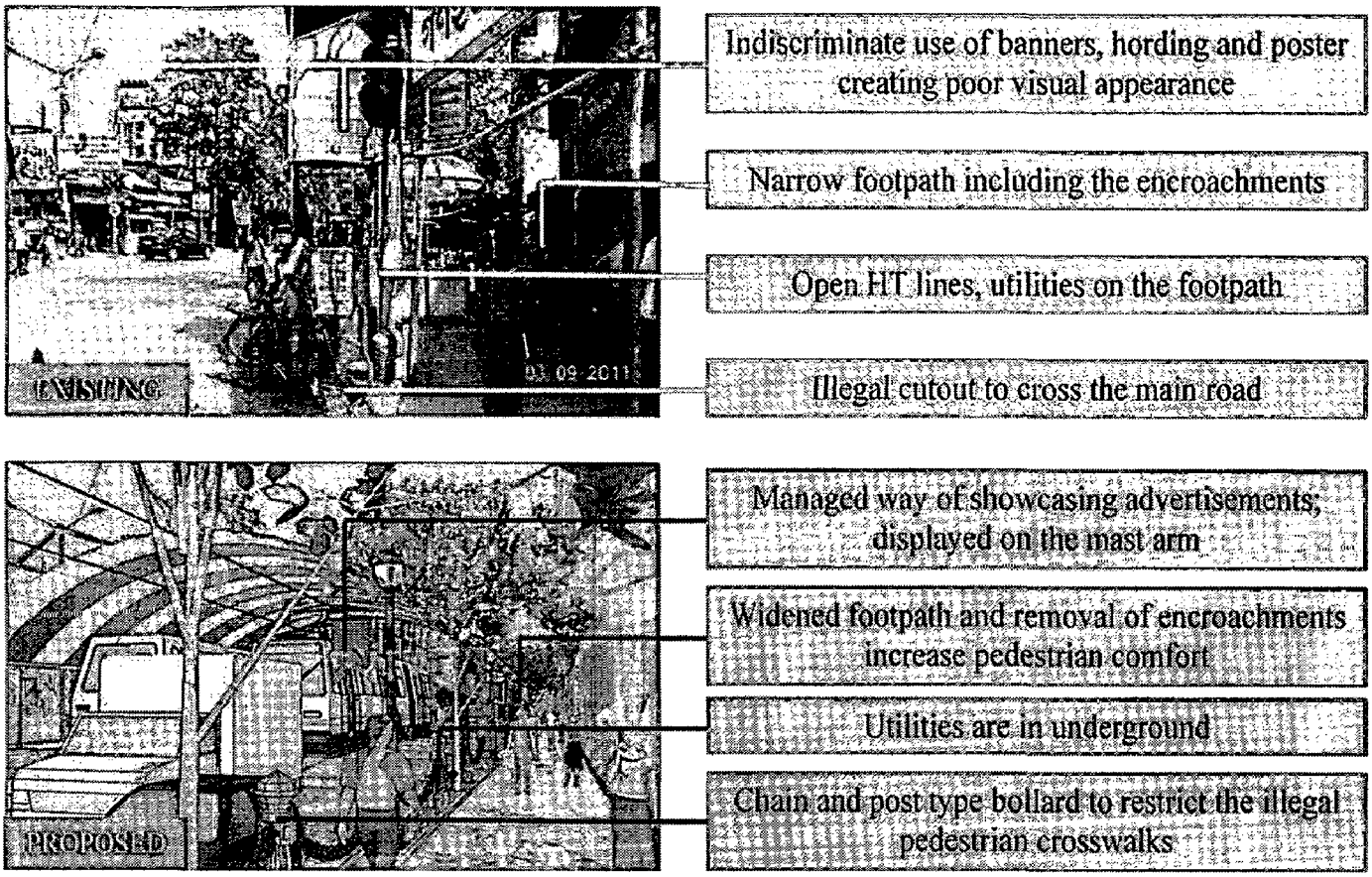


Figure 155 Wide footpath with utilities in underground and managed way of advertising

6.2.10 Public amenities: The well designed streetscape is not said to be completed unless it has the provision of the public amenities. Maximum of the roads and footpaths in the Kolkata are suffering from the absence of public amenities. It is very much advisable to construct the public amenities while designing the streetscape. The public amenities includes public toilet, information kiosks, seating in the public realm, ATM, public phone booth, drinking water etc (Fig: 154).

