Annual Report 2012-'13

National Transportation Planning and Research Centre

Sasthra Bhavan, Pattom Palace P.O,
Thiruvananthapuram-695 004

ANNUAL REPORT
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National Transportation Planning and Research Centre
(An Institution of Kerala State Council for Science, Technology and Environment)
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From Director's Desk…

Yet another year has passed with lot of activities for NATPAC. During the year, the Centre has demonstrated what it would represent for the future of transportation scenario in the State of Kerala.

The year 2012-'13 saw NATPAC stabilising its position as a key player in the traffic and transportation sector and traffic safety. Core facilities at NATPAC continued to improve. We now have a new Campus of NATPAC at Aakkulam that has been named after the former Chief Minister of Kerala, Sri.K.Karunakaran as 'K Karunakaran Transpark'. We have been working hard towards our destiny - becoming pioneer in the field of transportation. This report gives an overview of the activities of NATPAC from April 2012 to March 2013. During the year, the Scientists of the Centre handled 19 R&D Projects and 37 Sponsored Studies.

NATPAC suggested implementable solutions to reduce transportation problems of Pala Town on a long term perspective. Government of Kerala awarded NATPAC the feasibility study for setting up of a Monorail system between Pallipuram and Neyyattinkara. As part of Statutory Town Planning Schemes, the Centre prepared Transport Infrastructure Development plans for various towns of Kerala. By involving the Grama Panchayaths the Centre prepared a scientific spatial database for rural roads.

The Price Indices PISCO and PIATO prepared by NATPAC are based on a scientific methodology that would be helpful in taking decisions on revision of fare for Stage Carriages, taxis and autos in our State. This model is being looked into by other States also. A scientific study to assess the quantum of hike in the fares for operation of boat services was also carried out by NATPAC.

Our activity in the area of tourism focuses on pre-feasibility studies for developing rope ways in Kerala. For making Secretariat Campus a cleaner and greener place of the capital city, NATPAC suggested various measures for mitigating the Green House Gas emission from transport sector.

Critical appraisal of the highway development projects was significant with respect to the highway research in the State. Steps were taken to explore the possibility of usage of waste plastics in road construction by constructing test stretches and carrying out periodic evaluation. The Centre also explored the possibility of using coir geo textiles in road construction on a large scale in Kerala. This will gradually result in NATPAC becoming a leading player in the field of transportation.

Water Transport Division of NATPAC is concentrating on the areas of inland water transport, waterway/canal development, rehabilitation of existing waterways, economics of waterways, environmental studies related to waterways etc. The Centre assessed the utilisation of waterway network for transport and identified new routes that will help to establish an efficient and integrated transportation system within Central Kerala. By enhancing the efficiency and sustainability of inland water transport, NATPAC is trying to establish a comprehensive normative frame work for the key aspects of inland navigation. NATPAC is thus all set to make its mark as a key player in multi-modal system of transportation.

NATPAC has a dedicated Traffic Safety Division, which collects, compiles and analyses road accident data which in turn serve to deepen our understanding of why crashes happen and what we can do to prevent them. The Road Safety Week – 2013 was observed with the aim to give every one an opportunity to promote road safety in their community, school, work place and on the roads in general. 'International Level Cross Awareness Day (ILCAD)' was observed to educate the public on the risks involved in crossing unmanned crossings. Two day 'National Seminar on Transport Vision Kerala – 2030' was organised to have wider consultation of Transport Development and to evolve Transport Vision Kerala 2030. Under the aegis of NATPAC and Kerala Road Safety Authority, several road safety awareness programmes have been launched which focussed on educating and engaging the public to reduce road accident deaths.

The Library of NATPAC is a specialized one which caters not only to the scientific community of the institute but also extends its services to the scientists and research students of various research institutions and universities.

We once again express our deep gratitude to the Hon'ble Chief Minister of Kerala, Hon'ble Minister for Transport and Hon'ble Minister for Public Works for their sustained and unflinching support to this institution. The guidance received from the Executive Vice President of KSCSTE, Research Council and Management Committee of NATPAC is gratefully acknowledged. The various achievements made during this period were due to the whole-hearted and sincere efforts made by the entire NATPAC community. We are determined for better performance in the coming years. This confidence stems from the fundamental truth that one can't change the direction of the wind, but can adjust the sails to reach the destination.

B G SREEDEVI
DIRECTOR

1. Preparation of Traffic Improvement Plan for Pala Region

NATPAC has undertaken detailed traffic and transportation studies to reduce transportation problems of Pala Town and suggested implementable solutions on a long term perspective. The study aimed at preparing a Transport Infrastructure Development plan for a horizon of 20 years thereby solving present and future traffic problems faced by Pala town. The anticipated growth in the traffic and enhanced pace of development of the region demands an orbital linkage to decongest the traffic flow of Pala town (**Figure 1**).

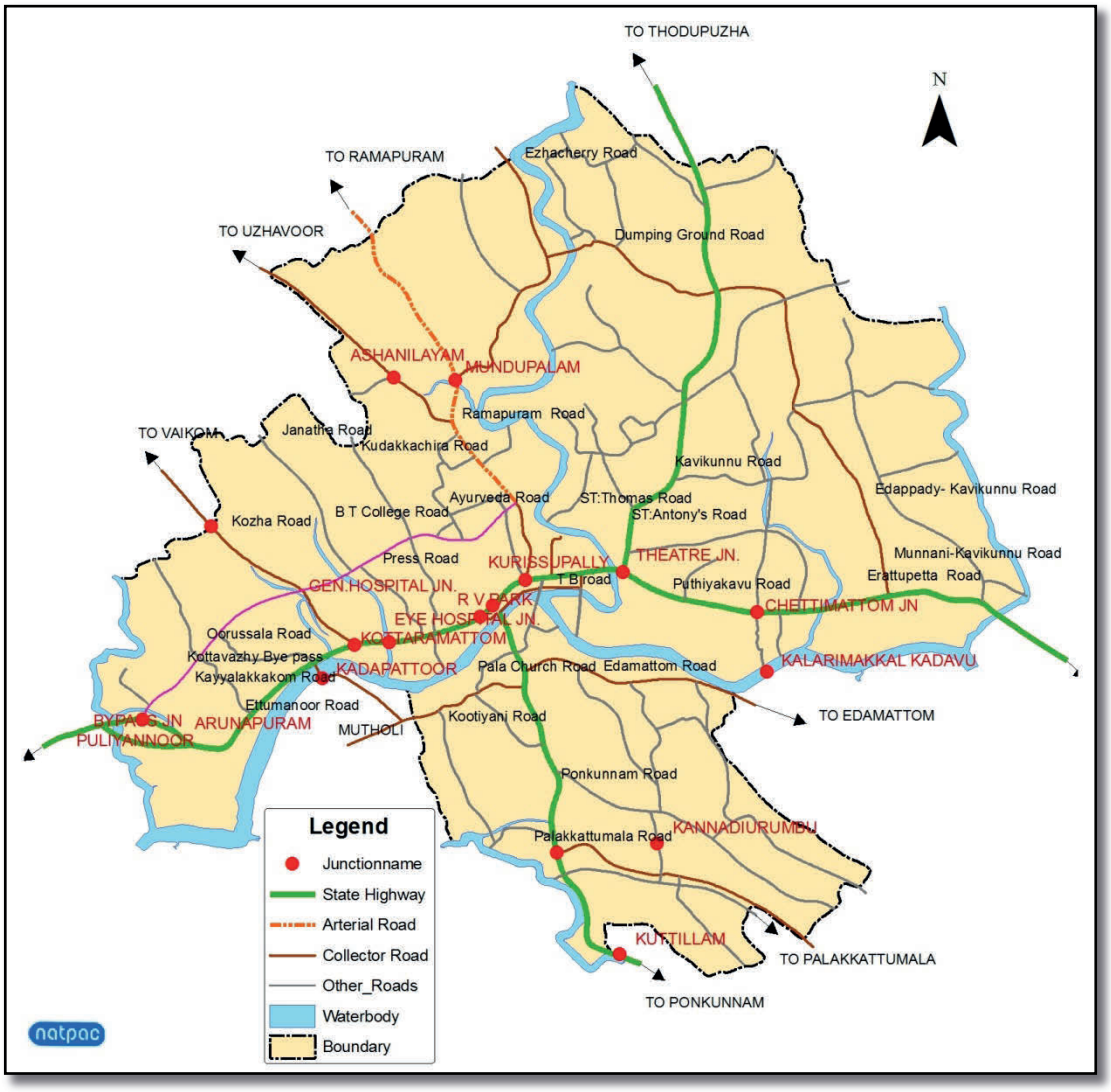


Figure 1: Map Showing the Study Area

The objectives were traffic and transportation studies, road inventory, collection of traffic volume data on major roads, assessing geometric deficiency of road sections and pedestrian facilities, evaluating parking demand and supply characteristics and to formulate suitable short-term and long-term improvement schemes for the development of Pala town.

Based on the implementation strategies the study was divided into two phases. The methodology adopted for the study consisted of reconnaissance survey, literature review, secondary data collection, traffic surveys, topographical surveys, data analysis, proposals for junction improvement and preparation of traffic and transportation improvement proposals for the horizon years.

NATPAC formulated implementable solutions to the traffic problem of Pala town. Suitable improvement measures were suggested in three stages namely:

1. Short-term traffic improvements
2. Medium-term traffic improvements and
3. Long-term transport development

Short-term measures are those schemes that involve less land acquisition which could easily be implemented. These are intended to optimize the use of available road space and other transport facilities at minimum cost with maximum benefits. The various short-term schemes suggested are:

- Junction Improvement Proposals (9 junctions)
- Road Widening Schemes
- Parking proposals
- Traffic management measures (traffic signal installation, traffic signs, roadway marking, relocation of bus stops, pedestrian facilities)
- Traffic circulation plan

Medium and long-term schemes are those that are essentially required to meet the anticipated traffic demand for the next 5-20 years period. The suggested proposals are:

- Widening of existing roads to four lane/ two lane standards
- Construction of missing links
- Development of off-street parking lots
- Junction improvement proposals (30 junctions)
- Pedestrian facilities
- Construction of road over bridge
- Construction of outer ring road

A phased implementation of medium and long-term development may be considered as per the priority fixed by the local people through public participation programme. It is hoped that implementation of proposed traffic and transportation improvement proposals would bring a better level of service and qualitative improvement in traffic and transportation system of Pala town.

2. *Limited Use Road Over Bridges for Light Vehicles in Lieu of Low Traffic Vehicle Unit Level Crossings*

The development of road network and increase in traffic both on roads as well as railways have resulted in the increased requirement of Road Over Bridges (ROB) in recent years. In the present trend of train and road traffic, elimination of level crossings by providing Limited Use ROB will help in improving safety and speed by maintaining the track parameters.

The study aimed at evaluating the need and feasibility of constructing limited use ROB at low Traffic Vehicle Unit (TVU) Level Crossings. ROB at Nettoor was considered as a case study.

The methodology adopted for the study consisted of reconnaissance survey, preliminary survey, classified traffic volume count survey, preliminary design and drawings and preparation of rough cost estimate.

The provision of an ROB at the proposed location will realise the mobility and better and faster accessibility of the people of the region. A population of about 10000 comprising of 2500 households will be benefitted by the proposed ROB project. It is known from the secondary data that mainly around 3 wards (ward no. 30, 31and 1) of the Maradu Muncipality will be most benefitted by the project. Hence the most benefitted population of the wards coming within the influence area is around 3965 (2001 population). Maradu Muncipality extends over an area of 12.35 sq km and has a total population of 41012 (2001 population). The decadal growth rate of population is 21.73% in 1981-91 and 17.19% in 1991-2001. Considering the decadal growth rate as 17.19%, the estimated population for the study area for 2011 is 4647. The traffic estimated by conducting traffic volume counts was forecasted and the divertible traffic was also assessed.

A site plan showing the selected site, ground details and land use of the adjoining area is prepared. Preliminary design drawing is given for two alternative options in the form of an RCC bridge and a Steel bridge for the proposed ROB (**Figure 2**).

Travel demand was estimated from the statistics of benefitting population of the region using the tool of modal split analysis. The estimated travel demand is given in **Table 1.** The estimated travel demand exceeds the limiting value mentioned in IRC 62:1976. Hence the provision of Road Over Bridge at the proposed location is justified as per IRC standards. But as per Indian Railway specifications, the grade separation at crossings will be justified only if the daily traffic movement exceeds 100000 TVU.

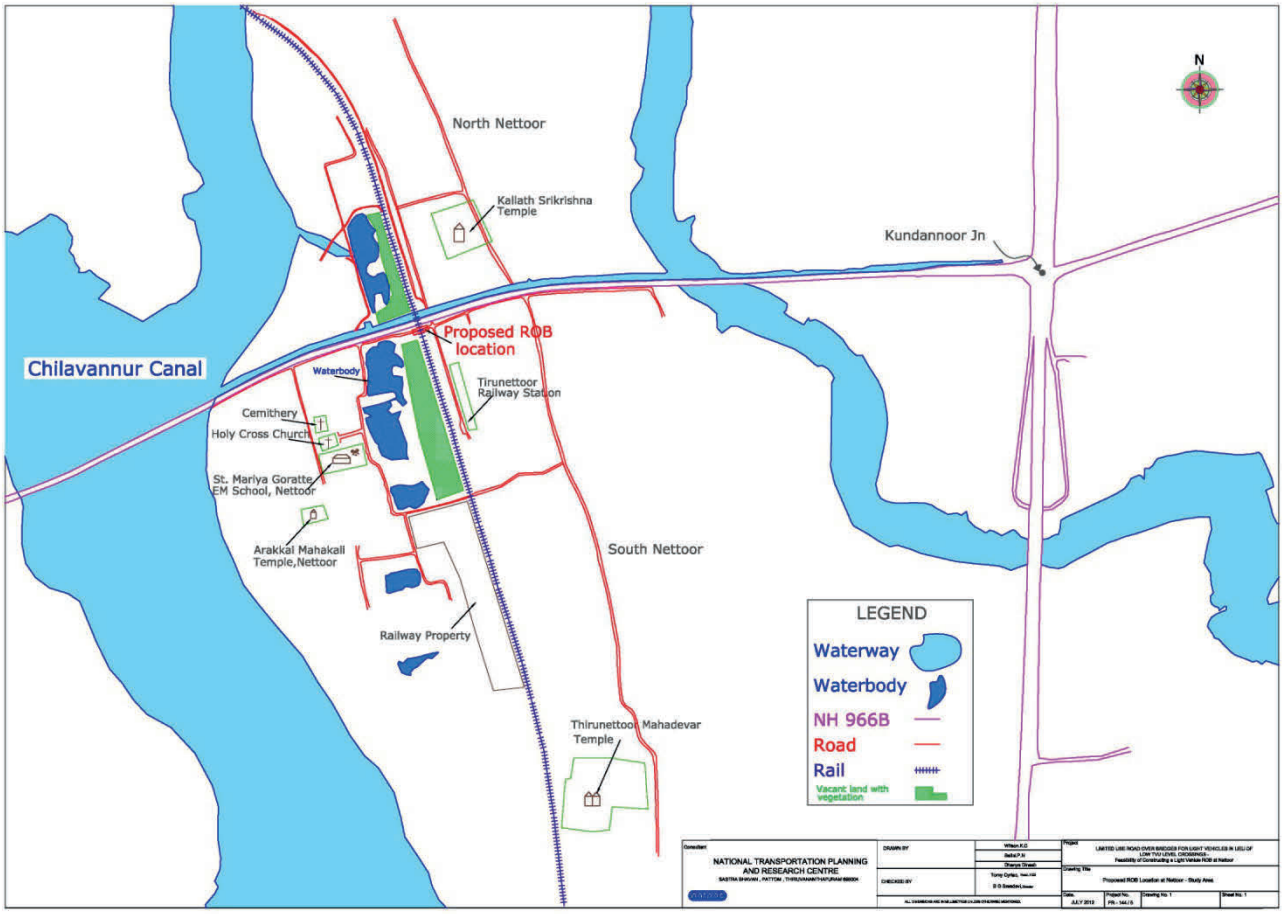


Figure 2: Map Showing the Study Area

Table 1: Estimated Travel Demand

Sl. No.	Period	Estimated Travel Demand for the proposed ROB		Train Vehicle Unit (ATVU)	Remarks
		No of total vehicles	No of fast Vehicles		
1	2012	2463	1833	56823	TVU>50000
2	2017	2855	2125	65875	TVU>50000
3	2022	3310	2463	76353	TVU>50000
4	2027	3837	2856	88536	TVU>50000
5	2032	4448	3311	102641	TVU>100000

Alternative I

RCC bridge consisting of 9 spans each of 20 m length out of which an approach length of 110 m is provided on either side. Hence the total length of the bridge comes out to be 240 m. The girder and slab type (T-beam) bridge is considered here, which is the most frequently used RCC bridge for similar span. A clear height of 6.55 m should be maintained from the rail level to the bottom level of bridge. This clear height along with the structure thickness (girder and slab) of the bridge

makes a total height of about 8 m. Because of the site specific reasons like proximity of cross roads and economic considerations, an exceptional gradient of 1 in 12 is considered for the approach portion of the bridge. Considering relatively weak soil of the region, pile foundation is considered for the structure. Preliminary design drawing for the proposed ROB is prepared.

Alternative II

Considering the various characteristic features of steel bridges half-through type plate Girder Bridge (steel bridge) is considered as alternative II. In this the superstructure is of steel and the substructure is of RCC. The span arrangement and the total length remains the same as that of alternative I.

The preliminary cost estimates have been prepared for the proposed ROB separately for the two alternatives. The rate analysis has been carried out on the basis of Standard Data Book for analysis of rate and adopting schedule of rate provided by the PWD Kerala. For items where these rates are not available, the rates were adopted as per previous experience of the consultant / market rates. Preliminary quantities of various items are worked out.

In the efforts to eliminate some feasible level crossings with low train vehicle units by duly providing limited use Road Over Bridge for Light Vehicles, the preliminary design of ROB at Nettoor was taken as a case study. Two alternative options - RCC bridge (Girder and Slab type) and Steel bridge (Plate girder bridge) are studied based on the site specific circumstances. Preliminary design drawings were prepared for both. The rough cost was estimated for both the alternatives based on the preliminary design. Construction of RCC girder bridge costs around ₹ 2.72 crores while the steel bridge costs around ₹ 4.21 crores (**Table 2**). Hence the construction of RCC girder bridge is found to be the more viable option.

Table 2: Comparison of Cost for RCC Girder Bridge and Steel Bridge

Sl. No.	Particulars	Amount (₹)	
		RCC Girder	Steel Bridge
1	Excavation for Structures and Soil filling	49377.00	49377.00
2	PCC	100056.00	100056.00
3	RCC M30	11774755.52	10155015.08
4	HYSD Steel for Reinforcement	12643836.51	10216112.11
5	Bituminous Surfacing	473088.00	473088.00
6	Steel for Superstructure	-	20784622.68
7	Miscellaneous	2205956.00	303156.00
TOTAL AMOUNT		**27247069.04**	**42081426.87**
In ₹ Crores		**2.72**	**4.21**

3. *Feasibility Study for the Setting up of Monorail between Pallipuram (Technocity) and Neyyattinkara in Thiruvananthapuram District*

For the sustained growth of urban centres and to improve the quality of people, an efficient, safe and effective transportation system is a prerequisite. Thiruvananthapuram City is continuously growing due to its ever increasing commercial activities and the City is also growing as an important IT destination in India. Since bus based public transport system cannot cater to the increasing travel demand beyond a particular level, necessary steps have been initiated by Government of Kerala to develop proper mass transportation facilities and decided to conduct a feasibility study for setting up of a Monorail system between Pallipuram and Neyyattinkara and entrusted the assignment to NATPAC.

The major scope of the study is to prepare a feasibility report for the proposed monorail. The objectives of the study are:

i. Review of available Master Plan and all other earlier study reports related to the development of transport infrastructure in Thiruvananthapuram.

ii. Collection of secondary data from all the available sources regarding the study area, existing and future land use pattern, population growth, traffic volume, travel characteristics, modal split, etc.

iii. Conduct comprehensive traffic surveys to generate sufficient database regarding the traffic characteristics and travel demands of the study corridor.

iv. Conduct topographical surveys, road inventory survey for information on roadway details, road furniture, land use aspects, etc.

v. Identification of most suitable alignment corridor for the proposed monorail system.

vi. A thorough review on travel characteristics and the existing public transport system and the possible efficacy of monorail system in meeting the transportation requirements of the city.

vii. Travel demand forecasts and projections of future modal shift and provide estimates of fare revenues under a range of fare, service level and integration assumptions.

viii. Identification of potentialities of the monorail system in further development as a network plan to be used in the future.

ix. Identification of the possible sites of terminals, depots and workshops.

x. Financial and economic analysis of the project and the steps to ensure a robust viability of the system.

xi. Identification of the financial structure and risks associated with the project.

xii. Preparation of an action plan for the successful financing and implementation of the project.

