

BEFORE THE NATIONAL GREEN TRIBUNAL (SZ) AT CHENNAI
DAIRY NO. 64/2019 (SZ)
IN
APPEAL NO. 08/2020
BETWEEN:

**ENVIRONMENT SUPPORT GROUP
& ANOTHER**

...APPELLANTS

Vs.

**KARNATAKA ROAD DEVELOPMENT
CORPORATION LIMITED & OTHERS**

...RESPONDENTS

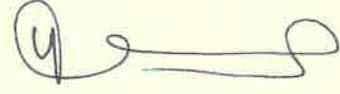
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Place: Chennai

Date: 20/10/2020



Advocate for the Respondent No.1

[YASHODHAR HEGDE]

KAR/1220/14

BEFORE THE NATIONAL GREEN TRIBUNAL (SZ) AT CHENNAI
DAIRY NO. 64/2019 (SZ)
IN
APPEAL NO. 08/2020
BETWEEN:

ENVIRONMENT SUPPORT GROUP
(Trust Registered under Indian Trust Act, 1882)
Represented by Dr. Shirdi Prasad Tekur,
1572, 100 Feet Ring Road,
36th Cross, Banashankari II Stage,
Bangalore – 560 070
and **ANOTHER**

...APPELLANTS

Vs.

**KARNATAKA ROAD DEVELOPMENT
CORPORATION LIMITED**
“Samparka Soudha”, Sy. No. 8,
B.E.P Premises (Opp. Orion Mall)
Dr. Rajkumar Road,
Rajajinagar 1st Block,
Bangalore – 560 010
And **OTHERS**

...RESPONDENTS

**COUNTER STATEMENT TO THE APPEAL FILED UNDER SECTION
18(1) READ WITH SECTIONS 16(h) OF THE NATIONAL GREEN
TRIBUNAL ACT, 2010 FILED ON BEHALF OF THE RESPONDENT
NO.1 (KARNATAKA ROAD DEVELOPMENT CORPORATION
LIMITED)**

I, Dr. H.S. Prakash Kumar, S/o. J. Shivanna, aged about 58 years, having office at Samparka Soudha, No. 8, BEP Premises, Opposite Orion Mall, Dr. Rajkumar Road, Bangalore - 560 010 do hereby solemnly affirm, swear and state on oath as under:

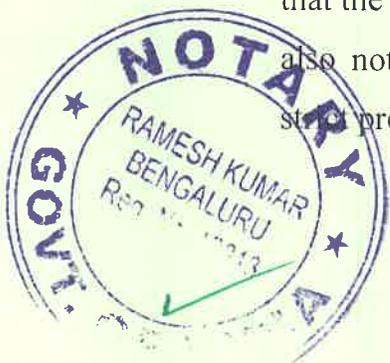
1. I am the Managing Director of the Respondent No.1 Corporation in the abovementioned Appeal and as such I am fully conversant with the facts and circumstances of the present case based on my personal knowledge and official records available with me and hence I am competent to affirm the present Counter Affidavit.



ERRORS / CORRECTIONS ETC, /


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2. I state that save and except those which are matter of record and are specifically admitted in the present Counter Affidavit, all the statements, averments and submissions made in the instant Appeal are categorically denied. It is further submitted that no statements, allegations and submissions should be deemed to have been admitted unless specifically admitted to herein.
3. The address of the Respondent for the purpose of service of notices, summons, processes etc., of this Hon'ble Tribunal is as stated in the cause title above and also that of his advocates, Ajay J Nandalike, Manu K, Tanya John, Ashvini Patil, Manasa H S, Yashodhar Hegde, Alka Tripathi and Sreenath K M associated with Pragati Law Chambers, #5A, Bharat Apartments, 44/1, Fair Field Layout, Race Course Road, Bangalore – 560 001; and at the email ids ajay@pragatilaw.in and yashodhar@pragatilaw.in.
4. The Appellants have filed the instant Appeal challenging the Prior Environmental Clearance (“EC”) granted in favour of the Respondent No.1 *vide* Order dated 02/03/2019 bearing No. SEIAA 135 CON 2018 passed by the Respondent No.6. The Respondent No.1 hereby denies all the averments made by the Appellants in the Appeal except the ones specifically adverted to or admitted to herein. The Appellants are put to strict proof of all the averments made in the Appeal.
5. At the outset, it is submitted that the averments made by the Appellants with respect to the 1st Appellant being a trust and being represented by Mr. Shirdi Prasad Tekur, are not substantiated by the Appellants inasmuch as the Trust Deed of the 1st Appellant has not been produced by the Appellants and the Appellants are put to strict proof of the same. The fact that the 2nd Appellant and said Mr. Tekur being the Trustees of the Trust is also not substantiated by the Appellants and the Appellants are put to strict proof of the same.




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6. Though the Appellants have challenged the Environmental Clearance accorded to the Respondent No.1 on various technical grounds, the Appellants have failed to establish as to how the 1st Appellant organization is aggrieved by the grant of the EC or as to how the 2nd Appellant is aggrieved by the grant of the EC in favour of the 1st Respondent. It is submitted that the clearance granted to the Respondent No.1 is a prior EC and EC has been accorded in due compliance with the EIA notification and other statutory norms. Under the circumstances, the Appellants have failed to establish that they are aggrieved persons under the provisions of the National Green Tribunal Act, 2010 and the instant Appeal is therefore liable to be dismissed.
7. It is submitted that averments made in the Appeal are under the presumption that the Prior Environmental Clearance granted to the Respondent for the Elevated Corridor Project tantamount to appropriate consents and necessary approvals that the Respondent No.1 is required to obtain at the time of implementation of the Project. The clearance granted to the Respondent No.1 is a Prior Environmental Clearance granted in view of the EIA Notification of 2006 and the contentions raised by the Appellants are therefore grossly misconstrued and are premature.

Brief description of the Project and the necessity of the Project:

8. The Respondent No.1 is a wholly owned Government of Karnataka Company as per the provisions of the Companies Act. The Respondent No.1 falls under the Public Works, Ports & Inland Water Transport Department (PWPITD) of the State of Karnataka and was established to promote surface infrastructure by taking up Road Works, Bridges etc., and to improve road network by taking up construction widening and strengthening of roads, construction of bridges, maintenance of roads etc.




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Notably, the Respondent No.1 has strived to improve the road network and to establish connectivity to all the nook & corner of the State.

9. Bangalore city is the third most populous city & fifth largest Metropolis in India as well as 18th most populous City in the World making it the most sought after cities in India by people, companies and multinationals. The massive growth that the city has witnessed in the last two decades has brought the city to fame but also to chaos due to inadequate infrastructure in all fronts.

10. It is submitted that Bangalore, being one of the fastest growing cities in India, is one of the leading cities in the country providing infrastructure development for supporting the information technology sector, the real estate sector, industrial sector and various other sectors of commerce. Due to this, Bangalore attracts people from across the nation to settle in Bangalore, which was lead to the sudden growth of population and correspondingly lead to the unprecedented and unexpected growth of traffic in Bangalore.

11. The exponential growth of traffic has caused Bangalore to face a challenge in providing road transport infrastructure to its residents so as to ease the traffic congestion. Bangalore is a multi nodal city and it is the persistent complaint of Bangaloreans that being a multi nodal city, Bangalore lacks wider roads and connectivity to different parts within the city limits and suffers from bottle neck traffic congestions due to narrow roads. For the past decade or more, one of the complaints that is floated against the city is that there are good transit corridors in the city that connects southern and northern eastern and western parts of the city.

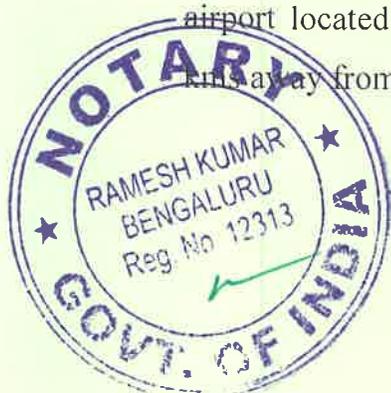
12. It is submitted that due to large scale initiative and support by Government of Karnataka for establishment of IT & BT industries during 1990-2000, Bangalore attracted large scale investments in IT / BT sector




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from many global / MNCs thus triggering exponential growth of Real estate industry and many other service related industries. It resulted in rapid increase of population from 4.10 million in 1991 to 8.4 Million in 2011 census and 115.50million in 2016 thus the city is 3rd most populous city in the country. With the exponential growth of IT/ BT and service sectors, the population has increased from 7-8 % per annum during 2011-2016 as against 0.5% per annum during 1991 – 2001 and the vehicle population has also grown at a rate of over 10% per annum during 2011-2016. With this, the projected population by 2020 will be 13 million.

13. It is submitted that reports suggest that about 5 lakh new vehicles are added to the city roads every year. As of February 2016, the number of two wheelers and cars and other non transport vehicles was about 54.67 lakhs. According to the data, there are more than 41.86 lakh two wheelers in the city and the number of cars is more than 11.8 lakh. Pertinently, this number does not include the incoming and outgoing traffic from outside the city.
14. The traffic congestion in the city is such that as per the Comprehensive Traffic and Transportation Plan for Bangalore 2011 (CTTP), an average Banagloorean spends more than 240 hours a year being stuck in traffic. As per the CTTP, the traffic condition in the city has not only resulted in deteriorated air quality, reduced quality of life and increase in the cost of services and goods. A copy of the CTTP is produced herewith as Annexure-R1.
15. Since terrain of Bangalore is plain and accessible at all sides, the city has developed laterally and spread on all directions. This spread has resulted in taking longer commuting distances to cross city from one side to other. At present, the city has spread to about 40 km of radius with International airport located at Devanahalli, which is on the north Bangalore and 60 km away from electronic city situated in Southern most part of Bangalore




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and similarly 40Kms away from IT Park & Export promotion Industrial Park (EPIP) in White field in Eastern part of Bangalore where the maximum concentration of IT firms and supporting service industries are located inducing crisscross movement of traffic across the City throughout the day and night.

16. High volumes of traffic and congested roads have resulted in very high ratio of Volume to capacity of Roads (V/C ratio), which is as high as 4 in most of the roads. As per IRC, the V/C ratio shall be 0.6 for city roads and more than 1 means the roads are in worst level of service.
17. The Comprehensive Traffic and Transportation Plan (CTTP) for Bangalore city, prepared in year 2011 have found the following among many other issues:
 - a. Road network capacity is grossly inadequate. Most of the major roads are with four lanes or less with little scope of their widening. This indicates the need for judicious use of available road space.
 - b. V/C ratios on most of the roads are more than 1. Overall average traffic speed is about 13.5 Kmph in peak hours. This not only indicates the need of widening of the roads but the also the need to plan high capacity mass transport systems on many corridors;
 - c. Outer cordon surveys indicate high through traffic to the city. These points to the need of road bypasses not only for Bangalore Metropolitan Area (BMA) but also for BMRDA area. High volume goods traffic also indicates the need of truck terminals at the periphery of the city;
 - d. The Area of the BMA has been increased as per Revised Master Plan-2015. This plan has provided for densification of existing areas, Mutation corridors, hi-tech areas etc in various parts of the city. This is likely to have a major impact on traffic demand. Taking into




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consideration the huge potential for further development of Bangalore, The Integrated transport network including Grade separated Intersections at all major road intersections, Elevated corridors, Mass transport system like Metro rails along all arterial roads / Ring Roads connected with feeder Mono rails along Sub arterial roads needs to be planned.

18. The solution to the problems mentioned above is to reduce the traffic on roads either by policy implementation on restriction of usage of vehicles, providing mass transport facilities, feeder line connectivity and last mile connectivity which encourage people to shift from private mode to public transport, encourage usage of walking and also by capacity augmentation by building wider roads and Elevated corridors that are fast, efficient and safe.
19. Reducing vehicles on roads by policy or through encouragement is possible only when the cities are built through long term planning and have a ceiling on population. Since our cities are neither planned on long term nor have a ceiling limit on population, it's not possible to save cities without going for a massive capacity augmentation by adding wider, fast & safe roads which are sustainable for longer durations. Since widening of roads is not possible due to non-availability of road right of way (RoW) widths, the next inevitable solution is to build road over roads, i.e., elevated roads on existing major roads as part of capacity augmentation.
20. It is submitted that Bangalore Metropolitan Area, being one of the fastest developing metropolitan area, has been facing severe traffic woes since many years. The road congestion is a serious issue that has plagued all the major metropolitan cities in India. The road congestion culminates in more number of vehicles spending more time on the road, in an idle or a static position and as such, the increased idling of the vehicles on the road results in more Carbon Dioxide and other pollutants being released into

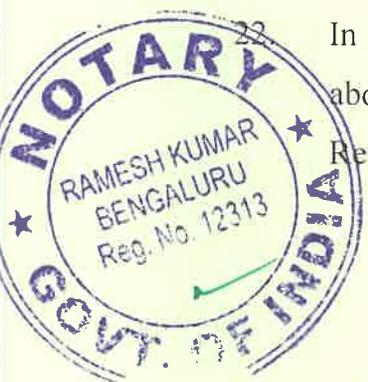



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the atmosphere. The increase of traffic congestion in a fast growing metropolitan city like Bangalore not only causes loss of man hours but also contributes to the increased emission from the vehicles. As per a study conducted on congestion costs incurred on Indian Roads by IIT Madras pertaining to New Delhi, it was reported that total productivity loss caused due to road congestion in New Delhi for the year 2014 was a whopping 7410 Million USD (*about Rs. 51,800 crores*) per year. As per the said study [Annexure-R2] the productivity losses for buses are the highest due to higher occupancy as compared to other modes of transport.

21. The city of Bangalore, being one of the largest cities in India has average population of 1.2 crore. The population of Bangalore is fast growing and such a fast growing population and growing economy stresses its transportation network and road traffic congestion is also increased as a result. It is a known fact that the traffic congestion in Bangalore is not only extreme but also varies within the day. As per the study conducted for the city of Bangalore by Gabriel E Kreindler [*Research fellow at Becker Friedman Institute, University of Chicago*], in a paper dated 14/11/2017 titled '*The Welfare effect of Road Congestion pricing : Experimental Evidence and Equilibrium Implications*' [Annexure-R3], on an average between 7 AM to 10 PM on weekdays across all routes, it takes 3.41 minutes to advance one kilometer. That is to say the average speed comes up to 17.5 kilometers per hour. The data collected by him confirms that a Bangalore citizen spends an average of 1.5 hours driving each week day [Annexure-R4]. It is pertinent to mention here that the average speed so calculated is with respect to the whole city of Bangalore, including the outer city limits. However, for the Central Bangalore District, the average speed of vehicular may be about 4-5 kilometers per hour.

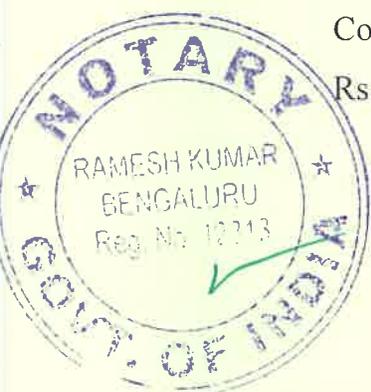
In case of Bangalore, having a population of about 12.952 million i.e., about 1.2 Crores, as per the surveys conducted during the preparation of Revised Master Plan 2031 ("**RMP 2031**"), an average of 1.18 Crore




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citizens of Bangalore lose about 60 crore hours of productivity due to road congestion, which translates to about Rs. 3,700 crores. The fuel loss that occurs due to the congestion is estimated to be Rs. 1,350 Crores annually. Due to traffic congestion, almost 2.8 lakh liters of fuel is wasted per hour a day in Bangalore. [News report of Times of India dated 06/01/2017 produced as Annexure-R5].

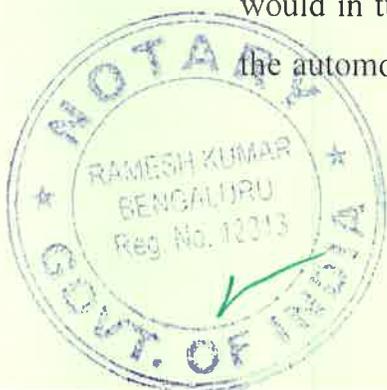
23. An archive available online that is based on the WHO study from 2014 reports that the cost of traffic congestion for Bangalore city is approximately 5% of its economic output. In the year 2018, it has been reported that the traffic congestion loss costs Rs. 38,000 Crores annually for Bangalore city. As per the report, travel during the peak hour takes average of 162% more time than the same distance travelled during off peak hours. Another report suggests that the cost of congestion calculated on the basis of fuel burned, man hours lost, opportunity cost, pollution and health costs incurred on an annual basis for Bangalore City is about 41,000 Crores. [News paper reports produced as Annexure-R6 (Series)]
24. It is submitted that the detailed study undertaken by the Respondent No.1 for the implementation of the Elevated Corridor Project also goes on to show that if the Elevated Corridor Project is implemented, around 2 million man-hour daily and around 769 man-hour annually could be saved in case of cars and in case of 2 wheelers, around 1 million man-hour daily and around 387 man-hour annually could be saved. In case of buses, around 32 million man-hour daily and around 11,713 man-hour annually could be saved [Annexure-R7].
25. As the man-hour loss that occurs in Bangalore due to road congestion is astronomical, the Government of Karnataka had proposed the construction and implementation of the Elevated Corridor Project. If the Elevated Corridor Project is implemented, then it has been estimated that a sum of Rs. 9000 Crores could be saved by the residents of Bangalore and the




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average travel time in Bangalore would be reduced substantially and the time for travelling between any two given points in Bangalore would be less than 45 minutes. The execution and implementation of Elevated Corridor Project will not only decrease the traffic congestion on the existing road, but it will also save the congestion cost that Bangalore city is incurring due to the bottle neck traffic faced by Bangalore.

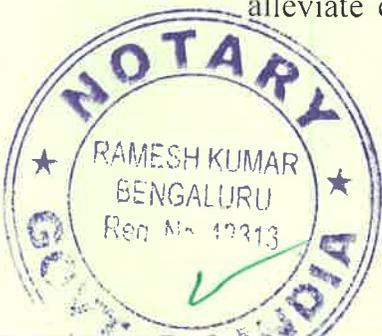
26. It is submitted that apart from the congestion cost, the bane of traffic also extends to emission of carbon dioxide (CO₂), which is at its highest during the vehicle idling duration and at low speeds. It is submitted that as per the study conducted by the Applicant, the average speed on the existing grade road (*on which the Elevated Corridor has been proposed*) is about 13.5 kilometers per hour. The average speed in city of Bangalore (*for the whole city of Bangalore*) is about 15-17 kilometers per hour. In engineering parlance, the road existing on the ground level are termed as 'Grade Road' and the elevated roads that are raise above the ground level, over the existing road are called 'Elevated Roads / Elevated Corridors'.
27. In case of the Metropolitan city of Bangalore, it is submitted that the implementation of the Elevated Corridor Project would increase the average speed to 25 kilometers per hour on Grade Roads and to about 45-50 kilometers per hour on the Elevated Corridor; even during the peak traffic hours. The increase in the average speed of the vehicles automatically decreases the vehicle idling time, thereby reducing the CO₂ emission by 4.74 lakh. It is submitted that the reduction in the CO₂ emission is equivalent to planting of 50,000 trees.
28. It is submitted that the vehicular emission is stated to be one of the causes of increase in the global warming. The idling of vehicular traffic would cause the increased release of pollutants to the environment and that would in turn result in causing air pollution. The air pollution caused by the automobiles has impacts on health and imposes potentially substantial




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economic costs to society. Most of the health effects from air pollution come from respiratory symptoms in the levels of pollution. Due to the increase in particulate matter of air, cardiovascular and coronary heart disease may be caused. Similarly, longer-term responses to particulate matter emitted due to vehicular traffic have also been associated with health outcomes including increased cases of chronic bronchitis, respiratory or cardiovascular problems, asthma attacks, symptoms etc. [The copy of study report on the Urban CO2 emissions in the city of Xi'an and Bangalore and the copy of the research study on air pollution by automobiles in Bangalore City are produced herewith as Annexure-R8 and Annexure-R9 respectively].

29. Furthermore, with the carbon crediting gaining prominence in the commercial sphere, the reduction of CO2 emission will also fetch carbon credit to the State Government. It is submitted that as on date, carbon credit is priced at 25 USD (Rs. 1750/-) per tone of CO2 emission. Therefore, the implementation of the Elevated Corridor Project is estimated to reduce the CO2 emission by 4.74 lakh tones. The prospective monetary benefit in implementing the Project is about Rs. 81.77 Crores.
30. It is submitted that traffic congestion also causes vehicle operating cost. That is to say, due to longer hours that a vehicle spends in traffic, the average speed of the vehicle reduces drastically. The reduced speed of vehicle increases the fuel cost, tyre cost, engine oil cost, spare part cost etc. If the average speed of the vehicles are increased, the vehicle operating cost is also reduced substantially. It is submitted that the implementation of Elevated Corridor Project will result in increasing the average speed of vehicles which would result in saving about Rs. 1,878 Crores per year in vehicle operating costs.
31. As the traffic woes in the city of Bangalore became worse, in order to alleviate congestion and provide unhindered travel along the length and

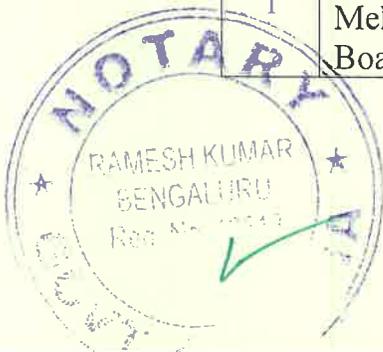


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breadth of the city, that will contribute to savings in travel time, vehicle operating cost, improve road safety and minimize carbon emissions resulting in overall economic growth, the Government of Karnataka (GoK) proposed the construction of Elevated Corridor Project (“Project”) connecting North-South and East-West parts of the city to ensure smooth and hassle free connectivity within the city and outskirts of the city. The project was announced by GoK in year 2015 and further included in the budget speech of Chief Minister for the year 2016-17.

32. Considering the complexity of the Project and since Respondent No.1 specializes in infrastructural developments relating to road and road development, the Project was handed over to the 1st Respondent.
33. It is submitted that the Elevated Corridor Project is a ‘grade-separated’ road where a corridor is built to enable vehicles to keep moving in their desired direction, without having to cross oncoming traffic. The elevated corridors connecting the suburbs to the city centre and to each other, are meant to enable seamless, stop-free travel between any of the corridors’ entry and exit points.
34. It is submitted that Project proposes the construction of 7 (seven) corridors in total as a part of the Elevated Corridor Project and the following table encapsulates the details of the corridors proposed in the Project:

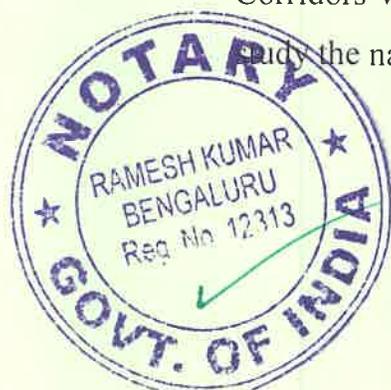
Sl No.	Name of the Corridor	Lane Configuration	Corridor Length (Km)	Entry/Exit ramps (Nos.)	Total Length (Km)
1	NS-1: North-South Corridor-1 connecting Baptist Hospital, Mekhri Circle to Central Silk Board (i.e., NH- 7 towards	6 Lane/4 Lane	27.79	17	27.79



[Signature]
 Managing Director
 KRDCCL

	Bellary to NH-7 towards Hosur)				
2	EW-1: East-West Corridor-1 connecting K.R. Puram to Yeshwanthpura Flyover (i.e., NH-4 towards Old Madras and NH-4 towards Tumkur Road)	4 Lane	9.67	14	9.67
3	EW-2: East-West Corridor-2 connecting Varthur Kodi to Sirsi Circle (Old Airport Road, SH-35 to Mysore Road, SH-17)	4 Lane	27.95	13	27.95
4	CC-1: Connecting Corridor-1 Connecting North-South corridor at St. John's Hospital Junction to Agara on Outer Ring Road	4 Lane	4.45	0	4.450
5	CC-2: Connecting Corridor-2 Connecting East-West Corridor-1 at Ulsoor to East-West Corridor-2 at D'souza circle.	4 Lane	2.8	4	2.80
6	CC-3: Connecting Corridor-3 Connecting East-West Corridor-1 at Wheeler's road jn.to Hennur Flyover at Outer Ring Road	4 Lane	4.20	5	4.2
7	EW-1 Additional Corridor from Rammurthy Nagar (Ring road) to ITPL Stretch	4 Lane	11.00		11
TOTAL LENGTH			87.86	53	87.86

35. The Government of Karnataka (“GoK”), through the Respondent No.1, *vide* letter no: KRDC/CE-EE2/EC/LOA//2015-16/-3024 dated 30 January 2016 had appointed ‘M/s AECOM Asia Company Limited’ in Association with ‘M/s Deloitte Touché Tohmatsu India private Limited’ and ‘M/s Infra Support Engineering Consultants Pvt. Ltd’ as technical consultant (“Consultant”) for “Consultancy Services for Preparation of Detailed Feasibility Report for the Construction of Proposed Elevated Corridors within Bangalore Metropolitan Region, Bangalore” in order to study the nature, magnitude and significance of the potential impact on the



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KRDC

environment and the social impacts of the Project and in order to ensure an environmentally sustainable development.

36. The Detailed Feasibility comprises of multiple volumes comprising of Environmental Impact Assessment Report, Traffic Feasibility Reports, Design Reports, Technical Specifications, Land Acquisition Plan and drawing pertaining to the proposed project. The copy of the main volume (Volume-I) of the Detailed Project Feasibility Report (“DFR”) prepared by the Respondent No.1 through its Consultants is produced herewith as Annexure-R10.
37. It is submitted that the Respondent No.1, though being aware of the fact that the proposed Project fell within category 8 (b) of the EIA Notification of 2006 and also knowing the implication of the directions passed by this Hon’ble Tribunal concerning steel flyover in Bangalore, engaged the services of the Consultants in order to prepare a Detailed Project Feasibility Report, including a Environmental Impact Assessment (EIA) Report, Social Impact Assessment report. The copy of the EIA report prepared by the Respondent No.1 through its consultant is produced herewith as Annexure-R11.
38. It is submitted that the 1st Respondent, complying with all the directions of the Ministry of Environment and Forest as well as the directions passed by this Hon’ble Tribunal, had approached the Respondent No.6 seeking Environmental Clearance by filing Forms I and IA before the Respondent No.6.
39. It is submitted that after the Respondent No.1 had submitted the Forms, the Respondent No.6 and the State level Expert Appraisal Committee, after scoping of the propose Project, issued the Terms of Reference (ToR) [copy of which has already been produced by the Appellants] for EIA studies. Pursuant to the ToR so issued and in compliance with the ToR,




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the Respondent No.1 has prepared the Detailed Project Feasibility Report. It is submitted that after the Respondent No.4 had appraised the DFR prepared by the Respondent No.1 and after it had satisfied itself of the EIA studies conducted by the Respondent No.1, the Environmental Clearance was granted to the Respondent No.1.

Environmental Clearance and processes:

40. It is submitted that requirement of obtaining an Environmental Clearance emanates from Rule 5 (3) of the Environment (Protection) Rules, 1986, which provides the power to the Central Government to impose restrictions and prohibitions on new projects and activities, or on expansion or modernization of existing projects based on their potential environmental impacts. In exercise of such power, the Central Government had issued the Notification dated 14/09/2006 (“**EIA Notification**”) which prescribes that procedure for obtaining the Prior Environmental Clearance (“**EC**”) before any construction work or preparation of land by the project management except for securing the land, is started on the project or activity *inter alia* for all new projects or activities mentioned in the schedule to the EIA Notification.
41. It is submitted that as per Section 6 of the EIA Notification, an application seeking prior environmental clearance shall be made by Form I and Form IA, after identification of prospective site(s) for the project or activity to which application relates, before commencing any construction activity, or preparation of land, at the site by the Applicant.
42. The very perusal of Section 6 of the EIA Notification makes it clear that at the time of applying for the EC, what is required to be submitted is not a finalized plan / report of the Project but a prospective identifications of the details of the project. This is further evidenced by the fact that in case of construction projects (*falling under Item 8 of the Schedule*) the




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requirement of a pre-feasibility report is also relaxed and a copy of conceptual plan is required to be submitted instead.

43. Therefore, in cases of construction projects or activities falling under Item 8 of the Schedule 8 to the Notification, such as the Elevated Corridor Project, the EIA Notification recognizes that while making an application for Prior Environmental Clearance, what is required to be submitted is the conceptual plan and not the finalized plan that will be employed in construction of the project.
44. On the basis of the Form I and Form IA and the pre feasibility report or the conceptual plan provided, the project will then be assessed / scoped and a Terms of Reference (ToR) will then be issued to the project proponent for Environmental Impact Assessment studies. After the project proponent submits the EIA, then the Form I, Form IA and the EIA report and other documents will be appraised in detail by the Expert Appraisal Committee and on the basis of the appraisal, a decision will then be taken by the concerned authority (MoEF or SEIAA) granting or rejecting the EC.
45. It is submitted that while applying for Prior Environmental Clearance, it is thus impossible for a project proponent to finalize all the minute details of the proposed project and only the conceptual plan of proposed implementation of the project is provided. It is for the said reason, Section 10 of the EIA Notification mandates that a project proponent must submit half yearly compliance reports in respect of the stipulated prior environment clearance terms and conditions, on 1st June and 1st December of each calendar year.
46. When such is the scheme of the EIA notification, to contend that the Project Proponent must finalize every aspect of the Project at the stage of obtaining Prior Environmental Clearance not only goes against the intent




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of the EIA Notification but would also make the proposed project impossible to implement. Therefore, it is submitted that, the Appeal filed by the Appellants is based on the ground that the Respondent No.1 had not 'finalized' each and every specific aspect pertaining to the implementation of the Project, is premature and is not maintainable and is liable to be dismissed.

47. It is submitted that the Respondent No.1, had submitted Form I and Form IA along with conceptual plan of the proposed Project. After considering the documents provided by the Respondent No.1 and after the screening of the same, the Respondent No.6 had issued ToR and additional ToR to the Respondent No.1 for conducting EIA study. The Respondent No.1 had accordingly submitted EIA report on 14/02/2019. Pursuant to Respondent No.1 complying with the terms and conditions mentioned in EIA Notification and the ToR and the additional ToR, prior environmental clearance was granted to the Respondent No.1. It is pertinent to mention here that the Prior Environmental Clearance granted to the Respondent No.1 is subject to strict compliance of the terms mentioned in the EC.

48. Whilst granting the EC, the Respondent No.6 has recognized that the details submitted for the grant of the EC are proposals and that at the time of implementing the Project, further compliances are necessary and for the said reason, strict terms and conditions have been imposed on the Respondent No.1 for the implementation of the Project for construction of Elevated Corridors.

49. The EC granted in favor of the Respondent No.1 *inter alia* mandates the following :

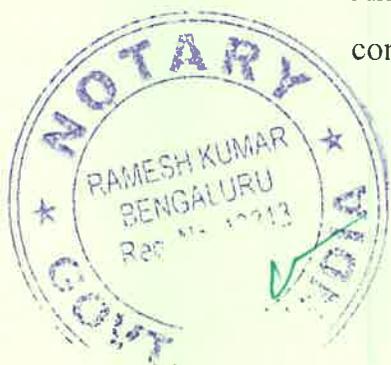
- Statutory Compliances are to be obtained, including clearance / permission from the Town Planning Authority and that the construction is done in accordance with the building bye-laws. It is mandated that Consent to Operate under the Air (Prevention and




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Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974 from the State Pollution Control Board. The EC also mandates that the Indian Road Congress codes shall be adhered to and it also mandates that buffer zone from water bodies as ordered by this Hon'ble Tribunal in OA 222/2014 must also be adhered to.

- At the time of construction, Statutory Compliances are to be obtained, including clearance / permission from the Town Planning Authority and that the construction is done in accordance with the building bye-laws.
- The Consent to Operate under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974 from the State Pollution Control Board must be obtained while implementing the project.
- The Indian Road Congress codes shall be adhered to while constructing the Project and it also mandates that buffer zone from water bodies as ordered by this Hon'ble Tribunal in OA 222/2014 must also be adhered to while putting up the construction.
- No construction shall be allowed to obstruct the natural drainage through the site, on wetland and water bodies and that the construction shall be designed to follow the natural topography.
- While implementing the Project, a certificate shall be obtained from local body supplying water, specifying the total annual water availability with local authority, quantity of water already spent and the quantity of water allotted to the Project and the balance water available.
- Any ground water dewatering should be properly managed and shall conform to the guidelines of CGWA.



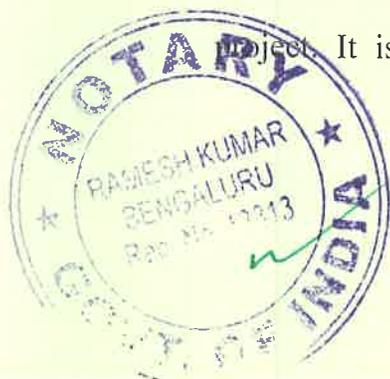

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- A minimum of 1 tree for every 80 sqm of land should be planted and that for every tree cut 10 trees must be planted
- Project proponent shall upload the status of compliance of stipulated environment clearance conditions on their website and update the same half-yearly basis and shall submit six-monthly reports on the status of the compliance of the stipulated environmental conditions on the ministry's website.
- No further expansion or modification in the plan shall be carried out without prior Environmental Clearance from the competent authority.

50. It is therefore submitted that the very conditions imposed under the EC and the scheme of Sections 6 and 7 of the EIA Notification makes it clear that the Prior Environmental Clearance is accorded to the conceptual plan of a project and the specific approvals and consents are to be obtained by the Project Proponent, in accordance with the EC, only at the time of implementation of the Project.

51. The Appellants in the instant case have however completely misconstrued the intent of the Prior Environmental Clearance and have grossly misinterpreted the conditions under the EIA Notification. The Appellants have placed the cart before the horse and have urged that the Respondent No.1 ought to have obtained all necessary permissions, sanctions and consent from the appropriate authority even before initiating the implementation the Project and it is submitted that such an interpretation adopted by the Appellants is not only ludicrous but is also contrary to the intent of the EIA Notification.

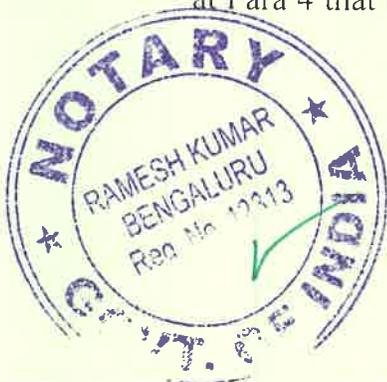
52. It is the case of the Appellants' that the EC is allegedly invalid since the Respondent No.1 has failed to finalize the alignment and obtain change in land use and acquire the lands required for the implementation of the Project. It is submitted that the acquisition of land and obtaining the



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change in land use and other particulars must occur at the stage of implementing the Project and not at the stage of obtaining Prior Environmental Clearance. The Appellants have misconstrued the intent and purport of obtaining the prior Environmental Clearance and have alleged that grant of EC is tantamount to permitting the Respondent No.1 to implement the project without having to obtain any further clearances and permissions. The Appeal is therefore clearly misconstrued and the Appellants have evidently misunderstood the process of grant of Prior Environmental Clearance. Under the circumstances, the Appeal is therefore liable to be dismissed.

53. The Appellants are seeking to challenge the EC granted to the Project by making baseless and unfounded allegations against the EIA conducted by the Respondent No.1 and on various other grounds, which are not supported by law or on merits. It is submitted that the Appellants have made vague statements whilst challenging the EC granted and have failed to make out a case for the cancellation of the EC granted.
54. The Appellants have contended that the Project will change the very face of the City, causing severe environmental and social distress and the 6th respondent has failed to appreciate any of such concerns and inter-related relevant issues and has issued the impugned order ritually, and without application of mind. It is submitted that the averments made by the Appellants in Paragraph 1 and 2 not only unfounded but are made without any basis and such allegations are contrary to the documented facts and are hereby denied.
55. It is submitted that though the Appellants agree that Project is indeed necessary in view of wider public interest, the Appellants have however challenged the EC granted to the Project. The contention of the Appellants at Para 4 that the project is being rushed through without paying any heed




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to compulsory review of laws relating to land use planning and mobility is false and hereby denied.

56. It is submitted that the Appellants have raised multiple grounds to challenge the Environmental Clearance granted to the Project and the Respondent No.1 seeks the leave of this Hon'ble Court to respond to some of the specific contentions raised by the Appellants and also craves the leave of this Hon'ble Court to advert to the generic contentions raised by the Appellants in the Appeal as below.

Re. Project Alignment is yet to be finalized:

57. The allegation of the Appellants that the Project is not yet formulated as a Project and it lacks even a Detailed Project Report or an exhaustive EIA report is not only misleading but is also contrary to the public records. It is submitted that the Respondent No.1, being the project proponent, has conducted a Detailed Feasibility Report, which included an exhaustive Environmental Impact Assessment and the same were made available to public at large by the Respondent No.1 and the copy of the same have also been annexed herewith this Statement of Objections.
58. The averment made in para 5 that proposed Elevated Corridor is not yet formulated as a Project as it lacks even a Detailed Project Report or an exhaustive EIA report is false and is contrary to the documents which were made available in the public domain. The Appellants are well aware that the Respondent No.1 has prepared a Detailed Project Feasibility Report and has conducted a detailed and thorough Environmental Impact Assessment study as a part of the DFR. It is submitted that the DFR clearly mentions that the Project follows the existing road alignment for the implementation of the Elevated Corridor and moreover, the details of proposed alignment of the project has been detailed in Chapter 2 of the EIA report as well as Volume I of the DFR. It is also submitted that




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Sl. No	Cl aus	Description	Comments from Petitioner	Clarification
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proposed typical cross section details have also been detained in the report and the finalization of the alignment would occur only at the stage of implementation of the Project and as such, the contentions raised in para 5 of the Appeal are therefore hereby denied as false.

Re. Brief overview of Elevated Corridor proposal

59. It is submitted that the Appellants are attempting to misconstrue the Government Approval and the financial sanction granted to the Project. The Government approval was granted for the implementation of the Project, which is an administrative decision and the financial department cleared the Project with the estimated cost of Rs. 26,690 Crores. It is submitted that the initial amount sanctioned through the Government Approval is only an advance released towards the initiation of steps for the implementation of the project. It is submitted that there is no variance, much less an irreconcilable variance with the said Approval and clearance and the averments made in paragraph 7 are hereby denied.
60. The averments made by the Appellants that the Project has been rushed through and that the clearances were issued in a haste is a conjecture made by the Appellants and the Appellant have failed to establish any wrongdoing by the Respondent No.1 in according sanctions and approvals and the averments made in paragraphs 8, 9 and 10 of the Appeal are hereby denied as false.