Proposals should be given for design guidance and policy direction for the provision and design of public toilets covering city-wide, district-level and site-specific principles. It should be considered as a fundamental principle that toilets should not be dealt with in isolation from mainstream urban policy, but that they should be seen as a serious core component in both strategic urban policy and local area design. Toilets are valuable townscape features in their own right as manifestation civic pride and good urban design - essential architectural components which add to the quality and viability of an area. Although a range of design guidance on toilets exists there is still considerable dissatisfaction with the end product in terms of building design, levels of provision, location, safety,

layout, and accessibility. Public toilets should be provided in: all main public transport termini and stations and major car parks, central areas, and in all district centers, and local shopping centers, all parks, allotments, urban farms and leisure areas at main junctions and by post offices in all suburban areas out of town developments in office, industrial and retail parks. User consultation and public participation should shape toilet policymaking. A toilet strategy, an overall spatial plan setting out the hierarchy, location and distribution of public toilets should be provided for every local authority as part of mainstream planning policy development. Maintaining specific facilities for disabled people, while: providing adequate toilets for all, not disenabling everyone else through narrow cubicles, poor access, steps, providing unisex disabled toilets for spouse partner cares, putting disabled facilities, baby-changing, adult-changing 'between' the ladies and gents, but having supervision and attendants where possible. A proper SAP (survey, analysis, and plan) programme should be undertaken to ascertain local needs, needs of tourists, shoppers, workers, commuters, visitors as well as residents should be included in toilet calculations as to need.

Publicly accessible places to sit in the public realm are important not only as basic amenities, but also in sponsoring causal public interaction. Seating can be both formal and informal, park benches on the tops of garden walls or the entrances to public buildings. The stairs at the entrance building can provide ample casual seating. Wherever possible provide seating adjacent to bus and tram stop. New public spaces should provide as many seating opportunities as possible. Planter walls should be set at a maximum height of 3'- 6' to allow for their use as seating.

6.3 Proposed views of the selected three areas

COLLEGE STREET ROAD (COLLEGE STREET)