The methodology workflow diagram is shown in **Figure 3.**

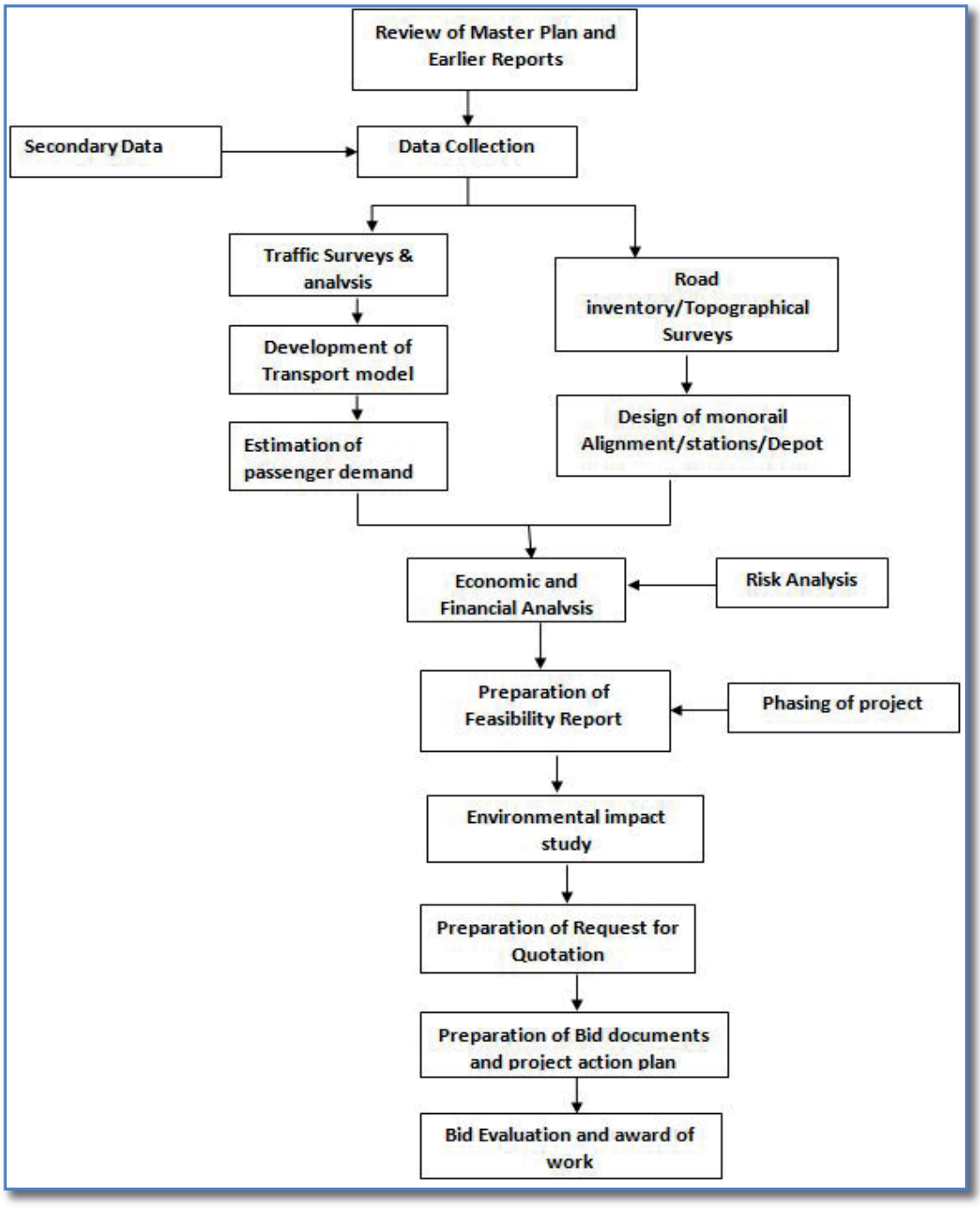


Figure 3: Methodology Adopted for the Study

Study Area and Monorail Alignment

The study area includes all Corporation wards, adjoining Panchayaths and Neyyattinkara Municipality. The proposed monorail alignment starts from Technocity (Pallipuram), 400 m away from Mangalapuram Junction and passes along National Highway-47 towards Neyyatinkara. The total distance of the proposed project stretch is about 41.8 km. There are about 35 stations proposed along the monorail alignment and a depot proposed at Pallipuram near CRPF camp. Proposed typical terminal depot is shown in **Figure 4.**

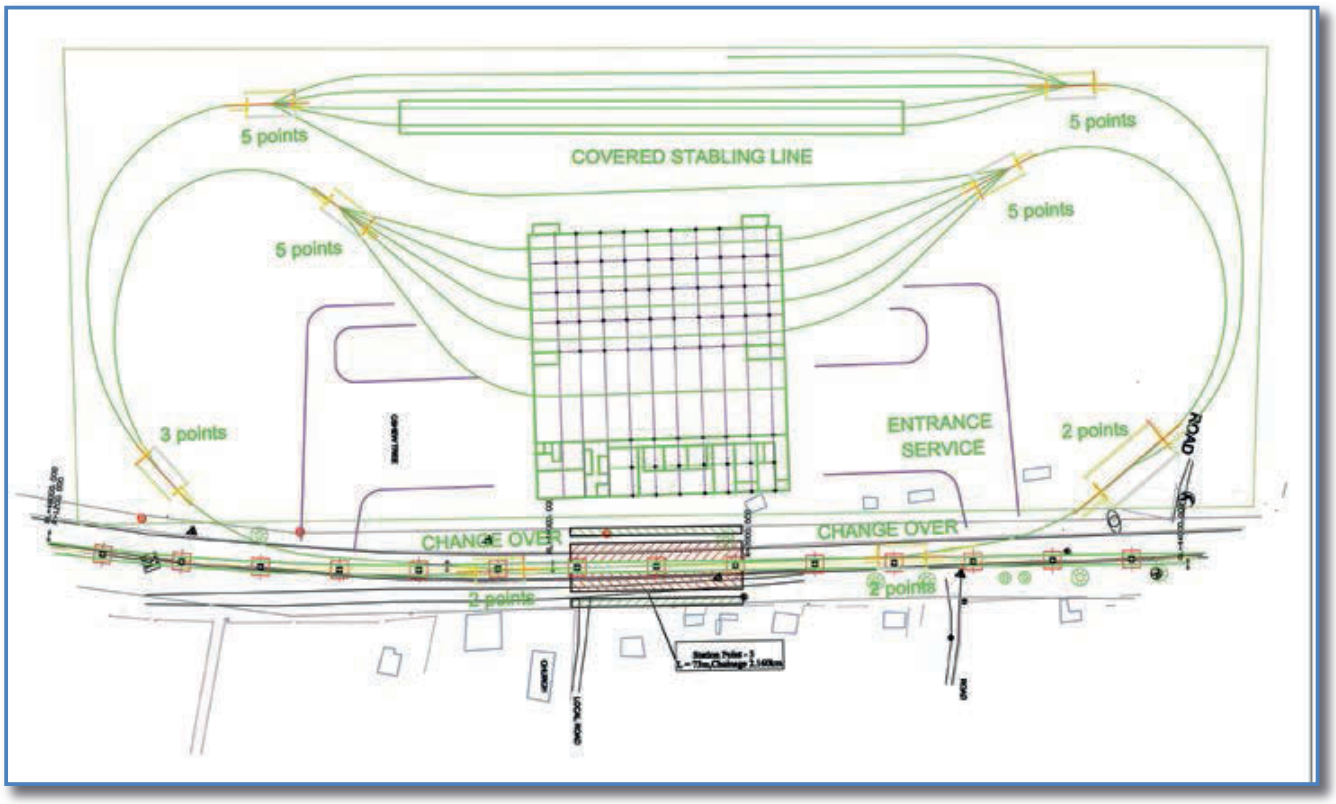


Figure 4 : Typical Terminal Depot

Design

The monorail alignment is an elevated one about 11-15 m above the ground level. Single pier arrangement will be used for the development of elevated monorail. The details of monorail are as follows.

- Train composition 4-6 cars
- Train capacity 560 -840
- Scheduled speed 40 kmph
- Operational hours 06:00- 22:00 hrs.

The proposed cross section for monorail between Kazhakootam and Kesavadasapuram is shown in **Figure 5.**

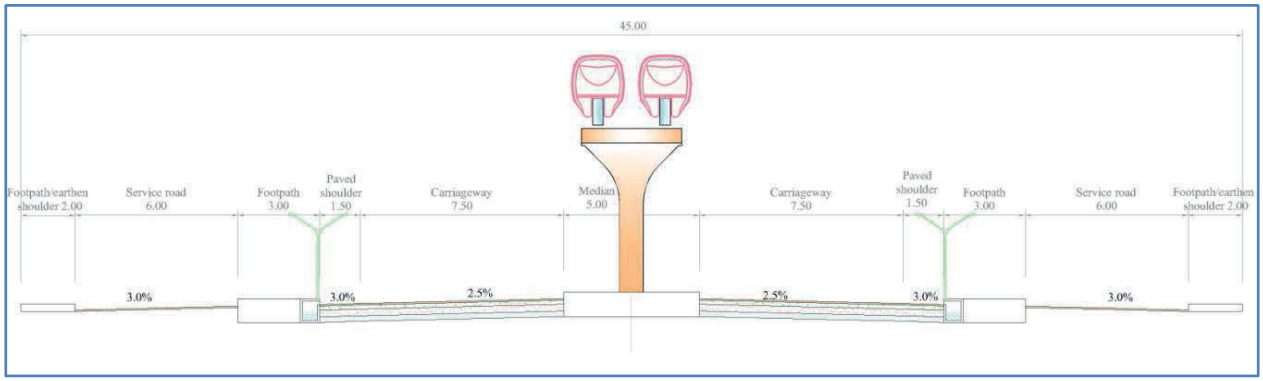


Figure 5: Proposed Cross Section for Four Lane Divided Carriageway for Kazhakoottam-Kesavadasapuram Section

Land acquisition for the monorail system is very minimum (only in stations and depots) and cost is around ₹ 479 crores including the land value, compensation of buildings and depot land (30 acres). For the full length of the monorail corridor, alignment formation is estimated to cost ₹ 1,168 crores. Based on the Mumbai monorail project, each station building is estimated to cost ₹ 8.26 crores at 2012 prices. For the 35 stations, the cost is estimated to be ₹ 289 crores. For traction and power supply, the rate per kilometer is estimated as ₹ 9 crores, the total cost estimated for this component is ₹ 377 crores. In the case of signaling and telecommunications, it is estimated that the cost will be ₹ 7.31 crores per kilometer, which indicates the cost of signaling and telecommunication at ₹ 305 crores for the complete project. Provision for costs for switches and crossings, miscellaneous utilities, road works, civil works not considered above and for providing feeder service is given a lumpsum of ₹ 300 Crores. In addition, design charges are provided with 5% of the estimated cost of the project, but excluding land value and compensation for buildings. Another 5% is provided for contingency expenses. Taxes and duties are also added at 20% of the cost. With all the above components, the total cost of the project is estimated as ₹ 5099 crores, with ₹ 2775 crores in Phase I and ₹ 2324 cores in Phase II. The cost works out to ₹ 125 crores per kilometer for the Phase I and ₹ 118.7 crores per kilometer for Phase II.

The Financial Internal Rate of Return (FIRR) has been computed by using the revenue and cost streams with a conservative and optimum fare structure. Financial analysis shows that FIRR varies from 7% to 13% depending on the various scenarios adopted for the feasibility study.

The economic evaluation of the project corridor has been carried out by applying the Social Cost-Benefit Analysis Technique. The technique uses the incremental costs and benefits under the 'with' and 'without' project scenarios. The Economic Internal Rate of Return (EIRR) for the project computed using Discounted Cash Flow technique showed the value of 12.6%.

4. *Road Connectivity to the Special Economic Zone area at KINFRA Park in Kakkanchery*

The industrial park of Kerala Industrial Infrastructure Development Corporation (KINFRA) located in Kakkanchery, near University of Calicut, Malappuram District has an area of about 70 km^2 of which 30 km^2 has been included as a Special Economic Zone (SEZ). There is a need to have separate entry/exit points for the SEZ area. As the SEZ area is lying on an undulating terrain there is a need for proper road arrangements for the plots allotted to have good access. At the instance of KINFRA, NATPAC carried out a feasibility study for establishing separate road connectivity to the KINFRA site at Kakkanchery along with details regarding internal road arrangement within the SEZ plot.

The methodology adopted for the study consisted of reconnaissance and topographic surveys, laboratory testing of soil samples from the field at subgrade level, traffic studies to determine the existing traffic in the Park as well as potential traffic through the new road, pavement design, geometric design, suitable internal road arrangement plan within the SEZ area, division of SEZ area into appropriate plots and preparation of cost estimate.

Traffic studies shows that the number of commercial vehicles passing through the existing road per day is 146, which consists of 116 trucks, 20 mini trucks and 10 goods autos in addition to cars and two wheelers plying on the section.

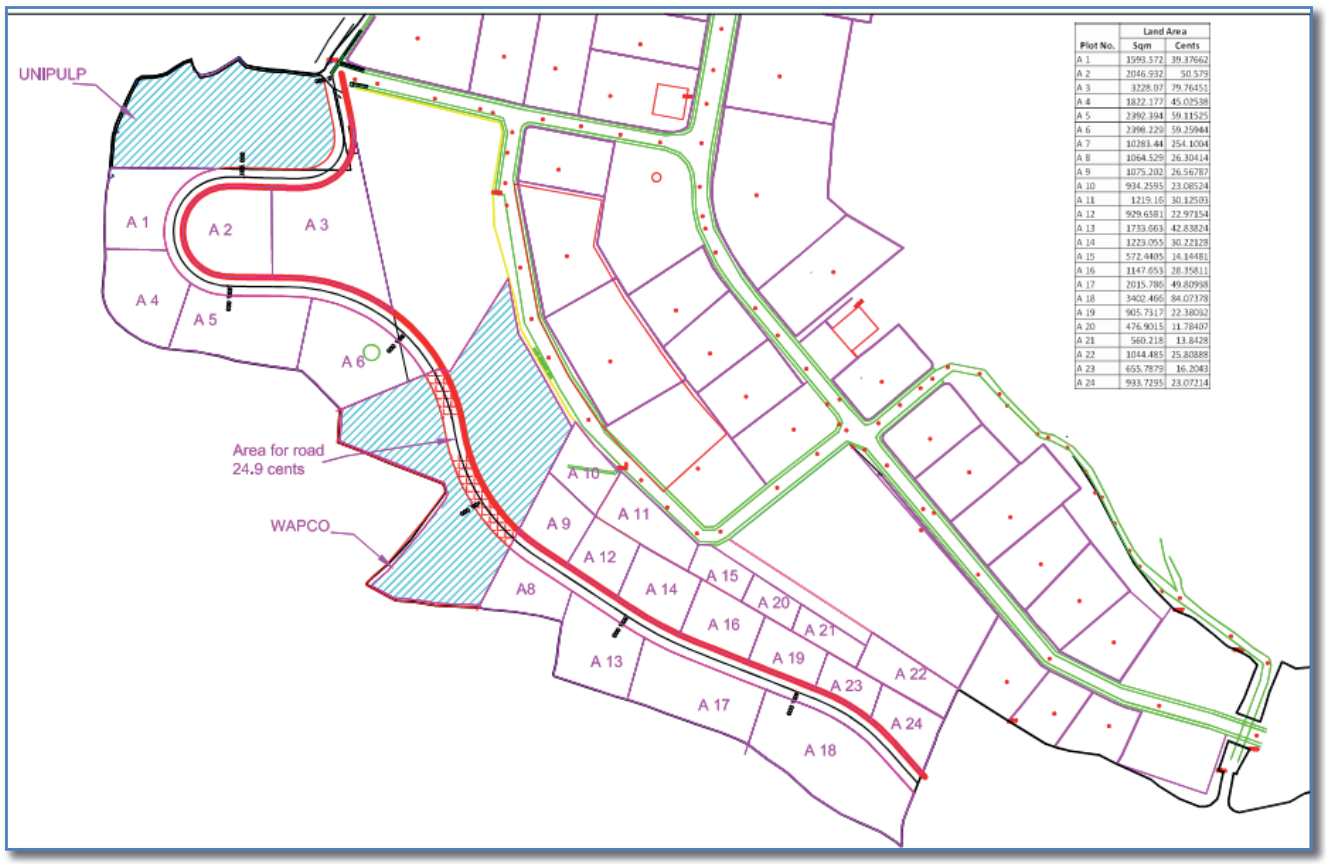
After the detailed soil testing at laboratory it has been found that the subgrade soil was generally sand with different percentage of fines. The Optimum Moisture Content (OMC) was on an average 11% and the California Bearing Ratio (CBR) obtained was above 20.

It was proposed to provide flexible pavement for the new alignment, as per IRC: 37-2012. The design traffic in terms of cumulative number of Million Standard Axle (MSA) load repetitions was 1.23 MSA for a design period of 20 years. Thus a minimum traffic of 2 MSA is adopted for the pavement design. The design of pavement layers depending on the cumulative traffic and the design subgrade CBR is shown in **Table 3.**

Table 3: Proposed Pavement Composition

Design Life	Design Traffic in msa	Total Pavement Thickness	Design Sub-Grade CBR = 15%			
			Bituminous Surface		Granular Base	Granular Sub Base
			BC	DBM		
20 years	2.0	400 mm	20 mm	30 mm	250 mm	100 mm

The vacant land in the SEZ area was divided into number of plots with access to the newly proposed internal roads. For developing the proposed internal roads in the SEZ area, cost estimate has been worked out based on Central Public Works Department (CPWD) specifications and corresponding Schedule of Rates (SOR-2013) applicable to Malappuram District. The cost for different items including cutting of earth, construction of embankment, side protection works, construction of side drains, pavement etc has been worked out and the total cost estimate of the road amounted to ₹ 5.00 Crores. The road arrangement pattern for SEZ area is shown in **Figure 6.**



Plot No.	Land Area	
	Sqm	Cents
A 1	3593.572	39.37662
A 2	2046.932	50.579
A 3	3228.07	79.76451
A 4	1822.177	45.02538
A 5	2392.394	59.11525
A 6	2396.229	59.25964
A 7	10283.44	254.1004
A 8	1064.529	26.30414
A 9	1075.202	26.56787
A 10	934.2595	23.08524
A 11	1219.16	30.12503
A 12	929.6581	22.97154
A 13	1733.663	42.83824
A 14	1223.055	30.22128
A 15	572.4405	14.14481
A 16	1147.653	28.35811
A 17	2035.786	49.80998
A 18	3402.466	84.07378
A 19	905.7317	22.38052
A 20	476.9015	11.78407
A 21	560.218	13.8428
A 22	1044.485	25.80889
A 23	655.7879	16.2043
A 24	933.7295	23.07214

Figure 6: Road Arrangement Pattern for SEZ Area

The SEZ area was decided to be given with an exclusive connectivity from the water tank plot within the KINFRA area. The SEZ area need to be divided into plots and this needs to be accomplished with the provision of internal road arrangements. Hence an internal road has also been proposed and the zone has been divided into 22 plots with suitable areas. The cost of developing the internal roads as per standard, including the construction of retaining wall and pavement layers along with side drains has been worked out to be ₹ 500 lakhs.

5. *Traffic and Transportation Studies for Kodungallur Municipality*

As part of Statutory Town Planning Schemes, District Town Planning Office entrusted NATPAC the task of carrying out traffic and transportation study for Kodungallur town. The scope of the study is confined within the area of Kodungallur Municipality (**Figure 7**). The study aimed at compiling the base year traffic and transportation data in Kodungallur Municipality which could act as a feeder to the preparation of development plan for the town.

