Kochi Metro Rail Ltd.

Final Report

Ridership Updation of Kochi Metro and Impact on Pollutants

CDM Smith

December 2013

DISCLAIMER

"The present study cannot be construed and be substituted as an investment grade study to secure project financing. Professional practices and available procedures were used in the development of the study findings. However, there is considerable uncertainty inherent in future traffic prediction and reduction in carbon emission forecasts for any Mass transport facility due its dependence on future planning assumptions and master plan predictions. These differences could be material. It should be recognized that traffic and revenue forecasts in this document are intended to reflect the overall estimated long-term trend and not for year on year comparison as for any given year, it may vary due to economic conditions and other factors.

The report and its contents are confidential and intended solely for use for the study project. Any use by third parties for use or for publication without the express written consent of CDM Smith is prohibited.

LIST OF ACRONYMS

LNG: Liquefied Natural Gas

GDP: Gross Domestic Product

KMRL: Kochi Metro Rail Limited

GCDA: Greater Cochin Development Authority

IT: Information technology

VOC: Vehicle Operation Cost

VOT: Value of Time

FACT: Fertilisers and Chemicals Travancore Limited

TELK: Transformers and Electricals Kerala Limited

NH: National Highway

KSRTC: Karnataka State Road Transport Corporation

JNNURM: Jawaharlal Nehru National Urban Renewal Mission

IPT: Intermediate Public Transport

CAGR: Compound Annual Growth Rate

LPG: Liquefied Petroleum Gas

ICTA: Institute for counselling and Transactional Analysis

JLN: Jawahar Lal Nehru

KSEB: Kerala State Electricity Board

CUSAT: Cochin University of Science and Technology

MG: Mahatma Gandhi Road

ICT: International Container Terminal

SA: Sahodaran Ayyappan Road

RBI: Reserve bank of India

HMT: Hindustan Machine Tools

LIC: Life Insurance Corporation of India

DPR: Detailed Project Report

LCV: Light Commercial Vehicles

PCU: Passenger car unit

IRC: Indian Roads Congress

KMPH: Kilometers Per Hour

PIA: Project Influence Area

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1. CHAPTER

INTRODUCTION

1.1 Background

Kochi, the commercial hub of Kerala, is already experiencing signs of urban growth pressures. As per World Bank, Kochi is recognized as one of the seventeen major industrial cities of India and an easy city to start business in India. This decade is witnessing huge investments in the region like International Container Transshipment Terminal at Vallarpadam, Info park at Kakkanad, Special Economic Zone by NEST, LNG terminal, Electronic hardware park. Among the districts, Ernakulum district contributes the highest portion (14.47%) of Kerala's GDP. Being a centre of excellence of education and a destination for major industries and establishments like High court, Stock exchange, Kochi shipyard, Spice board etc. attract significant floating population form the neighboring districts for their livelihood. In addition to this, Kochi has been emerged as a major tourist destination to domestic as wells as international tourists. Recently opened mall by Lulu group has multifolded the number of visitors in the city.

Urbanization has been observed as a new phenomenon with a quickening pace in the last 15 to 20 years. Kochi Corporation with a population of 602046 in 2011 (Census 2011) will grow at an annual growth rate of 1.0% during 2011-2031 (Development Plan for Kochi city region-Draft (2031)). Kochi city region comprising two municipalities and surrounding local bodies with an area of 369.72sq.km will carry a population of 22.73 lakhs by 2031 (Development Plan for Kochi city region-Draft (2031)). Roughly 68% of the population, compared to about only 48% in 2001, lives in urban areas in the Ernakulum district which is far beyond the state average. The urban population in Ernakulam is presently estimated to increase 4.2% annually.

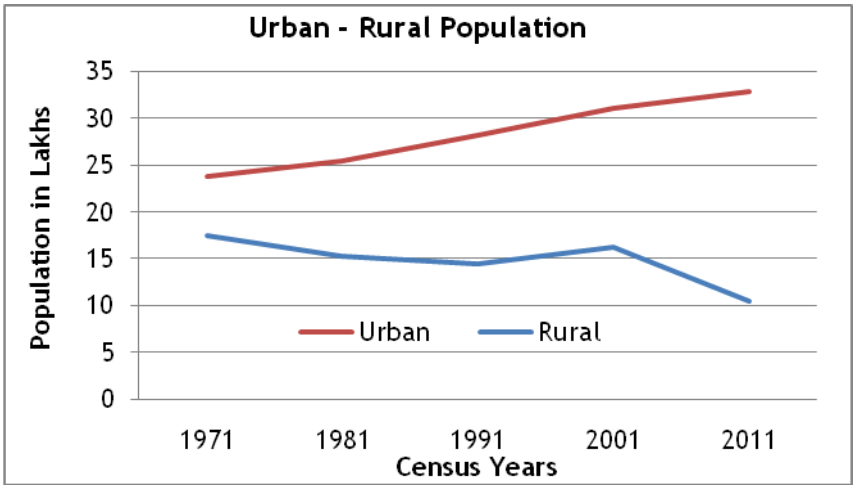


Figure 1.1 Urban Growths Trend in Ernakulum

(Source: Census of India)

The vehicle growth in the Ernakulum district is significant with 9.85 lakhs registered vehicles as of July 2011 (Economic Review 2012) with an average household vehicle ownership of 1.35. Seventy percent (83%) of all vehicles are privately owned, namely cars and two wheelers.

The buses run by private operators and Kerala State Road Transport Corporation (KSRTC) accesses most of the developed areas within the city. However, there is a need to improve the operation by introducing eco-friendly buses, passenger information system and improve facilities at the bus stops and access to the bus stops.

Traffic problems in both the cities have been created by the growth of motor vehicles and also the absence of a quality public transport system to cater to large intra city demand. Residents thus opt for personalized mode of transport to sustain the growing economic activities.

In this context, Kerala Govt. has assigned Delhi Metro to carry out a detailed project report for Kochi metro project for the corridor between Aluva-Petta (25.6 kms) during 2006. The study has carried out the ridership projections for a period of twenty years. In order to update the projections, KMRL has mandated CDM Smith to carry out a traffic study and support the client in estimating the impact of pollutants during the construction and operation period.

1.2 Objective & Scope of Work

KMRL has hired CDM Smith to carry out a traffic updation study for the corridor between Aluva-Petta (25.6 kms) and the impact of pollutants in the city with the introduction of metro in Kochi. The study area include Kochi Corporation, six Municipalities, thirty five census towns and villages (12nos) in the peripheral area of the corporation which constitute to the Greater Cochin Area administered by Greater Cochin Development Authority (GCDA). The delineation is based on the observed travel pattern in the project corridor and the expected urban sprawl in the future. Figure 1.2 presents the Kochi urban area limits.

Scope of services:

The scope of study includes:

- Present traffic (mode wise) along the metro alignment
    - Public transport (i.e. buses operated by private or public operators, rick-shaws, taxis etc.)
    - All other modes (Lorries, private cars, private motorcycles, etc.)
    - Primary traffic surveys
        - Road Network Inventory
        - Screen Line and Cordon Traffic Counts
        - Passenger Count Survey at Rail Terminals
        - O-D Survey at cordon locations
        - Midblock Traffic Counts + OD

- Opinion Survey at Bus/Rail Terminals

o Secondary data collection and past study reports

- Ridership estimation for the metro service for the section, Aluva-Petta for the Horizon years 2018, 2033, 2048
- Future traffic (mode wise) along the metro alignment for the Horizon years 2018, 2033, 2048
- Forecast of reduction of carbon emissions along the metro alignment from 2018 to 2048
- Information about multimodal integrated approach with buses, boats and rick-shaws and about integrated ticketing linked with metro development.

Figure 1.2 gives study area of Greater Cochin Development Authority (GCDA)

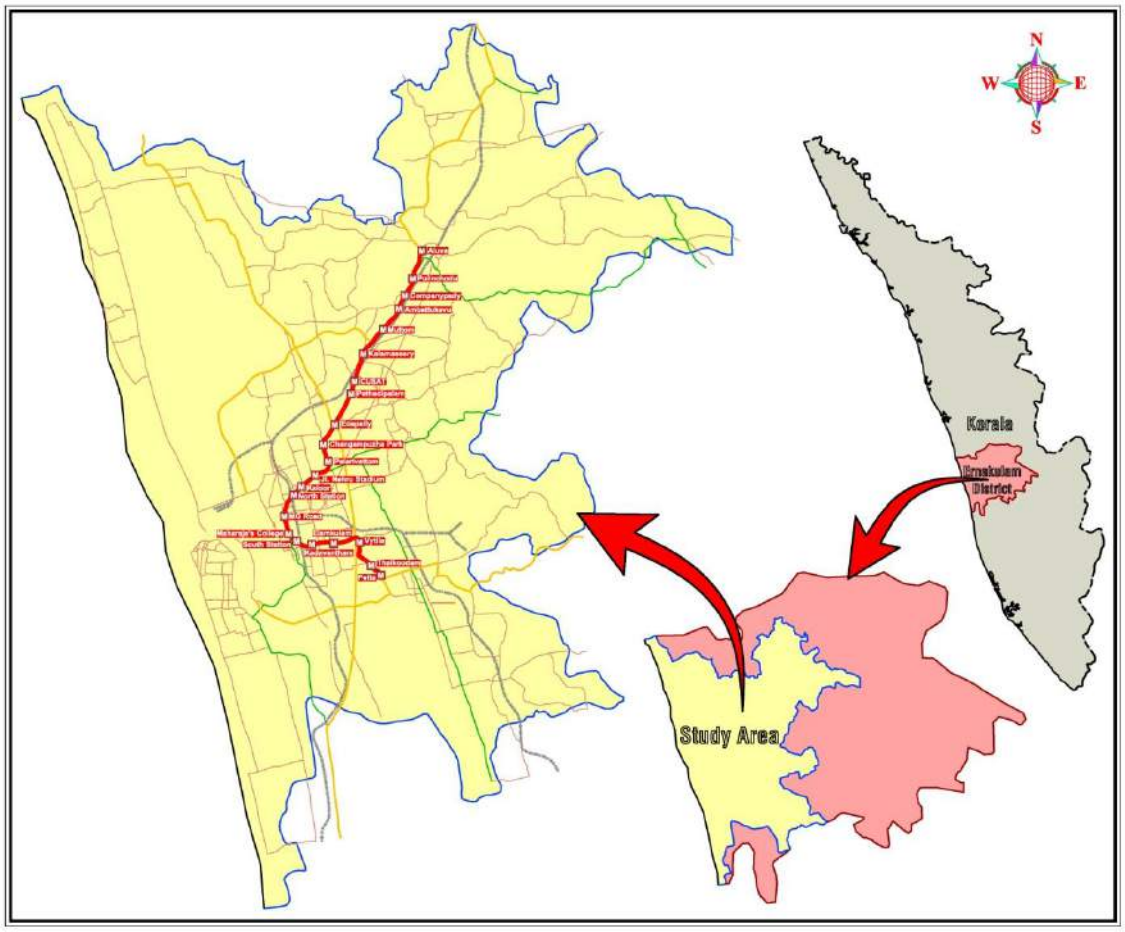


Figure 1.2 Study Area (GCDA)

1.3 Purpose of the Report

The present submission is a Final report. The purpose of this report is to outline the approach, methodology and techniques used in the data collection and analysis and the interpretation of the present traffic scenario for the Kochi city. The intent is to provide a clear understanding of the full range of activities that have been undertaken in the data collection stage for the updation of transport model for Kochi.

1.4 Organisation of Report

The report is set out as follows:

- Chapter 1 provides the background of the study, purpose of the report, the objective and scope of the study and the organization of the report.
- Chapter 2 details the approach and methodology in updating the transport model for the study area through huge dataset and development of database.
- Chapter 3 presents the Kochi City profile and describes the existing transport infrastructure in the city.
- Chapter 4 presents the primary data collection and analysis.
- Chapter 5 portrays the traffic characteristics, the land use along the proposed metro rail corridor and the operational characteristics of the metro system.
- Chapter 6 presents the ridership estimation
- Chapter 7 details the carbon emissions during metro construction
- Chapter 8 presents the conclusion of the study

2. CHAPTER

APPROACH AND METHODOLOGY

2.1 General Approach

A systematic approach has been adopted in developing a firm methodology for the ridership estimation of proposed metro rail project in Kochi. Prior to firming up the methodology, the team reviewed various past studies carried out in the transportation sector in Kochi. In addition, relevant suggestions given by the client has been incorporated in the methodology.

The general approach to carrying out the study is along the following lines:

- Close liaison with the client
- Application of the most advanced, appropriate and well established methodologies during the study
- Use of the latest version of CUBE, a widely used transport demand modeling software, for the updation of the model
- Adherence to codes and guidelines, Development Plan provisions, planning regulations and the latest development guidelines
- Close adherence to study time period by scheduling and monitoring during the study

The following software applications have been employed for this study:

- CUBE : For urban transport modeling
- CAD : For production of drawings

CDM Smith has used software programmes developed and tested in-house for the purpose of data analysis of various traffic surveys such as traffic volume counts, road side interviews, and opinion surveys.

2.2 Study Methodology

For the fulfillment of the study objectives, the study is divided into the following tasks taking into consideration the time and budgetary constraints. These tasks are the major activities which are interlinked with each other. The activities are detailed out in the subsequent chapters.

Task 1: Mobilization and Reconnaissance and collect information from secondary sources

The task included the mobilization of both human and material resources, involving the establishment of the project facility and allocation of staff and material resources to the site. The kick-off meeting with the client served the following purposes:

- Introduction of CDM Smith team
- Established general communication and project progress reporting procedures
- Established co-ordination mechanism between different agencies involved

- Reviewed and assessed project needs and CDM Smith's approach and methodology

CDM Smith staff went on a site visit to appreciate the overall transportation scenario, the issues, and bottlenecks in the transport system in the study area focusing key on the project corridor. Based on the site reconnaissance and review of past reports, consultants designed a gap assessment to choose the methodology and final data collection plan for the entire study.

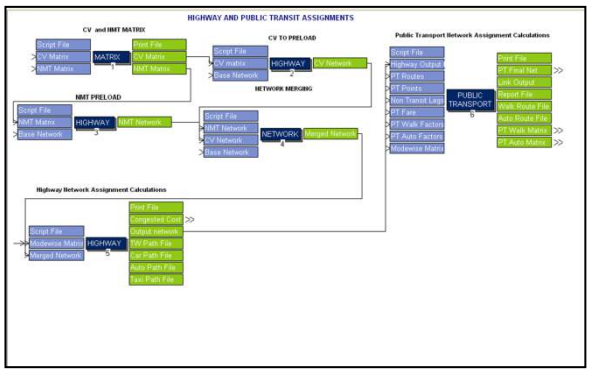
Task 2: Data Collection and Analysis

This includes the delineation of study area, the development of the zoning system and network, the collation of socioeconomic indicators for the study area, the establishment of present travel patterns by means of traffic surveys, and finally the processing of the data.

Task 3: Updation of Urban Transport Model

We have developed an urban transport model for the ridership estimation study for the Kochi metro. Following with the review of the assumptions on the various inputs and variables in the model, the necessary modifications will be done on the same. The model will be revalidated with the fresh screen line/outer cordon and mid-block volume.

The assigned traffic volume will be compared with the observed traffic counts on screen lines to find that the validation is within a tolerance limit of less than 15%. Once the validation is within the acceptable limit of ±15%, the calibration of the model parameters will be done with the validated OD matrices, generalized cost and the respective socioeconomic data at the zonal level. The validation will also be done for the speeds on the existing highways where urban rail project is proposed.



Synthetic validation: Synthetic trip ends will be estimated using the calibrated trip end equations. Synthetic trip matrices will be developed by the calibrated distribution cum mode choice parameters. These synthetic matrices will be compared with the observed matrices. Once the difference between the synthetic traffic volume and the observed volume at the screen line is within a confidence range of 15%, the model is ready for the forecasting purpose.

Task 5: Travel Demand Forecast and Ridership Estimation

Government of Kerala has been in the process of establishing new investment opportunities through policies in sectors such as IT, Hardware Industry etc. in the study area. New policies have attracted recent investment into the city and to account for the impact of development in transport demand, the study area included these planned developments. This step explored the existing land use and the growth trends based on the Development Plans to establish the transport

demand due to the same. This step establishes the socioeconomic projections along the corridor and at proposed transit access points.

With the transport proposals and the forecasted socioeconomic indicators in place, the mode-wise travel demand will be predicted with the help of calibrated trip end, trip distribution and mode choice models for the given horizon years. The assumptions used in the horizon years include the network, the cost parameters like VOC, VOT, speed of the systems and fare.

The calibrated model will be used to test the "Do-Nothing "and "With Project" scenarios to establish the ridership and comparative modal splits. Finally, for each of the scenarios, the following outputs will be extracted.

- Desire line estimates
- Passengers per hour per direction
- Daily ridership
- Station-wise boarding and alighting
- Passenger kms/Passenger hours
- Vehicle kms/hours
- Fuel consumption
- Occupancy Trend
- Reduction in carbon emissions

The study methodology is shown in the Flow chart below.

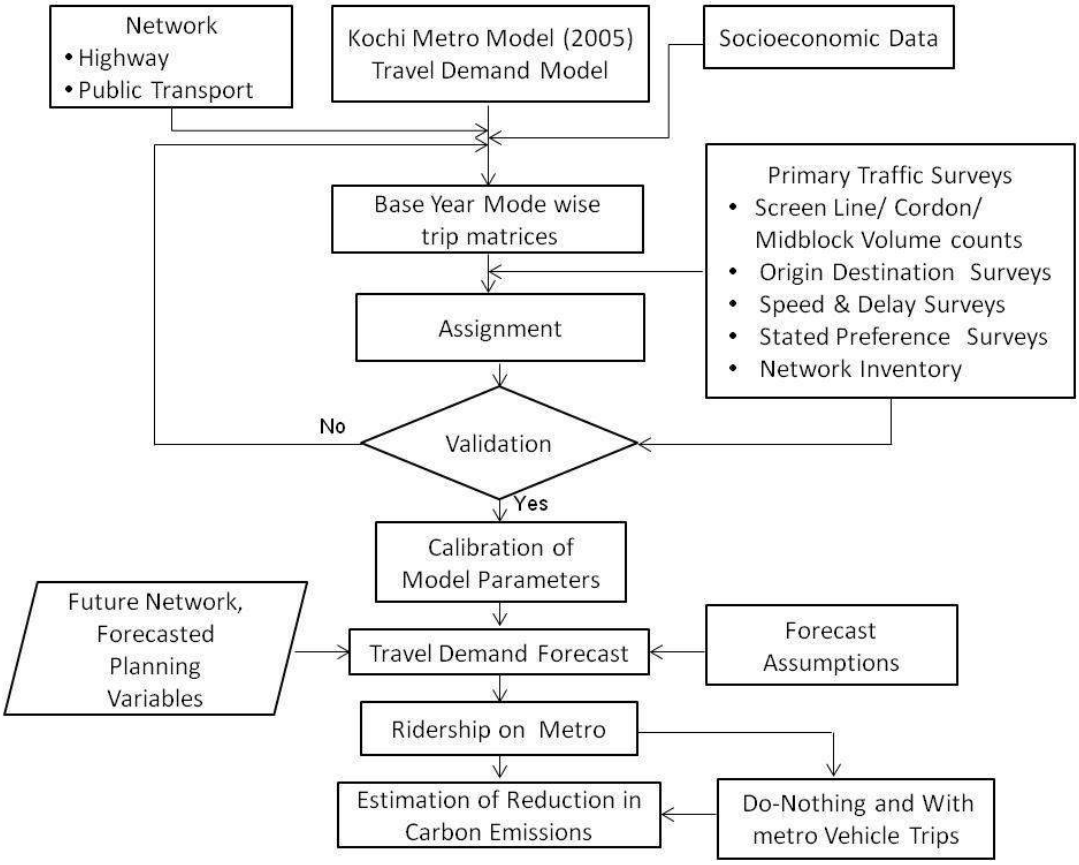


Figure 2.3 Study Methodology

3. CHAPTER

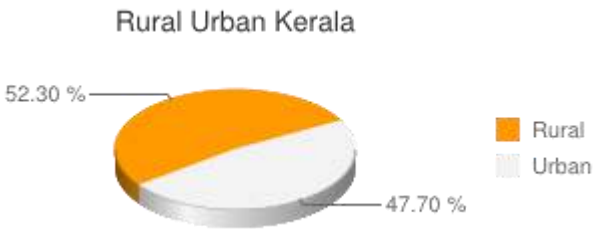
CITY-PROFILE

3.1 Socio-Economic Characteristics

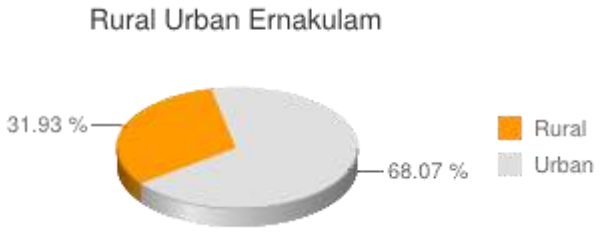
3.1.1 City Structure and Demography

Kochi, the most vibrant city in the southern part of Kerala is part of Ernakulum District. The city of Kochi with a population of 6.02 lakhs is the most densely populated city. The extended metropolitan region, "Greater Cochin" has a population of 2.1 million comprising of six municipalities and villages. Kochi is home to the High Court of Kerala and Lakshadweep, Southern Naval Command of the Indian Navy and the state headquarters of the Indian Coast Guard, Port of Kochi, International Container Transshipment Terminal, Kochi Shipyard, Kochi Refineries, Kochi Stock Exchange, International Pepper Exchange, major industries like FACT, TELK. The industrial parks like the Kochi Special Economic Zone and Info park provided enormous employment opportunities in the city. Cochin University of Science and Technology attracts considerable domestic and international students. As a favorable tourist destination of south India, Kochi ranks first in the total number of international and domestic tourist arrivals in Kerala.

According to census 2011, urban proportion has gone up from 17.3 per cent in 1951 to 31.2 per cent in 2011. Kerala is one of the top five states contributed towards the higher urban population in the nation. The state has witnessed a steady growth in the urbanization during last three decades. The urban content of the state's population which was only 15.11 % in 1961 has risen to 47.70% in 2011 which is almost double of the nation average of 27.82%.



The huge growth in urban population during the past decade 2001-2011 (92.72 %) could be attributed due to the manifold increase in number of towns in the state between 2001 & 2011 from 159 to 520. Among the districts, Ernakulam is the most urbanised district with 68.07%.



The district wise distribution of the population is presented in Table 3.1 and Figure 3.1. The percentage decadal growth rate of population between 2001 and 2011 for Kerala state is 4.86%. Among the southern districts, Ernakulum has reported highest growth with a decadal growth of 5.6%.

Table 3.1 District-Wise Population and Density

Sl. No	District	Population 2011	Percentage decadal growth rate of population	Population density per sq.km
			2001-11	2011
1	Kasargod	13,02,600	8.18%	654
2	Kannur	25,25,637	4.84%	852
3	Wayanad	8,16,558	4.60%	383
4	Kozhikode	30,89,543	7.31%	1318
5	Malappuram	41,10,956	13.39%	1158
6	Palakkad	28,10,892	7.39%	627
7	Thrissur	31,10,327	4.58%	1026
8	Ernakulum	32,79,860	5.60%	1069
9	Idukki	11,07,453	-1.93%	254
10	Kottayam	19,79,384	1.32%	896
11	Alappuzha	21,21,943	0.61%	1501
12	Pathanamthitta	11,95,537	-3.12%	453
13	Kollam	26,29,703	1.72%	1056
14	Thiruvananthapuram	33,07,284	2.25%	1509
Kerala		**3,33,87,677**	**4.86%**	**859**

(Source: Census of India 2011)

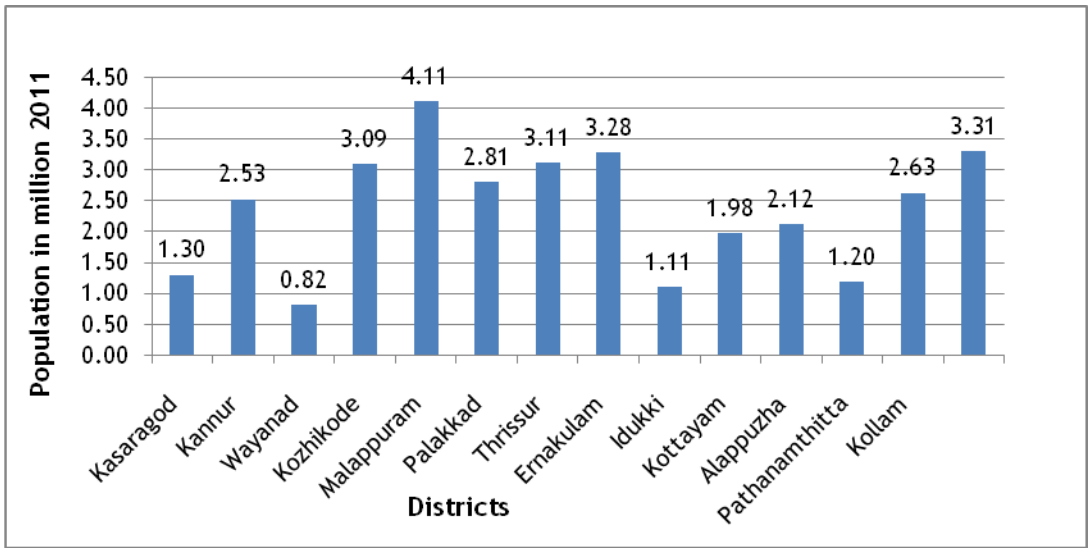


Figure 3.1 District-Wise Population and Density (in Million)

(Source: Census of India 2011)

Kochi City Population

As per census statistics, population of Kochi in 2011 is 601, 574 of which male and female are 296, 668 and 304, 906 respectively. Table 3.2 presents the growth of urban population of Kochi City in the past three decades. Ward wise population is presented in Table 3.3. Kochi Corporation as per 2011 is divided in to seventy four

wards. The growth in urban population is almost steady during 1981-2011 with an average decadal growth of 37.9%.

Table 3.2 Kochi Urban Agglomeration Population

Census	Population	Growth in %
1981	824,900	-
1991	1,140,600	38.3%
2001	1,536,400	34.7%
2011	2,117,990	37.9%

(Source: Census of India 2011)

Table 3.3 Kochi Population-Ward level (2011)

Sl. No.	Ward name	Total population
1	Fort Kochi	10279
2	Kalvathy	7814
3	Eeraveli	6425
4	Karippalam	8882
5	Mattancherry	10144
6	Kochangadi	7108
7	Cheralaayi	7741
8	Panayappilly	11429
9	Chakkaamaadam	5046
10	Karuvelippady	7673
11	Thoppumpady	9266
12	Tharebhagam	8925
13	Kadebhagam	10203
14	Thazhuppu	10699
15	Idakochi north	9574
16	Idakochi south	7808
17	Perumbadappu	9442
18	Konam	9863
19	Palluruthy Kacheripady	11100
20	Nambyapuram	8747
21	Pullaardesham	11046
22	Mundamveli	14723
23	Manassery	8403
24	Moolamkuzhi	8121
25	Chullikkal	6623
26	Nasrath	7277
27	Fort Kochi veli	7456
28	Amaraavathy	9439
29	Island north	4666

Sl. No.	Ward name	Total population
30	Island south	10076
31	Vaduthala west	9025
32	Vaduthala east	7795
33	Elamakkara town	8547
34	Puthukkala vattom	9034
35	Ponekkara	8757
36	Kunnumpuram	7589
37	Idappally	9183
38	Devankulangara	8634
39	Karukappilly	7638
40	Maamangalam	5770
41	Paadivattom	11745
42	Vennala	9708
43	Palarivattom	9354
44	Karanakkodam	8582
45	Thammanam	9938
46	Chakkaraparambu	6557
47	Chalikkavattom	4952
48	Ponnurunni east	9126
49	Vytila	7524
50	Chambakkara	8024
51	Thripunithura	8935
52	Vytila janatha	10726
53	Ponnurunni east	5119
54	Elamkulam	6279
55	Girinagar	11267
56	Panamppilly nagar	7933
57	Kadavanthra	5522
58	Konthuruthy	9973
59	Thevara	4569
60	Perumaanoor	5941
61	Ravipuram	8721
62	Ernakulam Jn.	10047
63	Gandhinagar	7887
64	Kathrukkadavu	8734
65	Kaloor south	4414
66	Ernakulam central	5970
67	Ernakulam town	9018
68	Ayyappankaavu	10174
69	Thrikkanaarvattom	10488
70	Kaloor north	8968
71	Elamakkara junction.	7881

(Source: Census of India 2011)

The population density in persons/sq.km is derived for the year 2011 and presented in Figure 3.2. The population density along the project corridor is more than 6000 persons/sq.km with few zones with more than 10000

persons/sq.km. The denser zones along the project corridor include Panampilly nagar, Thrikkanarvattom, Kaloor North, Elamakkara, Pottakuzhi, Pachalam, Elamkulam and Ernakulam centre.

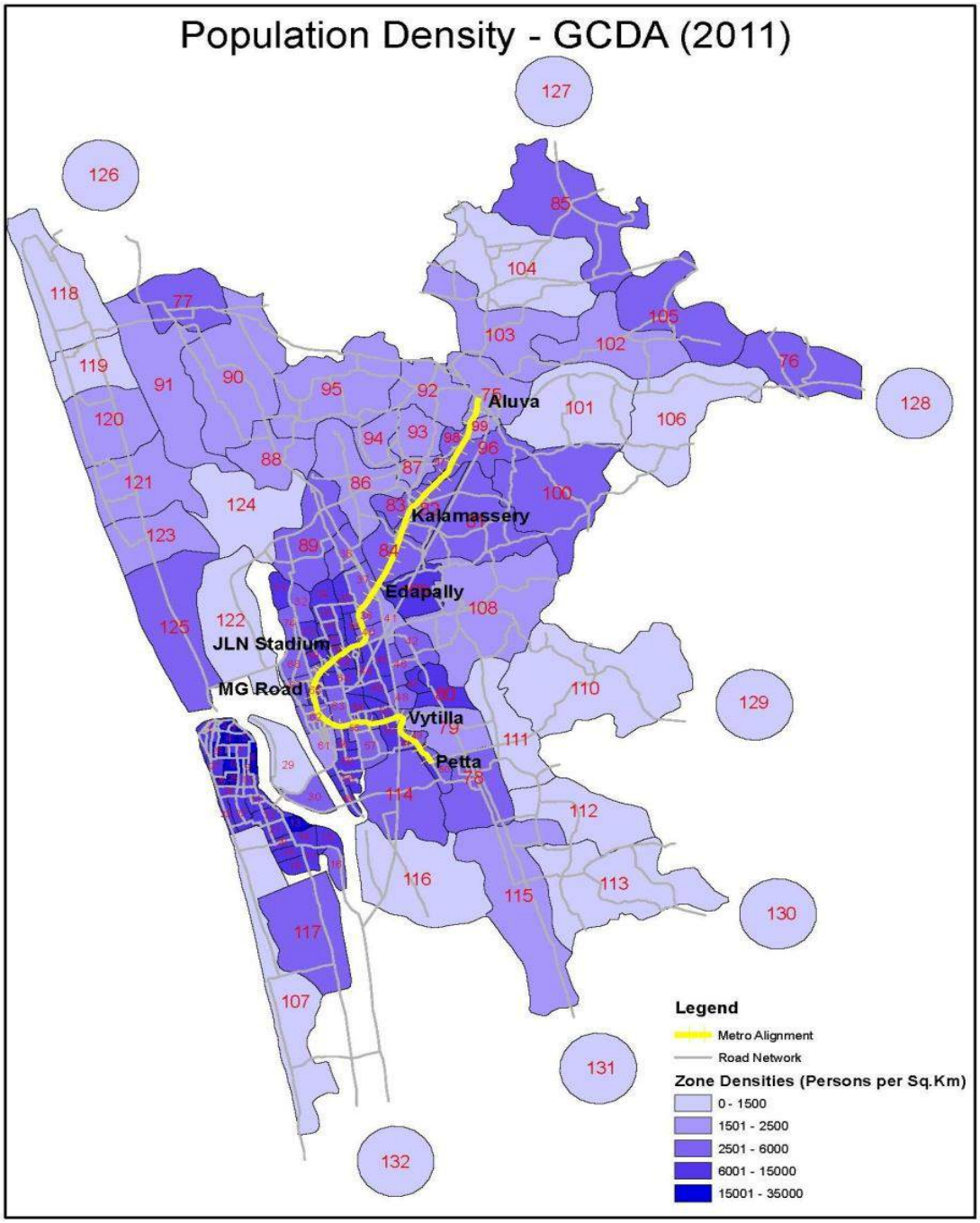


Figure 3.2 Zone-Wise Population and Density of GCDA 2011 (Persons/Sq.Km)

(Source: Census of India 2011)

3.1.2 No of Schools in Ernakulum District

Education trips play a dominant role next to work trip in the overall travel demand during the peak hours. To assess the extent of education centers in the city centre, the data on the schools is collected from Kochi Corporation. There are 1014 schools present in the district. The list of school numbers for the district and city is given in Table 3.4 and Table 3.5 respectively. The Table 3.6 gives the detailed educational facilities available in Kochi city.

Table 3.4 List of Schools in Kochi (2012)

Sl. No.	Assistant Educational Office	UP Schools				LP Schools			
		Govt.	Aided	Unaided	Total	Govt.	Aided	Unaided	Total
1	Ernakulam	3	16	1	20	8	30	3	41
2	Mattanchery	4	8	1	13	5	27	-	32
3	Thripunithura	5	12	-	17	13	21	2	36
4	Vypeen	4	10	-	14	5	25	-	30
5	Koothattukulam	4	4	-	8	8	6	1	15
6	Muvattupuzha	7	3	-	10	7	9	2	18
7	Kalloorkkad	-	5	-	5	5	11	-	16
8	Piravom	8	3	2	13	10	11	-	21
9	Kolenchery	11	4	3	18	20	9	2	31
10	Aluva	7	8	6	21	16	26	5	47
11	Angamaly	7	8	2	17	21	27	3	51
12	North Paravoor	5	5	2	12	24	20	3	47
13	Perumbavoor	11	5	2	18	18	16	5	39
14	Kothamangalam	15	11	1	27	22	29		51
	Total	91	102	20	213	182	267	26	475

(Source: Kochi Corporation)

Table 3.5 Summary of Schools in Ernakulum District

Higher Secondary School + Special Schools	316
TTI Schools	4
Upper Primary Schools	215
Lower Primary Schools	479
TOTAL	1014

(Source: Kochi Corporation)

Table 3.6 Educational Facilities in Kochi City (2010)

Sl. No.	Areas	LP(L.P+U.P+H.S)	U.P(U.P+H.P)	H.S.S+H.S	Colleges	Others	Student Population per L.P	Student Population per U.P	Student Population per H.S + H.S.S	Student Population Existing
1	Kochi Corporation	219	146	114	7	18	2720	4079	5224	595575
2	Thirupunithura	26	18	12	2	3	2303	3327	499	59884
3	Kalamassery	15	11	10	4	8	4208	5738	6312	63116
4	Chellanam	7	4	3	0	1	5173	9052	12069	36209
5	Cheranallur	9	5	2	0	0	2924	5263	13158	263126
6	Elamkunnappuzha	19	9	3	0	0	2661	5618	16854	50563
7	Eloor	11	10	5	0	1	3234	3557	7115	35573
8	Kadmakudy	5	3	2	0	0	3365	5275	7912	15824
9	Kumbalam	15	8	4	2	1	1837	3444	6887	27549
10	Kumbalangy	10	4	2	0	0	2666	6665	13330	26661
11	Maradu	9	5	3	0	0	4557	8202	13671	41012
12	Mulavukadu	10	4	2	0	0	2284	5711	11421	22842
13	Njarakkal	10	5	3	0	1	2417	4833	8055	24166
14	Thiruvankulam	8	2	2	0	1	2715	10,859	10859	21717
15	Thrikkakkara	20	13	11	3	3	3299	5076	5999	65984
16	Vadavukodu	15	11	9	0	0	1781	2428	2968	26710
17	Varapuzha	8	4	3	0	0	3061	6131	8175	24524

(Source: Development Plan for Kochi City Region 2031)

3.1.3 Land Use

Land use distribution in the Kochi city region as per Kochi City Region Development Plan is presented in Figure 3.3 and Table 3.7. The predominant land use along the project corridor is residential except along the MG road where commercial, public and semipublic present.

Table 3.7 Existing Land Use of Kochi City Region, in 2009

Sl. No.	Land use	Area (Ha)	% to gross area	% to net area
1	Residential	16057.9	43.43	69.39
2	Commercial	367.1	0.99	1.59
3	Public & Semi public	1538.37	4.16	6.65
4	Industrial	2123.18	5.74	9.17
5	Transportation	1486.35	4.02	6.42
6	Park & Open spaces	113.79	0.31	0.49
7	Hazardous	23.66	0.06	0.1
8	Other (SEZ and Unclassified area)	397.3	1.07	1.72

Sl. No.	Land use	Area (Ha)	% to gross area	% to net area
9	Paddy land/ Marshy land	6817.55	18.44	
10	Dry Cultivation/ Agriculture	754.06	2.04	3.26
11	Water bodies	7011.43	18.96	
12	Port Land (Puthuvype)	281.12	0.76	1.21
13	Total	36971.81	100	

(Source: Development Plan for Kochi City Region 2031)

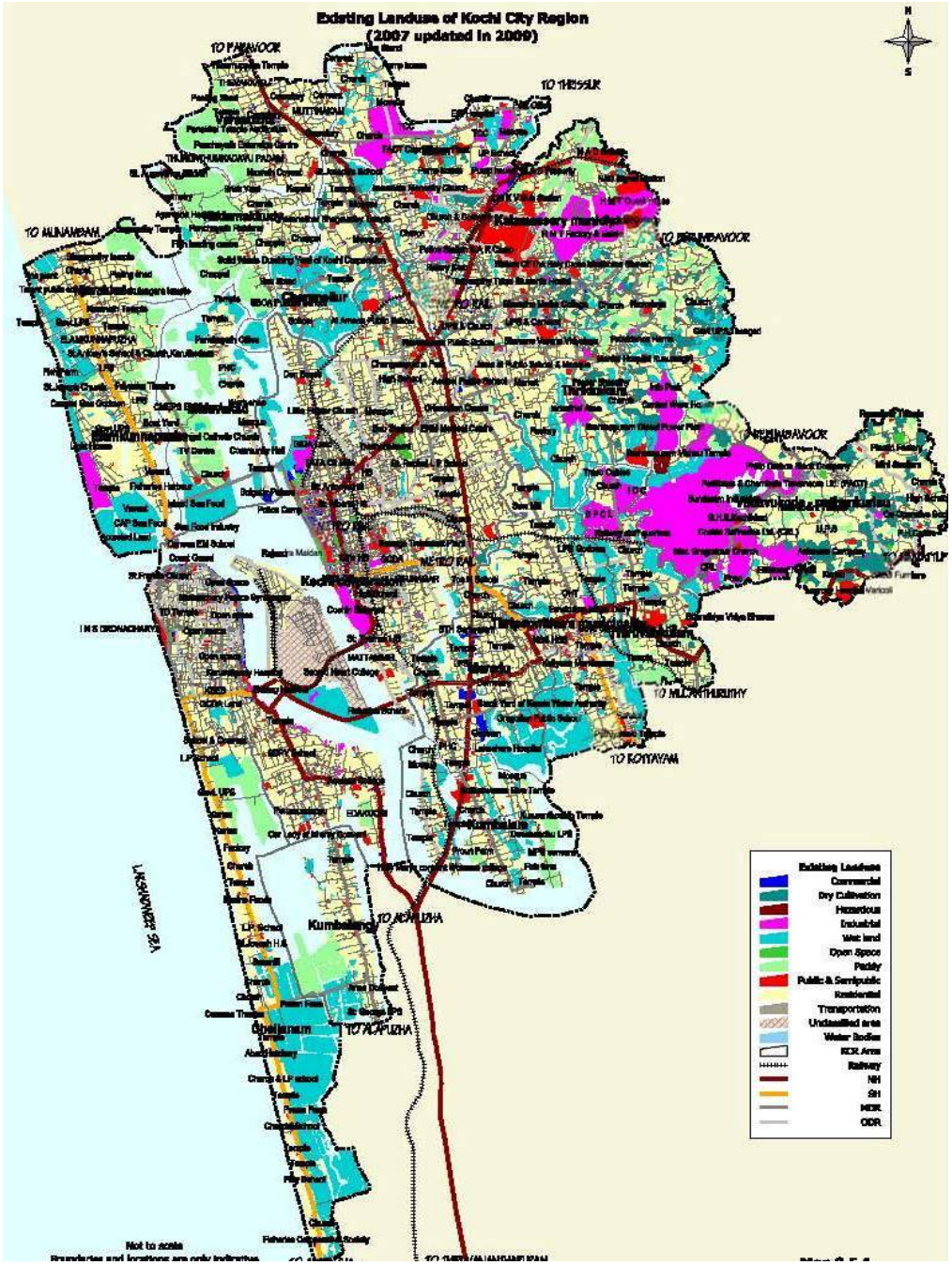


Figure 3.3 Land Use Map

(Source: Development Plan for Kochi City Region 2031)

3.1.4 Economic Activities in Ernakulum

The sector wise distribution of gross domestic product income of the district is given in Table 3.8. The major striving sector contributing to income is tertiary with 57% in year 2009-10.The share of tertiary sector has increased over the years (2001-10) resulting in drop in the primary sector. Ernakulum district stands first with Rs 89,131 at constant (2004-2005) prices in 2011-12 as against 81,768 in 2010-11 in the per capita income among other districts of Kerala.