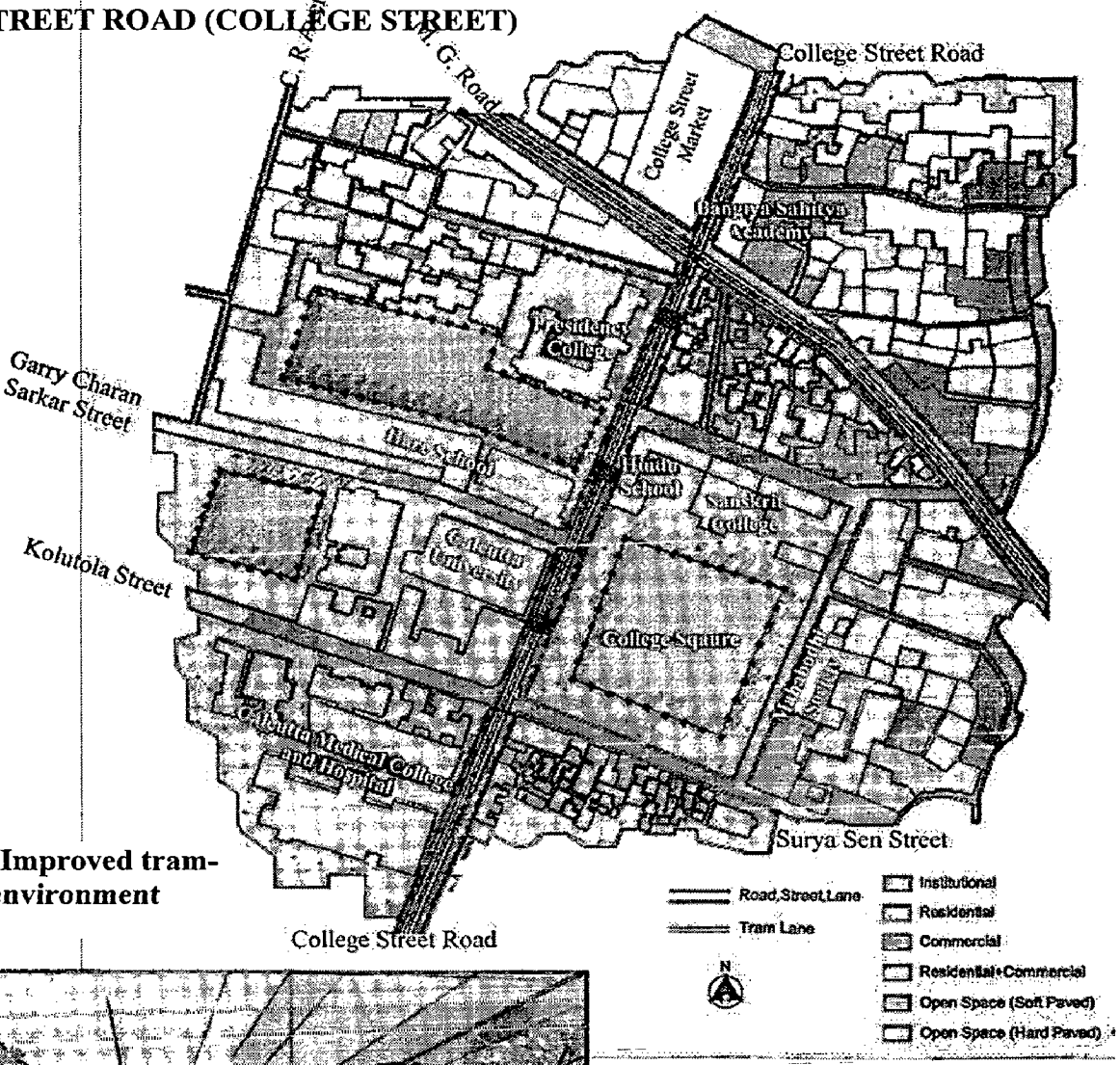


Figure 156 Improved tram-street environment

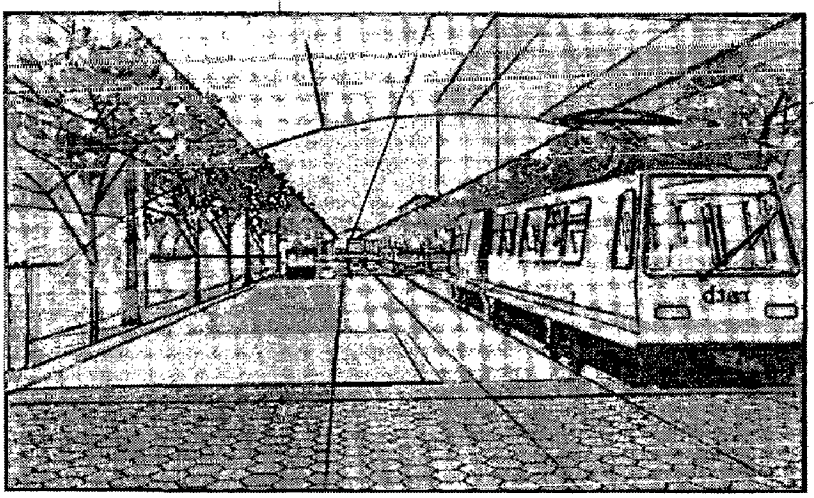


Figure 157 Proper tram stoppage with improved streetscape

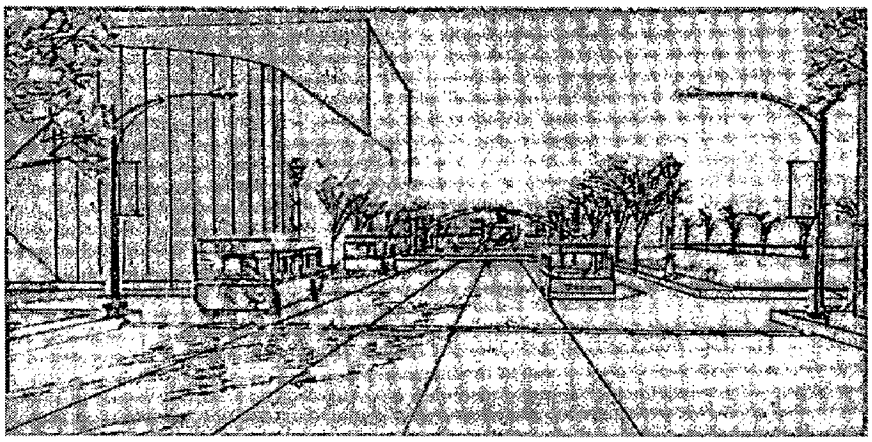