The objectives of the study are:

- To access the speed and delay characteristics along the existing road networks.
- To study the traffic volumes on selected roads and intersections
- To assess Pedestrian flow along and across road stretch and intersections
- To conduct parking accumulation studies (on street and off street) and duration of parking

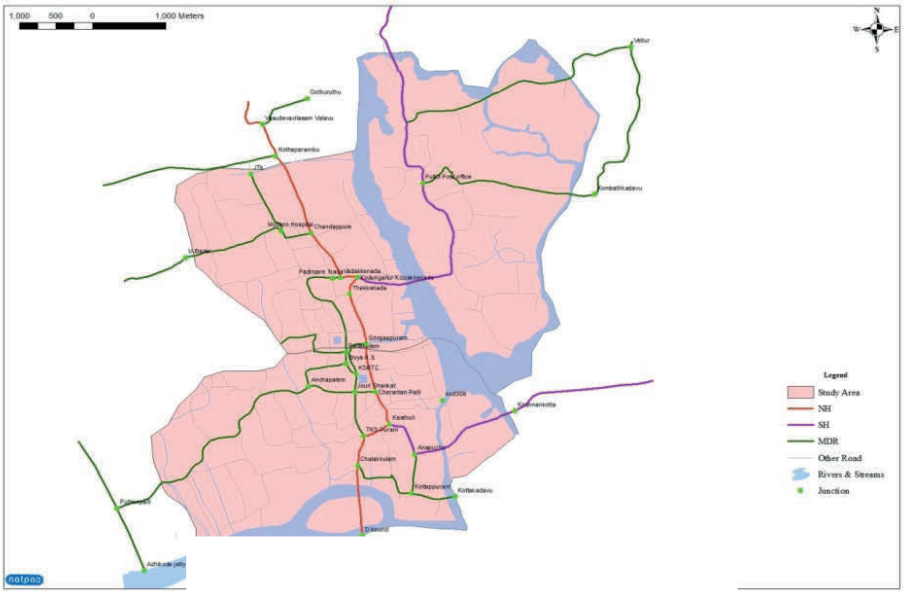


Figure 7: Map of Study Area

- To study origin and destination characteristics of the traffic passing through the town
- To assess the traffic flow pattern for the horizon year and to formulate a suitable road development plan.

The NH 66 passing through the centre of the town is forced to carry both intra-town and inter-town traffic. Presently this road carries traffic far exceeding its capacity and is likely to sustain in the horizon year. After the speed and delay survey, it was found that delay was maximum in NH 66 along Kothaparambu to Kottappuram (59 seconds). The major reasons for the delay have been heavy traffic congestion and presence of intersections. It was seen that the traffic on the NH, especially within the Central Business District (CBD) area is very high. A maximum daily traffic of 35,000 PCU was observed in the Chanthappura – bus stand junction link. The Vadakkenada - bus stand junction link had a daily traffic volume of 29,500 PCU followed closely by Chanthappura – Kothaparambu link with 28,000 PCU. The Allieds Mall to bus stand junction is a major hub for parking with a total capacity of 155 vehicles. Majority of the vehicles parked at most of parking corridors were found to be for short duration of less than 30 minutes.

An analysis of the Origin-Destination (O-D) survey data collected from outer cordon survey locations revealed that an estimated 3,82,391 inter-town passenger trips were performed in the study region on a reference day and almost 32.50% of the total trips were performed for work or related purpose, followed by personal and back home trips. The O-D pattern of inter-town passenger traffic revealed that there were 1.20 lakh internal - external trips. A total of 1.39 lakhs trips were external – internal trips constituting 36.5% of the total trips. External – external trips to the tune of 1.22 lakhs trips were performed through the study region and they were 32.2% of the total trips.

A total of 9,760 goods vehicles passed through the outer cordon points in Kodungallur Municipality on the reference day. It was observed that 1496 tonnes of goods originated from the study region and 7896 tonnes of goods terminated in the study region. About 9619 tonnes of traffic are of divertible nature.

A road development plan has been formulated for the town (**Figure 8**). While the NH 66 being the major North-South corridor, it is proposed to be of six lane primary distributor road. The Shornur road is proposed to be another North-South corridor and is to be developed as secondary corridor. An inner ring road on the eastern side of the NH is proposed, which starts from Chanthappura and ends at Sringapuram crossing the Shornur road near Uzhuvathukadavu. This could serve as a bypass for small and medium vehicles from Sreenarayanpuram side and Chappara side.

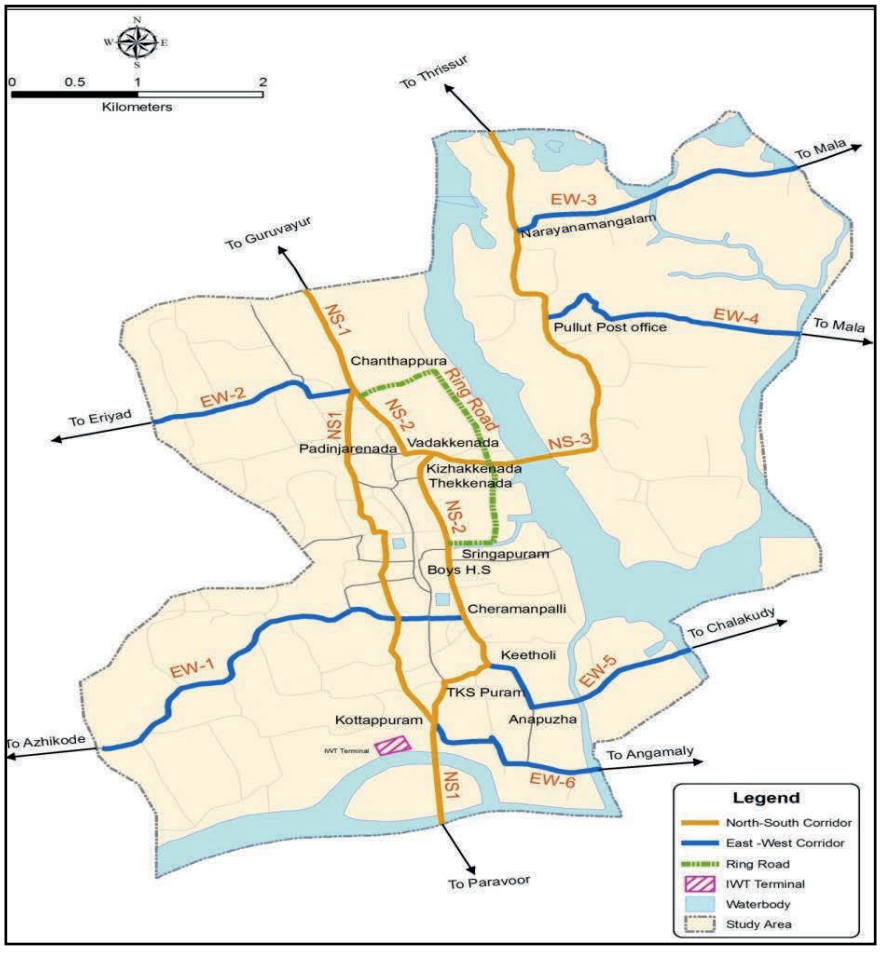


Figure 8: Proposed Transport Development Plan for Kodungallur Municipality

6. *Traffic and Transportation Studies for Kunnamkulam Town*

To find out a solution to reduce the heavy traffic congestion in Kunnamkulam Town, NATPAC compiled base year traffic and transportation data in Kunnamkulam municipality (**Figure 9**) which could act as a feeder to the preparation of development plan for the town.

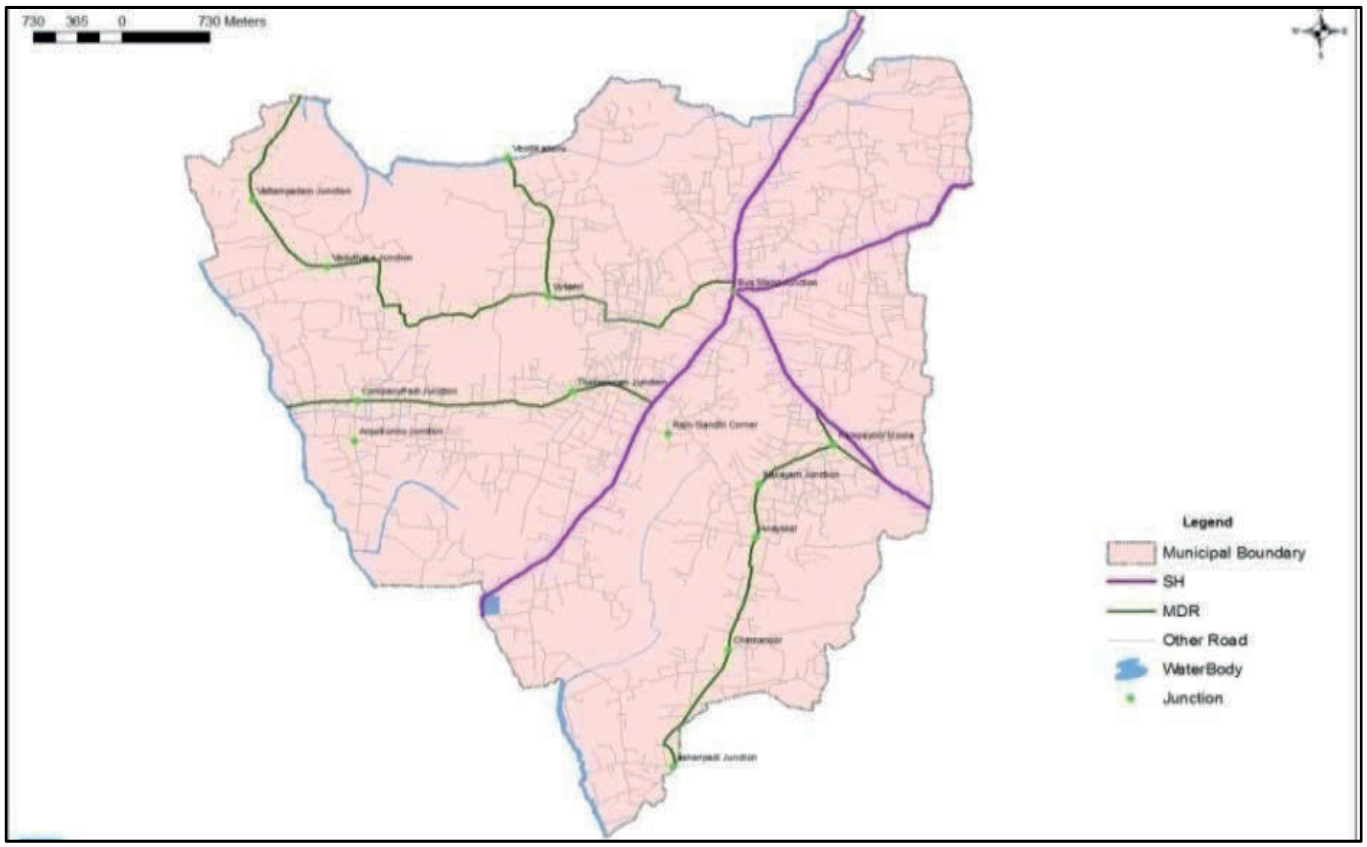


Figure 9: Base Map of Kunnamkulam Town

The objectives of the study are:

- To assess the existing condition of road network
- To identify the existing street architecture
- To assess the speed and delay characteristics along the existing road networks
- To study the traffic volumes on selected roads and intersections
- To assess pedestrian flow along and across road stretch and intersections
- To conduct parking accumulation studies (on street and off street) and duration of parking
- To study origin and destination characteristics of the traffic passing through and within the town
- To appreciate the characteristics of public transport users and intermediate public transport users like origin-destination, mode, trip length, travel cost, etc.

- To assess the traffic flow pattern for the horizon year and
- To formulate a suitable road development plan.

The methodology adopted for the study consisted of reconnaissance survey, literature review, data collection from secondary sources, primary surveys to assess the problems, data analysis and to prepare long term transportation development plan for the town.

It can be seen that major road corridors of Kunnamkulam town viz., Thrissur – Kozhikode Road (SH 69), and Guruvayur – Wadakkanchery Road, would be severely congested in the horizon year with anticipated traffic more than the capacity of the roads under "do-nothing option". For most of the other roads also, the traffic situation will be reaching the saturation level in the year 2030. The projected traffic on the existing road network within the CBD area implies that the existing road network would not be able to handle the traffic in the horizon years without upgradation of the transport infrastructure facilities.

Augmentation of the capacity of existing road network by strengthening/widening and construction of alternate link roads is a must considering the dramatic increase in the traffic volume. The Parayil centre or the bus stop junction is the busiest location and the reason is mainly attributed to the intersection of two state highways coupled with the presence of the bus stand. The two state highways viz., SH 69 and SH 50 intersecting at the CBD carries huge volume of traffic, most of which are bypassable. Anjoor road is another inter-town road, but the volume through this road is meager. Most of the through traffic has to pass via the CBD area and the absence of a proper circulation system aggravates the problem.

The most important problem of Kunnamkulam town is high traffic load along the SH 69, especially near the CBD area. Hence emphasis is given to develop alternative links to divert the bypassable traffic passing through the stretch. This would also help to reduce the inter mixing of intra-town and inter-town traffic on roads within the central part of the town.

The major intersections along the roads also need to be improved and suitable designs are to be made to increase the efficiency level of these intersections. Special emphasis should also be given to improve the pedestrian facilities and also to develop off-street parking lots.

7. *Traffic and Transportation Studies for Karunagappally and Punalur towns in Kollam district*

At the instance of Town and Country Planning Department, Government of Kerala, National Transportation Planning and Research Centre (NATPAC) has been entrusted with task of carrying out Traffic and Transportation Study for Karunagappally and Punalur towns in Kollam District, Kerala.

Scope and Objectives of the Study

The purpose of the study is to compile the base line data, summary findings and recommendations of Transportation Sectoral Plan for incorporation into the Development Plan of the Towns. Accordingly, the following are the objectives of the study:

(i) To assess the condition of road network and to identify the traffic bottlenecks and physical constraints,
(ii) To identify the existing street architecture and traffic control systems in the town,
(iii) To study the traffic volumes on selected roads and intersections, and to assess the extent of short fall of the road system,
(iv) To assess pedestrian flow along and across road stretch and intersections
(v) To study origin and destination characteristics of the traffic passing through the town and quantify the extent of bypassable traffic and the scope for developing a bypass route for the town.
(vi) To study the characteristics of public transport users and also Intermediate Public Transport (IPT) users in the study region,
(vii) To estimate the traffic demand for the horizon year and formulate a road development plan keeping the growth potential of the town in mind, making optimum trade-off between "land use driven transportation network" and "transportation network driven land use".

i. Karunagappally Town

Karunagappally town has an area of 18.65 sq km with a population of 47,483 as per 2001census. The present population of the town is about 60,000 as of 2011.

Karunagappally town has a grid-iron pattern of road network. A major North-South link is the NH 66 which passes through the centre of the town. A number of links exist in the North-South

direction and need to be developed to form full-fledged North-South links. There are a number of East-West links existing in the town and together with the North-South links complete the grid-iron pattern of network for the town.

Traffic volume and capacity utilization: On NH- 66, the daily traffic volume varied from 38,000 PCU to 52,000 PCU. On the Sasthamkotta road, the traffic volume was 23,000 PCU per day (between Market Jn. and Alumoodu Jn.).

Traffic volume above 10,000 PCU was observed on the railway station road. Traffic volume in the range of 5,000-10,000 PCU was observed on most of the East-West links in the town.

Capacity utilization of NH-66 has shown that the entire NH stretch was over-utilized to the extent of twice its carrying capacity. Most of the parking activities in Karunagappally town were confined to NH 66 between Karottu and Pulliman Jn. Other than NH 66, minimal parking activities were also found along Sasthamkotta road between Civil Station and Market.

The O-D pattern of inter-city passenger trips revealed that there were 1,32,158 internal - external trips, out of 2,91,718 inter-city passenger trips. This constituted 45% of total trips. A total of 1,05,411 trips were external – internal trips (outside study region to study region) constituting 36% of the total trips. External – external trips to the tune of 54,149 were performed through the study region and they were about 19% of the total trips.

A total of 8,246 goods carriers were observed at entry/exit points of the town, consisting of 3,898 trucks, 2,810 mini-trucks and 1,539 goods autos. The quantum of goods handled by these vehicles was to the tune of 21,000 tonnes per day. Nearly 10,216 MT of traffic (49%) are of divertible nature, which, are passing through the CBD area of the city due to non-availability of bypass.

Traffic projections were carried out according to the growth rates worked out from time series data. The projected traffic on the existing road network within the CBD area implies that the existing road network would not be able to handle the traffic in the horizon years without upgradation of the transport infrastructure facilities. Augmentation of the capacity of the existing road network by strengthening/widening and the construction of alternate link roads is a must considering the dramatic increase in the traffic volume.

Transport development plan for Karunagappally town is prepared taking into account the existing traffic scenario and based on an evaluation of the future traffic on the base year network. Transport development schemes are formulated so as to reduce the severe strain put on the existing road network. All committed development schemes were taken into account while formulating the transport development plan.

The hierarchical pattern of road network recommended for Karunagappally town include:

(i) Primary distributor road – Providing connectivity to State and district headquarters
(ii) Secondary distributor road – Providing connectivity to neighbouring towns inside and outside districts
(iii) Tertiary road – providing connectivity to town centre with commercial centres and transport terminals
(iv) Local roads – connecting residential areas with the above categories of roads

On the basis of the projected volume of traffic and alternative network development schemes considered, a road development plan has been formulated for the town. As per the road development plan for the town, the proposed network conforms to a grid-iron pattern.

ii. Punalur Town

The existing population of Punalur Town is around 50,000 which is divided into 35 municipal wards. The Punalur economy was at its height during the time of Punalur paper mill. However, other industries like Agro-Fruit, State Farming Corporation, Rehabilitation Plantations, RPC Kraft Paper, plywood industry, etc. still provides a significant contribution to Kerala.

Punalur is famous for its Suspension Bridge which was constructed by British in the 19th century. The Government has declared this Suspension Bridge as a monument of national importance. Pilgrims going to Sabarimala have transit camp at Punalur Town.

Kollam-Thirumangalam NH-744 which traverses through the central area of the town has a length of 9.8 Kms in the municipal area. Punalur-Muvattupuzha State Highway (SH 8) and Punalur-Anchal (SH 48) road are the other major roads passing through the town. Other roads passing through the town are Kariyara road, Chemmanthoor-Market Jn. road, railway station road and hospital road.

Speed flow characteristics: The road stretch passing through the CBD area of the town namely Post office Jn. to Hospital Jn. observed a low speed of 25 kms/hr, the major

causes of delay being traffic congestion, parking of vehicles on road sides etc. The highest traffic speed was observed on the rural stretches of major roads namely Nellippally Jn. to Mukkadavu Jn. on Pathanapuram road (44 kms/hr), followed by the road stretch from School Jn. to Paper Mill on Paper Mill road (38 kms/hr). Other road stretches in the town witnessed a speed in the vicinity of 30 kms/hr.

Volume and capacity utilization on important roads: In central area of the town, as high as 21,839 PCU of daily traffic volume was observed on the road section between Hospital road junction and KSRTC junction which forms a part of Kollam-Thirumangalam National highway. In other stretches of the town, the traffic volume varied from 11,028 PCU on the one-way street of Post office Jn-Chemmanthoor Jn stretch to 21,263 PCU on KSRTC Jn-TB Jn stretch. The lowest daily traffic volume of 8,460 PCU was observed on the rural stretch of NH from Vazhakkode to Kshetragiri

Many road sections within the study area were over utilized with traffic volume more than their carrying capacity.

Traffic volume at major intersections: KSRTC Jn. witnessed the maximum peak hour traffic flow of 5,412 PCU, followed by 4,558 PCU at TB Jn. and 3,149 PCU at Post Office Jn. Other junctions handled peak hour traffic flow in the range of 1,500 to 2,000 PCU.

Parking characteristics: The NH road section running through the town area accommodated the maximum number of 323 vehicles consisting of 51 vehicles along Chenkottai arm of TB junction, 46 vehicles within TB junction area, 45 between Suspension bridge and KSRTC Jn., 87 vehicles between KSRTC Jn. and Post office Jn. and 94 vehicles between Post office Jn. and Chemmanthoor Jn.

Pedestrian movement: As high as 5,100 cross movements were observed around KSRTC junction area, followed by 2,100 pedestrian crossings around Post office junction area and 1,300 crossings at Market junction area.

Inter-city passenger traffic: 1.62 lakh inter-city passenger trips had been performed in the study region on a reference day consisting of more than half the trips by bus (85,916 passenger trips), another 20% by four-wheelers (30,439 trips), 15% by autorickshaws (24,106 trips),

12.2% by two wheelers (19,094 trips) and one percent by train (1,900 trips). It could be inferred that public transport has a dominant role in meeting the inter-city passenger demand in Punalur region.