Table 3.8 Sector Wise Gross Domestic Product – Ernakulum (in Rs.)

Year	Primary Sector	Secondary Sector	Tertiary sector	NDDP	Per Capita Income
2000-2001	109625	306589	462020	878234	28376
2001-2002	115053	309291	494806	919150	29469
2002-2003	139015	428623	658256	1225894	38893
2003-2004	151216	485573	738719	1375508	43228
2004-2005	147353	586281	822223	1555857	48454
2005-2006	180269	667690	923045	1771004	54661
2006-2007	227406	788686	1066225	2082317	63699
2007-2008	243902	919937	1229144	2392983	72581
2008-2009	133444	658663	972563	1764670	53073
2009-2010	205015	946751	1513249	2665015	79553

(Source: Department of Economics and Statistics)

Per capita Income: One of the major indicators of the regional development is per capita income (PCI). Per capita income for the duration of 2010-11 is presented in Table 3.9. Ernakulum has the highest per capita income than the state average.

Table 3.9 District-Wise Per Capita Income

Sl. No.	District	2010-11(P)	Rank	2011-12(Q)	Rank	Growth Rate (%) 2010-11	Percent with respect to State Average
1	Thiruvananthapuram	59885	4	65419	4	9.24	108%
2	Kollam	51741	10	56132	10	8.49	93%
3	Pathanamthitta	61325	3	66940	3	9.16	111%
4	Alappuzha	56014	7	60989	6	8.88	101%
5	Kottayam	63708	2	69259	2	8.71	114%
6	Idukki	56406	6	60127	7	6.6	99%
7	Eranakulam	81768	1	89131	1	9	147%
8	Thrissur	59080	5	64629	5	9.39	107%
9	Palakkad	51182	11	55365	11	8.17	91%
10	Malappuram	36068	14	39005	14	8.15	64%
11	Kozhikode	53670	9	58498	9	8.99	97%
12	Wayanad	40997	13	44123	13	7.62	73%
13	Kannur	54492	8	59354	8	8.92	98%
14	Kasaragod	46161	12	50122	12	8.58	83%
STATE		**55667**		**60536**		**8.75**	

(Source: Department of Economics, State of Kerala- 2011-12, P: Provisional Q: Quick, at constant (1999-2000) Prices)

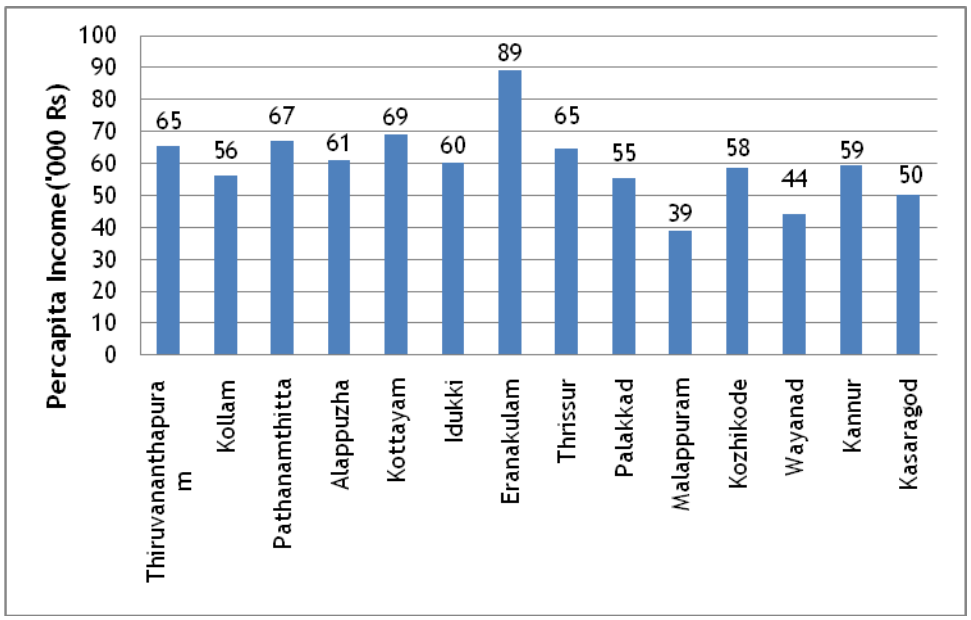


Figure 3.4 Distribution of District-wise Income of Kerala State

3.2 Special Economic Zones

Kerala was the first State in India to set up a Special Economic Zone. According to the Ministry of Commerce & Industry, Govt. of India, there are 7 operational SEZs in Kerala. After the SEZ Rules 2006 came into force; formal approvals were granted to 28 more SEZs in the state. Table 3.10 listed out the number of operational SEZs in Kerala. Of the SEZs, Kochi, Info park and Kochi port trust fall in the project study area.

Table 3.10 List of Operational SEZs in Kerala

Sl. No.	Name of the Developer	Location	Type of SEZ
1	Kochi SEZ	Kochi	Multi product
2	Info park SEZ	Kochi	IT/ITES
3	Electronic Technology Park-SEZ-I	Trivandrum	IT/ITES
4	Electronic Technology Park-SEZ-II	Trivandrum	IT/ITES
5	Kochi Port Trust	Vallarpadam	Port based
6	KINFRA Film & Video Park	Trivandrum	Animation & Gaming
7	Kochi Port Trust	Puthuvypeen	Port based

(Source: http://www.emergingkerala2012.org/sez.php)

Kochi SEZ

Kochi Special Economic Zone accommodates a Multiproduct SEZ in Kerala.

Figure 3.5 Kochi SEZ

(Source: http://www.csez.com)

3.3 Transport Infrastructure

Kochi is one of the few two-tier cites of India blessed with good transport connectivity through all major modes of transport like road, rail, air and water. National Highways NH 17, NH 47 stretched out in the North-south and NH 49 in the east-west connects the city with the neigbouring districts and surrounding states. The population from the neighbouing villages and districts commute to the city by rail with three major stations including Ernakulum junction, Ernakulum north and Aluva railway station. International Airport at Nedumbassery connects Kochi with nearly 30 destinations nationally and internationally. The water transport is limited to passenger and ferry services between Marine drive, Fort Kochi and Vypeen. Proposals exist to connect Edapally with Vytilla with water transport mainly for tourism. The transport network in the study area is shown in the Figure 3.2.

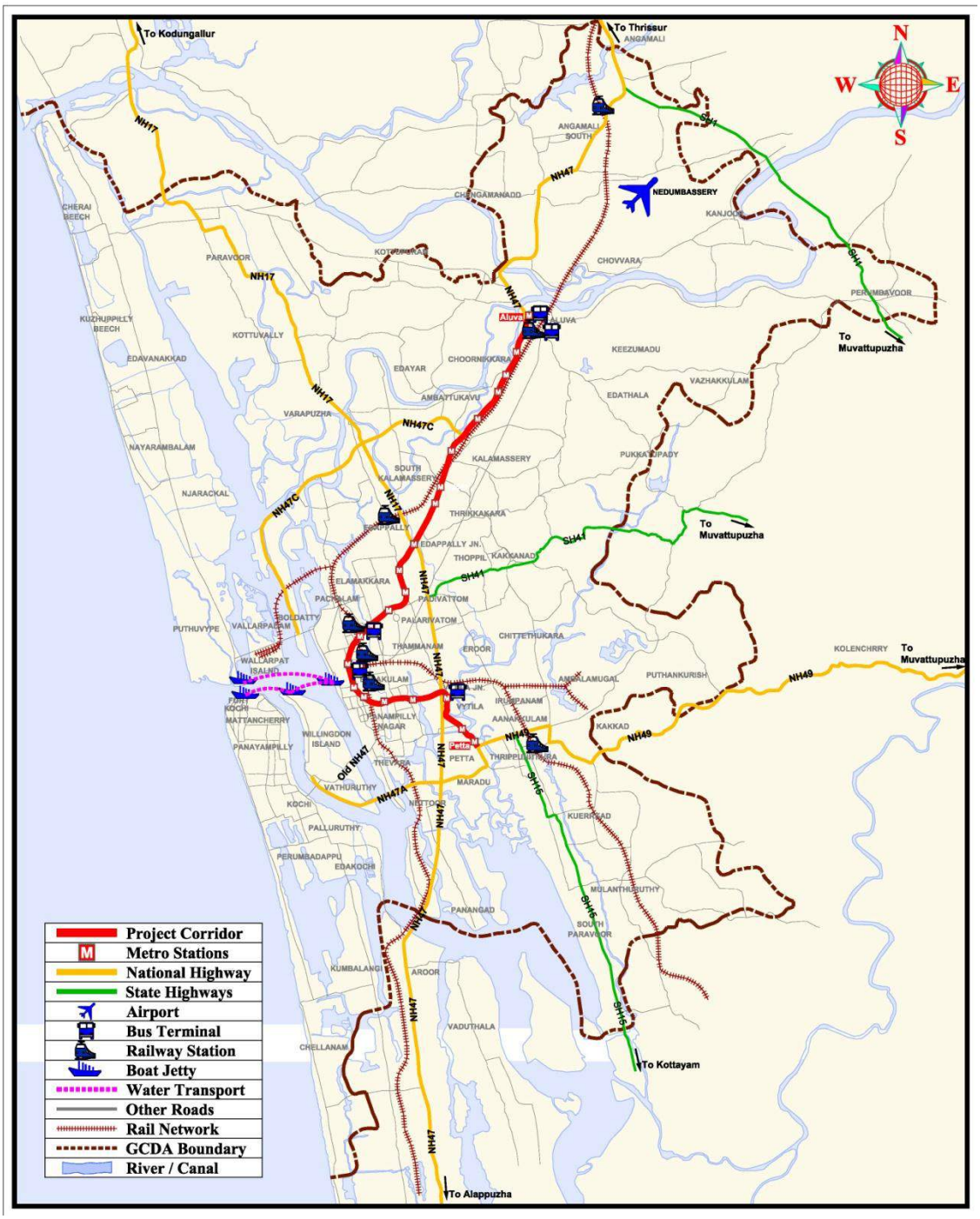


Figure 3.6 Transport Network - Study Area

3.3.1 Road Network

The total length of roads in Kochi City (except the roads belonging to Kochi Naval Base in ward No.26) is 614 Km. The city has a road density of 1.03 km/1000 population and 6.47 km/sq.km of surface area.

3.3.2 Public Transport

The city has a very efficient bus transport system operated by public and private operators, known as Red-Buses. The operation was mainly by Red buses till 2010. In 2010, the state public transport company, KSRTC started city services due to frequent complaints against red-buses. KSRTC operates two classes of service including low floor buses funded by JNNURM . KSRTC operate about 46 buses per day in the city and expecting 150 more AC and non-AC low floor buses under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) scheme.

The JNNURM transport services operated by KSRTC offer premium air-conditioned low-floor bus services known as Orange Buses and non-air conditioned semi low floor buses known as Yellow Buses. Both the buses connect the central business district areas of Kochi with the nearby suburbs. At present, 630 intra-buses are authorized to operate inside the city. The city also caters to nearly 2100 long-distance private buses, which include 466 inter-city state buses.

There are 160 official authorized routes to operate connecting 60 destinations in the city and nearby suburbs. Most of the buses run primarily on four major routes i.e. Aluva-Fort Kochi, Aluva-Kakanad, Ernakulam-Fort-Kochi and Aluva-MG road. There is no numbering system for the routes; rather all buses carry destination boards with important bus stops marked below. The details of operational routes by KSRTC and private are given in Annexure 3.1.

The city has primarily four major bus stations:

- Kaloor Bus station (Punching station)
- KSRTC Central Bus Station - South,
- Vytilla hub
- Rajiv Gandhi Municipal bus terminal at Aluva (mainly for Private)

The KSRTC bus fares were revised on 11 November 2012. The fare for different services is listed in Table 3.11.

Table 3.11 Fare for Bus Services

Type of Bus	Minimum Fare in Rs.	Fare for every next Km in Rs.
City Fast	6	0.57
City/Ordinary	6	0.58
Super Express	17	0.70
Super-Fast Passenger	12	0.65
Volvo	35	1.20

(Source: CDM Smith Secondary Survey 2013)

To ease congestion within the city limits, a large integrated public transport terminus is planned to be constructed at Vytilla Junction, known as Integrated

Mobility Hub, which provides commuters multi-modal transport options. The first phase is completed and the intercity buses operate from this hub. Mobility hub plans to provide space for 170 buses, 2000 car bays, 50 inter-state buses parking bays, 5,000 two wheeler and three wheeler parking bays and a boat jetty with 3 piers for providing water ferry transport. A shopping mall and commercial towers are planned in the second phase to sustain with additional revenues. The proposed expansion will be completed by 2014.

3.3.3 Airport

Kochi has an international airport, known as the Kochi International Airport, which is about 25 km north of the city. This is the first airport which has been implemented under PPP. It currently is the fourth busiest International airport in India. Currently in expansion mode, the airport has been made ready to accommodate the super jumbo Airbus 380. The Airport is connected with most of the cities in the Middle-East and South East Asia with nearly sixteen international flight carriers operating to the city. Apart from this, the city is well connected to all major metros and cities of India with seven domestic carriers operating nationwide air services.

3.3.4 Ferry Terminal

Ferries are operated between Fort Kochi and the mainland. The stops include Embarkation on the eastern side of Willingdon Island, Terminus on the west one opposite to Mattancherry and Customs at Fort Kochi and at Mattancherry Jetty. The minimum fare is Rs.5.00.

Ernakulam: The ferry operates between 4.40am to 9.30pm and operate every 40mins to Fort Kochi from the main jetty. There are six ferries directly to/from the Mattancherry Jetty (5.55am to 6.45pm). Ferries run every 20mins to Willingdon and Vypeen Islands (6am to 10pm).

Fort Kochi: Ferries run between 6.20am to 9.50pm from Customs Jetty to Ernakulam and Willington Island. Car and passenger ferries cross to Vypeen Island from Fort Kochi between 6am to 10pm.

3.3.5 Railway

At present, there is no intra-city rail transport system in Kochi. The inter-city rail transport system in the city is administered by the Southern Railway Zone of Indian railways. Ernakulam junction and the Ernakulam town locally known as the 'South' and 'North' railway stations respectively serve as the major entry to or exit from the city. Both these stations fall in the project corridor and will act as major transfer stations for passengers commute from outside the city. The major stations at Aluva and Thripunithura and the halting station at Kalamassery serves the outskirts of the city and the surrounding metropolitan area. The train fare from Ernakulam station to major destinations surrounding the study area as is given in Table 3.12. Southern Railway is planning to start MEMU services for connecting nearby towns and cities by in the city.

Table 3.12 Train Fare from Ernakulam

Sl. No.	Station Name	Ordinary Fare from Ernakulam
1	Thripunithura	5
2	Piravam Rd	8
3	Ettumanoor	12
4	Kottayam	14
5	Kochi Harbour	6
6	Ernakulam Town	5
7	Edapalli	5
8	Aluva	7
9	Angamali	8
10	Chalakudi	11
11	Iringalakkuda	13
12	Thrissur	16

(Source: CDM Smith Secondary Survey 2013)

3.3.6 Intermediate Public Transport

Intermediate Public Transport (IPT) system in the city comprises of auto-rickshaw and taxis. Among this, two wheelers are very dominant due to the ease of access to the system, higher availability and lower fare compared to taxis. IPT modes are gradually becoming an important mode of the transport system of any urban city due to the absence of good quality public transport system coupled with long commuting time due to traffic congestion in the central business areas.

An analysis of the distance operated by the IPT modes in Kochi city revealed that auto rickshaws on an average, operated 63 Kilometers daily while taxis operated 74 kilometers daily. *(Source: Development Plan for Kochi City Region 2031).*

The annual growth of taxis in Eranakulam district shows that it is almost double compared to the growth of taxis in the state. The growth of intermediate public transport modes in Ernakulam district of Kerala is given in Table 3.13.

Table 3.13 Growth of Intermediate Public Transport Modes

IPT mode	No. of Vehicles in	
	2003-2004	2008-2009
Ernakulam District		
Taxi	10362	18285
Auto Rickshaw	35511	48238
Kerala State		
Taxi	93458	303092
Auto Rickshaw	142054	422905

(Source: Economic Review 2005)

Major Auto Stands

Major auto stands include Ernakulam Junction, Ernakulam town, South KSRTC bus terminal, Rajiv Gandhi bus terminal, Aluva, Vyttilla bus hub, Kaloor bus stand and Petta bus stop. The pre-paid auto stands are available at Vyttila bus hub, Ernakulam junction and Ernakulam town. There are 50 autos in vyttila bus hub which carry 450 trips per day to various destinations like Ernakulam Junction, Janatha bus stop, Kadavanthra, Kaiyapuzha, mathoor etc. Minimum charge is Rs. 15/- and 7.5/- for every next Km. There are 240 autos in South railway station which carry 4000 trips per day. Auto charges are uniform at every pre-paid stands.

Major Taxi Stands

Major taxi stands include Ernakulam juntion, Ernakulam town, Kaloor and Aluva.

Taxi fares are based on hourly basis or per Kilometre which amounts to Rs 11/Km or Rs 175/hour.

3.4 Parking Demand

Significant parking is observed on the project corridor on MG road and Banerji road. Other major locations include SA road, Shanmughom road, Broadway and Market road. As per *Development Plan for Kochi City Region 2031* the highest on-street accumulation takes place on MG road followed by Bannerji road and Sahodaran Ayyappan road where off-street parking facilities are provided.

3.4.1 Vehicle Registration

Kerala has 6.8 million registered motor vehicles at the end of 2011-2012. The total registered vehicles grew at a Compound Annual Growth Rate (CAGR) of 11.39% between 2000 and 2012. Personalized modes i.e. two wheelers and passenger cars dominated with 60.07% and 21.48% respectively. Goods vehicles constituted around 6.56%. Figure 3.6 represents the registered vehicles in Kerala state. Vehicle composition is presented in Figure 3.7.

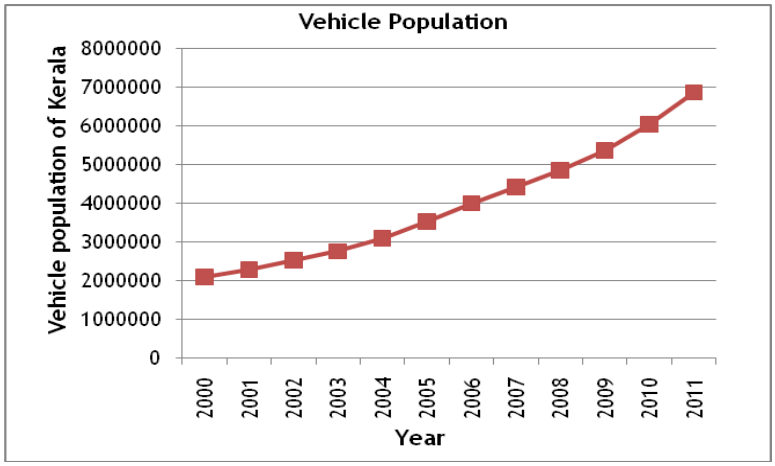


Figure 3.7 Registered Vehicles in Kerala State
(Source: Regional Transport Office Kerala)

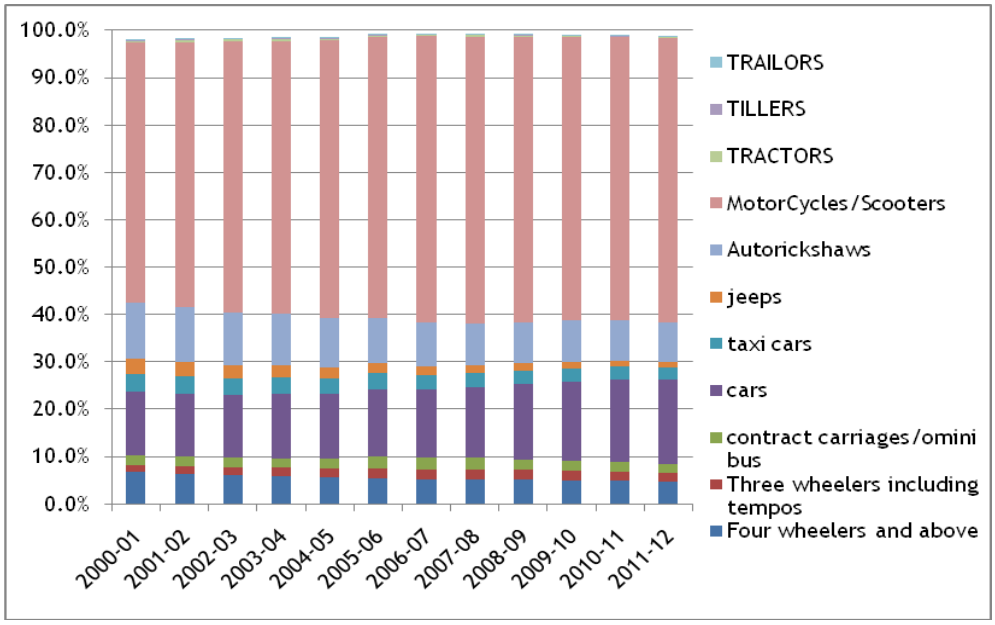


Figure 3.8 Vehicles Composition in Kerala State (2000-2012)

Vehicle population of Ernakulum District

The vehicle population of Ernakulum district is collected from the Motor vehicles department and is presented in Table 3.14. Ernakulum district contribute to 14% of the overall vehicle population. Cars and two wheelers account for major share with 20.4% and 62.1% followed by goods vehicle 7.7%.

Table 3.14 Motor Vehicles Registration in Ernakulam

Vehicle Type	2003-04	2006-07	2007-08	2008-09	2009-10
Goods	39874	54812	60241	64367	68150
buses	10931	21823	23292	24002	24544
Cars	80448	121503	140549	158516	181805
Autorickshaws	35511	41894	44679	48238	52307
Scootor/Motorcycles	285221	422473	471743	511857	553150
Tractors	2156	2436	2616	2732	2796
Others/slow moving vehicles	10781	4568	5485	6151	7881
Total	464922	669509	748605	815863	890633

(Source: Motor Vehicles Department, Government of Kerala)

Vehicle Population of Kochi city

Table 3.15 present the vehicle registered in the city for the period of 2007-2010. Out of the total vehicle registered 30% is registered in the city in 2009-10. An average vehicle growth of 9% is observed in Kochi city in the same period.

Table 3.15 Motor Vehicles Registration in Kochi City

Vehicle Type	2007-8	2008-9	2009-10
Two wheeler	119486	128823	137942
Car	92226	69056	75601
Jeep	5832	5832	5832
Omni Bus	4726	4899	5089
Buses	4848	5224	5470
Taxis	5026	5762	6295
Three wheeler	9239	10206	11402
Goods	13982	15358	54415
Others	1305	1350	1390
Total	**256670**	**246510**	**303436**

(Source: Road Transport Year Book (2007-09), Volume-1)

3.5 Accidents

The total number of road accidents in Kerala during 2011-2012 is 11076 as against 30237 in 2010-2011 showing a decrease of 63.36 percent. The trend of motor vehicles accidents in Kerala from 2007 onwards is shown in Figure 3.8.

Analysis reports that nearly 98% of the accidents occurred due to the rash driving of motor vehicles. Almost 59% of the accidents are by two wheelers. A significant decrease in accidents is observed between 2011-12 may be contributed by the increase in awareness of the traffic safety measures and regulations.

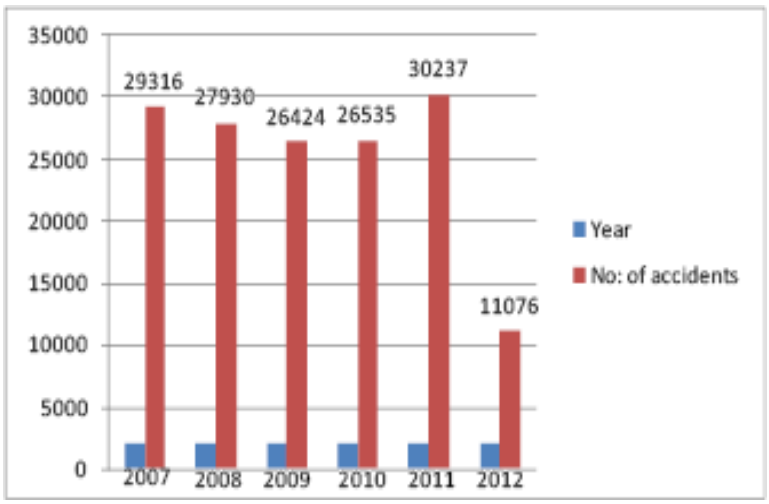


Figure 3.9 Trend of Motor Vehicles Accidents in Kerala

(Source: Economic Review 2012)

The number of motor vehicles involved in road accidents during 2010 is listed out in the Table 3.16. The 5% of total accidents of Kerala is occurred in Ernakulam during 2010. Among that 42% of the accidents are by two wheelers.

Table 3.16 Motor Vehicles involved in Accidents during 2010

Mode Type	Ernakulam City	Ernakulam Rural
KSRTC Buses	49	61
Other Buses	175	246
Goods Vehicles	116	179
Motor Cars	458	688
Jeeps	10	52
Auto	165	411
Two wheelers	869	1976
Miscellaneous vehicles	116	180
Class not known	81	24
Total	2039	3817

(Source: Economic Review 2012)

3.6 Fuel Efficiency Details

The fuel efficiency is related to measure the performance of a vehicle based on the fuel consumed per specified distance i.e. litre per kilometer. Fuel efficiency is dependent on many parameters like vehicle characteristics including its engine parameters, aerodynamic drag, weight, and rolling resistance, driver characteristics like number of breaks, speed, maintenance of vehicle, road characteristics etc. Recent innovation in vehicle design, engine design etc is claiming considerable energy savings.

Fuel efficiency directly affects emissions causing pollution based on the amount of fuel used. This also depends on the type of fuel used. Hence the fuel efficiency data is collected for Kochi by type vehicle and fuel. The fuel type included LPG, petrol, and diesel. The type of vehicle included cars (by model), bus, minibus, two wheeler and three wheeler.

The mileage of various cars inside the city were collected during secondary data collection in 2013 is presented as follows:

Table 3.17 Fuel Efficiency

Mode	Car-Petrol		Car-Diesel		Bus		Two wheeler	Three wheeler
	Small	Big	Small	Big	Mini bus	bus		
Mileage	14	8	15	10	7	3.5	35	16
Daily Trip Length	30	30	50	50	100	250	35	80
Consumption/km (liters)	0.07	0.13	0.07	0.10	0.14	0.29	0.03	0.06
Consumption/km (INR)	4.70	8.23	3.41	5.12	7.31	14.61	1.88	4.11

(Source: CDM Smith Secondary Survey 2013)

Consumption of Fuel

The consumption of fuel and the fuel price for petrol, diesel and LPG are collected on a sample basis from fuel stations which located along the project corridor. Table 3.18 presents the total consumption of respective fuel on an average working day. The fuel price for petrol, diesel and LPG is presented in Table 3.19.

Table 3.18 Total Consumption of Fuel

Petrol Pump Along Corridor	Consumption of Fuel		
	Petrol (litres)	Diesel (litres)	Auto LPG
Other Petrol Pumps	27500 to 30000	27500 to 37000	-
Reliance	4000	4000	4000

(Source: CDM Smith Secondary Survey 2013)

Table 3.19 Fuel Price as per June 2013 (in Rs./Litre)

Pumps along corridor	Petrol	Diesel	LPG
Reliance Pump	66.76	64.26	39.99
Other Pump	65.8	51.15	-

(Source: CDM Smith Secondary Survey 2013)

3.7 Air Pollution

Kerala State Pollution Control Board (Kochi) conducts regular air pollution monitoring at major locations in the city centre. The yearly data on the ambient air quality is collected for the last four years are presented in Table 3.20 to Table 3.23.

Table 3.20 Annual Average - Ernakulum District 2008

Sl. No	Monitering Location	So_2 ($\mu g/m^3$)	No_2 ($\mu g/m^3$)	Respirible suspended particulate matter($\mu g/m^3$)	Suspended Particulate ($\mu g/m^3$)
1	KWA Building, M.G road, Ernakulam	4.9	17.7	35	60
2	Near South Over Bridge, Ernakulam	4.1	18.8	41	80
3	FCI OEN Connectors Building, Vytilla, Ernakulam	4.2	13.1	38	63
4	Irumpanam, Ernakulam	4.2	10.1	38	60
5	Carborandum Universal Company, Kalamessery, Ernakulam	5.2	11.4	44	70
6	Eloor, Ernakulam	3.9	5.2	47	82
7	Fact QuArters, Udyogamandal, Ernakulam	3.1	6.4	49	92

(Source: Kerala State Pollution control Board)

Table 3.21 Annual Average - Ernakulum District 2009

Sl.No	Monitering Location	So_2 ($\mu g/m^3$)	No_2 ($\mu g/m^3$)	Respirible suspended particulate matter($\mu g/m^3$)	Suspended Particulate ($\mu g/m^3$)
1	KWA Building,M.G road, Ernakulam	3.8	15.7	-	63
2	Near South Over Bridge,Ernakulam	4.1	18.5	41	78
3	FCI OEN Connectors Building, Vytilla,Ernakulam	4.3	14.3	41	61
4	Irumpanam, Ernakulam	3.5	10.6	37	55
5	Carborandum Universal Company,Kalamessery,Ernakulam	4.5	12.5	40	61
6	Eloor,Ernakulam	2	6.5	51	104
7	Fact QuArters, Udyogamandal,Ernakulam	2	6.4	49	118

(Source: Kerala State Pollution control Board)

Table 3.22 Annual Average - Ernakulum District 2010

Sl. No	Monitering Location	So_2 ($\mu g/m^3$)	No_2 ($\mu g/m^3$)	Respirible suspended particulate matter($\mu g/m^3$)	Suspended Particulate ($\mu g/m^3$)
1	KWA Building,M.G road,Ernakulam	17.6	18.1	78	88
2	Near South Over Bridge,Ernakulam	17.6	18.1	78	88
3	FCI OEN Connectors Building, Vytilla,Ernakulam	17.6	18.1	78	88
4	Irumpanam, Ernakulam	17.6	18.1	78	88
5	Carborandum Universal Company,Kalamessery,Ernakulam	17.6	18.1	78	88
6	Ethanam	17.6	18.1	78	88
7	Industrial	17.6	18.1	78	88

(Source: Kerala State Pollution control Board)

Table 3.23 Annual Average - Ernakulum District 2011

Sl.No	Monitering Location	So_2 ($\mu g/m^3$)	No_2 ($\mu g/m^3$)	Respirible suspended particulate matter($\mu g/m^3$)	Suspended Particulate ($\mu g/m^3$)
1	Eloor-Methanam	2.24	5.04	16.73	-

2	Eloor-TCC	2.55	5.18	18.3	-
3	South Over Bridge,Ernakulam	3.59	17.2	52.5	-
4	FCI OEN Connectors Building, Vytilla,Ernakulam	3.9	15.31	46.5	-
5	Irumpanam,Industrial	3.16	12.04	37.4	-
6	Kalamassery,Industrial	3.8	15.2	58.6	-
7	Kalamassery, Residential, others	4.27	19.3	39.9	-

(Source: Kerala State Pollution Control Board)

As per the data the air pollution is mainly caused by some of the industries at Kalamessery and Ernakulam.

4. CHAPTER

DATA COLLECTION AND ANALYSIS

4.1 Introduction

An assessment of the prevailing conditions in the study area was made to provide a basis for:

- Preparing the detailed program for the subsequent field investigations and surveys; and
- Establishing the database of socioeconomic indicators of the study area at a micro level along the proposed corridors.

Based on this assessment, data has been collected through various secondary and primary sources to establish the existing traffic and travel characteristics of the project corridor and study area.

4.2 Primary Traffic Surveys & Results

The primary surveys are planned in such a way as to appreciate the present transport infrastructure in the study area and along the proposed metro corridor. The following primary surveys are conducted to update the transportation model for the study area which will simulate existing traffic condition and forecast transport demand for different horizon years.

- Road Inventory Survey
- Speed and Delay Surveys
- Screen Line Volume Counts
- Mid-Block Volume Count
- Volume Count at the Cordons
- Origin Destination Surveys
- Bus Occupancy Surveys
- City Bus Passenger Boarding and Alighting
- Opinion Survey i.e. Willingness to Pay and Shift Survey

The surveys are conducted between 30-05-2013 to 21-05-2013 as illustrated in Table 4.1.

Table 4.1 Traffic Survey Schedule

Sl. No.	Type of Survey	Duration	Locations/Km	Dates
1	Road Inventory Survey	Daylight	Information on functional characteristics of major roads in the study area All the roads in the PIA of metro alignment in detail	30-05-2013 to 31-05-2013 and 3-06-2013 to 5-06-2013
2	Speed and Delay Surveys	Morning Evening & Off peak hour	Project corridor and major roads in the PIA	3-06-2013 to 7-06-2013 and 10-06-2013 to 14-06-2013
3	Screen Line Volume Counts	8hrs	6 locations	31-05-2013 to 14-06-2013
4	Mid-Block Volume Count	18hrs	5 locations	5-06-2013 to 18-06-2013
5	Volume Count at The Cordons	18hrs	7 locations	3-06-2013 to 21-06-2013
6	Origin Destination Surveys and Mid-Block Survey	18hrs	12 locations	5-06-2013 to 21-06-2013
7	Bus Occupancy Surveys	18hrs	Vyttila hub Aluva Private bus Stand Ernakulam Jn Ernakulam Town & Major bus stops along the corridor	5-06-2013 to 21-06-2013
8	Stated Preference Survey	2000+along with OD	All major railway stations, bus terminals and at OD locations	5-06-2013 to 21-06-2013

(Source: CDM Smith)

Figure 4.1 presents the survey locations. Survey formats are presented in Annexure 1.

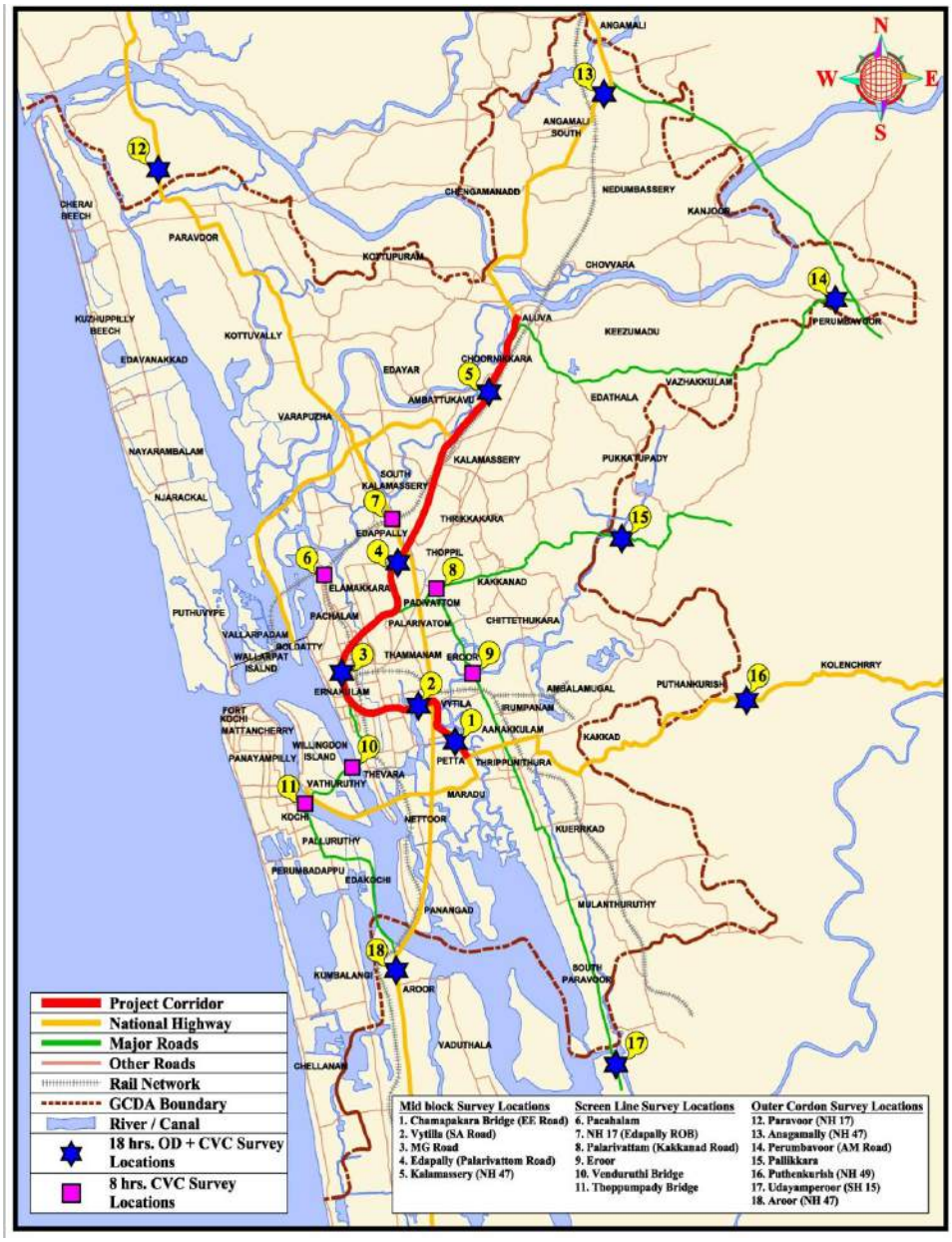


Figure 4.1 Traffic Survey Locations

Based on the type of surveys and the data it pertains to, the data is analyzed to evaluate the following characteristics of the study area:

- Existing Transport Infrastructure
- Public Transport/Intermediate Public Transport Systems
- Urban goods movement
- Traffic management
- Review of Environmental Conditions

4.2.1 Road Inventory Survey

Objective of the Survey: The road network inventory is aimed at developing the network database with the existing features of roadway sections covering the study area.

Scope of the Survey: The following data is collected during the field inventory survey:

- Effective road width
- Length between intersections (nodes of the Transport Network)
- Adjoining land use and available access control
- Intersection facilities

Conduct of the Survey: A team of two enumerators traversed the road network with a specified format for the purpose of recording the data. For all major road sections in the study area and in the project influence area, inventory surveys are undertaken to create a road network database.

Data Entry and Analysis: The road network attribute data collected from the field is integrated with the network database. The database is used in developing the base year network facilitating both qualitative and quantitative evaluation of the present sufficiency of road networks vis-à-vis existing standards and usage pattern.

Key Outputs: Road transport network database of the study area.

The road network covered in the survey is presented in Figure 7.2.

Figure 4.2 Road Network (GCDA)

Salient features of the road network in the study area and in the project influence area are presented below.

Road Length: The survey covered the project corridor of about 25 km, 36 Km in the project influence area. Details of major arterials and sub arterials in the study area are collected to develop the model network for the project corridor.

Lane characteristics: The characteristics of the project corridor and the roads in the project Influence area are presented in Table 4.2 and Table 4.3.

Table 4.2 Lane Characteristics – Project Corridor

Sl. No.	From Node	Via Route	Road name	Lane Type	Traffic Management
1	Petta to Vyttila Jn.	Chambakkara, Thykoodam	Ettumanoor-Ernakulam	2/UD	Two-way
2	Vyttila Jn to Pallimukku Jn.	Janatha bus stop, Kadavanthra, Ernakulam Jn.	Sahodaran ayyappan	4/D	Two-way
3	Pallimukku Jn to Kacheripady Jn.	Jose Jn, Ground Jn, PNVM hospital	Mahatma Gandhi	4/D	Two-way
4	Kacheripady Jn.	Ernakulam town.	Banerji	2/UD	Two-way
5	Ernakulam town to Palarivattom	Lissie Jn, Kaloor Jn, Deshaabhimani Jn.	Banerji	4/D	Two-way
6	Palarivattom to Edapally Jn.	Mamangalam, Changampuzha park	Edapally-Palarivattom	4/D	Two-way
7	Edapally Jn to North Kalamassery Jn.	Edapally Toll Jn, Pathadipalam, CUSAT	Salem-Ernakulam Hwy	4/D	Two-way
8	North Kalamassery Jn. to Aluva	Muttom, Ambattukavu, Companypady Jn.	Salem-Ernakulam Hwy	4/D	Two-way

*D- Divided; UD-Undivided; Jn-Junction

(Source: Primary traffic survey 2013)

Observations

- Majority of the roads are 4-lane divided with two-way traffic except between Petta to Vytilla junction and Kacheripady junction to Ernakulam town which is 2-lane divided.
- Ettumanoor to Ernakulam road and Banerji road which starts from Kacheripady to Ernakulam town consists of 2-lane undivided category with two-way traffic.
- The quality of the road is good along the project corridor and most of the major junctions are signalized.