Re. Form I and IA rife with false information:

61. It is the allegation of the Appellants that Form I and IA have purportedly been fed with misinformation and the Respondent No.1 is answering the allegations made by the Appellants as below:



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e no				
		Form I		
1	2, 9	Project Sector – New construction projects and Industrial Estates	The 102 Km long elevated highway is covered under entry 7 (f) under highways category and not just under 8 (b)	As has been explained above in paragraphs 22 to 26, it is submitted that by virtue of the operation of the direction of this Hon'ble Tribunal, the Project can be categorized under 8 (b) of the EIA notification and not under 7 (f)
2	8.3	Could the project be affected by natural disasters? (Floods, earthquake etc.) Answer provided - "NO".	Unless it is acknowledged that natural disasters, like earthquakes, are significant risk factors, and such risks have been comprehended, worst case scenario cannot be modelled and studied, and thus the presumption of no risk is clearly a figment of imagination.	<p>The Appellants have deliberately misrepresented before this Hon'ble Tribunal. The EIA prepared by the Respondent No.1 specifically takes into account the design considerations of natural disaster like Earthquake. The Respondent No.1 has considered and assessed the risk factors associated with seismic activities in the city of Bangalore.</p> <p>The Respondent No.1 has considered the following aspects and loading as per relevant codal provisions while formulating the design of structures</p> <ul style="list-style-type: none"> • The Bridge design life is expected to be 100 years; • The structures that are proposed to be built for the Project will be designed for normal exposure conditions with adequate concrete cover to exposed surfaces. <p>It is submitted that while preparing the EIA report, the Respondent No.1 has considered the following loads for Structural Analysis and Design</p> <ol style="list-style-type: none"> 1) Dead Load (DL) 2) Super Imposed Dead Load (SIDL): 3) Design Vehicular Loading (IRC Class Loading) 4) Longitudinal force of Live



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				<p>Load due to Braking (BR):</p> <p>5) Centrifugal forces (CF)</p> <p>6) Vehicular Collision Load:</p> <p>7) Accidental load on Crash Barriers</p> <p>8) Wind loads</p> <p>9) Seismic Loading- Zone-II</p> <p>10) Bearing Replacement</p> <p>11) Settlement (SE)</p> <p>12) Earth Pressure</p> <p>13) Creep and shrinkage effects (CR & SH)</p> <p>14) Thermal Effect (Cl.215 of IRC: 6-2014)</p> <p>15) Uniform temperature (TU)</p> <p>16) Temperature Gradient (TG)</p> <p>It is submitted that the Respondent No.1 has acknowledged and assessed the risk factors in the EIA report and for reasons best known to them, the Appellants have chosen to turn a blind eye to the details provided in the EIA report.</p>
3	9	Consequential Development and cumulative impacts - Answer provided "NO"	The project will have consequential development and during construction phase itself will have cumulative impact with other major projects like metro etc.	Since the Project is proposed to be constructed over the existing road alignment, there is no significant consequential development and cumulative impact. Moreover, it is submitted that all the concerned stake holders of the state machinery have been appraised of the integration of the Project and the implementation of the integration would be done while executing the Project.
4	III (2)	Ecological sensitive areas like waterbodies etc Answer provided NO	Deliberate suppression of the widespread impact on lakes, parks, trees and green cover of the city.	It is submitted that the Appellants have made a generic statement that the project would have widespread impact on lakes, parks, trees and green cover. The Respondent No.1 has dealt with each of these contentions separately in the following paragraphs individually. It is however submitted that since the proposed alignment follows existing road alignment, the question of



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				impact on the water bodies due to the implementation of the Project does not arise.
5	III (11)	Areas already objected to pollution or environmental damage (those where existing legal environmental standards are exceeded) – Answer provided – “NO”	Along the corridor, even according to KSPCB, air quality parameters exceed limits fixed by NAAQ 2009	<p>The Appellants have made a generic statement that along the proposed corridor, air quality parameters exceed fixed limits. The Appellants have failed to establish that the construction of the Project would invariably lead to further deterioration of the air quality parameters.</p> <p>It is submitted that one of the primal reasons for proposal of the Project is reduction of CO2 emission in the city of Bangalore. The implementation of the Project is estimated to reduce CO2 emission due to vehicular traffic by about 4.74 lakh tonnes. The implementation of the Elevated Corridor Project would substantially cut down the travel time and in turn would reduce the man hour spent in traffic. The estimated cost savings in terms of fuel and travel time cost is about Rs. 9,000 Crores.</p> <p>It is submitted that the construction of the Project would thus improve the air quality parameters and would reduce the CO2 emission due to vehicular traffic.</p> <p>The claim of the Appellant that the project would further deteriorate the air quality is therefore baseless.</p>
		Form IA		
7	1.3	What are the likely impacts of the proposed activity on the	Relevant information not provided. Land use, impact on open spaces or	It is submitted that to the maximum extent, the proposed project corridor follows the existing road alignments. Since the Project is proposed to be built over the



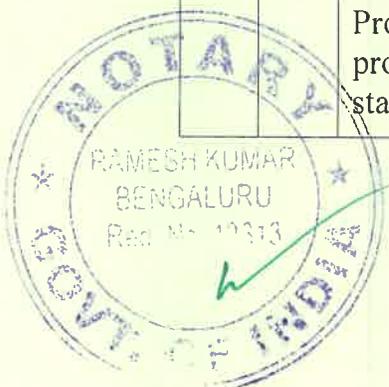
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		existing facilities adjacent to the proposed site? (Such as open spaces, community facilities, details of the existing land use, disturbance to the local ecology).	ecology not stated.	existing alignment. the impact on adjacent structures along the corridor are minimized by a large extent. Furthermore, the impact on the open spaces and ecology has been provided by the Respondent No.1 in the EIA report submitted and the Appellants are attempting to misconstrue the Form I and Form IA by reading them in isolation with the DFR and EIA report that were submitted by the Respondent No.1.
8	1.5	Will the proposal involve alteration of natural drainage systems? (Give details on a contour map showing the natural drainage near the proposed project site)	The interim alignments that have been released as part of the Detailed Feasibility Report reveal that the project will impact several lakes in Bangalore. It is admitted in fact at item 1.21 of Form 1 that "the alignment of East - West Corridor - 1 passes adjacent to KR Puram lake, Benniganahalli lake and Ulsoor lake; East - West Corridor - 2 passes adjacent to Varthur Lake, Thuberahalli lake and Vrishabhavathi Stream; North South Corridor passes adjacent to Sampangi	It is submitted that the proposed structure under the Project is an elevated structure (as the name itself suggests) and it does not affect the natural drainage system as runoff on elevated corridor is recharged through water recharge pit and at-grade level the existing drainage system/Patten remains same. The EIA report of the Respondent No.1 in fact clarifies this aspect at Section 6 of the Report.



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			lake; Connecting Corridor - 1 passes adjacent to Agara lake; Connecting Corridor -2 passes adjacent to Ulsoor lake and Connecting Corridor - 3 passes adjacent to Chalkere lake". It is evident that the proposed project has a direct and irreversible impact on the drainage patterns of surface runoff around the impacted lakes.	
9	2.1	Give the total quantity of water requirement for the proposed project with the breakup of requirements for various uses. How will the water requirement be met? State the sources & quantities and furnish a water balance statement. - Project proponent has stated that	No information on water source, quantity proposed to be extracted from each source and absolutely no water balance has been provided. Surprisingly, bore wells have been stated as water source when the entire Bangalore region has been classified as over exploited, there is serious threat of drinking water security and	It is submitted that at the initial stage of submitting the application, it was proposed to draw water from Borewell. Later during according EC, the Committee has advised to explore drawing of water from other sources also. It is pertinent to note that the required quantity of water will be spread over four years of construction and implementation. However, the Respondent No.1 has ensured that the bore well water alone is not prescribed as the source inasmuch as the in the bidding document (which has since stand scraped) the Respondent No.1 had mandated that the contractor shall also source the treated water from local STPs and from other sources.



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		243 Million litres of water is required and that it will be drawn from borewells.	drawal of groundwater megaproject construction cannot be permitted.	
10	2.2	What is the capacity (dependable flow or yield) of the proposed source of water?	No information provided	It is submitted that the water source will be from various borewells along the existing alignment, STPs, surface water, etc., which will be sources after obtaining necessary approvals from competent authorities. However, since the Project yet to be implemented such sources shall be identified by the contractor with the consent of the authority, during execution phase.
11	2.3	What is the quality of water required, in case, the supply is not from a municipal source? (Provide physical, chemical, biological characteristics with class of water quality)	No information provided	Since the Project proposes construction of elevated corridor, which is a corridor of elevated road over the existing alignment of the existing roads, the Ministry of Road Transport and Highways (MoRTH) guidelines on the quality of water, (<i>which prescribes the physical, chemical and biological characteristics of water</i>) will be followed.
12	2.4	How much of the water requirement can be met from the recycling of treated wastewater? (Give the details of quantities, sources and	Irrelevant information provided. Quantity, source, etc. not Specified.	It is submitted that the water source will be from various borewells along the existing alignment, STPs, surface water, etc., which will be sources after obtaining necessary approvals from competent authorities. However, since the Project is yet to be implemented, the quantity and source shall be identified by the



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		usage)		contractor with the consent of the authority, during execution phase.
13	2.9	What are the impacts of the proposal on the ground water? (Will there be tapping of ground water; give the details of ground water table, recharging capacity, and approvals obtained from competent authority, if any)	List of sources and plan for sourcing water has not been provided. The fact that approval has not been obtained has not been noticed.	Since the project draws water from several sources like number of borewells, surface water, treated water, etc. and quantity to be harnessed from each source cannot be realistically assessed at this stage. The ground water table/recharge capacity of each borewell source to be harnessed could be assessed only during implementation.
14	3.1	Is there any threat of the project to the biodiversity? (Give a description of the local ecosystem with its unique features, if any - Answer provided)	Suppression of fact that the felling of more than 3000 fully grown majestic heritage trees will affect biodiversity and local environment. During operation and construction, the increased pollution will affect photosynthesis and health of remaining avenue trees and trees in pans in a much wider area than the impact zone, including precious biological heritage in	It is submitted that though the implementation of the Project would require felling of trees, the issue has been considered and dealt by the Respondent adequately and as such there is no threat to the Biodiversity. The impact of felling of trees will be mitigated by compensatory afforestation at the rate 10 trees for each tree being cut. This factum has been elaborated by the Respondent No.1 in the EIA report filed.



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			Lalbagh, Cubbon Park and Palace Grounds.	
15	3.2	Will the construction involve extensive clearing or modification of vegetation? (Provide a detailed account of the trees & vegetation affected by the project)	Except to state that 3821 trees will be cut and 2084 trees need to be pruned, the project proponent has not provided "detailed account of trees and vegetation affected by the project." This, in any case, cannot be identified as the project alignment is yet to be finalized, though the project has been approved through an EPC tender.	It is submitted that the detailed account of trees (including the type of tree and other relevant details) affected by the Project has been provided at Annexure-5 of EIA report. As has been stated above, the Project is proposed over the existing road alignments and the allegation of the Appellants is therefore baseless.
16	4.1	Is there likely to be any displacement of fauna- both terrestrial and aquatic or creation of barriers for their movement? Provide the details. - Answer - NO	Felling and pruning of around 6000 trees and more will directly impact the population of critically endangered Slender Loris that uses the city's close canopies to migrate, and this also affects adversely the migration of wide range of birds and other fauna.	It is submitted that there is no displacement of fauna both terrestrial and aquatic and there is no creation of barriers for their movement. The Appellants have alleged that the felling of 6000 trees (<i>though the number of trees proposed to be cut by the Respondent No.1 is 3821</i>) will directly impact the population of critically endangered Slender Loris, the Appellants have failed to provide any document or study to support their contention. On the basis of only the pleadings and in the absence of any document to support their contention of



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				creation of a barrier to the migration of the birds and other fauna, the Appellants contentions are therefore liable to be disregarded.
17	4.2	Any direct or indirect impacts on the avifauna of the area? Provide details. - Answer - NO	The felling of trees has a critical and direct impact on avifauna, and is not stated in the Form.	The Respondent No.1 reiterates that there are no direct or indirect impacts on the avifauna. The Appellants have failed to produce any document or proof whatsoever to establish that the Project implementation would impact the avifauna. .
18	5.1	Will the project increase atmospheric concentration of gases & result in heat islands? (Give details of background air quality levels with predicted values based on dispersion models taking into account the increased traffic generation as a result of the proposed constructions) - Answer - NO	The construction of elevated corridor will lead to increased traffic and emissions from vehicles at an elevation and introduce areas along the alignment to increased exposure to pollutants. Such corridors will result in effects of heat island.	It is submitted that the Project will not increase atmospheric concentration of the gases and instead, after the construction of the project it will ease out the traffic congestion resulting in smooth flow of the traffic along the corridor. The implementation of the Project is estimated to reduce CO2 emission due to vehicular traffic by about 4.74 lakh tonnes. The implementation of the Elevated Corridor Project would substantially cut down the travel time and in turn would reduce the man hour spent in traffic. The estimated cost savings in terms of fuel and travel time cost is about Rs. 9,000 Crores.
19	5.2	What are the impacts on generation of dust, smoke, odorous fumes or other hazardous	Impact during construction phase grossly misrepresented.	The generation of dust during construction phase is mitigated by regular water sprinkling; however this aspect has been addressed by recommending appropriate mitigation measures under Chapter 5.2.5 of EIA.



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		gases? Give details in relation to all the meteorological parameters.		
20	6.3	Whether there are any local considerations of urban form & urban design influencing the design criteria? They may be explicit spelt out. Project proponent has responded saying that Master Plan 2015 has been considered.	Patently false. Fails to mention that the revised master plan 2015 does not factor the present elevated highway	<p>It is submitted that the Master Plan is nothing but a static long-term planning document that provides a conceptual layout to guide future growth and development. Master planning is about making the connection between buildings, social settings, and their surrounding environments. A master plan takes into account zoning regulations and includes analysis, recommendations, and proposals for housing, transportation, community facilities, and land use. It is based on public input, surveys, planning initiatives, existing development, physical characteristics, and social and economic conditions. It is important to consider the Master Plan as a dynamic document that can be altered based on changing project conditions over time.</p> <p>It is submitted that the area along which the Project is to be constructed have been allocated for roads in the Master Plan. In fact, the Project consists of elevated highway corridors that are to be built above the existing roads, so as to ease traffic conditions. Hence, there is no question of the same being in violation of the Master Plan. The Project is in consonance with the zoning regulations and the land use inasmuch as the Project has been proposed on the existing road alignment and as such, no change in land use is required for the purposes of implementation of the Project. The construction of the elevated</p>



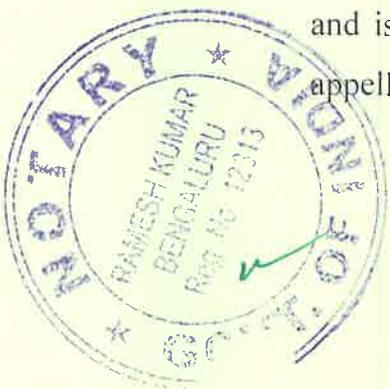
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				highway corridors does not change the Master Plan in any manner whatsoever
21	9.8	What are the likely effects of the building activity in altering the micro-climates? Provide a self assessment on the likely impacts of the proposed construction on creation of heat island & inversion effects? - Answer provided is NO.	Felling of several thousand trees and converting green cover to concretized surfaces and increased plying of vehicles and attendant pollution. will affect micro climate significantly and extensively.	As has been explained above, it is submitted that there are no effects from the project activity in altering the micro climate and elevated corridor will reduce the traffic and pollution load will come down moderating micro climatic parameters.

62. It is submitted that the Appellants have cherry picked the entries under Form I and Form IA and have found fault with the entries made therein. The Appellants have made wild conjectures against the Project and the allegations made against the information provided in Form I and IA have not been backed with any document and in the absence of any documentary support to establish the claim of the Appellants, the contentions made against the information provided by the Respondent No.1 in Form I and IA are baseless. Therefore, the averments made in paras 11 to 13 of the Appeal are hereby denied as false.

Re. Generic Terms of reference and EIA not fulfilling ToR:

63. At the outset it is submitted that the Project is an elevated corridor project and is not the construction or rebuilding of a highway and as such, the appellants are attempting to deliberately term the project to be a highway



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in order to give an impression to this Hon'ble Tribunal that the Project is somehow related to highways.

64. As per the said EIA notification, Entry 7 pertains to 'Physical Infrastructure including Environmental Services' and entry 7 (f) pertains to 'Highways'. As per entry 7 (f), a project falls under Category A if it is (1) A New National Highways; and (2) Expansion of National Highways greater than 30 Kilometers involving additional right of way greater than 20 meters involving land acquisition and passing through more than one State. Similarly, a project falls under Category B of entry 7(f) if (1) it is a new state highway and (2) Expansion of National / State Highway greater than 30 Kilometers involving additional right of way greater than 20 meters involving land acquisition.
65. For a project to qualify the criteria under Entry 7 (f) of the Notification, such a project must be 'New National or State Highway'. The Elevated Corridor Project is not construction of a New National Highway or State Highway. It is submitted that though, certain stretches of alignment of elevated corridor forms a part National Highways (NH 4 & NH 7) and State Highways, elevated corridors cannot be classified as NH or SH looking at their functional and locational role and there is no construction of a new national and state highways and as such, the Project cannot be considered to fall within the ambit of Entry 7 (f) of the Notification.
66. The proposed six elevated corridors having a length of 102.04 km is to decongest the internal city roads and to give access controlled connectivity to the arterial roads which are connecting important neighboring towns and cities and the proposed purpose of the Project is to ease the traffic congestion and to increase connectivity for the development of the Bangalore area. The elevated corridors are not continuous in nature to be considered as one project, and it constitutes of 6 different corridors connecting different parts of the city. Therefore the




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total length of all six corridors cannot be considered as a single project length so as to somehow make it fall under Category 7 (f). The Appellant is attempting to manipulate the facts and contort the details of the project to serve their purposes and the Project cannot be considered to fall under Category 7 (f) solely on the basis of the allegations made by the Appellants.

67. Even though the construction of 6 separate corridors connecting the city is not prescribed under the Notification and considering both length and width of the project, it is not required to obtain the environmental clearance. However, the Respondent No.1 has obtained the environmental clearance for the Project by considering the same under Townships and Area Development Projects at Entry 8(b) of the Notification. Proposed elevated corridor project has total built-up area of approximately 21,89,000 sqm and it exceeds 3,00,000 sq. mtrs., thereby qualifying under Schedule 8(b) of EIA Notification.

68. As explained above, though the Project does not fall under the category of 7 (f) under the EIA Notification and even though the Project is not entitled to be qualified under category 8 (b) of the EIA Notification, the 1st Respondent, in adherence of the directions passed by this Hon'ble Tribunal in Application No.243 & 245 of 2016, has conducted a detailed Environmental Impact Assessment and has also conducted a Social Impact Assessment study. The EIA report is based on the Terms of Reference issued by the Ministry and is in complete compliance of the ToR. It is submitted that the Appellants have made a bald and vague statement that the EIA is contrary to ToR and the Appellants have not substantiated their allegations with instances of alleged non adherence to ToR.

69. Though the Respondent No.1 has conducted a detailed EIA study in complete compliance with the EIA Notification, the Appellants have




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contended that the EIA conducted by the Respondent No.1 is not even an EIA and such a contention of the Appellants finds no basis either in the Appeal or in the documents. Moreover, the Respondent No.1 has provided the proposed cross sections and junction designs and the contention of the Appellants that the same are not 'finalized' is premature inasmuch as the finalization of the cross section and designs and approval of the same can occur only at the stage of tendering and implementation and moreover, as the conditions mentioned in the EC and the prevalent regulations, the designs proposed in DFR shall be adhered to the best of the ability of the answering Respondent at the time of implementation of the Project.

70. The Appellants have questioned the ToR issued by the 6th Respondent by way of a table in para 17 of the Appeal. The Respondent No.1 seeks the leave of the Tribunal to respond to the comments made by the Appellants as below:

Sl. No	Sl. No. in Application	Items	Section	Comments made by the Appellants	Response of the 1 st Respondent
1	2	Submit details of environmentally sensitive place, land acquisition status, rehabilitation of communities/ villages and present status of such activities	Refer to Section 4.7, Section 5.2.3 & 5.2.5 and Table No 5.10	4.7 is at pg. 4-92 Provides general description of the hydrology surrounding Bangalore and even has some studies of water quality. However, these studies are not dated 5.2.3 is at pg. 5-122. It also discusses impact of the project on water bodies. 5.2.5 Is at 5-128 considers the impact on air quality.	It is submitted that Details of land acquisition status, rehabilitation of communities etc. have been addressed in the Social Impact and RAP report under chapter 7 of Volume 1 of the DFR. The environmentally sensitive areas



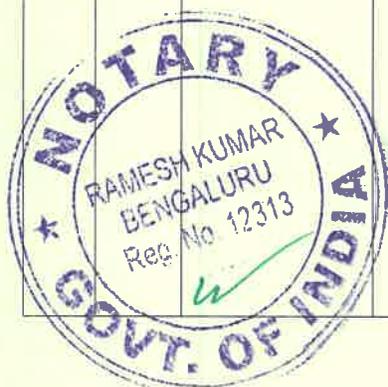
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				<p>Table 5.10 provides a list of noise sensitive receptors. along the proposed corridors. Details of land acquisition status, rehabilitation of communities and other environmentally sensitive places. (except water bodies) have not been provided at the sections indicated.</p>	<p>under the project are addressed in chapter 5 of the EIA.</p>	
2	3	<p>Examine baseline environmental quality along with projected environmental road [read as load] due to the project</p>	<p>Refer to Section Chapter 4</p>	<p>Chapter 4 starts on pg. 4-33. It contains a description of Environmental baseline data. However, such data has been collected between November 2018 and January 2019 which is, the North-East Monsoon period. Data cannot be collected during Monsoon since it is not representative of meteorological conditions for the rest of the year. Please refer para 21-24 below for detailed submissions on this issue. Projected Environmental Load of the project has not been provided. The details of modelling done has also not been provided. Please refer para 27-29 below for detailed submissions on this issue</p>	<p>It is submitted that Environmental Base Line data was collected post monsoon season (ie., from November 2018 to January 2019), pertinently, the baseline data so collected during the non-monsoon period has been accepted by committee.</p>	
	3	4	<p>Environmental data to</p>	<p>Refer to Section</p>	<p>Chapter 4 starts on pg 4- 33. The</p>	<p>It is submitted that the environmental</p>



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		be considered in relation to the project development would be (a) land, (b) ground water, (c) surface water, (d) air, (e) bio-diversity, (f) noise and vibrations, (g) socio economic and health.	Chapter 4	Environmental data collected and presented in this chapter is not according to the mandate of the sector specific EIA manual issued by the MoEF.	data collected and presented is as per standard and exhaustive ToR issued by committee. Apart from alleging that the environmental data collected is not as per the EIA manual, the appellant has not been able to point out any lacunae in the environmental data collected and compiled by the 1 st Respondent.
4	5	Submit a copy of the contour plan with slopes, drainage pattern of the site and surrounding area. Any obstruction of the same by the Project	Refer to Section 4.7	4.7 starts at pg. 4-92. Contour map has not been submitted. Project admittedly cuts through water bodies and impinges on their drainage area.	As has been explained above, the project is aligned on existing road and the elevated structures with the help of Piers generally at 40 meter interval and the proposed project does not cut through water bodies and does not impinge on their drainage area. The Project proposes to harvest the Rain water and implements rain water harvesting on the Elevated Corridor, thereby recharging the ground water reserve.



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					The Project does not add any additional water load to the drainage system and as such, the existing drainage systems is not affected by the Project.
5	6	Submit the details of the trees to be felled for the project.	Refer to Section Annexure 5	Annexure 5 is not found along with the EIA Report. Index at pg vi states "Error! Bookmark not defined"	The complete EIA report has been uploaded on the official website of the 1 st Respondent. However, the Respondent No.1 has annexed the EIA report along with this Statement of Objections and the details of the trees to be felled for the project is given in Annexure-5 of EIA Report.
6	7	Submit the present land use and permission required for any conversion such as forest, agriculture etc	Refer to Section 4.10	Section 4.10 is at pg. 4-109. Permission for conversion of land use (mandatory under form 1A) has not been provided in this section.	It is submitted that the project is aligned along the existing road alignment and acquisition of land for marginal widening is only envisaged. The details of land proposed acquisition and plan thereto are furnished in chapter 7 of Volume 1 of DFR and the detailed land acquisition plan has also been prepared.



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					It is submitted that the conversion of agriculture/forest land for the proposed Project does not arise.
7	9	Ground water classification as per the Central Ground Water Authority.	Refer to 4.9	Section 4.9 is on .pg. 4-106. Groundwater Classification has-not been provided. Suppression of the fact that entire Bangalore Urban area has been classified "Overexploited". In fact, the EIA report describes plans – to source water requirements from bore wells despite of this classification (in section 5.2.3).	<p>Existing Ground water condition as per central ground water board for Bangalore Urban area is brought out in EIA Report.</p> <p>In absence of sufficient surface water source alternatives available in the vicinity, source of water requirement should have to be met from bore wells.</p> <p>However, EIA mandates use of treated sewage water from the STPs.</p> <p>The Project also addresses recharge of ground water by guiding surface run-off from elevated road through recharge pits between the piers along the median after suitable treatment.</p> <p>The detailed plan in this regard has been provided at chapter 6 of the EIA.</p>
8	10	Examine the details	Refer Section	Section 5.2.1 at pg. 5-123 deals only with	Identification of sources of water for



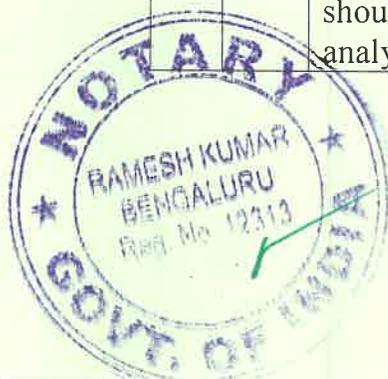
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		of Source of water, water requirement, use of treated waste water and prepare a water balance chart	5.2.1	the impact on topography. Source of water and water balance has not been provided even at 5.2.3 where water requirement has been stated as 266 million litres.	the project will be done by the contractor at the time of implementation with due consultation with the Environmental Engineer of the Respondent No.1 Consultancy service after due consideration of quantity/quality/distance. However as per the mandatory condition of Environmental clearance issued, a condition will be imposed for the usage of treated sewage water for construction.
9	13	Examine details of solid waste generation treatment and its disposal.	Refer Section 5.2.2	5.2.2 At pg 5-123 is titled "Impact on Soil". It considers the impact of construction on soil erosion. It does not provide details of solid waste generation including construction waste and municipal solid waste. It briefly mentions some mitigation measures for how debris should be disposed of.	It is submitted that the details of Solid waste (Soil Debris) is exhaustively covered in Section 5.2.2 and Table 5.4 and Section 5.2.9- Impact on Land Environment. At the time of implementation of the project, measures will also be imposed for disposal of solid wastes in environmentally sustainable manner, as prescribed in law.



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10	15	<p>DG sets are likely to be used during construction and operational phase of the project. Emissions from DG sets must be taken into consideration while estimating the impacts on air environment. Examine and submit details.</p>	<p>Refer Section 5.2.5</p>	<p>Section 5.2.5 is at pg. 5-128. Emissions from DG sets have not been modelled or considered.</p>	<p>Emission from DG Sets are expected during construction stage which will be mitigated by using low emission DG's and impact will be reduced by using Chimneys of required height.</p> <p>The impacts will be short term and limited in nature. Proper site selection, appropriate location of plant and regular maintenance and monitoring will be insisted during implementation in order to minimize such impacts. The details with regard to mitigating measures have been provided in chapter 5 of the EIA report.</p>
11	16	<p>Examine road/ rail connectivity to the project site and impact on the traffic due to the proposed project. Present and future traffic and transport facilities for the region should be analysed</p>	<p>Refer Section 5.2.4</p>	<p>5.2.4 is at pg. 5-128 and deals only with Traffic Diversions.</p>	<p>The claim of the Appellants is not true inasmuch as a detailed traffic analysis has been conducted by the Respondent No.1 and the same is a part of the DFR, which has been annexed herewith.</p>



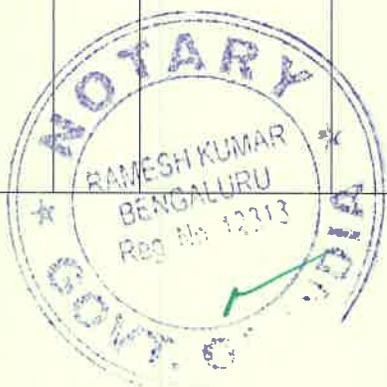
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		with measures for preventing traffic congestion and providing faster trouble free system to reach different destinations in the city.		
12	17	A detailed traffic and transportation study should be made for existing land projected passenger and cargo traffic.	Refer Section 2.7, 2.8 & 2.10	2.7 at pg. 24 is titled; "Proposals for the Elevated Corridor". 2.8. titled "Traffic Forecast" at pg. 2-9. 2.10 at pg. 2-12 is titled "Corridor of Impact". 2.7 discusses functional aspects of the project, 2.8 reproduces CTPP figures of Bangalore's projected Traffic Growth and 2.10 discusses the dimension specifics of the proposed Elevated Corridor and briefly alludes to the impact on traffic. It also mentions that a detailed traffic study report has been prepared. However, this study is not found as a part of the EIA report. As such no evidence of a detailed traffic and transportation study is found.



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13	19	Examine separately the details for construction and operation phases both for Environmental Management Plan and Environmental Monitoring Plan with cost and parameters.	Refer to Section Chapter 8	Chapter 3 is at pg. 8 - 166. The report itself states "A detailed EMP is to be prepared during DPR stage to address specific impacts of the project." The EMP provided at page 8 - 167 - 174 is generic and non-Specific concerns of pollution from the project and mitigation measures are not provided.	<p>It is submitted that the Environmental Management Plan and Environmental Monitoring Plan with cost parameters has been conducted in detail.</p> <p>The proposed mitigation measures have been enumerated in chapter 5 of Environmental Impact and Mitigation Measures of EIA report.</p> <p>The Appellant is making assertions against the EMP without spelling out the alleged irregularity in the study conducted by the 1st Respondent.</p>
14	20	Submit details of a comprehensive Disaster Management Plan including emergency evacuation during natural and manmade disaster.	Refer to Section 8.1.3 at 8.1.4	8.1.3 is on pg. 8— 179. It agrees with the need for a disaster management plan but does not provide it. 8.1.4 starts on 8-179. It outline the need for an Oil Spill Contingency Plan and identifies the contractor as for being responsible doing so.	<p>For Comprehensive disaster management plan including emergency evacuation have been described under section- 8.1.13 and 8.1.114.</p> <p>Though the section mentions that the Contractor has to come up with the contingency / emergency plans, it is pertinent to note that the EIA prescribes the requisite parameters</p>



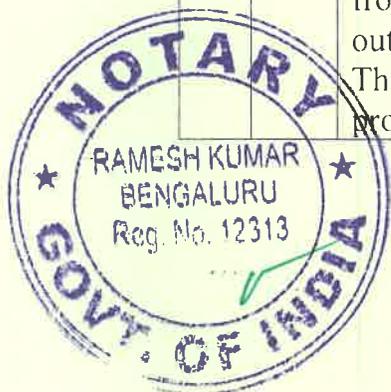

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					the plans should contain and as such, the contention that the Respondent No.1 has passed its responsibility on the contractor is contrary to the records.
15	22	The cost of the Project (capital cost and recurring cost as well as the cost towards implementation of EMP should be clearly spelt out.	Refer to Section 8.10 & Table 8.6	8.10 is at pg. 8—195 and refers to table 8.6 at pg. 8-196. Table contains cost for the implementation of the Environment Management Action Plan. Capital Cost of the project is not provided in this section.	It is submitted that the assertion made by the Appellants are untrue inasmuch the Capital and recurring cost with respect to Environmental management is detailed in Table 8.6 of EIA Report.
16	23	Any further clarification on carrying of the above studies including anticipated impacts due to the project and mitigative measure project proponent can refer to the model ToR available on Ministry Website http://moef/nic.in/Manual/Townships	Referred	The entire section from the model ToR considering alternatives is missing. When read with the sector specific Manual, the alternatives to be considered include other transportation systems. None of this has been considered. It is also surprising that a manual for townships has been referred for an Elevated Highway Project.	It is submitted that



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		Additional TOR			
17	1	The applicability of the Hon'ble National Green Tribunal order dated 4th May 2016 in O.A No.222 of 2014 on buffer zone for water bodies and nalas may be studied and submitted.	Refer to Section 3.11 and 4.7	3.11 is at 3-27 and effectively reiterates the order of the Tribunal.	<p>It is submitted that Order of the Hon'ble NGT in OA 222/2014 is applicable for the building projects wherein, the total obstruction of flow and drainage is going to be affected.</p> <p>The present project is the elevated structure aligned above the existing road with the help of Piers generally at 40m interval and it will not cut through water bodies and do not affect the existing drainage and therefore the said order of the NGT has no applicability to the instant case.</p> <p>Moreover, the EC specifically mandates compliance to the Order of the DRT in OA 222/2014.</p>
18	2	As per the proposal about 12 Lac cum of earth required to be brought from outside. The proponent	Refer to Section 5.2.2, 8.1 and Appendix 1	<p>5.2.2 is at pg 5-123. It only discusses the impact on soil during the construction phase and makes a recommendation to source the soil from infertile lands.</p> <p>8.1 is at pg. 8-179. It only deals with resettlement plan.</p>	<p>The Respondent No.1 has recognized that soil/debris will be generated during foundation excavations for pile construction and the debris so generated will be carefully and safely disposed off.</p>



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		should work out the alternative scheme to reduce the earthwork requirement.		construction water management plan, emergency response plan and oil spill contingencies plans. Therefore they have not worked out a way to reduce the earthwork requirement. Appendix 1, is titled "Disposal Site Management" but is not found along with the EIA report.	The debris generated at the pile foundation location will be partially utilized for construction of ramps and rehabilitation of quarries and borrow pits. The details pertaining to the debris are given in chapter 5.2.9 of EIA report.
19	3	Scientific handling of earthwork generated during construction may be detailed and submitted keeping in view best possible mitigation measures for dust.	Refer to Section Appendix 1	Appendix 1 is titled "Disposal Site Management" but is not found along with the EIA report. Document is also not found uploaded at http://environmentclearance.nic.in/onlineSearchState.aspx?type=TOR&status=19&statename=Karnataka	Details are given in chapter 5.2.9 of EIA report
20	5	Impact on the nearest water body and archaeological structures may be studied properly and submit.	Refer to Section 4.7, 5.2.3, 5.2.10, 3.1 & Table 8.1	4.7 is at pg. +92. Deals only with water environment. Impact on water bodies due to construction activities and during Operation have not been studied. 5.2.3 is at 5-125. Simply says that impact can be avoided by careful planning of construction activity. Does not contain a	The details are provided in para 5.2.3 & 5.2.8 for Water bodies along with mitigation measures. Table 8.1 of Chapter 8 of EIA Report discusses on impact and management measures on water resources and the quality, 5.2.10 (Archaeological buildings);



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				<p>study. 5.2.10 is at pg. 5-441. There is no study on impact, but merely states that two notified archaeological structures are within the prohibited distance of the East-West, Corridor. 3.1 is titled "Constitutional Provisions" at pg. 3-22. The relevance is not known. 8.1 is at pg. 8-167. It is the Environment Management Plan. It does not deal with a study of the impact.</p>	<p>However, during implementation, the mitigation measures/conditions imposed by the concerned authorities will be followed.</p> <p>These are all policies and regulatory frameworks and its applicability are made as per the basic constitutional provisions.</p>
21	9	Carbon foot print to be studied and suitable offsets may be suggested.	Refer to Section 6.7	<p>6.7 is at pg. 6-160. No study of carbon footprint is provided. However, an arbitrary calculation of emissions and offset is made available.</p>	<p>Carbon Footprint and carbon emission studies conducted, and the results are presented in Page No.6-160 to Page No. 6-163 of the EIA report.</p> <p>The Appellants have contended that the studies conducted by the Respondent No.1 to be an arbitrary calculation however the Appellants have failed to demonstrate any arbitrariness in the studies conducted.</p>
22	10	Steps taken to reduce the energy embodiment of the materials	Refer to Section 6.8	<p>6.8 at pg. 6-162 discusses the projected Carbon Emissions of traffic in Bangalore before and after the Elevated</p>	<p>One of the main reasons for proposing the Project was to minimise the traffic woes in Bangalore</p>



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		used may be detailed.		Highway Project. It only considers emission rates at different Speeds of traffic and assumes optimistically that speeds of traffic will increase. It fails to account for the increase in the number of vehicles on the road due to the Elevated Highway. Has no relevance to reducing energy of the materials used.	city. There are no study or report that indicates that construction of elevated corridor would prompt the citizens of Bangalore to buy more vehicles and such a presumption made by the Appellants is unfounded.
23	11	Changes to the micro climate to be modelled and simulation studies to be submitted.	Refer to Section 4.5.2	4.52 at pg. 4-73 is titled "Air Quality Modelling for the Project Area". As is apparent, there is no consideration of the general micro climate. Simulation studies have not been conducted. Micro climatic conditions depend on several factors like heat, tree canopy, humidity, wind, etc. and are not limited to air quality. In addition, the basis of the air pollution modelling is questionable as no methodology has been shared to explain the values arrived at.	Air quality Modelling has been done considering micro climatic conditions as presented in 4.5.2 of EIA.
24	12	List of trees to be felled, pruned, retained along with details of locality	Refer to Section Annexure 5 Section 8.10	Annexure 5 is not found along with the EIA Report. Index at pg vi states "Error! Bookmark not defined" 8.10 is at pg. 8-195. It contains the	It is submitted that the list of trees to be felled can be found at in Annexure-5 of EIA report and the said document was duly uploaded on



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		along with budget backup for plantation and its maintenance at least for 10 years.		Environmental Budgetary Provisions. The budgetary provisions are also only for a period of 5 years. There is no list of trees available.	the 1 st Respondent's website. A copy of the EIA report has already been Annexed to the instant statement of objections.
25	13	To propose suitable location details to take up compensatory plantation with budget details.	Refer to Section 6.3 & 8.10	6.3 is at pg 6-155 and 8.10 is at pg. 8-195. 8.10 contains no details of location. 6.3 contains general statements like "plantation of trees will be taken up in the upcoming new layouts" in the suburbs of Bangalore City, parks and forest under Bangalore Urban Division shown" in table".	The List of Forest land available in Bangalore Urban Division to take up compensatory plantation is given in section 6.3 of EIA. The concerned Tree committee of the forest department will suggest the locations for compensatory plantation as per the availability and the suitability for the recommended tree species which are to be planted as procedure laid down by forest department. Budgetary provision of 10 Crores has been earmarked for rising compensatory plantation which shows the commitment of project proponent towards conservation of environment.
26	16	Land use land cover	Refer to Section	4.10 is at pg. 4-109. Maps provided are	Detailed Land use land cover analysis



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	analysis of project corridor area using high resolution satellite data.	4.10	illegible and copies to scale have not been provided in the EIA report.	for the project corridor is done in section 4.10 from Page No. 4-109 to 4-112 of the EIA.
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71. The ToR issued by the Respondent No.6 is done after scoping (on the basis of the Form I and IA) and as explained above, the ToR issued by the Respondent No.6 is in adherence to the EIA notification and guidelines and the EIA prepared by the Respondent No.1 is in complete compliance to the ToR. Therefore, the averments made by the Appellants in paras 14 to 18 are hereby denied.

Re. Alleged flaw in baseline data collection:

72. The State Expert Appraisal Committee (SEAC), Karnataka has considered the Elevated Corridor proposal by Karnataka Road Development Corporation Limited (KRDCL) during its meeting held on 28th September 2018, and the Committee prescribed following the Terms of Reference (ToR) for preparing EIA/EMP report with latest one season baseline data other than monsoon for the proposed elevated corridor project.

73. It is submitted that the monsoon season in Bangalore is from June to September of every year and though the monsoon season extends some time to October, the monsoon season recedes thereafter and the period from November to January therefore cannot be considered as monsoon season. It is submitted that a bare perusal of the EIA report of the Respondent No.1 would clearly evidence that the baseline data has been collected from Nov 2018 to Jan 2019 i.e., non-monsoon period. It is pertinent to mention here that the study area under the EIA for baseline data is based on corridor of impact upto 100 M and corridor of influence upto 10 km from the proposed Project structure.

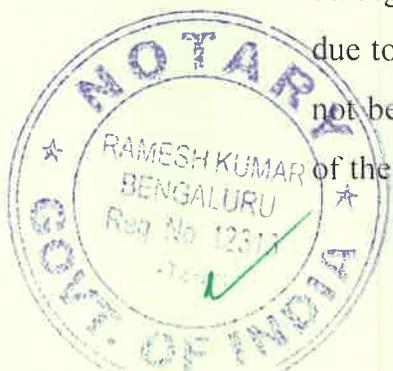


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74. The averments made in paragraph 19 of the Appeal are a matter of records and does not require traversal. For the reasons stated in the above paragraphs, the contentions of the Appellants in paras 20 to 24 that data collection is undertaken during monsoon period, the same is unscientific, erroneous and illegal is false and are hereby denied .