Figure 158 Improved streetscape with controlled traffic

S. P. MUKHERJEE ROAD (KALIGHAT)

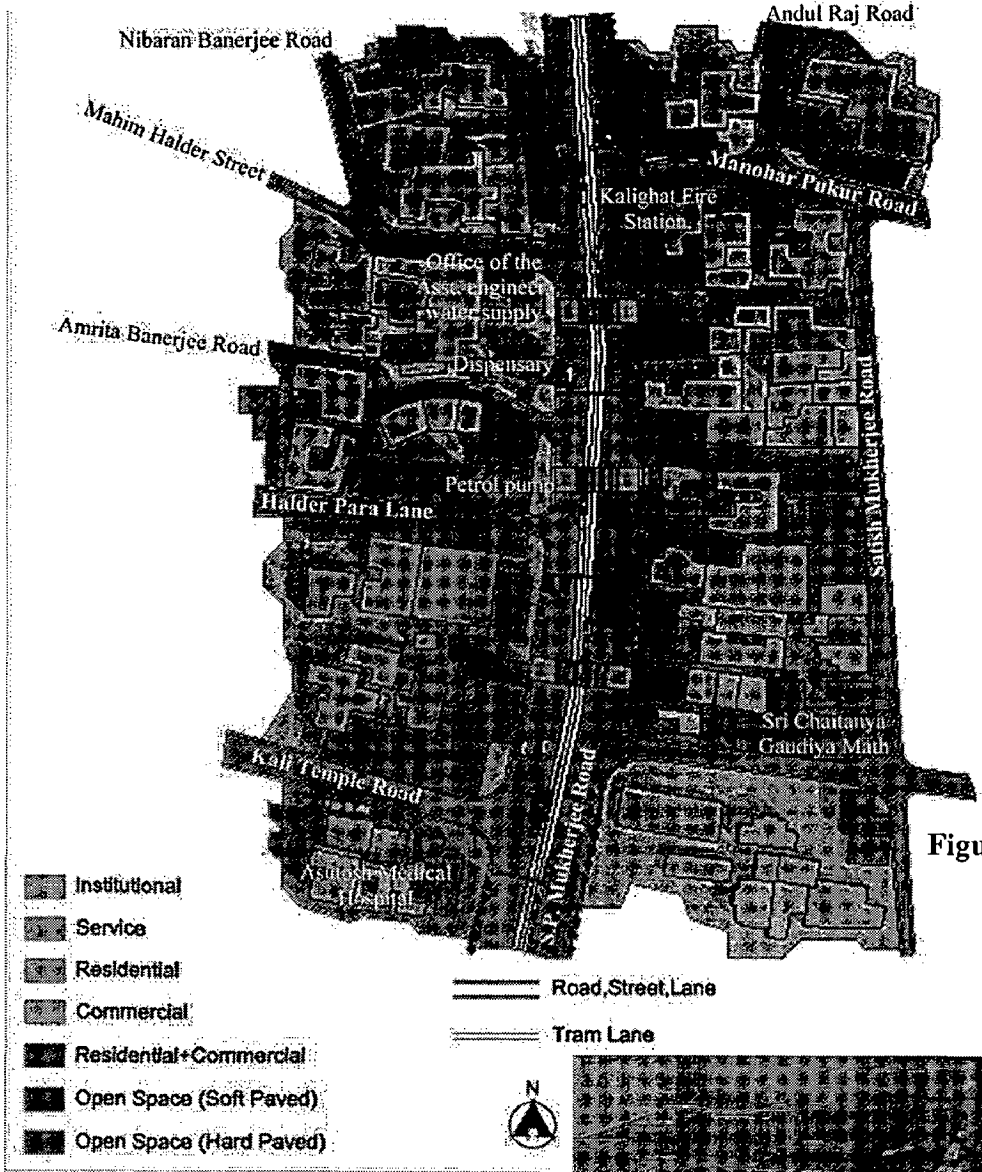


Figure 159 Improved tram-street environment

Figure 160 Aerial view of the road stretch (proposed)