Table 4.3 Lane Characteristics of Roads – Project Influence Area

Sl. No	From Node	To Node	Road name	Lane Type	Traffic Management
1	PNVM hospital	High court Jn.	Banerji	4/D	Two-way

Sl. No	From Node	To Node	Road name	Lane Type	Traffic Management
2	High court Jn.	Menaka Jn	Shanmugham	4/D	Two-way
3	Menaka Jn.	Durbar hall	Park Avenue	2/UD	Two-way
5	Pallimukku Jn.	Hotel Hamilton	Church Landing	Single Lane	Two-way
6	Hotel Hamilton	TDM Hall Jn.	Divans	Single Lane	Two-way
7	Manorama Jn.	Panampilly Nagar	Panampilly Nagar	4/D	Two-way
8	Panampilly Nagar	Kadavanthra Jn.	Shihab Thangal	Single Lane	Two-way
9	Kadavanthra Jn.	Kumaranasan Jn.	Kaloor Kadavanthara	4/D	Two-way
10	Kumaranasan Jn.	Kathrikadavu Jn.	Kathrikadavu ROB	2/UD	Two-way
11	Kathrikadavu Jn.	Kaloor Jn.	Kaloor Kadavanthara	4/D	Two-way
12	Palarivattom Jn	Pipeline Jn.	Kakkanad Rd & Civil Line	2/UD	Two-way
13	Pipeline Jn.	Vyttila Jn	Panavel-Kanyakumari Hwy	4/D	Two-way
14	Vyttila Jn	Sarovaram	NH47	4/D	Two-way
15	Vyttila Jn	Thammanam	Mahakavi Vailoppilli	2/UD	Two-way
16	Thammanam	Kathrikadavu Jn.	Thammanam-Pullepady	Single Lane	Two-way
17	Thammanam	NH 47	Vyloppilly, Pipeline	Single Lane	Two-way
18	NH 47	Edapally Jn.	NH47	4/D	Two-way
19	Edapally Jn.	Kunnumpuram Jn.	Edapally-Panvel Hwy	2/UD	Two-way
20	Kalamassery Panjayath	South Kalamassery Jn.	TVS	2/UD	Two-way
21	South Kalamassery Jn.	HMT Jn.	Old Kalamassery	2/UD	Two-way
22	North Kalamassery Jn.	Old eloor bridge	FACT Kalamessery	2/UD	Two-way
23	Old eloor bridge	Salem-Ernakulam Hwy	ICT	4/D	Two-way
24	Pulinchode Jn.	Karothukuzhi Jn.	Aluva-Ernakulam	2/UD	Two-way
25	Karothukuzhi Jn.	NH 47	NH 48	2/UD	Two-way
26	Mamangalam	Karukappilly Jn	Pottakuzhi Mamangalam	Single Lane	Two-way
27	Karukappilly Jn	Pottakuzhi Jn	Pottakuzhi Mamangalam	Single Lane	Two-way
28	Pottakuzhi Jn	Kaloor Jn.	Perandoor	2/UD	Two-way
29	Petta	Vadakkekotta	Kochi-Dhanushkodi	2/UD	Two-way
30	Petta	Mini Bypass	Kochi-Dhanushkodi	2/UD	Two-way

*D- Divided; UD-Undivided; Jn-Junction

(Source: Primary traffic survey 2013)

Observations

- Around 41% of roads are 2-lane undivided characteristics and about 36% of roads are 4-lane divided with two-way.
- Twenty three percent of roads are single lane with two-way.
- Among the major roads in the project influence area, 95% of the roads are of good quality.

Type of Carriageway

The share of various types of road carriageways on the project corridor and in the project influence area is presented in Table 4.4 and Table 4.5. The largest share of roads in the project corridor is of 4-lane divided carriage ways (87%) and in the project influence area is of 2-lane undivided carriage ways (41%).

Table 4.4 Type of Carriageway – Project Corridor

Sl. No	Carriage way type	Total Length (Km)	% of length
1	2-lane undivided	3.3	13%
2	4-lane divided	21.7	87%
	Total	25.0	100%

(Source: Primary traffic survey 2013)

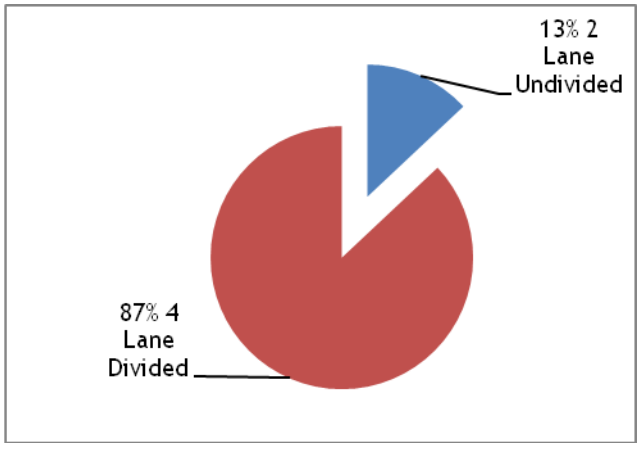


Figure 4.3 Type of Carriageway – Project Corridor

Table 4.5 Type of Carriageway – Project Influence Area

Sl. No	Carriage way type	Total Length (Km)	% of length
1	Single lane	8.20	23%
2	2-lane undivided	14.65	41%
3	4-lane divided	12.80	36%
	Total	35.65	100%

(Source: Primary traffic survey 2013)

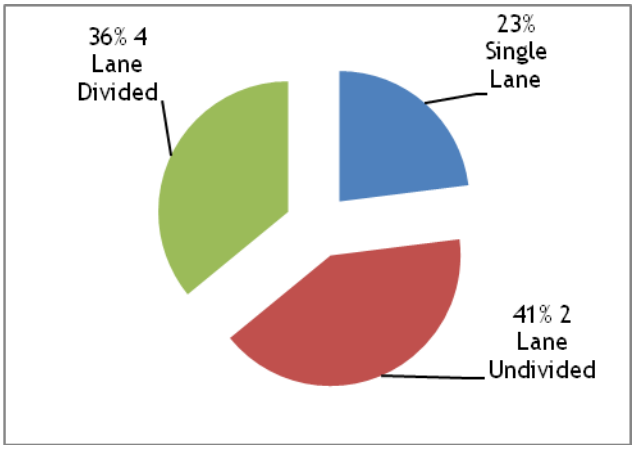


Figure 4.4 Type of Carriageway – Project Influence Area

Table 4.6 presents the major intersections and the connecting roads to the project corridor.

Table 4.6 Major Roads – Project Corridor

Major Junction Name	Type of Intersection/ Junction	Major Crossing Road	Road Name
Petta	3-arm	Kochi-Dhanushkodi road	Ettumanoor-Ernakulam road
Thykoodam	3-arm	Church road	Ettumanoor-Ernakulam road
Vyttila Jn	4-arm	NH 47 and Kaniampuzha road	Sahodaran Ayyappan road
Janatha Jn.	3-arm	Vytilla Janatha road	Sahodaran Ayyappan road
Elamkulam Jn.	3-arm	Chilavannur road	Sahodaran Ayyappan road
Kadavanthara	4-arm	Kaloor Kadavanthra road and KP Vallon road	Sahodaran Ayyappan road
Manorama Jn.	3-arm	Panampilly nagar Avenue	Sahodaran Ayyappan road
Valanjambalam Jn.	4-arm	Chittoor road and Ravipuram road	Sahodaran Ayyappan road
Pallimukku Jn.	4-arm	Church landing road and SA road	Mahatma Gandhi road
Jose Jn.	4-arm	Durbar Hall road	Mahatma Gandhi road
PNVM hospital Jn.	3-arm	Mahatma Gandhi road	Banerji road.
Kacheripady Jn.	4-arm	Chittoor road	Banerji road.
Ernakulam town	3-arm	Paramara road	Banerji road.
Lissie Jn.	4-arm	Golden Jubilee road and Judges Avenue	Banerji road.

Major Junction Name	Type of Intersection	Major Crossing Road	Road Name
Mathrubhumi Jn.	4-arm Junction	Azad road and Asoka road	Banerji road.
Deshabhimani Jn.	4-arm Junction	Desabhimani road and Ponoth road	Banerji road.
Stadium Rd Jn.	3-arm Junction	Stadium road	Banerji road.
Changampuzha Park	3-arm Junction	Edapally Raghavan pillai road	Palarivattom Edapally road
Edapally Jn.	4-arm Junction	Edapally Panavel Hwy and NH48	Palarivattom Edapally road
CUSAT University Jn	4-arm Junction	University road and TOG road	Salem-Ernakulam Hwy
North Kalamassery Jn	3-arm Junction	FACT Kalamassery road	Salem-Ernakulam Hwy
Companypady Jn.	3-arm Junction	SWTS road	Salem-Ernakulam Hwy

*Jn: Junction

(Source: Primary traffic survey 2013)

Figure 4.5 presents the distribution of road network by number of lanes in the GCDA.

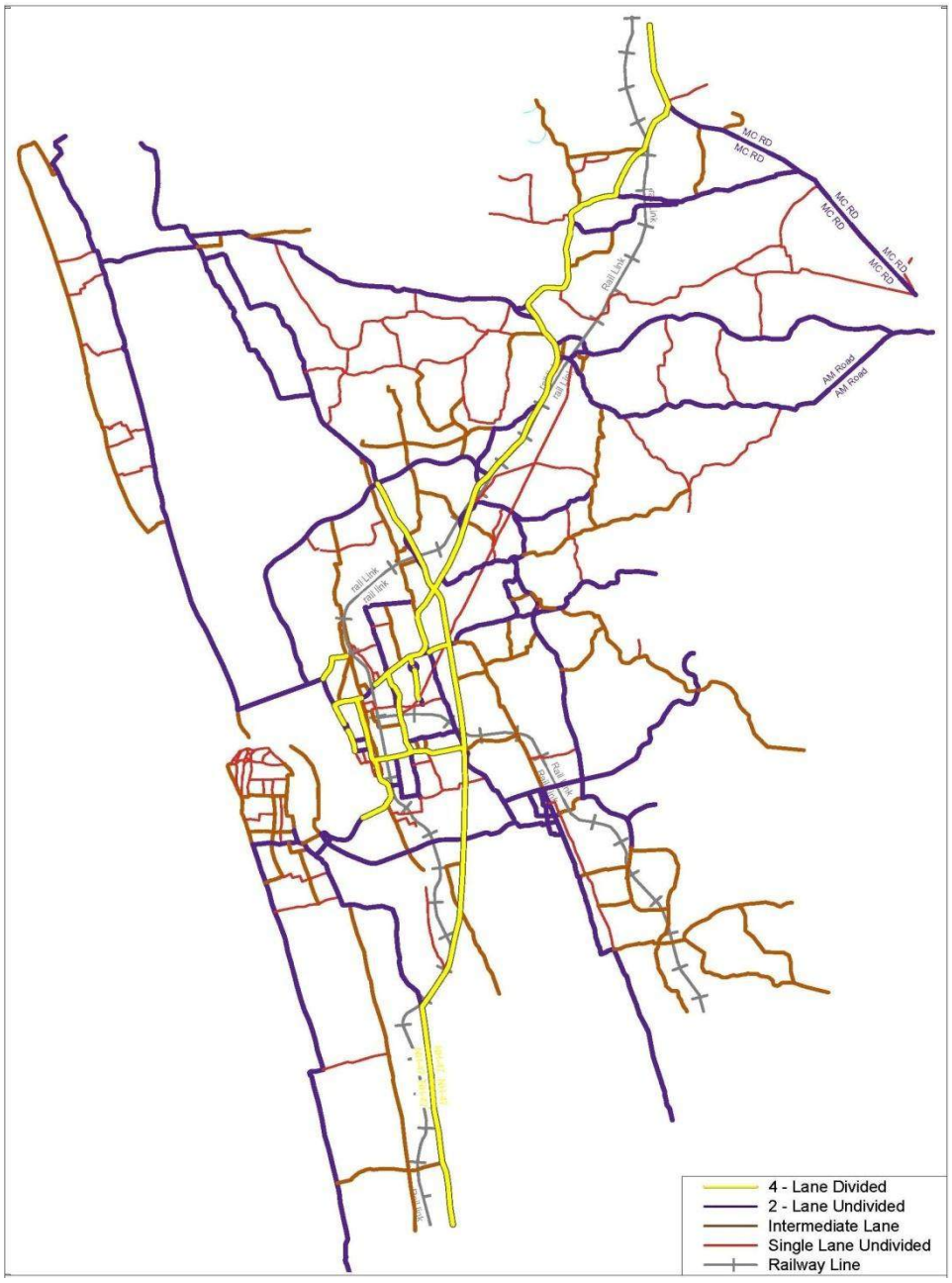


Figure 4.5 Network Characteristics

Road Furniture along the Project Corridor and Roads in PIA

Availability of Foot path: Foot path is absent on nearly 75% of major roads in the PIA.

Road Markings: Road markings are available only within the city core area and can be rated as good. The road quality along the project corridor and in the project influence area is good.

Sign boards: Out of the total major road network, sign boards are not available on 40% of the roads. Sign board quality within the city limits can be rated as fair.

Street Lighting: The street lighting is present for 30% of the project corridor and mostly on the central median. Street lighting is not available for 25% of roads in the PIA.

4.2.2 Speed and Delay

Objective of the Survey: To find out the journey speed, running speed and types of delay such as stopped delay and operational delay, and to evaluate the level of service or quality of traffic flow of a road or entire road network system. This will be used to develop the speed flow equations and to validate the transport model.

Scope of the Survey: To conduct the speed study on all major corridors during peak and off-peak hours on any normal day. The overall travel speed generally referred to as journey speed is the effective speed between two points, and is computed by the distance divided by the total time taken by the vehicle to complete the journey including delays incurred en-route.

Conduct of the Survey: The survey is conducted during peak and off-peak hours on a normal day using moving observer method. The survey vehicle is moved in the stream of traffic during different times of the day in both peak and off peak periods. The delays and corresponding causative factors at intersections/major activity centers is collected to identify major bottlenecks on the road.

Data Entry and Analysis: Speed and delay data collected on identified travel corridors of road network in the study area and along the project influence area. The observed journey speed and running speed along the project corridor are presented in Figure 4.6 and Figure 4.7 respectively. The direction wise journey speed and running speed observed on the project corridor and in the project influence area are presented in Table 4.7 and Table 4.8 respectively.

The observed journey speed in project influence area is presented in Figure 4.8.

- *Key Outputs:* Journey speeds and Running speeds (kmph) & Speed Flow equations

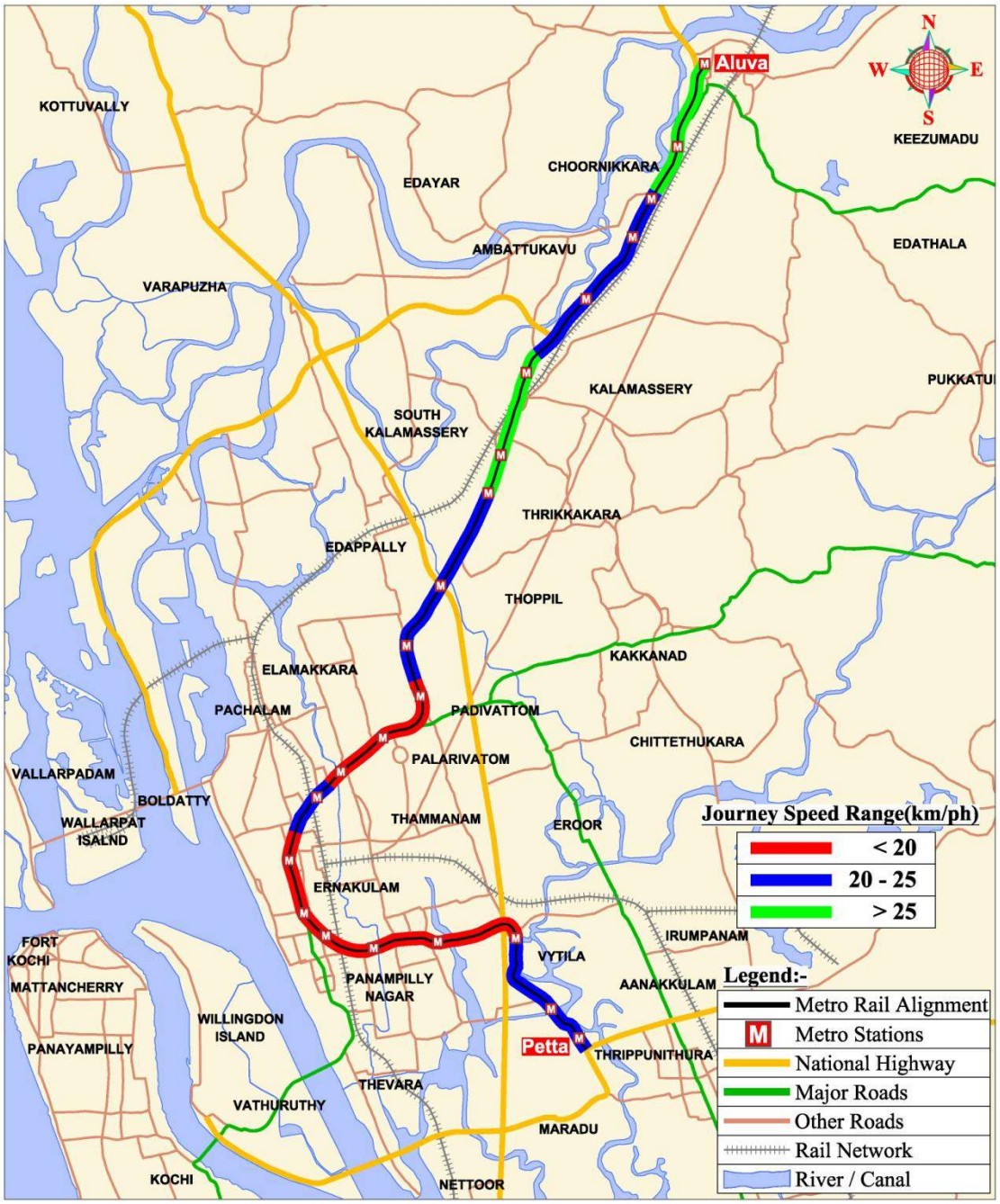


Figure 4.6 Journey Speeds - Project Corridor

The journey speed is less than 20 kmph between Vytilla and Palarivattam on the project corridor. Being the main spine of the core city area, this road accommodates the major establishments, private and Govt. offices, attracting the daily commuters in the peak hour. Delay at junctions is the main cause of the delay leading to lower speeds on the corridor between Vytilla and Palarivattam.

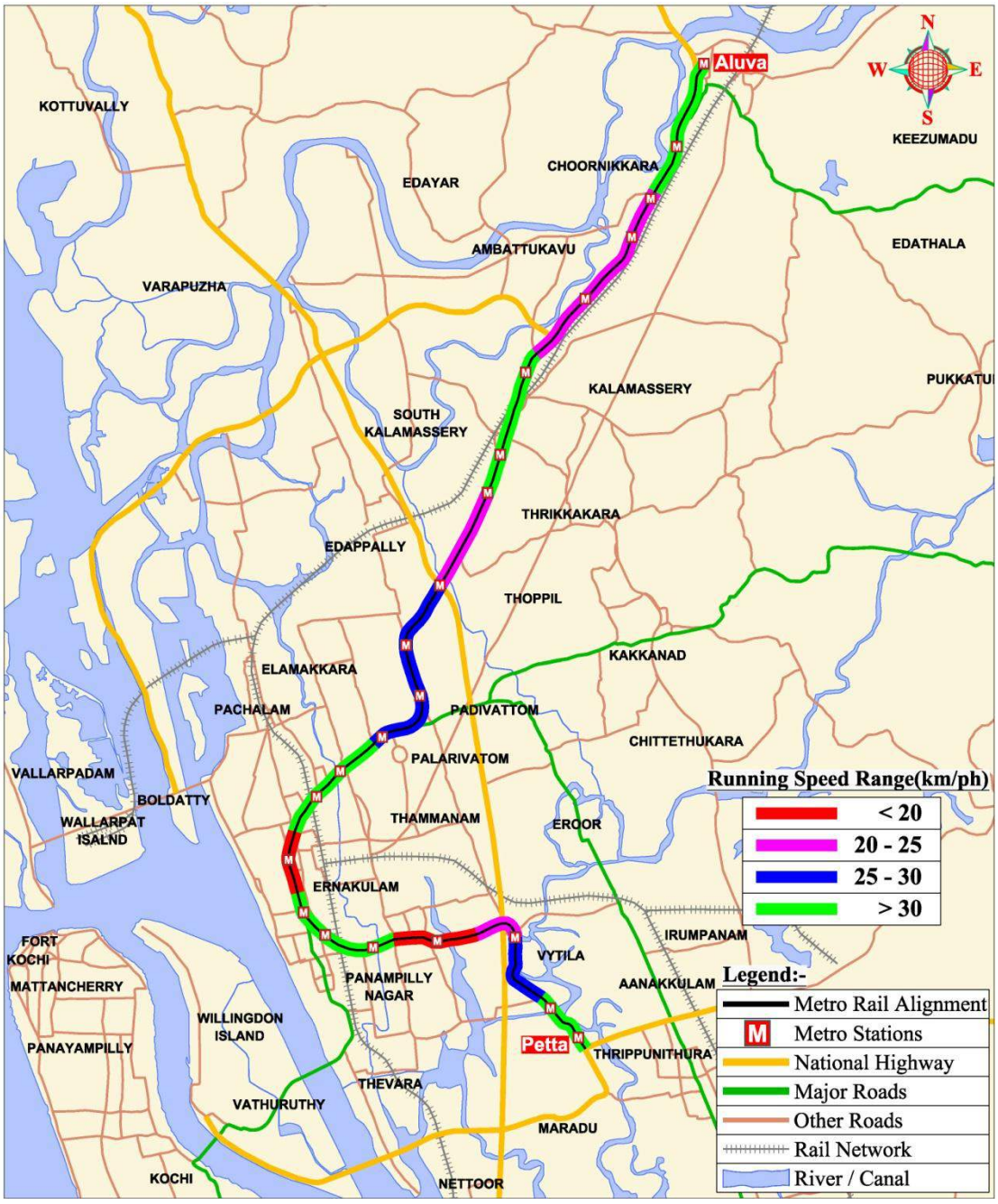


Figure 4.7 Running Speeds - Project Corridor

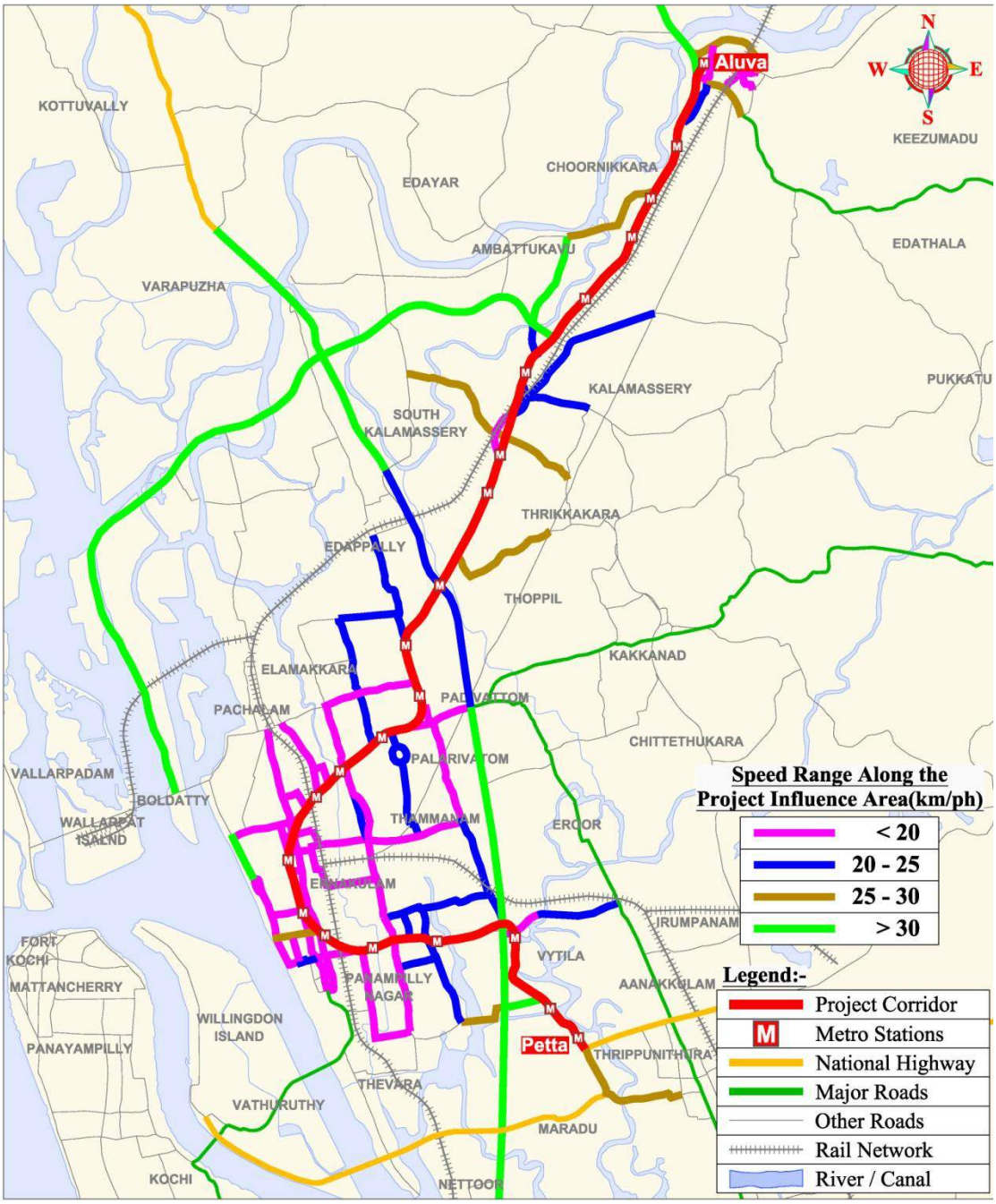


Figure 4.8 Journey Speeds - Project Influence Area

Table 4.7 Observed Journey Speeds and Running Speeds – Project Corridor

Sl. No	From	To	Distance in Km	Peak	Journey time taken in mins	Average JS (Kmph)	Delay in mins	Average RS (Kmph)
1	Aluva	Companypady Jn.	2.1	EP	4.49	28.06	1.29	39.38
				MP	4.59	27.45	1.20	37.17
				O	4.48	28.13		28.13
2	Companypady Jn.	Muttom	1.9	EP	4.6	24.78		24.78
				MP	5.09	22.40		24.31
				O	4.58	24.89		24.89
3	Muttom	North Kalamassery Jn	1.8	EP	5.37	20.11	0.16	20.73
				MP	4.37	24.71		24.71
				O	3.39	31.86		31.86
4	North Kalamassery Jn	Pathadipalam	2.6	EP	6.16	25.32		27.08
				MP	6.05	25.79	1.03	33.77
				O	5.4	28.89		28.89
5	Pathadipalam	Edapally Jn.	1.7	EP	5.08	20.08	2.35	37.36
				MP	4.37	23.34		23.34
				O	5.33	19.14	2.18	32.38
6	Edapally Jn.	Mamangalam	1.9	EP	6.17	18.48	1.39	23.29
				MP	5.54	20.58	1.48	25.12
				O	5.22	21.84		21.84
7	Mamangalam	Deshabhimani Jn.	1.7	EP	5.45	18.72	3.28	47.00
				MP	5.32	19.17	1.25	27.79
				O	5.07	20.12	1.32	30.45
8	Deshabhimani Jn.	Lissie Jn.	1.2	EP	3.54	20.34	2.00	46.75
				MP	4.09	17.60	2.12	45.86
				O	3.54	20.34	2.04	48.00
9	Lissie Jn.	Kacheripady	1.2	EP	3.01	23.92	1.10	37.70
				MP	3.56	20.22	2.07	48.32
				O	3.54	20.34		20.34
10	Kacheripady	Shenoys	1.4	EP	4.29	19.58	2.20	40.19
				MP	4.53	18.54	0.14	19.13
				O	4.09	20.54	1.08	32.18
11	Shenoys	Valanjambalam	1.6	EP	5.05	19.01	2.10	32.49
				MP	5.15	18.64	2.43	35.29
				O	4.15	23.13	1.01	30.57
12	Valanjambalam	Kadavanthra	1.1	EP	3.37	19.58	2.00	48.18
				MP	3.57	18.49	2.04	43.14
				O	2.82	23.40	1.39	46.15
13	Kadavanthra	Janatha stop	1.5	EP	4.31	20.88	2.41	47.37
				MP	4.59	19.61		19.61
				O	4.01	22.44	1.15	36.59

Sl. No	From	To	Distance in Km	Peak	Journey time taken in mins	Average JS (Kmph)	Delay in mins	Average RS (Kmph)
14	Janatha stop	Vyttila bus stop	0.8	EP	2.01	23.88	1.04	49.48
				MP	2.46	19.51	0.21	21.33
				O	2.38	20.17	1.32	45.28
15	Vyttila bus stop	Thykoodam	1.2	EP	3.02	23.84	0.50	33.96
				MP	3.59	20.06	1.00	27.80
				O	3.06	23.53	0.30	26.09
16	Thykoodam	Petta	1.3	EP	3.55	21.97		21.97
				MP	3.41	22.87	1.36	38.05
				O	2.2	35.45		35.45

*EP: Evening Peak; MP: Morning Peak O: Off-peak; JS: Journey speed; RS: Running Speed; Jn: Junction

(Source: Primary traffic survey 2013)

Table 4.8 Observed Journey Speeds – Project Influence Area

Sl. No	From Node	To Node	Road Name	Distance in Km	Average JS in Kmph
1	PNVM hospital	High court Jn.	Banerji road	0.50	19.74
2	High court Jn.	Menaka Jn.	Shanmugham road	1.00	34.29
3	Menaka Jn.	Durbar hall	Park Avenue	1.80	12.04
4	Durbar hall	Jose Jn.	Durbar hall road	0.50	25.21
5	Pallimukku Jn.	Hotel Hamilton	Church Landing road	0.80	20.87
6	Hotel Hamilton	TDM Hall Jn.	Divans road	0.70	16.22
7	Manorama Jn.	Panampilly Nagar	Panampilly Nagar Avenue	0.90	18.00
8	Panampilly Nagar	Kadavanthra Jn.	Shihab Thangal road	1.60	13.06
9	Kadavanthra Jn.	Kumaranasan Jn.	Kaloor Kadavanthara road	0.60	15.00
10	Kumaranasan Jn.	Kathrikadavu Jn.	Kathrikadavu ROB	0.60	13.95
11	Kathrikadavu Jn.	Kaloor Jn.	Kaloor Kadavanthara road	0.50	19.74
12	Palarivattom Jn	Pipeline Jn.	Kakkanad road & Civil Line road.	0.70	13.55
13	Pipeline Jn.	Vyttila Jn	Panavel-Kanyakumari Highway	4.00	34.09
14	Vyttila Jn.	Sarovaram	NH47	2.20	33.76
15	Vyttila Jn	Thammanam	Mahakavi Vailoppilli road	1.10	20.56
16	Thammanam	Kathrikadavu Jn.	Thammanam-Pullepady	2.50	16.22

Sl. No	From Node	To Node	Road Name	Distance in Km	Average JS in Kmph
17	Thammanam	NH 47	Vyloppilly road, Pipeline road	0.90	15.88
18	NH 47	Edapally Jn.	NH47	2.40	23.84
19	Edapally Jn.	Kunnumpuram Jn.	Edapally-Panvel Highway	2.30	21.33
20	Kalamassery Panjayath	South Kalamassery Jn.	TVS road	0.90	19.29
21	South Kalamassery Jn.	HMT Jn.	Old Kalamassery road	0.70	34.43
22	North Kalamassery Jn.	Old eloor bridge	FACT Kalamessery road	2.75	20.12
23	Old eloor bridge	Salem-Ernakulam Hwy	ICT road	0.70	35.00
24	Pulinchode Jn.	Karothukuzhi Jn.	Aluva-Ernakulam road	0.80	34.78
25	Mamangalam	Karukappilly Jn.	Pottakuzhi Mamangalam road	1.40	16.80
26	Karukappilly Jn.	Pottakuzhi Jn.	Pottakuzhi Mamangalam road	0.30	18.00
27	Pottakuzhi Jn.	Kaloor Jn.	Perandoor road	1.30	15.60
28	Petta	Mini Bypass road	Kochi-Dhanushkodi road	3.20	27.43

*JS: Journey speed; Jn: Junction

(Source: Primary traffic survey 2013)

4.3 Traffic and Travel Characteristics

4.3.1 Midblock Flows

Objective of the survey: To assess the total mode wise traffic along the project corridor for the peak hour and during the operation period of the proposed metro.

Scope of the survey: This includes identification of the homogenous sections and the midblock traffic count stations and count of vehicles classified by the type of vehicle crossing the midblock during the peak and off-peak periods.

Conduct of the survey: Manual traffic counts are carried out on a typical working day between 5.00:23.00 at the identified locations. At each identified station, directional counts are carried out by vehicle type. i.e. cars, taxis, buses, trucks, 2-wheelers, 3-wheelers and slow moving vehicles.

Data entry and analysis: The traffic data collected at identified locations is scrutinized and processed.

- ☞ *Key Outputs*

- Peak hour volume at the survey stations (Vehicles/Hr and PCU/Hr)
- Share of traffic in the peak hour
- Traffic composition

Observed traffic at all the survey locations along the project corridors is presented in Table 4.10. The PCUs corresponding to urban roads as per IRC: 106-1990 is used for converting vehicles to equivalent passenger car units. PCU values adopted is given in Table 4.9. The volume count summary is given in Annexure 2.

Table 4.9 Equivalency Factors by Type of Vehicles

Vehicle Type	PCU Value	
	Urban	
	UP TO 5 %	> 5%
City buses Public/Private	2.2	3.7
Long Distance Bus Public/Private	2.2	3.7
Institutional/ Company Buses	2.2	3.7
Mini Bus	1.5	1.5
Car	1	1
Taxi	1	1
2-Wheeler	0.5	0.75
3-Wheeler	1.2	2
Share Auto	1.2	2
Trucks	2.2	3.7
MAV & above	4	5
LCV	1.4	2
Cycles	0.4	0.5
Others	2	3

(Source: IRC 106-1990)

Traffic Volume: The traffic volume (18 Hours) at midblock locations is presented in Table 4.10.

Table 4.10 Traffic Volume (18 Hours) at Midblock Locations

Sl. No	Location	Name of the Road	Direction 1		Direction 2		Total	
			Towards Petta		Towards Aluva			
			Vehicles	PCUs	Vehicles	PCUs	Vehicles	PCUs
1	Chumbakkara	Ettumanoor-Ernakulam	11576	14126	11602	15094	23178	29,220

2	Edapally	Salem-Ernakulam Highway	29,586	33,380	28,888	33,659	58,474	67,040
3	Kalamessery	Salem-Ernakulam Highway	25,945	36,202	31,343	50,504	57,288	86,706
4	MG road	MG road	19,208	21,848	25,347	30,929	44,555	52,777
5	Vytilla	SA road	24,876	27,664	37,554	37,664	62,430	65,328

(Source: Primary traffic survey 2013)

Peak Hour Traffic: The peak hour traffic volume is presented in Table 4.11. The share of traffic during the peak hour ranges between 6.2% and 12%.

Table 4.11 Peak Hour Traffic at Midblock Locations

Sl. No.	Location	Name of the Road	Peak Hour	Peak Traffic in PCU	Traffic (18hrs) in PCU	Share of Peak Traffic (%)
1	Chumbakkara	Ettumanoor-Ernakulam	08.30-09.30	3,438	29,220	12%
2	Edapally	Salem-Ernakulam Highway	08.45-09.45	5,186	67,040	7.7%
3	Kalamessery	Salem-Ernakulam Highway	11.00-12.00	5,386	86,706	6.2%
4	MG road	MG road	11.00-12.00	4,314	52,777	8.2%
5	Vytilla	SA road	09.00-10.00	6,666	65,328	10.2%

(Source: Primary traffic survey 2013)

The analysis on the share of traffic in the peak hours demonstrates that the peak period for the project corridor in the morning is between 08:00 to 11:00 hrs.

Hourly Distribution: The hourly distribution of traffic along the project corridor is presented in Figure 4.9.

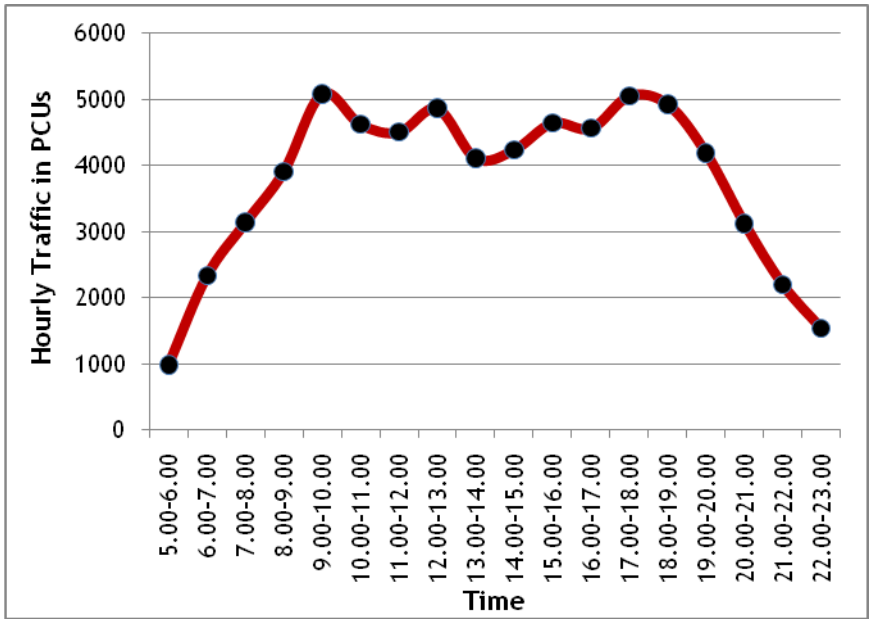


Figure 4.9 Hourly Traffic Distribution

Traffic Composition: Composition of traffic during peak hour is presented in Figure 4.10. Private modes dominated with 73% followed by 21% of public transport and intermediate public transport (IPT). IPT include 3-wheelers and taxis (4-wheelers). Table 4.12 presents an average vehicle composition for the surveyed locations on the project corridor during 9.00:10.00.

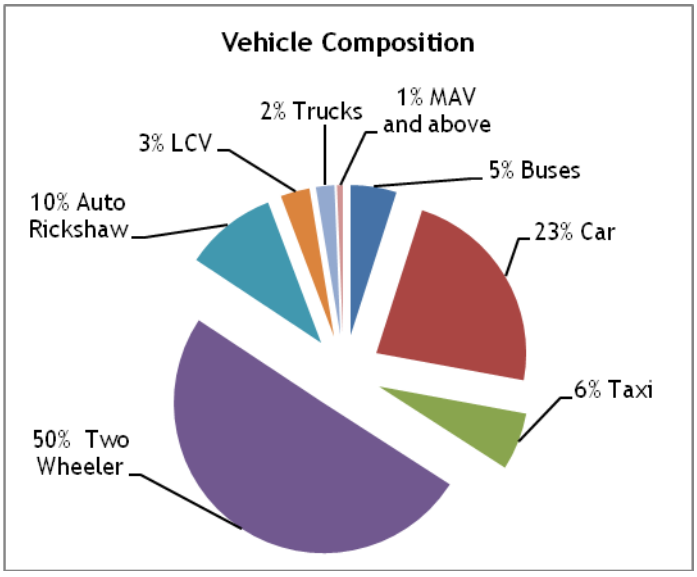


Figure 4.10 Traffic Composition - Peak Hour

Obervations

- Highest volume - 86706 PCU at Kalamassery location, Salem Ernakulam Highway road in between 18 Hours.
- Share of peak traffic is only 6.2% at Kalamassery illustrating a uniform flow over the day
- Traffic at Edapally and Vytilla is in the range of 65000 PCUs

- Seventy three percent accounts to private modes with almost fifty percent contributed by 2-wheelers illustrating that significant share of commuters choose 2-wheelers as their mode to work.
- Goods traffic is maximum at Kalamassery with 6% i.e. on NH47 Salem Ernakulam Highway road for 18 hours.

Table 4.12 Vehicle Composition (9.00:10.00)

odes		Chumbakkara		Edapally		Kalamessery		MG road		Vytilla	
		Vytilla to Petta	Petta to Vytilla	Aluva to Palarivattom	Palarivattom to Aluva	Aluva to Ernakulam	Ernakulam to Aluva	Vytilla to Ernakulam	Ernakulam to Vytilla	Kadavanthra to Vytilla	Vytilla to Kadavanthra
City bus	Public	9	27	46	19	27	37	3	6	31	32
	Private	49	60	69	49	30	30	26	24	68	87
Institutional/ Company Bus		6	4	2	11	3	9	0	0	8	1
Mini Bus		8	4	5	9	6	15	2	3	14	4
Long Distance Bus	Public	19	5	4	11	38	20	21	1	5	14
	Private	15	0	5	3	10	10	18	1	0	8
Car		287	506	353	607	700	446	335	348	506	787
Taxi		78	159	194	104	277	102	70	48	73	211
2-Wheelers		525	572	2137	756	491	397	665	610	1080	3432
3-Wheelers		133	164	169	233	77	189	377	291	141	331
LCV		44	45	77	42	85	227	32	28	22	66
Trucks		19	30	34	23	120	170	8	0	10	6
MAV and Above		9	22	1	0	60	44	0	0	1	0
Cycles		4	0	5	4	0	2	0	11	2	0
Others		3	0	0	1	0	2	0	1	0	0
Total Vehicles		1208	1598	3101	1872	1924	1700	1557	1372	1961	4979
Total PCUs		1422	1946	2969	2080	2564	2515	1900	1558	1996	4670

(Source: Primary traffic survey 2013)

4.3.2 Screen Line Flows

Objective of the Survey: To estimate the traffic at the identified screen line locations to validate the urban transport model.