Re. Alleged Non-modeling and non study of impact on environment

75. It appears that the Appellants have leveled allegations against the Respondent No.1 without even going through the EIA report submitted by the 1st Respondent. Section 4-11 of the EIA report prepared by the Consultants of Respondent No.1 studies and models, in detail, the impact of the proposed project.
76. It is submitted that a detailed study has been carried out on air pollution, detailed predicted impact on air pollution has been provided as per the actuals approximated at the initial stages of the Project. The report under Section 4.5.1 of the EIA report. The Appellants have ignored the same.
77. Sections 4 and 5 of the EIA report has clearly enumerated the impact of the Project and in the EIA report, the Respondent No.1 has also enlisted the mitigating measures that will be adopted by the 1st respondent. The Appellants have conveniently ignored the same and have made allegations against the Respondent No.1 without any basis.
78. The contention of the Appellant that the data collected is illegal and that no modeling has been undertaken and that the severe air pollution caused during construction phase (construction activity, material transport, traffic due to diversion, etc.) and operation phase (vehicular pollution, etc.) have not been assessed, are therefore false and the averments made in para 25 of the Appeal are hereby denied.




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79. The Appellants have made a generic statement that construction of mega projects will result in particulate matter pollution and that the values of expected PM 10 and PM 2.5 are uncharacteristically low and that these aspect have allegedly not been studied property. The Appellants have however failed to establish any alleged lacunae in the EIA and the studies conducted by the Respondent No.1. The Appellants have not produced any document to prove that the studies conducted by the Respondent No.1 is allegedly unscientific or improper. Therefore, the averments made in paragraphs 26 and 27 of the Appeal are hereby denied as false.
80. It is submitted that chapters 5.2 and 6 of the EIA enumerates in detail, the impact of the proposed project on water and noise pollution and the mitigation measures proposed to be undertaken by the Respondent No.1 is also enlisted therein. Without appreciating the same, the Appellants have instead to turn a blind eye on the EIA study and have made averments as if the EIA study is non-existent. The averments made in paragraph 28 and 29 are therefore denied as false.

Re. Approval for Change in Land use:

81. It is submitted that the proposed Project follows the same alignment of the existing road alignment. Being an elevated corridor, the proposed Project does not require the change in the land use. For the portion of land where land is required to be acquired, the change in land use will be obtained by the Respondent No.1 at the time of land acquisition and implementation of the project and as such, since the proposed alignment of the project follows the alignment of the existing roads in Bangalore, the contention that change in land is not obtained by the Respondent No.1 is premature and is untenable.




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82. It is submitted that as has been explained above, as the Project follows the existing alignment of the already existing roads, the question of the Appellants obtaining change in land use does not arise. It is submitted that the Prior Environment Clearance is granted on the basis of the conceptual details of the Project and it is improbable and impractical to for a project proponent to obtain change in land use when the proposed alignment of the corridor is the same as that of the existing road. Moreover, insofar as the proposed lands to be acquired, at the time of implementation of the project and at the time of acquisition of such lands, as per the terms of the EC, the Respondent No.1 will need to obtain necessary clearance from the town planning authority.

83. Under the circumstances, the contention that the Respondent No.1 ought to have obtained change of land use for the lands that haven't been acquired is untenable and impractical. The averments made in paragraphs 30 to 34 contending that the EC ought have been rejected for allegedly not obtaining change in land use are therefore denied as false.

Re. Alleged violation of constitutional mandate by bypassing of Metropolitan Planning Committee

84. The Appellants have contended that the Project allegedly contravenes the Constitutional 74th Amendment Act. It is submitted that the intention of the legislature in enacting the 74th Amendment to the constitution was to bring about co-ordinated developmental activities in a Metropolitan region by making provision for the preparation of a Draft Development Plan to be prepared by the Metropolitan Planning Committee in consonance with the developmental activities and plans prepared by the local bodies for such development.

85. The Argument of the Appellants that the MPC is the sole instrumentality that is vested with the powers of urban planning and development and any other enactment that provides for the planning or development of a

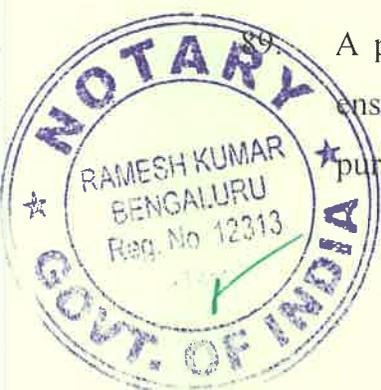


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- metropolitan area or municipal corporation is totally contrary to Article 243ZE (3) (i) of the Constitution which specifically emphasizes that the draft development plan that the MPC would prepare cannot contravene the plans prepared by the Local Planning Authority.
86. Moreover, the interplay between the Constitutional 74th Amendment Act, Article 243ZE of the Constitution and Karnataka Municipal Corporation Act is under consideration before the Hon'ble High Court of Karnataka in Writ Petition bearing No. 48720/2014. In the said Writ Petition, the Elevated Corridor Project of the Respondent No.1 was also made a part of the proceedings. The Respondent No.1 has impleaded itself in the said proceedings.
87. It is submitted that the Statement of Objects for the enactment of Constitution (Seventy-fourth Amendment) Act, 1992 (hereinafter referred to as the "74th Amendment") was *inter alia* to put on a firmer footing the relationship between the State Government and the Urban Local Bodies to provide for municipal corporations for large urban areas. With such an objective, the 74th Amendment was included, which *inter alia* introduced Article 243ZE to the Constitution of India
88. From the perusal of Article 243ZE, it becomes clear that the intention of the legislature was to bring about co-ordinated developmental activities in a Metropolitan region by making provision for the preparation of a Draft Development Plan (hereinafter referred to as "DDP") to be prepared by the Metropolitan Planning Committee ("MPC") in consonance with the developmental activities and plans prepared by the local bodies for such development.

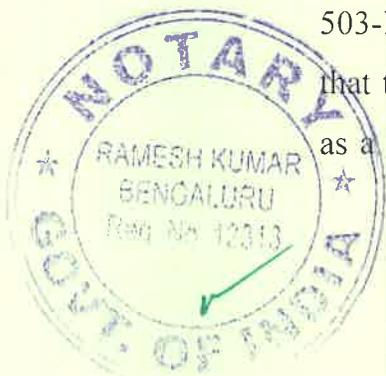
A perusal of the Rules would indicate that BMPC is essential meant to ensure a coordinated development of the entire BMC and not for the purpose of promotion of local self-government as alleged by the




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Petitioner. A reading of Article 243ZE would indicate that the intent is to ensure coordinated planning and to ensure that there is no wasteful expenditure.

90. A combined reading of the Article 243ZE and Section 503-B and the rules framed thereof, there appears no conflict with or violation of the object or intent of the 74th Amendment by the provisions of Section 503-B of the KMC Act or rules that have been framed thereof.
91. The argument that the MPC is the sole instrumentality that is vested with the powers of urban planning and development and any other enactment that provides for the planning or development of a metropolitan area or municipal corporation is totally contrary to Article 243ZE (3) (i) of the Constitution which specifically emphasizes that the draft development plan that the MPC would prepare cannot contravene the plans prepared by the Local Planning Authority.
92. It is submitted that as per Article 243ZE (1), the MPC shall prepare a draft development plan for a Metropolitan area as a whole. Furthermore, Article 243ZE (3) (a) provides that the DDP prepared by the MPC must have regard to the plans prepared by the Municipalities and the Panchayats in Metropolitan Area, matters of common interest between the Municipalities and the Panchayats, including co-ordinated spatial planning of the area, sharing of water and other physical and natural resources, the integrated development of infrastructure and environmental conservation and the overall objectives and priorities set by the Government of India and the Government of the State.
93. Similarly, the MPC constituted by the Respondent State under Section 503-B of the KMC Act (enacted pursuant to Article 243ZE) also provides that the BMPC shall prepare a DDP for the Bangalore Metropolitan Area as a whole and in preparing the DDP, the BMPC shall have regard to the



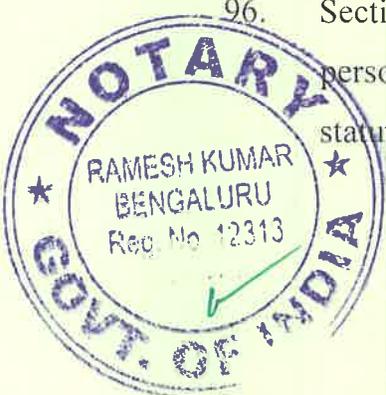

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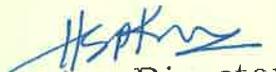
plans prepared by the local authorities in Metropolitan Area such as the BDA and the BMRDA, matters of common interest between the Municipalities and the Panchayats, including co-ordinated spatial planning of the area, sharing of water and other physical and natural resources, the integrated development of infrastructure and environmental conservation and the overall objectives and priorities set by the Government of India and the Government of the State and the extent and nature of investments likely to be made in the Metropolitan area by agencies of the Government of India and of the State Government and other available resources whether financial or otherwise. Moreover, as per Rule 9 and 10 of Bangalore Metropolitan Planning Committee Rules, 2013, the DDP is to be prepared with alignment to the State 5 years plan and the DDP is prepared for a period of 5 years.

94. The State Government accorded approval to the Project and the Urban Development Department was consulted and the same can be evidenced from the perusal of the approvals produced by the Appellants themselves. Such being the case, after having produced the approval given by the State Government to the Project, the Appellants are now alleging that the consent of the State Government was not obtained and such an allegation made by the Appellants is blatantly false and is contrary to the records produced by the Appellants themselves.
95. In light of the above, the averments made in paragraphs 35 to 41 that the Project ought to have been submitted to the MPC and only then could the Respondent No.1 apply for EC, are hereby denied as false.

Re. Social Impact Assessment under the 2013 Land Acquisition act not conducted:

96. Section 5 of the EIA report specifically mentions that the project-affected persons, families, households and groups shall be compensated as per the statutory provisions before the commencement of project. The impact




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shall be addressed as per the KIADB Act with Compensation at par with Land Acquisition, Rehabilitation and Resettlement Act, 2013. Furthermore, Volume I Chapters 2 and 7 contains the detailed social impact study carried out by the 1st Respondent.

97. As per the EIA notification, the Respondent No.1 had applied for the Prior Environmental Clearance as per Section 6 and 7 of the EIA. The Form I and IA and the DFR and EIA prepared pursuant to the ToR issued thereto relates to the proposed alignments and proposed plans of implementation. The impact of the proposed project is captured in the EIA report and the Social Impact Assessment, which was conducted and placed along with the DFR was considered by the Respondent No.4 while granting the EC to the Respondent No.1.
98. The EC granted to the Respondent No.1 is a prior environmental clearance and the same is granted on the basis of the proposed plan for the implementation of the Project. As such, it cannot be said that at stage of conceptual planning of the Project, the Respondent No.1 must finalize the specific details land acquisition and social impact assessment of such acquisition ought to have been conducted and submitted. Therefore, the averments made in paragraphs 42 to 45 of the Appeal are hereby denied.

Re. Impact on Cubbon Park and other parks – Alleged conversion of parks:

99. The Appellants have falsely contended that the project would ‘convert’ the parks along the alignment for the construction of the Elevated Corridor. The allegation of the Appellants is based on surmises and false conjecture. Though the Project will have an impact on the public parks, there exists no question of conversion of the public parks for the construction of the Project Corridor.



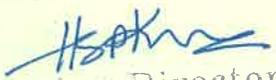

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100. The allegation of the Appellants that the Project encroaches the public parks is baseless and is not supported by any document, let alone the DFR of the 1st Respondent. It is submitted that the Project would require felling and pruning of certain trees that form a part of certain public parks. However, it is beyond the knowledge of this Respondent as to the basis on which the Appellants are claiming that the construction of the Project would result in encroachment of the Parks.
101. The Project does not entail allotment / conversion of the public park areas nor does it entail selling or disposing the areas reserved for public parks. The Project will be constructed as an elevation, mostly above the existing road alignment. As such, the question of allotment or public parks for the construction of the Project does not arise and the Project is not in contravention of Section 38A of the BDA Act or the rulings of the Hon`ble Supreme Court.
102. The Respondent No.1 has in fact recognized the loss of green cover due to the implementation of the project and as a measure of sustainable development, the Respondent No.1 has addressed the mitigation measures for loss of green cover in its EIA report.
103. The averments made in paragraphs 47 to 59, where the Appellants have presumed that the proposed felling and pruning of the trees would result in ‘allotment / conversion’ of public parks, are therefore misconstrued and are hereby denied as false.

Re. Loss of Greenery and biodiversity increases air pollution:

104. The averment in para 60 that the Respondent No.1 has admitted that the Project would not help relieve traffic congestion is false and is an attempt by the Appellants to mislead this Hon`ble Tribunal. The Appellants in paras 61 and 62 have contended that in all the material supplied in favor of the instant project, there is absolutely no concern expressed by the




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Project Proponents or its Consultants to the critical importance of retaining the greenery of Bengaluru. It is submitted that admittedly, the Respondent No.1 has duly acknowledged the loss of greenery in implementing the proposed project and has also therefore proposed mitigating measures against the felling and pruning of trees.

105. Under the circumstances, the averments made in paragraphs 60 to 62 are on the basis of presumptions and assumptions of the Appellants and the Appellants have failed to substantiate as to how the Respondent No.1 has contravened the EIA notification and therefore, the said averments are hereby denied.

Re. Impact on lakes and Hydrology

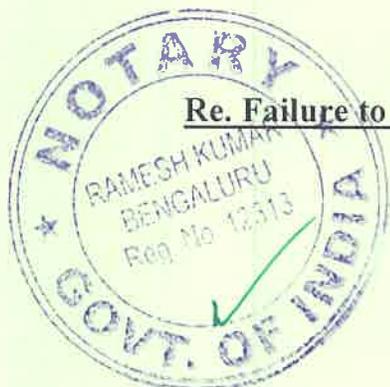
106. A perusal of the Form I and IA and the EIA report, it can be evidenced that the proposed corridors do not pass over the water bodies. However, as the elevated corridor alignments are proposed along the existing roads which are parenthetically adjacent to the water bodies. Except for Thubarahalli Lake, it is submitted that all other water bodies mentioned in table 5-13 of EIA Report are within the buffer zone established *vide* the Order of the Hon'ble NGT Order. Moreover, the Mitigation measures are explained in Section 5.2.8 of EIA Report.

107. The Respondent No.1 are not utilizing any fresh land for putting up constructions over the areas situated in the buffer zone. The proposed Project involves construction of elevated corridor over the already existing roads. That is to say, the construction of the corridors will be made above the already existing roads. As such, no construction will be implemented on any fresh area inside the buffer zone and as such, the Project therefore does not contravene the Order of this Hon'ble Tribunal creating the buffer zone.




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108. As has been rightly mentioned by the Appellants, the alignments given under the DFR and 'interim alignments' and it is the proposed alignments for the construction of the elevated corridor. The proposed structure is Elevated and it does not affect the natural drainage system as runoff on elevated corridor is recharged through water recharge pit and at-grade level the existing drainage system/Patten remains same.
109. The Project proposes to implement rain water harvesting systems in the elevated corridors. The Project corridors will not result in creation of any extra water load and therefore, the load on the existing drainage will be unaffected. Moreover, the downpour of rain over the Elevated Corridor would be diverted into the rain water harvesting pits thereby increasing the ground water reserve.
110. Moreover, it is submitted that even as per the EC, at the time of implementation of the Project, the Respondent No.1 is required to obtain requisite consent from the concerned departments (*including the KSPCB and the BBMP etc.*). It is submitted that the water bodies along the project alignment will not be affected and even otherwise, as the Respondent No.1 is required to obtain consent for the implementation of the Project, granting of EC does not in any manner authorized the Respondent No.1 to violate the buffer zone and put up constructions within 30 meters of the water bodies.
111. The averments made by the Appellants in paras 63 to 69 are on a presumption that the EC has authorized the Respondent No.1 to start construction across the water bodies and the Appellants are attempting to mislead this Hon'ble Tribunal misinterpreting the details provided in the EIA and the averments made in the said paragraphs are therefore denied.



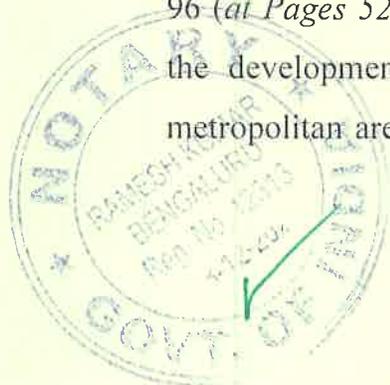
Re. Failure to consider alternatives:


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112. It is submitted that as per the EIA Notification, in the event of the scoping exercise results in the need for an alternative, in such a scenario, the project proponent is required to analyze the alternative technology and alternative site, for the implementation of the Project.
113. In the instant case, the SEIAA and the SEAC after scoping the project, has not found the need to seek for alternatives to the proposed Project. Moreover, while conducting the DFR, after a detailed reconnaissance and identification of possible improvements in the existing alignment and bypassing congested locations with alternatives, evaluation of different alternatives comparison on techno-economic and other considerations and recommendations, construction of elevated corridor was considered as the best suitable plan for decongesting the traffic in the city of Bangalore.
114. The Detailed traffic study and financial analysis for viability of the project was carried out benefit by implementing the Project was also assessed and provided in the DFR. Moreover, since the Project is proposed along the existing road alignments, the question of considering alternatives for the already existing alignments does not arise.
115. Furthermore, as has already been explained, the proposed Project is not a highway falling within category 7 (f) and as such, the EIA guidance sector specific manual for highways cannot be made applicable to the instant Project. Therefore, the averments made in paragraphs 70 and 71 are hereby denied as false.

Re. Para 72 to 96 (@ pages 52 to 69) of the Appeal

116. It is submitted that averments made by the Appellants at Paragraphs 72 to 96 (*at Pages 52 to 69 of the Appeal*) are generic averments pertaining to the development of urban localities and the projects implemented in metropolitan areas and the law laid down by various courts pertaining to




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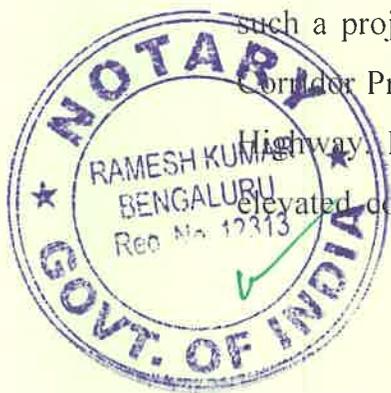
sustainable development and the averments made therein does not require specific denials.

117. **Re. Para 104 and 105 (@ Page 64 and 65 of the Appeal):** It is submitted that the Appellants have alleged that there is a non application of mind by SEAC And SEIAA in granting the EC and that minutes of the meeting of SEAC and SEIAA shows no reasons or discussion. Surprisingly the Appellants have not produced the minutes of meetings of SEIAA or SEAC to substantiate their contentions and instead, the Appellants have made bald assertions that the SEAC has failed to appraise the Project scientifically. In the absence of documents supporting the contentions of the Appellants the averments made in paragraphs 104 and 105 of the Appeal at pages 64 and 65 are hereby denied.

Re. Para 97 to 104 (@ pages 69 to 72 of the Appeal) - Project highway allegedly covered under 7 (f) and not 8 (b)

118. It is submitted that as per the said notification, Entry 7 pertains to 'Physical Infrastructure including Environmental Services' and entry 7 (f) pertains to 'Highways'. As per entry 7 (f), a project falls under Category A if it is (1) A New National Highways; and (2) Expansion of National Highways greater than 30 Kilometers involving additional right of way greater than 20 meters involving land acquisition and passing through more than one State. Similarly, a project falls under Category B of entry 7(f) if (1) it is a new state highway and (2) Expansion of National / State Highway greater than 30 Kilometers involving additional right of way greater than 20 meters involving land acquisition.

119. For a project to qualify the criteria under Entry 7 (f) of the Notification, such a project must be 'New National or State Highway'. The Elevated Corridor Project is not construction of a New National Highway or State Highway. It is submitted that though, certain stretches of alignment of elevated corridor forms a part National Highways (NH 4 & NH 7) and




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State Highways, elevated corridors cannot be classified as NH or SH looking at their functional and locational role and there is no construction of a new national and state highways and as such, the Project cannot be considered to fall within the ambit of Entry 7 (f) of the Notification.

120. Even though the construction of 7 separate corridors connecting the city is not prescribed under the Notification and considering both length and width of the project, it is not required to obtain the environmental clearance. However, the Respondent No.1 has obtained the environmental clearance for the Project by considering the same under Townships and Area Development Projects at Entry 8(b) of the Notification. Proposed elevated corridor project has total built-up area of approximately 21,89,000 sqm and it exceeds 3,00,000 sq. mtrs., thereby qualifying under Schedule 8(b) of EIA Notification.

121. Therefore, it is submitted that the contention of the Appellant that Project needs to be assessed under Category 7 (f) of the Schedule and the consequential averments made in paragraphs 97 to 104 at pages 69 to 72 of the Appeal are hereby denied as false.

Re. Public hearing not conducted

122. As per the EIA Notification of 2006, public consultation has been made mandatory for all Category 'A' and Category 'B1' projects or activities **except:**

- a. Modernization of irrigation projects (Item 1 (c) (ii) of Schedule)
- b. All project activities located within the industrial estates or parks (item 7 (c) of the schedule) approved by the concerned authorities, and which are not disallowed in such approvals
- c. Expansion of Roads and Highways (item 7 (f) of the Schedule) which do not involve any further acquisition of land




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- d. All Building / Construction projects / Area Development projects and Townships (item 8)
- e. All Category B2 projects and activities
- f. All projects or activities concerning national defense and security or involving other strategic considerations as determined by the Central Government

123. As has been explained above paragraphs, the Project, being a Area Development Project, falls under Category 8 (b) of the Schedule and is specifically exempted from the mandatory requirement of public consultation under the EIA Notification of 2006.

124. The contentions of the Appellants, that the EC is bad in law as no public consultation was held, is therefore baseless and invalid and the averments made in paragraphs 105 to 109 are hereby denied as false.

125. Though the Appellants have themselves claimed that the Project does not have an alignment, the Appellants have contradicted themselves and have alleged in para 110 that the basis for alignment of the Project is not stated. Though the Respondent No.1 is taking initiatives to ensure a cleaner environment by proposing to implement a pilot project of installing air purifiers at polluted junction, the Appellants have gone as far as terming such an initiative to be absurd and unscientific. While making such allegations, the Appellants have failed to produce any document to establish that the installation of air purifier would deteriorate the air quality or that it is unscientific. The averments made in paragraphs 111 and 112 are therefore denied as false.

126. The proposed acquisition of land, the Respondent No.1 conducted a detailed study and has prepared a framework in compliance with the Land Acquisition and Resettlement & Rehabilitation Policy and same has been detailed in Chapter 2 & 7 of Vol-1 Main Report of Detailed Feasibility




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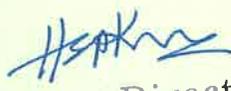
Report. The Appellants have however chosen to ignore the report to contend that the framework does not have a statutory framework and such a contention is nothing but an attempt by the Appellants to misconstrue the DFR and the averments made in paragraph 113 is hereby denied as false.

127. It is pertinent to mention here that the Appellant is basing its contentions pertaining to the quality of construction on media reports and not on any technical specifications provided by the Respondent No.1. The averments made in paragraph 114 that the Respondent No.1 is not confident about the quality of the project are hereby denied. The Appellant have claimed that globally the projects similar to the Elevated Corridor project are guaranteed for atleast century. However, apart from a mere averment, the Appellants have not produced any document to establish that the Project is proposed to be implemented to deliver inferior quality and the averments made by the Appellants in para 114 is therefore denied as false.

128. In light of the aforementioned paragraphs, the purported grounds raised by the Appellants in paragraph 116 are untenable and baseless and are hereby denied.

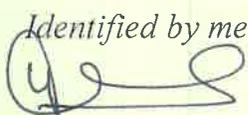
129. It is submitted that the Appellants have failed to establish any grounds for challenging the EC. As has been explained above, the Appeal challenges the Prior Environmental Clearance under the mistaken assumption that the Project will be implemented solely on the EC and thereby completely overlooking the terms and conditions imposed on the Respondent No.1 in the EC. The Appeal is therefore grossly misconstrued and is premature and the Appeal is therefore liable to be dismissed.

130. **Re. Interim Reliefs & Prayer:** I state that the instant Appeal is not maintainable in law or on facts. I state that the Appellant is not entitled to the reliefs claimed in the prayer to this Appeal.


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131. The Respondent No.1 craves the leave of this Hon'ble Tribunal to add, delete, modify, alter or amend the pleadings during the course of the Appeal. It is submitted that the Appellants have made vague and generic pleadings in the Memorandum of Appeal and the same have been answered by way of this Statement of Objections. In the event of the Appellants making any further contentions or introducing any further documents by way of rejoinder or any other form of pleadings, the Respondent No.1 reserves its liberty to file an additional counter statement and the Respondent No.1 prays that this Hon'ble Tribunal may grant the liberty to the Respondent No.1 to file such additional counter statement.

WHEREFORE, in light of the foregoing, it is most humbly prayed that this Hon'ble Court may be pleased to dismiss the Appeal with costs, in the interests of justice and equity.

Identified by me

Advocate


DEPONENT
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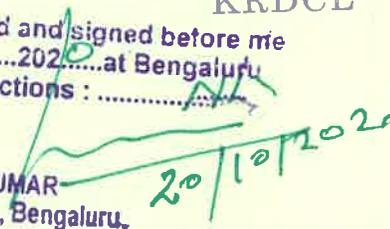
VERIFICATION

I, Dr. H.S. Prakash, the Deponent above named do hereby verify that this is my signature and what is stated above in paragraphs 1 to 131 are true to the best of my knowledge, information and belief and as per the records maintained by the Respondent No.1 Corporation. The Annexures filed along with the Counter Affidavit are the true copies of the originals.

Place: Bengaluru
Date: 20/09/2020


DEPONENT
Managing Director
KRDCL



Sworn / Solemnly affirmed and signed before me
on this 20 day of Oct, 2020 at Bengaluru
N.R.SI. No. 3932 Corrections : N/A

RAMESH KUMAR
Advocate & Notary, Bengaluru.

KARNATAKA URBAN INFRASTRUCTURE DEVELOPMENT AND FINANCE CORPORATION

COMPREHENSIVE TRAFFIC AND TRANSPORTATION PLAN FOR BANGALORE



OCTOBER 2007



RITES Ltd

(A Government of India Enterprise)

Comprehensive Traffic and Transportation Plan for Bangalore

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LIST OF ABBREVIATIONS

AMP	Automated Mechanical Parking
ATC	Area Traffic Control
BBMP	Bruhat Bangalore Mahanagara Palike
BDA	Bangalore Development Authority
BIAPPA	Bangalore International Airport Planning Authority
BMA	Bangalore Metropolitan Area
BMICAPA	Bangalore Mysore Infrastructure Corridor Area Planning Authority
BMRCL	Bangalore Metro Rail Corporation Limited
BMRDA	Bangalore Metropolitan Region Development Authority
BMTC	Bangalore Metropolitan Transport Corporation
BRTS	Bus Rapid Transit System
B-TRAC	Bangalore Traffic Regulation and Control
CBD	Central Business District
CMP	Conventional Multi-storey Parking
CRR	Core Ring Road
CRS	Commuter Rail System
GPS	Geographical Positioning System
HCV	Heavy Commercial Vehicle
IFC	Integrated Freight Complex
ITS	Intelligent Transport System
IVRS	Interactive Voice Recording System
KSPCB	Karnataka State Pollution Control Board
KSRTC	Karnataka State Road Transport Corporation
KUIDFC	Karnataka Urban Infrastructure Development and Finance Corporation
LCV	Light Commercial Vehicle
MCV	Medium Commercial Vehicle
NHAI	National Highways Authority of India
NICE	Nandi Infrastructure Corridor Enterprise
ORR	Outer Ring Road
PCU	Passenger Car Unit
PHPDT	Peak Hour Peak Direction Traffic
PIS	Passenger Information System
PRR	Peripheral Ring Road
ROB	Road over Bridge
RUB	Road under Bridge
T&CP	Town & Country Planning
TTMC	Traffic & Transit Management System
VMS	Variable Messaging Signs

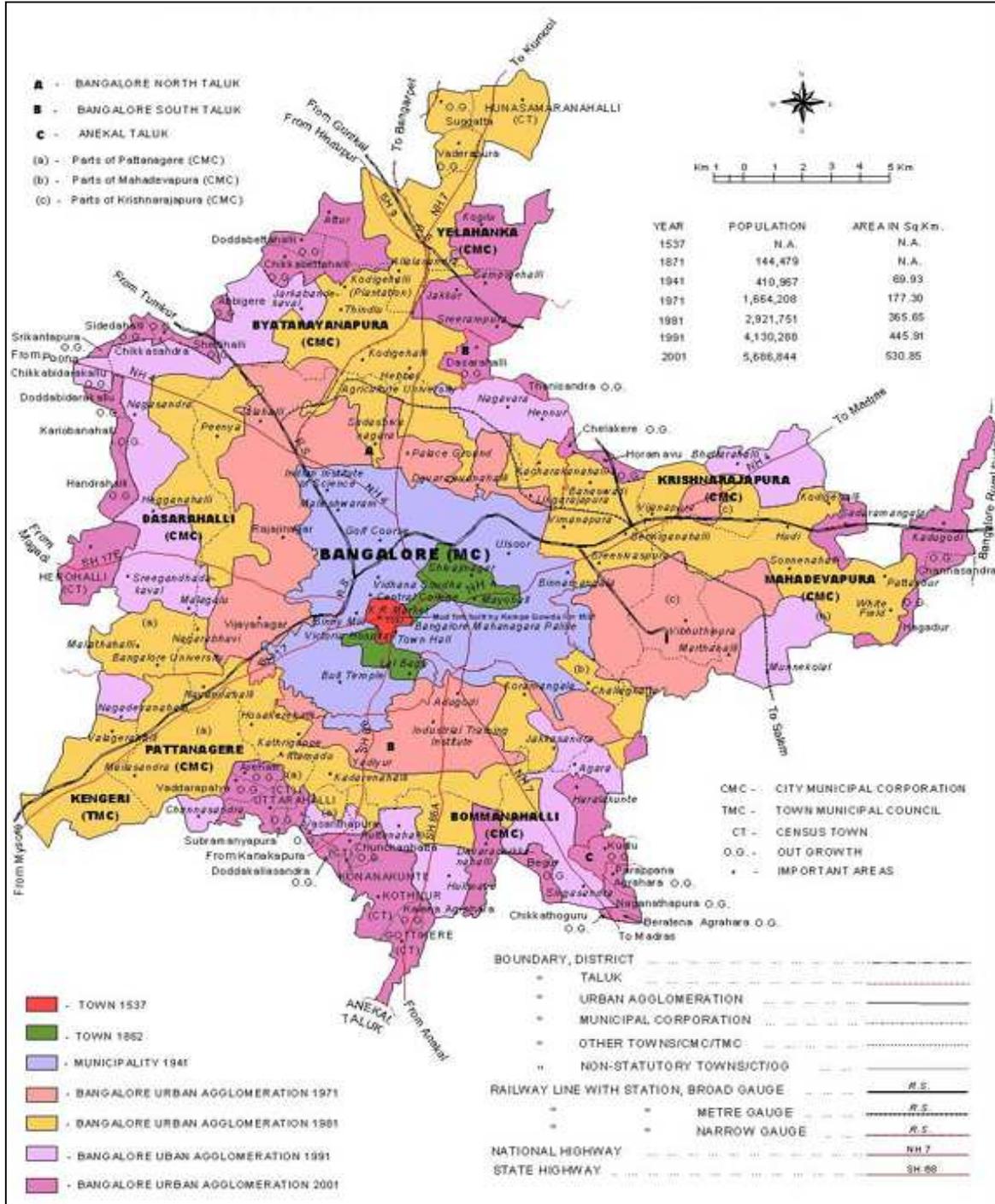
CHAPTER - 1

INTRODUCTION

1.1 GENERAL BACKGROUND

- 1.1.1 Bangalore is the fifth largest metropolis (6.5 m in 2004) in India and is one of the fastest growing cities in Asia. It is also the capital of State of Karnataka. The name Bangalore is an anglicised version of the city's name in the Kannada language, Bengaluru. It is globally recognized as IT capital of India and also as a well developed industrial city.
- 1.1.2 Bangalore city was built in 1537 by Kempegowda. During the British Raj, Bangalore developed as a centre for colonial rule in South India. The establishment of the Bangalore Cantonment brought in large numbers of migrant Tamil Nadu and Andhra Pradesh and North Indian workers for developing and maintaining the infrastructure of the cantonment. New extensions were added to the old town by creating Chamarajpet, Seshadripuram, Nagasandra, Yediyur, Basavanagudi, Malleswaram, Kalasipalyam and Gandhinagar upto 1931. During the post independence period Kumara Park and Jayanagar came into existence. The cantonment area covers nearly dozen revenue villages, which included Binnamangala, Domlur, Neelasandra and Ulsoor to name a few. In 1960, at Binnamangala, new extension named Indiranagar was created. The defence establishments and residential complexes are in part of the core area. It is a radial pattern city growing in all directions. The Bangalore city which was 28.85 sq. Km. in 1901 increased to 174.7 sqkm in 1971 to 272 sqkm in 1986 and presently it has expanded to nearly 437 sqkm. **Figure 1.1** shows the physical growth of Bangalore during the last five centuries. This indicates that the city has a long history and the transport system has grown organically with its inherent problems to meet the requirements of changing times.
- 1.1.3 The city which was originally developed as a Garden City has slowly transformed into an industrial and software hub of India. The establishment of the Silicon Park on the outskirts of the city has converted the city and its surroundings into Silicon Valley of the country. It has also caused an urban sprawl around, to some extent lop sided towards south and east. It has become a commercial, administrative and military centre for the region because of its salubrious climate and cosmopolitan nature of people. It is also known as pensioner's paradise with well developed residential areas, roads with well grown trees, good commercial establishments, shopping malls etc. Despite such growth it is trying to maintain its character of garden city.

Figure 1.1 Physical Growth of Bangalore during the Last Five Centuries



1.2 PHYSICAL CHARACTERISTICS

- 1.2.1 Bangalore is located in the south east of Karnataka. It is located in the heart of the Mysore Plateau at an average elevation of 920 m (3,018 feet) above mean sea level. It is positioned at 12.97° N 77.56° E. Bangalore District borders with Kolar District in the northeast, Tumkur District in the northwest, Mandya District in the southwest, Chamarajanagar District in the south and the neighbouring state of Tamil Nadu in the southeast.
- 1.2.2 The topography of Bangalore can be classified as a plateau, with a central ridge running NNE–SSW and land sloping gently on either side and longitudinally. The highest point is Doddabettahalli, which is 962 m and lies on this ridge. The roads generally have gentle to medium gradients. No major rivers run through the city, but the Arkavathi and South Pennar cross paths at the Nandi Hills, 60 km to the north. River Vrishabhavathi, a minor tributary of Arkavathi, originates within the city at Basavanagudi and flows through the city. Bangalore has a number of fresh water lakes and water tanks, the largest of which are Madiwala Tank, Hebbal Lake, Ulsoor Lake and Sankey Tank. The soil is predominantly of red soil interspersed with rock helping quicker drainage.
- 1.2.3 Due to its elevation, Bangalore enjoys a pleasant and equable climate throughout the year. The highest temperature recorded is 41°C and the lowest is 7.8°C. Winter temperatures rarely drop below 12°C and summer temperatures seldom exceed 38°C. Monsoons commence sometime around mid April. The wettest months are August, September and October, in that order. The summer heat is moderated by fairly frequent thunderstorms. Bangalore, receives both incoming and outgoing monsoons because of its geographic location. The city receives rainfall of about 860mm from the North–East and South–West monsoons.

1.3 DEMOGRAPHIC AND SOCIO–ECONOMIC CHARACTERISTICS

- 1.3.1 Population of Bangalore has been growing @ over 3% per annum since independence as shown in **Table 1.1**. The city, which had a population of 1.6 lakh in 1901 reached nearly 61 lakh in 2001. With a decadal growth rate of 49%, Bangalore was one of the fastest–growing indian metropolis for the decade 1991–2001. It has an average density of about 147.97 people/hectare. Currently the Bangalore Metropolitan Area (BMA) is estimated to have population of about 70 lakh and is expected to be 80 lakh by 2011 and 88.40 lakh by 2015 as per Master Plan, 2015. By 2025, population of BMA is expected to be 122.52 lakh as indicated in **Table 1.1**.

Table 1.1 Growth of Population in Bangalore

YEAR	Population (lakh)	Decadal Growth (%)	Annual Growth
1901	1.63	-9.58	-1.00%
1911	1.89	16.18	1.51%
1921	2.40	26.69	2.39%
1931	3.10	29.05	2.58%
1941	4.11	32.66	2.87%
1951	7.86	91.34	6.70%
1961	12.07	53.49	4.38%
1971	16.64	37.88	3.26%
1981	29.22	75.56	5.79%
1991	41.30	41.36	3.52%
2001	61.70*	49.39	4.10%
2011	80.15*	29.90	2.65%
2015	88.00*		
2025	122.52**		3.07%

(* -Revised Master Plan, 2015 for BMA, ** -projected for BMA)

- 1.3.2 Bangalore has the second highest literacy rate (83%) for an Indian metropolis, after Mumbai. The city's workforce structure is predominantly non-agrarian, with only 6% of Bangalore's workforce being engaged in agriculture-related activities. Roughly 10% of Bangalore's population lives in slums – a relatively low proportion when compared to other cities in the developing world.
- 1.3.3 Bangalore's Rs. 26000 crore economy makes it a major economic centre in India. Indeed, Bangalore is India's fourth largest and fastest growing market. Bangalore's per capita income of Rs.49,000 is one of the highest for any Indian city. The city is the third largest hub for high net worth individuals after Mumbai and Delhi.
- 1.3.4 In the 1940s industrial visionaries such as Sir Mirza Ismail and Sir Mokshagundam Visvesvaraya played an important role in the development of Bangalore's strong manufacturing and industrial base. Bangalore is headquarters to several public manufacturing heavy industries such as Hindustan Aeronautics Limited (HAL), National Aerospace Laboratories (NAL), Bharat Heavy Electricals Limited (BHEL), Bharat Electronics Limited, Bharat Earth Movers Limited (BEML) and Hindustan Machine Tools (HMT). In 1972 the Indian Space Research Organisation (ISRO) was established under the Department of Space and headquartered in the city. Globalisation has seen the city's potential to grow as an IT capital of the country so much so that foreign visitors to the country including many Heads of Governments make it appoint to visit the city during their visit to the country. Bangalore is also called the "Silicon Valley of India" because of the large number of Information Technology companies located in the

city which contribute 38% of India's IT and software export market. As headquarters to many IT companies, Bangalore's place in the global IT map is prominent. Bangalore's IT industry is divided into three main clusters — Software Technology Parks of India, Bangalore (STPI); International Technology Park Bangalore (ITPB), formerly International Technology Park Ltd. (ITPL); and Electronics City. Infosys and Wipro, India's largest software companies, have big campuses in Electronics City. If the growth of Information Technology has presented the city with unique challenges, Biotechnology has now become another rapidly expanding field in the city. Bangalore accounts for 47% or 127 of the approximately 265 biotechnology companies in India. The Bangalore Stock Exchange is the largest in South India. **Figure 1.2** shows the major activity centres along with the transport network in Bangalore.