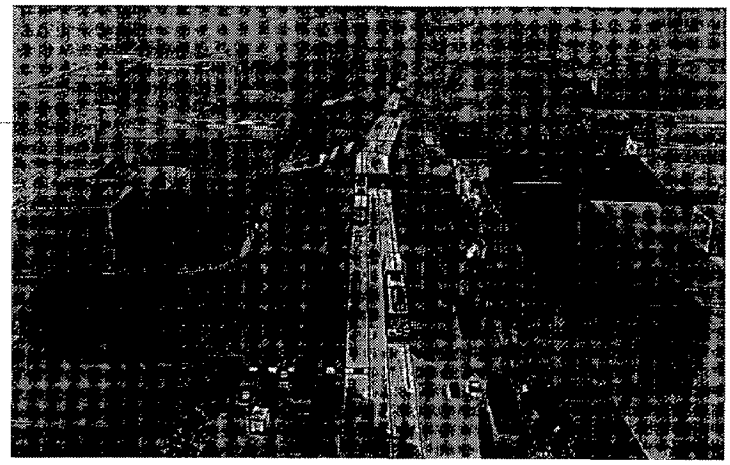


Figure 161 Smooth movement of tram with controlled traffic

STATE HIGHWAY 1 (SEALDAH)

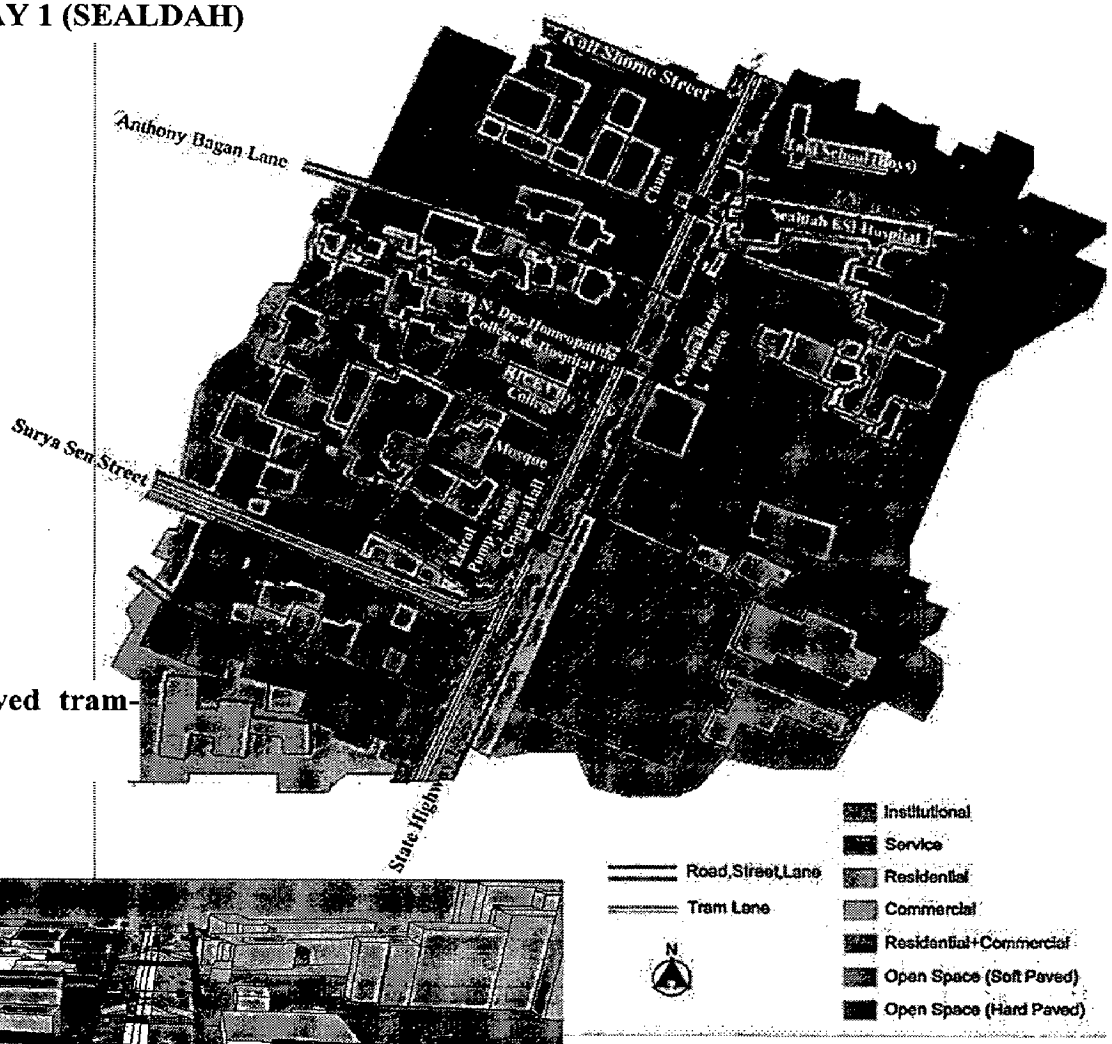


Figure 162 Improved tram-street environment

Figure 163 Aerial view of the road stretch (Proposed)

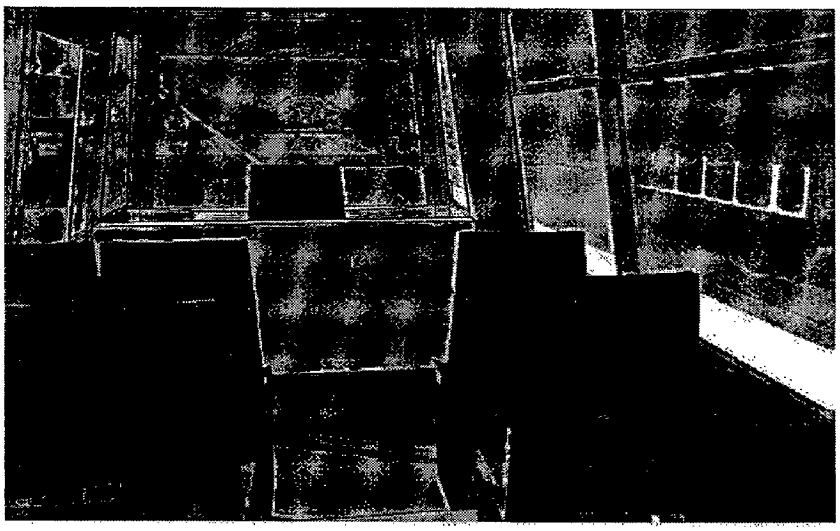


Figure 164 A view of the improved road stretch looking from a tram

The selected three tram roads of Kolkata are quite different from their nature; the problems relating to streetscape and the tramways system are almost same. The first stretch – College Street Road at College Street- is a purely institutional road stretch having a numbers of institutional and educational buildings along the stretch, requires a lots of detailing which can harmonize with the surrounding colonial architecture. The street furniture, new developments, land use everything should be considered in the context of the heritage and historical value of the area. Figures 158, 159 and 160 show the proposed view of the road stretch after improving the streetscape. The second stretch – S. P. Mukherjee Road at Kalighat – is a road having mixed use developments along its entire length. Maximum buildings have commercial activities at the ground floor and the residences start from the second floor. The tram routes should be designed and well integrated with the streetscape so that the people would like to travel by tram. The more numbers of passengers will increase the more commercial activity will grow. Thus it results in improving the economy of that area. Figure 161 shows the plan view of the road stretch after the improved streetscape. Figure 162 shows the aerial view of the improved road stretch and figure 163 shows the smooth movement of tram after having good road traffic management. The third stretch – State Highway at Sealdah – is a purely commercial road stretch as well as a main transport corridor. The detailing and the design of the streetscape will be different from the others. The stress should be given on the maximum use of the existing commercial activities and the incorporation of tramway with these activities. The tramway can be used to transport goods as well as a mode of mass transportation in this road stretch. It will benefit to earn revenue and thus it will help the tramway system. Figure 164 is the plan view of the road stretch after introducing designed streetscape and the integration of tramways to the streetscape. Figure 165 is the aerial view of the road stretch where it shows the controlled traffic movement, signaling system, tram stoppage and the accessibility of the tram by the passengers. Figure 166 is the view which would be seen by the passengers inside from a tram.

The proposals of improving the streetscape are not only for the betterment of the tram-street environment, it can also be applied to the other streets of the other Indian cities. The streetscape design recommendations can be achieved to the roads having BRTS/LRTS/MRTS. It is necessary to understand the nature, quality and the usage pattern of the road which would be developed and the area surrounding of it. The streetscape design should be followed by those factors and above all it should reflect the culture and heritage value of the particular area as well as the aesthetics value.