Scope of the Survey: This includes identification of the screen lines, traffic count stations and count of vehicles classified by the type of vehicle crossing the screen lines during the peak and off-peak periods.

Conduct of the Survey: Manual traffic counts are carried out on a typical working day for duration of 6:00 to 14:00 at the identified locations. At each identified station, directional counts are carried out by vehicle type. I.e. cars, taxis, buses, trucks, 2-wheelers, 3-wheelers and slow moving vehicles.

Data Entry and Analysis: The traffic data collected from the field is scrutinized and processed. Passenger car unit (PCU) values as recommended by Indian Roads Congress (IRC) for urban roads is used in the analysis (Refer Table 4.9).

The screen line count locations are presented in Figure 4.1.

- *Key Outputs*
  - Peak hour volume at the survey stations (Vehicles/Hr and PCU/Hr)
  - Share of traffic in the peak hour
  - Traffic composition

Traffic Volume: The traffic volumes (8 Hours) at screen line locations are presented in Table 4.13.

Table 4.13 Traffic Volume (8 Hours) at Screen Line Locations

Sl. No.	Location	Name of Road	Direction 1 Towards Ernakulam		Direction 2 From Ernakulam		Total	
			Vehicles	PCUs	Vehicles	PCUs	Vehicles	PCUs
1	Amirtha	Edapally-Panavel highway	5475	6444	4672	5148	10,147	11,592
2	Pachalam	Chittoor road	7362	7695	6248	6610	13,610	14,305
3	Palarivattom	Kakkanad road	9883	11849	8418	8441	18,301	20,290
4	Thopumpady	Kottayam road	9373	11800	10266	15092	19,639	26,893

(Source: Primary traffic survey 2013)

Peak Hour Traffic: The peak hour traffic volume is presented in Table 4.14.

Table 4.14 Peak Hour Traffic at Screen Line Locations

Sl. No.	Location	Name of Road	Peak Hour	Peak Traffic in PCU	Traffic (8hrs) in PCU
1	Amirtha	Edapally-Panavel highway	08:00-09:00	2052	11592
2	Pachalam	Chittoor road	08.45-09.45	2942	14,305
3	Palarivattom	Kakkanad road	08:00-09:00	3319	20,290
4	Thopumpady	Kottayam road	08.45-09.45	4819	26,893

(Source: Primary traffic survey 2013)

The analysis on the share of traffic in the peak hours demonstrates that the common peak hour in the morning for all the locations is between 08:00 to 11:00 hrs.

- Highest volume- 19,639 vehicles (26893 PCUs) on Kottayam road at Thoopumpady location in 8 hours
- Least volume- 10,147 vehicles (11592 PCUs) on Edapally Panavrel highway road at Amirtha location in 8 hours
- Peak traffic is high on Kottayam road with 4819 PCUs

4.3.3 Cordon Count and Roadside Interview Surveys

Objective of the Survey: These surveys are conducted at identified cordon locations to derive the passenger and freight travel pattern by road and also to assess the traffic movement between the study area and other parts of the country.

Scope of the Survey: This includes roadside interviews at the crossing of the identified cordons in the study area. Counts of vehicles are also done at the same locations to expand the captured trips. The Traffic Analysis Zones adopted are utilized to establish the travel pattern.

Conduct of the Survey: At the cordon points, classified volume counts are carried out for 18 hrs (05:00 to 11:00). Interviews as well as counts are carried out on a sample basis for 18 hours on a typical working day by stopping the vehicles with the help of police. Directional and mode wise classified volume count data is collected and used to calculate the expansion factors. The information collected includes origin and destination of trip, purpose, frequency and occupancy.

Data Entry and Analysis: The traffic data collected at identified locations is scrutinized and processed.

☞ *Key Outputs*

- Peak Hour Volume at the survey stations (Vehicle/Hr and PCU/Hr)

The survey is conducted at seven cordon locations as follows:

1. Petta

2. Kadavanthra
3. MG road
4. CUSAT
5. Angamally
6. NH Vyttila
7. Aroor

Traffic Volume: The traffic volume (18 Hours) at cordon locations is presented in Table 4.15.

Table 4.15 Traffic Volume (18 Hours) at Cordon Locations

Sl. No.	Location	Name of Road	Direction 1 Towards Ernakulam		Direction 2 From Ernakulam		Total	
			Vehicles	PCUs	Vehicles	PCUs	Vehicles	PCUs
1	Angamally	NH 47 (Kaniyakumari highway)	20261	31115	23135	32966	43,396	64,081
2	Aroor	NH 47 (Kanyakumari highway)	29770	35482	26654	35090	56,424	70,572
3	Paravoor	NH 17 (Vazhikulangara -Anachaal road)	9881	14727	7873	11342	17,754	26,069
4	Perumbavoor	Aluva-Munnar road	19777	24520	16859	23821	36,636	48,341
5	Puthiyakavu	Kottayam road	12775	14790	13115	15730	25,890	30,520
6	Thiruvakulam	Madurai road	8689	10550	9586	11620	18,275	22,171
7	Wonderla	Kakkanad-Pallikara road	5124	7483	4579	6782	9,703	14,265

(Source: Primary traffic survey 2013)

Peak Hour Traffic: The peak hour traffic volume is presented in Table 4.16.

Table 4.16 Peak Hour Traffic at Cordon Locations

Sl. No.	Location	Name of Road	Peak Hour	Peak Traffic in PCU	Traffic (18hrs) in PCU
1	Angamally	NH 47 (Kaniyakumari highway)	08:00-09:00	4339	64081
2	Aroor	NH 47 (Kanyakumari highway)	08.45-09.45	6191	70572

Sl. No.	Location	Name of Road	Peak Hour	Peak Traffic in PCU	Traffic (18hrs) in PCU
4	Perumbavoor	Aluva-Munnar road	09.45-10.45	3508	48341
5	Puthiyakavu	Kottayam road	08.30-09.30	3178	30520
6	Thiruvakulam	Madurai road	09.00-10.00	1713	22171
7	Wonderla	Kakkanad-Pallikara road	10.00-11.00	1152	14265

(Source: Primary traffic survey 2013)

The analysis on the share of traffic in the peak hours demonstrates that the peak period for the project corridor in the morning is between 08:00 to 11:00.

- Highest volume- 56, 424 vehicles (70572 PCUs) at Aroor on NH47 Kaniyakumari highway road in 18 hours
- Least volume- 9,703 vehicles at Wonderla on Kakkanad-Pallikara road in 18 hours.
- Peak traffic ranges between 1100 to 6220 PCUs with the highest observed at Aroor on NH 47 Kaniyakumari highway road.

4.3.4 Trip Characteristics

4.3.4.1 Zoning System Adopted

The study area is broadly classified into two regions: Kochi City Corporation limit and the area outside the city limits including six municipalities and villages. The entire study area is divided into a total of 132 zones, out of which 1 to 74 zones are within the corporation and 51 zones outside the city limit. Seven external zones outside the study area are considered from which significant floating population move towards the city. Figure 4.11 presents the zone system adopted for the study analysis. List of zones is presented in Annexure 3.

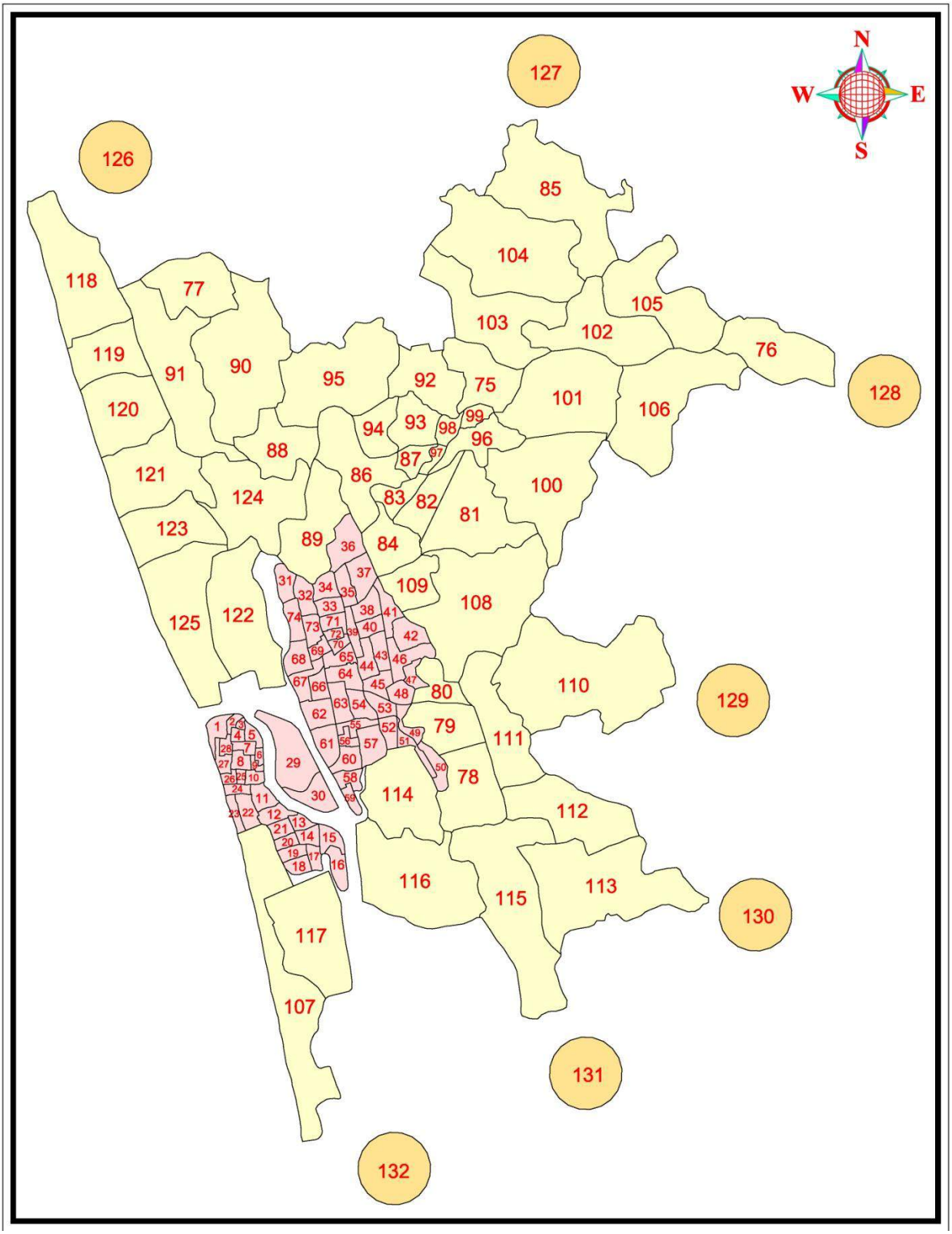


Figure 4.11 Zoning System

4.3.4.2 Sample Size

The roadside interview is carried out on a sample basis for different modes. The collected data is coded, processed and expanded to total traffic using the expansion factors for each vehicle type. Table 4.17 presents the sample size collected for the various modes in percentage.

Table 4.17 Sample Size Distribution

Mode	Petta	Kadavanthara	MG road	CUSAT	Angamally	Vyttila	Aroor
2-Wheeler	14.7%	3.9%	3.5%	5.0%	4.8%	3.5%	3.7%
Car	3.8%	3.1%	4.7%	2.9%	2.9%	5.8%	4.6%
3-Wheeler	2.3%	2.5%	1.1%	2.2%	3.1%	1.2%	2.8%

(Source: Primary traffic survey 2013)

4.3.4.3 Trip Frequency

Analysis of the trip frequency shows that the majority of trips are multiple and daily. Table 4.18 shows the trip frequency of passengers travelling on the project corridor and at the cordons.

Table 4.18 Trip Frequency - Project Corridor

Trips	2-Wheeler	Car	3-Wheeler
Multiple	30%	20%	30%
Daily	48%	31%	30%
Weekly	11%	15%	11%
Occasionally	11%	34%	30%

(Source: Primary traffic survey 2013)

Table 4.19 Trip Frequency - Cordon

Trips	2-Wheeler	Car	3-Wheeler
Multiple	22%	20%	34%
Daily	49%	34%	33%
Weekly	18%	24%	16%
Occasionally	11%	23%	17%

(Source: Primary traffic survey 2013)

Daily travelers mostly prefer 2-wheelers and the share of trips performed daily and multiple times by car is more than 50%. Occasional travelers travel by cars compared to other modes.

4.3.4.4 Purpose of Journey

Table 4.20 and Table 4.21 presents the trip purpose at all the locations across the project corridor and cordon locations. Analysis of 'purpose of journey' revealed that work trips made by 2-wheelers and 3-wheelers are in the range of 53-57%. Business trips are more often made by 4-wheelers i.e. cars.

Table 4.20 Purpose of Journey – Project Corridor

Trips	2-Wheeler	Car	3-Wheeler
Work	57%	37%	53%
Business	19%	25%	12%
Education	8%	5%	8%
Social & Recreation	5%	8%	6%
Medical	4%	5%	7%
Tourism	1%	8%	5%
Others	6%	12%	9%

(Source: Primary traffic survey 2013)

Table 4.21 Purpose of Journey – Cordon

Trips	2-Wheeler	Car	3-Wheeler
Work	46%	40%	41%
Business	26%	28%	21%
Education	7%	8%	5%
Social & Recreation	4%	7%	11%
Medical	7%	3%	8%
Tourism	0%	5%	0%
Others	10%	9%	14%

(Source: Primary traffic survey 2013)

The work trips are predominant on the project corridor and cordon locations, which is the typical travel characteristic of urban areas. Education trips ranges between 5-10%.

4.3.4.5 Occupancy

Table 4.22 presents the average occupancy of all the modes on the project corridor and at the cordon points. Analysis on occupancy of the vehicles excluding driver revealed that the average occupancy of the passenger modes in the city core is high compared to the outer areas.

Table 4.22 Average Occupancy - Project Corridor

Vehicle Type	Average Occupancy
2-Wheeler	1.4
Car	3.0
Taxi	2.7
3-Wheeler	2.4

(Source: Primary traffic survey 2013)

Table 4.23 Average Occupancy - Cordon

Vehicle Type	Average Occupancy
2-Wheeler	1.3
Car	2.9
Taxi	2.3
3-Wheeler	2.1

(Source: Primary traffic survey 2013)

Trip Characteristics: The traffic analysis zones are broadly classified into two major sectors for analyzing the trip characteristics. They are;

- Zones within the study area (Internal zones) – Zones 1 to 125
- Outside study area (External zones) – Zones 125-132

Table 4.24 shows the percentage of trips between the sectors for passenger vehicles. It is seen that external to internal trips is significant on the project corridor demonstrating considerable floating population in the study area. The external to external trips are found to be around 5.6% at the outer cordon points and about 0.6% on the project corridor which is insignificant.

Table 4.24 Travel Desire Pattern

Description	I-I	E-I	I-E	E-E
Project Corridor	82.0%	9.7%	7.7%	0.6%
Cordon	0%	49.2%	45.2%	5.6%

(E-E = Trips between External Zone to External Zone and I-E = Trips between Internal Zone & External Zone, I-I=Trips between Internal to Internal zones).
(Source: Primary traffic survey 2013)

Figure 4.12 to 4.14 presents the travel desire for private modes and IPT for the project corridor. Figure 4.15 to 4.17 presents the travel desire observed at the cordons.

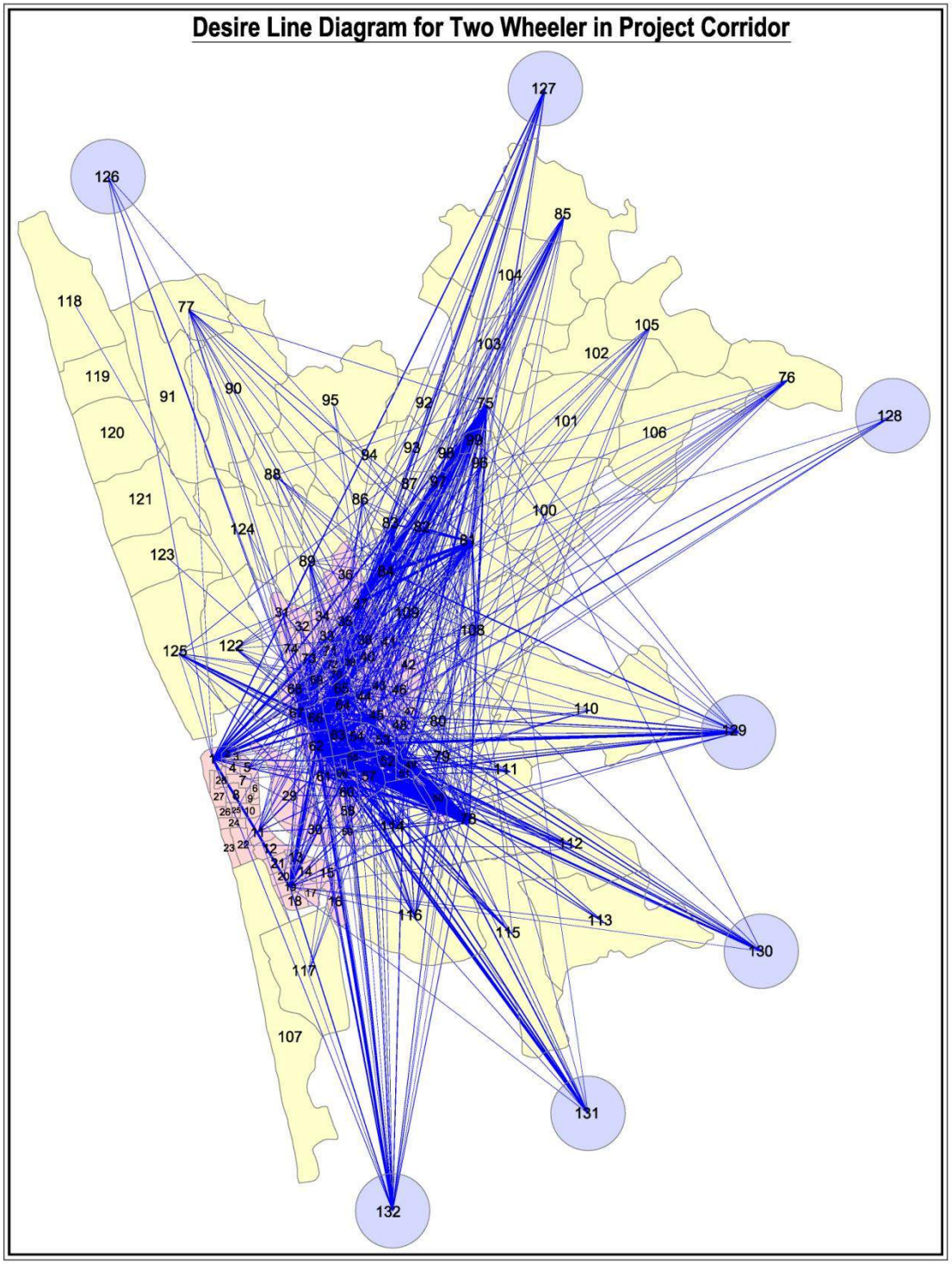


Figure 4.12 Desire-2-Wheelers – Project Corridor

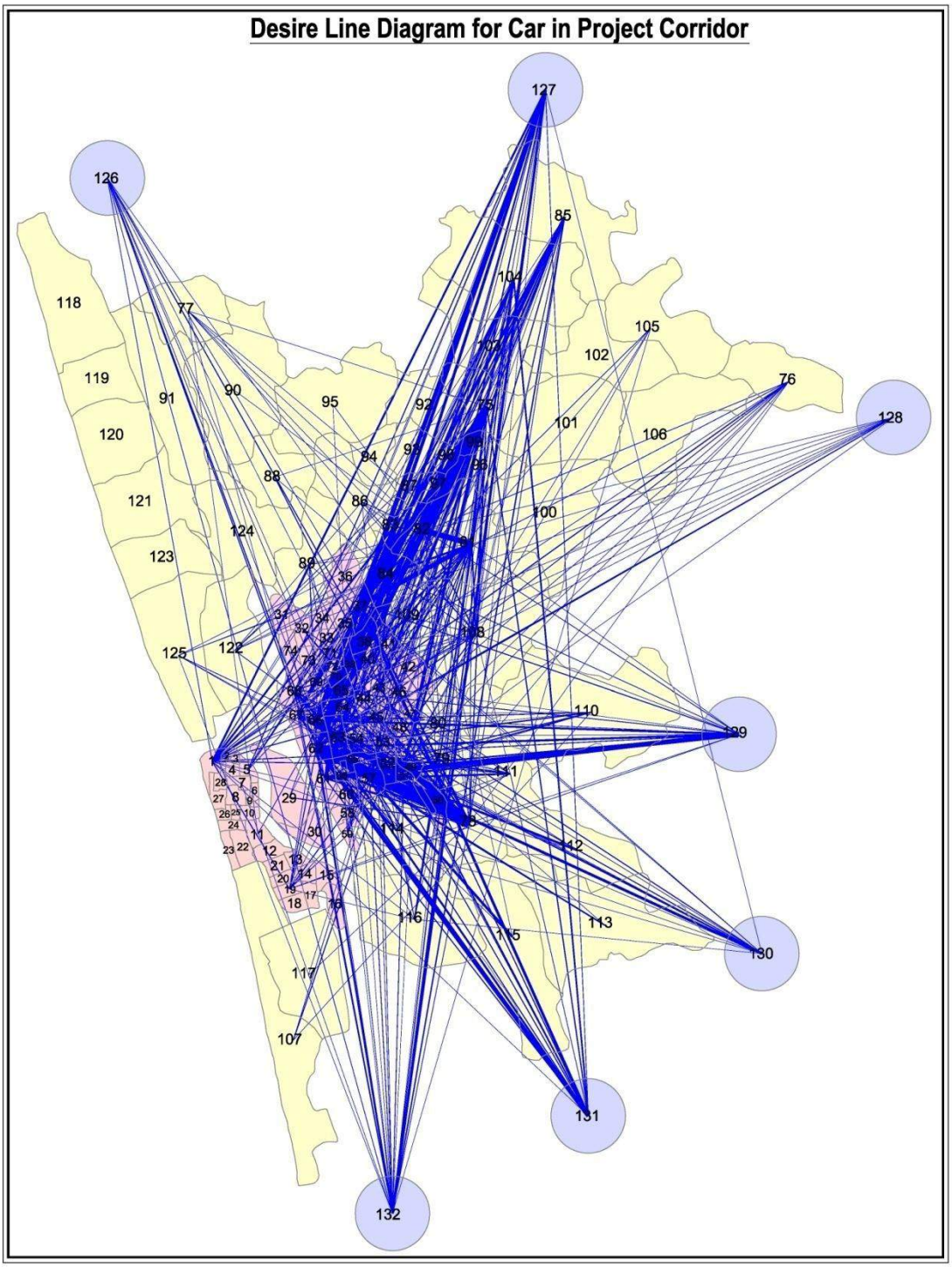


Figure 4.13 Desire-Cars – Project Corridor

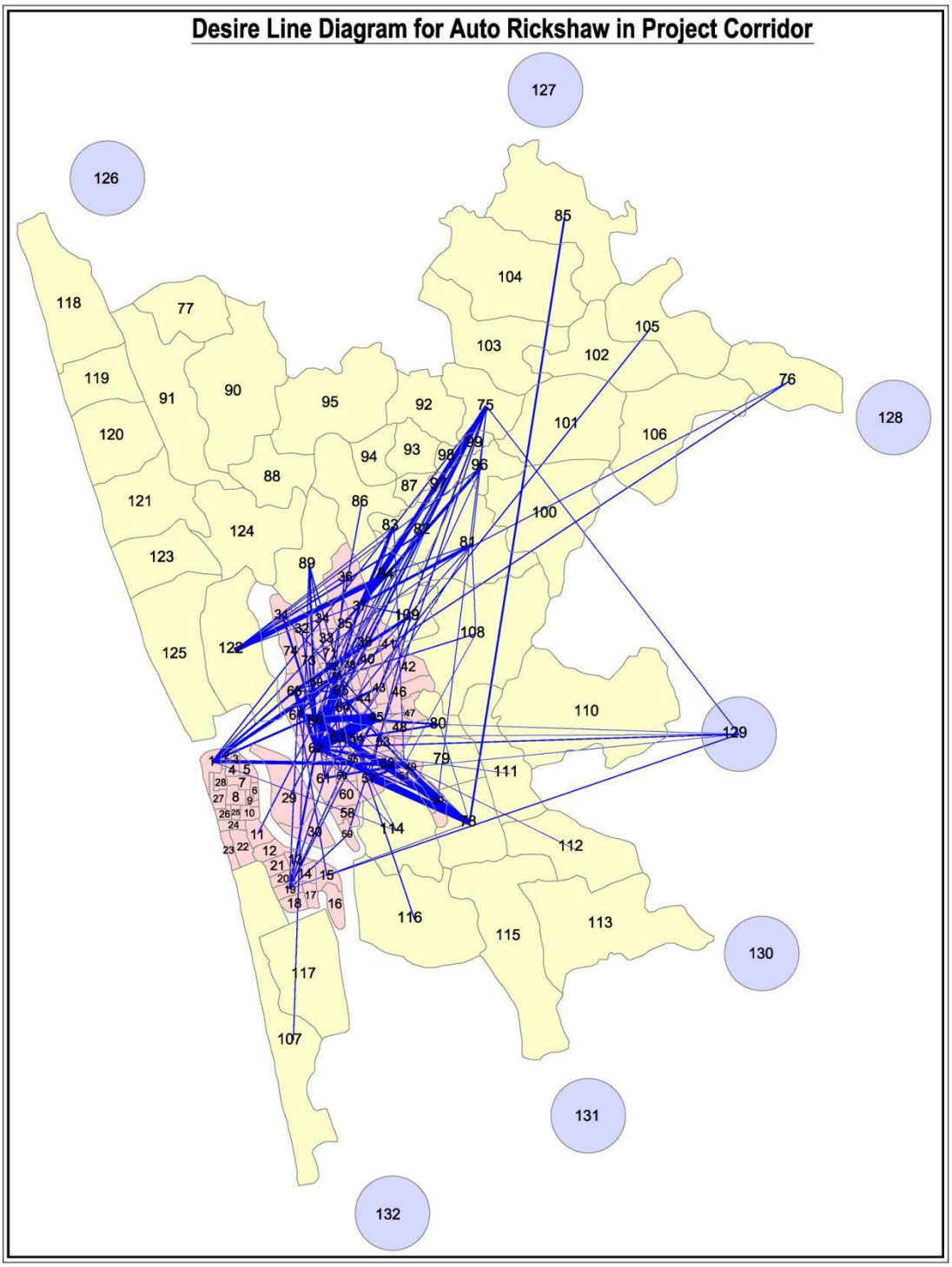


Figure 4.14 Desire-3-Wheelers – Project Corridor

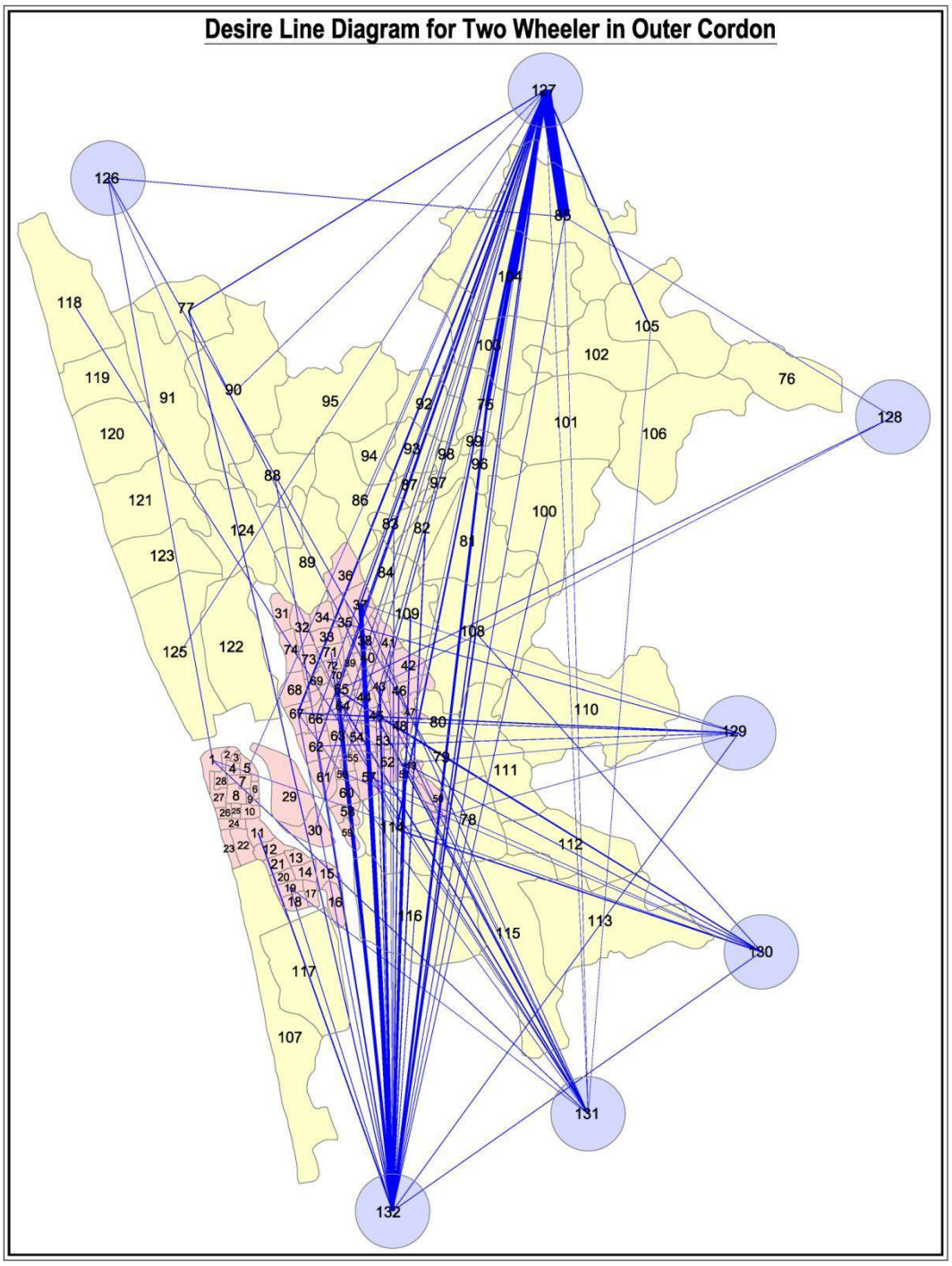


Figure 4.15 Desire-2-Wheelers – Outer Cordon

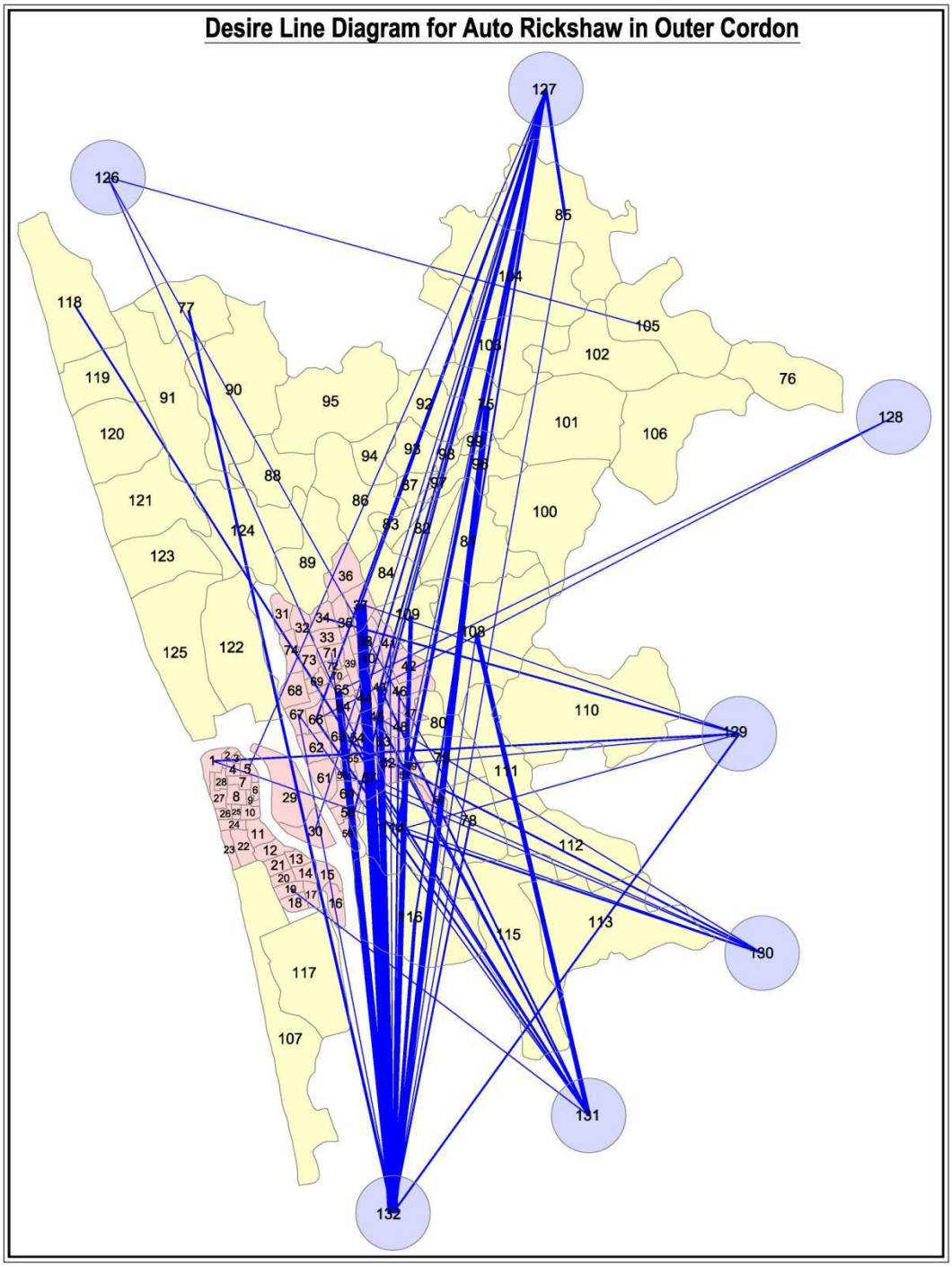


Figure 4.16 Desire-3-Wheelers – Outer Cordon

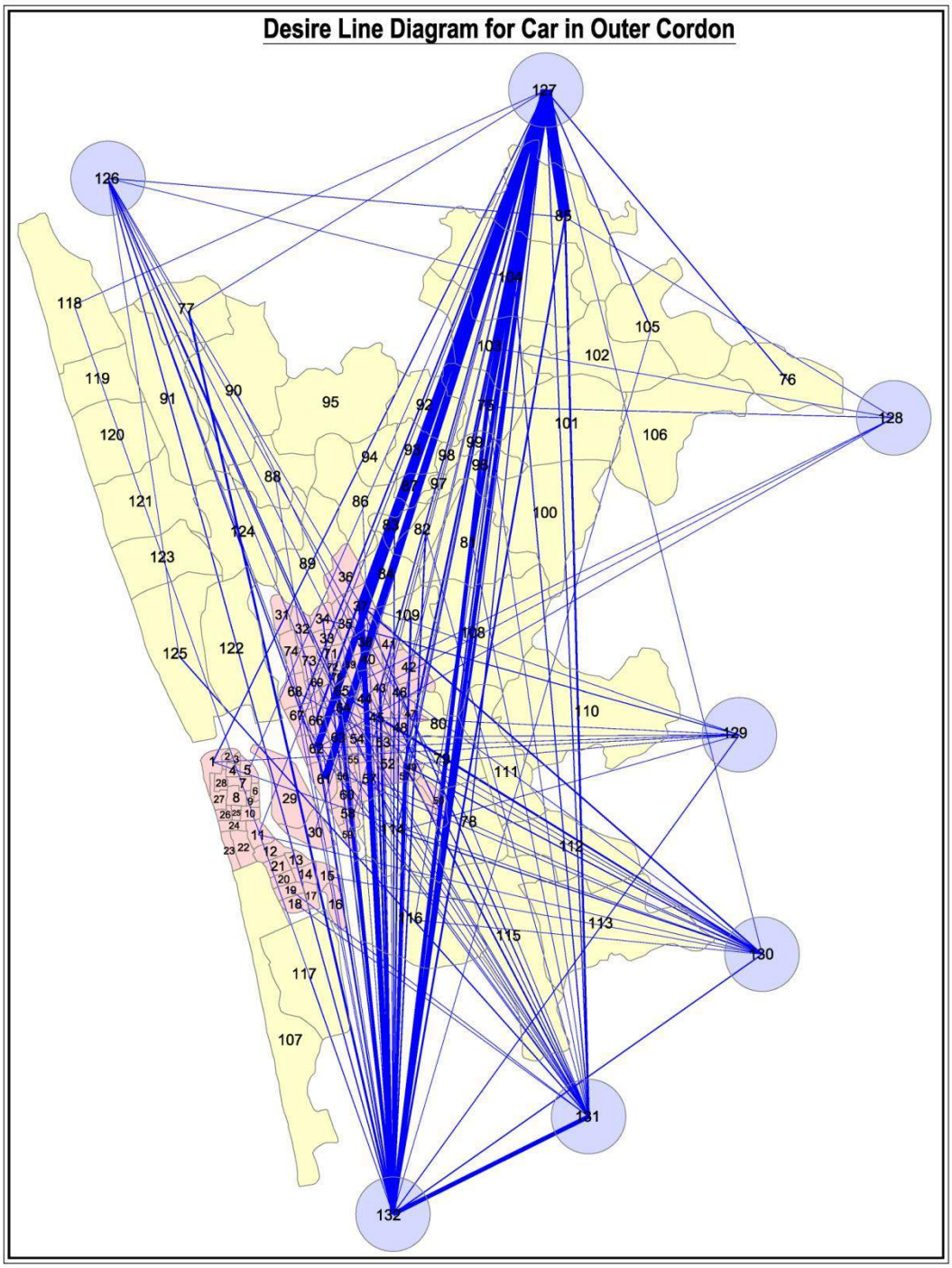


Figure 4.17 Desire-Cars – Outer Cordon

Trip Length Distribution: The average trip length is estimated based on the origin-destination and zone to zone distance matrix**.** The average trip length is presented in Table 4.25.

Table 4.25 Average Trip Length in Km

Mode	Project Corridor	Cordon
2-Wheeler	9.9	20.5
Car	10.4	29.9
3-Wheeler	8.1	15.6
Public transport (Bus)	9.8	-

(Source: Primary traffic survey 2013)

Average trip length for the 2-wheeler and cars is in the range of 9.9-10.4 km on the project corridor. At the cordons it ranges between 20.5-29.9 km. The average trip length for 3-wheelers is 8.1 km on the project corridor. Figure 4.18 and Figure 4.19 presents the trip length distribution for the project corridor and cordons.