- 1.3.5 With the growth of population and industries, the number of educational institutions has also grown up in the city and BMA. Numerous educational institutions up to High School and Colleges have come up in almost all the developing residential localities and extensions. Most of the institutions for higher learning like engineering colleges and medical colleges are located on the outskirts of Bangalore Corporation area. There are a few institutions of higher learning and special requirements like Government Educational Institutions are spread all over the city. Bangalore also has internationally acclaimed educational institutions like Indian Institute of Management (IIM), National Law College (NLC) and Indian Institute of Science (IISc).
- 1.3.6 In the planned growth over the last 2 decades, the primary and secondary educational institutions have been provided in each of the residential locality and to this extent the educational requirement of the younger people is satisfied by and large locally. It is for the higher and selective learning, that the people have to make longer trips requiring vehicular journeys.

1.4 TRANSPORT NETWORK

1.4.1 Road Network Characteristics

Bangalore is endowed with a radial pattern of road network converging in the core area of the city. The total road network of the city is about 4000 km of which arterial/sub-arterial roads account for about 350 km. The road network is shown in **Figure 1.2**. The road network in the central parts of the city has developed organically over the last few centuries and has inadequate right-of-way. There is also a ring road (Outer Ring Road of about 62 km) which cuts across the various radial roads. An intermediate ring road has been constructed in fragments e.g. at south-east between Koramangala and Airport Road. The National Highways which pass through Bangalore include:

Figure 1.2 Major Activity Centres along with the Transport Network in Bangalore

- NH – 4 connecting to Pune and Chennai
- NH – 7 connecting to Varanasi and Capecamorin
- NH – 209 connecting Dindigul / Pollachi

The following are the State Highways in Bangalore:

- SH – 17 connecting Mysore & Gundlupet
- SH – 17E connecting T G Halli
- SH – 19 connecting Hindupur via Yelahanka and Doddaballapur
- SH – 86 connecting Mysore via Kanakapura

Mostly the road network is underdeveloped in terms of size, structure, continuity and connectivity. Nearly 82% of the total existing road network of 1763 km (taken for travel demand modeling purposes) is with 2-lane carriageway as shown in **Table 1.2**. Length of roads with carriageway of 4 lanes and above is only 290 km. The roads indicating carriageway widths are shown in **Figure 1.3**. Thus most of the roads have inadequate carriageway widths to cater to growing traffic at an acceptable level of service. Most of the roads in the city are also used for on-street parking facility which even reduces the effective carriageway width available for traffic. Most of the major roads in Bangalore have V/C ratios > 1.0 indicating high congestion, low speeds and high delays. The intersections are also spaced quite closely which further increases the problem of traffic. Many of the intersections in core area are with 5 legs. This adds to traffic delays.

Table 1.2 Distributions of Roads with Carriageway Widths in Bangalore

Type of Road	Length (Km)	%
Two Lane Undivided One Way	62.3	3.53
Two Lane Undivided Two Way	1379.2	78.21
Three Lane	31.6	1.79
Four Lane Undivided One Way	10.3	0.59
Four Lane Undivided Two Way	49.7	2.82
Four Lane Divided Two Way	198.5	11.25
Six Lane Divided	31.4	1.78
Six Lane Undivided One Way	0.5	0.03
Total	1763.5	100.00

The available right-of-way of major roads are generally inadequate to allow for their major widening as given in **Table 1.3**. This is a major issue in augmenting the capacity of transport system in Bangalore. This indicates public transport system will have to play a very major role in satisfying the mobility requirements of people of Bangalore as they are the most economic users of the road space.

Figure 1.3 Carriageway Widths of the Roads

Table 1.3 Distribution of Roads with available ROW in Bangalore

Road ROW (m)	Length of Major Roads (%)
Less than 20	40.7
20-30	40.0
More than 30	19.3
Total	100.0

1.4.2 Rail Network

Bangalore is served by 5 radial rail corridors (shown in **Figure 1.2**), which are listed below.

- B.G. line from Chennai on east
- B.G. line from Mumbai-Pune on north-west
- B.G. line from Guntakal on the north
- B.G. line from Salem / Trivandrum from east
- B.G. line from Mysore from south-west

Though at present these rail corridors serve only intercity traffic, a small number of conventional short distance passenger trains are run in morning and evening hours to nearby (satellite) towns like Tumkur, Chikballapur, Bangarapet, Hosur and Mandya to serve the commuters. Its layout is conducive to convert them as "Commuter Rail System" (CRS), to provide viable commuter services to suburbs and also some nodes in the Bangalore.

1.4.3 Airport

The Bangalore Airport located about 11 km from city centre towards the east of the city and adjacent to the Hindustan Aircrafts Ltd (location of Airport is shown in **Figure 1.2**), was opened to passenger traffic in 1947. Direct flights from Bangalore fly to destinations in Asia, the Middle East and Europe. The liberalisation of India's economic policies has led to increase in the number of domestic carriers within India, with several carriers such as Indian, SpiceJet, Kingfisher Airlines, Jet Airways, Air Deccan, Paramount and Go Air servicing the city. Unlike most airports in the country which are controlled by the Airports Authority of India, the quasi government-owned Hindustan Aeronautics Limited owns and operates Bangalore's HAL Airport. This airport at present serves both domestic and international passengers. Due to its limited capacity and shorter runway, it has not been able to satisfy the growing demand for air traffic. A new international airport (catering to both domestic and international passengers) is being constructed at Devanahalli and is expected to become operational in early 2008. As part of its planning there are proposals to provide a dedicated rail line and an expressway connecting the city to the airport.

1.5 GROWTH OF MOTOR VEHICLES

1.5.1 Vehicle Growth and Composition

The vehicle population in all cities in India started growing rapidly since later part of 1980s. Bangalore is no exception. It has always had a reputation of having more two wheeler users. The liberalization policy of the country made availability of not only vehicles but also loans for buying vehicles. With the rapid growth of IT sector in Bangalore, the affordability of larger segment of employees increased for ownership of vehicles, more specially two wheelers. Coupled with inadequacy of comfortable and convenient public transport gave an impetus to more and more commuters shifting to cars and two wheelers for their commuting in Bangalore. Growth of motor vehicles is shown in **Table 1.4**. The number of registered motor vehicles has crossed 2.5 million and is growing at a rate of over 12% per annum. The two wheelers, which constitute about 72% of the total registered vehicles, are growing at a rate of about 13% per annum. Lately, cars have been growing even faster than two wheelers. Vehicle ownership has grown from 58 to 365 per 1000 population from 1981 to 2006. The trend is likely to continue. This will result in higher use of personalised modes of transport particularly cars unless extensive and convenient public transport system is provided.

Table 1.4 Growth of Motor Vehicles in Bangalore (in lakh)

Year	2-Wheelers	M/Cars	A/R, Cabs	Others	Total
1980	0.97	0.30	0.10	0.31	1.68
1985	1.89	0.47	0.11	0.30	2.77
1990	4.01	0.71	0.15	1.41	6.28
1995	5.94	1.07	0.34	0.62	7.97
1996	6.69	1.21	0.39	0.71	9.00
1997	7.58	1.38	0.47	0.80	10.23
1998	8.39	1.52	0.54	0.84	11.29
1999	9.10	1.64	0.55	0.94	12.23
2000	9.94	1.84	0.58	1.01	13.37
2001	10.92	2.07	0.62	1.12	14.73
2002	11.83	2.26	0.64	1.23	15.96
2003	13.23	2.53	0.69	1.37	17.83
2004	14.44	2.77	0.76	1.53	19.50
2005	16.71	3.51	0.81	1.69	22.72
2006	18.96	4.06	0.82	1.73	25.57

Source: Bangalore Traffic Police Web Site and RTO, Bangalore

1.5.2 Intermediate Public Transport

Autorickshaws (popularly known as autos) and taxis are the IPT facility available in Bangalore. Autos are the popular form of transport and can be called common man's taxi in Indian cities and towns. It is a hybrid three wheel, three-seater (in addition to driver) low floor vehicle, which is easily maneuverable and at the same time provides a fast service. Priced much lower than a car, majority of autos are owned by the driver himself. Apart from these autos, regular small cars (Maruti Omni vans and Indica diesel cars) as taxis are provided by several operators commonly referred to as City Taxis or call Taxis. The number of autos and call taxis registered in Bangalore is about 82000 and they are growing at the rate of 5-6 % p.a. The autos are used more for education and other trips and to a large extent by the visitors to the city. The drivers tend to take advantage of the vehicle's size and maneuverability and criss cross in traffic contributing a lot to accidents and traffic indiscipline and delays to overall traffic flow.

1.5.3 Public Transportation System

Buses are the predominant public transport system in all Indian cities except Mumbai. While four other metropolises Mumbai, Kolkata, Chennai, Delhi and even Hyderabad have one or more forms of rail transport systems to cater to varying extents for commuters, Bangalore has only bus as its public transport system. The city has one of the better run city bus transport systems in the country. It is operated in the Public Sector by Bangalore Metropolitan Transport Corporation (BMTc), a wholly owned company of the State Government. BMTc at present operates services on 1726 routes by utilizing 4100 buses with 3953 schedules. BMTc has 24 depots in and around Bangalore city. The corporation has 18500 employees to man its operation. It has established state of the art commuter friendly modernized bus stations at Shivaji Nagar and Shanti Nagar. The Kempegowda bus station at Subhash Nagar is also modernized with improved commuter amenities. In addition to this, sub nodal stations at different parts of the city have been constructed for the benefits of commuters. The corporation is operating more than 60,000 trips and carrying about 35 lakh passengers every day. Its patronage has started having significant growth since 2002-03. In order to increase the frequency of services and to provide direction-oriented services in place of the present destination oriented services, 27 high density trunk corridors (grid routes) have been started. These grid routes have been shown in **Figure 1.4**. The progress of BMTc during the last few years is briefly given in the **Table 1.5** below.

Table 1.5 Operational statistics of Bangalore Metropolitan Transport Corporation

Sl. No.	Factor	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
1.	Operations	1924	1960	2017	2190	2253	2302	2581	3199	3531
2.	Schedules	1934	2030	2121	2376	2535	2932	3291	3827	3957
3.	Fleet	2098	2160	2285	2473	2658	3036	3460	3925	4106
4.	Daily Average Scheduled Km (in lakh)	4.43	4.44	4.86	5.15	5.77	6.19	7.18	9.02	9.33
5.	Routes	1036	1048	1063	1147	1212	1345	1523	1690	1726
6.	City Services	740	783	789	798	817	988	1029	1131	1102
7.	Suburban Services	925	983	1065	1282	1412	1647	1985	2382	2542
8.	Pushpak Services	269	264	267	296	306	297	287	314	313
9.	Passengers carried per day (in Lakh)	24.50	25.00	25.50	25.75	26.25	26.75	30.35	32.07	34.78
10.	Accidents per Lakh Km	0.32	0.29	0.26	0.26	0.22	0.22	0.23	0.18	0.16

Source: BMTC

BMTC has plans to add new fleet through inducting new types of buses. It also has plans of adding new depots, new bus stations, commuter amenity centres, bus shelters, GPS system etc.

1.6 THE BANGALORE METROPOLITAN REGION :

1.6.1 The Bangalore Metropolitan Region Development Authority (BMRDA) has been given the responsibility of planning the 8,000 sq km of Bangalore Metropolitan Region (BMR) consisting of 2191 sq km in the Urban Districts and 5814 sq km in the Rural Districts. The planning areas falling in the BMR are indicated in the **Figure 1.5** and **Table 1.6**.

Figure 1.4 Grid Routes of BMTC

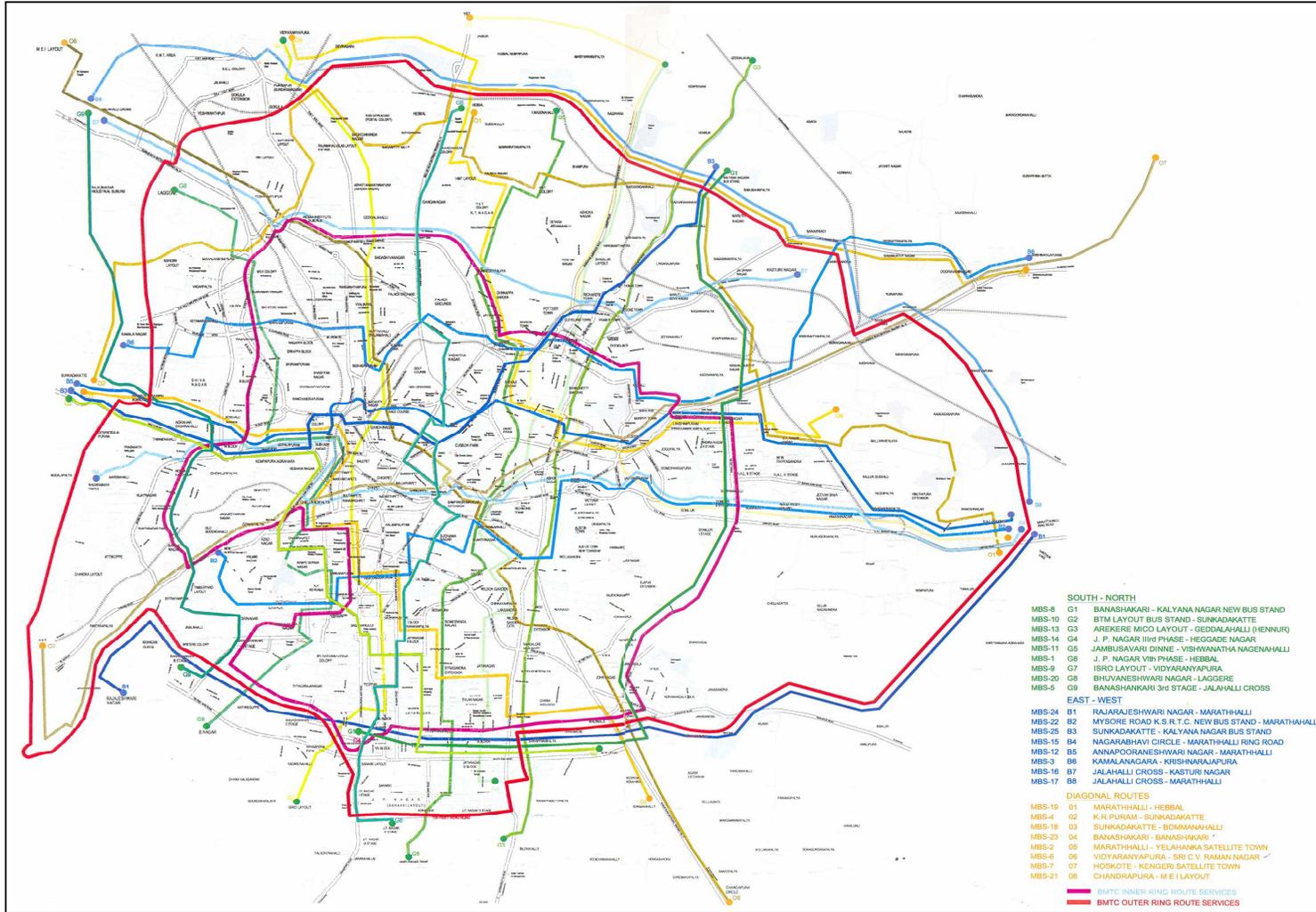


Table 1.6 Bangalore Metropolitan Region

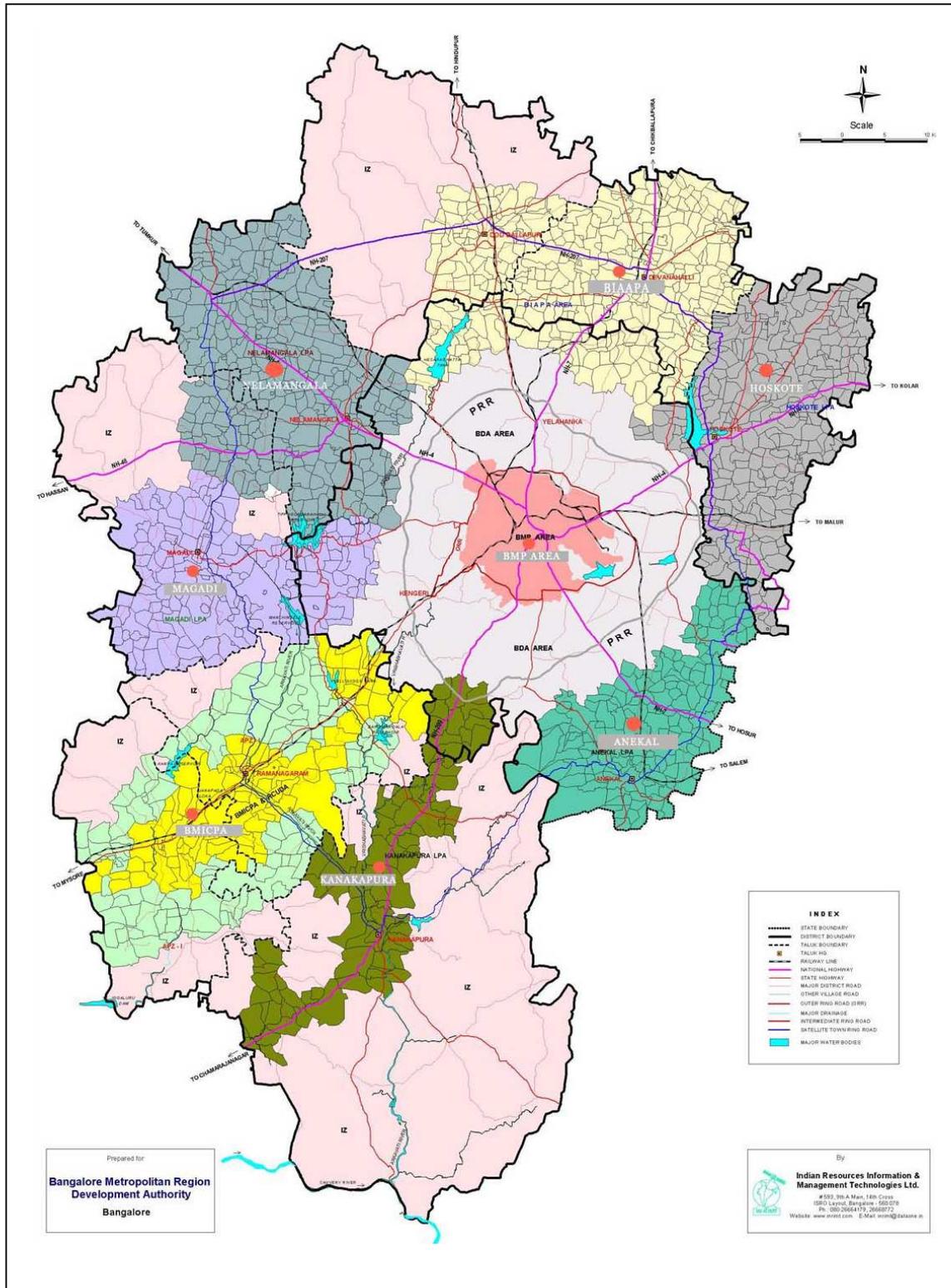
Sl. No.	Area	Area Sq. Kms
1	B M A	1240.69
2	BMICAPA (within BMA) 65.31	
3	BMICAPA (outside BMA but within BMR) 338.74	
4	Ramanagaram Taluk	200.25
5	Channapatna Taluk	110.60
6	Bangalore South Taluk	27.89
7	Anekal LPA	406.00
8	Nelamangala LPA	750.00
9	Magadi LPA	501.00
10	Hoskote LPA	591.00
11	Kanakapura LPA	879.00
12	BIAAPA LPA	985.00
13	RCUDA LPA	62.50
14	APZ-1 (excl. RCUDA)	462.50
15	Industrial Zones in B.M.R	1723.26
Total		8005.00

1.6.2 The regional plan while emphasizing on development of a regional transport network is also under taking the planning and development of 5 new township at Bidadi, Ramanagaram, Solur, Sathanur & Nandagudi covering a total area of 61,000 hectares on the outskirts of BMA. These townships are proposed to create the modern work and play environment in urban settlements within the areas as per **Table 1.7**.

Table 1.7 BMRDA TOWNSHIPS AREAS (Acres)

Township	Pvt. Land	Govt. Land	Total
Bidadi	6959	2725	9684
Ramnagar	3621	392	4013
Sathanur	5891	10341	16232
Solur	9661	2864	12525
Nandagudi	13762	4745	18507
Total	39894	21067	60961

Figure 1.5 Bangalore Metropolitan Region – Local Planning Areas



1.6.3 The following road network proposed by the BMRDA within the BMR consists of:

1)	Satellite Town Ring Road	–	204 km
2)	Intermediate Town Ring Road	–	130 km
3)	Radial Roads	–	180 km
4)	Town Ring roads	–	176 km

1.7 URBAN LAND USE STRUCTURE FOR BMA

1.7.1 Existing Situation

Bangalore city has spatially developed in a concentric manner. The economic activities have been growing at an unprecedented pace locating themselves in a sporadic manner with limited plan intervention covering an area of 1307 Sq. Kms. The existing landuse distribution of the BMA for 2003 & its comparison with the proposed Land use as per Revised Master Plan 2015 is given in the **Table 1.8**. The spatial distribution of existing land use is shown in **Figure 1.6**.

1.7.2 Revised Master Plan – 2015

Bangalore Development Authority (BDA) is responsible for preparing Master Plan for the BMA and guiding its development. Salient features of the Revised Master Plan–2015 are as follows:

- Local planning area(LPA) or Bangalore Metropolitan Area (BMA) – 1307 sqkm (including BMICAPA area)
- The city has to be planned for a population of 80 lakh by 2011 and 88 lakh by 2015.
- Land Use Proposals: Keeping in view the rapid socio-economic development in Bangalore and the development patterns in the BMR, the Master plan has evolved the following proposed land use for the Bangalore Metropolitan Area as indicated in **Table 1.8** and **Figure 1.7**.
- Economic activities & their spatial distribution: During the year 2003 approx. 6,30,000 Sq. Mts of office space was sold which consisted 5,00,000 Sq. Mts for suburban Hi-Tech firms and the balance 150,000 Sq. Mts for other businesses. For the year 2015 the Plan envisages following requirement of office spaces:

Office Type	Area in Sq. Mts		
	Suburb	CBA	Total
High-Tech	6,71,006	813,293	1484299
Non- High-Tech	234,093	585,394	819,487
Total	905,009	1,398,687	2,303,786

Figure 1.6 Spatial Distribution of Existing Land Use

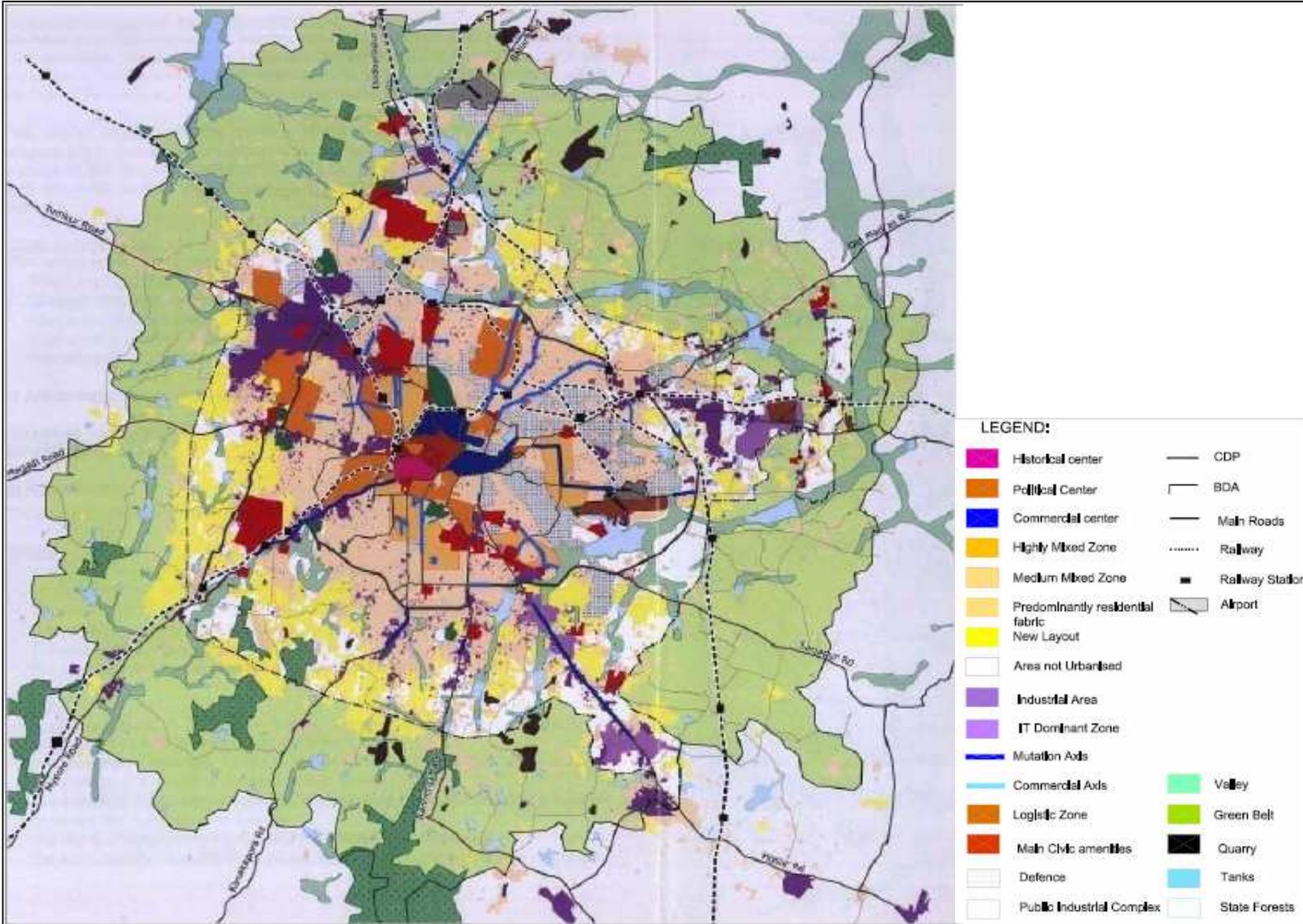


Figure 1.7 Proposed Land Use for the Bangalore Metropolitan Area

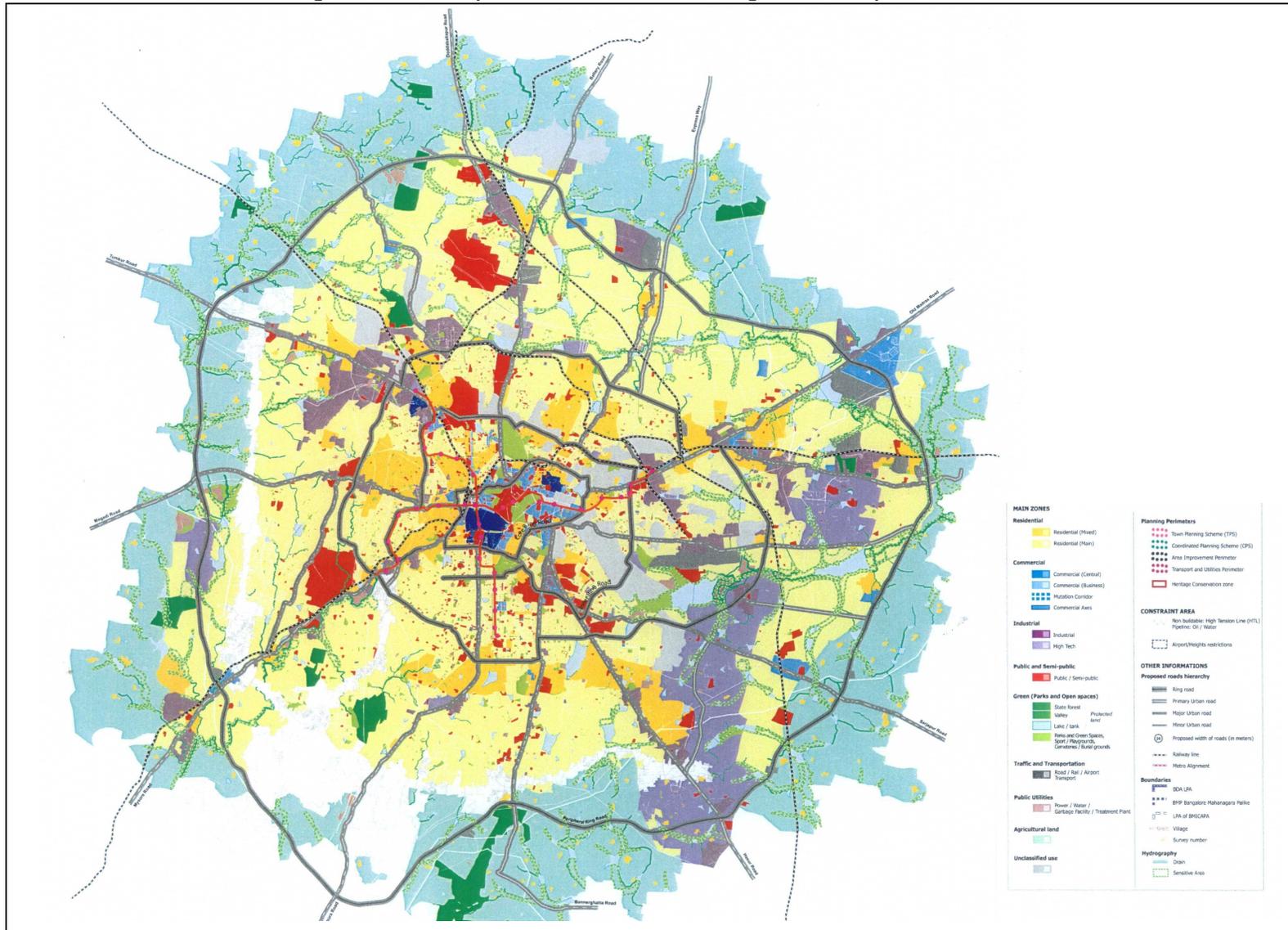


Table 1.8 Existing and Proposed Land Use for BMA

Land Use	2003		2011	
	Sq. Kms	% age distribution	Sq. Kms	% age Distribution
Residential	159.76	37.91	243.69	43.16
Commercial	12.83	3.04	16.43	2.91
Industrial	58.83	13.96	38.44	6.81
Open spaces	13.10	3.11	77.88	13.79
Publi & Semi-public	46.56	11.05	49.08	8.69
Public Utilities	2.49	0.59	-	0.00
Offices and Services	4.27	1.01	-	0.00
Traffic & Transportation	88.31	20.96	116.97	20.72
Un-classified	35.26	8.37	22.14	3.92
Total	421.41	100	564.63	100
Agriculture land	649.24			
Lakes & Tanks	39.02			
Quarry	9.61			
Vacant	187.72			
Total	1307.00		564.63	

Source- Revised Master Plan-2015

Keeping the above in view, the Master Plan has proposed the following development strategy:

- i. In order to reap the benefits of the potential expected to be created by Multi-Modal Transport System at the transport Hub in the centre, Highest FAR is proposed in identified Central Business Area. FAR 2.5; Ground Coverage 75%. within the core area surrounded by the proposed Core Ring Road.
 - ii. Strengthening and extensions of employment areas along major roads and in clusters like Peenya, Bommasandra or Electronic City.
 - iii. Identifying new industrial areas. - 3 locations in the north accessible directly from PRR and the Radial Roads.
 - iv. High tech zone with FAR ranging between 2 to 3.25 - vacant area between Whitefield (ITPL) and Electronic City proposed as Hi-tech zone.
- e. Secondary Centres: 10 Secondary Sub Centers (administrative / education & health) to be located at places to be served by Public transport - near railway station and big rail road junction.
 - f. Compact City Development: Vacant areas in the City need to be occupied and spread of layouts needs to be minimised.
 - g. Protection of natural drainage and ground water sources.

- h. Land values to be linked to market economy – built area density to be proportionate to land price and presence of transport infrastructure.
 - i. Higher FAR for old bungalow and villa areas.
 - ii. Review of the areas accompanied by Industries along the major Roads – Virtually extension of core area to the periphery – Mutation zones.
 - iii. Redevelopment of derelict industrial areas – promotion of market (actual and creation of mini zones of activities public amenities & infrastructure and social housing.
 - iv. Densification of low density area (< 200 ppha)
 - v. Encourage mixed land use in core areas – the live work mixed use reduces commuting time and mix of different activities increases economic efficiency. For these areas action imperatives defined are:
 - Diversion of traffic in mixed land-use areas by introduction of “one way”
 - Enforcement of new parking regulations.
 - Ban on entry of heavy goods vehicles in such areas
 - Widening of Roads
 - Removal of encroachments.
 - Appropriate transport system for the commuters to reduce owner vehicle usage
 - Demarcation into transport and utility zones.
 - Maintenance of open spaces
 - Improvement of Civic services.

- i. Development of a Structured Road Network : The emphasis being on:
 - i. Core Ring Road
 - ii. Supplementing Outer Ring Road
 - iii. Organising transportation/Logistic facilities: Specific Areas strategically located to provide for storages facilities, garages, and heavy vehicles supported by personnel, technicians and offices as well as integrating various transport modes like road, railway and air.
 - iv. Developing Multimodal Public Transport System: consisting of rail & road based systems i.e. Metro-Rail, Mono-Rail, Circular Rail and other proven MRT systems.

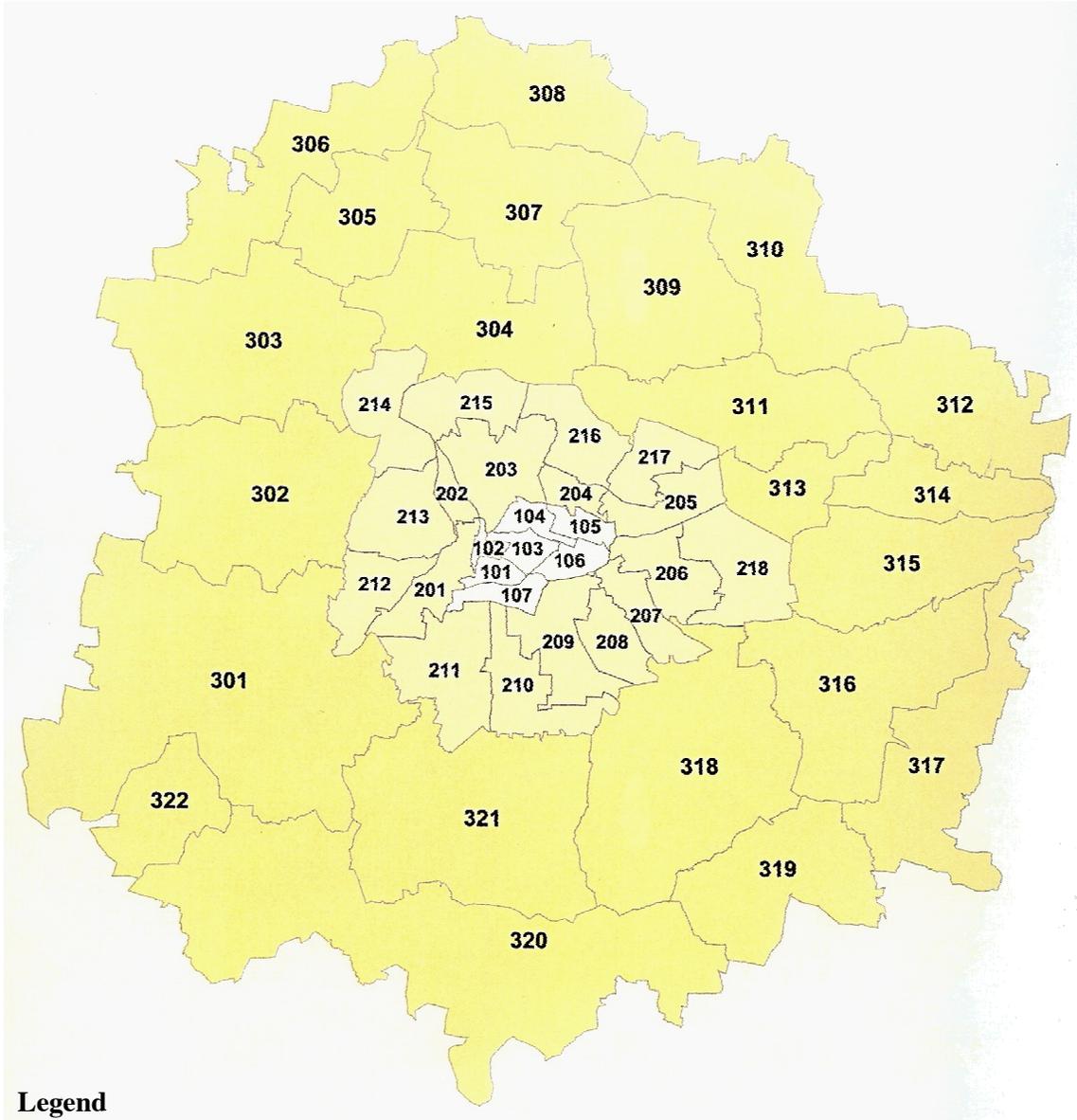
- j. Local Planning Area: The entire local planning area of Bangalore has been categorised into three major areas for application of Zonal Regulations and consist of:
 - 1. Main Areas : Comprising
 - i. Old Urban Areas including the Petta Zone & Traditional Area Zone

- ii. Urban Redevelopment Areas M.G. Road Area Zone, CBD Zone, CBD Areas, CD Precinct Zone, Transformation / Development Zone and Mutation Corridor Zone
 - iii. Residential Areas including mixed residential area, mainly residential area, and Commercial Axis Zone.
 - iv. Industrial / Activities Areas including Industrial, High Tech and Logistics/ Transport Zone
 - v. Green Areas including Protected Land, Restricted Development, and Agriculture Land Zones.
2. Specific Areas: Areas not covered by main areas and comprise large public and semi-public infrastructure; large transport structures, dedicated land uses, scheme areas & heritage conservation areas.
3. Constraint Areas: Areas having restrictions on type of development with its internal technical rules determining regulations within the site and around.
- k. Based on the ward boundaries, existing physical features, and the analysis of the existing development trends within the City, 47 Planning Districts (PDs) have been delineated to implement the Master Plan. The planning districts are organized in three rings :
- 1st Ring: The Core area PDs 1.01 to 1.07
 - 2nd Ring: The development urban areas surrounding the core are PDs 2.01 to 2.18
 - 3rd Ring: The urban extension areas in the City's outskirts PDs 3.01 to 3.22
- These planning district boundaries are indicated in the **Figure 1.8**

1.8 BANGALORE MYSORE INFRASTRUCTURE CORRIDOR AREA PLANNING AUTHORITY (BMICAPA)

The BMICAPA Planning Area comprises of BMIC Project Area and its environs. The total area is 701.01 Sq.kms. The BMICP comprises five self sustainable new townships viz., Corporate Township, Commercial Township, Industrial Township, Heritage Township & Eco-Tourism Township, 111 kms. of Expressway between Bangalore & Mysore, 41 kms. of Peripheral Road connecting NH 4 and NH 7 on the southern segment of Bangalore and about 9 kms. of Link Road connecting west of Chord Road/Mysore Road junction and "O" point of the Expressway. It also includes interchanges at the junction of main, arterial and major roads.

Figure 1.8 Planning Districts in the Bangalore Metropolitan Region



101	Petta	210	Jayanagar	308	Bettaalasuru
102	Majestic	211	Banashankari	309	Tanisandra
103	Gandhi Nagar	212	Vijaya Nagar	310	Bagaluru
104	Vasantnagar	213	Rajaji Nagar	311	Horamavu
105	Shivaji Nagar	214	Peenya	312	Avalahalli
106	Richmond Town	215	Mathikere	313	K R Puram
107	Chamarajpet	216	Kaval Byrasandra	314	Sadara Mangala
		217	Kammanahalli	315	Whitefield
201	Kempapura Agrahara	218	C.V. Raman Nagar	316	Varthur
202	Srirampuram			317	Dommasandra
203	Malleswaram	301	Kengeri	318	Begur
204	Jayanagar	302	Herohalli	319	Electronic City
205	Baiyyappanahalli	303	Makali	320	Bannerghatta
206	Indiranagar	304	Byatarayanapura	321	Anjanapura
207	Unclassified	305	Bavalakere	322	Kumbalagodu
208	Koramangala	306	Hesarghatta		
209	Shanti Nagar	307	Yelahanka		

The BMICP Planning area (64 sq km in BMA) within which the 41 kms. of Peripheral Road connecting NH 4 and NH 7 on the southern segment of Bangalore and the link road are located has been planned for various land uses as under:

Table 1.9 Proposed Land Use of BMICAPA in BMA

Land Use	Area (Ha.)	% age
Residential	4882	8
Commercial	2174	3
Industrial	708	1
Public & Semi-Public	415	1
Parks & Open Spaces	1052	2
Traffic & Trans.	3230	5
Sub Total	12461	19
Agriculture Land	51875	81
Total	64336	100

Assuming a normal residential density of 350 pph & overall density of 150 pph this corridor will be able to accommodate between 17 to 18 lakh of population.