The movement pattern of inter-city passenger traffic in the study region revealed that nearly half of total passenger traffic originated from the study region to external zones and 38% of trips were attracted to the study region. The remaining 13% of trips were found to be passing through the town with both origin and destination lying outside the study region.

Inter-city goods transportation: Inter-city goods transportation in the study region has been handled by a fleet of goods carriers consisting of 1,793 trucks, 1,390 mini-trucks/ tempos and 853 autorickshaws. The quantum of goods transported through Punalur town accounted for 14,388 metric tonnes of which the share of trucks formed a whopping 77%, followed distantly by mini-trucks 17% (2,401 MT) and goods autos by 6% (900 MT).

Movement pattern of goods traffic: It has been found that the study region served as major transit point for collection and distribution of commodities from Tamil Nadu to other districts of Kerala State. The traffic generation from the study region was 21% of the total movements and traffic attraction was to the tune of 18%. Rest of the movements namely 60% was external-external movements, implying 'through' traffic.

Traffic projection: Traffic projections were carried out according to the growth rates worked out on the following basis:

- Growth rate based on realistic estimates using influencing parameters
- Studies conducted by NATPAC in different towns of similar size in Kerala in the past,
- Growth rate of vehicular population in Kollam over the years and
- Variation of AADT on major roads from biannual counts made by PWD periodically.

It is estimated that most of the major road stretches in the town will have volume-capacity ratio more than one by the year 2015 itself.

Transport development plan for Punalur town: On the basis of the projected volume of traffic, a Road Development Plan has been formulated for the town. The proposed network conforms to a radial pattern as illustrated in Figure 10. This would involve developing ring

road, bypass and widening of major roads as radial roads with the following hierarchical pattern.

(i) Primary Distributor Road – Providing connectivity to State and district headquarters with a 'right of way' width ranging between 30 and 45 m.

(ii) Secondary Distributor Road – Providing connectivity to neighbouring towns within and outside the district with a 'right of way' width ranging from 12 to 23m.

(iii) Tertiary Road – providing connectivity to town centre with rest of activity centres with a 'right of way' width ranging from 8 to 12 m.

(iv) Local roads – connecting residential areas with the above categories of roads and providing access to various activity areas.

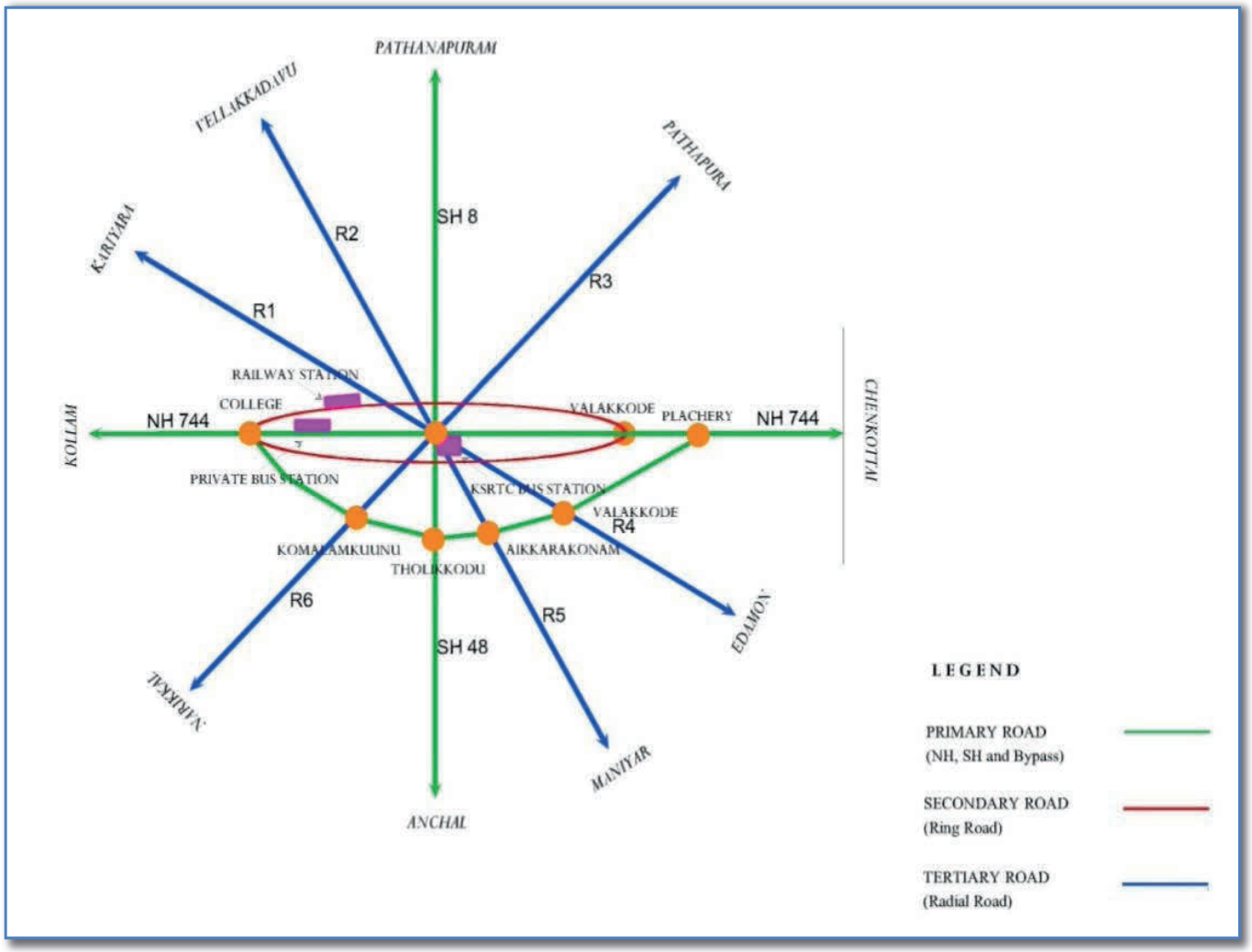


Figure 10: Conceptual Road Network Proposed for Punalur Town

8. *Relocation of Toll Plazas on NH-17 in Salem District, Tamil Nadu and its effect on Toll Collection Potential*

At the instance of National Highways Authority of India (NHAI), Chennai region, National Transportation Planning and Research Centre (NATPAC) carried out traffic surveys to assess the relocation of toll plazas and their toll collection potentials at two locations on Thumbipadi - Namakkal section of NH 7 near Salem in the State of Tamil Nadu.

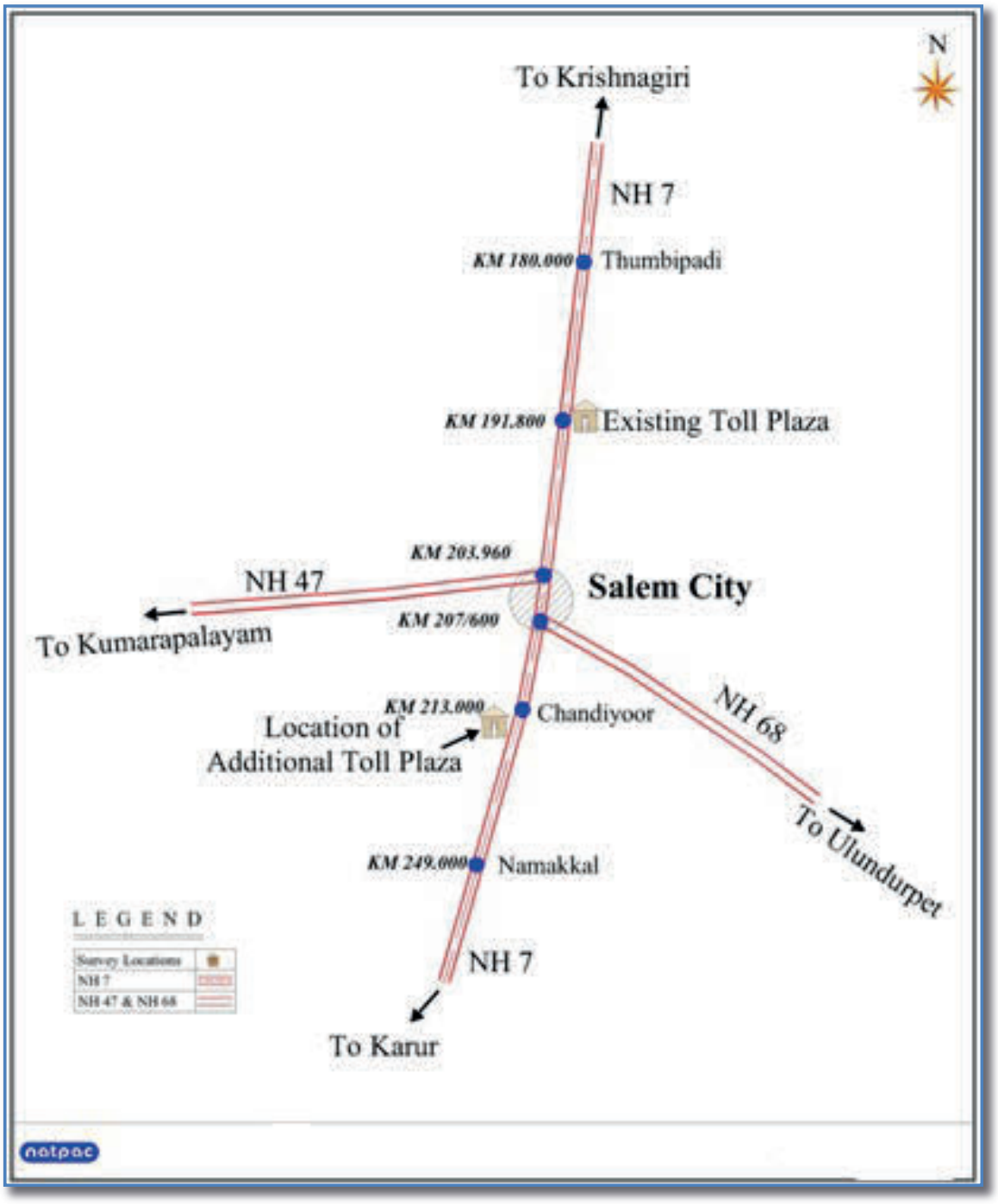


Figure 11: Diagram Showing Survey Location on NH-7 near Salem

Accordingly, NATPAC carried out seven days continuous classified volume counts and three days origin-destination surveys at two locations namely at km 191/800 (existing Toll Plaza) and km 213/000 (Chandhiyoor). Schematic diagram showing the survey locations is shown in **Figure 11.** Based on the analysis of traffic data, the financial implications of shifting existing Toll Plaza and/or establishment of additional toll plaza were assessed.

Daily toll collection was estimated for two different scenarios namely

i. Shifting the existing toll plaza at km 191/800 to km 213/000, and
ii. Retaining the existing toll plaza and establishing additional toll plaza at km 213/000.

Based on classified volume counts, the Average Daily Traffic volume was worked out. To assess the movement of tollable vehicles through the survey locations and the amount of toll paid, motorists were interviewed to obtain the information like type of vehicle, origin and destination of the vehicle, type of toll ticket (either single or multiple trips in a day) or trip with a daily pass or monthly pass.

A total of 29,619 toll paying vehicles were interviewed for this purpose. The sample size was 29% of total tollable vehicles of 102,448 during the three-day survey period. For the purpose of assessing the pattern of vehicles passing through the two survey locations, origin/ destination of the vehicles were classified into three regions (i) Bangalore bound vehicles, (ii) Salem based including Kumarapuram and Ulundurpettai and (iii) Namakkal based

The tollable vehicles passing through the existing toll plaza and Chandhiyoor with different toll tickets were estimated from the total number of vehicles passing through both locations and movement of vehicles through the toll plaza. Thus, an estimate of daily tollable vehicles (both through vehicles and Salem based vehicles) according to vehicle type and type of toll paid was made. Similarly, tollable vehicles at Chandhiyoor were estimated separately for 'through' vehicles and 'Salem-based' vehicles.

It is observed that shifting of the toll plaza from the existing location at km 191/800 to new location at km 213/000 will generate additional revenue of ₹ 7,137 daily, whereas establishment of new toll plaza at km 213/000 will yield additional revenue of ₹ 76,007.

9. Traffic Forecasts for Personal Rapid Transit (PRT) System for Thiruvananthapuram City

Thiruvananthapuram is the second largest and most populous city in the State. The City has several government offices, public and semi-public institutions, major IT hub, higher education and medical institutions, religious centres, commercial establishments and tourist spots. With intense real estate developments around the city and major work centers spread over the city centre, there has been a steep rise in mobility pattern of the people thereby putting the transport infrastructure of the city to great stress.

Realizing the need for providing an efficient and seamless travel facility, Infrastructures Kerala Ltd (INKEL) in association with ULTra Fairwood Pte Ltd. proposes to introduce Personal Rapid Transit (PRT) System on selected corridors in Thiruvananthapuram City. National Transportation Planning and Research Centre (NATPAC) was entrusted with the task of assessing traffic potentials for the proposed PRT system and forecasts the ridership for horizon year. The objective of the study is to estimate the passenger load between different stations on the selected routes of PRT network and forecast the same for next 35 years, coinciding with concession period. Tentative routes identified for assessing traffic potentials for the proposed PRT System in Thiruvananthapuram City is shown in **Figure 12**.

Based on the analysis of user O-D data, quantum of passenger movements on the selected corridors, willingness to shift and willingness to pay different fares for PRT system have been estimated. Passengers who have expressed their willingness to shift to PRT, with a fare structure equivalent to two times of city bus fare, have been considered as captive riders for PRT system. It has been estimated that a little over 1.41 lakh person trips would be willing to shift to PRT system in the base year 2012. Of these, 26% are bus users, 45% two wheeler users and the rest are car and autorickshaw users.

It is expected that the ridership would increase to 1.81 lakh passengers, subject to the following development.

(i) Multi-level parking facilities are provided at East Fort, Thampanoor and Kowdiyar terminals which would induce 16,500 passengers per day
(ii) Time of operation of PRT system is extended from 16 to 20 hours resulting in 8,500 passengers per day.
(iii) There is an induced demand of 10% on account of improved transport facility with an additional demand of 14,160 passengers per day.

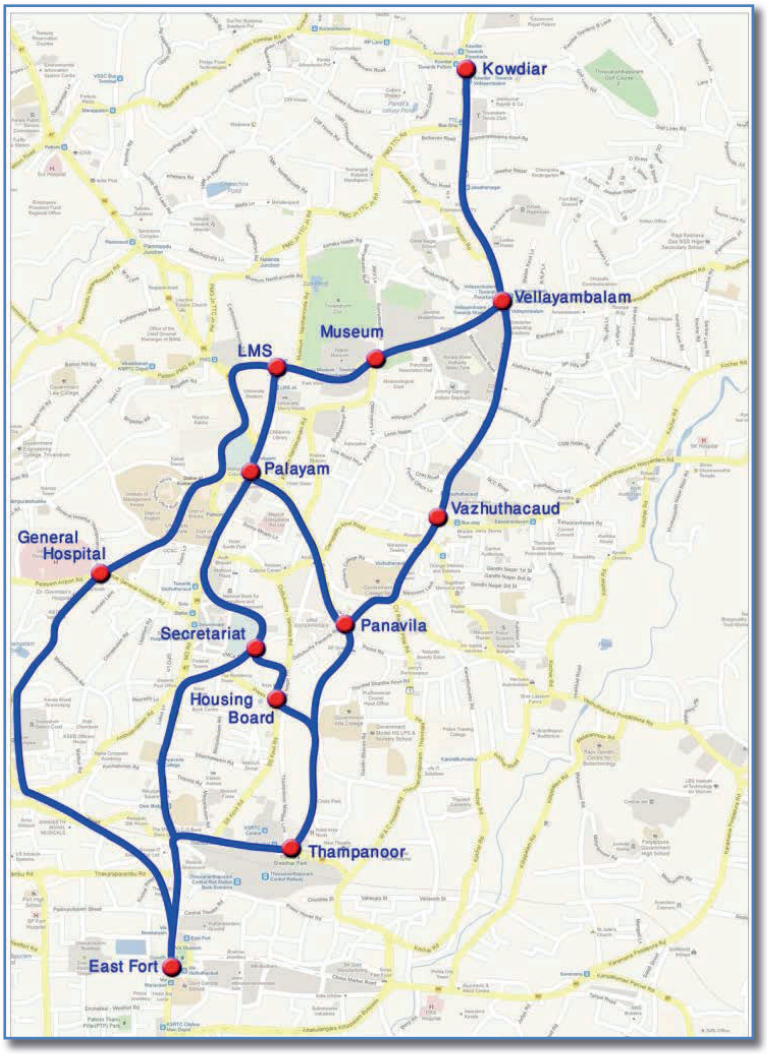


Figure 12: Tentative Routes Identified for Proposed PRT System in Thiruvananthapuram city

- Average trip length of PRT passengers is worked out as 2.89 in 2012
- High demand for PRT ridership comes from the people drawing income between ₹20,000 and ₹30,000.
- Value of time is estimated as ₹1.17 per minute for car passengers, ₹0.89 for auto passengers, ₹0.65 for two wheeler passengers and ₹0.44 for bus passengers.

Fare sensitivity analysis has been carried out using the information obtained from household surveys, establishment surveys and user surveys at bus stops and terminals. It has been revealed that the modal shift towards PRT is highly sensitive to fare structure. Among the bus users who are willing to shift to PRT, nearly 10% dissipation would take place if the fare is 2 ½ times the bus fare and nearly one –third of the bus users would move away from PRT, if the fare is equivalent to auto rickshaw charges. Among the private vehicle users, nearly a quarter of the patronage will be affected, it the PRT fare is 2.5 times bus fare and 40 to 53% will come down if the fare is equivalent to autorickshaw fare.

10. Price Index for Stage Carriage Operations in Kerala

Bus transport meets the travel needs of commuters in urban and semi-urban areas, for intra and inter-city mobility. In Kerala, both KSRTC and private operators provide bus transport services. National Transportation Planning and Research Centre (NATPAC) brought out Price Index for Stage Carriage Operations (PISCO) in Kerala State based on limited field studies conducted in 1998 on private bus operations in Kerala State. The index compares the movement of prices of operating components for any base year with current year. The index was revised based on Cost Table approach in 2005.

Although PISCO gives a scientific basis for revision of fares of stage carriages, it does not estimate the absolute cost of stage carriage operation and it is to be used only for comparison of prices at the review year as compared to the base year. PISCO cannot be used for determining the minimum fare. It can only predict by how much percentage the cost of operation has varied between two reference periods. The percentage of variation as predicted in the Price Index Model can be applied on the prevailing fare rate to fix the fare rate at the current level.

Updation of PISCO as on September 2012 prices

The last bus fare revision was announced in August 2011. The prices of diesel, lubricants, tyre, insurance and certain other spare parts items have been increased since then. The diesel price alone increased from ₹ 44.55 per liter in August 2011 to ₹ 49.61 per litre with effect from 14th September 2012. PISCO estimated a variation of 11.2% in the variable cost and a variation of 5.5% in the fixed cost between September 2011 and September 2012. The overall Price Index for stage carriage operation showed a variation of 8.85% during the period. Thus, there is a case for revising the existing minimum bus charge from ₹ 5.00 to ₹ 6.00 in ordinary services in the State of Kerala.

The overall Price Index showed a variation of 8.85% in cost of operation of stage carriages between the period of last fare revision in August 2011 and September 2012. Computation of Price Index for ordinary stage carriage operation is given in **Table 4**.