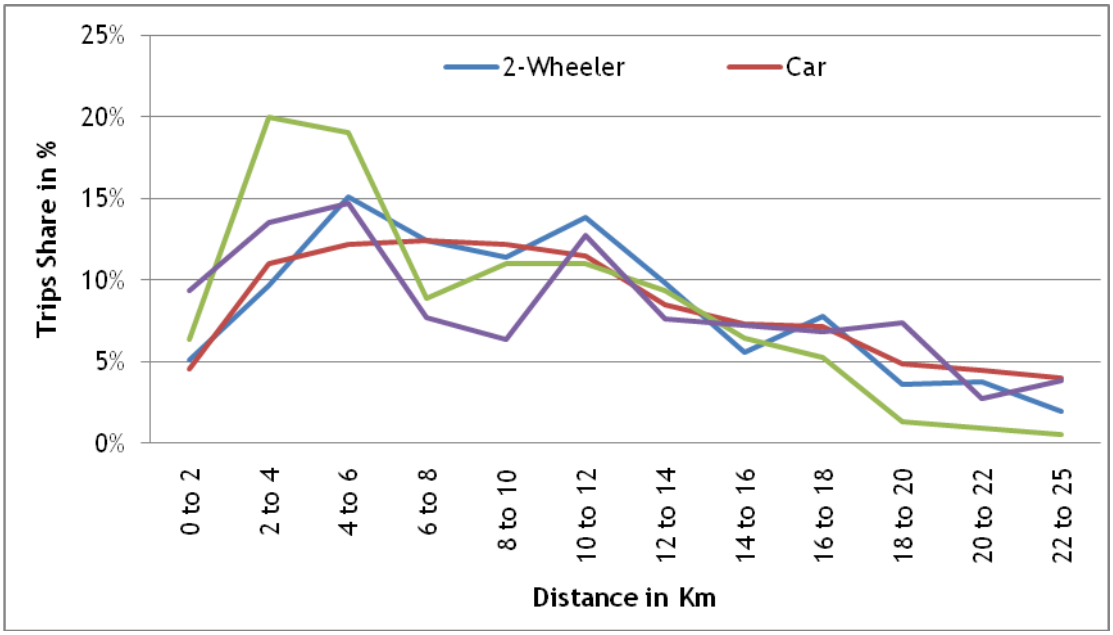


Figure 4.18 Trip Length Distribution - Project Corridor

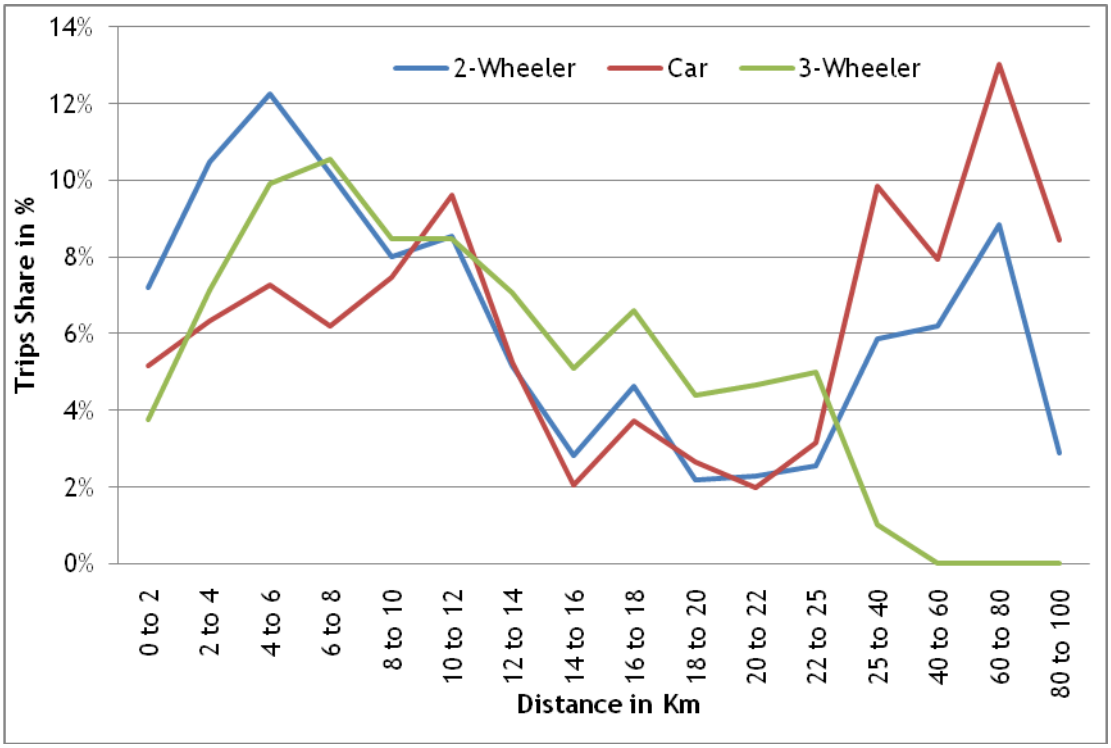


Figure 4.19 Trip Length Distribution – Cordon

4.3.5 Origin Destination Survey at Major Public Transport Terminals

The distribution of passengers from the major bus and rail terminals are gathered. The data on origin, destination and the mode to final destination is collected. The survey is carried out at the following terminals/stations:

1. Bus terminal
    a. Aluva
    b. KSRTC stand at Ernakulam
    c. Kaloor
    d. Vytilla hub
2. Rail Terminal
    a. North railway station
    b. South railway station
    c. Aluva

The passenger data is collected from the pre-paid auto stands from the following major terminals.

a. Vytilla hub
b. North railway station
c. South railway station

The data is analyzed to estimate the potential passenger traffic to the proposed metro system. Figure 4.20 to Figure 4.22 presents the travel desire from the Vytilla hub, North railway station and South railway station respectively. It can be observed that major share of traffic is destining in the city centre i.e. in and around MG road/Marine drive. Other destinations include Thammanam Jn, Eloor (Fact), Kumbalam, Fort Kochi, Palluruty,

Vaduthala, Edapally, Devankulangara, Palarivattom, Vytilla, Ravipuram, Kaloor and Ayyppankavu, Kadavanthra, Ernakulam centre, Ernakulam town and Ernakulam junction.

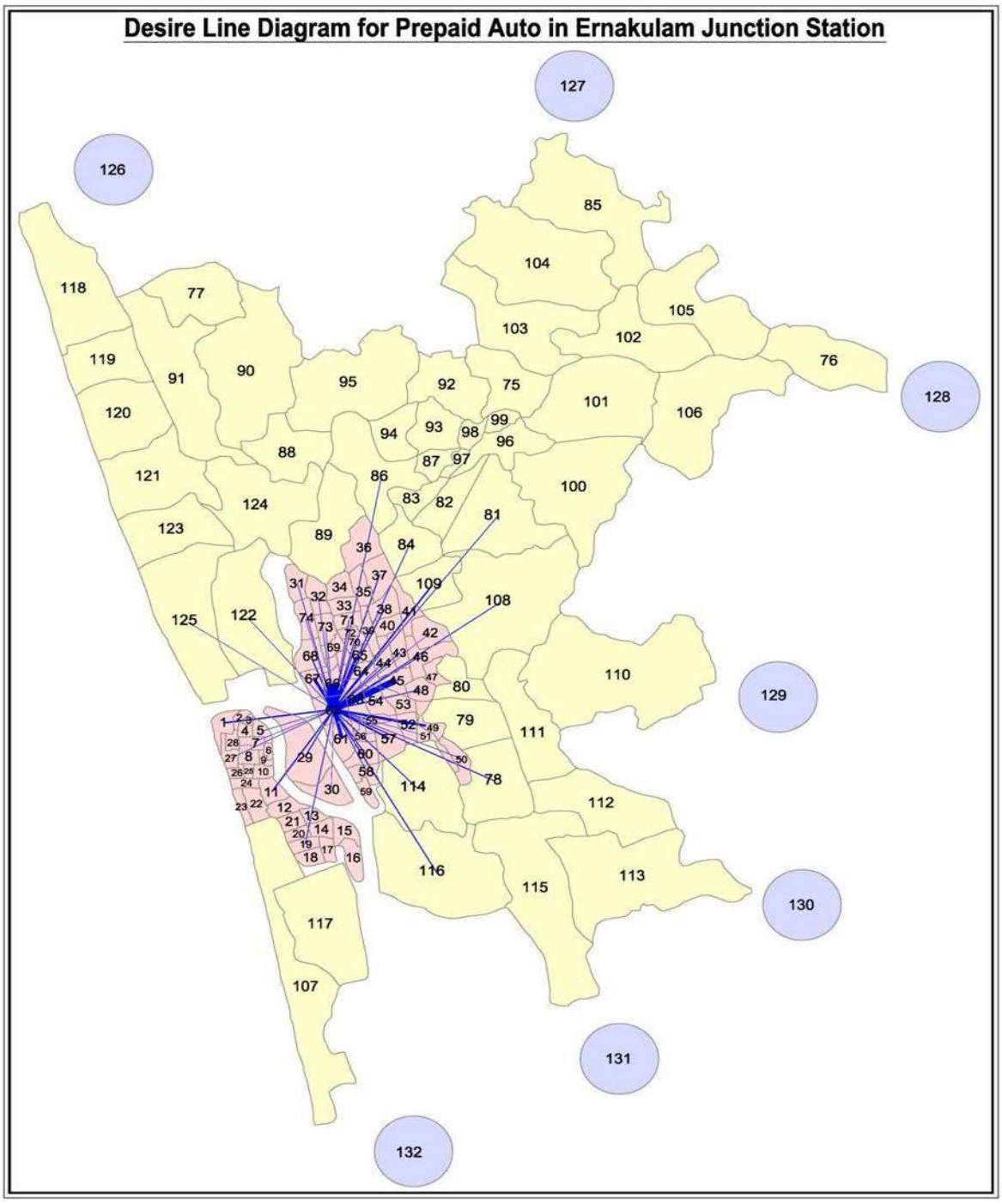


Figure 4.20 Desire-3-Wheelers at Ernakulam Junction

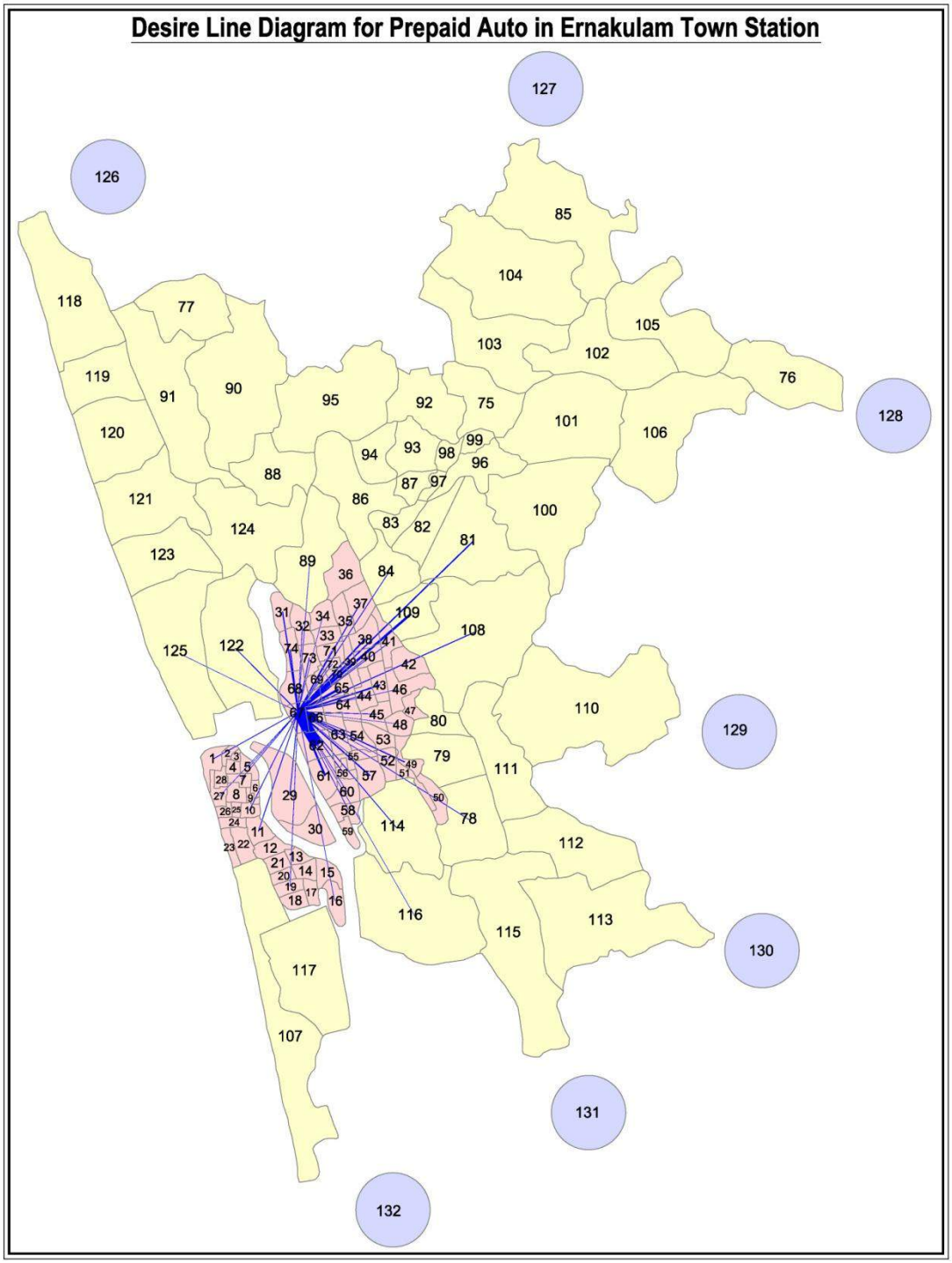


Figure 4.21 Desire-3-Wheelers at Ernakulam Town

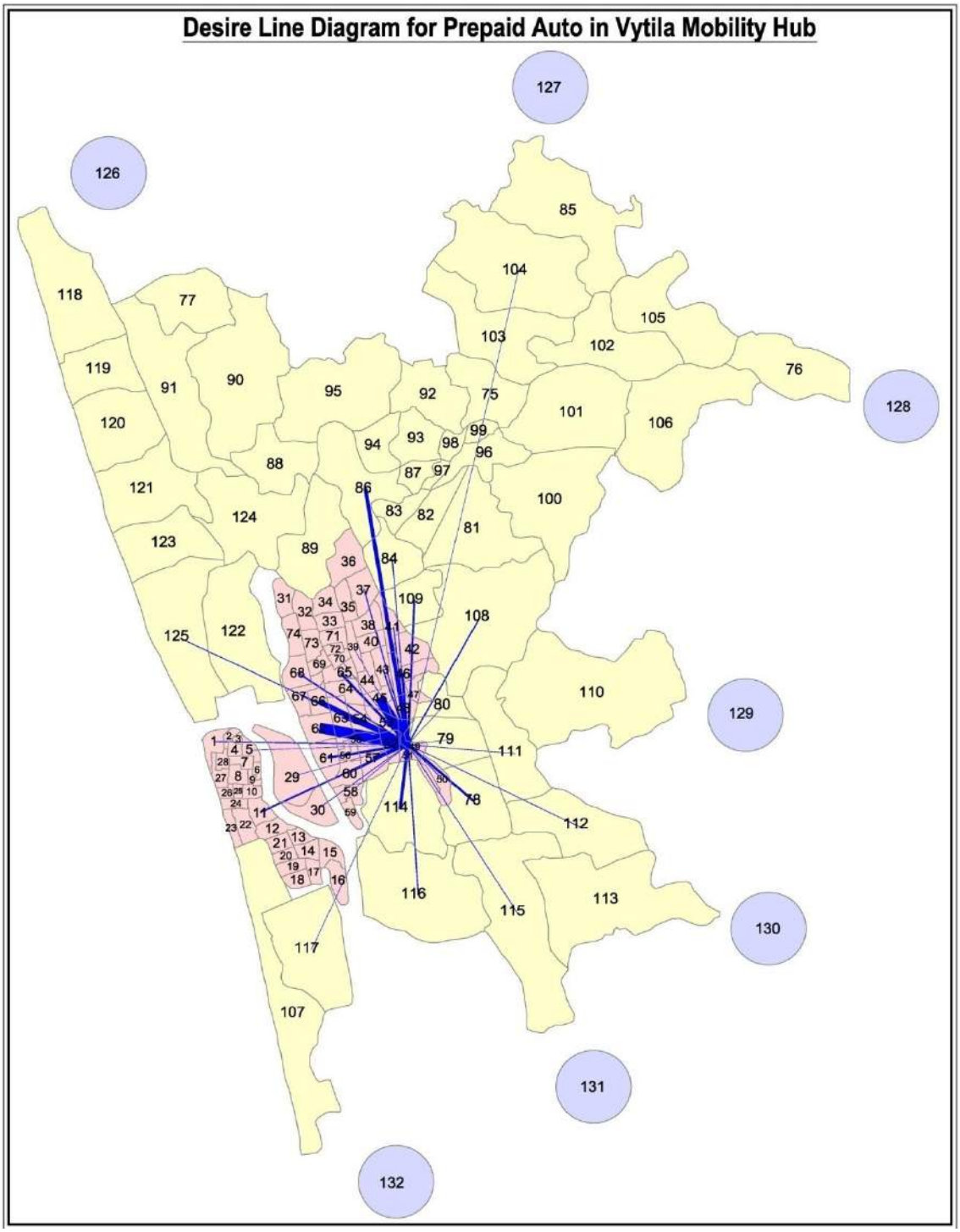


Figure 4.22 Desire-3-Wheelers at Vytilla Hub

4.3.6 Public Transport-Boarding and Alighting Survey

Objective of survey: To assess the quantum of passengers served by the major bus stops along the project corridor by public transport.

Scope of the survey: To count the number of people boarded and alighted at each bus stop in either direction.

Conduct of the Survey: The survey is conducted at the major bus stop locations along the corridor during public transport operation period during a normal day using manual counting method.

Data Entry and Analysis: The hourly distribution of passengers boarded and alighted at major bus stops along the corridor is presented in Figure 4.23 to Figure 4.26.

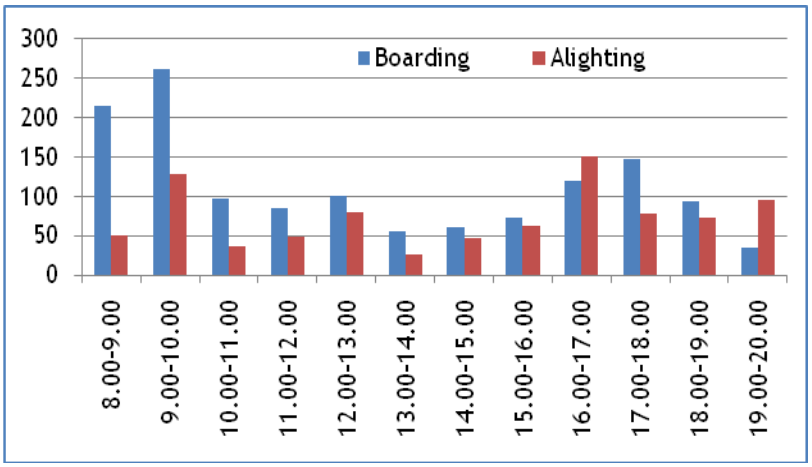


Figure 4.23 Bus Passenger Survey at Petta - Towards Vyttilla

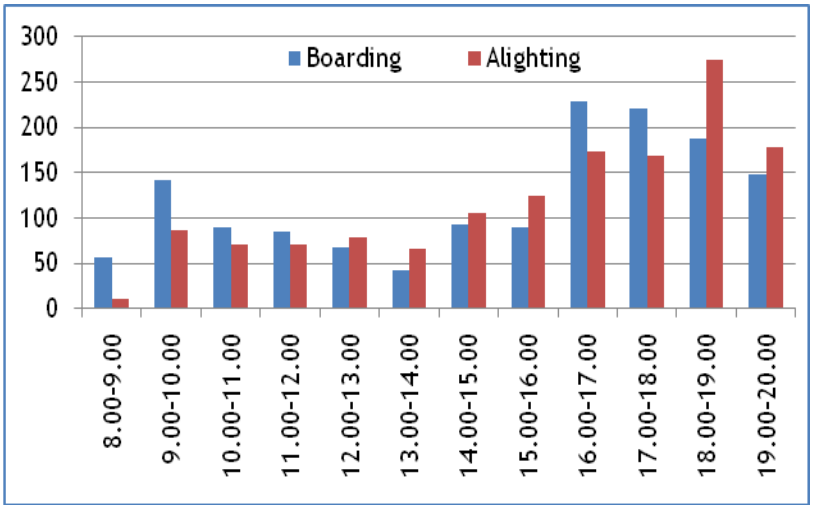


Figure 4.24 Bus Passenger Survey at Petta - Towards Thirupunithra

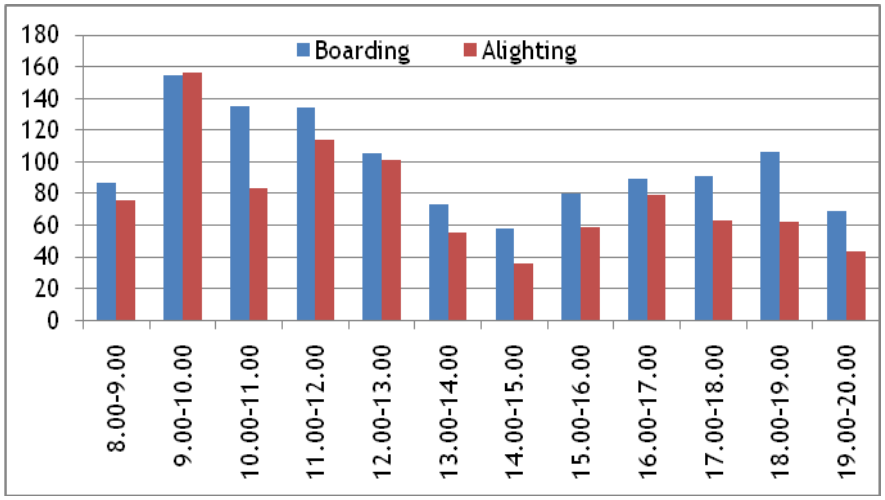


Figure 4.25 Bus Passenger Survey at Edapally - Towards Ernakulam

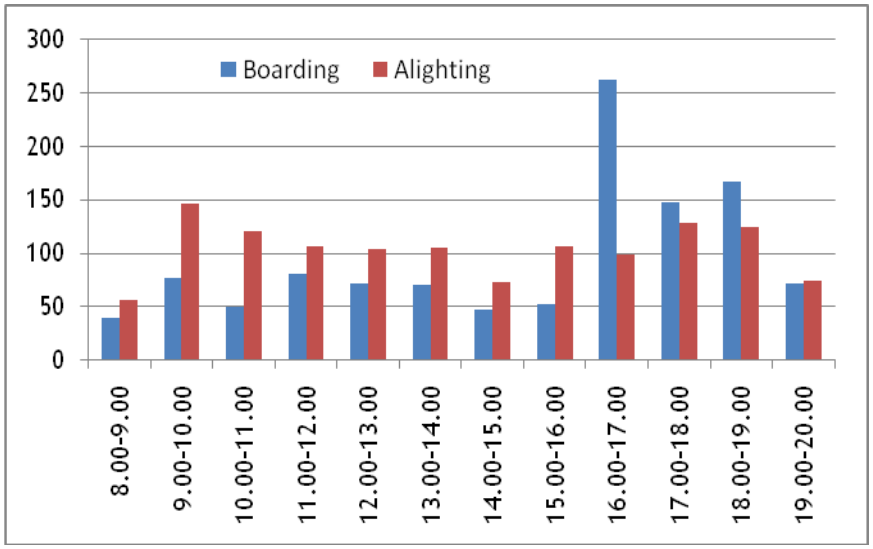


Figure 4.26 Bus Passenger Survey at Edapally - Towards Aluva

4.4 Public Transport - Occupancy

Objective of survey: To assess the quantum of passengers served by public transport at the identified homogenous sections along the corridor and hence establish the average occupancy and crush capacity

Scope of the survey: To assess the number of people inside the system at various sections in either direction.

Conduct of the Survey: The survey is conducted at the midblock locations along the project corridor during public transport operation period during a normal day using manual counting method.

Data Entry and Analysis: The section wise daily and peak capacity of public transport at various sections on the project corridor.

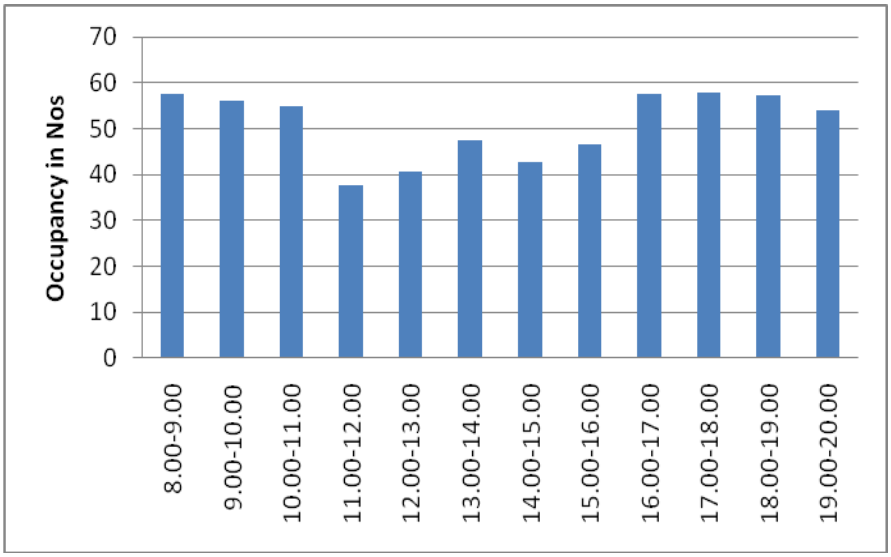


Figure 4.27 Average Occupancy - Bus

4.5 Opinion Survey

Stated Preference Survey

Objective of survey: To estimate the user's willingness to use and pay for the proposed Metro rail system.

Scope of the survey: The respondents are presented with hypothetical mode choice situations with recommended metro fare and savings in travel time. The assumed fare for the metro rail is given in Table 4.26. The savings in travel time is estimated based on the difference between travel time taken between the proposed mode and by other modes. The travel time by other modes is estimated from the speed and delay surveys. The travel time by the proposed mode is estimated by assuming a speed as 33Kmph. In the process of estimating the future ridership for a system, the probability of shift from different modes can be estimated from user's opinion on.

Table 4.26 Recommended Fare for Metro

Sl. No	Distance in Km	Basic Fare in Rs.
1	0-2	10
2	2-4	13
3	4-6	15
4	6-9	19
5	9-12	21
6	12-15	23
7	15-18	24
8	18-21	27
9	21-24	28
10	24-27	30

(Source: Kochi DPR Study by DMRC)

Conduct of the Survey: Two thousand users are interviewed at the following terminals/stations:

1. Bus terminal
    a. Aluva
    b. KSRTC stand at Ernakulam
    c. Kaloor
    d. Vytilla hub
2. Rail Terminal
    a. North railway station
    b. South railway station
    c. Aluva

The opinion is also gathered along with the road side interview at all the origin-destination survey locations. The collected data is coded, processed and analyzed.

The respondent's trip purpose and trip frequency at the surveyed bus and rail terminals are presented in Table 4.27 to Table 4.30 respectively.

Table 4.27 Purpose of Trip – Bus Terminals/Stands

Trip	Vyttila	KSRTC	Kaloor	Aluva KSRTC
Work	31%	37%	52%	50%
Business	11%	19%	18%	21%
Education	19%	12%	12%	6%
Social & Recreation	14%	6%	2%	12%
Medical	12%	7%	5%	2%
Tourism	7%	5%	2%	4%
Others	7%	14%	10%	5%

(Source: Primary traffic survey 2013)

Table 4.28 Purpose of Trip – Railway Stations

Trips	Ernakulam Junction	Ernakulam Town	Aluva
Work	57%	61%	52%
Business	18%	15%	10%
Education	10%	6%	15%
Social & Recreation	2%	3%	18%
Medical	2%	2%	2%
Tourism	2%	5%	0%
Others	9%	8%	4%

(Source: Primary traffic survey 2013)

Table 4.29 Trip Frequency – Bus Terminals/Stands

Trip	Vyttila	KSRTC	Kaloor	Aluva KSRTC
Multiple	10%	0%	3%	6%
Daily	36%	28%	68%	68%
Weekly	35%	35%	16%	13%
Occasionally	19%	37%	13%	13%

(Source: Primary traffic survey 2013)

Table 4.30 Trip Frequency – Railway Station

Trips	Ernakulam Junction	Ernakulam Town	Aluva
Multiple	10%	11%	0%
Daily	11%	56%	29%
Weekly	17%	18%	26%
Occasionally	62%	16%	45%

(Source: Primary traffic survey 2013)

Willingness to Shift to Metro

The user's opinion on the willingness to shift to the proposed metro system is presented in Table 4.31 to Table 4.32 for the bus and rail passengers respectively. Figure 4.28 to Figure 4.29 presents the willingness to shift for the private modes (cars/2-wheelers) and 3-wheelers respectively.

Table 4.31 Willingness to Shift – Bus Passenger

Trip	Vyttila	KSRTC	Kaloor	Aluva KSRTC
Very Unlikely	1%	1%	0%	1%
Unlikely	1%	2%	1%	0%
Neutral	6%	4%	5%	20%
Likely	22%	23%	16%	20%
Very Likely	70%	71%	79%	58%

(Source: Primary traffic survey 2013)

Table 4.32 Willing to Shift Metro System – Rail Passenger

Trips	Ernakulam Junction	Ernakulam Town	Aluva
Very Unlikely	0%	0%	3%
Unlikely	0%	1%	2%
Neutral	6%	0%	10%
Likely	5%	1%	44%
Very Likely	89%	98%	40%

(Source: Primary traffic survey 2013)

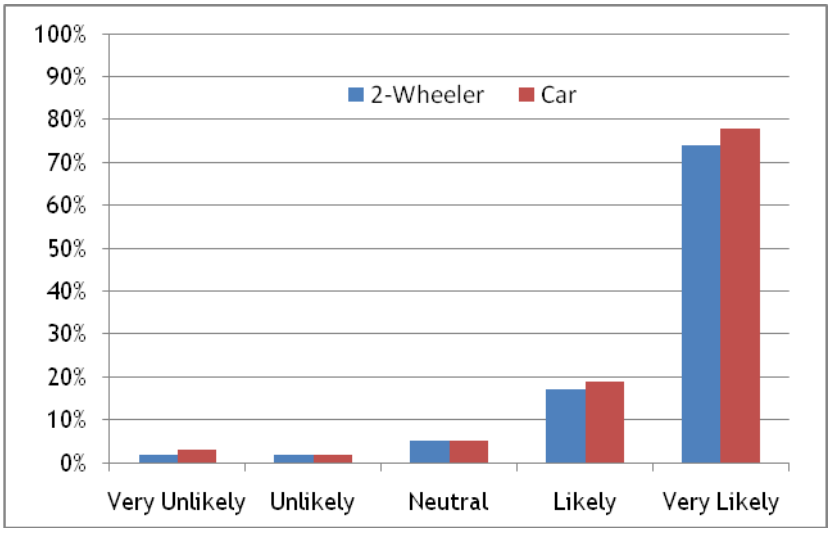


Figure 4.28 Willingness to Shift – Car/2-Wheeler

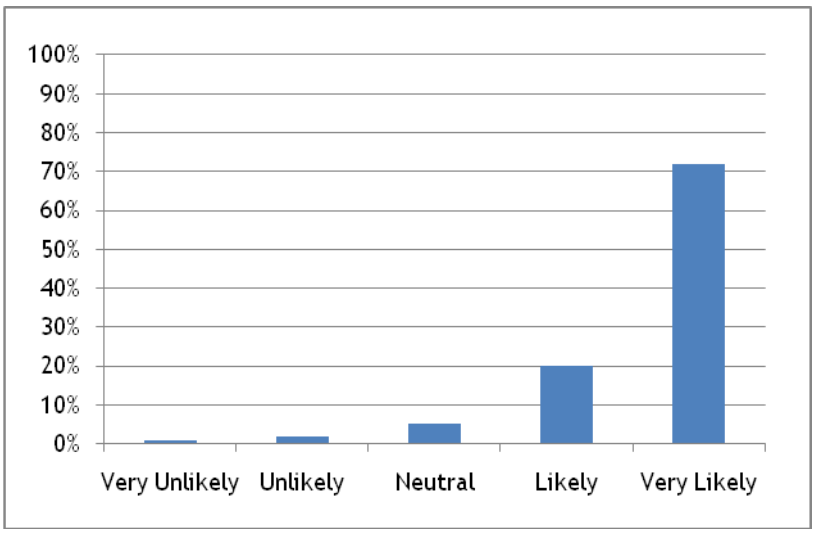


Figure 4.29 Willingness to Shift – 3-Wheeler

Potential Metro Passengers: The travel desire is examined in detail to extract the potential passengers for the metro system. Figure 4.30 presents the zones included in the project influence area. The direct project influence area is assumed as the zones falling within one kilometer on both sides of the project corridor. The rest of the zones in the study area are defined as the indirect influence zones. The zone pairs falling in the PIA is extracted by mode and the share of likely traffic on the proposed metro is analysed.

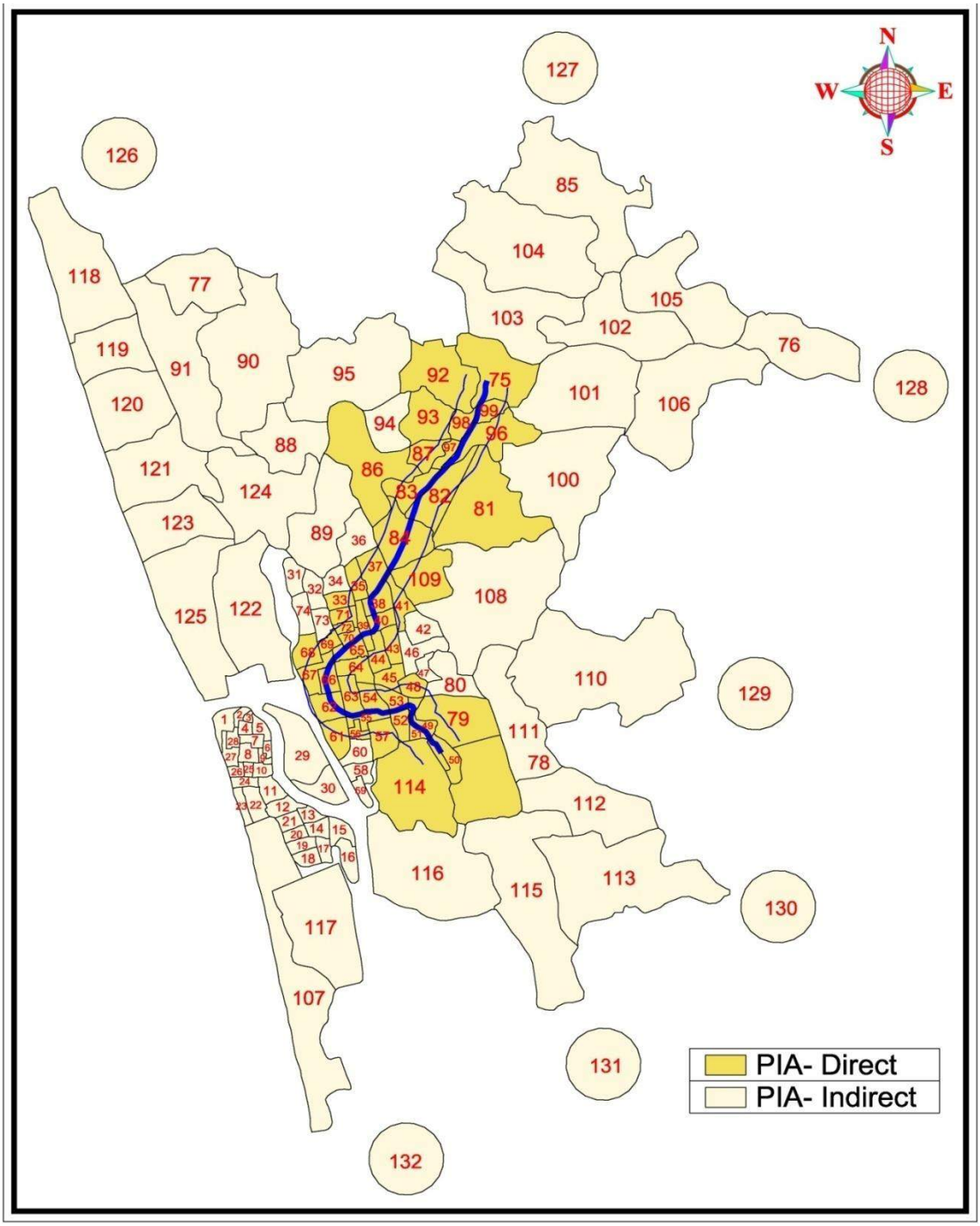


Figure 4.30 Project Influence Area

It has been observed that the 51% of passengers (all modes) are originating or destining from the project influence area with an average trip length of 7.5Km. About 12% to 16% either originate or destinate in the indirect project influence area. The travel pattern for the potential passengers in the direct influence area is given in the Figure 4.31.

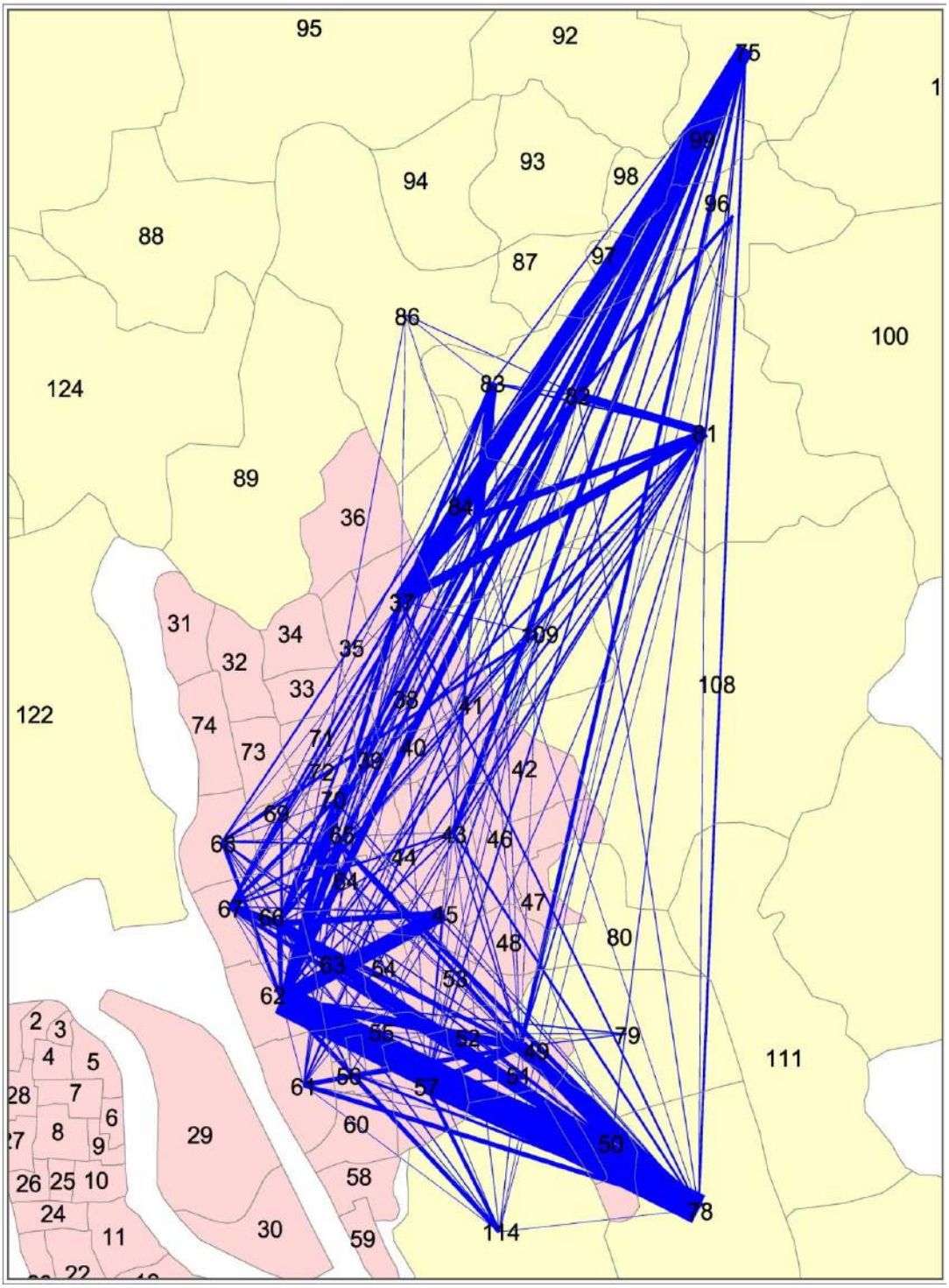


Figure 4.31 Travel Pattern for Potential Passengers

Conclusion

Traffic studies are carried out to assess the present traffic and travel characteristics in the study area and on the project corridor. The data collection included secondary and primary traffic surveys like classified volume count, roadside interview, public transport surveys, road network inventory and speed and delay studies. The analyzed data will be used to update the transport model to establish the ridership for the next thirty five years.

5. CHAPTER

METRO RAIL CORRIDOR CHARACTERISTICS

A detailed corridor inventory is carried out along the proposed metro rail alignment between Aluva and Petta for a length of 25.6 km. The data is gathered on the geometric characteristics, land use along the corridor and around 500 meters around the proposed metro stations, major intersecting roads, traffic generators, bus stops, parking stands for intermediate public transport including 3-wheeler and taxis, potential multimodal integration locations. The corridor characteristics is discussed in the following sections.

5.1 Corridor Characteristics

Corridor: Aluva - Petta

The corridor with a length of 25.6km will be served by 22 stations (Figure 6.1). The corridor starts at Aluva in the North and continue on NH-47 till Edapally. The metro passes through major establishments like KPKM Hospital, Aluva market, CPK hospital, Government housing colony, KSRTC Garage road, Panchayat office, Metco House, Honda Showroom, SCMS college, CUSAT university, Mega Mart, ICTA (Institute for counselling and Transactional Analysis), KIMS hospital, Hyundai Showroom, AZAT homes apartments. The shopping mall opened by Lulu group is located very close to Edapally station. The mall attracts substantial visitors and tourists to the city, mostly by private driven vehicles and taxis resulting in heavy traffic chaos on the corridor. Further, the alignment crosses the NH47/NH17 at Edapally Junction, and proceeds on Palarivattom-Edapally Road. The alignment passes through major destinations like Changampuzha park, JL Nehru. Stadium, Kaloor, and reaches North Station.