1.9 EARLIER STUDIES

1.9.1 The first committee to work on a planned development of Bangalore was Bangalore Development Committee (BDC) constituted in 1952. Subsequently in 1961, the Bangalore Metropolitan Planning Board was constituted for bringing out a Master Plan for Bangalore. The BMPB prepared an outline development plan for BMA.

1.9.2 The Town and Country Planning Act came into force from 1965 and a City Planning Authority was constituted in August 1967. A Comprehensive

Development Plan (CDP) was prepared by the City Planning Authority for the year 2001 with an estimated population of 38 lakh.

- 1.9.3** In order to implement CDP, the Bangalore Development Authority (BDA) came into existence in 1976 with the authority to control the land-use in the metropolitan area. The result of 1981 census, however, threw over board the assumptions of CDP. As the population anticipated for 1991 was reached in 1981 itself, the CDP had to be revised drastically and the population projections were revised in view of the recent trends. A plan was prepared and approved in 1984, then revised 10 years later and approved in 1995 for a population of 45 lakhs in 1991 and 70 lakhs for the year 2001. This plan is merely a zoning document with rough location of the road network. This has now been updated by BDA and French Consultants using satellites imagery and digital area maps and Revised Master Plan – 2015 published.
- 1.9.4** However, rapid growth in population and economic activities after independence brought to the fore increasing traffic and transportation problems due to the gap between demand and supply of transport system. In order to look for solutions to the traffic problems, several studies have been conducted in the past. Some of these major traffic studies are described briefly below.
- 1.9.5** The first Comprehensive Traffic and Transportation Plan was prepared in 1963 – 64 by CRRRI, New Delhi. The plan was based on the population, land use and area projections made in the Outline Development Plan for Bangalore Metropolitan Region prepared by the Town Planning Department.
- 1.9.6** An effort to refresh the data and update the proposals was made by the Town Planning Department in 1977. One of its recommendations was to look into a Mass Rapid Transit Project i.e. a metro for Bangalore in 1981. Based on Lynne Committee's recommendations, Southern Railway team recommended a 2–corridor metro of 24 km, 3 commuter rail lines, and a 58 km ring railway at a cost of Rs.6500 million in 1983 terms and to be completed over a period of 25 years.
- 1.9.7** In 1988 under World Bank funding, RITES Ltd was commissioned to carryout another transport study with broad coverage of roads, traffic and mass transit. The study was completed proposing various roads and traffic improvements, as also commuter rail lines but again without much follow up.
- 1.9.8** In 1993, State of Karnataka established a committee to look into MRTS, which recommended the same metro project put forward by Southern Railway in 1983 and the same circular railway.
- 1.9.9** In 1994, the Government of Karnataka created BMRTL to seek public/private partnership of MRTS project. BMRTL commissioned a feasibility study, which pointed out to develop LRT based 96 km long MRTS network.

- 1.9.10** A study was carried out in 1999 proposing a large and varied road improvement program, including 45 multi-grade intersections, 25 pedestrian underpasses and various corridor improvements. In the process, grade separators were reduced to 19 with 9 to be done in the first phase.
- 1.9.11** In 2001, the State Government along with railways commissioned RITES to study introduction of commuter rail facility. The report is still under active consideration of the State Government.
- 1.9.12** In 2003, Government of Karnataka, commissioned Delhi Metro Rail Corporation (DMRC), to carry out a Detailed Project Report for metro in Bangalore. The study recommended 2 line metro, 18 km and 15 km in length, cross shaped. The lines intersect at the Bangalore city railway station and Bus station.

1.10 NEED FOR THE COMPREHENSIVE TRAFIC AND TRANSPORTATION PLAN

- 1.10.1** Thus several studies have been carried out for the city to improve transportation system in Bangalore. As short-term measures, road widening, flyovers, junction improvements were suggested and some of them have been implemented also. As long term solution, versatile and comfortable Mass Rail Transit System and commuter rail services have been recommended. However, the traffic and transportation scenario continues to be worsening. The BDA has recently got prepared a comprehensive development plan (Revised master Plan-2015). This plan has considered the first phase of Bangalore Metro Rail Project as well as network augmentation of Bangalore Metropolitan Transport Corporation. It, however, does not cover the urban transportation needs of the city fully. Therefore, it was felt by the Government of Karnataka to take a stock of the prevailing situation and prepare a comprehensive traffic and transportation plan which will not only cover short term requirements but also medium and long transport system requirements upto 2025. It should also provide for proper inter-modal transport integration.
- 1.10.2** It is in this context that Karnataka Urban Infrastructure Development Finance Corporation (KUIDFC) has initiated this study for preparing a Comprehensive Traffic and Transportation Plan for Bangalore and engaged RITES Ltd, a Government of India Undertaking, to carry out this study.

CHAPTER – 2

STUDY OBJECTIVES AND METHODOLOGY

2.1 STUDY GOALS

The present study goals include:

- i) Development of transportation network to achieve convenient and cost effective accessibility to places of employment and education for the next 20 years;
- ii) Optimal utilization of funds and human resources.

2.2 OBJECTIVES OF THE STUDY

- i) Identify travel pattern of residents of the local planning area of Bangalore which is co-terminus with the territorial jurisdiction of Bangalore Development Authority (BDA);
- ii) Select, develop and operationalise an Urban Transport Planning model using state of the art modeling techniques and software package, appropriate to the conditions and planning needs of the study area;
- iii) Assess the relevance of the existing strategy, identify the consequences of pursuing alternative transportation strategies and recommend / update a long - term comprehensive transportation strategy for the study area up to 2025 (2015 and 2025);
- iv) Identify for all modes, a phased program of appropriate and affordable investments and policy proposals; and also integration of various modes of mass transits.
- v) Help strengthen transport planning skills, and transfer all data, planning model/tools and knowledge obtained through the study to KUIDFC and other agencies such as BDA, BMTC, KSRTC, South Western Railway, BMRTL, Traffic Police, etc.
- vi) Strategize transport policy as an integrate part of urban planning
- vii) Recommend institutional mechanism for inter agency co-ordination
- viii) Assess existing infrastructure and forecast requirement – short term and long term.

2.3 SCOPE OF THE STUDY

In line with the specific objectives of the study described above, the scope of work is divided roughly into the following areas of activities as follows.

- i) Collecting household, land use, and travel demand data
- ii) Development and operation of an urban transport model
- iii) Formulation of transport strategy and institutional mechanism;

- iv) Identification of a phased program of transport investments and management proposals; and
- v) Training and knowledge transfer to the concerned agencies

2.4. STUDY METHODOLOGY

The adopted study methodology to achieve the set objectives and scope is given in **Figure 2.1**. The study methodology adopted can be broadly divided in to five stages.

Stage 1:

Finalisation of study methods

- Secondary data collection and analysis.
- Finalization of zone plans and hierarchy of zones
- Detailed sampling basis and questionnaires for Household interviews, Business interviews and Roadside interviews.
- Base road and public transport network survey.
- Draw up Proposal for traffic surveys like speed- flow, parking, traffic counts, network inventory, and their analysis.
- Required computer program suites etc.

Stage 2:

The second stage was the collection of information, and review of existing transport scenario. In order to collect various travel information following surveys were conducted.

- Household interviews
- Roadside interview surveys
- Public transport surveys
- Traffic surveys
- Road network inventory
- Speed and delay studies

The data so collected was analyzed and validated to the existing traffic scenario which forms an input to the transport models.

Stage 3:

Development of detailed operational model forms the fourth stage of the study, this included

- Development of observed trip matrices
- Calibrate and validate trip end models
- Formulation of projects necessary to fulfill the requirement of master plan using forecast models
- Calibration and validation of trip distribution – modal split model
- Validation of Assignment models and running them for different schemes / combination of facilities
- Formulation of management policies

Stage 4:

The fourth stage involved development of Transport Strategy for Bangalore

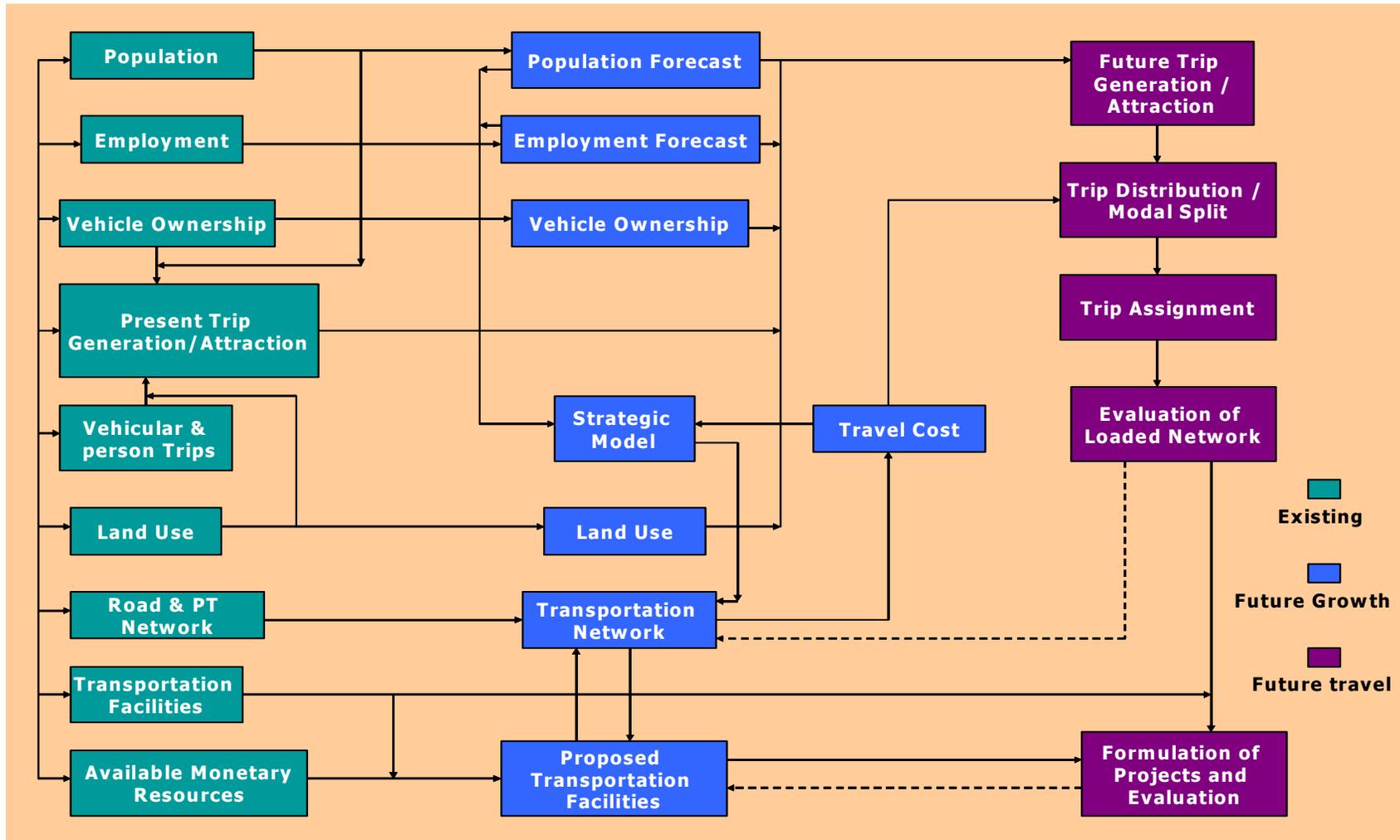
- Taking stock of current situation of Bangalore – Urban Transport Policy, Economic growth, current initiative, land use plans both existing and proposed etc.,
- Analyzing the traffic situation in terms of present situation and constraints and future growth.
- Proposed land use based on the newly prepared Master Plan.
- Analyzing the transportation demand vis-à-vis the supply and the constraints.
- Analyzing the present institutional arrangement and future requirement.

Stage 5:

The fifth and the final stage of CTTS study involve the following:

- Development of various strategies to address the transport requirements
- Evaluation of strategies based on selected criteria (mobility, congestion, safety, environmental and economic) and recommendation of suitable strategy
- Drawing up a Transport Plan for BMA and investment requirements
- Preparation of investment program for various schemes in operational plan,
- Carrying out a financial analysis of the proposals identified for Implementation in regard to implementing agencies with funding options
- Carrying out economic analysis for the recommended strategy to establish viability
- Recommending Organizational set up and institutional arrangement for implementation of plan.

Figure: 2.1 Methodology for Preparing Comprehensive Traffic and Transportation Plan for Bangalore



CHAPTER – 3

EXISTING TRAFFIC AND TRAVEL CHARACTERISTICS

3.1 INTRODUCTION

The first and foremost step to be initiated in the development of any Comprehensive Transportation Plan for a city is the collection of data relevant to the travel pattern of the residents of the city and the factors which influence the travel pattern. Transportation studies have revealed that the travel pattern in any urban agglomeration is strikingly regular and a definite pattern develops in the movement of people which can be anticipated for the future years also. This in turn helps in developing a transportation plan with a reasonable level of confidence. This data collection is done through secondary sources and conduct of primary surveys. Some of the data collected through secondary sources has already been given in Chapter 1. This chapter gives account of primary traffic and travel surveys conducted as a part of this study and emerging traffic, socio-economic and travel characteristics. This database will help in identifying issues and in travel demand modeling and forecasting exercise.

3.2 PRIMARY TRAFFIC AND TRAVEL SURVEYS

3.2.1 A study of this nature requires a number of primary surveys in order to understand the problems, demographic characteristics and travel habits of the people, which have a direct bearing on their demand for travel. Under-mentioned surveys have been conducted.

- House Hold Interview Survey (HHI)
- Business Interview Survey (BIS)
- Mid Block Volume Count Survey
- Road Side Interview (RSI) or O – D Survey
- Screen line Survey
- Parking Survey
- Pedestrian Survey
- Speed & Delay Study
- Terminal Survey
- Public Transport Survey
- Road Network Inventory

This chapter presents major results and analysis of the different surveys.

3.3 TRAFFIC ZONE DELINEATION

3.3.1 The Bangalore Metropolitan Area covers 1307 sq. km. as per Revised Master Plan-2015. Delineation of traffic zones has been made based on ward boundaries within the Municipal Corporation areas and village / TMC / CMC boundaries outside the corporation area, also taking into account homogeneity of land use. **Figure 3.1** shows the traffic zone boundaries in BMP, outside BMP but within BMA areas. It will be seen that the size of the zones are smaller in inner areas and they become larger in outer areas. The detail of the zoning adopted within BMA is furnished below:

• Within Corporation limits (1 to 128)	128 zones
• Covering CMC & TMCs (201 to 234)	34 zones
• Covering villages outside CMCs & TMCs (301 to 312)	12 zones
Total	174 zones

3.3.2 Thus the BMA has been delineated into 174 zones. Of this, 128 zones lie within the corporation area and 46 zones in the rest of metropolitan area. These zones have been coded adopting a simple three digit numbering system, which also helps in identifying zone locations.

3.4 ZONAL POPULATION

The area and population of the individual administrative wards within Bangalore city limits for the years 1981, 1991, and 2001 have been collected from primary census abstracts of the Directorate of Census Operations, Karnataka. The growth rate of population for each of wards has been calculated. The city and rest of BMA were subdivided wherever necessary to ensure that the population of the modified zone in the horizon year (2025) is around 50,000. Based on other consideration such as the area of zone, travel distances, density of population and land use, certain zones with population in excess of 50,000 are sub-divided. Utilizing the population figures of BMA based on the census carried out in 2001, the figures for the base year 2005 was estimated. The zonal population has been further projected to the horizon years. The population for the horizon years of 2015 and 2025 was projected so that the figures tally with those projected in the Revised Master Plan prepared by BDA for 2015 and using the growth trend as well as proposed land use details for 2025.

3.5 TRAFFIC CHARACTERISTICS

3.5.1 Traffic Surveys

Traffic surveys form an integral part of the study to assess the present day traffic situation, which in turn helps in evolving the short, medium and long term strategies to ameliorate the traffic problems of the city. Accordingly, classified traffic volume surveys mainly comprising of volume counts at 24 mid block

Figure 3.1 Traffic Zone Boundaries in BMP, outside BMP but within BMA areas

locations, 16 screen line surveys and 10 outer cordon O-D surveys have been conducted, the details of which are described in the subsequent paragraphs. Locations of traffic surveys are shown in **Figure 3.2**.

3.5.2 Mid-Block Location Volume Counts

Traffic volume count at mid-block locations give a clear picture about the density of traffic volume along different stretches of roads within the study area, which helps in assessing the V/C ratio of the road stretches. This in turn helps in assessing the current strategies to be adopted to ease the prevailing congestion as also in evolving future long term strategies. 24 mid-blocks were identified for carrying out the volume count survey covering some of the major and important roads of the city as shown in **Figure 3.2**. Mid-block volume counts were carried out for 12 hours continuously from 8 AM in the morning upto 8 PM in the evening. The volume counts were carried out on typical week days only and not on holidays and week ends.

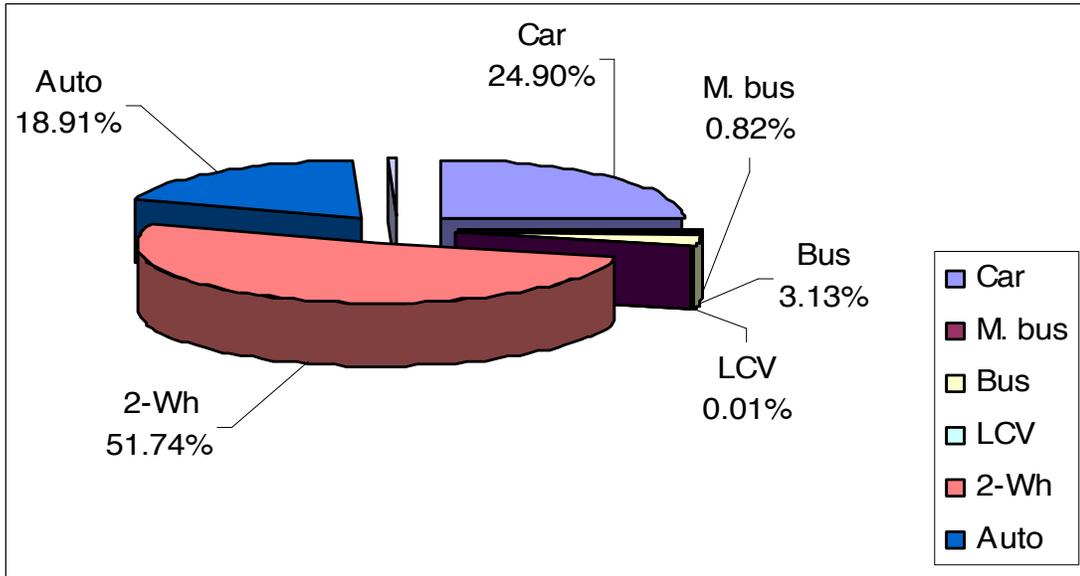
The total vehicles per day, the corresponding PCUs and the peak hour timings during morning and evening are given in **Table 3.1**. It is observed that the traffic volume is of the order of 18000 to 19000 PCUs on Sankey Road (T. Chowdaiah Road) followed by 15200 PCUs on Rajajinagar Link Road near Sujatha Theatre during peak hour. From the analysed data, is observed that the intensity of 2-wheelers is predominant on most of the roads with the composition varying between 40% & 60%, while that of cars vary between 20% and 33%. The morning peak hour is generally observed between 9 AM and 10 AM, while the evening peak hour is between 6 PM and 7 PM. However, there is slight variation in the peak hours in some of the corridors. It can therefore be concluded that the morning peak hour generally varies between 9 AM and 11 AM while the evening peak hour varies between 5 PM and 7 PM. Peak hour factor is generally about 10% of 12 hour traffic. Traffic composition and hourly traffic variation for typical locations are shown in **Figures 3.3 and 3.4**. Peak hour traffic volumes on these roads suggest that V/C ratios on most of these roads are >1 .

Figure 3.2 Locations of Volume Count Surveys (Midblock, Screenline and Outer Cordon)

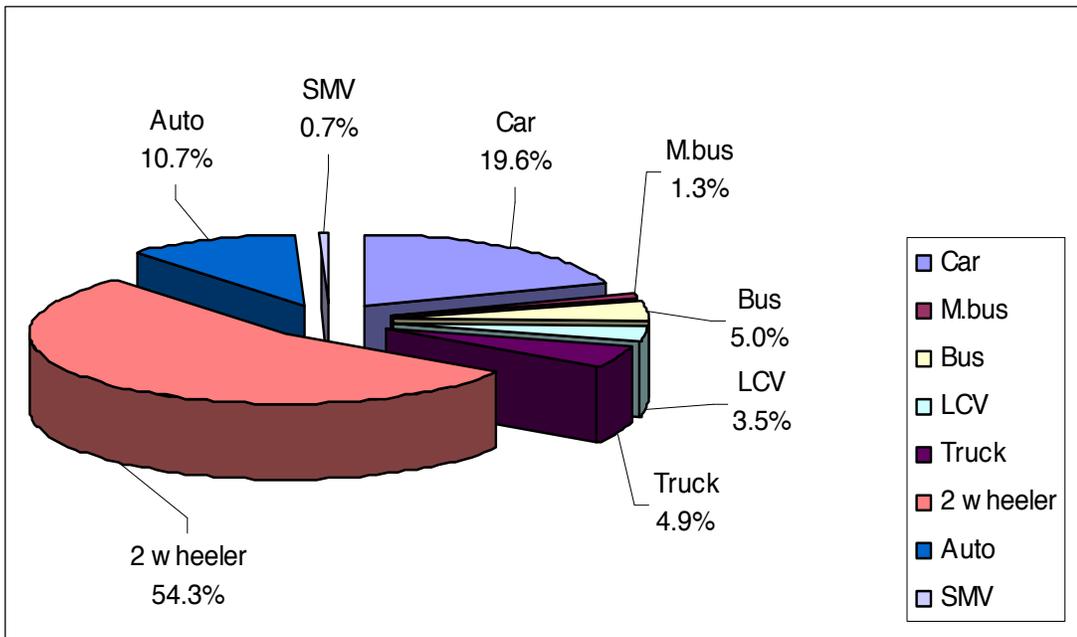
Table – 3.1 Traffic Volume at Mid-Block Locations

Sl. No.	Road Name	Total Traffic Volume (12 Hour count)		Peak Hour	
		Vehicles	PCUs	AM	PM
1.	Chord Road near Toll gate	67015	76556	9 – 10	5 – 6
2.	Magadi Road near Prasanna Theatre	14596	14724	9 – 10	6 – 7
3.	R.V. Road near Vijaya College (South End Circle)	56770	60236	9 – 10	7 – 8
4.	Hosur Road (NH-7) near Wipro- CSB Junction	62514	66116	9 – 10	6 – 7
5.	Airport Road near Kemp Fort	30146	29589	9 – 10	6 – 7
6.	Rajajinagar Link Road near Sujatha Theatre	127741	146209	10 – 11	5 – 6
7.	Sampige Road near Sampige Theatre	57547	68045	11 – 12 Noon	6 – 7
8.	M.G. Road near Trinity Circle (Big Kids Kemp)	99404	109114	9.45 – 10.45	6 – 7
9.	Richmond Road / Gen. Timmaiah Road near Masjid (Richmond Circle)	59866	69452	10 – 11	6 – 7
10.	Residency Road / F.M. Cariappa Road near St. Joseph's College (Richmond Circle)	38510	45024	10 – 11	5 – 6
11.	K.G. Road near Cauvery Bhavan	69896	100455	10.15 – 11.15	6 – 7
12.	Mahakavi Kuvempu Road near Varalakshmi Nursing Home	36684	43720	10 – 11	6 – 7
13.	Outer Ring Road near Kamakya	37467	38026	9 – 10	5.15 – 6.15
15.	Bannerghatta Road near Mantri Apartments	55529	59087	9 – 10	6 – 7
16.	Mysore Road near KIMCO	33097	36667	9 – 10	5 – 6
17.	J.C.Road near BMP Parking Lot (Bharat Theatre Jn.)	99821	106048	10 – 11	6 – 7
18.	Lal Bagh Road near Urvashi Theatre	52944	58226	11 – 12 Noon	5 – 6
19.	K. R. Road near National High School	49536	56291	10.15 – 11.15	5 – 6
20.	Old Madras Road / Swami Vivekananda Road near NGEF	68781	70039	9 – 10	6 – 7
21.	Sankey Road (T.Chowdaiah Road) near NTI	179067	182047	9 – 10	5.15 – 6.15
22.	Sankey Road (T.Chowdaiah Road) after Cauvery Theatre	183194	185057	9 – 10	5 – 6
23.	Bellary Road (Ramana Maharshi Road) near Mekhri Intersection Underpass	95424	100973	9 – 10	5 – 6
24.	Dr. Raj Kumar Road near Navarang Theatre	81116	97489	10 – 11	5 – 6

Figure 3.3 Traffic Composition at Typical Mid Block/Screenline Locations

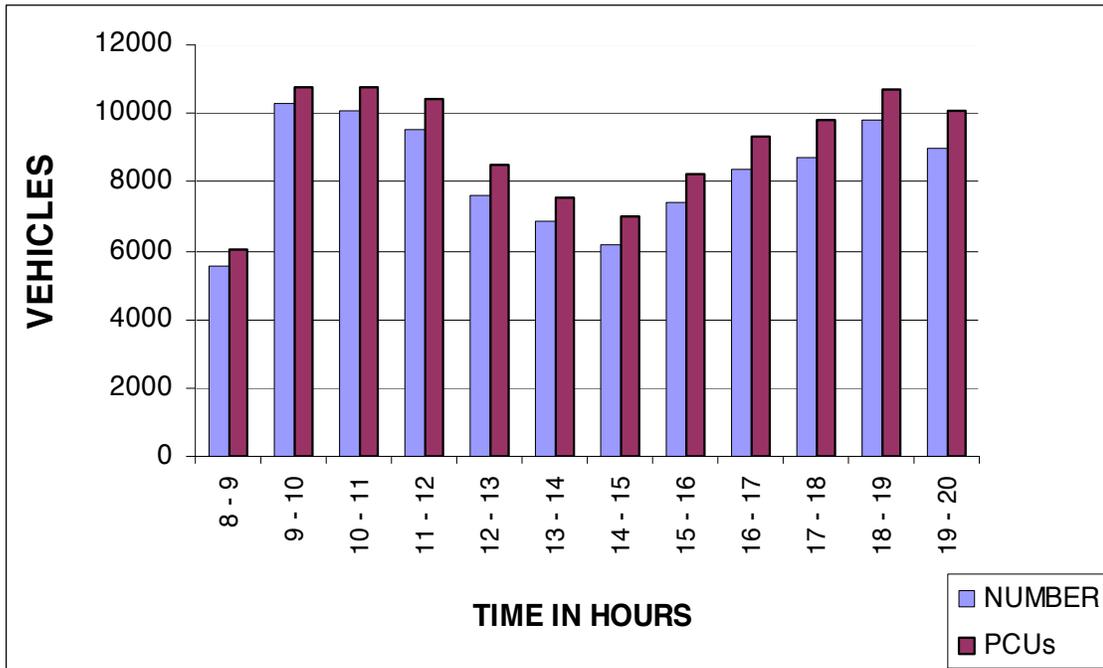


At M G Road (Mid Block)

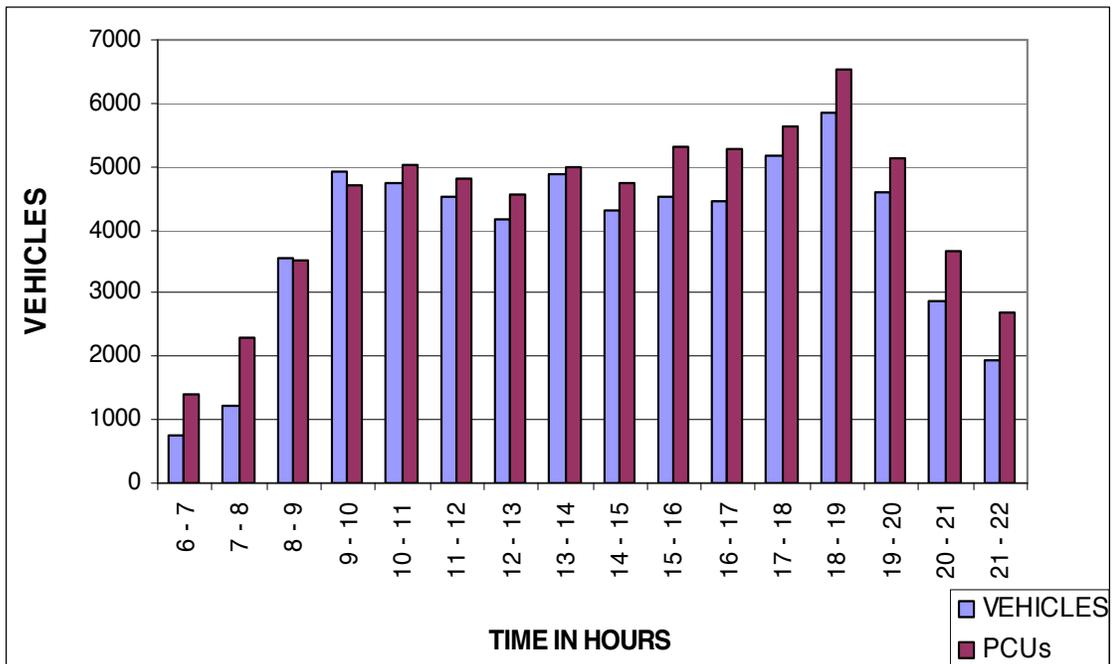


At ROB on Chord Road near Mysore Road Intersection (Screen line)

Figure 3.4 Hourly Traffic Variation at Typical Mid Block/Screen line Locations



At M G Road (Mid Block)



At ROB on Chord Road near Mysore Road Intersection (Screen line)

3.5.3 Screen Line Traffic Volume Counts

Screen line survey is the typical traffic volume count conducted at different road stretches within the study area limits preferably along the natural barriers like rivers, canals, bridges, railway lines etc. As no natural barriers exist in Bangalore, the existing railway lines and the ROB / RUBs constructed across / along these railway lines have been taken for conducting screen line surveys. For the BMA, the screen lines considered are railway lines to Mysore, Tumkur, Yelahanka, White Field / Chennai and loop from Hebbal to Baiyyappanahalli and Salem line. Screen line surveys give an idea about the movement pattern of people in the city and helps in cross checking the movement pattern. The basic purpose of screen line surveys is validation of the model developed. The trip and movement pattern of residents of the area to different parts of the city are obtained through household survey and the direction of movement of different modes of vehicles is collected through traffic volume count survey. Based on the information collected through household survey, the trip assignment is run which gives the assignment values along different routes. This is cross checked with the traffic census as also the household survey data and the model is then validated so that the errors are minimized or nullified and the trip assignments for the horizon years reflects almost a true picture.

Screen line surveys were conducted for a period of 16 hours duration from 6 AM in the morning upto 10 PM in the evening at 16 locations as shown in **Figure 3.2**. The total vehicles per day and the corresponding PCUs plying on the locations identified for screen line volume count is given in **Table 3.2**.

It is observed that the traffic volume is of the order of 18000 PCUs during peak hour at RUB on Sankey Road near Windsor Manor followed by 15000 PCUs during peak hour at RUBs near Binny Mill and Dhanvantari Road and 13000 to 14000 PCUs at RUBs near Okalipuram and Millers Road.

Table – 3.2 Traffic Volumes at Screen Line Locations

Sl. No.	Location	Total Traffic volume (16 Hour count)		Peak Hour	
		Vehicles	PCUs	AM	PM
1.	RUB near Cantonment Railway Station on Millers Road	128528	151910	8.30 – 9.30	5.45 – 6.45
2.	Level Crossing near ITC on Wheelers Road	53850	60469	10.00 – 11.00	6.00 – 7.00
3.	ROB near BHEL on Chord Road	62515	70264	10.00 – 11.00	6.00 – 7.00
4.	ROB near Devaiah Park on Mahakavi Kuvempu Road	128136	133638	9.00 – 10.00	5.30 – 6.30
5.	ROB near Yeshwanthpur on Tumkur Rd (NH4)	61218	68620	9.00 – 10.00	6.00 – 7.00
6.	RUB near Benniganahalli on NH - 4	80876	83078	9.00 – 10.00	6.00 – 7.00
7.	RUB near Binny Mill on Tank Bund Road	132795	157592	9.00 – 10.00	5.00 – 6.00
8.	RUB near Platform Road junction Dhanvantari Road	119240	141294	11.00 – 12.00 Noon	6.00 – 7.00
9.	RUB near Khodays Factory	108918	142815	9.00 – 10.00	5.30 – 6.30
10.	RUB near Okalipuram	113608	147112	9.00 – 10.00	5.30 – 6.30
11.	RUB near Marathahalli on Ring Road	71678	83183	9.00 – 10.00	5.15 – 6.15
12.	RUB near Kino Theatre on S.C. Road	36934	45743	10.00 – 11.00	5.45 – 6.45
13.	RUB near Windsor Manor on Sankey Road	188394	192547	9.00 – 10.00	5.15 – 6.15
14.	RUB near Shivananda on Hare Krishna Road	79404	86615	9.00 – 10.00	5.00 – 6.00
15.	RUB near Coles Park on Millers Road	123055	148966	8.30 – 9.30	6.00 – 7.00
16.	RUB near Fraser Town Police Stn. on Pottery Rd.	25199	28186	9.00 – 10.00	6.00 – 7.00

3.5.4 Road Side Interview Survey (Outer Cordon O – D Survey)

The O-D surveys were conducted to get an idea about the traffic pattern of inter-city traffic entering/leaving Bangalore. The survey is basically conducted to collect information on trips (origin, destination, mode, purpose, time and vehicle occupancy) actually performed at different points. O-D survey was conducted in the BMA at 10 outer cordon locations as shown in **Figure 3.2**. Random sampling has been adopted as it was not feasible to stop all the vehicles plying on the road. It was ensured that at least 10% sampling was done. However, as per the conditions prevailing at site at the time of survey, more samples were collected, wherever possible. The O-D survey was carried out for 24 hours on a typical week day. The survey was started at 8 AM and concluded at 8 AM the next day. The vehicles entering the city or leaving the city to different destinations were stopped at random and the vehicle users were asked certain questions and the answers were duly recorded by the enumerators. Police assistance was taken for stopping the vehicles.

Daily traffic at the outer cordon locations is given in **Table 3.3**. It shows that Hosur Road carries maximum volume of traffic followed by Tumkur Road and Old Madras Road. **Figure 3.5** shows the traffic desire for through traffic. It indicates that there is substantial through traffic particularly between both the legs of NH4 and NH7 pointing to the need of road bypass so that this traffic need not enter the city.

Figure 3.5 Desire Line Diagram for Through Traffic – Base Year (PCU/day)

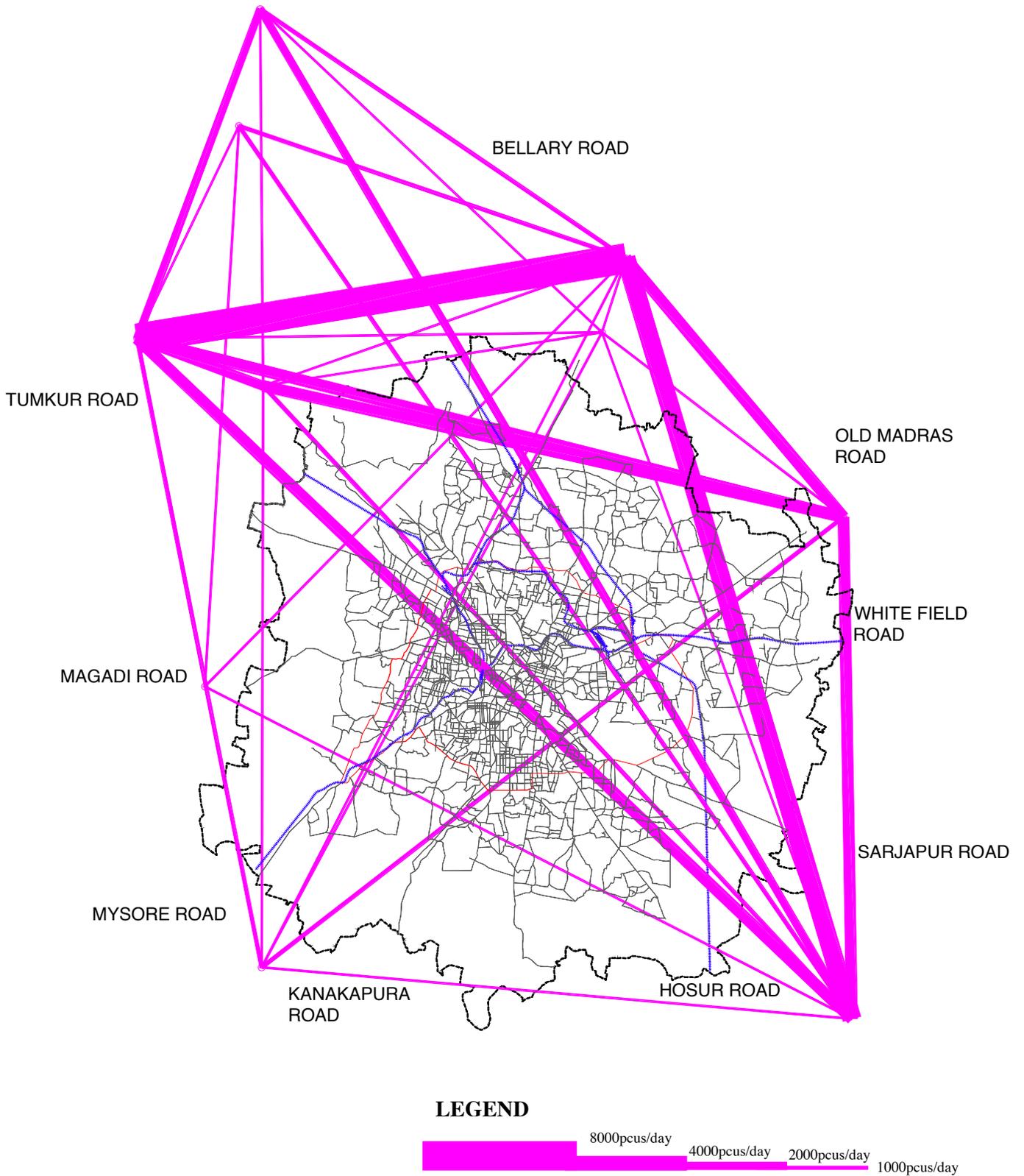


Table 3.3 Daily Traffic Volume at Outer Cordon Survey Locations

S.No.	Road	Daily Traffic Volume (24 hours)					
		Direction 1		Direction 2		Total	
		Vehicle	PCU's	Vehicle	PCU's	Vehicle	PCU's
1	Sarjapur Road	3876	5247	4749	6686	8625	11933
2	Old Madras Road	11287	18503	12060	21496	23347	39999
3	Bellary Road	7651	13651	8252	13817	15903	27468
4	Doddballapura Road	7049	11611	5794	9829	12843	21440
5	Tumkur Road	16900	29129	19357	33272	36257	62401
6	Magadi Road	5239	6969	5563	7183	10802	14152
7	Mysore Road	2511	2655	2524	2717	5035	5372
8	Kanakapura Road	9455	16093	7012	11688	16467	27781
9	Bannerghatta Road	7455	9857	6473	9482	13928	19339
10	Hosur Road	18525	37539	20200	40467	38725	78006

Source – RITES Primary Surveys, 2006

3.6 SOCIO-ECONOMIC AND TRAVEL CHARACTERISTICS

3.6.1 Household Interview surveys

The HHI survey is a part of the CTTT for BMA. Household Interview Survey is one of the main surveys conducted as part of Comprehensive Traffic & Transportation Plan for Bangalore. The main aim of the survey is to collect the socio-economic and travel characteristics of residents in BMA. The survey is intended to collect the details about the number of residents of the household, their income range and their travel pattern. The entire BMA was divided into four categories viz., Inner Ring, Middle Ring, TMC / CMC and Villages. The sample size adopted and the number of households selected for interview is given in the **Table 3.4**.