Table 4

Computation of Price Index for Ordinary Stage Carriage Operation (PISCO) with September 2011 base

Items	Components	Quantity(Q)	Price(Sep. 2011)	Value (Sep.2011)	WPI/CPI factor (Sep.2012/ Sep.2011)	Price (Sep.2012)	Value (Sep.2012)
A. VARIABLE COST							
Fuel	Diesel	0.285522	44.550	12.720	1.114	49.610	14.165
Lubricants	Engine oil	0.002244	197.400	0.443	1.212	239.249	0.537
Tyre	Average for MRF 900-20 & 1000-20	4.61E-05	14450.000	0.666	1.238	17881.875	0.824
Engine system	Piston set BS2 Henoi engine (Leyland)	1.84E-05	10505.000	0.193	1.076	11302.072	0.208
Fuel injection	Fuel injector pipe kit	1.72E-05	1489.000	0.026	1.023	1522.933	0.026
Exhaust	Hybrid silencer	3.63E-06	3331.000	0.012	1.009	3361.938	0.012
Electrical	Battery cable unit	1.91E-05	5161.000	0.098	0.989	5103.061	0.097
Clutch	Clutch disc	2.77E-05	3166.000	0.088	1.026	3248.912	0.090
Gear box	Pinion bearing	3.07E-05	1683.000	0.052	1.039	1748.140	0.054
Propellor haft	Centre bearing housing	5.55E-05	3570.000	0.198	1.052	3755.781	0.208
Housing system	Crown & pinion set	9.96E-06	8839.000	0.088	1.052	9298.976	0.093
Break system	Break lining 6'F1 Std (4 items)	2.64E-05	8408.000	0.222	1.003	8431.519	0.223
Body & frames	Bumpers	0.00039	300.000	0.117	1.076	322.763	0.126
Steering system	Catridge assembly	7.79E-06	3400.000	0.027	1.052	3576.934	0.028
Suspension system	Tapper roller bearing	0.000187	2040.000	0.381	1.038	2117.200	0.396
Sub Total (material cost)	**Materials other than fuel**			2.610			**2.922**
Maintenance Labour	Labour cost per hour	0.005142	250.000	1.286	1.081	270.305	1.390
Total Variable Cost				**16.616**			**18.477**
PISCO index (Variable cost)				**100.000**			**111.198**
B. FIXED COST							
Crew	Crew cost per day	0.014545	500.000	7.273	1.081	540.609	7.863
Depreciation	Annual depreciation	1.25E-05	106667.000	1.333	1.000	106667.000	1.333
Financing cost	Annual interest payment on capital	1.25E-05	69705.000	0.871	1.000	69705.000	0.871
Insurance	Insurance premium per annum	1.25E-05	25009.000	0.313	1.147	28685.231	0.359
Motor vehicle tax	Annual tax	1.25E-05	100800.000	1.260	1.000	100800.000	1.260
General overheads	Annual overhead cost	1.25E-05	39840.000	0.498	1.000	39840.000	0.498
Working capital interest	Interest on working capital	1.25E-05	2800.000	0.035	1.000	2800.000	0.035
Total fixed costs				**11.583**			**12.219**
PISCO INDEX (Fixed Cost)				**100.000**			**105.494**
C. Grand Total				**28.199**			**30.696**
PISCO INDEX (All Items)				**100.000**			**108.855**

11. Price Index for Auto Taxi Operations in Kerala

National Transportation Planning and Research Centre (NATPAC) brought out Price Index for Auto Taxi Operations (PIATO) in Kerala based on detailed survey of the operating cost and fixed cost of taxis and autos in different terrain conditions in the State in June 2006. The Price Index presents a clear scientific methodology that would be helpful for taking decisions on revision of fare for taxis and autos in the State.

Price Index for Autorickshaw Operation (PIARO) in Kerala

The total cost of operation for autos is taken by adding all the variable and fixed cost components. Same quantities and variables have been retained to compute the Price Index. The Price Index for Autorickshaw Operations (PIARO) moved from 100 (Base year-June 2006) to 145.07 in December 2011. The index had increased to 145.61 in April 2012 and further to 150.26 as on 30th September 2012. The percentage variation of Price Index for Autorickshaws between March 2011 and September 2012 is shown in **Table 5.**

Price Index for Taxi Operation (PITO) in Kerala

The total cost of operation for taxies is taken by adding all the variable and fixed cost components. Same quantities and variables have been retained to compute the Price Index. The Price Index for Taxi Operation (PITO) moved from 100 (Base year-June 2006) to 118.45 in March 2011 and further to 124.52 in April 2012. The index has moved to 132.63 as on 30th September 2012 showing an increase of 3.19%**. (Table 6).**

The computation and periodic updation of Price Indices for autorickshaw and taxi operation in Kerala has been very effective in reflecting the relative variations in cost of operation between two time periods. The last fare revision for auotrickshaw and taxi services were announced by the Government in January 2011.

Between January 2011 and September 2012, the Price Index for autorickshaw operations has shown a growth of 10.40% and that of taxi operations increased by 11.99%. This suggests that the fare level of auto and taxi services in the State may be revised upwards by 10.4% and 12% respectively.

Table 5

Computation of Price Index for Autorickshaw Operation (PIARO) as on September 2012 Prices

(Base Year-June 2006)

Items	Price as on June 2006	Quantity(Q)	Value (June 2006)	Price as on March 2011	Value March 2011)	Price as on September 2012	Value (September 2012)
A. VARIABLE COST							
Fuel (Petrol)	50.34	0.045	1.5000	61.51	2.7680	70.91	3.1910
Engine System	14241.34	1.185E-05	0.1687	14813.02	0.1755	15780.95	0.1870
Lubrication system	10395.54	2.5E-05	0.2599	10812.84	0.2703	11519.39	0.2880
Clutch system	1995	2.002E-05	0.0399	2075.08	0.0415	2210.68	0.0442
Housing System	2992	7.787E-06	0.0233	3112.11	0.0242	3315.46	0.0258
Propeller system	968	1.839E-05	0.0178	1006.86	0.0185	1072.65	0.0197
Gear Box	3967	1.67E-05	0.0662	4126.24	0.0689	4395.87	0.0734
Exhaust system	1154.25	1.282E-05	0.0148	1200.58	0.0154	1279.03	0.0164
Wheels and tyres	5410	3.273E-05	0.1771	6391.37	0.2092	6778.09	0.2218
Body	12702	8.936E-06	0.1135	13211.89	0.1181	14075.19	0.1258
Brake system	3533	2.519E-05	0.0890	3674.82	0.0926	3914.95	0.0986
Front &rear suspension	5010	2.295E-05	0.1150	5211.11	0.1196	5551.62	0.1274
Steering system	1154.5	4.981E-05	0.0575	1200.84	0.0598	1279.31	0.0637
Electrical system	6864.4	1.462E-05	0.1003	7139.95	0.1044	7606.50	0.1112
Fuel System	2328.25	1.192E-05	0.0278	2421.71	0.0289	2579.95	0.0308
Miscellaneous	4320	2.222E-05	0.0960	4493.41	0.0999	4787.03	0.1064
Total Variable Cost			**2.8669**		**4.2147**		**4.7312**
B. FIXED COST							
Wages and Salaries	36000	0.000025	0.9000	41521.91	1.0380	43911.29	1.0978
Road Tax	530	0.000025	0.0133	530	0.0133	530	0.0133
Interest	2561	0.000025	0.0640	2561	0.0640	2561	0.0640
Depreciation	5667	0.000025	0.1417	5667	0.1417	5667	0.1417
Insurance	2200	0.000025	0.0550	1775	0.0444	1775	0.0444
General Overheads	2000	0.000025	0.0500	2080.28	0.0520	2194.35	0.0549
Total Fixed Costs			**1.2240**		**1.3534**		**1.4160**
C. Grant Total			**4.0908**		**5.5681**		**6.1472**
PIARO INDEX (All Items)			**100**		**136.11**		**150.26**

Table 6

Comptation of Price Index for Taxi Operation (PITO) as on September 2012 Prices

(Base Year-June 2006)

Items	Price as on June 2006	Quantity(Q)	Value (June 2006)	Price as on March 2011	Value (March 2011)	Price as on September 2012	Value (September 2012)
A. VARIABLE COST							
Fuel (diesel)	33.94	0.0625	2.1094	41.39	2.5869	50.75	3.17188
Engine	67106.34	5.493E-06	0.3686	78998.60	0.4339	84160.62	0.46228
Lubrication	14631.80	1.572E-05	0.2300	17224.78	0.2708	18350.30	0.28845
Clutch	5871.11	1.031E-05	0.0606	6911.56	0.0713	7363.18	0.07594
Housing	9735.35	4.747E-06	0.0462	11460.60	0.0544	12209.47	0.05796
Propeller	5119.05	5.228E-06	0.0268	6026.22	0.0315	6420.00	0.03356
Gear Box	19761.99	5.517E-06	0.1090	23264.11	0.1283	24784.27	0.13673
Cooling system	2962.19	1.04E-05	0.0308	3487.14	0.0363	3715.00	0.03863
Exhaust system	868.69	7.746E-06	0.0067	1022.64	0.0079	1089.46	0.00844
Wheels and tyres	16741.55	1.757E-05	0.2941	24933.88	0.4380	26442.57	0.46451
Body	27749.51	4.401E-06	0.1221	32667.14	0.1438	34801.72	0.15315
Brake system	20151.55	9.746E-06	0.1964	23722.71	0.2312	25272.83	0.24631
Suspension system	16936.23	1.124E-05	0.1903	19937.59	0.2240	21240.37	0.23866
Steering system	5032.35	9.022E-06	0.0454	5924.16	0.0534	6311.26	0.05694
Electrical	34009.29	1.022E-05	0.3475	40036.25	0.4091	42652.35	0.43581
Fuel system	10737.01	1.336E-05	0.1434	12639.77	0.1688	13465.70	0.17984
Total Variable Cost			**4.3273**		**5.2896**		**6.0490**
B. FIXED COST							
Wages and Salaries	48000.00	1.538E-05	0.7385	53207.12	0.8186	56268.93	0.8657
Road Tax	1140.00	1.538E-05	0.0175	1140	0.0175	1140	0.0175
Interest	3498.00	1.538E-05	0.0538	3498	0.0538	3498	0.0538
Depreciation	26666.00	1.538E-05	0.4102	26666	0.4102	26666	0.4102
Insurance	5250.00	1.538E-05	0.0808	5250	0.0808	5250	0.0808
General Overheads	6000.00	1.538E-05	0.0923	6788.30	0.1044	7160.52	0.1102
Total Fixed Costs			**1.3931**		**1.4854**		**1.5382**
C. Grant Total			**5.7204**		**6.7750**		**7.5872**
PITO INDEX (All Items)			**100**		**118.43**		**132.63**

12. Revision of Fares for Operation of Boat Services

Government and private agencies are operating inland water transport services in the passenger transport sector in Kerala. The operation was taken over by Kerala State Water Transport Department (SWTD) which comes under the Transport Department, Government of Kerala in 1968. A scientific study to assess the quantum of hike in the fares to be imposed on various categories of boat users was carried out by NATPAC.

The study was aimed at covering all aspects of SWTD boat operation and determining an economic fare structure. The objectives of the study consisted of assessing operational characteristics of boat services, its passenger load and lead factors, fixed and variable costs and income and expenditure pattern. NATPAC assessed the services provided by SWTD in Kerala and suggested an appropriate fare structure for different types of boat services and also computed appropriate price indices to help future fare revision in SWTD.

Findings

The Department has a fleet strength of 95 boats of which only 50 were put into operation at the time of this study. In addition to these services, the Department has a pilot boat, a speed boat and an ambulance boat which are available on hire to public.

NATPAC conducted in-boat survey and interviewed the passengers to know about their travelling and socio-economic characteristics. The average passenger lead is found to be 6.8 kms and average load per boat is less than 30. The average fuel mileage is also found to be less than 1.2 kms per liter which is very low. The average speed of a boat is 8 to 9 kilometers per hour. While the increase in revenue per hour operation was not even 10 percent, the increase in per hour expenditure was 180%. A detailed analysis of the trips of each schedule of operation of all stations shows that there is some heavy loss making trips. Cancelling or rescheduling some of the trips can reduce the loss. This would make savings in terms of man-hours, fuel cost and operational cost.

The Department is forced to operate boat trips even in the absence of passengers, due to social obligation to ensure freedom of movement to public in isolated islands. SWTD should make every effort to operate the trips that are essential without cancellation so that the people could rely on it. A crash programme has to be set out to repair all the boats in the dock at the earliest. SWTD can think of introducing smaller boats of lesser passenger capacity in areas of less passenger traffic to cut down operating and maintenance cost. Till acquisition of smaller boats, private boats may be operated on contract basis.

The older boats in the dock and repair section meant fordisposal are auctioned off through public auction to earn some revenue and also to save some space in the dock and repair section.

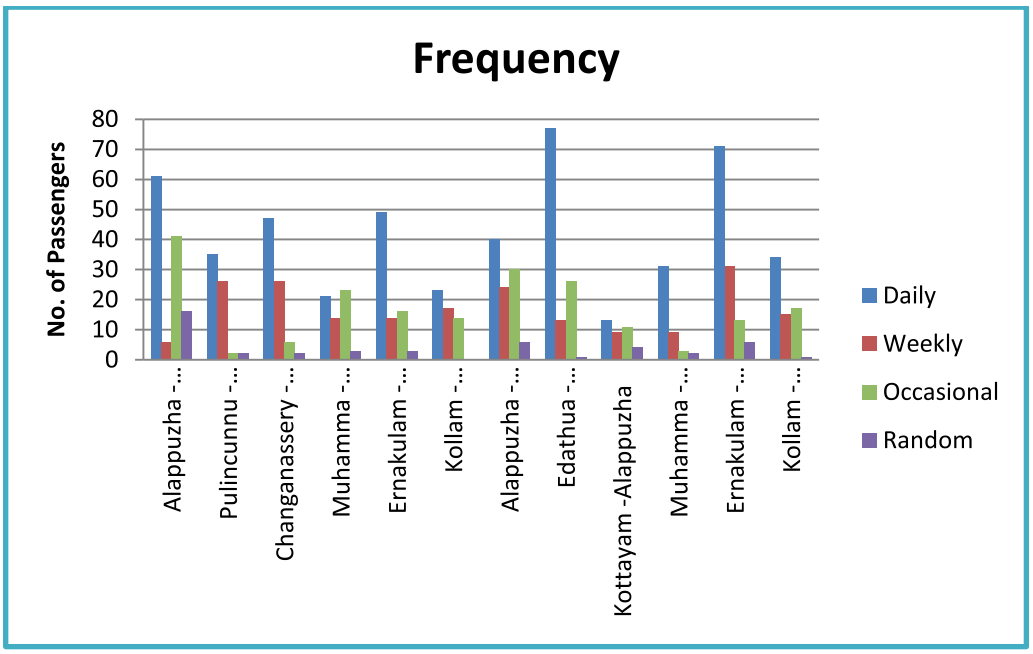


Figure 13: Route-wise Travel Pattern

The total variable cost for providing a unit passenger kilometer of boat service by SWTD boats is found to be ₹ 0.50. This can be adopted as the passenger fare rate. For fixing the minimum fare for SWTD boat services, a fixed cost component of 2.5 per passenger may be added in addition to the fare rate. Thus the minimum fare may be be added in addition to the fare rate. Thus the minimum fare may be revised as ₹ 4/- up to the travel distance of 3 kms. For any travel beyond 3 kms the fare may be fixed as ₹ 2.5 (fixed cost) + ₹ 0.50 x distance. Suitable concession may be offered to students and handicapped as per the policy of the Government. **Figures 13** and **14** show the route-wise travel pattern and trip-wise variation of passenger and luggage of a typical route respectively.

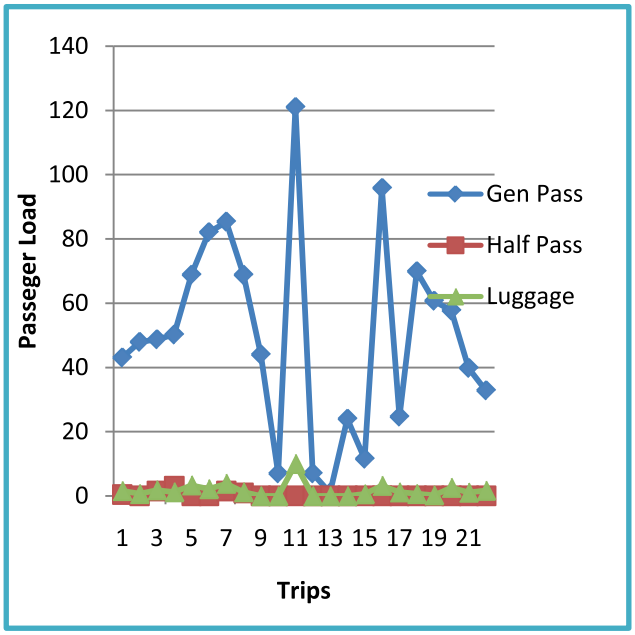


Figure 14: Trip-wise variation of Passenger and Luggage Load of a typical route between Ernakulam

13. *Development of Ropeways in Kerala*

Ropeways will greatly improve the tourism activities in an area adding to the economy of the country and fortunately, Kerala State is blessed with a lot of locations suitable for constructing ropeways.

At the instance of Tourist Resorts (Kerala) Ltd (TRKL), NATPAC carried out a prefeasibility study for developing ropeways in Kerala at the following five locations (**Figure 15**) with a tourism perspective:

i) Akkulam – Veli (Thiruvananthapuram District)
ii) Thumboormoozhi Dam, near Athirappilly (Thrissur District)
iii) Munnar – Mattupetty – Top Station area (Idukki District)
iv) Kakkayam – Banasurasagar (Kozhikode/ Wayanad District)
v) Karapuzha Dam (Wayanad District)

The objectives of the study consisted of:

i) Field reconnaissance survey for locating possible alternative alignments

ii) Identification of possible alignment with a rough sketch of the alignment based on available satellite maps, incorporating the location of base and intermediary stations along with typical details about the span arrangement

iii) Specification of general guidelines regarding the consideration of geological, traffic, climatological and meteorological data and other surveys relevant to the development of concept of ropeway system

iv) An inventory of available ropeway systems and details about manufacturers /vendors/ suppliers

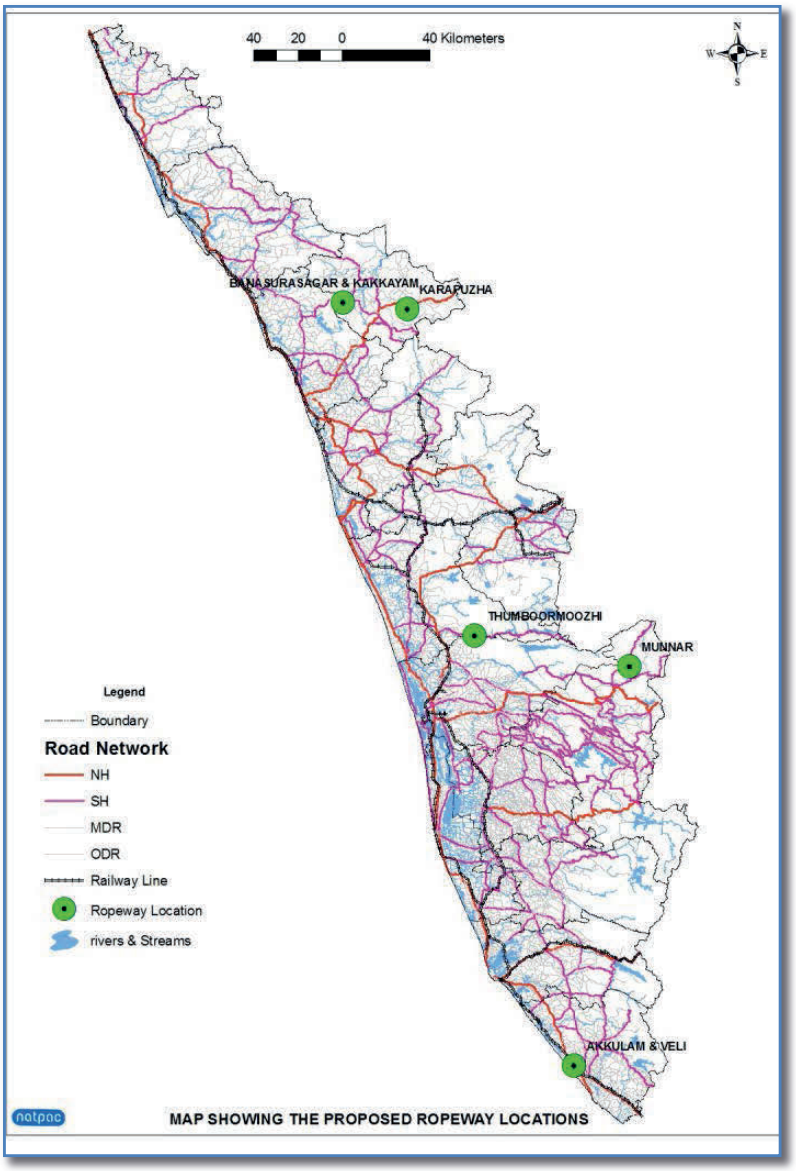


Figure 15: Map Showing the Proposed Ropeway Locations

v) Broad assessment of passenger demand and deriving system capacity
vi) Broad assessment of the required area/space for support services like parking facilities etc.
vii) Identification of constraints like requirement of EIA, crossing of Railway lines, electric lines, etc.
viii) Assessment of the abstract cost of total capital investment required for ropeways.