North station will act as a major transfer point to the passengers from the neighbouring cities and villages who commute regularly for their work or education trip. The alignment proceeds towards Peta via Maharaja's College in MG road, South Station, Kadavanthra, Vyttila and Tykoodam. Vytilla station will be developed as the multimodal hub for the intercity, ferry and the metro along with provision for park and ride facility. Figure 6.1 represents the proposed metro alignment with the stations marked.

The major network connectivity and attractions along the metro alignment is represented in Table 6.1.

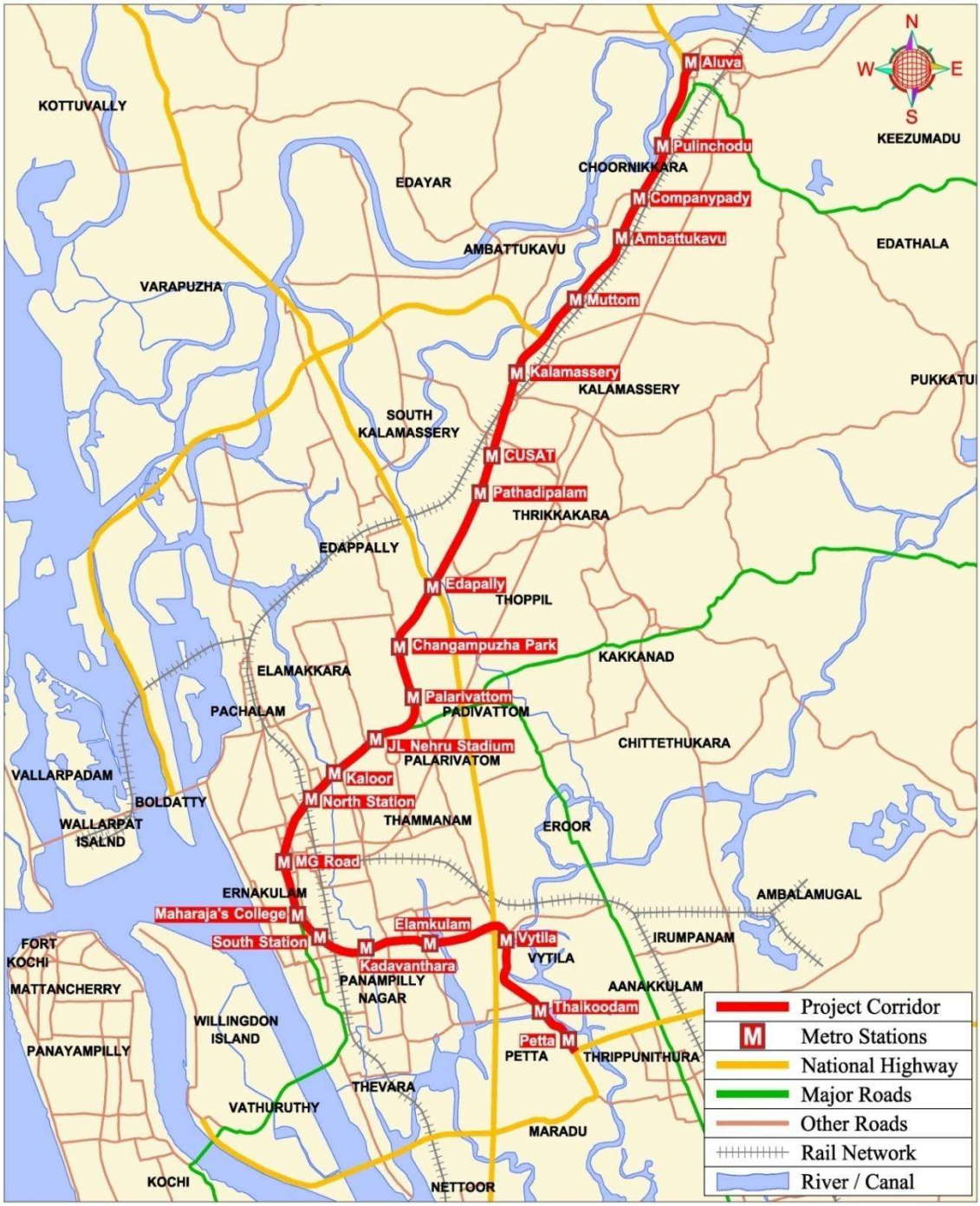


Figure 5.1 Metro Rail Alignment

(Source: Kochi Metro Rail Ltd)

Table 5.1 Major Attractions along the Metro Corridor

Sl. No.	Station		Major Interconnecting Roads	Major Junctions	Major Attractions
	From	To			
1	Aluva	Pulinchodu	NH-47, Aluva - Eranakulam road	Pulinchode Jn	KPKM Hospital, Aluva market, CPK hospital
2	Pulinchodu	Companypady	NH-47	SWTS road Jn	Government housing colony, KSRTC Garage
3	Companypady	Ambattukavu	NH-47		Tata Motors, Grandfresh
4	Ambattukavu	Muttom	NH-47, SWTS road		Metco House, Honda Showroom,
5	Muttom	Kalamassery	NH-47, ICT road,	Appolo Tyree Jn	SCMS college, Maruthi Truevalue
6	Kalamassery	Cochin University	FACT Kalamassery road, HMT road, TVS road	FACT Kalamassery Jn, University Jn	Govt Polytechnic college, CUSAT, KSEB, St. Pauls college
7	Cochin University	Pathadipalam	NH-47, University road, TOG road,	TOG road Jn	Little flower Engineering, ICTA (Institute for Counselling and Transactional Analysis)
8	Pathadipalam.	Edapally	NH-47, AKG road, Pukkattupady road, NH-17	Edapally Toll Jn, Edapally Jn	KIMS hospitsal, Hyundai Showroom, AZAT homes appartments, Lulu mall, Oberon mall, PTM Channel appartments
9	Edapally	Changampuzha Park	Palarivattom-Edapally road, Elamakara road		St.George high school, MG University
10	Changampuzha Park	Palarivattom	Palarivattom-Edapally road, MK Nair road	Edapally Raghavan pillai road	High School, Mordern Bread Factory, Popular Vehicles & Services

11	Palarivattom	J.L.Nehru Stadium	Banarji road, Stadium road,	Stadium road Jn.	Palarivattom acts as a Major Transit Point e.g (Kakannad, Aluva, Vyttila, Fortkochi), J.L Nehru Stadium
12	J.L.Nehru Stadium	Kaloor	Banarji road, Desabhimani road, Azad road, Kaloor Kadavanthara road	Deshabhimani Jn. Mathrubhumi Jn. Kaloor Jn.	St. Albert's College Tennis court, Mathurbhumi, Vijaya Institute of Medical Sciences
13	Kaloor	Lissie	SRM road, Lissie Hospital road	Lissie Jn.	Kaloor Market, PVS memorial Hospital, Penta Towers, Muthoot Towers
14	Lissie	M.G road	Chitoor road	Ernakulam North Jn, Kacheripady Jn.	RBI, Lissie Hospital, North Railway station, PNVM Hospital, Seematti
15	M.G road	Maharaja's College	Jew street, Convent road	PNVM hospital Jn, Jose Jn	Chennai silks, Kavitha theatre, ABAD plaza, Centre square mall, Shenoys theatre
16	Maharaja's College	Ernakulam junction	Hospital road, Durbar Hall road,	Pallimukku Jn	Maharaja's College, LIC Divisional Office, Pallimukku
17	Ernakulam junction	Kadavanthra	Church Landing road, SA road, Chittor road, Panampilly Nagar road, Kaloor Kadavanthara road	Valanjambalam Jn, Manorama Jn, Kadavanthara	Medical trust hospital, GCDA office, Regional town planning office
18	Kadavanthra	Elamkulam	Chillavannur road	Elamkulam Jn	Kochi Shipyard Quarters
19	Elamkulam	Vytila	Vyttila Janatha road, NH-47	Janatha Jn	GEO Motors Mobility hub,
20	Vytila	Thaikoodam	Ettumanoor - Eranakulam road	Vyttila Jn, Thykoodam	EYE hospital, Power House , KSEB Substation
21	Thaikoodam	Petta	Ettumanoor - Eranakulam road, Kochi Dhanushkodi road	Petta Jn	Chambakara Fish Market, Thrippunthura

*Jn-Junction (Source: Primary Traffic Survey 2013)

5.2 Station Locations and the Inter Station Distance

The inter station distance between Aluva and Petta is given in Table 6.2. The station spacing along the alignment varies from 0.49km to 3.42km with an avergae sapcing of 1.30km.

Table 5.2 Inter Station Distance – Metro Corridor

Sl. No.	Station Name	Inter station distance (Km)
1	Aluva	-
2	Pulinchodu	1.904
3	Companypady	0.942
4	Ambattukavu	1.008
5	Muttom	0.959
6	Kalamassery	3.421
7	Cochin University	2.400
8	Pathadipalam	1.000
9	Edapally	1.453
10	Changampuzha Park	1.424
11	Palarivattom	1.048
12	J.L.Nehru Stadium	1.055
13	Kaloor	1.095
14	Lissie	0.490
15	M.G Road	1.188
16	Maharaja's College	1.204
17	Ernakulam junction	1.229
18	Kadavanthra	0.853
19	Elamkulam	1.156
20	Vytila	1.106
21	Thaikoodam	1.256
22	Petta	1.119

(Source: Kochi Metro Rail Ltd)

5.3 Land Use

The detailed inventory is carried out on the existing land use along the corridor and about 500m approximately around the metro stations. The land use is described in terms of

residential, commercial, industrial, institutional and others. Table 5.3 presents the land use around the metro stations.

Table 5.3 Predominant Land Use at Metro Stations

Sl. No	Station name	Land Use (%) around the metro stations (with in 500m radius)			
		Commercial	Residential	Industrial	Institutional & Others
1	Aluva	55	45	-	-
2	Pulinchodu	20	80	-	-
3	Companypady	30	45	5	20
4	Ambattukavu	5	90	5	-
5	Muttom	20	80	-	-
6	Kalamassery	20	40	20	20
7	Cochin University	10	50	-	40
8	Pathadipalam	30	35	10	25
9	Edapally	70	25	-	5
10	Changampuzha Park	10	50	-	40
11	Palarivattom	30	50	-	20
12	J.L.Nehru Stadium	10	50	-	40
13	Kaloor	50	20	-	30
14	Lissie	40	20	-	40
15	M.G road	90	-	-	10
16	Maharaja's College	80	-	-	20
17	Ernakulam junction	70	-	-	30
18	Kadavanthra	20	40	-	40
19	Elamkulam	30	60	-	10
20	Vytila	10	60	-	30
21	Thaikoodam	-	90	-	10
22	Petta	5	90	-	5

(Source: Primary Traffic Survey 2013)

Figure 5.2 presents the land use along the proposed metro corridor.

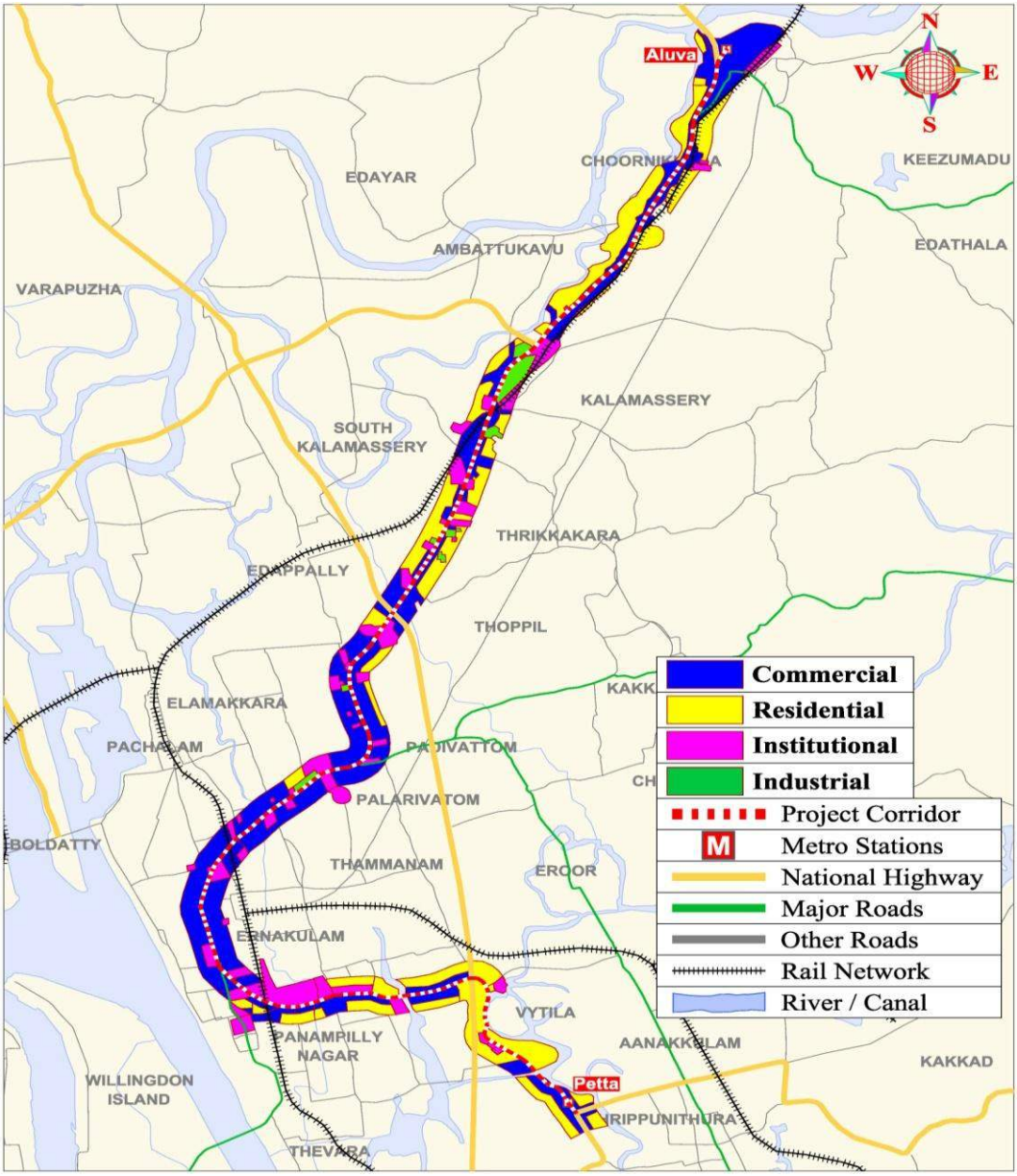


Figure 5.2 Land Use along the Project Corridor

5.4 Multimodal Integration

Seamless connectivity to mass transit corridor will be given by providing intermodal interchange stations at major stations along the corridor. Figure 5.3 presents the proposed multimodal stations along the corridor. The metro rail will be integrated with the existing conventional rail, and bus system at various stations along the metro rail corridor. Park and ride facility is proposed at major stations. Details regarding the integration with other modes is presented in Table 5.4.

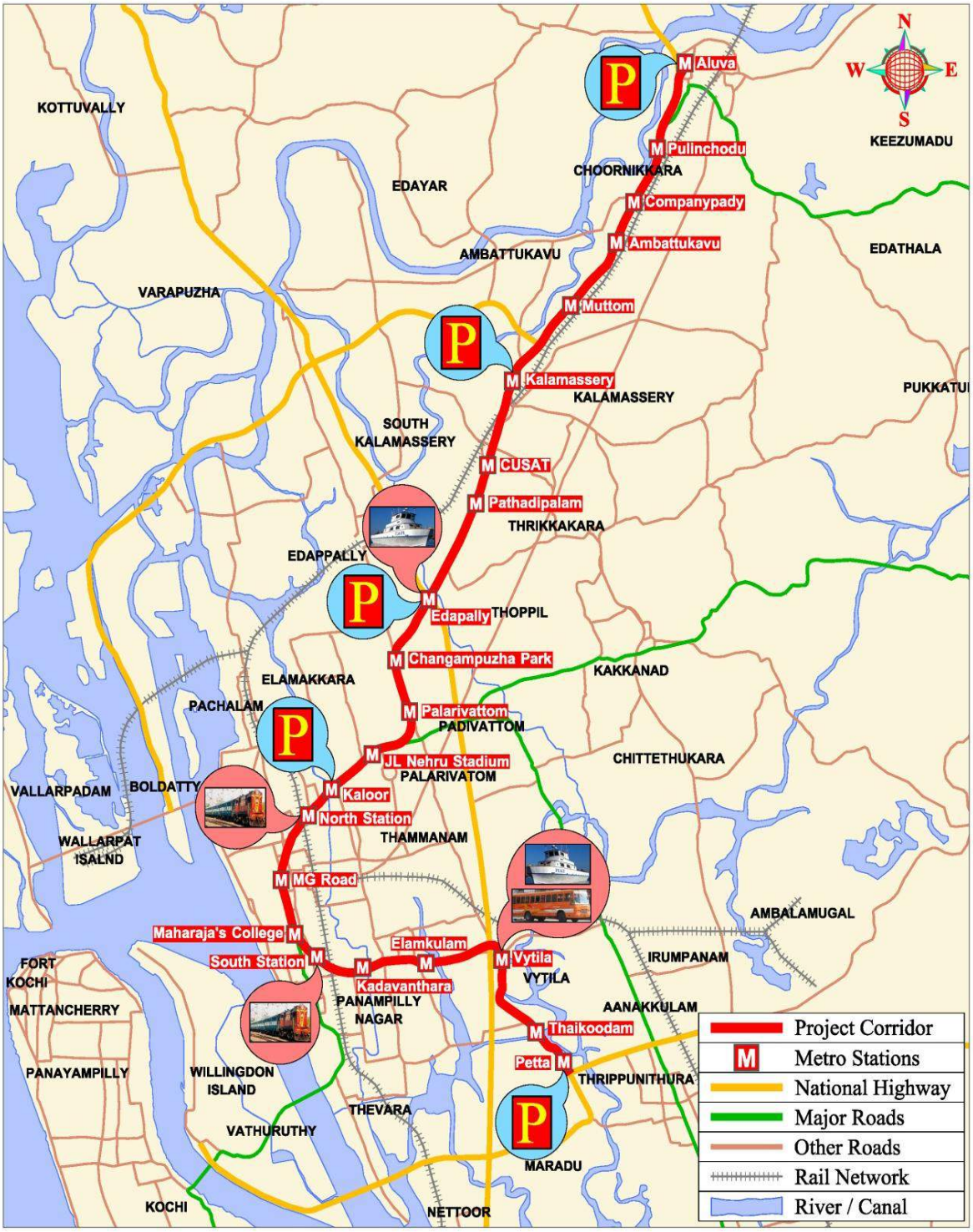


Figure 5.3 Multimodal Integration along Project Corridor

(Source: Kochi Metro Rail Ltd)

Table 5.4 Multimodal Integration along Project Corridor

Sl. No.	Station Name	Bus	Railway Station	Park & Ride	Water Transport
1	Aluva	√		√	

Sl. No.	Station Name	Bus	Railway Station	Park & Ride	Water Transport
2	Pulinchodu				
3	Companypady				
4	Ambattukavu				
5	Muttom				
6	Kalamassery			√	
7	Cochin University				
8	Pathadipalam				
9	Edapally			√	√
10	Changampuzha Park				
11	Palarivattom				
12	J.L.Nehru Stadium				
13	Kaloor	√		√	
14	Lissie		√		
15	MG road				
16	Maharaja's College				
17	Ernakulam junction		√		
18	Kadavanthra				
19	Elamkulam				
20	Vytila	√			√
21	Thaikoodam				
22	Petta			√	

(Source: Kochi Metro Rail Ltd)

5.5 Operational Characteristics of Metro Rail System

The operational characteristics (as recommended by DPR Kochi Metro) assumed for the estimation of ridership is presented in Table 5.5.

Table 5.5 Operational Characteristics of Metro Rail

Year	Heady Way in Minutes	Speed in Kmph
2015	5	33
2020	4	33
2025	3	33
2048*	1.5	33

**CDM Smith Estimate (Source: Kochi Metro DPR Report)*

6. CHAPTER

RIDERSHIP ESTIMATION

6.1 Travel Demand Forecast

The calibrated urban transport model developed for the Kochi Metro Ridership study-2005 is updated to the base year i.e. 2013 using fresh traffic surveys carried out during the months of May and June, 2013. The updated urban transport demand model has been used to predict the travel characteristics for the horizon years. The methodology for travel demand forecast is shown in Figure 6.1.

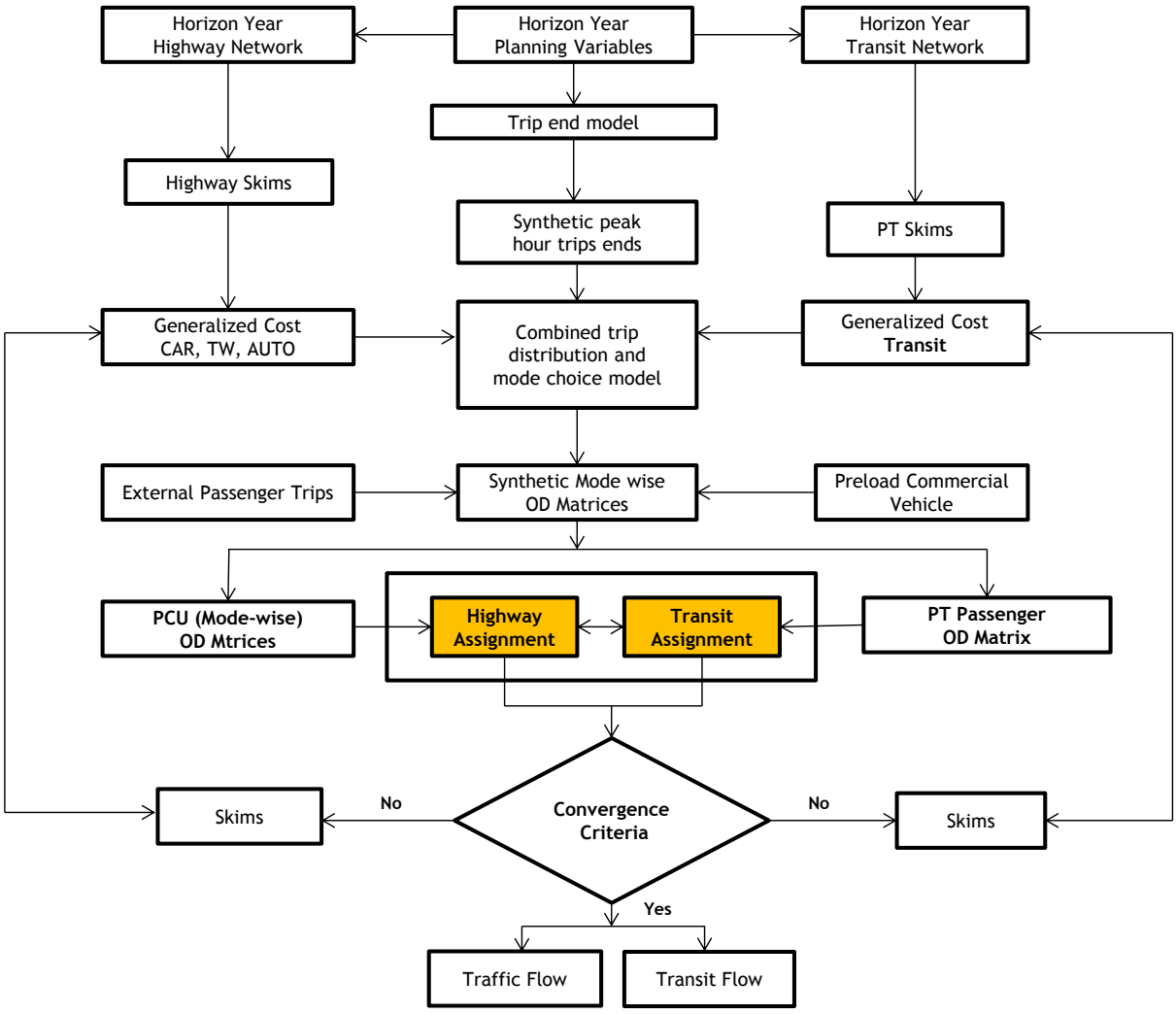


Figure 6.1 Travel Demand Forecast

The horizon years include 2018, 2033 and 2048. The transport proposals already in the implementation stage or been committed has been included in the forecast years. The highway (road) network considered all the key arterials, sub arterials and collectors. The base year highway network is presented in Figure 6.2 and the committed bus transit network is shown in Figure 6.3. Detail of bus routes are presented in Annexure 3. The

study area is divided into 125 zones in the GCDA including six municipalities and many villages and 7 external zones. (Refer Figure 4.11 for zone map)

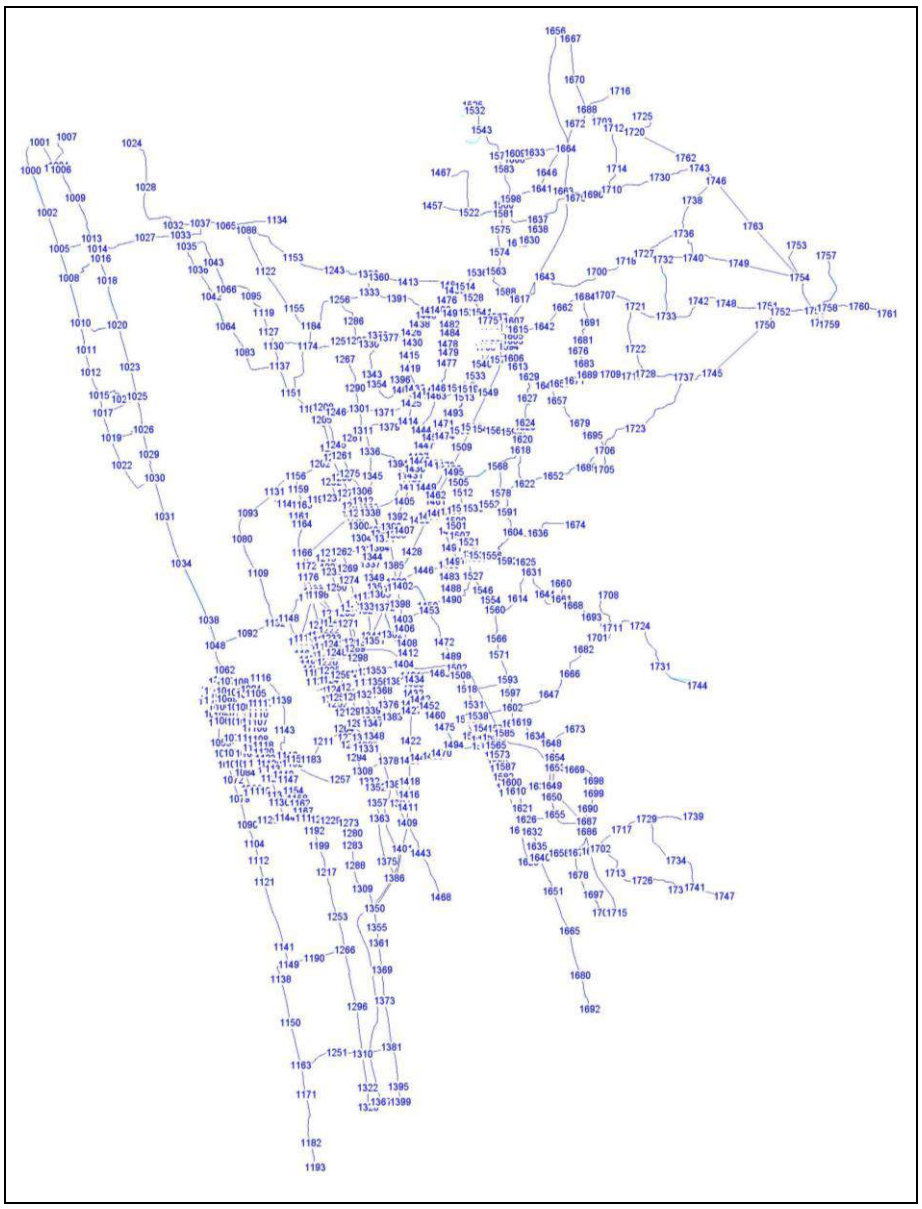


Figure 6.2 Highway Network-2013

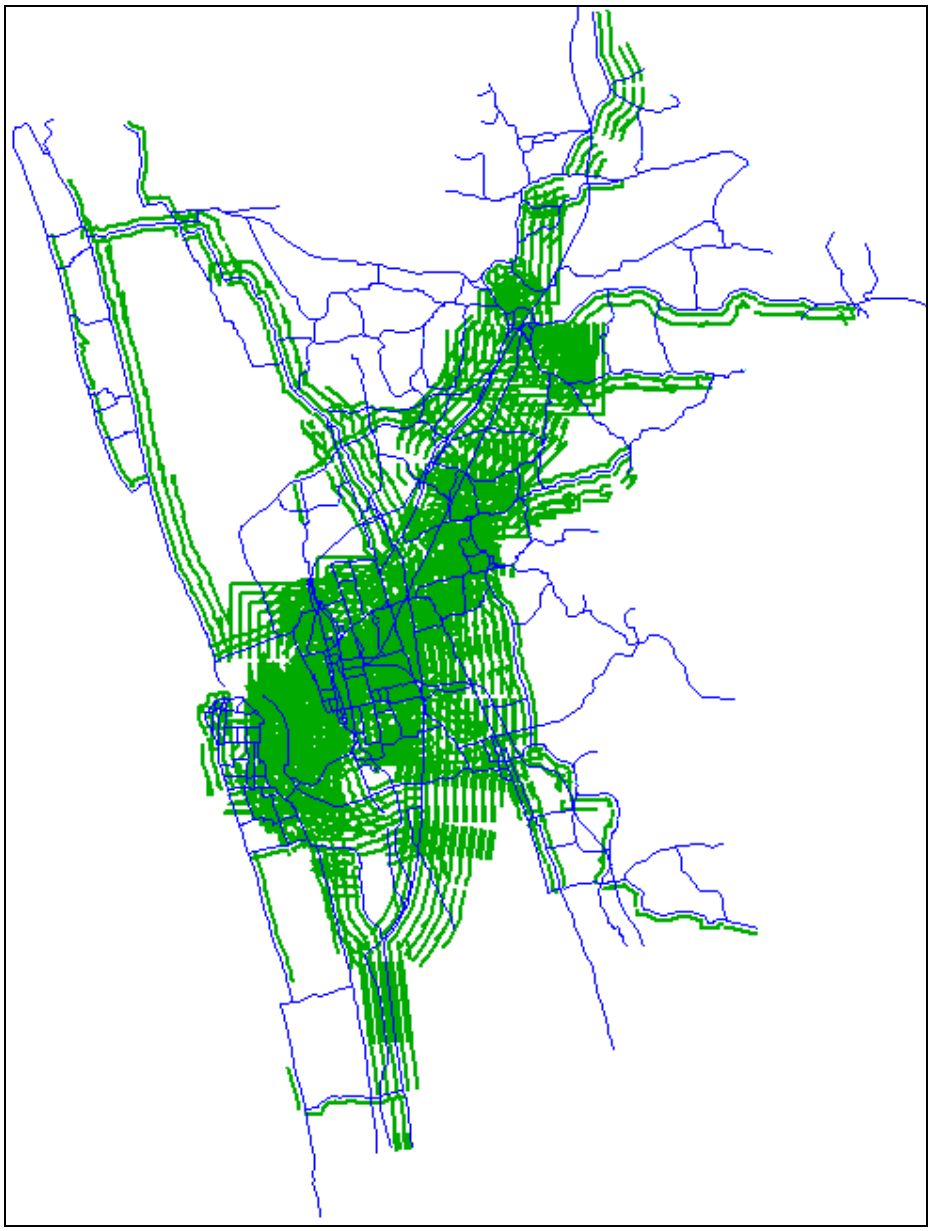


Figure 6.3 Public Transport Network-2013

6.2 Population and Employment Projections

Population Projections

The development of a particular city, town or a region depends upon natural, physical and socio-economic factors. Among these factors, the population assumes significance in determining the future pattern of progress and development.

The project area encompasses an area under Greater Kochi Development Authority (GCDA), which is spread upto 632 sq. km. There are around 52 towns and villages including Kochi Municipal Corporation within GCDA's jurisdiction. As the growth factors vary from town to town, it is essential to understand the present and future town/village specific physical and socio-economic activities while projecting the town population, which would

ultimately influence the growth of the town. Hence, while, estimating the population projections, town wise/village wise population projections are carried out by employing both mathematical and graphical methods. The projection methods include Arithmetic Method, Incremental Increase Method, Geometric Method, and Polynomial Method. In addition, the projections were also compared with the projections carried out by other agencies for other different studies like City Development Plan (CDP) under JNNURM, City Sanitation Plan (CSP), and Development Plan for Kochi City Region – 2031, etc.

Assumptions

1. City Development Plan (CDP) for Kochi prepared under JNNURM encompasses about 330.02 sq. km of area covering Kochi Municipal Corporation, 2 municipal areas and 13 panchayats with a population of about 11.38 lakhs. As most of the CDP area falls under GCDA, hence, the assumptions considered for projecting populations for municipalities and panchayats in CDP forms one of the important basis to adopt the same/similar applicable assumptions to project other the town/villages under GCDA. Table 6.1 presents the assumptions in CDP related to migration.

Table 6.1 Estimated Migration Components as % to Total Population

Year	2011	2021	2026
KMC	11.46%	18.98%	24.74%
2 Municipal Areas	26.04%	38.61%	46.27%
13 Panchayats	14.16%	20.83%	28.28%
CDP Area	13.77%	22.61%	29.60%

(Source: City Development Plan for Kochi)

2. The assumptions considered for Development Plan for Kochi City Region (2031) (refer Table 6.2) for population projections is also considered while projecting the population for GCDA.

Table 6.2 Assumptions Considered in Development Plan for Kochi City Region (2031)

Sl. No	Name of Local Body	Assumed % of Migration	Assumed % of Floating Population
1	Corporation of Kochi	10%	20%
2	Thripunithura (M)	10%	20%
3	Kalamasserry (M)	30%	20%
4	Maradu (P)	30%	10%
5	Thiruvankulam (P)	10%	20%
6	Thrikkakara (P)	30%	20%
7	Cheraneloor (P)	Nil	20%
8	Eloor (P)	Nil	30%
9	Varapuzha (P)	30%	Nil
10	Kadamakudy (P)	Nil	20%

Sl. No	Name of Local Body	Assumed % of Migration	Assumed % of Floating Population
11	Mulavukad (P)	Nil	20%
12	Elamkunnapuzha (P)	30%	20%
13	Njarakkal (P)	30%	20%
14	Kumbalam (P)	30%	10%
15	Kumbalangy (P)	Nil	20%
16	Chellanam (P)	Nil	20%
17	Vadavucode	30%	20%

Population and Employment Projections for GCDA

Considering the above assumptions and studying the physical and socio-economic characteristics of the towns/villages located within GCDA, the population projections carried out using both mathematical and graphical methods. Table 6.3 presents the summary of population projections. Considering the development potential in the study area and trend in work participation rates, the potential employment growth in the horizon period is worked out, which is presented in the Table 6.3

Table 6.3 Summary of Population and Employment Projections

Particulars	2013	2018	2033	2048
Population(in Millions)	2.46	2.78	3.41	4.05
Employment(in Millions)	0.857	0.994	1.29	1.59

(Source: CDM Smith projections)

The population density distribution for the study area for the year 2011 and 2033 is presented in the Figure 6.4 and Figure 6.5.

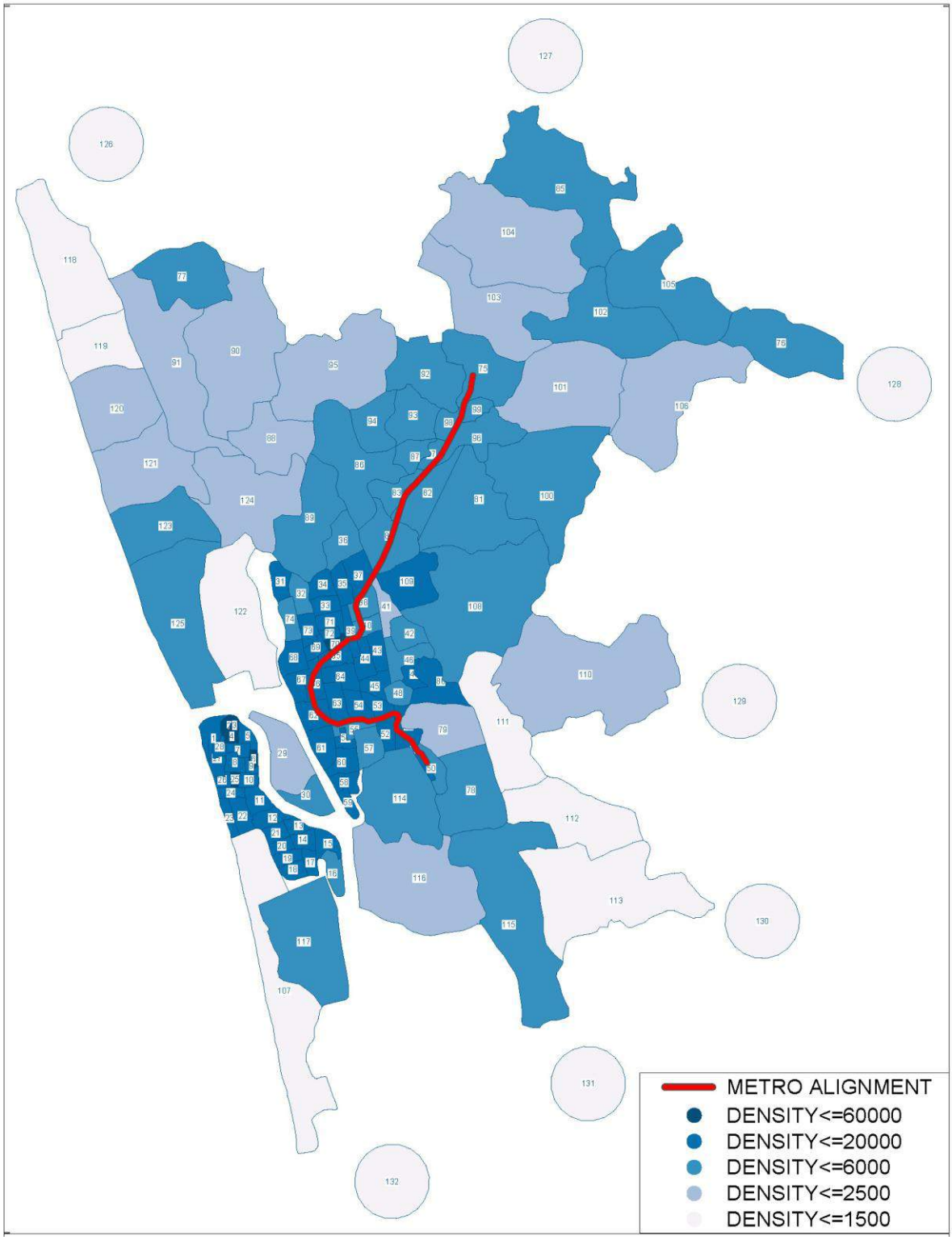


Figure 6.4 Population and Density Distribution of Study Area - 2011 (Persons/Sq.Km)

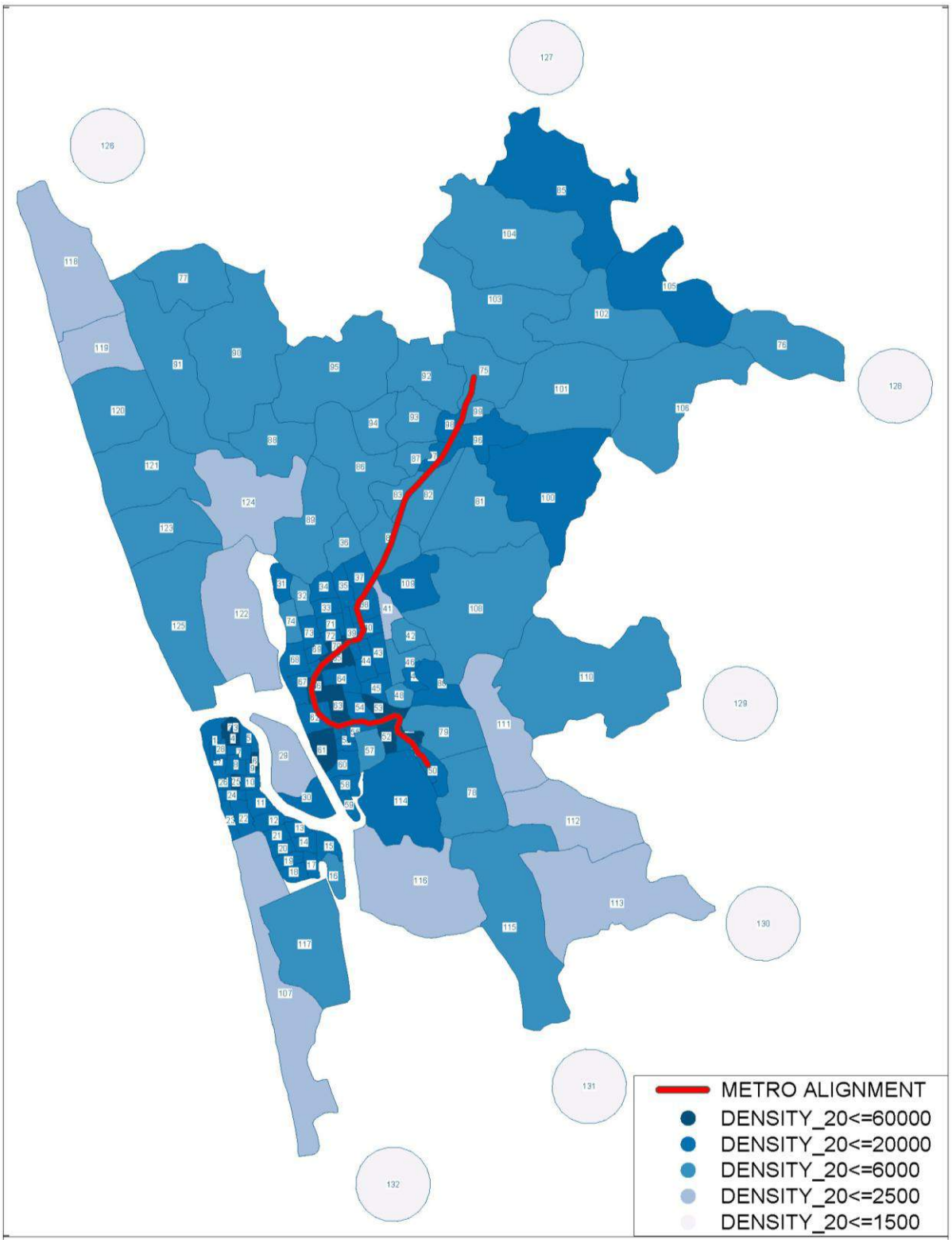


Figure 6.5 Population and Density Distribution of Study Area - 2033 (Persons/Sq.Km)

Trips assigned and Per Capita Trip Rate (PCTR)

The PCTR adopted and daily trips for different horizon years are presented in Table 6.4.