Table 3.4 Area wise Sample size adopted for the HHI survey

Area	Sample Size	No. of House Holds	Population	No. of House holds surveyed
Inner Ring	1.589%	110101	556331	1749
Middle Ring	1.80%	837068	3744995	15067
TMC / CMC	2.00%	272103	1147297	5442
Villages	2.40%	155897	700600	3742
Total		1375169	6149223	26000

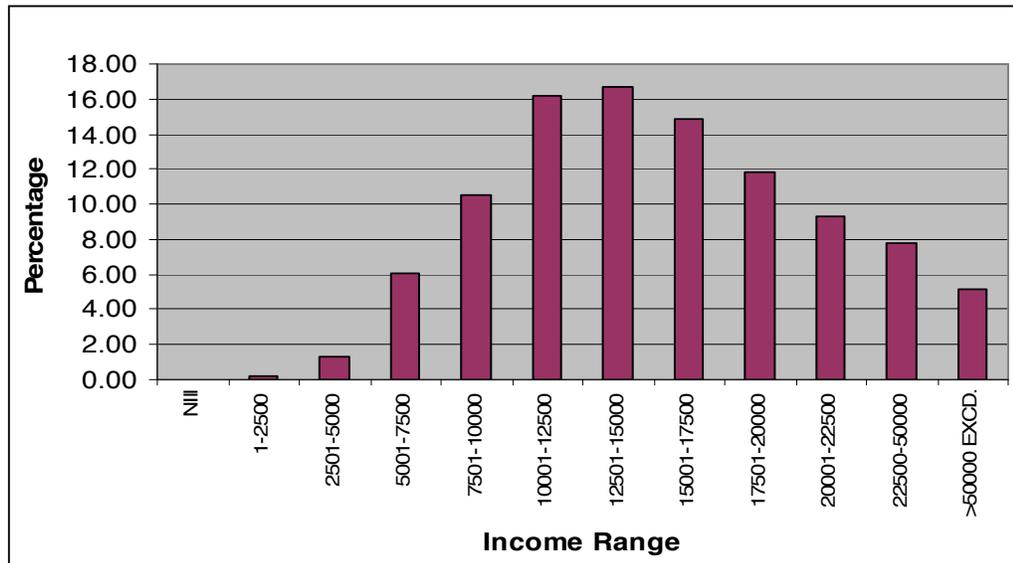
3.6.2 Socio - Economic Characteristics

It is observed that the average household size as per survey is 3.88 while the same as per census 2001 is 3.95. The details are furnished in the **Table 3.5**.

Table 3.5 Distribution of Households by Family Size

Zone Group	Household size (Persons)							Average Household size	Actual Household size as per census
	1	2	3	4	5	6	Total		
BMC	56	1595	3889	5692	3122	2461	16815	4.04	4.12
	0.33%	9.49%	23.13%	33.85%	18.57%	14.63%	100%		
TMC	15	645	1741	1741	796	505	5443	3.77	3.72
	0.28%	11.85%	31.99%	31.99%	14.62%	9.27%	100.00%		
VILLAGE	11	489	1148	1223	553	319	3743	3.74	3.77
	0.29%	13.07%	30.68%	32.68%	14.77%	8.51%	100.00%		
Total	82	2729	6778	8656	4471	3284	26000	3.88	3.95
	0.32%	10.50%	26.07%	33.29%	17.19%	12.63%	100.00%		

Household Income: The distribution of households by income level in BMA (Figure 3.6) indicates that the highest proportion of households (16 – 17%) belong to income category Rs.10,000 – 12,500 p.m. followed by 15% in the category of Rs.15,000 – 17,500, 12% in the category Rs. 17,500 – 20,000 and 9% in Rs. 20,000 category.

Figure 3.6 Distribution of Households by Income Range

Thus, the average household income is found to be between Rs. 14500 and 15500 per month.

3.6.3 Travel Characteristics

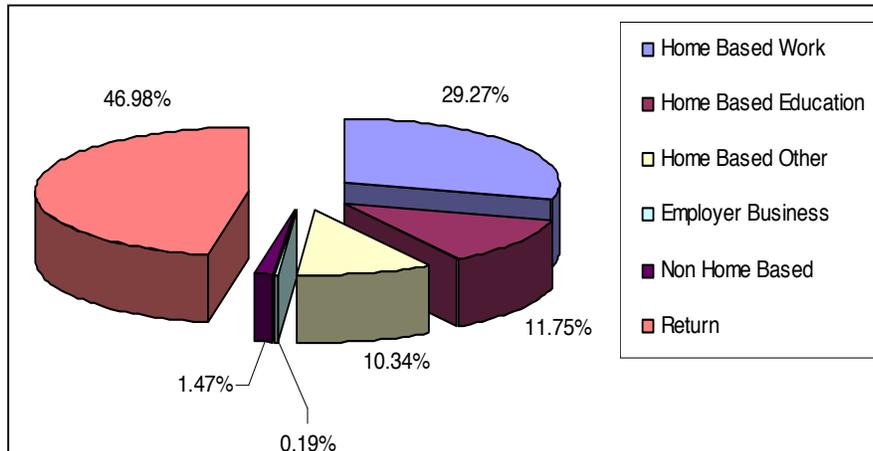
Trip Purpose

The distribution of trips by purpose indicates that out of 61.79 Lakh daily trips performed home based work trips account for (28.79%) share followed by home based education trips (11.86%) and home-based other trips (10.28%) respectively. Non-home based trips account for only 1.42% share while return trips account for 47.46%. **Table 3.6** shows the distribution of trips by purpose. **Figure 3.7** shows the graphical presentation of trips by purpose.

Table 3.6 Distribution of Trips by Purpose

Purpose Home Based	No.	% Share
Work	1839819	29.27
Education	738799	11.75
Others	649737	10.34
Non-home based	92347	1.47
Employer Business	11747	0.19
Return	2953229	46.98
Total	6285678	100.00

Figure 3.7 Trips by Purpose

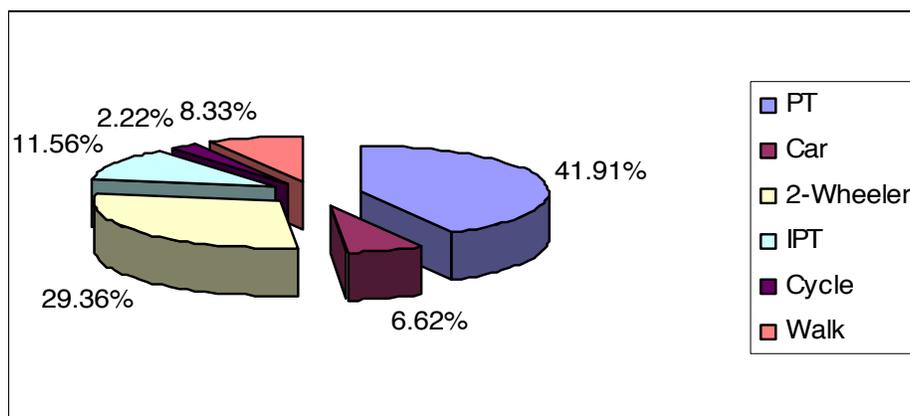


Trips by Mode of Travel

An analysis of trips by mode of travel indicate that majority of the trips (41 to 45%) are performed by bus followed by two-wheeler (29 to 32%). **Table 3.7** shows the distribution of trips by mode of travel. **Figure 3.8** shows graphical presentation of modal split.

Table 3.7 Distribution of Trips by Mode of Travel

PT	Car	2-Wheeler	IPT	Cycle	Walk	Total
With Walk						
2634471	416304	1845476	726425	139407	523597	6285680
41.91%	6.62%	29.36%	11.56%	2.22%	8.33%	100.00%
Without Walk						
2634471	416304	1845476	726425	139407	0	5762083
45.72%	7.22%	32.03%	12.61%	2.42%	0.00%	100.00%

Figure 3.8 Modal Split with Walk Trips

The distribution of trips by purpose & trip length indicate that 38% of home based work trips are performed within 10 – 20 km distance while 53% of education trips & 57% of other trips are performed within 10 – 20 km distance.

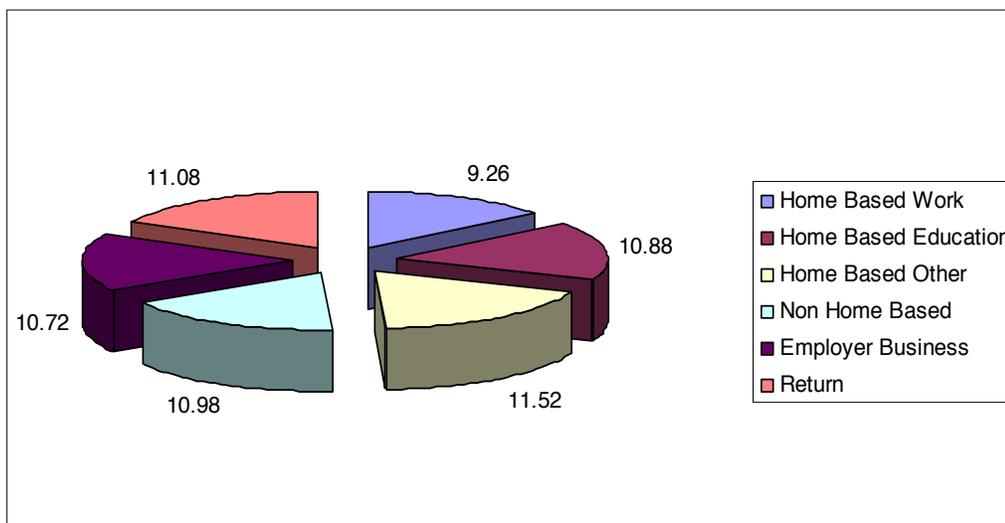
Table 3.8 and **Figure 3.9** shows the distribution of trips by purpose & trip length.

Table 3.8 Distribution of Trip Length by Purpose of Travel

Trip Length (KMS)	Home Based Work	Home Based Education	Home Based Other	Non Home Based	Employer Business	Return	Total
0-2	327907	137356	28133	4852	1681	223144	723074
2-5	278904	78626	120412	17595	1712	458116	955365
5-10	433673	73612	87537	26870	1371	579279	1202342
10-15	422495	235376	222539	21646	3759	891636	1797451
15-20	281664	156917	148359	14431	2506	594424	1198301
20-35	95176	55422	41802	2939	675	200621	396636
>35	0	1490	954	4013	43	6011	12511
Total	1839819	738800	649737	92346	11747	2953230	6285680
Avg. Trip Length	9.26	10.88	11.52	10.98	10.72	11.08	10.57

It will be seen that the trip lengths for education is unusually high, even higher than that of work trips. This can be attributed to the probability that most of the education trips captured are for higher education and more of such institutions including Bangalore University lying on the periphery of the city. The percentage of education trips is comparatively low indicating that lot of education trips at primary and secondary level are intra zonal, due to availability such schools within most zones. Overall, the average trip length observed is 10.57 Km.

Figure 3.9 Trip Length by Purpose



Trips by Mode & Trip Length

The distribution of trips by mode & trip length as shown in **Table 3.9** reveals that 68% of bus trips are made for covering distance varying from 10 Km to 20 Km while it is 47% in case of car trips & 33.5% in case of two-wheeler trips for the same distance. Nearly 30% of cycle trips are performed for a travel distance of upto 5 Km while it is 43% for distance of upto 2 Km by cycles.

Table 3.9 Distribution of Trips by Mode & Trip Length

Trip Length (Km.)	Bus	Car	Two Wheeler	Three Wheeler	Cycle	Walk	Total
0-2	197	46	142633	0	59137	521061	723074
2-5	117434	27809	482306	279891	45390	2536	955365
5-10	134333	151603	725082	165814	25509	0	1202342
10-15	1429620	152409	316173	192265	6560	0	2097026
15-20	612694	65318	135503	82399	2811	0	898725
20-35	329555	17627	43779	5675	0	0	396636
>35	10639	1492	0	381	0	0	12511
Total	2634471	416304	1845476	726425	139407	523597	6285680
Average Trip Length	14.99	11.59	8.02	8.59	3.88	1.01	10.57

Travel Cost by Purpose of Travel

The average travel cost for various purpose of travel (**Table 3.10**) reveals that the costs for non home based trips are higher compared to work trips. The Employee Business trips cost Rs. 5.74 per Km.

Table 3.10 Average Travel Cost by Purpose of Travel

Purpose	Average travel cost (Rs.)
Work / Business	7.49
Education	2.73
Employee Business	5.74
Others	6.04
Return	6.12
Non Home Based	8.74

Per Capita Trip Rate (PCTR)

PCTR refers to the number of inter zonal trips made by an individual per day. Accordingly, PCTR has been calculated purpose wise for the BMA and the same is presented in **Table 3.11**.

Table 3.11 per – Capita Trip Rates by Purpose in BMA

Trip Purpose	Trips	Percentage	PCTR
Work	1839818	29	0.271
Education	738799	12	0.109
Others	649737	10	0.096
Non-Home Based	92347	1	0.014
Employer Business	11748	0	0.002
Return	2953228	47	0.434
Total	6285677	100	0.924
Total Population	6800000		0.924

3.7 PEDESTRIAN TRAFFIC CHARACTERISTICS

3.7.1 Bangalore city is witnessing considerable pedestrian traffic especially in the CBD areas. With the increase in the commercial activity in some of the important areas like Koramangala, M G Road, Shivajinagar, K G Road etc., there is an increased demand for better pedestrian facilities. The increase in vehicular traffic has given rise to widening the carriageway width to accommodate the vehicles resulting in reduction in the size of the foot paths. This in turn has given room for pedestrians to spill over to the carriageway, thereby affecting the flow of vehicles.

3.7.2 In order to safe guard the interests of the pedestrians in particular, it was decided to carry out pedestrian survey at some important locations where there is heavy

inflow of pedestrians. This would give us an idea about the volume of pedestrian traffic which in turn would help us in developing some facilities for the pedestrian traffic. Pedestrian surveys were conducted for 12 hours at 8 mid block and 9 junction locations (locations shown in **Figure 3.10**). The survey was conducted from 8 AM to 8 PM on typical week days. **Table 3.12 and 3.13** give the peak hour pedestrian at major locations. From the analysed data, it is observed that the pedestrian traffic is highest along 9th Main Road (Jayanagar 4th Block) followed by M G Road. It is also observed that the pedestrian traffic is at its peak during holidays / weekends at 9th Main Road (Jayanagar 4th Block), M G Road, Brigade Road and Gandhi Bazaar Road. The volume of pedestrian traffic is maximum between 10 AM and 11 AM in the morning and between 5 PM and 6 PM in the evening.

Table 3.12 Volume of Pedestrian Traffic at Mid Block Locations

Sl. No.	Road Name	Pedestrian Volume (12 Hours)
1.	Along Brigade Road (Near Rex Theatre)	5198
2.	Along M G Road (Near Plaza Theatre)	5366
3.	Along Hosur Road (Near Madiwala Police Station)	3426
4.	Along Gandhi Bazaar Road (Near Roti Ghar)	2578
5.	Along CMH Road (Near HDFC Bank)	2273
6.	Along Kuvempu Road (Near Varalakshmi Nursing Home)	1203
7.	Along Hare Krishna Road (Near Shivananda Bus Stop)	1787
8.	Along 9th Main Road (Jayanagar 4th Block near Janata Bazaar)	5797
9.	Mysore Bank Circle	19168

Table 3.13 Pedestrian Traffic Volume on Major Junctions

Sl. No.	Name of the junction	Peak Hour Pedestrian Traffic
1.	Mysore Bank Circle	19168
2.	K G Circle	10761
3.	Ananda Rao Circle	9002
4.	Yeshwantpur Circle	5475
5.	South End Circle	4870
6.	Malleswaram Circle	3579
7.	Toll Gate Junction	2937
8.	K R Circle	2778
9.	Prof. Shivashankar Circle	2114

Figure 3.10 Pedestrian, Parking and Terminal Survey Locations

3.7.3 Footpath facilities have been provided by BMP. However, the footpaths in many locations, especially in the commercial areas are occupied or encroached upon by vendors and hawkers resulting in spilling over of the pedestrians on to the road. This in turn results in vehicle–pedestrian conflicts. At many places the footpaths are narrow. Most of the footpaths do not have proper surface which forces pedestrians to walk on roads. Zebra crossings have generally not been provided on busy roads. Heavy pedestrian traffic is observed in the core areas of the city. However sufficient facilities, particularly for crossing, have not been provided for pedestrians. At some locations, foot over bridges have been constructed. However, these are not being effectively utilised by the pedestrians. This is an aspect which will need priority consideration. Facilities like subways or sky-walks with lift facilities may be a better option.

3.8 PARKING CHARACTERISTICS

3.8.1 Parking is assuming critical dimensions in Bangalore. Demand for parking is increasing with increasing vehicles and on–street parking is almost exhausted in the city centre. Parking surveys done at some important locations (shown in **Figure 3.10**) like bus terminals and commercial areas have indicated large parking demand as given in **Table 3.14**. Most parking requirements are of short duration upto two hours. Some of the roads like J C Road, Sampige Road, M G road, Brigade Road, Commercial Street, CMH Road, Jayanagar 4th Block, Shivajinagar and K G Circle attract huge volume of vehicles especially during peak hours, week ends and holidays. Sufficient provision has been made for parking at KSRTC Bus Terminal and Railway Station. Parking lots have been constructed on J C Road and K G Road. However, the demand for parking is so heavy that the parking lots have not been able to cater to the increased demand.

Table 3.14 Parking Characteristics at Selected Locations

Sl. No.	Road Name	Peak Accumulation		Avg. duration in Hrs	
		Cars	Two wheelers	Cars	Two wheelers
1.	Jayanagar 4th Block– nr. Arya Bhavan	48	301	1.562	1.785
2.	Sampige Road / Margosa Road (Malleswaram Circle upto 18th Cross)	63	299	1.681	1.825
3.	M.G. Road (Brigade rd to Mayo Hall)	155	45	1.710	1.843
4.	(Brigade Rd to Kumble circle)	84	331	1.738	2.287
5.	Commercial Street	39	7	1.544	4.000
6.	Gandhi Bazaar Road	88	350	1.840	1.711
7.	J.C. Road	97	391	2.441	1.763
8.	KSRTC Bus Stand	-	482	-	2.998
9.	City Railway Station	121 +23	339	2.120	1.718
	City Railway Station– second entry	48 +26	260	2.033	2.008
10.	Banashankari Temple	8	22	1.836	1.924

11.	Banashankari BDA Complex	58 +5	327	1.661	1.969
12.	Rajajinagar RTO Complex	34 +13	66	0.838	2.575
13.	Koramangala BDA Complex	44	329	1.443	1.982
14.	CMH Road	98 +3*	335+21@	1.984	1.595
15.	Russel Market	226 +4*	236+47@	1.759	2.033

* Auto rickshaws @ Cycles

3.8.2 Measures in force

- Pay & Park for on street parking
- Conservancy parking
- Parking lots by BMP – Market, J.C.Road, Jayanagar, PUB etc.,
- BMTC parking lots at Shivajinagar, BSK etc.,

3.8.3 Future plans

The future plans on the anvil initiated by the ULBs are listed below:

- Increased Pay & Park systems
- New MS Parking lots by BMP, BMTC
- More conservancy parking

Parking is causing traffic obstruction. A comprehensive parking survey needs to be taken covering the entire city and parking plan prepared indicating on-street and off-street parking locations. A suitable parking policy needs to be devised for the city.

3.9 SPEED & DELAY STUDY

3.9.1 Average network travel time and journey speed provides an insight into the road traffic performance. This in turn helps in identification of specific traffic congestion spots. Moving car method is the general method used for establishing the speed flow relationship for different types of road categories. This method was adopted to measure the network speeds and delays occurring at junctions which in turn is used for developing the speed flow relationship.

3.9.2 The moving car survey was conducted on 16 selected routes. The routes selected for the speed and delay study is given in **Table 3.15**.

Table 3.15 Speed & Delay Survey Routes

SN.	Road Name	Type of Road
1.	South End Road – From Jayadeva Hospital to R V Road	4L, 2W
2.	R V Road – Rajalakshmi Nursing Home to Minerva Circle	4L, 2W, D
3.	KR Road – Krishna Rao Park to Banashankari Temple Bus Stand	2L, 2W, UD
4.	Airport Road – Trinity – Marathahalli Bridge	4L, 2W, D
5.	M G Road – Kumble Circle to Brigade Road	4L, 2W, UD
6.	M G Road – Brigade Road to Trinity Circle	4L, 2W, D
7.	Dr. Rajkumar Road (Sujatha Theatre to Prasanna Theatre)	4L, 2W, UD
8.	Palace Road (Mysore Bank Circle to Basaweshwara Circle)	
	a) Mysore Bank Circle to Kantharaj Urs Circle	2L, 1W, UD
	b) Kantharaj Urs Circle to Basaweshwara Circle	4L, 2W, UD
9.	Bellary Road – Cauvery Theatre to Ganganagar	4L, 2W, D
10.	Ring Road – Hebbal Flyover to Banaswadi	6L, 2W, D
11.	Mysore Road – Sirsi Circle to Ring Road	4L, 2W, D
12.	District Office Road – Police Corner to Mysore Bank Circle	6L, 1W, UD
13.	ASC Junction to Richmond Circle via Victoria Road	4L, 1W
14.	Magadi Road – Leprosarium to Prasanna theatre	2L, 2W, UD
15.	Sampige Road and Margosa Road – Malleswaram Circle to 18th Cross	2L, 1W, UD
16.	CMH Road – Adarsha to CMH Road Junction	2L, 2W, UD

Note: 6L : 6 Lanes 2W : 2 - Way D : Divided
4L : 4 lanes 1W : 1 - Way UD : Undivided
2L : 2 lanes

The road stretches were so selected that it covers all the categories of roads like 2 lane roads 1 way and 2 way, 4 lane roads divided and undivided, 6 lane roads divided and undivided, 4 lane road one way and 6 lane road one way. This helps in arriving at a proper relationship of the speed–flow diagram.

3.9.3 Seven runs were made along each route, three each in the morning & evening peak hours and one run in the afternoon off–peak hour. Morning peak hour is generally observed between 9 AM and 11 AM while the evening peak hour is between 5 PM and 7 PM. The time taken to travel from one node to the next node along the identified routes was noted down in the data sheets. Whenever queuing was encountered, the time of delay was noted down as this helps in isolation of delay from the running time.

3.9.4 Classified traffic volume count was also conducted on the link on which the moving car survey was conducted. Volume counts were taken to cover two peak periods of morning and evening as also the afternoon off–peak period of the day.

3.9.5 The speed data by moving car, the network inventory data and the volume counts have been made use of to derive the speed flow relations in the form

$$Y = a - bx^n \quad \text{Where}$$

Y = Speed

a = constant (speed at free flow)

b = Coefficient of x

x = Flow in PCUs / hour / lane

n = Power of x

This is the form of equation which can be directly fed as an input into the SATURN network. For the development of speed flow relationship, data for each peak and off peak period has been averaged on each link. The links have then been classified into 8 categories based on the number of lanes. Accordingly, the following categories have been identified viz,

- 2 Lane, Undivided, One-way
- 2 Lane, Undivided, Two-way
- 3 Lane, Undivided, One-way
- 3 Lane, Undivided, Two-way
- 4 Lane, Undivided, One-way
- 4 Lane, Undivided, Two-way
- 4 Lane, Divided
- 6 Lane, Divided
- 6 Lane, Undivided, One-way

The curves so developed have been presented in **Table 3.16**.

Table 3.16 Results of Speed & Delay Study

Lane Category	Speed at Free Flow (Kmph)	Assumed Directional Capacity in PCU / Hr	Power Term n	Speed at Capacity (Kmph)	R ²
2 Lane, Undivided, One-way	35.59	3600	0.58	13.13	0.926
2 Lane, Undivided, Two-way	27.59	1800	1.20	10.91	0.856
4 Lane, Undivided, One-way	40.72	5800	0.52	17.35	0.722
4 Lane, Divided	41.82	3600	0.78	13.70	0.701
6 Lane, Divided	42.82	3600	0.55	17.02	0.712
6 Lane, Undivided, One-way	48.92	7000	0.60	19.25	0.576

The average peak hour speed is found to be 13.2 Kmph.

3.10 PUBLIC TRANSPORT SURVEY

3.10.1 Public transport survey was conducted along selected 10 bus routes. The routes were so identified and selected such that the survey covers the North-South and East-West corridors of the study area Bus route survey was done in order to

assess loading pattern and running time. The shortest route was 14.6 km and the longest route 76 km. Analysed results for the ten routes are tabulated in **Table 3.17**.

Table 3.17 Public Transport Survey on some Bus Routes

Route No	Route-from-to	Distance Km	Maximum passengers	Booked time	Actual Time	
					Minimum	Maximum
500	Banasankari to Banasankari	76	88	2:55	2:40	3:29
202	Yeshwantpur B.S to Kumaraswamy layout	24.2	47	1:20	1:32	1:45
287 M	Hebbal to Konankute Cross	20.0	69	1:20	0:50	1:12
TR-7	Banashankari III s II Ph to Jeevanahalli	17.0	78	1 ;05	1:10	1:35
MBS 4	K.R.Puram to Sunkadakatte	28.0	86	1 ;10	0:56.	1:34
TR 2	Basaweshwara Nagar to Koramangala	22.5	47	1:10	0:56	1:34
210 H	Shivajinagar to Uttarahalli	17.1	66	0:55	0:56	1:34
311 D	K.R.Puram to Shivajinagar	14.6	57	0:55	0:57	1:20
259	Shivajinagar to Jalahalli East 7th Cross	21.5	46	0:55	0:55	1:20
164	Shivajinagar to BTM Layout	14.5	89	0:45	0:43	1:05

3.10.2 It is seen that average journey speed goes down to below 15 Kmph on some routes. Overcrowding does not seem to be a problem in 80 % of routes.

3.10.3 Opinion survey for Bus and Rail passengers was conducted at 7 bus and rail terminals to study the existing travel characteristics and also to find out the intention of the passengers in modal shift. In spite of a fairly good route network, the bus service cannot provide direct home to work service for many commuters. In many users perception as ascertained from the opinion survey the services the expectation of the commuters is summed up below:

- i) Over 70 % of commuters feel that (a) buses are delayed resulting long waiting times; (b) the frequency is not adequate; (c) distance to bus stops should be less
- ii) For 52 %, access distance at origin should be less than 250 m and 32 % will accept half mile access distance at origin and the corresponding percentages at destination end are 45 % and 37 % respectively
- iii) 69 % feel the numbers of routes are not adequate.
- iv) 98 % of respondents are in favour of MRTS in city
- v) 81 % would like feeder bus service to MRTS stations
- vi) 89 % would like to have parking facilities at MRTS stations
- vii) 43 % want MRTS fares to be same as in us for comparative distance and 32 % are prepared to pay only 25 % extra over bus fare for same distance.
- viii) 90 % of respondents prefer single ticketing system between bus and MRTS

3.10.4 The longer access distance, low frequency and high travel time combined with longer waiting times have caused lower patronage of bus transport. Majority of commuters are reluctant to walk more than a quarter kilometer to the bus stop or from bus stop to destination. All these have caused a number of commuters who would have otherwise traveled by bus to prefer a two wheeler for travel. Thus, over the years, the numbers of private vehicles on roads have gone up causing congestion, which in turn has further reduced average speed of buses making them less attractive. This trend can be seen from **Table 3.18** which gives the change in modal split over the last 24 years. This table shows that over the years share of trips by cars has increasing due to rising car ownership levels, inadequate and unattractive public transport system. Share of trips by two wheelers has also gone up significantly. Of late two wheeler users have been switching over to cars due to rising income levels. Share of public transport has declined to some extent although in terms of absolute numbers it has increased. Share of trips by cycles has declined.

Table 3.18 Trend in Modal Split in Bangalore Metropolitan Area

Year	Modal Share (%)					Total
	Car	Two wheeler	Public Transport	IPT	Cycle	
1982	3.5	12.1	55.0	13.3	16.1	100.0
2003	5.4	36.3	48.9	7.3	2.0	100.0
2006	7.2	32.0	45.7	12.6	2.4	100.0

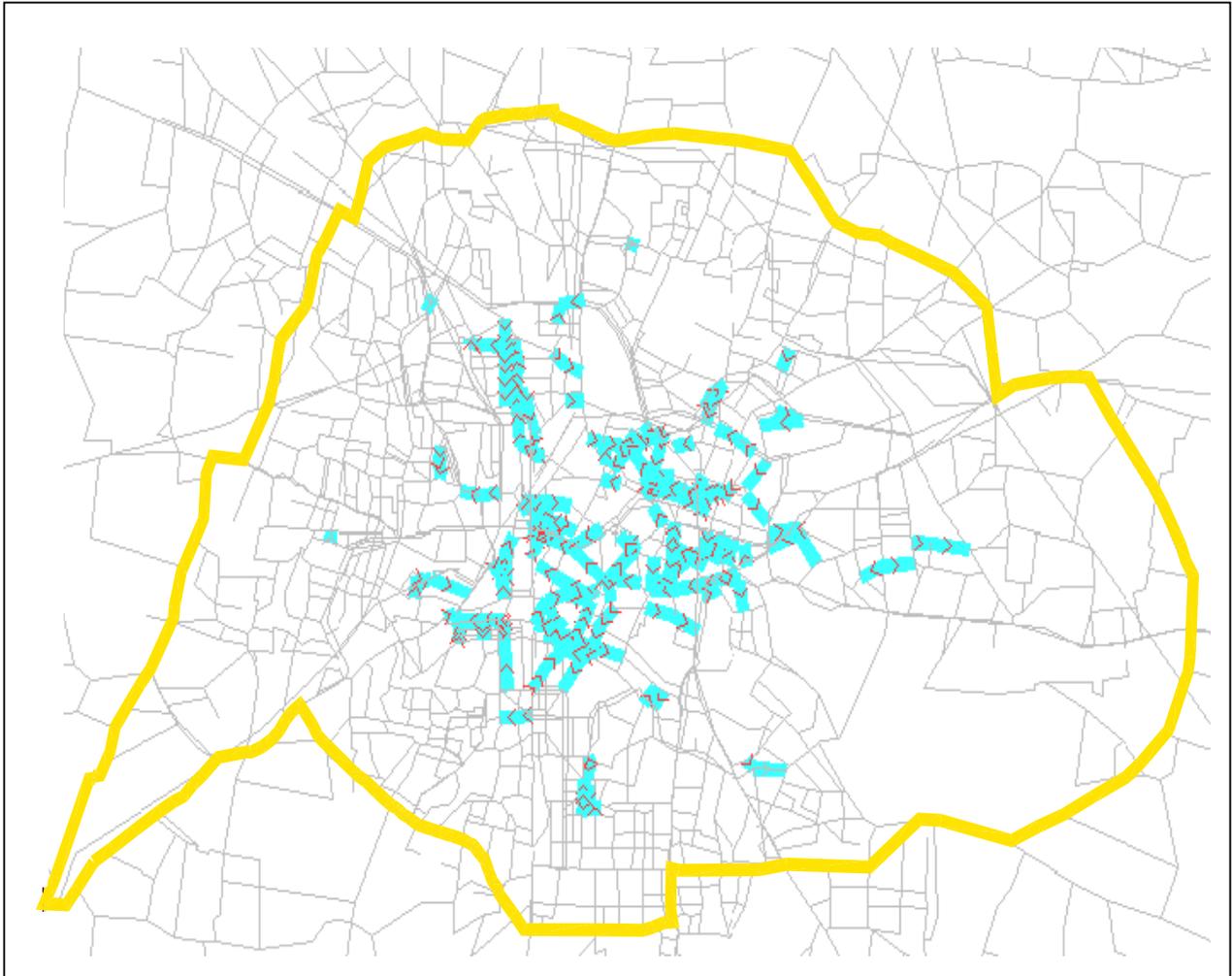
3.11 TRAFFIC MANAGEMENT

3.11.1 With nine radial corridors and a number of orbital roads, some of which are not continuous, there are a large number of intersections in the city. With the rapidly growing traffic, delays at junctions increase causing difficulty in controlling and regulating them. Traffic police who are in charge of enforcement also do the planning required for such regulation. The Policy that the Traffic Police has been emphasizing has been a multi-layered approach:

- Traffic Management – through regulations and restructure
- Traffic Infrastructure – in terms of grade separators and sub-ways
- Intelligent Transportation Systems (ITS) – use of Automated Traffic Control Systems
- Synchronised Signal Systems
- Automated Enforcement – through PDAs

3.11.2 As part of this strategy the Bangalore City Police has been undertaking the management by introducing one way systems in central areas. Over the past thirty years, about 260 km of roads have been converted as one way streets, of which 87 km were converted in the last two years only (shown in **Figure 3.11**).

Figure 3.11 Existing One Way Streets



LEGEND

 ONE WAYS

 RING ROAD

The Police has launched the AECs and is in the process of installing synchronised signals in phases. The City Police has drawn up plans to undertake the Intelligent Transport Systems (ITS) in the near future.

3.11.3 Bangalore is characterised by the presence of numerous junctions at short distances. The distance between two junctions is hardly about 300 to 400m. BMP has 162 signalised and 600 manual intersections. Intersection management often constitutes a major chunk of traffic management. Intersections invariably delay traffic since all the arms of the junction share the same space for proceeding and turning. In view of this, the vehicles pile up at the junctions. The traffic is however being managed by installation of traffic signals at major junctions and the minor junctions are being controlled by traffic police. The traffic is being controlled by the traffic police and depending on the quantum of vehicles plying on the road network, the traffic management measures are being implemented which include one way roads, ban on entry of certain type of vehicles, exclusive lanes for IPT vehicles etc.

3.11.4 Medians: Most of the multi lane roads are provided with medians and where there is no provision for the same, the medians are being implemented in phases. However, the dimensions of the medians erected are not as per standard IRC norms. This is basically due to non availability of land to widen the road. BMP has plans to widen some of the roads.

3.11.4 Parking: Parking is a major problem in the city. Parking Demand is increasing with increasing vehicles and on-street parking is almost exhausted in the city centre. Enforcing parking restrictions on roads will require provision of alternatives in form of multi storeyed lots and alternative pricing mechanism as a disincentive.

3.12 ROAD ACCIDENTS

3.12.1 Accident data for the past 6 years has been collected from the traffic police department i.e. from 2001 upto November 2006 and is given in **Table 3.19**. The data pertains to Bangalore Corporation area only. The table shows that a large number of road accidents take place and claim many lives every year. The table also shows that the numbers of accidents have stabilized. This may be due to high congestion and declining speeds on roads.

Table 3.19 Road Accident Scenario of Bangalore City

Year	Fatal	Killed	Non-Fatal	Injured	Total
2001	668	703	8358	6929	9026
2002	783	820	9073	7577	9856
2003	843	883	9662	7980	10505
2004	875	903	8226	6921	9101
2005	793	833	6782	5899	7575
upto 30.11.06)	776	809	6051	5457	6827

Source: Traffic Police Department, B'lore

3.12.2 Most traffic accidents result from the careless behaviour of road users viz., drivers or pedestrians. The probability of accident occurrence and the severity of the accidents can be reduced by proper application of traffic control devices, good road way design features and traffic road management measures.

3.13 PROBLEMS AND ISSUES

3.13.1 The analysis of collected data from primary and secondary sources has brought the following major issues regarding the transport system of Bangalore.

1. Road network capacity is grossly inadequate. Most of the major roads are with four lane or less with small scope of their widening. This indicates the need for judicious use of available road space.
2. The junction spacings are with small length on many roads. Many junctions in core are with 5 legs. This makes traffic circulation difficult. There is need to optimise the available capacity by adopting transport system management measures and by making use of intelligent transportation systems.
3. Traffic composition on roads indicates very high share of two wheelers. The share of cars is also growing. This indicates inadequate public transport system.
4. V/C ratios on most of the roads are more than 1. Overall average traffic speed is about 13.5 kmph in peak hour. This not only indicates the need of widening of the roads but the also the need to plan high capacity mass transport systems on many corridors.
5. Outer cordon surveys indicate high through traffic to the city. This points to the need of road bypasses not only for BMA but also for BMRDA area. High goods traffic also indicates the need of truck terminals at the periphery of the city.
6. Household surveys indicate high household incomes. So the vehicle ownership levels are increasing. In the absence of adequate and comfortable public transport system, people are using their personal modes creating not only congestion problems but also environmental pollution.
7. The household surveys indicate high share of work trips. This segment of travel demand needs to be mostly satisfied by public transport system. Considering the large employment centres being planned in the BMA, the public/mass transport system needs to be upgraded substantially.
8. Modal split in favour of public transport is about 46%. The trends show a decline in this share over the last two decades. This is further expected to fall

unless adequate and quality public transport system is provided to the people of Bangalore. Share of two wheelers and cars in travel demand is disturbingly high. This trend needs to be arrested.

9. There is high pedestrian traffic in core area and some other areas in Bangalore. Footpath facilities are generally not adequate and their condition is deteriorating. Therefore up gradation of their facilities is very important.
 10. Parking is assuming critical dimensions in Bangalore. Parking facilities need to be augmented substantially. In the long run, city-wide public transport system needs to provide not only to reduce congestion on roads but also to reduce parking demand.
 11. Share of cycle traffic has declined over the years. This mode of transport needs to be promoted by providing cycle tracks along the roads.
 12. Area of the BMA has been increased as per Revised Master Plan-2015. This plan has provided for densification of existing areas, Mutation corridors, hi-tech areas etc in various parts of the city. This likely to have a major impact on traffic demand. The transport network including mass transport system needs to be planned taking the proposed development in to consideration.
 13. Large areas are planned being planned by BMRDA in the BMR. This is likely to increase interaction between Bangalore and suburban towns. There will be need to provide commuter rail services to these towns from Bangalore.
 14. Opinion surveys indicate most of respondents will prefer to Metro system. They will also be willing to pay slightly extra for the improved services.
- 3.13.2 Thus while planning for the transport system of Bangalore, the above problems and issues need to be kept in consideration.

CHAPTER – 4

DEVELOPMENT OF OPERATIONAL TRAVEL DEMAND MODEL

4.1 INTRODUCTION

4.1.1 A Detailed operational model is required to enable estimation of future travel demand which will help in identifying transport requirements. A number of sub-models have to be developed as follows

- Trip end model
- Trip distribution model
- Modal split model
- Assignment model

4.1.2 India is one of the developing country having heterogeneous type of vehicles on road starting from slow moving vehicles such as cycles to medium speed auto rickshaws to fast moving two-wheelers, cars, buses, trucks etc. It is necessary to select appropriate travel demand software which can model multi modal transport system. Various soft-wares are available such as EMME2, SATURN, TRIPS/CUBE etc. An effort has been made in **Table 4.1** to compare these three popular soft-wares as mentioned above to select a best suited to Bangalore city.