The length of the proposed ropeways varies from 240 m to 17 km. Mono-cable gondola system of ropeway was proposed at Akkulam, Veli, Karapuzha, and Banasura sagar. In Munnar, the type of ropeway proposed was bi- cable jig back gondola system. A bi-cable gondola system of ropeway was proposed in Banasura Sagar also. The cost of installation worked out to about ₹13.26 Crores/km. Details of the proposed ropeways is shown in **Table 7.**

Table 7: Salient Features of the Proposed Ropeways

Location		Length (m)	Elevation(m)	Span length (m)	Estimated cost (crores)
Akkulam	Alignment 1	260 in one direction	18 with zero gradient	varying from 51.25 to 96.25	3.5
	Alignment 2	120 in one direction	18 with zero gradient	varying from 39 to 45.45	1.6
Veli	Alignment 1	563	15 with zero gradient	varying from 36 to 174	7.5
Munnar	Mattuppetty and Echo point	4045 in one direction	33 with zero gradient	varying from 363.63 to 969.7	54
	Echo point and Kundala	6339 in one direction	Tower varies due to mountainous terrain	varying from 96.77 to 846.77	84
	Kundala dam and Top station	6650 in one direction	Tower varies due to mountainous terrain	varying from 200 to 775	88
Banasura sagar - Kakkayam	Alignment 1	2576.82 in one direction	Tower varies due to mountainous terrain	varying from 48.07 to 1076.88	34
	Alignment 2	1007.6 in one direction	Tower varies due to mountainous terrain	varying from 102.28 to 196.97	14
	Alignment 3	3584.42 in one direction	Tower varies due to mountainous terrain	varying from 48.07 to 1076.88	48
Karapuzha	Alignment 1	887 in one direction	Tower varies due to mountainous terrain	varying from 110 to 227	11.76
	Alignment 2	2161 in one direction	Tower varies due to mountainous terrain	varying from 113 to 605	28.66
Thumboormoozhi	Alignment 1	230 m in one direction	Tower varies due to hilly terrain	length being 56 , 154 and 20	5

14. Estimation of Carbon Footprint with Transportation in and around Government Secretariat Building, Thiruvananthapuram

Carbon foot print is a synonym for emissions of Carbon dioxide or other Green House Gases (GHGs) expressed in Carbon dioxide equivalents. This has been used as an environmental indicator to understand and quantify the main emission sources and it constitutes an effective tool for energy and environment management. NATPAC, at the instance of Energy Management Centre (EMC) estimated existing carbon footprint with respect to transport activity at Government Secretariat Building, Thiruvananthapuram.

Tasks involved:

- Measure the concentration of Green House Gases (GHGs) such as water vapour, Carbon dioxide, Methane and Nitrous oxide
- Assess the in-use vehicle population at Secretariat Building as per Indian Roads Congress (IRC) guidelines
- Determine the carbon foot print united with transportation activities
- Formulate further preventive and mitigation measures for abatement of GHGs emission.

The methodology adopted for the study consisted of:

- Monitoring of Greenhouse Gases

  Monitoring of pollutants was carried out for 16 hours with a frequency of four days observation at the station. The sampling equipments were located at three gates of the campus. The pollutants included for measurement were Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O) and Carbon monoxide (CO).

- Traffic Survey
- Estimation of Carbon Footprint

  There are three Tiers (TIER 1, TIER 2 and TIER 3) presented in the '2006 IPCC Guidelines' for estimating emissions from automobiles. The Tier 1 method is fuel-based, since emissions from all sources of combustion can be estimated on the basis of the quantities of fuel combusted (usually from national energy statistics) and average emission factors. In the Tier 2 method, emissions from combustion are estimated from similar fuel statistics, as used in the Tier 1 method, but country-specific emission factors are used in place of the Tier 1 defaults. In the Tier 3 method either detailed emission models or measurements and data at individual plant level are used where appropriate.

In this study TIER 2 method is adopted and the vehicular emission estimated using the following equation:

$$E_i = \sum (Veh_j \times D_j) \times E_{i,j,\ km}$$

Where;

E_i – emission of compound (i)
Veh_j – number of vehicles per type (j)
D_j – distance traveled by vehicle type (j)
$E_{i,j,\ km}$ – emission factor (i),vehicle type (j) per driven kilometer

The emission factors used in the estimation of vehicular emission is given in **Table 8.**

Table 8: Emission Factors for in-use Automobiles

Pollutant	Bus	Omni Bus	Two Wheeler	Light Motor Vehicles (passenger)	Cars and Jeep	Taxi	Truck and Lorry	Light Motor Vehicles (goods)	Trailer/Tractor	Others
CO_2	515.2	515.2	26.6	60.3	223.6	208.3	515.2	515.2	515.2	343.9
CO	3.6	3.6	2.2	5.1	1.98	0.9	3.6	5.1	5.1	3.9
Nox	12	12	0.19	1.28	0.2	0.5	6.3	1.3	1.3	3.9
CH_4	0.09	0.09	0.2	0.2	0.2	0.01	0.09	0.09	0.09	0.1
SO_2	1.4	1.4	0.013	0.03	0.05	10.3	1.4	1.4	1.4	1.9
PM	0.6	0.6	0.05	0.2	0.03	0.07	0.3	0.2	0.2	0.2
HC	0.9	0.9	1.42	0.14	0.25	0.13	0.87	0.14	0.14	0.5

Findings

Concentration of Greenhouse Gases

In addition to CO_2, carbon monoxide, oxides of nitrogen, methane and other pollutants are also emitted from the vehicles. To know the concentration levels of these pollutants, monitoring of greenhouse gases was conducted. **Table 9** shows the results of greenhouse gases concentration.

Table 9: GHG Concentration in mg/m^3

Sl. No.	Pollutant	Concentration (ppm)	Concentration (mg/m^3)
1	Carbon dioxide	250	449.63
2	Carbon monoxide	2.20	2.52
3	Methane	65.55	65.55
4	Oxides of nitrogen	1.49	2.80

The concentration levels at the campus were well within the permissible limits of Central Pollution Control Board (CPCB).

Vehicle Population

Classified volume count survey has been conducted for 12 hours duration for four normal working days of a week covering morning and evening peak hours. It was found that the total number of vehicles passing through Secretariat campus was 4696/day. Among these, personalised

vehicles such as two wheelers, cars and Multi Utility Vehicles (MUV) are dominant. The contribution of these vehicles is 44.10%, 42.29% and 12.95% respectively. Other vehicles like three wheelers (0.38%), Light Commercial Vehicles (0.28%) are relatively less and bus, truck and tractor category vehicles are nil.

Carbon Footprint

From the determined vehicular emission the carbon footprint is calculated based on its Global Warming Potential. The Global Warming Potential for the greenhouse gases such as CO_2, CH_4 and N_2O are 1, 25 and 298 respectively. The estimated carbon footprint is given in **Table 10.**

Table 10: Carbon Footprint at Secretariat Campus

Sl. No.	Greenhouse Gas	GHG Concentration(g)	GWP
1	Carbon dioxide (CO_2)	543514.1	543514.10
2	Methane (CH_4)	933.97	23349.25
3	Nitrous oxides (N_2O)	1590.52	473974.96
Total Carbon Footprint			1040838.31

The carbon footprint caused by transportation in the secretariat campus is 1040838.31 g or 1040.84 kg per day. For calculating the annual footprint, 330 days of transportation activity is assumed. The estimated carbon footprint with respect to transportation activity in the Secretariat campus is 343476642.3 g/year or 343.48tonnes/year.

Various measures for mitigating the GHG emission from transport sector are suggested by NATPAC for making Secretariat campus a cleaner and greener place of the capital city. Alternative fuels like ethanol, bio-diesel, natural gas, liquefied petroleum gas, synthetic fuels, hydrogen and electricity have to be used. Car-pooling techniques have to be adopted and popularized and use public transport wherever available. Fuel filters, air filters, oil filters and carbon deposits from silencers must be cleaned regularly. Recommended tyre pressure has to be maintained. Awareness campaigns have to be conducted for building awareness among the public.

Plate 1: Greenhouse Gases Monitoring at Secretariat Campus

15. *Feasibility of Ropeway System at Elaveezhapoonchira in Kottayam District, Kerala*

Department of Tourism and Kottayam District Tourism Promotion Council had entrusted the task of conducting feasibility study for developing ropeway system at Elaveezhapoonchira to NATPAC, considering environmental impact and huge capital investment required for implementing such a project. As part of this, NATPAC carried out various field studies which included terrain evaluation, tourist demand survey, environmental impact assessment and selection of most feasible alignment for the project.

Scope and Objectives of the Study

The main objective of the project is to establish the feasibility of developing a ropeway system at Elaveezhapoonchira and the scope of the study has been limited to the conduct of technical and economic viability of the Ropeway project at Elaveezhapoonchira region.

Towards this, the following tasks were performed:

i. Reconnaissance survey to identify possible alignment for Ropeway System
ii. Assessment of geological, climatological and meteorological data of the region
iii. Fixing the location of base station, intermediary points and hill top station
iv. Assessment of tourists demand for the Ropeway project
v. System selection, power/ electrical and telecommunication requirements
vi. Estimation of cost of operation and maintenance of the system and staff requirement
vii. Space requirement for support services, parking and resting places
viii. Assessment of the capital investment including Civil, Mechanical and Electrical components
ix. Environmental impact assessment of the project and mitigative measures
x. Financial analysis of the project

Estimation of Tourist Demand

The base year tourist demand at Elaveezhapoonchira during the peak seasons was arrived at from local enquiries of jeep drivers, travel/ tourist operators and local residents. Daily tourist arrival to Elaveezhapoonchira during peak season was estimated to be 250 persons/ day. With the development of Elaveezhapoonchira as a premium tourist centre, it is expected that there will be a quantum jump in the number of tourists visiting the spot. Based on the Tourist interviews conducted at nearby tourist destinations in Idukki and Kottayam districts, it was estimated that, nearly 30% of the tourists visiting these two districts were expected to visit Elaveezhapoonchira. To be on the conservative estimate, 25% of tourists visiting Kottayam and Idukki district were

taken as potential tourists to ropeway site for the base year 2013 and thus the tourist demand has been estimated as 2,53,176 per year.

Projection of ridership for ropeway system for various horizon years was carried out to arrive at the number of rope cars required and also to estimate the revenue accruals from operation of the system. The projected ridership for various horizon years is given in (**Table 11**) below:

Table 11: Ridership Forecast of Ropeway for Different Horizon Years

Particulars of Ridership	2013	2015	2020	2025
Average per month	15,247	17,784	26,131	36,650
Average per day	610	711	1,045	1,466
Peak ridership/ day	1,108	1,293	1,899	2,664
Average day peak hour ridership	102	119	174	244
Peak day peak hour ridership	185	215	317	444

Route Selection

Based on reconnaissance survey several alignment options were considered. Using Geo-maping software and GIS tools three alternative alignments were established connecting the hill top with base station. Based on the technical evaluation, the most feasible alignment for ropeway system is given in **Figure 16**.

Environmental Analysis

An evaluation of the existing environmental condition was carried out. Attributes of physical environment like air and noise qualityin and around the region were assessed through field studies and appropriate mitigation measures have been suggested.

Figure 16: Map Showing the Final Alignment Chosen for Ropeway System

16. Application of Congestion Pricing as a Tool for reducing Traffic Congestion in Cities

Traffic congestion has a number of negative effects which includes wasting time of motorists and passengers, increasing air pollution due to wasted fuel, wear and tear of vehicles, stressed and frustrated motorists, blocked traffic interfering with the passage of emergency vehicles and spill-over effect from congested main arteries to secondary roads and side streets.

Congestion pricing is one of the most widely applied techniques in advanced countries for reducing congestion. Road pricing is a system that directly charges motorists for the use of a road or a network of roads. *Congestion-pricing* is a system of surcharging users of a transport network in periods of peak demand to reduce traffic congestion. The level of congestion-pricing depends upon the distance of the area under consideration, and the time. The following are various categories of congestion-pricing adopted in area/ cordon/ lane congestion-pricing systems:

- *Toll road-pricing* approach
- *Electronic road-pricing* method using smart-cards and cameras

The present work focuses on analyzing the effect of congestion pricing on route choice, mode choice and travel time choice of commuters. The analysis was performed using four stage transportation model in CUBE 6.

Scope and Objectives

The study area was confined to the major arterial road corridor from to Balaramapuram Sreekariyam in Thiruvananthapuram region. The objectives of the study are:

i) To study the traffic flow pattern on the selected roads in the study region
ii) To assess the extent of traffic congestion and to review various means of reducing traffic congestion
iii) To identify the potential areas and institutional mechanism for implementing congestion pricing
iv) To assess the viability of introducing congestion pricing tools and to evaluate its impact on the traffic condition and level of service

Methodology

Tasks carried out include: collection of necessary data through primary and secondary sources, and analysis of data to extract the necessary inputs for the study. These include:

- Detailed inventory of the study area to assess the characteristics of roads and their capacity
- Traffic surveys to assess the traffic flow pattern including vehicular flow, parking and pedestrian activities
- Opinion survey of vehicle users regarding congestion pricing and evaluation of the impact of congestion pricing

Findings

The modal split was performed for the base year 2012 using the multinomial logit modal module in Cube 6 software. The weighted average cost of travel for private modes was computed as ₹ 6.87 per km. It was observed that the ridership by public modes varied from the existing 39.1% to 49.4% when the travel cost by private modes increase by 70%. Similarly, it was observed that the ridership by public modes varied from the existing 39.1% to 30.4% when the travel cost by private modes decreased by 70%.

From willingness to pay survey, it was observed that about 60% of the trip makers were willing to pay the congestion price. From this, it is inferred that 35% of vehicle trips by cars and two wheelers will be diverted to alternative routes of travel. Thus the flow along the selected links was reduced by 40%.

It was found that the speed for the existing condition is 21 kmph for a vehicular flow of 2705 pcu/hr/direction. With the implementation of congestion pricing, when the traffic flow is reduced by 40%, the speed along the road section increased by 88%.

17. Traffic Improvement Plan for Bolgatty Junction in Cochin Region

As part of developmental program proposed in Bolgatty Island in Cochin Region, Lulu Convention and Exhibition Centre Pvt. Ltd has mooted a major Convention Centre cum Hotel with 250 rooms and 2,500 persons capacity Convention Halls. It was expected that the entry/exit of vehicles to/from the proposed project would cause congestion on GIDA road immediately after the "Goshree" bridge. Besides this, the road leading to Kalamasserry town and Vallarpadam International Container Transhipment Terminal (ICTT) is branching off from this location. At the instance of M/s Lulu Convention and Exhibition Centre Pvt. Ltd., NATPAC undertook a study to formulate suitable Traffic Improvement Plan for Bolgatty Junction. The location of the proposed project site and adjoining roads is shown in **Figure 17**.

Figure 17: Satellite Imagery of Project Site in Bolgatty Island and the GIDA Road in Cochin Region

In order to estimate the generated volume due to the establishment of Hotel cum Convention Centre in Bolgatty Island, detailed traffic surveys have been carried out for Bolgatty-GIDA Bridge Junction in Ernakulam.

The scope of work involves assessing the adequacy of existing road infrastructure and transport facilities available in the influence area of the intersection near the proposed Convention Centre and propose appropriate traffic improvement for Bolgatty Road-GIDA bridge junction.

The following tasks were performed as part of the study:

- Inventory of existing roads leading to the proposed project site and assessing the scope for further improvements
- Topographic survey of the study area covering 200m along each arm of the junction
- Conducting traffic surveys at proposed intersection to evaluate the capacity of roads
- Estimation of anticipated vehicular traffic from the Convention Centre using appropriate modal choice and demand estimation methods
- Design of road intersections that connect Vallarpadam ICT Road, Goshree Road to High Court (Goshree Bridge No.1), Goshree Road to Vallarpadam (Goshree Bridge No.2), Bolgatty Road, and IWAI Boat Jetty.

Based on detailed inventory of roads in the influence area and topography survey of Bolgatty Intersection covering a bell-mouth area of 200 m on all roads using Total Station equipment, a base plan of the study area was prepared. The traffic volume counts and turning flow at intersection were recorded for three days continuously.

Considering the anticipated traffic generated from LuLu Convention Centre and heavy volume of container lorry movement expected on the Vallarpadam road, the Bolgatty Junction was designed by giving priority to truck traffic turning to Vallarpadam ICT and vice versa. The improvement proposal of Bolgatty intersection is shown **Figure 18**.

Figure 18:Traffic Improvement Proposal for Bolgatty Junction in Kochi

18. Comprehensive Mobility Plan for Kalamasserry Town in Ernakulam District

Kalamasserry, often regarded as the Gateway to Kochi, is one of the industrial hubs of Kerala which has several major establishments of national importance. Kalamasserry town lies on NH 544 (earlier NH 47) from where road to Vallarpadam International Container Transshipment Terminal branches off. The NH-544 is passing through the town which carries heavy volume of commercial vehicles and container trucks. This causes severe strain on the urban road system. At the instance of Roads and Bridges Development Corporation of Kerala (RBDCK), NATPAC conducted a detailed traffic and transportation study for Kalamasserry town to propose integrated transportation system development plan for the town.

The purpose of the study is to prepare a Comprehensive Mobility Plan for Kalamasserry town in Ernakulam district. Towards this, the following specific objectives were identified:

i. To assess the existing traffic flow pattern and transportation requirements of the study region;
ii. To identify the deficiencies in road system, short-falls in traffic and transportation infrastructures of the town;
iii. To estimate the future traffic demand and evaluate the adequacy of the existing road network and transport facilities;
iv. To formulate a Comprehensive Mobility Plan for Kalamasserry town indicating long term road development plan and multi-modal transport system to cater to the traffic and transport needs of the town for the next 15 to 20 years horizon period.

The scope of the study is confined to Kalamasserry town covering an area of 27 km^2, with a population of over 70,000 as per 2011 census.

Mobility Plan for Kalamassery town

Based on the field studies and analysis of data, deficiencies in the existing road system and short falls in transport facilities have been identified. Suitable traffic management measures and short-term improvement schemes were suggested. The short-term measures include: traffic improvement plan for intersections, minor alterations to roads, construction of missing links,

provision of parking facilities and designated pedestrian cross-walks at selected locations and development of multi-modal transport terminal.

Long-term development strategies have been proposed to meet the anticipated traffic demand in 2030. For integrated development of the region, a Comprehensive Mobility Plan (CMP) has been prepared. The CMP recommended a hierarchical pattern of road system consisting of Ring and Radial Roads for Kalamasserry town.

The existing NH-544 from Edappally Jn. to Aluva direction will serve as the major arterial road for Kalamasserry Urban Centre. The volume-capacity ratio for horizon year indicated that this corridor would be highly congested in the near future. Hence, it is proposed to develop NH 544 into six-lane divided carriageway with segregated bus bays and off-street parking lots in another 5-10 years. Proposed conceptual road network pattern for Kalamasserry town is shown in **Figure 19.**

It is recommended that the extension of Seaport-Airport Road beyond HMT junction needs to be taken up on priority basis. In order to divert the heavy volume of goods traffic and container trucks from Vallarpadam ICT Road to North and South bound NH network, road link connecting ICT Road and Seaport-Airport Road is recommended. The report evaluated three alternative options for this new road connectivity.

As a part of integration of goods transport modes, an Intermodal Freight Terminal is suggested between ICT Road Jn. and Apollo Junction on NH-544. Similarly for integration of public transport buses, a bus station is recommended near HMT road by the side of Seaport-Airport road.

Implementation of short-term schemes would reduce the traffic congestion and ensure a safe and smooth operation of traffic on the existing road system. A phased implementation of long term development schemes would bring a better level of service and qualitative improvement in traffic and transportation system of Kalamasserry Town.