Table 6.4 Daily Trips Assigned and PCTR for Different Horizon Years

Year	PCTR	Daily trips (Millions)
2013	0.80	1.97
2018	0.88	2.46
2033	1.03	3.50
2048	1.11	4.48

(Source: CDM Smith Estimate)

By adopting the forecast assumptions, the travel demand has been forecasted for the given horizon years. The Metrorail alignment is coded in the forecast model with access and egress links updated with the cost parameters. Headway is adopted for the Metrorail as recommended by KMRL. Metro fare is adopted as per the *Kochi DPR Study by DMRC* (Refer Table 4.26). The model outputs have been extracted to estimate the ridership on the proposed Metrorail and the travel characteristics such as trip length and passenger-kilometers.

6.3 Peak Hour Ridership

The morning peak hour boarding and alighting is presented in Table 6.5.

Table 6.5 Hourly Boarding and Alighting (Morning Peak)

Sl. No.	Station Name	2018		2033		2048	
		Peak Hour Boarding	Peak Hour Alighting	Peak Hour Boarding	Peak Hour Alighting	Peak Hour Boarding	Peak Hour Alighting
1	Aluva	2902	1504	4824	3172	6024	4640
2	Pulinchodu	2184	954	2520	1537	3199	1951
3	Companypady	1576	820	1959	1367	2238	2042
4	Ambattukavu	1204	858	1932	1168	2623	1472
5	Muttom	1144	934	1925	1339	2354	1824
6	Kalamassery	1922	890	2656	1333	3679	1715
7	Cochin University	2417	630	2743	1081	3188	1557
8	Pathadipalam	1533	610	2461	935	3199	1320
9	Edapally	1857	1699	3852	3016	5124	3751
10	Changampuzha Park	1431	1630	2095	2331	2399	2898
11	Palarivatom	1267	2871	2373	4095	3349	4904
12	J.L.N Stadium	1208	2457	1947	3610	2403	4449
13	Kaloor	1137	2527	1959	4209	2864	4993
14	Lissie	1729	2787	2373	3466	3214	4797
15	M.G Road	1059	2828	1437	4728	1817	5478
16	Maharaja's College	1377	1787	1796	2452	2479	2974
17	Ernakulam south	1955	2309	3036	3550	3303	4149
18	Kadavanthra	1650	1623	2633	2640	3018	3452
19	Elamkulam	1185	1380	2007	1988	2627	2853
20	Vytila	3025	3346	5327	5491	7107	7020
21	Thaikoodam	723	409	1196	660	1702	914
22	Petta	1032	664	2288	1172	3435	2193
Total		**35517**	**35517**	**55339**	**55339**	**71345**	**71345**

(Source: CDM Smith Estimate)

Daily Ridership

Daily ridership figures are estimated by applying the peak hour factors (peak hour trips/daily trips) derived from the primary traffic surveys. The estimated daily ridership on the proposed Metrorail corridor is presented in Table 6.6.

Table 6.6 Summary of Daily Ridership

Year	Daily Ridership (in Millions)
2016	0.36
2033	0.55
2048	0.71

(Source: CDM Smith Estimate)

Table 6.7 Daily Station Loading for Corridor

Sl. No.	Station Name	2018		2033		2048	
		Daily Boarding	Daily Alighting	Daily Boarding	Daily Alighting	Daily Boarding	Daily Alighting
1	Aluva	8535	8432	17463	17143	28320	27970
2	Pulinchodu	5703	5618	9361	9213	13188	12967
3	Companypady	31810	31852	54064	54036	70645	70515
4	Ambattukavu	12798	12853	19979	19975	27364	27424
5	Muttom	16366	16362	26368	26369	32285	32413
6	Kalamassery	21276	21373	32858	33007	37142	37380
7	Cochin University	15707	15872	21071	21334	27084	27336
8	Pathadipalam	19186	19684	30362	31287	35965	36995
9	Edapally	22434	22730	29045	29354	39832	40273
10	Changampuzha Park	18121	18518	30522	31159	38987	39585
11	Palarivatom	18149	18500	27544	28018	33968	34546
12	J.L.N Stadium	20464	20913	32092	32578	41044	41483
13	Kaloor	15277	15332	22094	22157	26412	26558
14	Lissie	17804	17762	34460	34221	44568	44184
15	M.G Road	10847	10586	17193	16763	22863	22328
16	Maharaja's College	15488	14981	19361	18887	23956	23497
17	Ernakulam south	14205	13914	20129	19757	27249	26691
18	Kadavanthra	10415	10360	16405	16239	20963	20810
19	Elamkulam	10363	10261	15606	15391	20632	20309
20	Vytila	12087	11877	16711	16543	21420	21371
21	Thaikoodam	15861	15511	20424	20147	25928	25571
22	Petta	22226	21831	40214	39748	53509	53118
	Total	**355122**	**355122**	**553326**	**553326**	**713324**	**713324**

(Source: CDM Smith Estimate)

6.4 Trip Length Frequency Distribution

The trip length distribution for the metro passengers is given in Table 6.8.

Table 6.8 Trip Length Distribution – Metrorail (2016)

Distance (Kms)		Percentage of total trips		
From	To	2018	2033	2048
0	2	11%	11%	9%
2	4	19%	16%	15%
4	6	14%	13%	14%
6	9	22%	25%	24%
9	12	15%	14%	15%
12	15	8%	7%	8%
15	18	6%	6%	6%
18	21	4%	4%	4%
21	24	1%	4%	4%
More than 24		0%	1%	1%

6.5 Model Outputs

The model outputs for the horizon year 2018 is presented below Figure 6.6, Figure 6.7, Figure 6.8 which represents passenger load on the metro corridor, passenger flow for the entire public transport network and the traffic flow in PCUs for the study area highway network respectively.

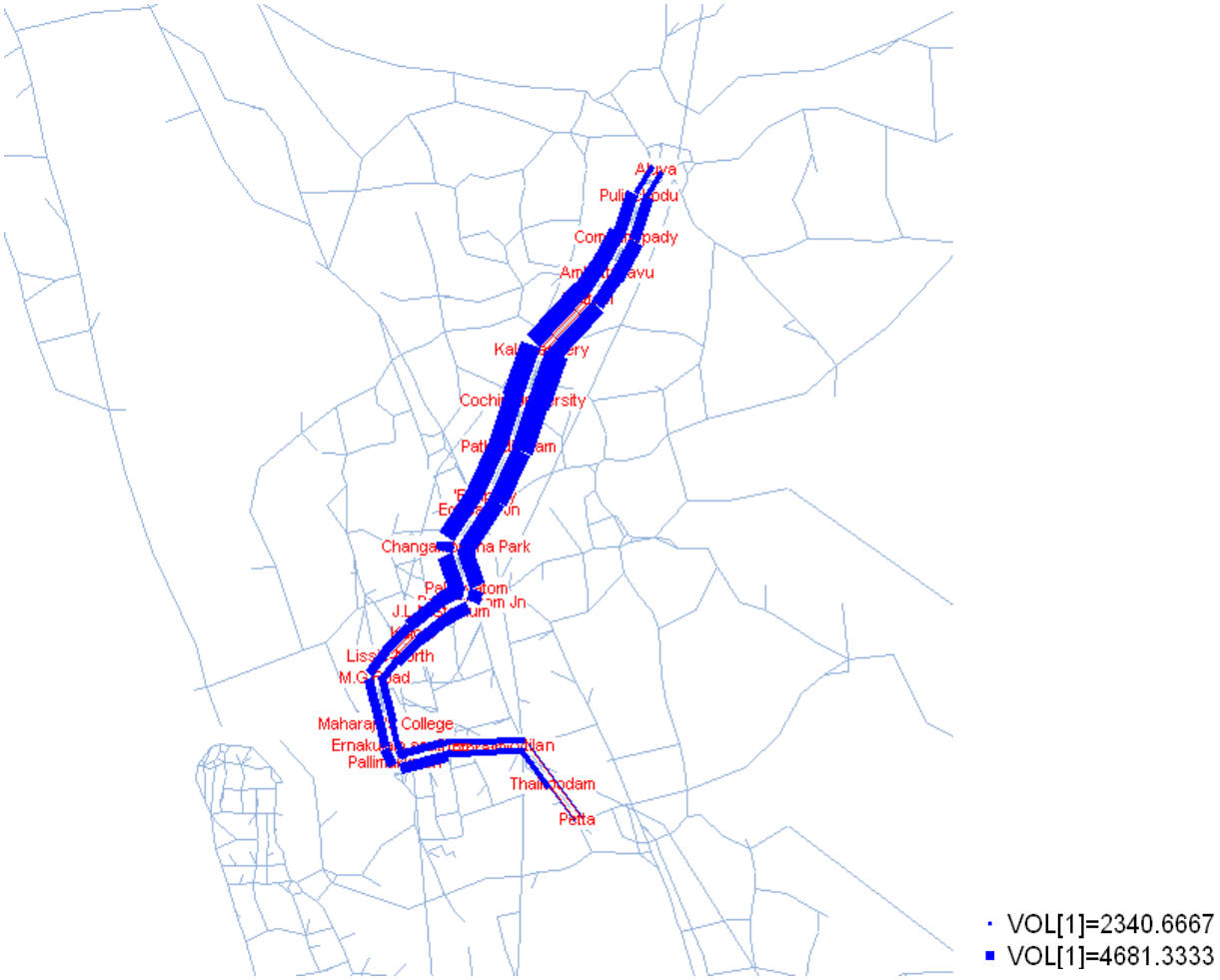


Figure 6.6 Passenger flow on the Metro Corridor

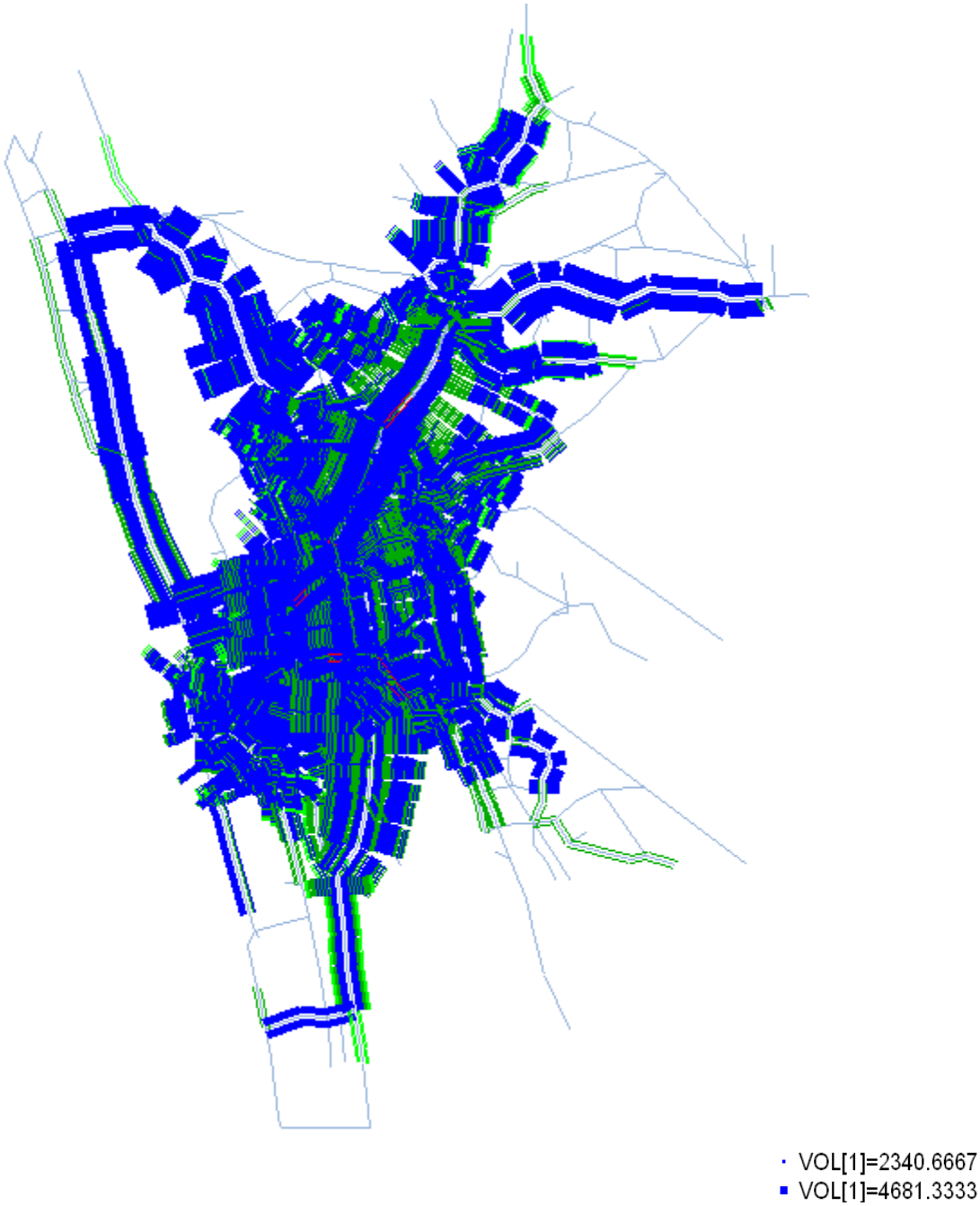


Figure 6.7 Passenger Flow - Public Transport Network

Figure 6.8 Traffic Flow - Highway Network (in PCUs)

Peak hour Boarding and alighting at the proposed stations for the horizon year 2018 is presented in Figure 6.9 and Figure 6.10 respectively.

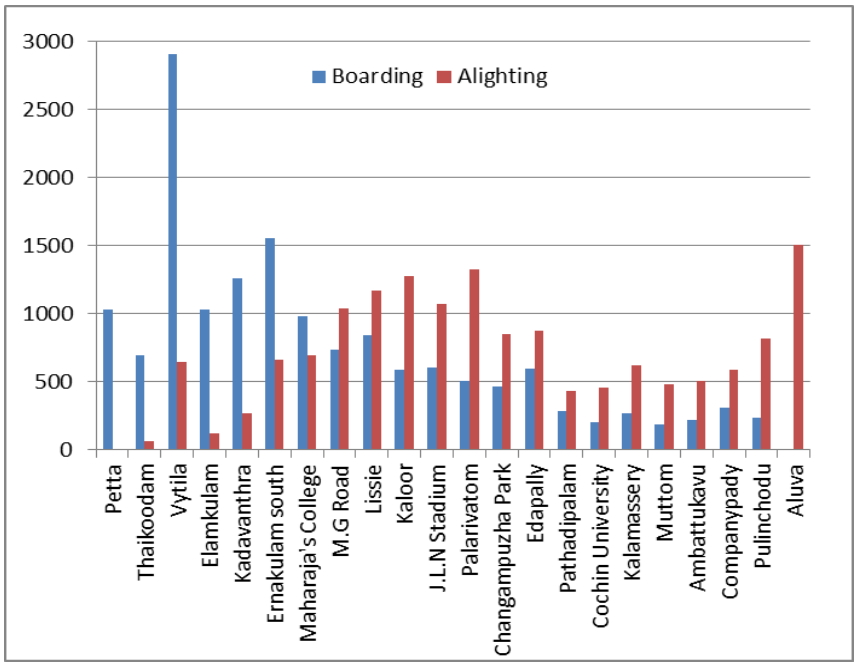


Figure 6.9 Boarding and Alighting - Metro Passengers (Petta to Aluva) - 2018

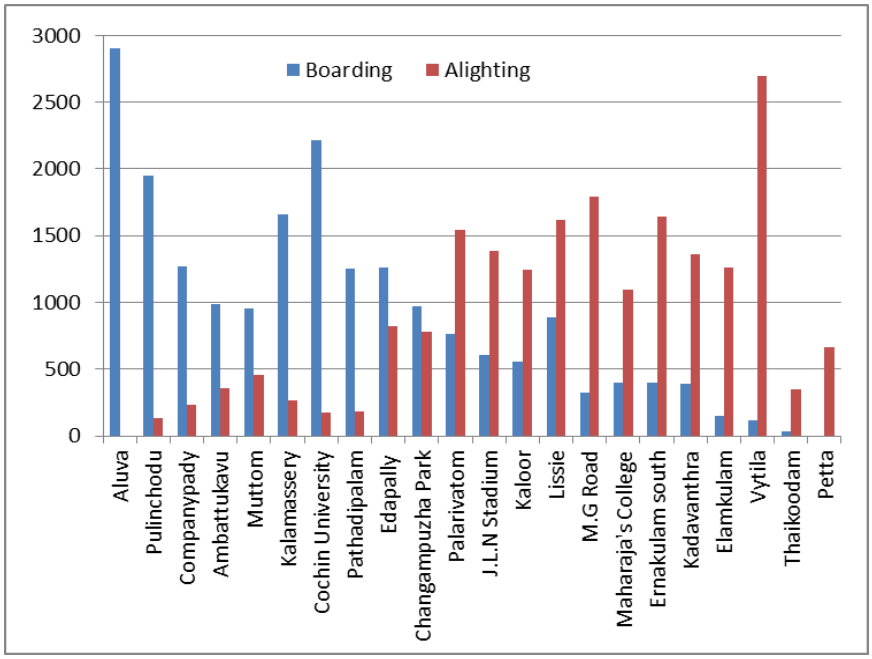


Figure 6.10 Boarding and Alighting - Metro Passengers (Aluva to Petta) - 2018

6.6 Daily Ridership with Transit Oriented Development

A transit-oriented development (TOD) is planned along the metro corridor including Increase in FSI, land use reclassification and station development focusing on commercialization. The idea would be to maximize access to public transport, and hence encourage transit ridership. TODs generally are located within a radius of 400 to 800 m from a transit stop thus solving the last mile connectivity problem. Based on the past experience in similar studies and discussion with KMRL, daily ridership figures are derived for the TOD scenario. The daily ridership thus arrived based on the above assumptions on the proposed Metrorail corridor is presented in Table 6.6. The increase in ridership will vary based on the kind of developments which will realize in the horizon period.

Table 6.9 Summary of Daily Ridership

Year	Daily Ridership (in Millions)
2016	0.43
2033	0.69
2048	0.89

7. CHAPTER

CARBON EMISSIONS

7.1 Introduction

Transport sector contributes to about 40 % of the total greenhouse gas emissions, across the cities world over. Particularly in urban areas, transport is one of the main factors for GHGs and also affecting the local air quality. Urban air quality management is thus closely linked to improvement in urban transport – increasing the share of public transport system, promoting non-motorized modes such as walking and cycling, with compatible land use planning of the city. Further, as transport is the main consumer of fossil fuels, which are mostly imported by the developing countries, improvements to urban transport will also enhance the energy efficiency.

Situated in central part of Kerala State between 9° 52' and 10° 10' North Latitude and between 76° 14' and 76° 21' East Longitude, Kochi is the second most important port city on the western coast of India. City is situated along the Arabian Sea and Vembanad Estuary. The city is well connected to other parts of the country. The National Highway NH-47 passes through the city while NH-49 and NH-17 originate and radiate outwards from the city. Kochi is 220 km north of Thiruvananthapuram, the State Capital. The Cochin International Airport is 32 km from the city center. The Greater Cochin Development Authority (GCDA) area, which encompasses the majority of the urbanized area, covers 732 square kilometres (km^2) and has a population of 2.02 million (2011 census). Kochi is also known as 'economic capital' of Kerala. In recent years, the city has witnessed heavy investments, thus making it one of the fastest growing second-tier metro cities in India.

Considering fast growth urban transport need a metro rail system is being development in Kochi. Being implemented by Kochi Metro Rail Corporation Limited, the project funded through various sources. French Development Agency (AFD) is the main agency that is likely to provide financial assistance to the project. AFD requires assessment of carbon foot print of its funded projects to fulfill its comment towards sustainable development. AFD's commitment to act in favour of sustainable and equitable development is the cornerstone of its Social and Environmental Responsibility (SER) policy. It applies to all AFD activities.

7.2 Kochi Metro – A Low Carbon Emission Option

Based on the traffic studies, metro rail has considered an appropriate option. Metro is a rail-based mass transit system that delivers fast, comfortable, and cost effective high volume urban mobility. As seen in the above sections, the metro has ability to attract commuters from low efficient and high fuel intensive transport modes, which ultimately reduces the overall greenhouse gas emissions.
The Metro rail system also has potential to reduce the greenhouse gas emissions through:

- Improved fuel-use efficiency of public transport;
- Increase share of public transport - mode switching due to the availability of a more efficient and attractive public transport system;

- Load increase by having a centrally managed organisation dispatching metro cars with varied demand-based frequency;
- Potentially a fuel switch to low carbon fuels
- Reduction in road congestion and improvement in speed of vehicular road traffic

1. Mode Share Shift from Inefficient and High Energy Intensive Modes to Metro

As presented in the Table 8.1 to Table 8.4, it is projected that Kochi will generate 1.41 million road transport based passenger trips (~ 14.14 million passenger-km) in 2018, which is likely to increase to 2.87 million passenger trips (~ 31 million passenger-km) in 2048. With the introduction of metro, the mode switch from the road based transport to metro is likely to be in an extent of 30%.

Table 7.1 Traffic Share in Passenger Trips

Modes	Without Metro			With Metro		
	2018	2033	2048	2018	2033	2048
City Bus	5,82,449	8,36,308	9,31,662	4,24,752	6,35,703	7,08,707
Mini bus	27,463	38,675	48,579	18,939	24,840	30,742
Other Bus	1,37,614	1,92,666	2,39,386	94,993	1,37,327	1,76,959
Car	1,89,840	2,96,224	5,72,442	1,30,171	1,71,711	3,94,078
Taxi	58,221	86,034	1,31,817	41,173	58,364	87,226
TW	2,72,663	3,77,086	4,72,035	2,00,207	2,31,820	2,75,835
Auto	1,44,900	2,65,002	4,78,295	76,707	1,40,488	3,08,849
Metro	-	-	-	4,26,208	6,91,743	8,91,819
Sum	14,13,150	20,91,995	28,74,216	14,13,150	20,91,996	28,74,215

Table 7.2 Percentage Traffic Share in Passenger Trips

Modes	Without Metro			With Metro			Contribution to Metro		
	2018	2033	2048	2018	2033	2048	2018	2033	2048
City Bus	41%	40%	32%	30%	30%	25%	37%	29%	25%
Mini bus	2%	2%	2%	1%	1%	1%	2%	2%	2%
Other Bus	10%	9%	8%	7%	7%	6%	10%	8%	7%
Car	13%	14%	20%	9%	8%	14%	14%	18%	20%
Taxi	4%	4%	5%	3%	3%	3%	4%	4%	5%
TW	19%	18%	16%	14%	11%	10%	17%	21%	22%
Metro	-	-	-	30%	33%	31%	-	-	-
Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 7.3 Traffic Share in Passenger km

Modes	Passenger Km - Without Metro			Passenger Km - With Metro		
	2018	2033	2048	2018	2033	2048
City Bus	5822160	8911900	10325129	4033531	6435492	7461525
Mini bus	246507	366481	478744	161494	223613	287818
Other Bus	1788266	2643116	3415405	1209730	1846257	2474238

Modes	Passenger Km - Without Metro			Passenger Km - With Metro		
	2018	2033	2048	2018	2033	2048
Taxi	721537	1147678	1828753	469437	716283	1113314
TW	2725536	4018320	5231318	1801146	2297409	2812378
Auto	825930	1616510	3013256	406546	786733	1791325
Metro	-	-	-	36,39,813	66,96,067	93,01,670
Sum	1,41,43,755	2,20,53,905	3,10,25,096	1,29,78,270	2,07,68,910	2,94,59,894

Table 7.4 Percentage Traffic Share in Passengers

Modes	Without Metro			With Metro			Contribution to Metro		
	2018	2033	2048	2018	2033	2048	2018	2033	2048
City Bus	41%	40%	33%	31%	31%	25%	36%	29%	25%
Mini bus	2%	2%	2%	1%	1%	1%	2%	2%	2%
Other Bus	13%	12%	11%	9%	9%	8%	12%	10%	8%
Car	14%	15%	22%	10%	9%	14%	16%	21%	23%
Taxi	5%	5%	6%	4%	3%	4%	5%	5%	7%
TW	19%	18%	17%	14%	11%	10%	19%	22%	23%
Auto	6%	7%	10%	3%	4%	6%	10%	11%	12%
Metro	-	-	-	28%	32%	32%	-	-	-
Sum	100%	100%	100%	100%	100%	100%	-	-	-

2. Improvement in Fuel Efficiency

Since the metro has potential to attract commuters that are using less efficient road transport vehicle to the metro as seen in the earlier section, it is likely to lead to reduced fossil fuel consumption. At present, Petrol (Gasoline) and Diesel are the two principle fossil fuels moving the vehicular transport in Kochi, while the use of gaseous fuels (CNG/LPG) is negligible. In terms of fuel mix of vehicles: all type of buses – 100% diesel; taxi – 40% diesel & 60% petrol; personal cars – 5% diesel & 95% petrol; two & three wheelers – 100% petrol; and metro rail – electricity.

The Table 8.5 presents the fuel consumption 'without Metro' and 'with Metro' scenarios, and the estimated fuel savings. The fuel usage is estimated to reduce by 19,510 KL in 2018 to 47,546 KL in 2048. This accounts to about 30% reduction in total fuel demand.

Table 7.5 Fuel Consumption (in kilo liters)

Modes	Without Metro			With Metro		
	2018	2033	2048	2018	2033	2048
City Bus	18.39	24.15	26.71	14.25	18.58	19.87
Mini bus	0.90	1.22	1.51	0.62	0.79	0.94
Other Bus	7.31	9.81	12.12	5.20	7.24	9.08
Car	60.62	99.83	200.63	41.20	59.00	140.83
Taxi	17.81	27.08	42.30	12.08	17.31	26.09

Modes	Without Metro			With Metro		
	2018	2033	2048	2018	2033	2048
Auto	19.56	36.42	67.89	10.97	21.37	48.66
Metro	0.00	0.00	0.00	0.00	0.00	0.00
Total (KL/day)	175	269	443	121	177	312
Total (KL/year)	63,742	98,092	1,61,547	44,232	64,750	1,14,001
Savings(KL/year)				19,510	33,342	47,546

7.3 Carbon Emission Estimate

i. The Table 8.6 presents the carbon emissions estimates for various scenarios and projected years. Taking into consideration the carbon emissions from Metro operations (electricity consumption), the net emission reduction is estimated at 31,719 tCO2e in 2018 and increasing to 79,060 tCO2e in 2048.

ii. *Carbon emissions from use of construction material*. It may be noted that in general as a practice Emissions from Construction are neglected in estimating the carbon emission reductions as per the CDM (Clean Development Mechanism) methodology for carbon credits. As per the CDM methodology for metro rail projects indicates that, "these (*i.e. construction emissions*) have not been included as other methodologies in the energy or industrial sector do not include them also, based on the argument that material demand resulting from the project is non-significant in relation to national production. A clear case is e.g. ACM 0002 where dams can be built for hydropower projects without requiring the inclusion of construction related emissions (cement basically) although these might be very large quantities. ACM 0002 chapter leakage: "The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction, fuel handling (extraction processing, and transport), and land inundation (for hydroelectric projects – see applicability conditions above). Project participants do not need to consider these emission sources as leakage in applying this methodology." In the context of consistency of methodologies and equal approach to projects independent of the sector in which they are realized the construction related emissions for MRTs are not included in this methodology." There is also another reason that, without metro, improvements to the road infrastructure (such as widening, new roads, flyovers, grade separators etc.) will be required, which also require significant quantities of construction material.

iii. However, based on the AFD request, emissions from the usage of construction material are estimated. The metro construction requires large quantities of materials like cement, steel and bitumen. Besides, dust (particulate matter) emissions from the construction phase are also estimated. The construction is implemented though four packages and all works running parallel the construction period is 24 month.

iv. It is estimated that the embedded carbon emissions in construction material is 359,247 tCO2e. During the construction, about 58 tons of total suspended particulate matter is likely to be emitted. However this will vary depending on the dust control mechanisms in place; a good control mechanism will ensure reduce this amount to a great extent. The Table 7.6 presents the carbon emission estimates with metro and without metro.

Table 7.6 Carbon Emission Estimates

Particulars		Units	Without Metro			With Metro		
1	Carbon Emission & Reduction		**2018**	**2033**	**2048**	**2018**	**2033**	**2048**
	Road Traffic Emissions	tCO2e/day	404.5	620.7	1,016.80	281.2	410.7	717.5
		tCO2e/year	1,47,650	2,26,561	3,71,134	1,02,631	1,49,888	2,61,896
	Emission Reduction due to speed improvement	tCO2e/year				-1,894	-3,062	-5,075
2	Metro Power consumption							
	Traction	million units/year				20.26	29.18	47.00
	Auxillary	million units/year				20.24	28.82	46.96
	Total	million units/year				40.50	58.00	93.96
	Emissions	tCO2e/year				15,195	21,885	35,252
3	Total Emission Reductions	tCO2e/year				31,719	57,851	79,060
4	Emission from Metro Construction	tCO2e				3,59,247		
5	Particulate Matter (PM) Emissions from Construction							
	TSP	tons				58.06		
	PM10	tons				29.10		
	PM2.5	tons				2.91		

8. CHAPTER

CONCLUSIONS

The present report focused on establishing the overall socioeconomic and traffic and travel characteristics of the project corridor by conducting fresh traffic and travel surveys on the project corridor and in the project influence area. Additional surveys are carried out to update the urban transport model developed during 2005 for the metro ridership study. Analysis has brought the following broad observations on the study area characteristics.

1. Majority of the roads are 4-lane divided with two-way traffic except between Petta to Vytilla junction and Kacheripady junction to Ernakulam town which is 2-lane divided. The quality of the road is good along the project corridor and most of the major junctions are signalized.

2. Around 41% of roads in the PIA are 2-lane undivided characteristics and about 36% of roads are 4-lane divided with two-way. Twenty three percent of roads are single lane with two-way.

3. The journey speed is less than 20kmph between Vytilla and Palarivattam and along MG road on the project corridor.

4. Traffic on the project corridor varies between 20000 PCUs to 86000 PCUs (18 hours) and highest observed between Vytilla to Edapally. The share of traffic during the peak hour ranges between 6.2% and 12%.

5. Seventy three percent accounts to private modes with almost fifty percent contributed by 2-wheelers illustrating that significant share of commuters choose 2-wheelers as their mode to work. Goods traffic is maximum at Kalamassery i.e. on NH47 Salem-Ernakulam highway road.

6. At the outer cordon (entry to the study area), maximum traffic volume is observed at Aroor on NH47 Kaniyakumari highway road with 56, 424 vehicles (70572 PCUs) in 18 hours.

7. The entire study area is divided into a total of 132 zones, out of which 1 to 74 zones are within the corporation and 51 zones outside the city limit. Seven external zones outside the study area are considered from which significant floating population move towards the city.

8. Analysis of the trip frequency shows that the majority of trips are multiple and daily. Daily travelers mostly prefer 2-wheelers and the share of trips performed daily and multiple times by car is more than 50%. Occasional travelers travel by cars compared to other modes.

9. The work trips are predominant on the project corridor and cordon locations, which is the typical travel characteristic of urban areas.

10. Analysis on travel desire shows that external to internal trips is significant on the project corridor demonstrating considerable floating population in the study area.

11. Average trip length for the 2-wheeler and cars is in the range of 9.9-10.4km on the project corridor. The average trip length for 3-wheelers is 8.1km on the project corridor.

12. Data on travel desire from the Vytilla hub, North railway station and South railway station shows that the major share of traffic is destining in the city centre i.e. in and around MG road/Marine drive. Other destinations include Thammanam Junction, Eloor (Fact), Kumbalam, Fort Kochi, Palluruty, Vaduthala, Edapally, Devankulangara, Palarivattom, Vytilla, Ravipuram, Kaloor and Ayyppankavu.

13. Around 70% of the private mode and IPT passengers are very likely to shift to the proposed metro system. The share of passengers willing to shift is comparatively less at Aluva KSRTC and Aluva Railway station.

14. The population forecasts in the horizon years ie 2018, 2033 and 2048 is estimated as 2.78, 3.41 and 4.05 million respectively. Accordingly the expected employment in the horizon years ie 2018, 2033 and 2048 would be 0.99, 1.29 and 1.59 million respectively.

15. The estimated daily ridership on the proposed Metrorail corridor for the year 2018, 2033 and 2048 are 0.36 million, 0.55 million and 0.71 million respectively.

16. Almost 35% of total metro passenger trips are anticipated to use the project corridor for more than 9 km in the year 2018.

17. The carbon emissions estimates for various scenarios and projected years are worked out, while considering the carbon emissions from Metro operations (electricity consumption), the net emission reduction is estimated at 31,719 tCO2e in 2018 and increasing to 79,060 tCO2e in 2048. It is estimated that the embedded carbon emissions in construction material is 359,247 tCO2e. During the construction, about 58 tons of total suspended particulate matter is likely to be emitted. However this will vary depending on the dust control mechanisms in place; a good control mechanism will ensure reduce this amount to a great extent.

ANNEXURE – 1

SURVEY FORMATS

Classified Traffic Volume Count Survey
Kochi Metro Rail Limited

Location Date

Road Name

Direction

Time	Bus						Private Vehicle & IPT					Goods Vehicles			Slow Moving Vehicles	
	City bus		institutional/company Bus	Mini Bus	Long Distance Bus		Car	Taxi	Two Wheelers	Auto Rickshaws	Shared Autos	LCV	Trucks	MAV and Above	Cycles	others
	Public	Private			Public	Private										

Traffic Study for Kochi Metro
Road Side Interview
Kochi Metro Rail Limited

Name of the Road :

Location:

Direction:

Interviewer :

Date :

Day :

Time (24:00 Hours Format) :

Time	Vehicle Type	Occupancy	Trip Frequency	Origin of the Trip	Destination of the Trip	Purpose of Journey	Approximate Distance between O-D (Km)	Do you prefer to travel by metro once it is operational?	If parking facility is provided at stations, do you prefer to park your vehicleand travel by metro?