Table 4.1 Comparative Capability Statement of three popular transportation planning software

S. No.	Particulars	EMME2	SATURN	TRIPS/CUBE
1	Network Scenario	Network consists of modes, nodes, links, turns and transit lines (up to 1,50,000 links, 60,000 nodes and 6000 zones) – up to 30 modes (such as car, truck, bus, train, walk etc.) – Possible to model the interaction between the modes. – A data bank can contain several scenarios – base year, alternatives to future years etc.	Network consist of modes, nodes, links, turns and transit lines (up to 2,00,000 links, 1,00,000 nodes and 8,250 zones) – Up to 32 modes – Possible to model the interaction between modes – Data bank contains all scenarios.	Network with links, nodes and transit links.
2	Matrices	Matrices contain results as well as in-put data – demand and travel time by O-D pair. – Zone grouping can be defined to allow the production of aggregate matrices.	Matrices contain results as well as in-put data – demand and travel time by O-D pair. – zone grouping can be defined to allow the production of aggregate matrices	Matrices contain input data – demand and travel time by O-D pair.
3	Functions	Functions are defined by the	Functions are defined by	Flexible command

		user.	the user.	language for implementing demand modals. – Advanced, built in functions for implementing standard modeling processes. – User interface in multiple languages
4	Matrix manipulation tools	Can be used to implement any travel demand forecasting model from the classical 4-step model to multi-modal assignment with direct demand functions as well as modes based on trip chains.	Provides facilities to build and modify trip matrices with options for factoring, combining, transposing, Furnessing, compressing / Disaggregating zones.	Matrix estimation functions for private and public transportation.
5	Assignment	Provides an equilibrium road assignment procedure.	Supports a wide range of assignment options, equilibrium, stochastic user equilibrium, All or nothing, stochastic, – Full demand responsive options available (elastic assignment)	Dynamic traffic assignment Multi-path public transit assignment
6	Transit assignment	Provides a multi-path transit assignment for modelling and analyzing.	Solution towards integrated transport – evaluate PT networks & service levels – examine routing options – determines route loading – skim public transport cost – Bus priority measure, LRT & guided bus system, park & ride and Traffic restraint.	Innovative multi-path and multimode approach for modeling public transit path building and assignment.
7	Graphic tools	All elements of the data bank may be displayed using various tools – interactive graphic editor, matrix histogram, shortest path builder, scenario comparison etc.	A vast range of display options – multiple network – analysis option – link and junction annotation – network comparison – turning movement annotation – GIS backgrounds – individual junction plot – lane allocations and speed – identification of problem junctions – journey time plots – bus route information	– Power of GIS – Capability to build, compare and spatially analyze transportation system.

8	Wide variety of application	Can be used to address wide variety of transportation planning problems from inter-urban highway studies to urban road, public transport and multi-modal studies.	Traffic congestion solution, revised traffic management arrangements by-pass or town center relief, development impact, local junction improvement, forecasting the impacts of traffic growth, assessing induced traffic, impact of capacity reduction economic or environmental assessment. From tolling to traffic management, from handful of junctions to full regional studies.	- Simulation of personal travel -Freight -Environmental impact
9	International user base	Supports international character sets, plot titles in several languages and representation of left-hand traffic.	Has over 300 users' world wide in 30 countries and also widely used for research projects. Has been used in Santiago, Cambridge, Kuwait, Dublin, Leeds, Chennai and Mumbai.	Used in many countries by various consultants.
10	Use in India	Information not available	Used in Chennai and Mumbai and the software is customized to Indian conditions	Information not available

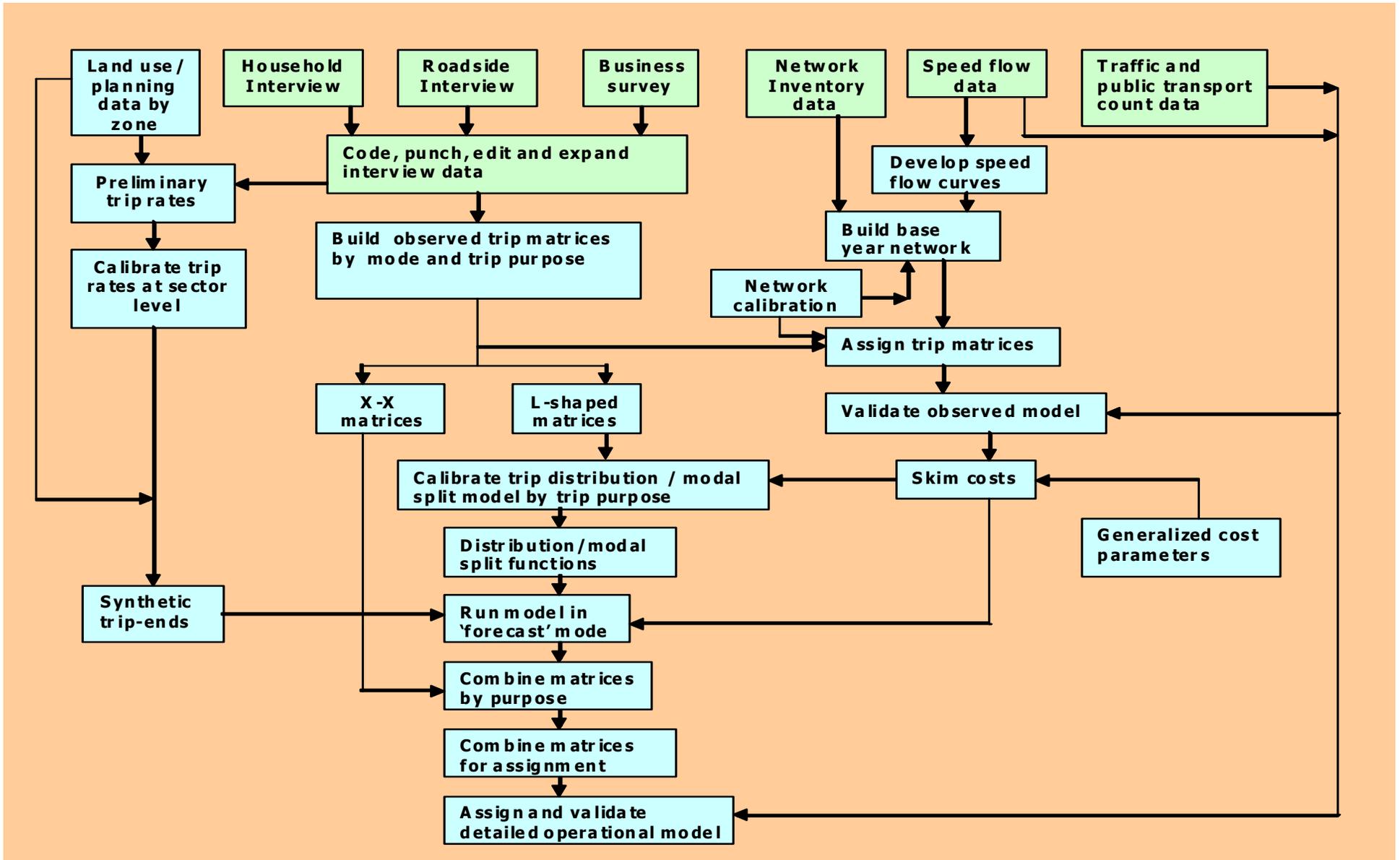
4.1.3 The comparison of the above three software infers that the software PT-SATURN developed by University of Leeds and M/s WSATKINS has been customized to Indian conditions while being used in Chennai and Mumbai. It will be prudent to mention here that the software at Chennai has been used by M/s RITES Ltd during the preparation of Comprehensive Traffic and Transportation Plan for Chennai Metropolitan Area in 1992-95. Hence SATURN was found the appropriate one to use for Bangalore.

4.2 METHODOLOGY FOR MODEL DEVELOPMENT

4.2.1 The steps involved in model development are indicated in **Figure 4.1**. Trip end models have been developed using multiple linear regression. SATURN /PT-SATURN packages have been used for the other three steps.

4.2.2 The model developed has been used for traffic forecasting for the horizon year at the strategic level including public transport corridor system. The extensive data base that was established as a result of the traffic surveys in 2006 provided the base for the model development, calibrated and validation.

Figure 4.1 Development of Detailed Operational Model



4.3 TRIP GENERATION

4.3.1 The first step is to derive the models for trip generation / production in different zones. The trip generation models can be obtained either by using Multiple Linear Regression (MLR) technique or simple linear regression techniques. The models are based on the premises that;

- (i) a linear relationship exists between the trip generation and the other various independent variables which influence the trip production; and
- (ii) The influence of each such independent variable on trip production is additive i.e. addition of each variable in the model contributes in a positive or negative way towards the value of dependent variable.

4.3.2 In case of MLR it takes the form

$$T_o = a_o + a_1 x_1 + a_2 x_2 + \dots + a_n x_n$$

a_o is a constant;

a_1, a_2, \dots, a_n are coefficients;

x_1, x_2, \dots, x_n are influencing variables

which include one or more planning factors, socio-economic characteristics and trip characteristics. They should normally cover the factors like

- (i) The land use pattern and development in study area
- (ii) the user characteristics like household size, income, vehicle availability; and
- (iii) the nature, extent and capacities of the transportation system

In case of simple linear regression equation the equation takes the form of:

$$Y = a + bX$$

Where, a is a constant, b is the coefficient and X is the independent variable.

4.3.3 Since number of households is highly correlated to either number of workers, number of students, or number of households as a variable would take a negative coefficient and it was not desirable to be included.

4.3.4 As the projection of vehicle ownership or number of vehicles in zone is difficult especially because of non availability of zone-wise economic data this variable has not been considered. But the variables which were decided to be included is as follows:-

For Work : 'Zonal population'.
 For Educ : 'Zonal population'.
 For Other : 'Zonal Population'.

The trip generation models developed for peak and off peak period for full BMA are given below:

WHOLE DAY MODELS

Work trips = **7092.014 + 0.230406 P** **R2= 0.829**
Educ. trips = **3287.878 + 0.088129 P** **R2= 0.759**
Other trips = **2734.769 + 0.108239 P** **R2= 0.722**

Where

P = Population
 R2 = Coefficient of Multiple Correlation

4.4 TRIP ATTRACTION

4.4.1 Trip attraction can be done only at zonal level. The trip attraction models are mostly derived using regression approach. The data availability at zonal levels, which could be forecasted were checked first. But the relevant data's like number of work places, student enrolment for future years and also land use in terms of commercial area for future years were not available neither in Master Plan prepared by BDA nor else where. In absence of such data effort was made to forecast work places and student enrollment based on information like population and future activity shifting as per the Master Plan. The equation for other trips were developed based on available data like area of commercial areas at planning district levels as data was not available at traffic zonal level. Based on the above the variables used were

Work Trips : Number of work places.
 School Trips : Number of school enrolment
 Other trips : Commercial area

WHOLE DAY MODELS

Work trips = **4904.793+0.68661*WP** **R2= 0.768**
Educ. trips = **2469.983+0.415853*SE** **R2= 0.700**
Other trips = **8989.15+ 401.10 * CA** **R2= 0.7267**

Where

WP = Work places
 SE = Students enrollment
 CA = Commercial Area
 R2 = Coefficient of Multiple Correlation

4.5 BASE YEAR NETWORK DEVELOPMENT

4.5.1 Introduction – SATURN / PT SATURN

Having identified the study area and traffic zones, the base road network (in SATURN) and public transport network (in PT-SAT) were defined.

4.5.2 SATURN (Simulation and Assignment of Traffic on Urban Road Networks)

4.5.2.1 SATURN is a suite of computer program which has four basic functions

- As a network database and analysis systems
- As a combined traffic and simulation and assignment model for the analysis of traffic management schemes over relatively localized networks
- As a conventional traffic assignment model for the analysis of larger network
- As a simulation model of individual junctions

4.5.2.2 The basic SATURN model has the following six components programs

- The Network build program
- Assignment program
- Simulation program
- Analysis program
- Network editing program
- Network plot program

4.5.2.3 For the network build program SATNET, data required are the link data like distance, free and capacity speed capacity, power of speed – flow curve, bans on links coordinates of nodes, public transport routes etc.

4.5.3 PT-SATCHMO (SATURN Travel Choice Model)

4.5.3.1 SATCHMO is a multi-modal transport package to complement SATURN and provide facilities to model the new measures and responses. The public transport programs are used to

- Build Network (SAT10)
- Build paths
- Skim trees
- Evaluate inter zonal costs
- Assign a trip matrix to network

4.5.3.2 To build network, link speed will be read from SATURN network factored for allowing slowing at stoppages. The bus route is also read from the SATURN private network.

4.5.4 Private Vehicle Network

4.5.4.1 The Bangalore Metropolitan Area is served by a network of roads and railways to facilitate travel within the area by both private and public transport. But the network within the area is not well defined on scientific basis and also it does not have proper well defined hierarchy of roads. Depending on the characteristics of some of the roads it is possible to broadly divide them into 4 categories like

- Arterial roads
- Sub-Arterial roads
- Collector-distributors roads
- Local Streets

4.5.4.2 It was assumed that all trips generated within zone will emanate from zone centroid. In order to load the trips on to the network they are connected to the network with the help of zone centroid connector. The travel characteristics of a centroid connector will represent the zonal average of trips starting and ending at that zone. For any centroid there may be more than one centroid connector depending on the local conditions of a traffic zone, and network links in the zone. The base road network, centroid and centroid connectors are shown in **Figure 4.2** and **4.3**. Centroid connectors linking zones with nodes were assigned with speeds of 15 Km/h in the city, 20 Km/h in outer regions. Distance is measured from each loading point to the theoretical centre of gravity.

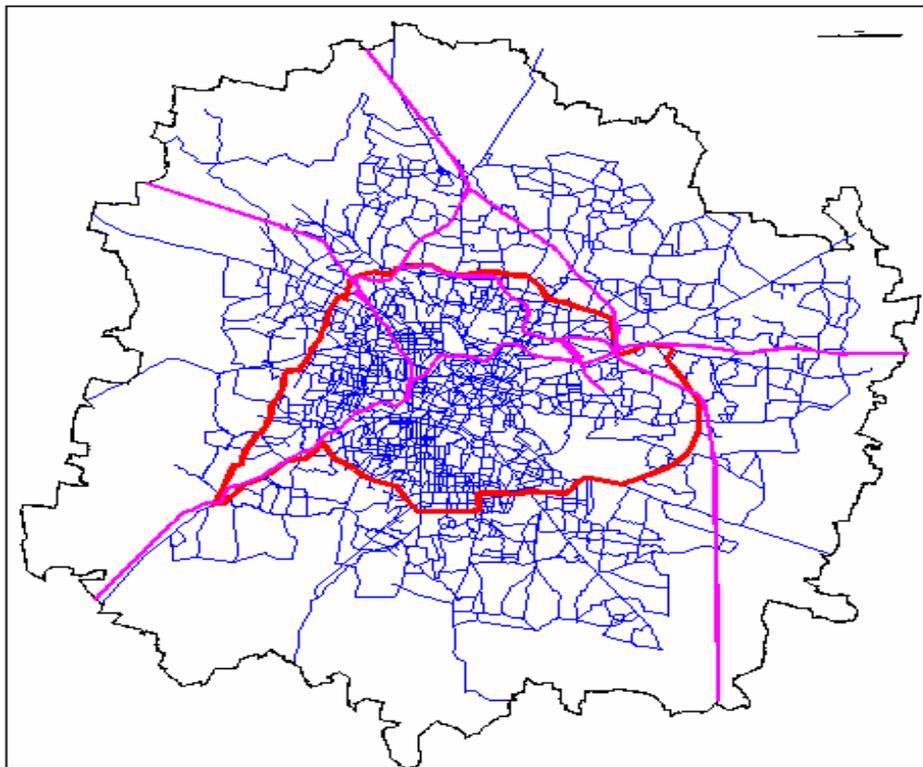


Figure 4.2: Base Road Network

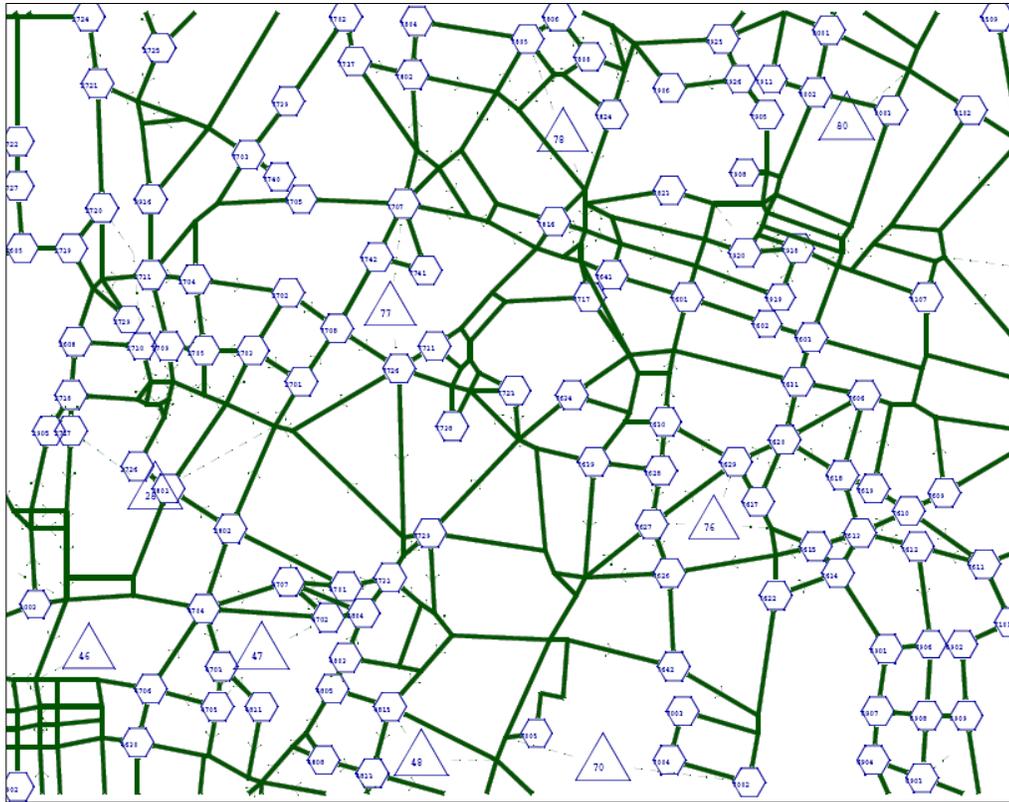


Figure 4.3: Road Node and Centroid and their Connectors

4.5.4.3 Link lengths were measured from the plans and checked at random by measuring at sites. Each link was also allocated a speed flow curve according to the speed flow study mentioned earlier and depending on category of the link in which it is falling.

4.5.4.4 Bus services of BMTC were coded with more details. The frequency of buses operating on each route was coded so as to preload the same to the private vehicle network. A bus PCU value of 3.0 was assumed.

4.5.5 Public Transport Network

4.5.5.1 The public transport network developed in PT-SAT is a composite network consisting of both bus and rail services. This helps in passenger interchange between the two. The composite network allows greater flexibility in route choice and helps in realistic assignment of trips from the combined public transport matrix.

4.5.5.2 PT SATURN extracts the bus routes and frequencies from SATURN network file. An extensive system of both bus and rail routes were modeled. This include all the intra city bus services run by BMTC and suburban rail service and exclude the intercity bus and rail services.

- 4.5.5.3 Bus speeds are read directly from SATURN network file which includes the effect of congestion due to private vehicles. A factor of 1.2 was used on these speeds to reflect time lost at bus stops.
- 4.5.5.4 Centroid connectors link centroids to the bus and rail network at major nodes and appropriate stations. The Centroid connectors represent overall walking time from Centroid to the public transport system. The mean walking speed was considered as 5 Kmph.
- 4.5.5.5 Transport links represent connections between bus to bus routes and railway stations. They are considered as walk links.
- 4.5.5.6 Important assumptions which were made while building public transport network are :
- Private Vehicle link times are factored by 1.2 to allow time lost at bus stops enroute
 - Actual walk time is factored by 2.0 to represent perceived walk times.
 - Waiting time is calculated as half the service head way. This is factored by 2.0 as for walking time.
 - Bus transfers at a node accrue an additional 2 minute penalty.
 - Bus fares calculated as Rs.1.00 as fixed fare, taking in to account the sale of monthly, weekly and daily passes, plus Rs.0.50 per Km. The fixed fare is charged every time a transfer is made.

4.5.6 Network Calibration

Both private and public transport networks were checked thoroughly and corrected wherever necessary in order to achieve reliability and accuracy. The checks included

- Private road network link lengths, bus and rail link lengths in PT network were checked.
- Test tree builds from selected zones to ensure logical routing pattern
- Modelled and observed journey time comparison
- Comparison of modeled and observed vehicles across screen lines in private network and passenger counts in public transport network.
- Assignment checks.

4.6 GENERALIZED COST

- 4.6.1 The generalized cost of travel is the sum total cost of a traveler's out of pocket expense and the perceived cost of his time of travel by the mode. Generalized cost may therefore differ not just by the mode of travel, but also according to the characteristics of the traveler and of the particular trip that he is making.

4.6.2 Value of Travel Time

4.6.2.1 In order to apply this approach to the valuation of travel time it is necessary to estimate average income and complete travel time cost. Based on the statistical data available the per capita income (per annum) has grown from Rs. 28305 during 1998–99 to Rs. 53625 by 2004–05 at constant prices. The average income per employed resident using a particular mode was extracted from 2% household data collected during HHI. The results are summarized in **Table 4.2**. Assuming full time employees work for 176 hours per month, the time cost was worked out per minute.

Table 4.2 Average per Capita Income per month of Persons Using Different Modes

Mode	Average individual income / month	Rs / hour
2-Wheeler	4469	25.39
Car	7388	41.98
IPT	3611	20.52
PT	2110	11.99

- NOTE: 1. Extracted from household survey data.
 2. Hourly incomes assume monthly working hours of 176.
 3. Income is in Indian rupees

4.6.2.2 Business travel time is valued approximately at the person's wage rate, non-business travel or other trips like leisure, shopping, education etc., is valued at 25% of person's wage rate. In education and other leisure trips it is usually assumed as everyone in household behaves as if his/her income is equal to that of the head of the household, trip to or from work is valued as 50% of person's wage rate.

4.6.2.3 The value of time for peak and off-peak for different modes like car, two wheeler, IPT and public transport is shown in **Table 4.3**.

Table 4.3 Value of Time – Mode wise, Purpose wise and Period wise

Mode	AV Occu	Income/ Month (Rs)	Time Cost per minute	Value of Time / Minute		
				HBW	HBE/O	EB
2-Wheeler	1.53	4469	0.42 per person	0.21	0.11	0.42
			0.65 per mode	0.32	0.16	0.65
Car	2.59	7388	0.70 per person	0.35	0.18	0.70
			1.81 per mode	0.91	0.17	1.81
IPT	2.49	3611	0.34 per person	0.17	0.08	0.34
			0.85 per mode	0.43	0.21	0.85
PT		2110	0.20	0.10	0.05	0.20

- NOTE: 1. Income of IPT user is weighted average of both auto rickshaw user and taxi user.
2. HBW cost = time cost per person * 0.5
HBO cost = time cost per person * 0.25
EB cost = time cost per person * 1.00
3. Income and time cost is in Indian rupees

4.6.3 Operational Cost

4.6.3.1 Car users:

This will include car operation in terms of fuel and oil. The break up of cars of various makes can be considered as Small cars 55%, big and SUV cars 30% and Rest: 15%. Accordingly the average operating costs will be worked out.

Also it is proposed to take in to account the type of fuel used by various cars and they are given in **Table 4.4**.

Table 4.4 Mileage by various Cars

CARS	Total	Km / Lt	Petrol	Diesel
Small Cars	55 %	16	35 %	20%
Big cars	30 %	10	20 %	10 %
Others	15 %	8	5 %	10 %

Average Vehicle Mileage – 13.35 Km/Lt

Cost of fuel – Rs. 50.40 for petrol and Rs. 35.26 for diesel as on 2006

Average Fuel cost per Km – Rs 3.31 per Vehicle.

4.6.3.2 Two Wheelers

Depending on the type & make of Two Wheelers available on road it is proposed adopt the breakup as given in **Table 4.5**.

Table 4.5 Mileage by Various Two wheelers

Mode	Total	Km/ Lt
Scooters	35%	35
Motor cycles	40%	50
Mopeds	35%	60

Average vehicle mileage – 48.5 Km/ Lt
 Cost of petrol – Rs. 54.50 as on 2006
 Average fuel cost per Km – Rs. 1.12

4.6.3.3 Public Transport

The out of pocket expense consists of fare paid by the passenger. The fare is minimum for the first few kilometers and increased on a per kilometer basis or depending on stages. For buses the average fare per km is Rs. 0.50 for ordinary bus with Rs. 3.00 as minimum and Rs.0.75 for pushpak buses with a minimum fare of Rs.4.00. The weighted average of minimum fare was worked out taking in to account the sale of daily passes, weekly passes and monthly passes and it is Rs.1.00

4.6.3.4 IPT

For Auto & Taxi the fare depends upon per km rate. At present min auto fare is Rs. 12.00 for 2.0 Kms & for Taxi it is Rs. 30.00 for 3 Kms. The weighted average fare for IPT per km works out to Rs. 7.50 / km and the same has been proposed to use in model.

4.6.3.5 Commercial vehicles

It is assumed that on an average the salary of driver and the helper works out to Rs.12000/- per month. It was also found that they work for about 20 days in a month and for a period of about 12 hrs in a day. Similarly on analysis of fuel consumption it was found that HTV give 3.84 km/ltr of diesel and LCV give 8.73 km/Lt. A combined weighted average for the commercial vehicles gives 5.13 km/Lt of diesel.

Time cost for Driver/helper – Rs.0.83/min
 Expenditure on fuel – Rs.6.87/km (at 2005 price)

4.6.7 The determined time costs and operation costs goes as input in the assignment and distribution model to extract cost matrices for various modes and purpose.

4.7 CALIBRATION AND VALIDATION OF OBSERVED MODELS

4.7.1 There are two clear links between private vehicle and public transport assignments and the subsequent development of cost matrices – SATURN takes route and frequency data from the PT-SAT network takes link speed data from the SATURN assignment.

The private vehicle cost matrices were produced in three steps:

- * Matrix development
- * Network calibration/assignment validation
- * Cost skims

4.7.2 Matrix Development

4.7.2.1 A total of 21 observed private vehicle trip matrices were produced as follows for the whole day.

- * Light vehicles – 5 purposes (HBW, HBE, HBO, NHB, EB)
3 modes (car, 2-wheeler, IPT)
- * Commercial vehicles – (all employees business)
- * Cycle – 5 purposes (HBW, HBE, HBO, NHB, EB)

4.7.2.2 Private vehicle passenger matrices and Public Transport passenger matrices both purpose wise and mode wise was built for distribution and modal split and the Private Vehicle (PV) matrices in terms of PCUs was built for assignment purposes. The heavy vehicles, private vehicles and cycle matrices were in PCUs and have been derived by converting person trips matrices from corresponding purpose wise occupancy figures and PCU values.

4.7.2.3 The private vehicle – car, IPT and two wheelers were combined for assignment to the private vehicle network (See **Table – 4.6**).

Table 4.6 Total number of Vehicles and trips Assigned

Vehicle type	Peak Period
Cycle	10233 PCU's
Commercial vehicles	10199 PCU's
Private modes – cars, 2-w and IPT	189569 PCU's
Public Transport	338195 person trips

Note: PCU values Car : 1.00, Cycle : 0.50, Truck : 3.00, 2-W: 0.75 and Auto : 1.20

4.7.3 Network Calibration / Assignment Validation

4.7.3.1 Private Vehicles

Approach to assignment in SATURN is to allow different vehicle types or road users to follow different routes through network up to 20 iterations for each ij pair. The basis for route choice was also varied and tested in each case in order to produce an assignment which best fitted observed behavior. BMTCL scheduled bus routes were incorporated as fixed flows. Commercial vehicles and cycles were

assigned to the network first as preloads. Here the trees were based on minimum distance paths for cycles and minimum cost paths using free-flow speeds for commercial vehicles.

4.7.3.2 The private vehicles – car, IPT and two-wheelers matrices were then assigned to minimize generalized costs.

4.7.3.3 An “Equilibrium” assignment technique was followed whereby traffic arranges itself across network in such a way that all routes used for any origin and destination movement have equal and minimum costs, while all unused routes have greater costs. The algorithm employed in SATASS uses an iterative sequence.

- The complete matrix are assigned to minimum cost trees to produce a set of link flows.
- A new set of link costs are calculated as a result of first assignment and used to define new minimum cost routes.
- The matrix is reassigned to produce a newest of link flows.
- An improved set of link flows are calculated from a combination of the first two, the proportion of each being calculated on the basis of the need to minimize overall costs on all links across the network.
- A new set of link costs are then calculated and so on.

4.7.3.4 This procedure provided for satisfactory convergence after 20 iterations, convergences was defined as a situation where sum of link costs across the network, is within 1% of the costs where all trips properly assigned to equal minimum cost routes. Thus in an un-convergent assignment, the above equilibrium condition is not satisfied because different routes carrying traffic between the same destination pairs are not all of equal cost.

4.7.3.5 Calibration of Private Vehicle Network

The resulting assignment flows and journey times were compared with the ground count (observed flows and observed journey times). These checks on validation led to a sequence of minor network corrections, followed by assignment and further validation checks. Particular attention was placed on.

- checks on link capacity throughout the network especially at level crossing, bridges across rivers, causeways, roads with encroachment etc. by comparing journey times with observed values.
- revision to some zone centroid connectors to load traffic on to the network at more appropriate locations.

Generalized cost and time only assignment were tested using the Wardrop equilibrium assignment in SATURN. The principle behind this technique is traffic arranges itself on congested network in such a way that the cost of travel on all routes used between each O–D pair is equal to the minimum cost of travel and all unused routes have equal or greater cost (i.e. same as above). The finally selected assignment methodology was all or nothing for cycles, stochastic user equilibrium (SUE) assignment for commercial vehicles. In SUE technique, the traffic arranges itself on congested network such that the routes chosen by individual drivers are those with the minimum perceived cost; routes with perceived costs in excess of the minimum are not used. The main difference is that SUE goes through a fixed number of all-or-nothing assignments randomizing costs (within a range) each time.

4.7.4 Public Transport Network

4.7.4.1 The public transport network develop in PT–SATURN consists of both bus and rail services, so that passenger may interchange between the two. Bus routes are read into PT SATURN directly from SATURN network file. Bus speeds are read directly from the SATURN loaded network file so that journey times by bus include the effect of highway congestion. Before it is being assigned with PT trips the network was thoroughly checked and amended where necessary.

- Numbers of assumptions were made while building PT network.
- Private vehicles link times are factored by 1.2 to allow stoppages of buses at bus stops.
- Actual walk times doubled to represent perceived walk time, a common assumption.
- Waiting time will be half the service headway.
- Bus transfer will mean additional 2 minutes penalty.
- Bus fares calculated on the basis of Rs.1.00 fixed fare and Rs.0.50 per km.
- Fixed fare is charged to Bus passengers every time a transfer is made.

4.7.4.2 PT–SAT assigns the public transport matrix of both bus and rail to single all or noting trees based on minimum cost. All passengers between any two zones are assumed to travel along the same route. Each route may contain various elements of travel including

- Walk to bus stop or Railway station
- Bus or Rail options for major travel
- Transfer between bus and train / bus & bus.
- Waiting time at bus stops & Railway stations.

4.7.5 Validation Statistics for Assignment of the Observed Matrices

Screen line Comparison

Validation was assessed on the basis of comparison of observed counts against corresponding model forecasts. Traffic counts were those carried out at each of the screen line survey sites.

Total modelled flows across screen line, are within 0.12% of counts for morning peak hour. Individual directional screen line totals are generally within 10%. **Table 4.7** shows comparison of observed and assigned flows across screen line.

Table 4.7 Comparison of Observed and Assigned flows

Direction	Assigned	Observed	Difference	% difference
UP	47972	43953	4019	9.15%
Down	35762	36153	-391	1.81%
TOTAL	83734	80106	7714	9.63%

4.7.6 Travel Cost Extraction

The trees output by the final assignment from the SATURN for whole day were extracted to provide cost matrices for all modes and purposes, the bus passenger costs were obtained from extraction of the PT-SATURN assignments. Since a converged assignment by definition may contain a number of different but equal cost routes between pair of zones, it was necessary only to skim the final set of trees. The total cost for each zone pair was incorporated in a set of cost matrices.

4.7.7 Calibration and Validation of Gravity and Modal Split Model

4.7.7.1 The purpose of trip distribution modeling is to find equations that reproduce intra-zonal patterns of surveyed traffic. It should function to fill any unobserved cells of a partially observed trip matrix or to forecast the effects of changes in the transport system on the choice of trip destination used to predict changes in patterns of movement resulting from new infrastructure, changed land-use etc.

4.7.7.2 Modal split or modal choice modeling attempts to estimate the total amount of patronage on the different transport modes. Trip distribution indicates the spatial pattern of this demand. Modal split is the allocation of the total surveyed traffic to separate modes as normally used in the bi-partition of traffic in to private and public mode. For this study we have adopted joint distribution / modal split model based on gravity modeling as this option is available in SATURN / PT-SAT suite.

4.7.7.3 **The process of trip distribution and modal split is shown in Figure 4.4**

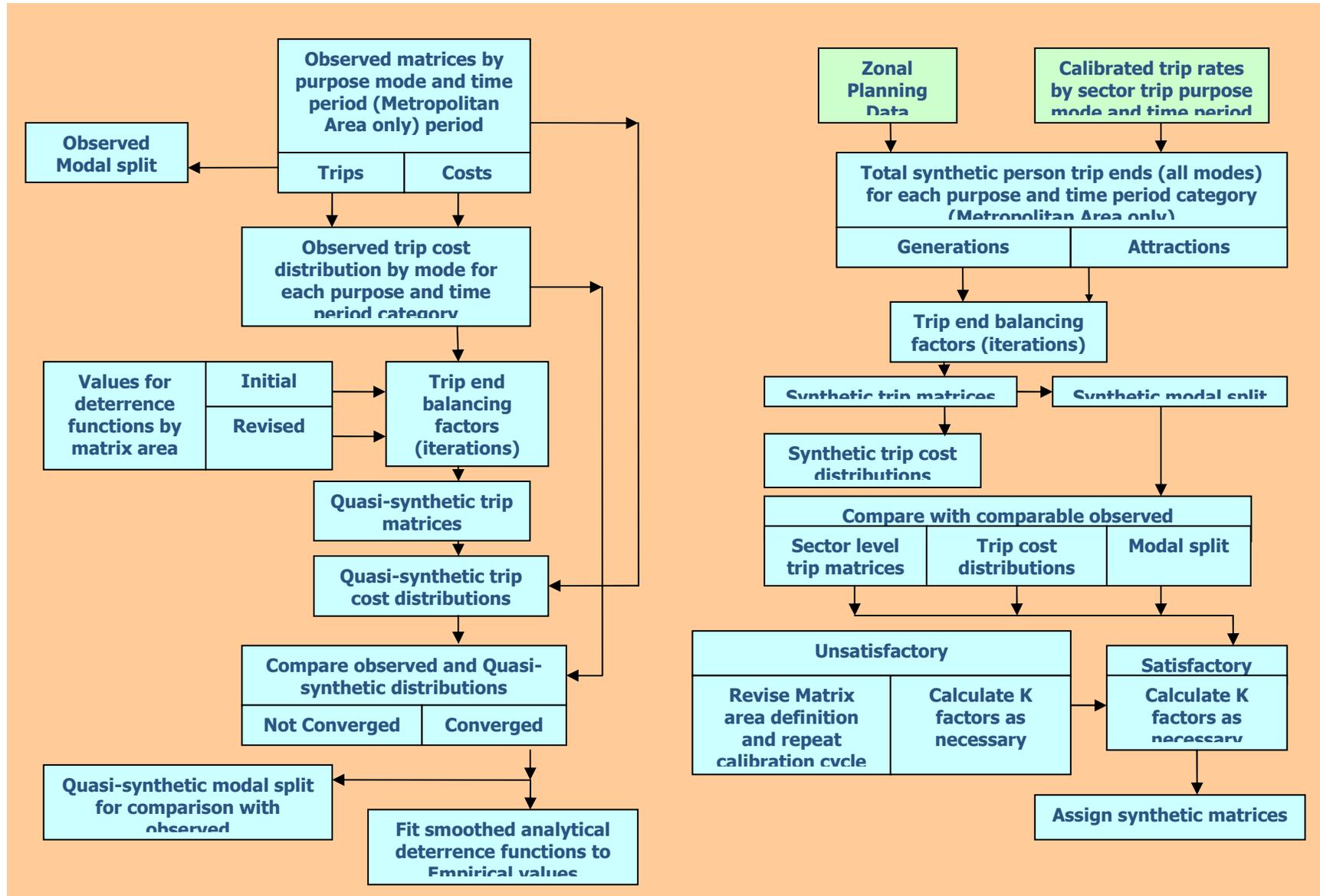


Figure 4.4 PROCESS OF TRIP DISTRIBUTION AND MODAL SPLIT

4.7.8 Approach

4.7.8.1 After successful completion of calibration and validation of observed models, the trip distribution and modal split phase were carried out jointly using a conventional doubly constrained gravity model of the form.

$$T_{ijm} = r_i G_i S_j A_j F_{ijm}$$

Where

- T = number of interzonal trips by mode m
- G = Total generation trip ends by zone
- A = Total attraction trip ends by zone
- i = Generation zone
- j = attraction zone
- r, s = balancing factors (constant)
- F_{ij} = deterrence function for mode m
- $= K_m e^{-\beta C_{ijm}} C_{jim}$

Where

- K = constant factor
- C = generalized cost of travel
- = Calibration constant – exponential function
- = Calibration constant – power function

Double constraints are imposed by ensuring that

$$\sum_{j,m} T_{ijm} = G_i \qquad \sum_{i,m} T_{ijm} = A_j$$

The form of the model in such that exponential ($\alpha = 0$) or power ($\beta = 0$) functions may be used for the deterrence function. The inclusion of both α and β represents a gamma function, sometimes called a Tanner function.

4.7.8.2 Given a matrix of intra-zonal costs and a set of generation and attraction trip ends, a gravity distribution model estimates the factor r and s automatically, leaving the calculation of the deterrence function as the main feature of the models calibration. The cost of travel between zones is associated with a deterrence function whereby the higher the intra-zonal cost, the greater the deterrence to trip making, and therefore the lower the number of trips between zones. This is the principle of the gravity distribution model.

4.7.8.3 Trip distribution models are generally run subsequently for a number of different trip purposes time periods or modes. A joint distribution and modal split model carries out this same process but for a number of different modes simultaneously. Calibration of a joint model is achieved by calculating deterrence functions for each mode as for a normal distribution model, but weighting these functions in accordance with observed modal split. The proportion of trips made by each mode is a function of the cost of travel on that mode compared with the

costs by all other modes. It is these weights which represent the different characteristics of each mode, the effects of which are not adequately determined by generalized cost variables.

4.7.8.4 Calibration constants defined by mode for each purpose and time period category are used to forecast the distribution and modal split of trip ends in conditions of changing inter-zonal costs.

4.7.8.5 This is conventional, calibrating the model on the basis of observed trip and cost matrices, and building synthetic matrices by applying the calibrated constants in forecast mode.

4.7.8.6 **Model inputs**

Trip matrices

The following observed trip matrices were input to the distribution/modal split model calibration:

- HBW, HBE & HBO trip purposes
- Whole day
- Car, two wheeler, IPT and PT passenger modes

This provides a total of 14 matrices.

Employers business and Non home based trips were not distributed, as these trips will make calibration of deterrence functions unreliable. Since small number of trips relationship between trip ends and planning data are difficult to establish. Cycles, Commercial vehicles were also excluded from distribution / modal split as these will be assigned as observed.

4.7.8.7 **Software**

The computer programme which is part of SATURN / PT-SAT is for distribution & modal split, and it includes four programs.

- D1
 - builds observed trip cost distribution
 - Calculates trip end balancing factors
 - Calculates empirical deterrence functions
 - Builds quasi - synthetic trip cost distribution
- DFIT
 - Fits smoothed analytical deterrence functions to empirical functions
- M5
 - Compares matrices from zone to sector level
- M2
 - Compares observed and synthesized matrices at the sector Level.

Calibration Statistics

Area definition

The deterrence function includes a factor K which allows different functions to be calculated, even with the same calibration constant, for different areas of the matrix that is different local areas within the study area. Here the model used a single area definition that is Bangalore Metropolitan Area, because results of a single area definition were adequate. This simplifies the forecasting procedure and makes the model more robust. The external trip ends were not distributed. This 'L' shaped portion of matrix consisting of external trips was input directly into the final synthetic matrix in different mode / purpose matrices.