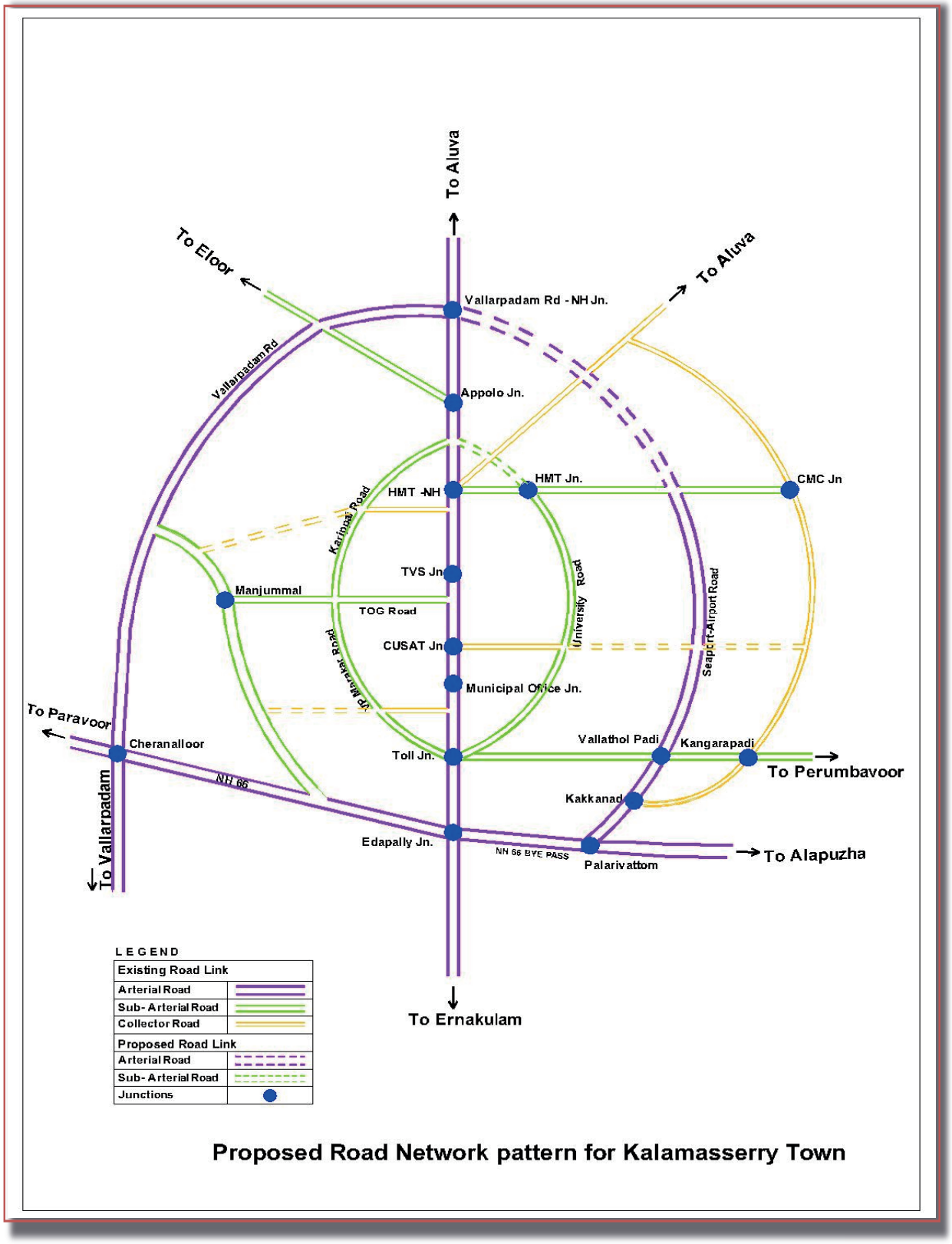


Figure 19: Proposed Road Network Plan for Kalamasserry Town

19. *Pedestrian Friendly Urban Transport System for Kochi City*

Pedestrians are an important component of road users. They are also considered as the most vulnerable road users in the entire traffic stream. Every trip starts and ends as a walk trip. To maintain and improve mobility, pedestrian facilities should be planned as an integral part of urban transportation system in developing areas. In urban areas, it is difficult for pedestrians to move around safely and comfortably. In Kochi city, the proportion of pedestrian movement is very large due to the following reasons:

i. Huge volume of floating population in the Central Area.
ii. Migrant labourers staying in inaccessible areas.
iii. More patronage of public transportation system forces the trips to end as walk trip either at the origin or at the destination.

Scope and Objectives

The aim of the study is to assess the adequacy of pedestrian facilities, formulate suitable improvement proposals and action plan for a pedestrian friendly transportation system for Kochi city in Kerala State. The study is confined to CBD areas of Kochi city. The specific objectives of the study are given below:

a) Assessing the existing pedestrian infrastructures in central area of Kochi city.
b) Conducting traffic surveys on major roads in the study region and identify pedestrian-vehicle conflict points in the road network.
c) Collection of data pertaining to qualitative and quantitative assessment of pedestrian facilities as well as their travel characteristic like O-D of trips, purpose, factors which affect travel choice etc.
d) Formulation of suitable proposals for improving pedestrian mobility and integration of pedestrian access with transport centers and traffic generators.

The following tasks were performed for the study:

a) Site appreciation and collection of data from primary surveys and secondary sources.
b) Identification of shortcomings in the existing pedestrian facilities;
c) Evaluation of pedestrian infrastructures in selected cities using walkability index for different road corridors.
d) Assessment of level of service of non motorized transport facilities for different cities.

e) Preparation of improvement schemes for streamlining pedestrian mobility in the study area.

f) Integration of pedestrian access with major transport terminals, work centres, and major activity areas of the city.

g) Preparation of cost-estimate for various schemes, prioritization and phasing of the schemes for implementation.

Figure 20 shows the major traffic generating points in the study area.

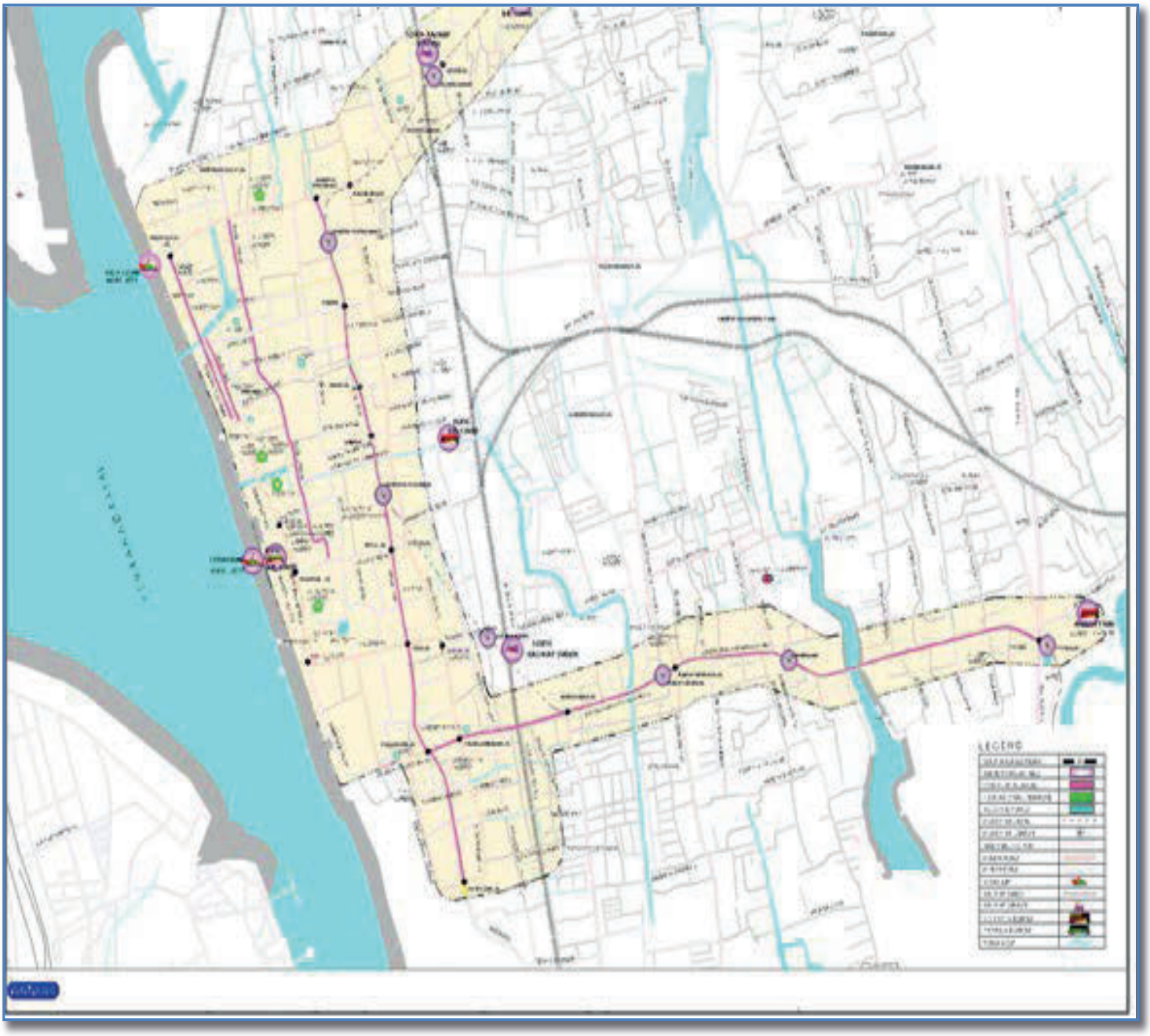


Figure 20: Map Showing Major Traffic Generating Points in the Study Area

Based on the analysis of data, improvement schemes for channelizing pedestrian and bicycle movement have been formulated for Kochi city. The proposals include: at-grade improvements to reduce vehicle-pedestrian conflicts by engaging segregated bus bays, widening of footpaths, provision of new walkways, reallocation of road space for pedestrians, pedestrianization of streets, integration of pedestrian facilities with public transport systems, improving the condition of street furniture, landscaping, provision of pedestrian amenities like toilets, drinking water facilities at vantage points etc. It also includes provision of traffic signs, road markings, traffic signaling etc to improve pedestrian and cyclist activity on important corridors.

Grade separated schemes recommended for Cochin city include pedestrian underpass, foot over-bridges, skywalk, etc. thereby encouraging a multi-modal transportation systems in cities of Kerala. The proposals are disable people friendly and necessary design modifications are recommended accordingly. About 28% of road accidents reported in Kerala involve pedestrian as victims. Implementation of proposed schemes would reduce the pedestrian casualties and ensure a better level of service for the Non-motorized Transport (NMT) users. By encouraging the mobility of people through non motorized transport modes, green house emissions can be reduced to a great extent. The study is expected to reduce the traffic congestion in CBD areas and also increase the patronage in public transport system in the region.

Summary

Keeping the long term transportation goals of the city, an integrated pedestrian infrastructure has been proposed. The improvement schemes include: footpaths/ walkways, cross walk facilities, grade-separated facilities, skywalk, pedestrian guidance measures, pedestrian amenities etc.

Detailed cost estimate for undertaking various schemes for improving pedestrian infrastructure in the city has been worked out along with an implementation plan involving various agencies.

It is hoped that early implementation of the proposals suggested in this report will go a long way in evolving a pedestrian friendly transport system for Kochi City. This will also reduce the traffic congestion on the city roads and also increase the patronage in public transport system in the region.

20. *Predictive Accuracy of Urban Transport Studies - A Case Study of Thiruvananthapuram and Kochi Cities in Kerala*

Kerala is one of the densely populated States in the country with a population density of 820 persons per sq.km, three times the national average. Nearly 48% of the State's populations live in urban areas. The State has five Municipal Corporations and 53 Municipal towns. The urbanization in Kerala is not limited to designated cities and towns. Barring a few Panchayats in hilly tracts and some isolated areas in backwater region, the entire state depicts the picture of an urban-rural continuum.

Traffic and transportation studies were carried out by different agencies for various towns in Kerala during the last three decades. There is a wealth of information and data-base available in the State. These data includes: socio-economic characteristics, travel data and traffic flow pattern for a number of urban centres. Further, database on population projections, growth of vehicles, trip rate, traffic volume, parking demand, public transport demand for different time periods are available. It is proposed to analyse the temporal variation and predictive accuracy of the identified variables for selected cities in Kerala.

Scope and Objectives

The scope of study was confined to selected cities (Thiruvananthapuram and Kochi) in Kerala State. The objectives of the study are:

i) To undertake an analysis of socio-economic variables, travel behaviour and traffic flow pattern that have influence on demand forecasting;
ii) To evaluate the accuracy of selected variables by comparing the study forecasts with the actual/observed data in the selected city;
iii) To critically examine the assumptions made in forecasts and the cause-effect in predictive accuracy of these variables;
iv) To prepare general guidelines for realistic assumption and forecasting of input variables in such studies.

Study Methodology

The data base available with NATPAC and other Government and Private consulting firms will be utilised to assess the accuracy of various parameters by comparing the study forecasts with the actual changes that have taken place. An evaluation of variations in planning variables like population growth, employment, land use, vehicle ownership, traffic volume etc was made. The assumptions made in those studies were critically examined and suitable recommendations were made.

Findings of the study

Considerable attention has been paid in improving the accuracy of model development, but little attention has been given to effect of errors on the accuracy of traffic forecasts. Data from 19 transport studies of Thiruvananthapuram and Kochi cities, undertaken between 1981 and 2011 were used to evaluate their predictive accuracy. Comparison of demographic and socio-economic variables forecast showed a trend of overestimation while the comparison of traffic characteristics showed a trend of under estimation. Planning variables (population and employment) of both cities were overestimated up to 24% for a forecasting period of 10 years. Almost all forecasts of land use inputs were overestimated by an average of 39% in case of Thiruvananthapuram city where as for Kochi city the forecasts were underestimated by an average of 17%.

Traffic parameters like future vehicle ownership and traffic flow on corridors were heavily under estimated for both cities by 13 to 94%. An important variable like per-capita income has not been forecasted for the horizon year in most of the studies and the base year value was assumed to grow in normative pattern errors in predicting the vehicle ownership levels of the city. Therefore, there occurred a flaw in the traffic flow assignment on the road network.

Conclusion

Although the results were based on those studies that were done between 1981 and 2001, many of the modeling methods used in those studies are still in common use. However, no evidence could be found to suggest that the more recent studies or the most sophisticated models employed in such studies performed better than the others. Lack of sufficient data and forecasting procedures posed difficulty in proper analysis of the accuracy of the forecast. It is concluded that optimistic planning forecasts and insufficient checking procedures were the most important factors in reducing the overall accuracy of the forecasts.

An assumption of zero change in input parameters would not have produced markedly greater forecast errors in most of the items. In many cases, the average errors would have been considerably less. Although the highway trip forecasts were dominated by the errors in the planning variables, there is evidence that the models used for forecasting transit trips contained errors of specification. However, despite the general over-estimation of the main parameters, there was some measure of agreement between the rankings of the observed and forecasted changes.

21. *Performance of Highways Developed under Kerala State Transport Project*

Kerala State has embarked on a massive highway development programme through projects like Kerala State Transport Project (KSTP) which could enhance the comfort and level of mobility on the State Highways. A critical appraisal of these highway development projects will be most befitting and significant as regard to the highway research in the State. An evaluation of the pavement performance by collecting data on pavement performance in terms of deflection, roughness, skid resistance, texture and condition of the pavement surface will contribute towards assessing the benefits of the highway development projects.

The scope of the study is limited to selected stretches of SH-1 developed under Kerala State Transport Project. The methodology adopted for the study consisted of collection of baseline data, evaluation of structural and functional performance of the study road pavements, axle load studies, traffic studies, assessment of Vehicle Operating Costs (VOC), capacity analysis and socio-economic impact assessment of the highway development project. The details of study roads is given in **Table 12.**

Table 12: Details of Study Roads

Road Name	Road Category	Traffic	Inventory details
Pala – Ettumanur (SH 32)	SH	12238 vehicles/day 2217 CVPD	C/W – 7 m ROW – 12m to 15m Earthen shoulder – 1.5 to 2m on either side, Side drains - nil
Vetturoad-Pothencode (Sainik School to Kinfra) HS I	SH	9368 vehicles per day 1288 CVPD	C/W – 7.5m ROW – 22 m Paved shoulder – 2.3 to 2.5m on either side Side drains - 0.9m
Chanthavila to Kattaikonam HS II			
Venjaramoodu to Nilamel (Thandrampoika) HS III		11184 vehicles per day 2868 CVPD	
Nilamel to Chadayamangalam HS IV		11124 vehicles per day 1908 CVPD	
Vayackal to Policodu Jn HS V		8803 vehicles per day 1776 CVPD	
Lower Karickam to Kottarakkara HS VI		12388 vehicles per day 1959 CVPD	

The data collected by pavement evaluation studies were analysed to assess the pavement performance including structural performance, surface quality etc**. (Table 13**)

Table 13: Engineering Properties of Subgrade Soil of Study Roads

Study Road Sections	OMC %	MDD g/cc	LL %	PL %	PI	Soil Type (IS)	CBR
Pala - Ettumanur	11.60	2.58	32.5	16.33	16.17	SC	13.5
HS I	21.20	1.572	37.90	26.93	10.97	SC	12.20
HS II	6.41	2.082	25.50	14.36	11.14	SC	17.90
HS III	11.90	1.980	27.50	21.11	6.39	SM-SC	11.70
HS IV	11.10	1.934	44.00	33.33	10.67	SC	9.90
HS V	7.80	2.102	20.50	16.67	3.83	SP	36.80
HS VI	11.00	1.790	35.50	13.39	22.11	SC	3.70

Plate 2: Unevenness Survey

From the laboratory studies it is clear that soil with good California Bearing Ratio (CBR) strength was used as subgrade. Mostly the soil is of clayey sand type (SC). Lower deflection value and desirable skid resistance value indicates that the study road has good performance. From the Benkelman Beam Deflection (BBD) studies, the deflection measured on the study stretches of SH 1 varied from 0.29 to 0.54 mm. The study roads exhibits a current functional performance of good to average rating based on the unevenness values indicated by the International Roughness Index (IRI) values of the study stretches which range from 2.512 m/km to 3.213 m/km (IRC:SP:16-2004). Signs of impending failures have initiated on the pavement surface of the study roads in the form of various distresses like fractures or cracks, distortion, disintegration etc. Ravelling and alligator cracks are the major distresses seen on the pavement surface. Initiation of potholes is also noticed at some of the locations.

The study brought out quantified results in figures and facts to substantiate the performance of State Highway strengthened through the Kerala State Transport Project.

22. *Use of Plastic Waste for Road Construction and Study on its Suitability to Kerala Conditions*

Disposal of plastic waste in an eco friendly way is the need of the hour. NATPAC explored the possibility of usage of waste plastic in road construction and conducted laboratory studies on various mixes with plastic coated aggregates and ordinary aggregates. The Centre also constructed test stretches with mixes of plastic coated aggregates and conducted their periodic evaluation.

The methodology adopted for the study consisted of research on past laboratory studies conducted and evaluation of pavement data for stretches in Kerala which use plastic coated aggregates for constructing pavements. Laboratory studies were conducted on bituminous concrete, semi dense bituminous concrete and dense bituminous macadam, all having plastic coated aggregates. Performance evaluation for road stretches before and after resurfacing with modified mix having PCA was also conducted. This year two roads – Menamkulam – Kadinamkulam road in Thiruvananthapuram District and Mutholi – Poovarani road in Pala were resurfaced with modified mix having waste plastics.

Menamkulam – Kadinamkulam Road

Menamkulam-Kadinamkulam Road in Thiruvananthapuram - an urban street with 700 m length and 7-8 m carriageway width was resurfaced with modified mix having waste plastic coated aggregates by NATPAC. 20mm thick Premix Chipping Carpet (PMC) was laid using a mix of Plastic Coated Aggregates (PCA). Detailed pavement condition survey was done before resurfacing. Other pavement evaluation surveys comprising of BBD Survey, roughness survey, skid resistance studies, texture depth studies etc., were carried out after resurfacing to assess the structural and functional performance of the pavement.

The data collected by pavement evaluation studies were analysed to obtain dataset I (October 2012) and dataset II (March 2013). This gives an indication on the structural adequacy and functional performance of the study road.

Mutholi – Poovarani Road

Mutholi-Poovarani Road in Pala is a rural road linking to SH-08 (Ponkunnam –Thodupuzha road) near Kumbani bridge. This road is having a carriageway width of 4 m and carries a traffic count of 800 vehicles/ day. 500 m of this road was surfaced with modified mix having PCA under the technical supervision of NATPAC.Detailed pavement condition survey was done before resurfacing. Other pavement evaluation surveys comprising of BBD survey, roughness survey, skid resistance studies,

texture depth studies etc., were carried out to assess the structural and functional performance of the pavement after resurfacing.