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ANNEXURE I

Table 35 List of European countries and the cities where tram is still running

Sl. Nos.	Countries	Cities
1	Austria	Linz
		Wien (Vienna)
2	Belarus	Minsk
3	Belgium	Antwerpen
		Brussels
		Gent
		Coastal Tram
4	Bosnia and Herzegovina	Sarajevo
5	Bulgaria	Sofia
6	Croatia	Osijek
		Zagreb
7	Czech Republic	Brno
		Most and Litvínov
		Liberec
		Plzen
		Prague
8	Denmark	Copenhagen
9	Estonia	Tallinn
10	Finland	Helsinki
		Angers
		Bordeaux
		Caen
		Clermont-Ferrand
		Grenoble
		Le Mans
		Lille, Roubaix

11	France	Lyon
		Marseille
		Montpellier
		Mulhouse
		Nancy
		Nantes
		Nice
		Orléans
		Paris
		Reims
		Rouen
		Saint Etienne
		Strasbourg
		Valenciennes
12	Germany	Augsburg
		Berlin
		Bremen
		Cottbus
		Erfurt
		Essen
		Dresden
		Frankfurt am Main
		Freiburg
		Halle (Saale)
		Hannover
		Heilbronn, Karlsruhe, Eppingen
		Kassel
		Köln (Cologne) / Bonn
		Leipzig
		Mannheim, Ludwigshafen,
		Heidelberg and surroundings
		Munich

		Nuremberg
		Naumburg (Saale)
		Plauen
		Rostock
		Stuttgart
13	Greece	Athens
14	Hungary	Hungary
15	Ireland	Luas (Dublin)
16	Italy	Milan
		Rome
17	Netherlands	Amsterdam
		Rotterdam
		Den Haag (The Hague)
		Delft
		Katwiik
		Utrecht
		Gouda
		Randstadrail
18	Norway	Trondheim
		Oslo
		Gråkall
		Bergen
19	Poland	Elbląg
		Gdańsk
		Katowice & Upper Silesia
		Łódź
		Poznań
		Szczecin
		Toruń
		Warszawa
		Wrocław
20	Portugal	Lisbon

		Metro Transportes do Sul
21	Romania	Bucharest
22	Russia	Saint Petersburg
		Moscow
		Kiev
23	Serbia	Belgrade
24	Slovakia	Bratislava
		Košice
25	Spain	Barcelona
		EuskoTran (Bilbao)
		Tranvía de Tenerife
26	Switzerland	Basel
		Bern
		Zurich
27	Sweden	Gothenburg
		Stockholm
		Norrköping
		Malmo
		Malmköping
28	United Kingdom	Great Orme Tramway (Llandudno)
		Manchester Metrolink
		Midland Metro (Birmingham)
		Nottingham Express Transit
		Sheffield Tramway
		Sheffield Supertram
		Tramlink (London)
		Tyne and Wear Metro

Source : http://commons.wikimedia.org/wiki/tram_in_europe http://en.wikipedia.org/wiki/tram_in_europe http://wapedia.mobi/en/wiki/tram_in_europe http://www.worldlingo.com/ma/index/enwiki/en/tram_in_europe

Table 36 Administrative division of Borough and Ward of KMC

BOROUGH Numbers	WARD Numbers
I	1,2,3,4,5,6,7,8,9
II	10,11,12,15,16,17,18,19,20
III	13,14,29,30,31,32,33,34,35
IV	21,22,23,24,25,26,27,28,38,39

V	36,37,40,41,42,43,44,45,48,49,50
VI	46,47,51,52,53,54,55,60,61,62
VII	56,57,58,59,63,64,65,66,67
VIII	68,69,70,71,72,73,84,85,86,87,90
IX	74,75,76,77,78,79,80,82,83,88
X	81,89,91,92,93,94,95,96,97,98,99,100
XI	101,102,110,111,112,113,114
XII	103,104,105,106,107,108,109
XIII	115,116,117,118,119,120,121,122,123
XIV	124,125,126,127,128,129,130,131,132
XV	133,134,135,136,137,138,139,140,141

Source: http://www.kolkatamycity.com