Generation / Attraction

The distribution of trip ends is based on generation and attraction, rather than origins and destinations.

4.7.8.8 Input Values

Initial input values for α & β were provided as 0.07 and 0.001. This provided a starting point for distributing observed trip ends which led to convergence after 18 - 19 iterations. Within these, the cycle of calculating balancing factors generally involved between 2 - 6 iterations. An initial value of 1.0 was input for the K factors.

4.7.8.9 Intra-zonal costs

In order to ensure that complete trip cost distributions are used in the estimation of deterrence functions, intra zonal costs are required by the distribution model. These do not appear in the cost skim matrices since intra zonal trips are not assigned to the model networks. Private vehicle costs were estimated using the generalized costs, average intra zonal speeds of 15 kph for the zones in the BMA and average intra zonal trip length based on the area of the each zone.

Average intra-zonal trip length = $\text{SQRT}(7 / 22) * \text{zone area}$

- * Zone areas were calculated as part of the dis-aggregation of planning data to CTTS zonal level.

The intra zonal costs for cars, 2W, IPT and public transport for whole day were.

Cars: Travel time * Time cost

2-W: Travel time * Time cost

IPT: (Distance * Time cost) + Min. fare

PT: Less than 2 km –

(fixed fare / km) + (Waiting time + travel time) * Time cost

More than 2 km –

(Distance * fare / km) + Fixed fare + (Waiting + travel time) * time cost.

4.7.9 Calibration Statistics

The single set of calibration constants were used for distributions over the complete matrix for mode / purpose categories.

4.7.9.1 Deterrence Functions

Deterrence functions (power functions, exponential function and constant) values were identified for different purpose, mode and period. The final analytical function outputs are given in **Table 4.8**.

Table 4.8 Calibrated Deterrence Functions for both Peak and Off Peak Periods

Purpose	Mode	Whole Day		
		Power Function	Exponential Function	Constant
Work	Car	-0.55279	-0.02618	0.79802E-01
	2-Wheeler	-1.02436	-0.02280-	0.74206E+00
	IPT	-1.08434	-0.05119	0.54307E+00
	PT	-1.72920	-0.02498	0.34888E+01
Education	Car	-1.48284	-0.03640	0.12916E+00
	2-Wheeler	-1.60020	-0.01896	0.12781E+00
	IPT	-1.27244	-0.07009	0.29600E+00
	PT	-2.05416	-0.02477	0.42883E+00
Others	Car	-0.93514	-0.02995	0.64678E-02
	2-Wheeler	-1.16506	-0.04154	0.67888E-01
	IPT	-0.51559	-0.09502	0.43992E+00
	PT	-1.79569	-0.04521	0.38062E+01

- Note: 1. Observed = Observed matrices
2. Synthetic = Synthetic matrices from gravity model

4.7.10 Comparison of Total Trips

4.7.10.1 **Table 4.9** shows corresponding comparison of total trips in each purpose and mode for both observed and synthetic trips. **Figure 4.5(a) to 4.5(c)** shows the comparison of trip cost distribution for different purposes for peak period. This guarantees the close fit shown in distribution model both in total number of observed and synthesized trips and also trip cost distribution.

Table - 4.9 Comparison of Total trips by Purpose, Mode and Time Period

Purpose	Mode	Peak Period		
		Observed	Synthesised	Difference
Work	Car	303274	303865	-591
	2-wheeler	1367549	1369695	-2146
	IPT	170541	171599	-1058
	PT	840104	836409	3695
	TOTAL	2681468	2681468	0
Education	Car	76784	76991	-207
	2-wheeler	159171	157869	1302
	IPT	77663	77620	43
	PT	784871	786058	-1187
	TOTAL	1098490	1098490	0
Others	Car	9812	10196	-384
	2-wheeler	112840	112469	371
	IPT	358600	359553	-953
	PT	659697	658755	942
	TOTAL	1140949	1140949	0

- Note: 1. Observed = Observed matrices
2. Synthetic = Synthetic matrices from gravity model

4.7.10.2 **Table 4.10** also shows the comparison of observed modal split with synthesized modal split. It depicts that both the values are within 5% for each purpose and mode. Synthesized average trip costs were also close to observed values.

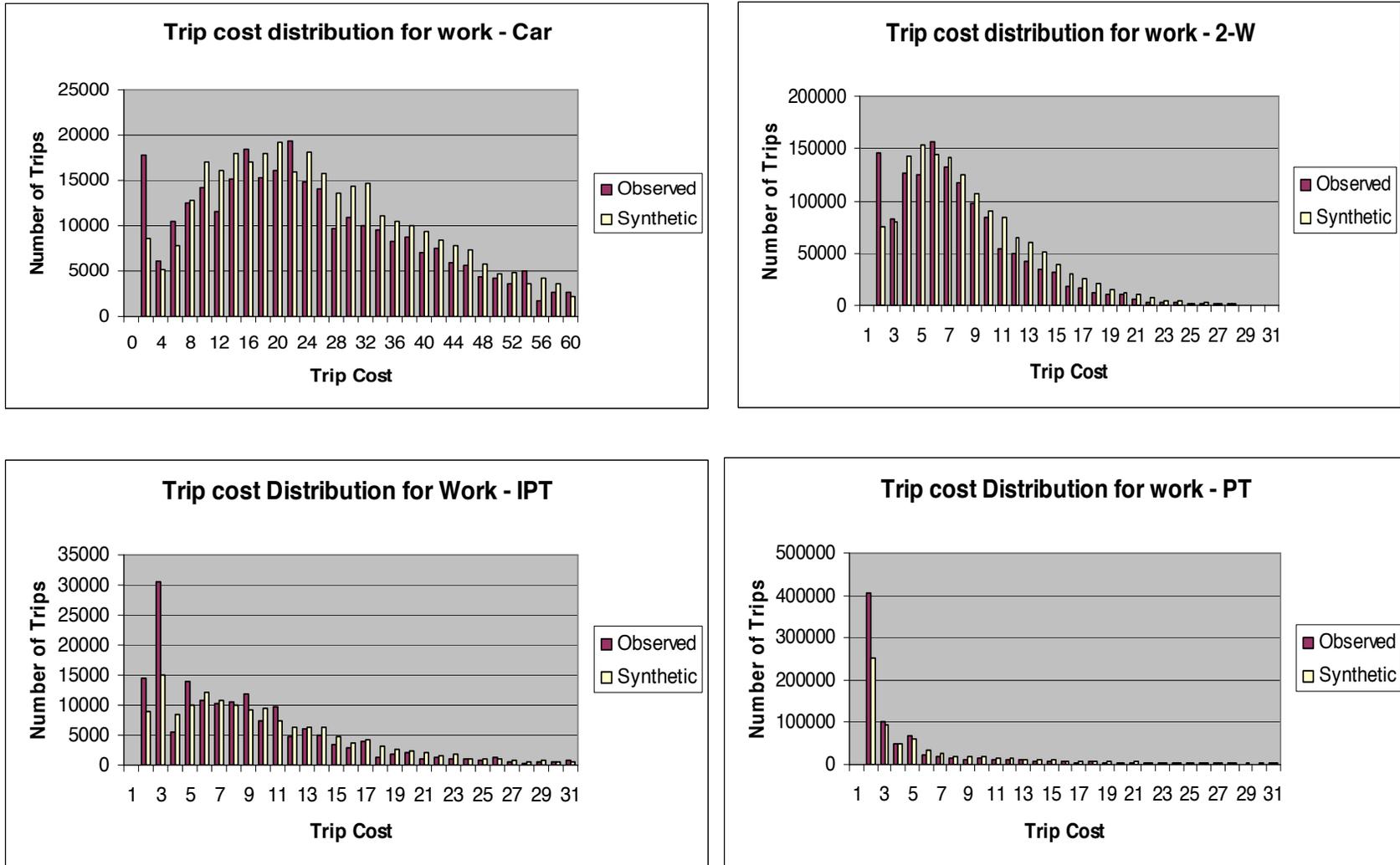


FIGURE 4.5 (a)

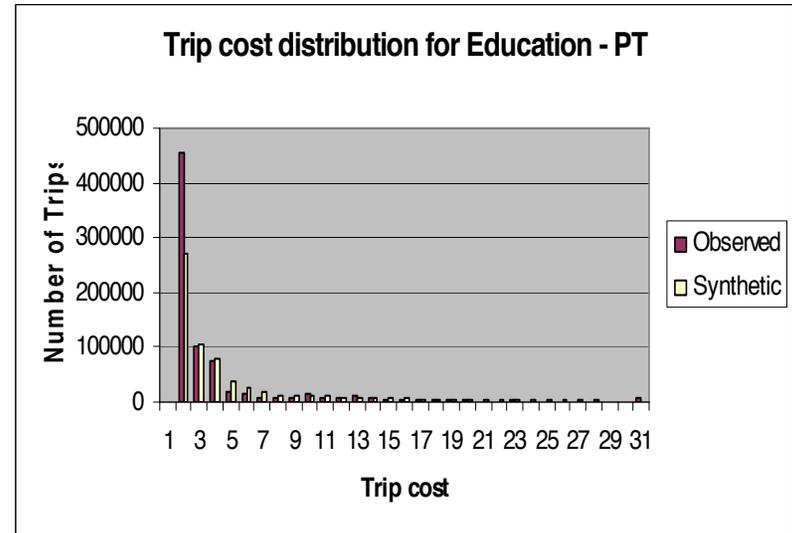
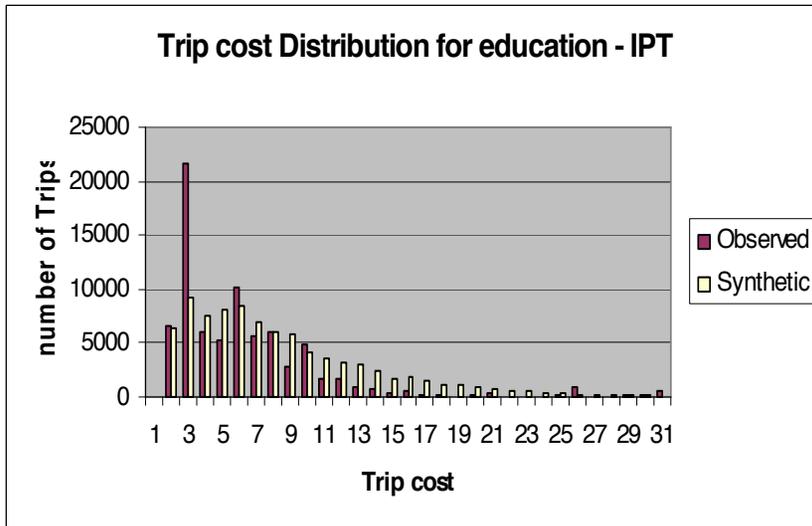
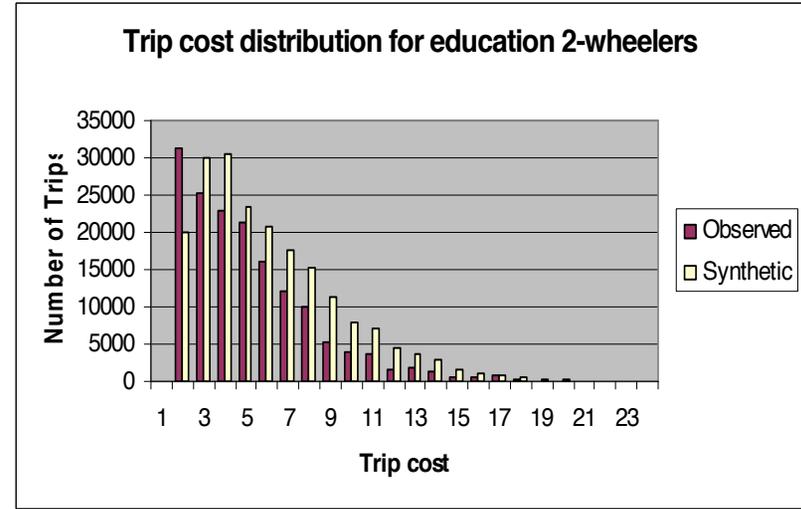
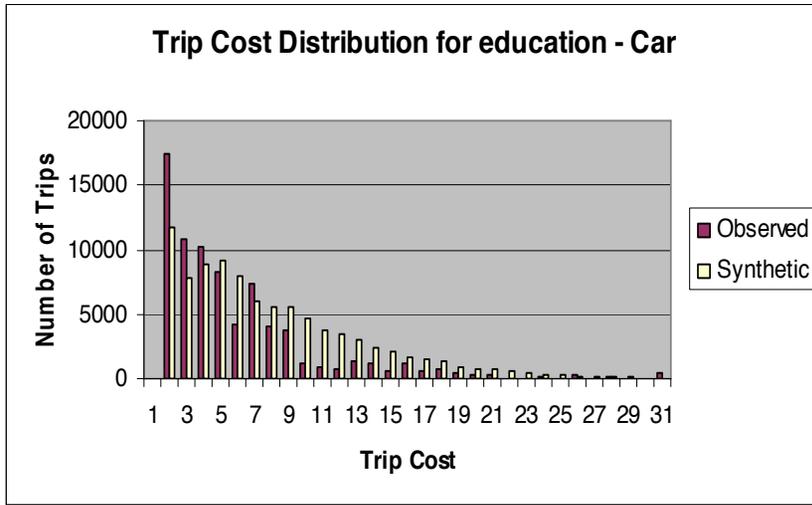


FIGURE 4.5 (b)

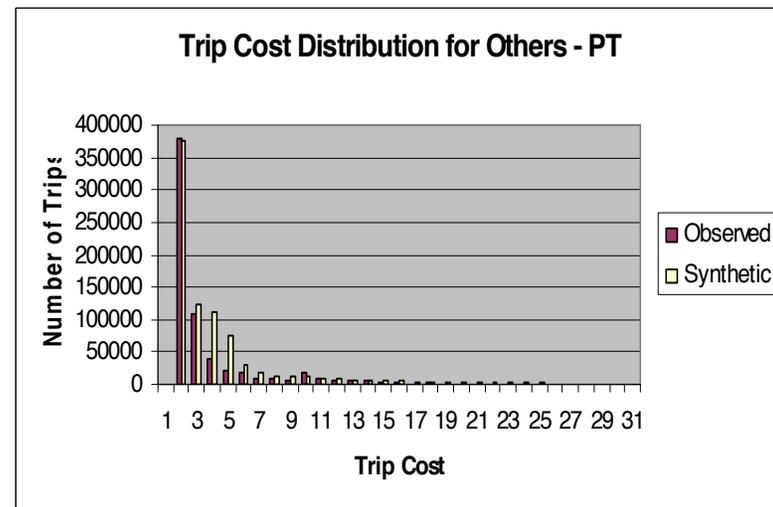
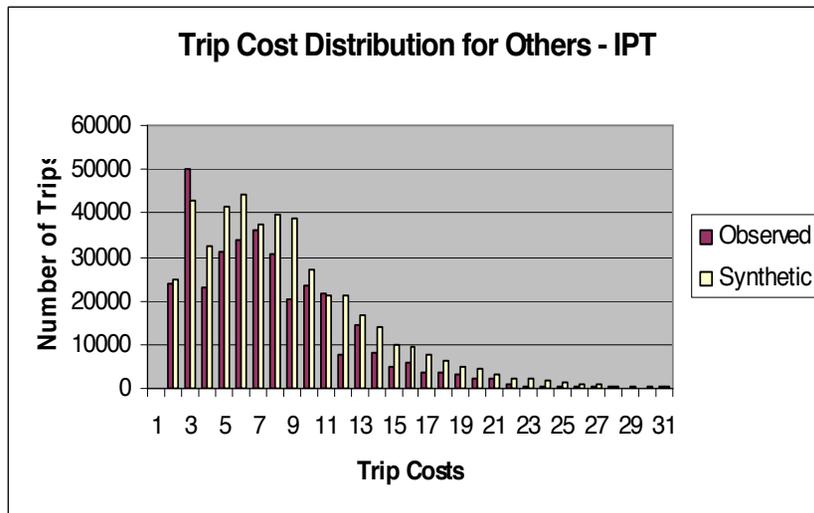
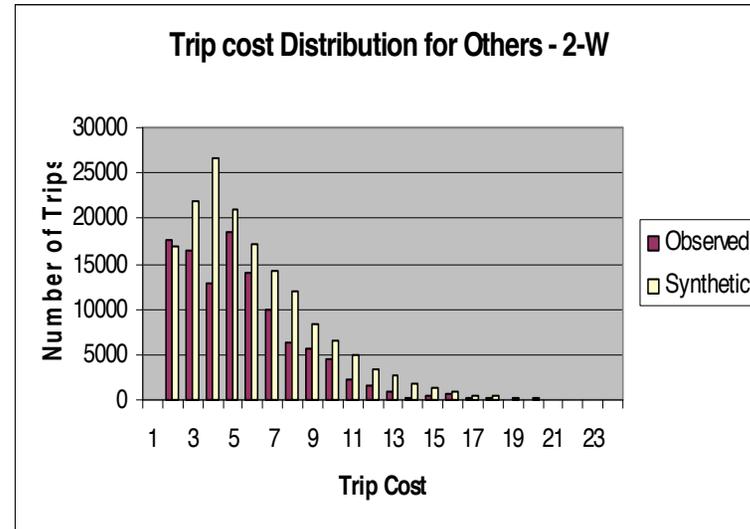
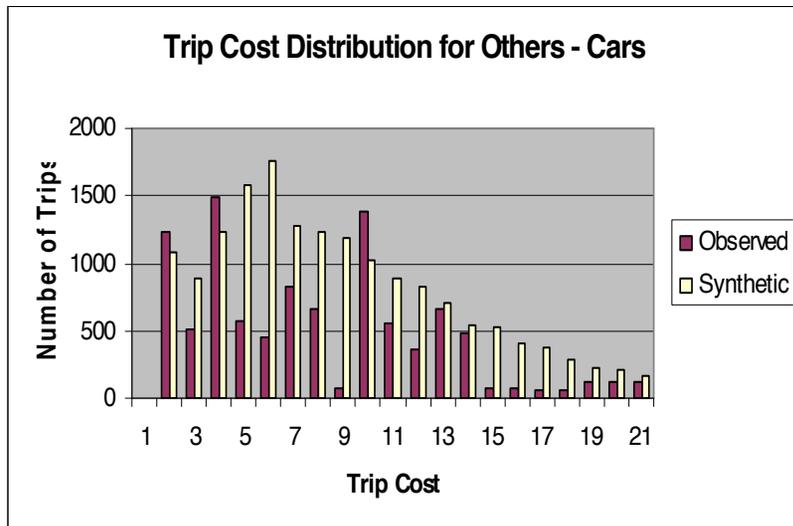


FIGURE 4.5(C)

Table 4.10 Comparison of Modal Split by Purpose and Time Period

Purpose	Mode	Peak Period	
		Observed	Synthesized
Work	Car	11.31	11.33
	2-wheeler	51.00	51.08
	IPT	6.36	6.40
	PT	31.33	31.19
Education	Car	6.99	7.01
	2-wheeler	14.49	14.37
	IPT	7.07	7.07
	PT	71.45	71.56
Others	Car	0.86	0.89
	2-wheeler	9.89	9.86
	IPT	31.43	31.51
	PT	57.82	57.74

- Note: 1. Observed = Observed matrices
2. Synthetic = Synthetic matrices from gravity model

4.7.10.3 These test results led to the following observations

- i) The detailed operational model is able to synthesize trip movements during peak and off peak period on the basis of travel costs. The travel costs are based on both value of time and out of pocket expenses. The model considers 4 different modes (cars, 2-wheelers, IPT, and public transport)
- ii) The model has been calibrated from the existing data and validated at various stages by comparing modeled and counts of traffic and passengers using public transport across screen lines. Journey times both modeled and observed are compared very well.
- iii) The model is sufficiently robust at strategic level to use for forecasting. The model has performed well at screen line levels and speeds.

4.8 CONCLUSIONS

- ### 4.8.1
- Operational transport of CTTS as developed using SATURN and PT-SATURN is able to synthesize patterns of trip movement during the whole day on the basis of travel costs. The model includes 4 modes (cars, two wheelers, IPT and public transport) and travel cost is based on value travel time and out of pocket expenses.

- 4.8.2** Patterns of movements and choice of mode are determined by a joint trip distribution / modal split model of gravity type. All other things being equal, the number of trips between any two zones will decrease as the cost of travel increases, and the number of people selecting a particular mode will decrease as its cost relative to other modes increases.

- 4.8.3** The model has been calibrated and validated from existing data by comparing modeled and counted flows of traffic and public transport passengers across screen lines.

- 4.8.4** Now the Model can be used for forecast with confidence.

CHAPTER – 5

STRATEGY FOR TRANSPORT DEVELOPMENT

5.1 NATIONAL URBAN TRANSPORT POLICY

5.1.1 The Government of India has evolved a policy to overcome the problem of poor mobility which dampens the economic growth and deterioration in the quality of life. The approach is to deal with this rapidly growing problem as also it can offer a clear direction and a framework for future action.

The vision of this policy is:

- To recognize that people occupy center-stage in our cities and all plans would be for their common benefit and well being
- To make our cities the most livable in the world and enable them to become the “engines of economic growth” that power India’s development in the 21st century
- To allow our cities to evolve into an urban form that is best suited for the unique geography of their locations and is best placed to support the main social and economic activities that take place in the city.

5.1.2 The objective of this policy is to ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents to jobs, education, recreation and such other needs within our cities. This is sought to be achieved by:

- Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement
- Encouraging integrated land use and transport planning in all cities so that travel distances are minimized and access to livelihoods, education, and other social needs, especially for the marginal segments of the urban population is improved
- Improving access of business to markets and the various factors of production
- Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus
- Encourage greater use of public transport and non- motorized modes by offering Central financial assistance for this purpose
- Enabling the establishment of quality focused multi-modal public transport systems that are well integrated, providing seamless travel across modes
- Establishing effective regulatory and enforcement mechanisms that allow a level playing field for all operators of transport services and enhanced safety for the transport system users
- Establishing institutional mechanisms for enhanced coordination in the planning and management of transport systems
- Introducing Intelligent Transport Systems for traffic management

- Addressing concerns of road safety and trauma response
- Reducing pollution levels through changes in traveling practices, better enforcement, stricter norms, technological improvements, etc.
- Building capacity (institutional and manpower) to plan for sustainable urban transport and establishing knowledge management system that would service the needs of all urban transport professionals, such as planners, researchers, teachers, students, etc
- Promoting the use of cleaner technologies
- Raising finances, through innovative mechanisms that tap land as a resource, for investments in urban transport infrastructure
- Associating the private sector in activities where their strengths can be beneficially tapped
- Taking up pilot projects that demonstrate the potential of possible best practices in sustainable urban transport

5.2 GROUND REALITIES VS URBAN TRANSPORT POLICY

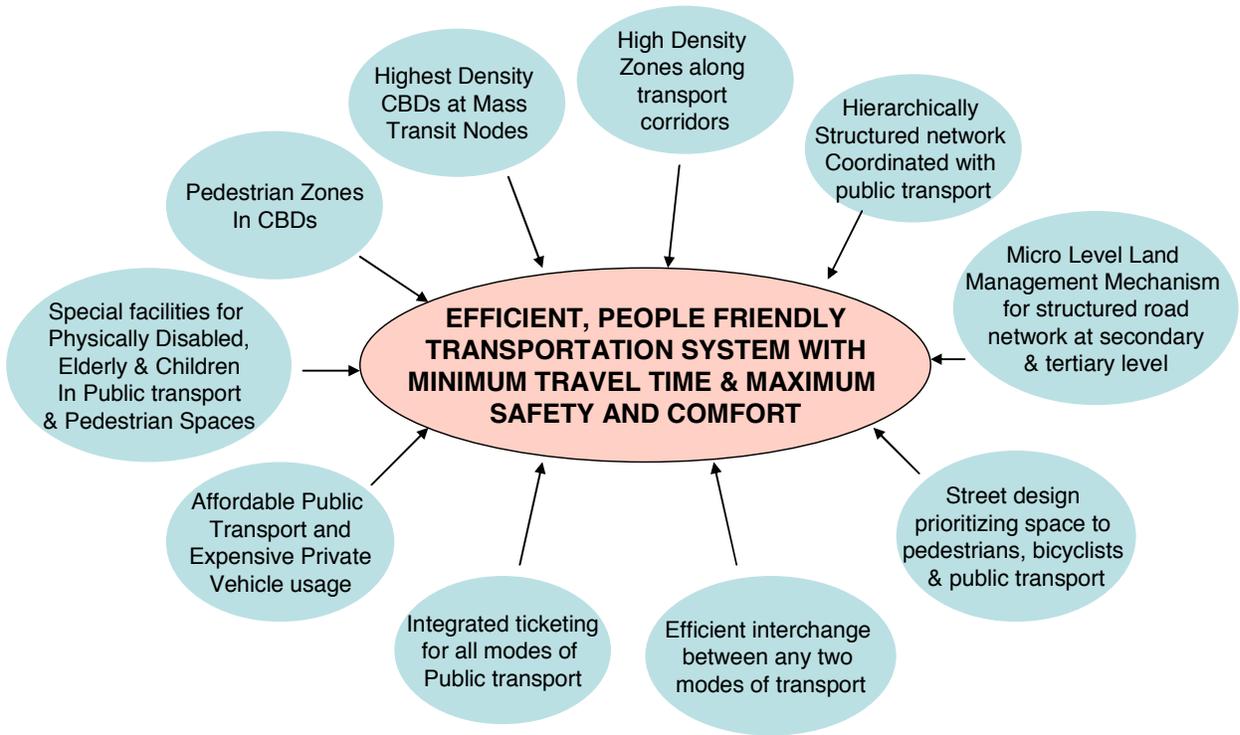
- i) The urban planners do consider the transportation as an important parameter, but the growth of the city has been so fast that the inadequacy sets in too fast to enable any possible review and taking remedial measure.
- ii) It is very much essential to carry out integrated land use transportation planning. However, as part of the study, the possible implications of the proposals on land use in some areas and recommendations for necessary changes in policy have been included. It is also proposed to test impact of densifying measures around MRTS stations. But such measures will require major policy change and practicability and implications of same will need to be studied.
- iii) Transport planning in the last two decades in BMA has been oriented towards developing a mix of public transport but funds have been a constraint. Despite same, a 36 km metro line has been taken up and the bus transport has been providing more and more services, which is indicated by the fleet growth and increased passenger trips.
- iv) Share of walk and cycle trips in Bangalore have been comparatively low in Bangalore even earlier. Non motorized trips share has been going down. Apart from non availability of cycle tracks on roads, increased trip lengths for almost all purposes may have caused this fall.
- v) The current policy has been more road oriented. The fast growing economy and higher per capita income has resulted in high vehicle ownership and usage. The roads in the core area getting congested and land cost mechanism has encouraged more of peripheral growth, increasing urban sprawl. This has resulted in longer trip lengths for all purposes.

5.3 VISION

- ### 5.3.1
- With this background, it is desirable to have a vision be developed before considering different alternative strategies. A vision by definition is 'a vivid image produced by the imagination'. A Transport Planner's vision for the city and

metropolitan area is to see ‘a well contained city with efficient people–friendly transport system with minimum travel time & maximum safety and comfort’. At the same time the facility provided should be optimally used. The different actions which have to contribute to this vision are diagrammatically represented in **Figure 5.1**.

Figure 5.1 Vision for Transportation and Associated Actions



The diagram above paraphrases what we would like to see when we look at Bangalore ten years from now. In order to achieve this, an integrated land use–transport strategy is called for. Preparation of such a step is diagrammatically indicated in **Figure 5.2** below.

Figure 5.2 Integrated Landuse Transport Strategy for Bangalore

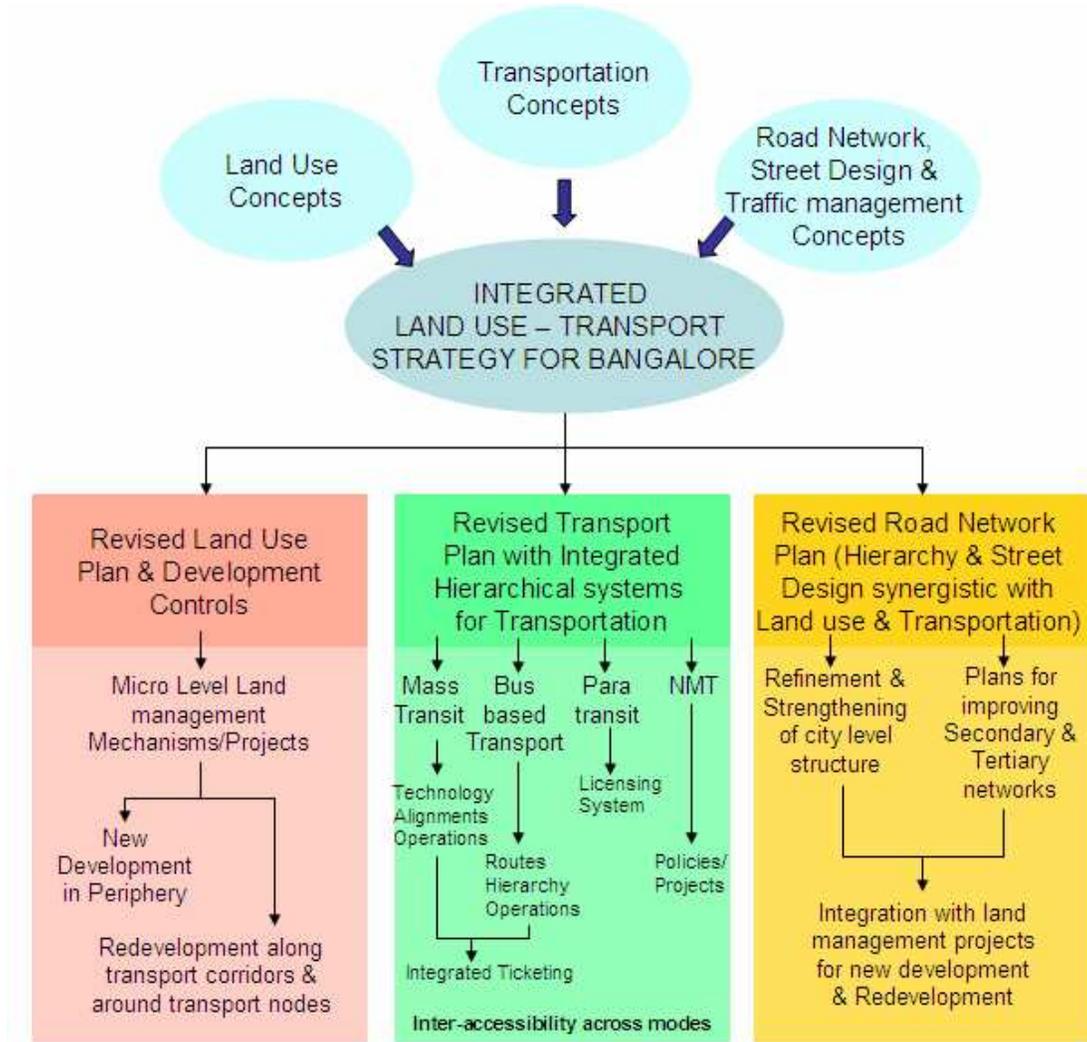


Diagram source: Balachandran and Sowmya Haran

5.3.2 The Road Map (Strategies)

Considering the status of progress in various fronts that have already been initiated in Bangalore, the road to an integrated urban transportation strategy is fraught with difficulties. The process is bound to be messy and will appear costly in terms of time, money and effort to be invested in such an exercise. However, the COST OF NOT DOING THE INTEGRATION is far higher than that of doing it and the resultant situation, if the integration is not done, will be far more messy than the process of doing it. Therefore the following initiatives are recommended.

5.3.2.1 Integrated land use – transport strategy

A team consisting of both urban planners and transportation planners and preferably led by an urban planner with a holistic understanding of urban

transport issues should put together an integrated land use – transport strategy for Bangalore. This strategy should incorporate modern concepts in land use planning, urban transportation planning road network planning and street design in a mutually complementary manner. Such an approach necessarily means that the team should review the city's Master Plan as well as plans relating to mass transport and road network improvements.

A strategy such as this will have no statutory backing as such. Therefore if this strategy is to be taken seriously then it should be mandated by an overarching body which has sway over all the stakeholder organizations. No such body exists as of today. A Unified Metropolitan Transport Authority has been mooted on many occasions. Even such a body would leave out land use planning. Therefore the possibility of an **Integrated Land and Transport Management Authority for Bangalore** may be considered to mandate the preparation and operationalization of this strategy.

5.3.2.2 Revised Land Use Plan and Development Controls

The land use and density component of the above strategy can be operationalized only through revisions in the Master Plan. High traffic generating activities and high density (high FSI) zones should be realigned around mass transport nodes and along major transportation corridors.

Such a reorganization of land use and density cannot be realized only through the modifications in the Master plan. In already developed areas, this needs to be translated into projects for planned redevelopment, ensuring that the high density and high intensity of activities are supported by appropriating land for improvements in the road network, street design and supporting infrastructure. The energy for redevelopment already exists in the real estate market in Bangalore, and will receive further impetus from the implementation of mass transport projects.

In new growth areas, a mechanism for micro-level planning (such as Town Planning Schemes in Gujarat) will need to be introduced to ensure that all new development is adequately served by primary, tertiary and secondary road network with provision for public transport facilities. These would also essentially have to be translated into land management projects.

5.3.2.3 Road network and street design

Having articulated the approach to road network planning and street design in the Strategy document, the primary road network proposals in the Master Plan should be modified appropriately. In many places, particularly in the already developed areas, these modifications can be realized only through carefully structured redevelopment projects as the missing links in the primary road network will have to go through existing development.

In the case of the secondary and tertiary level roads, as explained in the previous section, the improvements in developed areas, in many cases, will have to be achieved through planned redevelopment. In the new growth areas these have to be part of proactive land management initiatives.

Street design has to be standardized according to the hierarchical level and function of a street and customized according to local conditions. On all BRTS roads, the street design of extremely high importance. In the areas surrounding a mass transport node also, street design has to enable easy access of pedestrians, bicyclists and para transit passengers to the mass transport facility.

5.4 OBSERVATIONS

The important observations are as following, which will now guide the strategy for development.

1. The City though claimed to be compact in the basic premise, is actually quite wide spread – The development area of more than 800 sq km, to accommodate around 1 Crore persons by 2015/20 as per Master Plan 2015. Thus, a multi-modal system with a fairly large coverage will be required.
2. Pockets of economic activities like Hi-Tech & Electronic city having very large employment potential are planned. Of course a large part of the human resources to be engaged in these activities is expected to come from within BMA but quite a large no. is also to be expected from the Bangalore Metropolitan Region & even from towns like Hosur, Tumkur, etc. This will require special High capacity mass transport system connecting these work centres with the living areas within Bangalore as well as meeting the needs of the long distance / suburban commuters, especially along the corridors leading to these centers.
3. The present radial network is bringing the entire load of traffic to the ORR & core areas causing congestion. The trend needs to be stopped through :
 - Dispersal of traffic at the periphery by completing the PRR, & the other Ring Roads planned at the Regional level like the Intermediate Ring Road & Satellite Town Ring Road.
 - Creating Transport Hubs for goods traffic and the junctions of PRR & selected Radials
 - Banning the entry of Heavy vehicles at the Transport hubs & allowing only LCV to transport the goods from the Transport Hubs to the inner city areas and that too during the non-peak hours (i.e. No Entry between 9 A.M. to 9 P.M.)

4. The master plan proposal of having Mutation Zones along practically all the radial corridors would require some sort of mass transport system along them.
5. The core areas inside the core ring road are proposed to be fully traversed by the Metro. Therefore the vehicular movement inside this area should be minimized & if possible completely avoided during working hours for 9am to 9pm through:
 - Complete pedestrianisation of narrow commercial streets.
 - Providing adequate parking along the CRR and running dedicated BRT on the lower level of the CRR and restricting all private vehicles on the elevated portion thereof.
 - Smooth & free flow of emergency vehicles like Ambulance, Fire Engines etc in side the core area.
 - The goods feeder services like LCV be allowed to come in only doing 9PM to 9AM to unload materials etc.
 - Attempts may be made to decentralize certain trades requiring bulk carriage like heavy machinery, hardware, building material etc in organized markets beyond the ORR and preferably near the PRR.
 - On a few of the wide roads inside the core area the feasibility of running BRT etc. may be examined.

5.5 THE PREFERRED STRATEGY FOR TRANSPORT DEVELOPMENT

Based on the above observations it is clear that the already planned network will be insufficient to cope up with the future requirements especially after the target year of 2015. As such in order to prepare the Comprehensive Transport Plan the following policy measures are required to be taken based on which the CTTP will be finalized.

1. Extension of mass transport system to provide wide coverage and interchange facilities with other modes of transport.
2. Provide substantially large network of medium level mass transport system such as BRT to cover the areas beyond the Metro network and on over loaded corridors.
3. Landuse adjustments and densification of corridors along mass transport corridors where possible.
4. Extension of commuter rail system upto the BMRDA's New Townships & beyond upto Tumkur, Hosur etc. to act as sub-urban services.
5. Introducing BRT and wherever possible dedicated bus lanes
6. Rationalisation of Local Bus system and its augmentation.
7. Improvement in traffic management through TSM measures.
8. Special facilities for pedestrians within the entire network specially in the core areas ; pedestrianisation of selected shopping streets in side the core area

going to be served by Underground sections of Metro. Provision of pedestrian sky walks, under passes, footpaths and other road furniture along the roads where necessary.

9. Diverting through traffic on Peripheral Ring Road. Providing transport hubs at the junctions of Peripheral Ring Road with important radials such as; the National Highways and other heavily loaded roads.
10. Improving Primary, Arterial and other important roads by providing grade separation, junction improvements, adding missing links, widening and other road side facilities wherever necessary. The Arterial roads outside the PRR need to be improved upto the New BMRDA townships in order to take the increased load of commuters.
11. Transport integration of various modes.

CHAPTER – 6

FUTURE DEMAND ANALYSIS AND SYSTEM SELECTION

6.1 FUTURE GROWTH SCENARIO

6.1.1 Revised Master Plan–2015 for the BMA has been published. This document gives the likely growth to take place in various areas of the BMA. The population of the BMA is expected to grow from 61 lakh in 2001 (70 lakh in 2006) to 88 lakh in 2015 and 122 lakh in 2025. The plan also gives locations of various land uses such as residential, commercial, industrial, IT uses etc. This has already been explained in Chapter 1.

6.1.2 The proposed growth of population and economy is expected to generate high travel demand. As per travel demand modeling exercise, daily travel demand is expected to grow from 57.2 lakh person trips in year 2006 to 127 lakh in year 2025. Thus while population is expected to become 1.74 times in 19 years, the travel demand is likely to become 2.25 times. Similarly inter-city travel demand from/ to Bangalore and through traffic are also expected to more than double of present levels. Transport network will also need to be augmented to cater to the expected travel demand. The present chapter examines some transport scenarios to meet the travel demand and recommends the best scenario.

6.2 DO MINIMUM SCENARIO

6.2.1 The conventional approach is to assume a ‘Do nothing’ scenario in respect of transport facility development and assess what the problems would be with the expected growth of population and trip generation towards horizon year. But this is not considered realistic since some committed and sanctioned schemes of road-widening, provision of grade-separators etc would nevertheless be carried out as is being done at present. Otherwise dynamism of growth will be lost. The scenario that will be available by the horizon year therefore would be a ‘Do minimum’ situation with some of the committed schemes of road capacity augmentation implemented. The base year network was updated by including identified committed road and public transport schemes to form the forecast Do minimum network which includes

- a. Base year network with proposed road capacity augmentation.
- b. Changes to bus frequencies to keep up with increase in demand generally

6.2.2 Having achieved satisfactory validation of base year transport model, forecast year model for 2025 was set up with changes in population and other changed scale economic factors and also minimum network changes for peak and off peak. In each case, iterative procedure goes through a series of network skims, trip distribution / modal split runs to produce synthetic trip matrices, subsequent