Vehicle type
1. Two wheeler
2. Car-Big
3. Car-Small
4. Taxi-Big
5. Taxi-Small
6. Auto
7. Shared Auto

Trip frequency
1. Multiple trips a day
2. Daily
3. Weekly
4. Occasionally

Purpose of journey
1. Work
2. Business
3. Education
4. Social & Recreation
5. Medical
6. Tourism
7. Others

1. Very Unlikely
2. Unlikely
3. Neutral
4. Likely
5. Very Likely

1.Yes
2.No

Bus Passenger Boarding/Alighting Survey

Traffic Study for Kochi Metro

Kochi Metro Rail Limited

Date of Survey: **Enumerator Name:**

Location/Bus stop: **Direction:**

Type of Bus	Time	Number of Alighting Passengers	Number of Boarding Passengers	Sitting Capacity (%)	Standing Capacity (%)	Crush Capacity (Put✓ Mark)

1. Public City Bus(KSRTC)
2. Public Long Distance Bus(KSRTC)
3. Private City Bus
4. Private Long Distance Bus
5. Institutional/Company bus

Origin and Destination at Terminals/Major Transfer Points/Railway Stations

Traffic Study for Kochi Metro

Kochi Metro Rail Limited

Date of Survey: **Location:** **Direction:**

Passenger	Origin	Destination	Purpose of Journey	Frequency	What mode you will use to reach destination/ to reach here from Origin	Will you use metro system to reach your destination from this location once it is operational
1						
2						
3						
4						
5						
6						
7						
8						

Will you use Metro
1. **Very Unlikely**
2. **Unlikely**
3. **Neutral**
4. **Likely**
5. **Very Likely**

Purpose of Journey
1. **Work**
2. **Business**
3. **Education**
4. **Social & Recreation**
5. **Medical**
6. **Tourism**
7. **Others**

Frequency
1. **Multiple Trips a day**
2. **Daily**
3. **Weekly**
4. **Occasionally**

Train /Ferry Passenger In/Out Entry/Exit

Traffic Study for Kochi Metro

Kochi Metro Rail Limited

Date of Survey: **Enumerator Name:**

Location: **Direction:**

Time	Passengers In	Passengers Out

Traffic Study for Kochi Metro

Speed and Delay Survey

Kochi Metro Rail Limited

Road Name: **Sheet No:** **Date:**

Direction: **Weather:** **Trip No:**

Town: **Name of Surveyor:**

Sl.No.	Time	From Node	To Node	Lane Type	BEGIN		END		Delay (sec.)	Delay Cause
					Time	Km Reading	Time	Km Reading		

Delay Causes

(i) Traffic Signal/Police control
(ii) Stop sign
(iii) Market Pedestrian Crossing
(iv) Right turn / U-Turn (Uncontrolled junction)
(v) General congestion
(vi) Accident
(vii) Parked vehicles
(viii) Pedestrian interference
(ix) Level crossing
(x) Road repair
(xi) Breakdown
(xii) Passenger Boarding/Alighting
(xiii) Ticket issuing(Fare stage)
(xiv) Other delays(mention)

Traffic Study for Kochi Metro

Road Inventory Survey (Project Coridor)

Kochi Metro Rail Limited

Location		Distance in Km		Riding Quality	Number of Lanes / Road Width Details	Shoulder	Intersection		No of Bus Stops		Onstreet/Offstreet parking	One way Yes/No	Fly Over/Width from where to where	Land Use
From	To	From	To	Good/Fair /Poor			Type of intersection	Type of control	LHS	RHS				

P- Paved UP-Unpaved W-Working NW-Non Working

ANNEXURE – 2

Volume Count Summary

TRAFFIC STUDY FOR KOCHI METRO

Location : EDAPALLY
Direction : Both
Date 06/06/2013

Day Thrusday

Classified Volume Count - Midblock

PCU Values	2.2	2.2	2.2	1.5	2.2	3.7	1	1	0.75	2	1.4	2.2	4	0.4	2	TOTAL	
Time	Bus						Private Vehicle & IPT				Goods Vehicles			Slow Moving Vehicles			
	City bus		Institutional/Company Bus	Mini Bus	Long Distance Bus		Car	Taxi	Two Wheelers	Auto Rickshaw	LCV	Trucks	MAV and Above	Cycles	others	Vehicles	PCUs
	Public	Private			Public	Private											
5.00-6.00	16	41	7	11	17	13	212	104	287	56	50	52	9	1	0	876	1107
6.00-7.00	29	52	23	11	29	9	344	117	485	115	74	143	7	6	0	1444	1846
7.00-8.00	57	135	55	31	26	13	546	166	886	155	75	139	4	7	1	2296	2813
8.00-9.00	65	162	30	15	19	11	830	232	1739	276	83	72	3	9	1	3547	3881
9.00-10.00	65	118	13	14	15	8	960	298	2893	402	119	57	1	9	1	4973	5048
10.00-11.00	46	126	7	14	21	8	876	262	1578	380	156	109	0	5	0	3588	4032
11.00-12.00	45	94	0	4	30	9	854	327	1343	501	138	146	0	3	1	3495	4119
12.00-13.00	39	118	4	9	23	7	768	371	1078	501	211	199	1	4	1	3334	4135
13.00-14.00	38	86	12	9	20	10	770	234	1047	382	217	209	3	3	1	3041	3726
14.00-15.00	49	120	9	12	28	7	1186	242	1753	488	191	148	3	4	0	4240	4822
15.00-16.00	65	104	32	15	24	8	1136	404	1942	498	210	65	1	1	0	4505	4981
16.00-17.00	52	153	50	22	29	18	1093	366	2068	489	174	46	0	2	0	4562	5058
17.00-18.00	63	155	26	24	30	16	1148	568	1498	516	152	84	2	2	2	4286	4980
18.00-19.00	41	129	12	19	24	14	1051	493	2504	539	253	224	4	12	1	5320	5903
19.00-20.00	30	69	7	11	13	8	903	274	1136	384	246	153	0	2	1	3237	3789
20.00-21.00	20	47	7	8	18	8	868	156	584	256	93	34	1	1	0	2101	2427
21.00-22.00	16	31	4	8	22	8	1096	319	362	229	89	61	0	1	0	2246	2606
22.00-23.00	12	24	0	3	18	2	585	95	217	199	133	95	0	0	0	1383	1767
Total	**748**	**1764**	**298**	**240**	**406**	**177**	**15226**	**5028**	**23400**	**6366**	**2664**	**2036**	**39**	**72**	**10**	**58474**	**67040**

TRAFFIC STUDY FOR KOCHI METRO

Location : PADMA JN. **Classified Volume Count - Mid Block**

Direction : VYTILLA TO ERNAKULAM NORTH STATION

Date 06/05/2013

Day Wednesday

PCU Values	2.2	2.2	2.2	1.5	2.2	3.7	1	1	0.75	2	1.4	2.2	4	0.4	2	TOTAL	
Time	Bus						Private Vehicle & IPT				Goods Vehicles			Slow Moving Vehicles			
	City bus		Institutional/Company Bus	Mini Bus	Long Distance Bus		Car	Taxi	Two Wheelers	Auto Rickshaw	LCV	Trucks	MAV and Above	Cycles	others	Vehicles	PCUs
	Public	Private			Public	Private											
5.00-6.00	3	3	0	3	0	1	98	12	78	40	5	12	1	5	0	261	309
6.00-7.00	4	7	1	6	0	4	104	26	131	81	12	9	0	10	0	395	481
7.00-8.00	5	26	5	4	0	1	139	34	319	92	21	9	0	11	0	666	739
8.00-9.00	4	25	0	1	0	0	276	57	530	197	26	0	0	2	0	1118	1227
9.00-10.00	6	24	0	3	1	1	348	48	610	291	28	0	0	11	1	1372	1558
10.00-11.00	4	17	0	5	1	0	382	42	598	341	32	0	0	12	0	1434	1660
11.00-12.00	2	17	0	5	4	2	427	53	578	381	33	0	0	10	0	1512	1791
12.00-13.00	2	23	0	3	0	1	369	51	500	308	25	0	0	15	0	1297	1515
13.00-14.00	4	9	0	0	0	1	287	38	491	277	25	0	0	9	0	1141	1318
14.00-15.00	1	14	2	3	0	3	360	54	708	274	30	1	0	10	0	1460	1594
15.00-16.00	3	19	2	5	1	1	368	30	566	293	39	0	0	14	0	1341	1535
16.00-17.00	4	15	3	8	0	0	414	31	521	289	43	0	0	11	0	1339	1539
17.00-18.00	1	28	0	8	0	0	429	41	783	311	46	0	0	6	0	1653	1822
18.00-19.00	2	15	0	3	0	0	419	46	698	265	26	0	0	0	1	1475	1599
19.00-20.00	5	10	3	3	0	0	368	23	351	191	12	0	0	1	0	967	1098
20.00-21.00	5	5	0	2	0	0	298	28	321	156	16	2	0	3	0	836	932
21.00-22.00	0	1	2	3	1	1	148	19	174	126	8	3	0	5	0	491	586
22.00-23.00	1	3	2	2	0	1	157	21	139	109	5	4	2	4	0	450	546
Total	**56**	**261**	**20**	**67**	**8**	**17**	**5391**	**654**	**8096**	**4022**	**432**	**40**	**3**	**139**	**2**	**19208**	**21848**

TRAFFIC STUDY FOR KOCHI METRO

Location : AMBATUKAVU — **Classified Volume Count - Mid Block**
Direction : Both
Date 06/18/2013
Day Tuesday

PCU Values	2.2	2.2	2.2	1.5	2.2	3.7	1	1	0.75	1.2	2	3.7	4	0.4	2	TOTAL	
Time	Bus						Private Vehicle & IPT				Goods Vehicles			Slow Moving Vehicles			
	City bus		Institutional/Company Bus	Mini Bus	Long Distance Bus		Car	Taxi	Two Wheelers	Auto Rickshaw	LCV	Trucks	MAV and Above	Cycles	others	Vehicles	PCUs
	Public	Private			Public	Private											
5.00-6.00	10	4	1	8	9	6	288	51	118	33	122	135	73	0	0	858	1590
6.00-7.00	14	18	9	16	33	6	574	172	226	119	297	451	251	8	0	2194	4537
7.00-8.00	41	34	33	19	28	23	725	280	482	172	238	345	144	7	0	2571	4317
8.00-9.00	54	50	31	18	43	15	810	211	972	188	207	292	107	2	0	3000	4373
9.00-10.00	64	60	12	21	58	20	1146	379	888	266	312	290	104	2	2	3624	5160
10.00-11.00	78	52	7	18	43	8	1368	367	834	142	245	381	80	1	1	3625	5206
11.00-12.00	66	56	3	22	53	13	1476	336	609	179	336	401	118	0	2	3670	5588
12.00-13.00	64	61	4	31	46	15	1389	342	635	133	462	529	194	3	3	3911	6518
13.00-14.00	63	67	3	19	40	12	1269	251	546	120	330	337	160	5	1	3223	5078
14.00-15.00	60	52	9	13	33	9	1223	240	596	131	342	328	137	2	2	3177	4909
15.00-16.00	64	64	24	16	19	13	1159	293	729	131	383	313	133	0	1	3342	5062
16.00-17.00	52	38	24	14	22	14	1625	262	812	182	420	327	167	4	1	3964	5808
17.00-18.00	53	48	10	17	40	20	2103	458	1121	283	372	346	151	2	2	5026	6806
18.00-19.00	48	57	0	13	38	14	1639	277	1129	174	349	322	158	1	0	4219	5879
19.00-20.00	59	52	0	18	31	26	1887	334	809	246	414	334	189	0	0	4399	6378
20.00-21.00	40	46	2	13	27	28	1554	239	619	137	181	228	130	0	0	3244	4523
21.00-22.00	16	22	0	6	19	36	970	153	345	63	119	170	130	0	0	2049	3112
22.00-23.00	19	13	0	5	15	17	467	90	179	20	58	173	135	1	0	1192	2186
Total	**865**	**794**	**172**	**287**	**597**	**295**	**21672**	**4735**	**11649**	**2719**	**5187**	**5702**	**2561**	**38**	**15**	**57288**	**87031**

TRAFFIC STUDY FOR KOCHI METRO

Location : VYTILLA — **Classified Volume Count - Mid Block**

Direction : Both

Date 01/00/1900

Day 01/00/1900

PCU Values	2.2	2.2	2.2	1.5	2.2	3.7	1	1	0.75	2	1.4	2.2	4	0.4	2	TOTAL	
Time	Bus						Private Vehicle & IPT				Goods Vehicles			Slow Moving Vehicles			
	City bus		Institutional/Company Bus	Mini Bus	Long Distance Bus		Car	Taxi	Two Wheelers	Auto Rickshaw	LCV	Trucks	MAV and Above	Cycles	others	Vehicles	PCUs
	Public	Private			Public	Private											
5.00-6.00	8	24	0	2	3	4	86	17	100	31	11	6	0	0	0	292	363
6.00-7.00	19	55	35	15	3	7	230	64	301	130	24	11	2	14	0	910	1146
7.00-8.00	14	102	24	15	7	5	457	100	748	274	41	33	9	6	0	1835	2199
8.00-9.00	15	135	18	14	17	9	792	131	1548	273	50	30	3	9	0	3044	3243
9.00-10.00	32	87	1	4	14	8	787	211	3432	331	66	6	0	0	0	4979	4670
10.00-11.00	15	82	0	13	12	8	577	91	2220	232	73	19	4	2	0	3348	3247
11.00-12.00	14	76	0	5	7	6	398	87	1716	111	59	11	5	0	0	2495	2364
12.00-13.00	5	62	7	8	16	8	485	79	1932	135	61	29	2	3	0	2832	2681
13.00-14.00	8	62	8	5	7	6	448	103	1692	127	48	19	5	0	0	2538	2420
14.00-15.00	18	61	21	11	11	9	309	132	876	144	62	12	4	4	1	1675	1813
15.00-16.00	23	65	22	9	12	11	419	118	1272	210	43	11	1	17	0	2233	2329
16.00-17.00	11	97	30	9	13	12	470	162	1080	177	36	10	4	9	0	2120	2278
17.00-18.00	6	71	14	6	13	18	321	123	1032	160	38	8	3	14	0	1827	1931
18.00-19.00	14	59	1	12	16	13	342	82	1332	149	18	11	3	13	0	2065	2052
19.00-20.00	7	44	2	6	18	12	230	42	1416	78	18	5	1	4	0	1883	1741
20.00-21.00	6	18	0	4	12	17	379	54	1464	48	10	3	1	4	0	2020	1801
21.00-22.00	5	0	0	1	6	4	234	48	660	56	15	3	8	2	0	1042	990
22.00-23.00	0	0	0	5	2	1	107	12	252	28	5	1	2	1	0	416	397
Total	**220**	**1100**	**183**	**144**	**189**	**158**	**7071**	**1656**	**23073**	**2694**	**678**	**228**	**57**	**102**	**1**	**37554**	**37664**

Location :	**AROOR**																
Direction :	**Both**																
Date	**06/03/2013**																
Day	**Monday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**1.4**	**3.7**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	9	5	2	7	4	4	154	71	265	90	39	84	38	4	0	776	1192
6.00-7.00	22	23	6	13	13	5	461	161	457	118	92	162	30	13	0	1576	2233
7.00-8.00	45	52	18	15	23	4	724	193	1047	212	126	288	36	23	0	2806	3862
8.00-9.00	48	68	18	19	16	6	1088	147	2094	327	153	210	22	48	0	4264	4939
9.00-10.00	35	53	7	34	36	3	1612	220	2627	424	158	172	18	101	0	5500	5971
10.00-11.00	45	51	6	28	34	8	1224	198	1720	311	146	272	27	62	0	4132	5048
11.00-12.00	41	47	6	22	43	15	934	172	1462	356	168	282	23	73	0	3644	4704
12.00-13.00	37	48	12	11	38	5	986	190	1632	360	174	290	26	43	0	3852	4890
13.00-14.00	37	37	12	30	36	9	704	183	1326	301	126	265	22	32	0	3120	4088
14.00-15.00	32	35	9	21	48	9	938	172	1256	289	110	250	32	43	0	3244	4192
15.00-16.00	41	45	5	20	42	11	1007	219	1406	318	160	209	23	36	0	3542	4384
16.00-17.00	28	38	13	33	47	12	1017	201	1336	261	152	164	41	43	0	3386	4114
17.00-18.00	40	56	12	30	46	17	1170	234	1458	374	139	221	40	37	0	3874	4879
18.00-19.00	64	50	11	36	46	15	1448	257	2136	393	141	173	48	45	0	4863	5626
19.00-20.00	38	30	3	27	54	14	1059	155	1611	354	134	159	42	11	0	3691	4446
20.00-21.00	38	18	0	18	36	12	678	119	890	289	94	133	36	8	0	2369	3087
21.00-22.00	21	6	7	7	13	4	256	46	407	136	65	111	71	3	0	1153	1795
22.00-23.00	12	5	0	10	12	2	185	24	169	54	9	67	83	0	0	632	1122
Total	**633**	**667**	**147**	**381**	**587**	**155**	**15645**	**2962**	**23299**	**4967**	**2186**	**3512**	**658**	**625**	**0**	**56424**	**70572**

Location :	**ANGAMALLY**																
Direction :	**Both**																
Date	**06/21/2013**																
Day	**Friday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**1.2**	**2**	**3.7**	**5**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	0	0	2	4	9	6	148	68	78	15	24	70	26	0	0	450	782
6.00-7.00	0	0	12	6	30	17	523	260	227	62	65	206	104	0	0	1512	2604
7.00-8.00	0	0	21	13	49	29	716	267	353	53	136	244	104	0	0	1985	3287
8.00-9.00	0	0	27	15	44	32	884	248	841	76	147	233	224	0	0	2771	4427
9.00-10.00	0	0	13	19	51	40	820	278	845	121	156	220	203	0	0	2766	4335
10.00-11.00	0	0	9	19	65	40	866	352	578	103	155	217	140	0	0	2544	3927
11.00-12.00	0	0	6	13	68	31	991	247	512	93	218	233	145	0	0	2557	4054
12.00-13.00	0	0	6	14	58	35	903	343	607	141	183	177	132	0	0	2599	3843
13.00-14.00	0	0	11	14	38	24	798	235	475	72	116	162	91	0	0	2036	2980
14.00-15.00	0	0	10	14	70	33	905	266	498	117	147	207	138	0	0	2405	3754
15.00-16.00	0	0	12	9	63	32	1108	325	609	105	161	179	149	2	1	2755	4045
16.00-17.00	0	0	18	13	59	39	1272	385	615	132	185	172	145	0	0	3035	4341
17.00-18.00	0	0	10	13	50	47	1340	483	841	134	244	218	92	0	0	3472	4695
18.00-19.00	0	0	9	17	52	45	1266	496	723	114	285	168	142	0	0	3317	4669
19.00-20.00	0	0	5	20	54	45	1244	405	730	152	188	164	140	0	0	3147	4388
20.00-21.00	0	0	3	14	38	24	881	318	566	76	197	323	183	0	0	2623	4419
21.00-22.00	0	0	8	13	43	43	767	211	437	63	210	224	271	0	0	2290	4276
22.00-23.00	0	0	2	8	16	17	457	143	130	27	66	140	126	0	0	1132	2124
Total	**0**	**0**	**184**	**238**	**857**	**579**	**15889**	**5330**	**9665**	**1656**	**2883**	**3557**	**2555**	**2**	**1**	**43396**	**66949**

Location :	**PARAVOOR**
Direction :	**Both**
Date	**06/20/2013**
Day	**Thrusday**

PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**1.4**	**3.7**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/ Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	0	0	3	2	3	8	53	26	44	51	17	15	10	4	0	236	381
6.00-7.00	0	0	5	3	18	21	68	50	125	57	26	23	9	4	0	409	618
7.00-8.00	0	0	11	2	14	26	122	46	116	66	30	16	10	3	0	462	684
8.00-9.00	0	0	20	13	10	26	242	71	137	76	160	73	16	3	0	847	1309
9.00-10.00	0	0	13	9	14	27	264	56	119	89	101	75	13	6	0	786	1233
10.00-11.00	0	0	2	12	10	26	278	76	149	149	84	47	21	1	0	855	1280
11.00-12.00	0	0	2	2	9	21	249	41	122	122	76	41	13	8	0	706	1044
12.00-13.00	0	0	0	9	9	20	219	37	97	97	43	23	4	6	0	564	794
13.00-14.00	0	0	4	11	9	21	236	35	104	104	48	18	6	3	0	599	839
14.00-15.00	0	0	3	7	9	17	213	26	95	95	53	28	8	4	0	558	811
15.00-16.00	0	0	16	7	10	20	252	46	117	117	67	29	10	0	0	691	1003
16.00-17.00	0	0	17	10	10	19	254	38	104	104	56	20	17	9	0	658	947
17.00-18.00	0	0	14	9	8	22	275	39	169	169	58	26	9	7	0	805	1138
18.00-19.00	0	0	2	5	10	34	246	33	165	165	42	22	10	2	0	736	1073
19.00-20.00	0	0	2	5	8	20	129	17	63	63	42	17	11	1	0	378	589
20.00-21.00	0	0	0	3	5	7	87	16	42	42	21	29	17	5	0	274	467
21.00-22.00	0	0	1	1	4	6	66	14	17	17	17	12	13	1	0	169	282
22.00-23.00	0	0	1	2	2	7	61	21	14	14	8	9	9	0	0	148	237
Total	**0**	**0**	**116**	**112**	**162**	**348**	**3314**	**688**	**1799**	**1597**	**949**	**523**	**206**	**67**	**0**	**9881**	**14727**

Location :	**PERUMBAVOOR**																
Direction :	**Both**																
Date	**06/14/2013**																
Day	**Friday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**1.4**	**3.7**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	6	5	2	2	11	5	164	68	177	127	83	70	26	5	2	753	1178
6.00-7.00	16	15	4	6	19	7	228	98	674	265	127	105	33	8	2	1607	2221
7.00-8.00	28	25	19	15	24	17	293	191	1041	380	87	166	22	9	3	2320	3155
8.00-9.00	22	24	18	10	31	21	356	250	1211	266	102	156	23	17	13	2520	3193
9.00-10.00	15	16	6	8	33	30	512	254	879	372	107	99	20	8	3	2362	3052
10.00-11.00	9	14	1	6	28	23	504	263	616	450	118	204	39	6	4	2285	3424
11.00-12.00	11	13	0	7	23	18	432	193	485	416	117	163	28	5	5	1916	2892
12.00-13.00	12	11	4	3	33	21	419	196	510	282	87	129	27	5	4	1743	2493
13.00-14.00	15	18	3	8	25	16	405	189	639	312	104	145	44	4	1	1928	2764
14.00-15.00	30	22	0	4	34	20	454	144	931	294	123	100	32	3	0	2191	2825
15.00-16.00	17	15	6	9	28	23	565	141	1227	327	114	114	12	8	0	2606	3157
16.00-17.00	28	28	21	15	28	27	549	284	974	506	109	120	20	16	2	2727	3616
17.00-18.00	21	23	14	3	33	19	520	257	1170	365	110	105	16	12	1	2669	3273
18.00-19.00	25	14	5	2	24	24	453	213	1189	431	73	67	15	6	2	2543	3078
19.00-20.00	17	13	2	1	18	14	461	225	937	420	99	117	39	1	0	2364	3120
20.00-21.00	12	7	0	1	10	11	400	169	635	483	91	99	22	2	0	1942	2700
21.00-22.00	7	7	0	0	3	10	263	186	389	300	91	113	17	1	0	1387	2029
22.00-23.00	4	0	0	0	2	0	98	136	158	179	73	112	11	0	0	773	1284
Total	**295**	**270**	**105**	**100**	**407**	**306**	**7076**	**3457**	**13842**	**6175**	**1815**	**2184**	**446**	**116**	**42**	**36636**	**49452**

Location :	**PUTHIYAKAVU**																
Direction :	**Both**																
Date	**06/17/2013**																
Day	**Monday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**2**	**2.2**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	5	5	3	4	1	6	133	46	104	22	21	7	3	3	0	363	431
6.00-7.00	14	24	7	16	16	21	240	95	197	113	50	44	11	5	1	854	1189
7.00-8.00	11	25	25	19	15	28	357	108	588	259	56	42	4	7	0	1544	1947
8.00-9.00	21	19	22	21	17	45	646	79	1254	185	120	97	3	14	0	2543	2878
9.00-10.00	10	23	1	15	15	40	856	143	1307	242	113	43	3	7	1	2819	3079
10.00-11.00	11	15	2	8	10	27	587	135	592	166	117	109	5	10	1	1795	2193
11.00-12.00	7	11	0	5	16	45	582	144	563	148	109	70	6	12	0	1718	2094
12.00-13.00	4	11	1	4	16	32	520	92	455	165	105	90	6	4	0	1505	1912
13.00-14.00	3	7	4	7	12	38	403	78	334	134	77	52	6	1	0	1156	1501
14.00-15.00	5	14	4	12	14	37	403	100	409	154	95	59	13	6	0	1325	1728
15.00-16.00	7	7	11	15	11	29	538	153	493	167	111	69	5	8	0	1624	2001
16.00-17.00	15	12	21	20	8	38	595	178	682	193	110	36	7	11	1	1927	2298
17.00-18.00	18	13	12	21	16	40	640	132	764	217	79	69	7	8	0	2036	2429
18.00-19.00	14	11	5	11	15	42	471	99	806	157	55	28	10	5	0	1729	1973
19.00-20.00	4	7	0	4	21	41	387	117	541	109	64	23	6	0	0	1324	1558
20.00-21.00	1	0	0	4	13	21	244	78	258	105	77	22	8	5	1	837	1078
21.00-22.00	1	1	0	1	4	13	104	42	161	71	49	28	7	0	0	482	659
22.00-23.00	1	3	0	0	2	8	63	21	114	53	14	21	8	0	0	308	425
Total	**152**	**208**	**118**	**187**	**222**	**551**	**7769**	**1840**	**9622**	**2660**	**1422**	**909**	**118**	**106**	**5**	**25889**	**31373**

Location :	**Thiruvakulam**																
Direction :	**Both**																
Date	**06/19/2013**																
Day	**Wednesday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**1.4**	**3.7**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	6	3	4	4	8	5	84	18	150	27	14	12	5	4	0	344	425
6.00-7.00	10	1	8	3	8	1	121	35	187	29	22	56	9	3	0	493	697
7.00-8.00	11	3	22	12	8	3	247	47	367	50	46	96	7	9	0	928	1246
8.00-9.00	14	6	14	16	15	5	358	41	620	94	53	72	7	6	3	1324	1579
9.00-10.00	13	2	6	9	12	5	436	57	850	102	43	53	4	3	0	1595	1713
10.00-11.00	23	3	1	11	9	2	385	59	453	100	68	108	7	8	0	1237	1613
11.00-12.00	4	2	2	11	8	1	363	48	396	73	70	71	10	9	0	1068	1314
12.00-13.00	17	1	0	9	13	1	334	46	393	77	93	76	16	5	0	1081	1392
13.00-14.00	6	6	8	12	9	3	325	62	311	91	53	38	7	7	0	938	1141
14.00-15.00	20	3	13	6	7	0	421	69	401	102	69	40	7	2	0	1160	1372
15.00-16.00	15	2	8	9	13	0	347	44	365	90	58	75	15	7	0	1048	1363
16.00-17.00	15	2	22	22	12	2	409	46	486	98	72	32	9	9	0	1236	1427
17.00-18.00	14	0	11	16	5	8	385	44	598	112	61	45	6	4	0	1309	1499
18.00-19.00	17	2	4	13	21	1	434	76	520	90	56	35	6	7	2	1284	1439
19.00-20.00	15	4	1	13	9	3	369	63	624	88	66	76	8	6	2	1347	1582
20.00-21.00	12	0	0	3	7	3	368	19	305	45	35	47	15	0	0	859	1046
21.00-22.00	6	2	0	7	9	1	372	15	134	24	13	40	15	0	0	638	813
22.00-23.00	2	0	11	1	6	0	191	15	105	5	7	30	13	0	0	386	511
Total	**220**	**42**	**135**	**177**	**179**	**44**	**5949**	**804**	**7265**	**1297**	**899**	**1002**	**166**	**89**	**7**	**18275**	**22171**

Location :	**Pallikara**
Direction :	**Both**
Date	**06/21/2013**
Day	**Friday**

PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**1.2**	**1.4**	**3.7**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	0	0	2	1	1	0	27	12	29	37	1	1	2	0	0	113	156
6.00-7.00	0	1	1	1	2	0	35	13	36	24	5	9	4	0	0	131	190
7.00-8.00	0	0	2	0	2	1	67	35	63	70	33	4	4	0	0	281	379
8.00-9.00	0	2	1	1	2	2	178	49	68	98	27	10	6	0	0	444	593
9.00-10.00	0	2	1	2	5	4	174	35	69	87	9	16	5	0	0	409	562
10.00-11.00	0	1	0	0	2	4	178	27	49	94	15	36	8	0	0	414	637
11.00-12.00	0	1	0	2	2	3	98	22	39	29	7	22	5	0	0	230	339
12.00-13.00	0	1	1	1	2	1	85	15	33	29	15	40	8	0	0	231	398
13.00-14.00	0	0	0	1	2	3	64	25	44	41	14	34	8	0	0	236	398
14.00-15.00	0	0	0	5	1	3	64	29	69	22	13	21	12	0	0	239	353
15.00-16.00	0	0	2	4	3	3	81	30	47	45	16	25	9	0	0	265	415
16.00-17.00	0	0	1	6	4	2	200	71	49	87	36	27	13	0	0	496	711
17.00-18.00	0	2	1	3	4	3	197	56	83	71	25	24	10	0	0	479	652
18.00-19.00	0	0	2	4	7	3	139	49	94	93	40	31	14	0	0	476	708
19.00-20.00	0	1	1	6	4	3	108	27	80	68	25	18	4	0	0	345	482
20.00-21.00	0	1	0	2	4	1	76	20	42	46	23	16	5	0	0	236	349
21.00-22.00	0	0	0	0	0	0	24	11	16	18	15	11	4	0	0	99	161
22.00-23.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**0**	**12**	**15**	**39**	**47**	**36**	**1795**	**526**	**910**	**959**	**319**	**345**	**121**	**0**	**0**	**5124**	**7483**

Location :	**PACHALAM**																
Direction :	**Both**																
Date	**06/07/2013**																
Day	**Friday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**1.4**	**2.2**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.00-7.00	5	16	14	14	0	0	100	64	356	118	43	10	2	13	0	755	860
7.00-8.00	3	39	22	19	0	0	164	115	834	187	49	11	0	45	0	1488	1559
8.00-9.00	1	64	13	26	0	0	445	441	1193	310	45	22	3	44	0	2607	2752
9.00-10.00	3	52	2	21	0	0	540	265	1116	319	40	13	0	44	0	2415	2539
10.00-11.00	1	32	0	13	0	0	328	153	954	287	41	14	5	22	0	1850	1980
11.00-12.00	1	27	1	0	0	0	227	168	1026	230	48	15	1	16	0	1760	1799
12.00-13.00	2	30	4	7	0	0	175	150	852	192	41	25	0	18	0	1496	1557
13.00-14.00	2	26	2	7	0	0	151	123	733	135	30	17	1	12	0	1239	1258
14.00-15.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.00-16.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.00-17.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.00-18.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.00-19.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.00-20.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.00-21.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.00-22.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.00-23.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**18**	**286**	**58**	**107**	**0**	**0**	**2130**	**1479**	**7064**	**1778**	**337**	**127**	**12**	**214**	**0**	**13610**	**14305**

Location :	**PALARIVATTOM**																
Direction :	**Both**																
Date	**06/14/2013**																
Day	**Friday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**1.4**	**2.2**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.00-7.00	2	22	11	13	3	5	243	94	330	79	135	69	3	1	1	1011	1219
7.00-8.00	4	42	22	19	7	8	460	153	729	162	99	70	4	11	3	1793	2026
8.00-9.00	7	37	21	23	5	9	739	157	1711	249	59	129	11	18	1	3176	3319
9.00-10.00	5	32	7	31	2	8	709	187	1500	330	90	102	2	13	1	3019	3224
10.00-11.00	3	25	1	18	2	8	711	228	1502	274	108	72	7	5	0	2964	3078
11.00-12.00	1	25	1	11	2	6	671	203	1181	256	90	73	3	10	0	2533	2677
12.00-13.00	6	20	1	12	8	10	514	130	1021	139	81	85	8	10	3	2048	2162
13.00-14.00	10	20	3	16	4	5	435	118	921	83	77	47	6	8	4	1757	1780
14.00-15.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.00-16.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.00-17.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.00-18.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.00-19.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.00-20.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.00-21.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.00-22.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.00-23.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**38**	**223**	**67**	**143**	**33**	**59**	**4482**	**1270**	**8895**	**1572**	**739**	**647**	**44**	**76**	**13**	**18301**	**19485**

Location :	**THOPUMPADY TOLL BRIDGE**																
Direction :	**Both**																
Date	**06/07/2013**																
Day	**Friday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**2**	**3.7**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.00-7.00	9	82	11	12	13	3	116	132	417	222	65	133	9	3	0	1227	1946
7.00-8.00	25	113	13	13	12	1	313	161	860	269	116	231	10	4	0	2141	3167
8.00-9.00	42	160	10	18	12	1	847	181	1420	268	140	252	7	4	0	3362	4395
9.00-10.00	55	168	1	16	17	2	1050	161	1811	263	137	149	5	1	0	3836	4503
10.00-11.00	40	174	2	15	11	0	879	139	1219	210	192	188	9	1	0	3079	3990
11.00-12.00	30	75	1	8	12	2	885	102	618	166	136	181	8	0	0	2224	3035
12.00-13.00	29	79	1	7	17	3	654	99	489	194	192	228	13	0	0	2005	3086
13.00-14.00	23	80	4	16	10	1	577	97	466	182	140	160	9	0	0	1765	2581
14.00-15.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.00-16.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.00-17.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.00-18.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.00-19.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.00-20.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.00-21.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.00-22.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.00-23.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**253**	**931**	**43**	**105**	**104**	**13**	**5321**	**1072**	**7300**	**1774**	**1118**	**1522**	**70**	**13**	**0**	**19639**	**26702**

Location :	**EDAPALLY FLY OVER**																
Direction :	**Both**																
Date	**06/11/2013**																
Day	**Tuesday**																
PCU Values	**2.2**	**2.2**	**2.2**	**1.5**	**2.2**	**3.7**	**1**	**1**	**0.75**	**2**	**2**	**2.2**	**4**	**0.4**	**2**	**TOTAL**	
Time	**Bus**						**Private Vehicle & IPT**				**Goods Vehicles**			**Slow Moving Vehicles**			
	City bus		**Institutional/Company Bus**	**Mini Bus**	**Long Distance Bus**		**Car**	**Taxi**	**Two Wheelers**	**Auto Rickshaw**	**LCV**	**Trucks**	**MAV and Above**	**Cycles**	**others**	**Vehicles**	**PCUs**
	Public	**Private**			**Public**	**Private**											
5.00-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.00-7.00	4	13	5	4	1	2	123	21	255	71	9	27	9	4	1	549	658.25
7.00-8.00	3	27	16	13	5	9	222	67	767	148	27	29	10	6	0	1349	1485
8.00-9.00	7	41	4	5	16	8	388	86	1085	148	59	54	10	11	0	1922	2052
9.00-10.00	9	28	0	4	7	9	407	81	888	106	140	49	12	3	0	1743	1939
10.00-11.00	8	15	0	3	4	8	330	74	560	96	159	56	15	4	0	1332	1612
11.00-12.00	7	20	0	8	2	11	326	47	376	73	166	54	12	4	0	1106	1418
12.00-13.00	7	16	1	10	2	9	313	97	489	71	71	52	16	8	0	1162	1348
13.00-14.00	9	19	2	7	5	6	278	68	350	43	71	44	11	7	2	922	1094
14.00-15.00	0	0	0	0	0	0	26	4	13	5	12	2	0	0	0	62	78
15.00-16.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.00-17.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.00-18.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.00-19.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.00-20.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.00-21.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.00-22.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**54**	**179**	**28**	**54**	**42**	**62**	**2413**	**545**	**4783**	**761**	**714**	**367**	**95**	**47**	**3**	**10147**	**11684**

ANNEXURE – 3

Zone List & OD Matrix

ZONE LIST

Zone No	Name	Zone No	Name	Zone No	Name
1	Fort Kochi	51	Poonithura	101	Keezhmad
2	Kalvathy	52	Vyttila Janatha	102	Sreemoolanagaram
3	Earaveli	53	Ponnurunni	103	Chengamanad
4	Karippalam	54	Elamkulam	104	Nedumbassery
5	Mattanchery	55	Girinagar	105	Kanjoor
6	Kochangadi	56	Panampilly Nagar	106	Vazhakulam
7	Cheralai	57	Kadavanthra	107	Challanam
8	Panayappilly	58	Konthuruthy	108	Thrikkakkara
9	Chakkamadom	59	Thevara	109	Thoppil,Vazhakkala
10	Karuvelippady	60	Perumanoor	110	Vadavukode-Puthencruz
11	Thoppumpady	61	Ravipuram	111	Thiruvankulam
12	Tharebagom	62	Ernakulam South	112	Chotanikkara
13	Kadebagom	63	Gandhi Nagar	113	Mulamthuruthy
14	Thazhappu	64	Katrukadav	114	Maradu
15	Edakochi North	65	Kaloor South	115	Udayamperoor
16	Edakochi South	66	EKM Centre	116	Kumbalam
17	Perumbadappu	67	EKM North	117	Kumbalangi
18	Konam	68	Ayyappankavu	118	Pallipuram
19	Palluruthy Kacheripady	69	Thrikkanarvattom	119	Kuzhuppilly
20	Nambiapuram	70	Kaloor North	120	Edavamnakkad
21	Pullardesam	71	Elamakkara	121	Nayarambalam
22	Mundamveli	72	Pottakuzhi	122	Mulavakkad
23	Manasery	73	Pachalam	123	Njarackal
24	Moolamkuzhi	74	Thattazham	124	Kadamakkudy
25	Chullikal	75	Aluva (M)	125	Elamkunnapuzha
26	Nazarat	76	Perumbavoor (M)	126	Kodungallur
27	Fort Kochi Veli	77	Paravoor (M)	127	Thrissur, palakad
28	Amaravathy	78	Thripoonithura (M)	128	Perumbavoor (M)
29	Island North	79	Eroor South	129	Kizhakkambalam
30	Island South	80	Eroor	130	Muvatupulha
31	Vaduthala West	81	HMT Kalamassery,Kangarappady,Kaipadamugal	131	kottayam
32	Vaduthala East	82	Kalamassery North	132	Allapey
33	Elamakkara North	83	Kalamassery South		
34	Puthukalavattom	84	Pathadipalam,Koonamthai,Vattekkunom		
35	Ponekkara	85	Angamaly (M)		
36	kunnumpuram	86	Eloor		
37	Edappally	87	IAC Road,Kuttikattukara		
38	Devankulangara	88	Varappuzha		
39	Karukappilli	89	Cheranallur		
40	Mamagalam	90	Kottuvally		
41	Padivattom	91	Ezhikkara		
42	Vennala	92	Kadungallor,Uliyannoor		
43	Palarivattom	93	Venmanickachal,Elinjichuvadu		
44	Karanakodam	94	Edayar		
45	Thammanam	95	Alangad		
46	Chakkaraparambu	96	Thaikkattukara		
47	Chalikkavattom	97	Ambattukavu		
48	Ponnurunni East	98	Choornikkara		
49	Vyttila	99	Kattepadam,South Aluva		
50	Chambakkara	100	Edathala		

OD Matrix -2-Wheeler

TW	33	35	37	38	39	40	41	43	44	45	48	49	50	51	52	53	54	55	56	57	61	62	63	66	67	68	69	70	71	72	75	78	79	81	82	83	84	86	87	92	93	96	97	98	99	109	114
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	4	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	28	0	0	12	8	0	8	2	0	0	0	2	0	2	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0
43	0	0	0	2	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	2	0	6	0	0	6	2	0	0	0	0	9	3	0	2	2	0	3	0	0	0	0	0	0	0	0	0	3
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	6	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	2	0	0	0	2	4	0	2	0	9	9	3	3	2	0	0	1	9	11	14	0	21	2	2	2	1	0	0	14	26	0	0	2	0	3	2	0	0	0	0	0	0	0	2	3
50	0	0	1	0	0	0	0	0	0	1	0	4	0	0	1	0	0	0	0	2	0	1	0	2	5	2	0	1	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	1	0	0	0	0	0	0	0	0	2	2	0	2	2	0	0	0	2	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	3	0	0	0	3	0	0	6	0	20	15	6	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	8	50	0	2	0	0	0	0	0	0	0	0	0	0	0	0	20
61	0	0	2	0	0	0	0	2	0	2	0	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	6	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
62	0	2	18	0	2	0	0	2	0	49	0	29	23	12	0	0	0	0	0	0	2	0	0	20	0	6	20	12	0	0	16	117	0	6	4	4	5	0	2	2	0	0	0	0	0	4	26
63	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	2	0	2	0	4	0	3	0	3	0	0	0	0	0	0	0	0	0	10	2	2	0	10	0	0	12	23	0	3	3	0	2	0	0	0	0	2	0	0	0	2	3
67	0	0	16	0	0	0	0	4	0	10	0	4	6	0	0	0	0	0	0	6	0	2	0	26	2	0	0	10	0	0	6	6	0	6	2	0	2	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	4	2	0	0	0	0	5	1	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	29	0	0	0	0	8	0	0	0	3	0	0	0	1	0	2	0	3	0	12	6	0	0	6	0	5	0	0	0	6	0	2	3	2	3	0	0	0	0	0	0	0	0	0	0
78	0	0	2	0	0	0	0	2	0	1	1	23	0	0	3	0	2	0	3	19	15	18	1	23	7	11	2	5	1	0	5	0	0	2	2	0	1	0	0	0	0	0	0	2	0	2	0
79	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	4	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2	1	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
81	0	0	20	0	0	0	0	8	0	0	0	2	0	0	0	0	0	0	0	0	0	3	5	5	0	0	0	8	0	0	2	0	0	9	5	2	34	0	0	0	0	2	0	0	0	0	2
82	0	0	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	2	2	0	0	0	0	21	3	0	17	28	0	5	2	0	0	0	0	0	0	0	0	0
83	0	0	8	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	6	2	0	0	0	0	2	0	0	3	2	0	6	3	0	41	2	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	6	0	0	3	0	0	0	0	0	0	0	0	0	0
86	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	1	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	0	0	5	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	3	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0

OD Matrix - 3-Wheeler

Auto	33	35	37	38	39	40	41	43	44	45	48	49	50	51	52	53	54	55	56	57	61	62	63	66	67	68	69	70	71	72	75	78	79	81	82	83	84	86	87	92	93	96	97	98	99	109	114
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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OD Matrix- Car

CAR	33	35	37	38	39	40	41	43	44	45	48	49	50	51	52	53	54	55	56	57	61	62	63	66	67	68	69	70	71	72	75	78	79	81	82	83	84	86	87	92	93	96	97	98	99	109	114
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84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANNUXURE 4

BUS ROUTES DETAILS

Operational Routes by KSRTC Buses

Sl. No	From	To	Via
1	Ernakulam	Aluva	Menaka, Thoppumpady, Edakochi, Aroor
2	Ernakulam	Aluva	Padma, Thoppumpady, Edakochi, Aroor
3	Ernakulam	Aluva	Padma, Thoppumpady, Fort Kochi
4	Ernakulam	Fort Kochi	Menaka, Thoppumpady
5	Aluva	Ekm Jetty	Menaka
6	Ernakulam	Fort Kochi	Menaka, Mattanchery
7	Ernakulam	Cherai	
8	Aroor	Kakkanad	
9	Kollamkudimugal	Ernakulam	Kakkanad, MG Road
10	Eramalloor	North Paravoor	
11	Cherai	Eramalloor	
12	North Paravoor	Thripoonithara	
13	Thripoonithara	Ernakulam	
14	Ernakulam	Poothotta	Menaka
15	Ernakulam	Poothotta	Padma, Vytila, Thripoonithara, South Paravoor
16	Poothotta	Aluva	
17	Pookattupady	Aluva	
18	Thripoonithara	Pookattupady	
19	Thevara	Pookattupady	
20	Ernakulam	Pookattupady	
21	Kumbalangi	Kakkanad	Thoppumpady
22	Ernakulam	Kumbalangi	
23	Thuthiyoor	Mattanchery	
24	Kakkanad	Mattanchery	
25	Ernakulam	Thuthiyoor	Menaka
26	Thevara Ferry	Aluva	
27	Kakkanad	Thevara Ferry	
28	Ernakulam	Njarakkal	
29	Njarakkal	Aluva	
30	Kakkanad	Cherai	
31	Ernakulam	Kadamakudy	Varapuzha
32	Ernakulam	Thevara Ferry	
33	Kadamakudy	Aroor	Varapuzha
34	Varapuzha	Thevara Ferry	
35	Aluva	Cochi Airport	
36	Ernakulam	Kothamangalam	
37	Ernakulam	Ankamaly	
38	Ernakulam	Moovatupuzha	
39	Ernakulam	Koothattukulam	
40	Fortcochi	Ankamaly	Menaka
41	Ernakulam	Coimbatore	
42	Ernakulam	Banglore	
43	Ernakulam	Trivandrum	Alapuzha
44	Ernakulam	Trivandrum	Kottayam
45	Ernakulam	Manglore	
46	Ernakulam	Madhurai	
47	Ernakulam	Perumbavoor	Aluva
48	Ernakulam	Moovatupuzha	Aluva

Operational Routes by Private Buses

Sl. No.	From	To	Via
1	Chellanam	Aluva	Aroor
2	Aluva	Chittoor	
3	Aluva	Chotanikkara	
4	Aluva	Kakkanad	
5	Kannamaly	Aluva	Vytila
6	Kumbalam	Aluva	Vytila
7	Pambaimoola	Aluva	Vytila
8	Panangad	Aluva	Vytila
9	Perumpadappu	Aluva	Vytila
10	Aluva	Irumpanam	Vytila
11	Kothuruthy	Aluva	Vytila
12	Kumbalangi	Aluva	Vytila
13	Palluruthi	Aluva	Vytila
14	Panampilly Nagar	Aluva	Vytila
15	Cheppanam	Aluva	
16	Idacochi	Aluva	
17	Nettoor	Aluva	
18	Pallimukku	Aluva	Vytila
19	Pallimukku	Aluva	Kacheripady
20	Mundamveli	Aluva	Vytila
21	Kadavanthra	Vytila	
22	Ameda	Aluva	Vytila
23	Thevara Jn	Aluva	Vytila
24	Aluva	Kothad Ferry	Kadungaloor
25	Vattaparamba	Manjapra	Aluva
26	Kalamassery	Eloor Ferry	
27	Pallimukku	Kanjiramattom	
28	Vypin	Munambam	
29	Vytila	Vytila	

(Source: Rajiv Gandhi Municipal Bus Terminal, Aluva)