The data collected by pavement evaluation studies were analysed to obtain dataset I which gives an indication on the structural adequacy and functional performance of the study road. About 300 m of the road section is taken as control stretch, where plastic mix was not laid during resurfacing of the pavement. Another 200 m of the road section, which was not resurfaced was also included for pavement performance evaluation surveys.

Reduced damage in terms of potholes and cracks were seen on the stretches which used plastic coated aggregates for surfacing. This will lead to reduced distress and thereby considerable savings in economy because of less maintenance of roads.

Social benefit is predominant by using waste plastic in road construction as it generates wealth from waste. This will also become a value addition to municipal wastes which hitherto has been considered as 'unwanted waste'.

Plate 3 A view of Menamkulam- Kadinamkulam Road

Plate 4 Laying of plastic road in Mutholi-Poovar ani Road

23. *Pavement Deterioration Studies for Highways in Kerala*

For the efficient management and desired level of serviceability of the transportation infrastructure, the accurate prediction of pavement performance is important. Well developed performance models should satisfy both technical and economic requirements for the management of pavements and their development is a continuing process. Based on the pavement performance and maintenance NATPAC proposed to develop a performance model which will be able to predict likely deterioration and surface damages.

The objective of the study is to develop a comprehensive database on pavement performance, generate data on the construction and maintenance inputs of different pavements and to develop a model that will predict the likelihood of deterioration and surface distress like cracks, potholes, raveling etc.

The representative stretches from State Highways of Kerala SH-1 and SH-32 selected for the study are shown in **Table 14.**

Table 14: Stretches from SH-1 and SH-32 selected for the Study

Sl. No.	Name of Study Stretch	State Highway	Sections
1	Pala-Ettumanur Road	SH-32	-
2	Vetturoad to Pothencode (Sainik school to KINFRA)	SH-1	HS I
3	Chanthavila to Kattaikonam	SH-1	HS II
4	Venjaramoodu to Nilamel (Thandrampoika)	SH-1	HS III
5	Nilamel to Chadayamangalam	SH-1	HS IV
6	Vayackal to Policodu Jn.	SH-1	HS V
7	Lower Karickam to Kottarakkara	SH-1	HS VI

The methodology adopted for the study consisted of field investigations and performance monitoring, functional evaluation of pavements and conducting tests on sub grade soil. For all the road stretches inventory studies and traffic volume count studies were conducted. On the subgrade soil obtained from these road stretches, grain size analysis, consistency limit tests, modified Proctor compaction (heavy compaction) and CBR tests were carried out to find their index properties and engineering properties. Pavement evaluation data like unevenness index, characteristic deflection and total distress were obtained for all the road stretches under the study.

Unevenness Survey on Study Roads using MERLIN

Plate 5(a)

Plate 5(b)

It has been identified that clayey sand soil with good CBR strength and low plasticity index was used as subgrade in all road stretches. Most of the roads have sufficient skid resistance and those deficient must be improved by using aggregates having rough texture during next surfacing. The reduction in skid resistance is due to smooth texture of some of these road stretches. Based on roughness value and unevenness value roads are categorized as average. BBD tests indicate that the pavements are reasonably strong. Traffic volume count studies confirm heavy traffic on these roads.

24. *Use of Geotextiles in Road Construction and Embankment Works – A Demonstration Project in Aakkulam Campus*

Use of geotextiles, either natural or synthetic, in the construction of pavements is a common practice now a days. Coir geotextiles are locally available and most suited to climatic conditions of Kerala. Use of coir geotextiles have been found useful to increase the strength of the subgrade and capacity of pavement to carry more traffic/loads, reduces fatigue, cracking, amount of ruts and thus increase the life of pavements in weak subgrades and resulted in improved performance for different soil conditions. Coir geotextiles perform different functions like filtration, separation, drainage, reinforcement and erosion control. The major drawback in using the coir geotextiles is its biodegradability. But it can be treated with bituminous coating to ensure durability without reduction in friction.

The objective of the study is to explore the possibility of using coir geotextiles in road construction on a large scale in Kerala and to develop a methodology for using coir geotextiles in the protection of road embankment on soft clays. The study was also aimed at constructing test tracks and to conduct field studies to evaluate the performance of roads using coir geotextiles.

The methodology adopted for the study consisted of literature review, selection of suitable coir geotextile and study stretches, laying of test tracks, structural and functional performance evaluation of roads laid using coir geotextiles and data analysis.

NATPAC conducted pavement evaluation studies on roads laid with coir geotextiles. Two road stretches were selected in Thiruvananthapuram District for pavement evaluation studies where coir geotextiles were laid between subgrade and sub base layers. This was done as part of the joint research project undertaken by Coir Board and College of Engineering, Thiruvananthapuram. The details of road stretches selected for the study are given in **Table 15.**

Plate 6: Pavement evaluation done in Attukal-Pampadi Road

Table 15: Stretches of Road Selected for Study

Sl.No.	Name of road	Name of block	Length of test stretch
1	Attukal – Pambadi road	Nedumangadu	150m
2	Karikkuri – Chekidampara road	Nedumangadu	470m
3	Njekkadu – Panayara Road	Varkala	100m

NATPAC with the help of Public Works Department (PWD) also identified a road stretch, Kidangara – Kumarangiri near Alapuzha - Changancherry road, where coir geotextiles are laid to protect soil structure.

NATPAC evaluated performance of coir geotextiles reinforced road in the selected road stretches.An exhaustive condition survey and Benkelman Beam Deflection (BBD) survey was done to evaluate the functional and structural performance of the roads. A control section of 100m length was also taken along the road stretches to compare the performance of roads laid without coir geotextiles. The summary of the results of the survey is given in **Table 16.**

Plate 7: Laying of Coir geotextile along Njekkadu-Panayara Road

The performance evaluation of coir geotextiles laid road in Kidangara – Kumarangiri road stretch near Alapuzha -Changanacherry road was carried out by NATPAC. A control section of one km was also taken along the road stretch to compare the performance of road laid without coir geotextiles.

Plate 8: Laying of Coir geotextiles along Karikkuri - Chekidampara Road

Summary of BBD and IRI values are given in **Tables 17 and 18.**

Coir geotextiles offers a major solution for subgrade improvement and soil structure protection. Based on the performance evaluation studies conducted on coir geotextiles reinforced roads, it is found that H2M5 grade (700g/m^2) coir geotextiles reinforced roads perform better than H2M6 grade (400g/m^2) coir geotextiles.

Table 16: Summary of BBD Results

Road Name	Characteristic Deflection (mm)		
	Type	Stretch with coir	Control stretch
Attukal - Pambadi road	Coir 1 (H2M5)	0.72	1.03
Njekkadu - Panayara Road	Coir 2 (H2M6)	0.81	0.81

Table 17: Summary of BBD Results

Road Name	Characteristic Deflection (mm)		
	Type	Stretch with coir	Control stretch
Kidangara – Kumarangiri (Changanassery)	Coir (H2M5)	0.75	1.01

Table 18: Unevenness Values of Study Road

Road Name	IRI mm/km		
	Type	Stretch with coir	Control stretch
Kidangara – Kumarangiri (Changanassery)	Coir (H2M6)	6339	10060

Study of using coir geotextiles for embankment protection shows that coir geotextiles laid embankments perform very good in terms of functional and structural evaluation. BBD test results shows that characteristic deflection is high (1.01) in control stretch compared to the coir geotextile laid embankment stretch (0.75). Unevenness values of the study road stretch shows that IRI value is very high in control stretch where coir geotextiles were not laid, compared to the study stretch, where coir geotextiles were laid for the protection of road embankments. Use of coir geotextiles in subgrade reinforcement and road side embankment protection are very effective. It is also recommended to construct more test tracks using different grade coir geotextiles under different soil conditions to further evaluate their performances.

25. *Widening of NH-47 between Kazhakoottam and Kesavadasapuram in Thiruvananthapuram District*

To widen the National Highway-47 between Kesavadasapuram and Kazhakoottam in Thiruvananthapuram City and to ease the daily traffic condition, Government of Kerala decided to widen the arterial corridor to improve mobility and traffic safety, reduce congestion and to enable sustainable development of the city.

NATPAC prepared a project report for widening of NH-47 from Kesavadasapuram to Kazhakoottam in Thiruvananthapuram. The study aimed at preparing engineering design and detailed cost estimate for improving the existing road to four lane standards with minimum land acquisition. The methodology adopted for the study consisted of engineering surveys and investigations which includes topographic surveys, road inventory and condition surveys, alignment study, pavement investigations, Benkleman Beam Deflection survey, condition surveys for bridges and structures and exploration and selection of construction materials.

The entire stretch is divided into three homogeneous sections such as Kazhakoottam - Sreekariyam, Sreekariyam-Ulloor and Ulloor-Kesavadasapuram.

Typical cross section of proposed road includes 2.5 m central median, 0.25 m shyway distance on both sides, two lane dual carriage way (7.5m) on both sides and 3 m footpath/ utility corridor on both sides (**Figure 21**). This cross-section has been fixed based on 24 m Right of Way (ROW) availability and finalized based on the proposed monorail requirements along the study stretch. Widening of road was proposed concentrically from the centerline of existing road except at four locations where the religious structures exist.

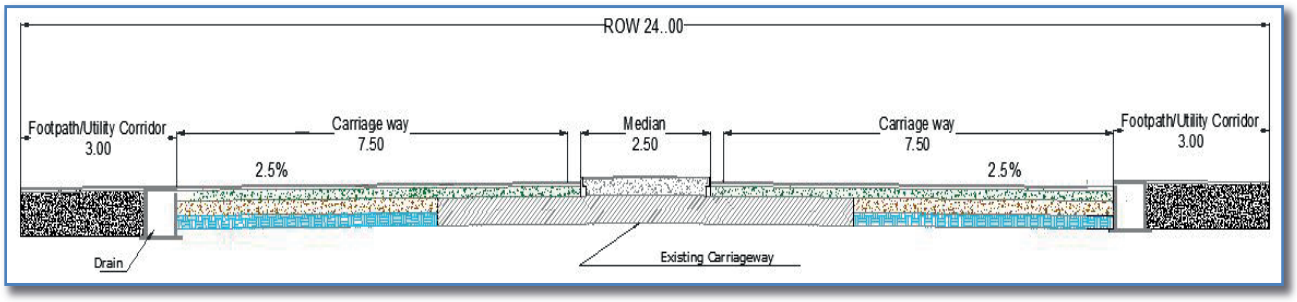


Figure 21: Proposed Typical Road Cross Section and alignment

Tables 19 and **20** give the pavement composition for widening and overlay of the section Kesavadasapuram- Kazhakkoottam.

Table 19: Pavement Composition for Widening

Homogeneous Section	Design CBR (%)	MSA	BC/SD BC (mm)	DBM (mm)	WMM (mm)	GSB (mm)	TOTAL (mm)
Kesavadasapuram - Kazhakoottam	7	134.22	50	160	250	230	690

Table 20: Pavement Composition for Overlay

Homogeneous Section	Char. Deflection (mm)	Proposed Overlay Thickness (mm)		
		BC (mm)	DBM (mm)	BM (mm)
Kesavadasapuram - Kazhakoottam	1.201	50	80	-

Three major bridges and one minor bridge are proposed for reconstruction. New two lane service road bridges are proposed on both sides across Ulloor Thodu. Other bridges one at Pangappara and two (major and minor bridge) at Kazhakoottam are also proposed for reconstruction. Detailed design of the bridges including the borehole investigation and structural design does not form part of the Terms of Reference of the study. All the seven existing culverts along the project corridor needs reconstruction. Two Road Over Bridges (ROB) are proposed at Sreekariyam and Ulloor to ease the traffic congestion along the project corridor. **Figures 22 and 23** show the typical cross section of Sreekariyam and Ulloor ROBs. The junctions at start and end of the project corridor are merged with the existing design. The junction at Sreekariyam and Ulloor are proposed with grade separated ROB's along major arms.

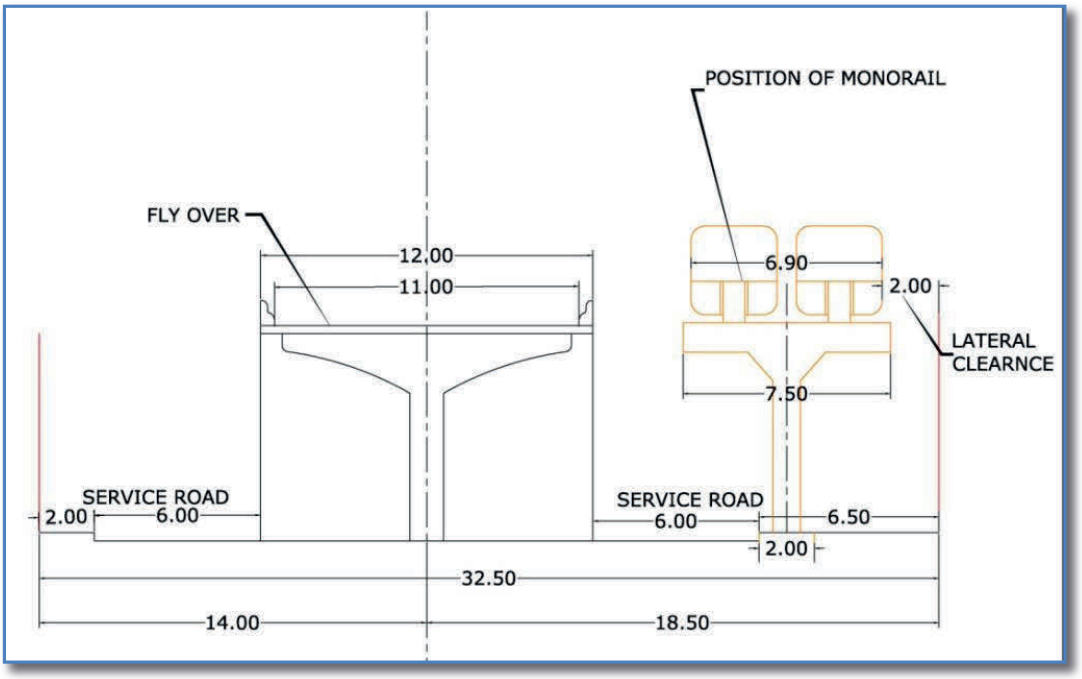


Figure 22: Typical Road Cross Section of Sreekariyam ROB

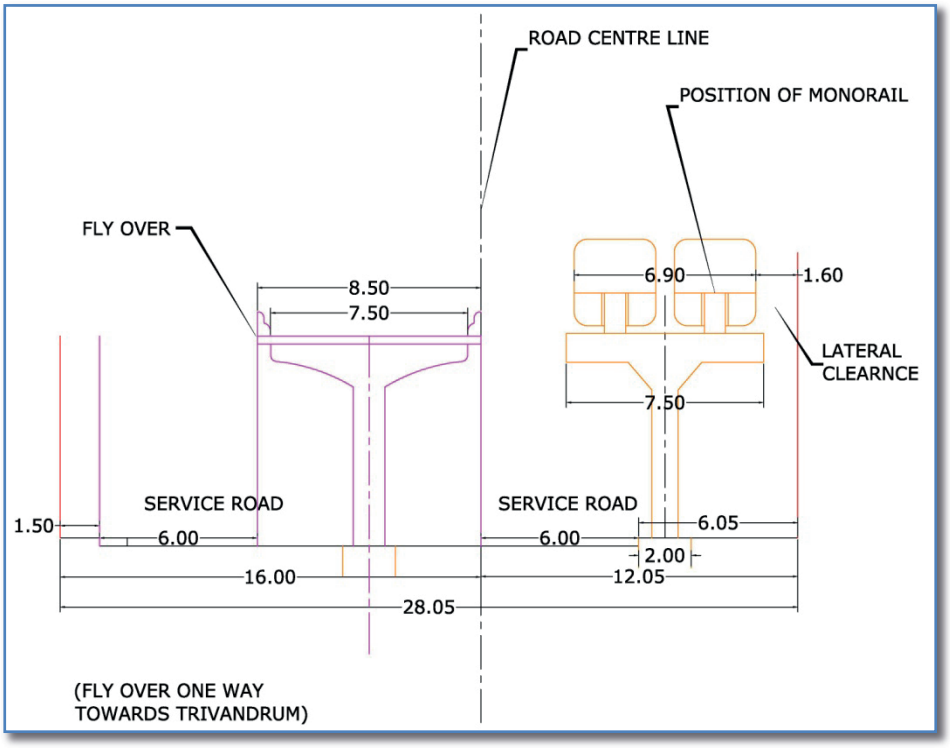


Figure 23: Typical Road Cross Section of Ulloor ROB

Construction Programme

Continuous interaction among the implementing authority, contractor and various utility departments would be necessary during the construction period. Since widening is required on both sides for most of the length of the project road, it will be necessary to make /keep in place traffic management plan to divert traffic from it and then switch over to the improvement of the existing Sub-arterial road. This will ensure minimum hindrance to traffic plying on the existing road. Further, the traffic may be allowed to ply on the half-carriageway (existing) and the remaining half can be taken up for widening on one side. After completing the widening, the traffic can be diverted to the completed new half-carriageway and the other half can be taken up for construction.

Land Acquisition and Total Cost Estimate

Land acquisition proposed for Kesavadasapuram - Kazhakoottam stretch is 24 m, except at Sreekariyam and Ulloor where grade separated schemes are proposed. The unit rates for various items of works have been worked out on the basis of the Kerala PWD schedule of rates. The total cost estimate worked out for this project is ₹548 crores including land acquisition cost of ₹ 426.44 crores.

26. *Pavement Evaluation Studies for Low Volume Roads in Kerala*

NATPAC carried out pavement evaluation studies for selected rural roads in Kerala constructed under the Pradhan Mantri Gram Sadak Yojana (PMGSY) scheme taking into consideration the distress levels, traffic etc. The methodology adopted for the study consisted of traffic volume survey, conducting functional evaluation of roads by condition survey and determination of pavement condition index of the study roads.

A total of 12 roads were identified, three roads from Thiruvananthapuram District and nine from Thrissur District. **(Table 21)**

Table 21: Details of Study Roads

Sl. No.	District	Road Name	Length (km)	Year of Construction
1	Thiruvananthapuram	Inchapuri - Cherumanjal	1.56	2003
2		Kurakonam - Karthikaparambu	1.1	2003
3		Kanampally - Chepode Road	0.96	2005
4	Thrissur	Chowkathazhoor -Chattikulam Road	4.7	2011
5		Chakrapany- Chattukallumthara Road	2.33	2011
6		Mattathoorkunnu - Kavanadu	3.15	2009
7		Palapilli - Vellikulangara	14.5	2010
8		Kundayi - Chakkiparambu	2.74	2008
9		Kavanadu - Chattilapadam	0.58	2010
10		Murikingal - Thaloopadam	2.01	2008
11		Mupliyam - Vellarampadam	4.9	2009
12		Kodakarakavil - Blachira Road	0.975	2011

Data pertaining to traffic volume and its composition was collected for all roads through link volume survey. It has been seen that the maximum daily traffic volume of 3,050 Passenger Car Unit (PCU) was observed at Chowkathazhoor – Chattikulam Road in Thrissur district, followed by 2,142 PCU at Kodakarakavil-Blachira Road and 1,538 PCU at Mupliyam – Vellarampadam Road. The

Murikingal – Thaloopadam Road had a daily traffic of about 783 PCU while Mattathoorkunnu-Kavanadu Road had a daily traffic of about 768 PCU.

The pavement evaluation survey was conducted on the study roads and the major distresses encountered were tabulated. The Pavement Condition Index (PCI) is a numerical indicator that rates the surface condition of the pavement. The PCI provides a measure of the present condition of the pavement based on the distress observed on the surface of the pavement, which also indicates the structural integrity and surface operational condition (localized roughness and safety).

PCI is calculated by subtracting the Corrected Deduct Value (CDV) from 100. Deduct value is defined as the value that represents the condition of the existing pavement, i.e., the amount of distress that a present pavement has undergone or is subjected to. Deduct value for each distress with different density and severity combinations were worked out. Condition of each road section can be classified based on the PCI values. The lowest possible score (0) represent a failed pavement, and the highest possible score (100) represent an excellent or new pavement condition. Based on the PCI values obtained, the study roads could be classified into failed to excellent as shown in **Table 22.**

Table 22: Classification of Study Roads

Sl. No.	Road Name	CDV	PCI Value (100-CDV)	Road Condition
1	Chawkathazhoor-Chettikulangara	64	36	Poor
2	Mattathoorkunnu-Kavanad	89	11	Very poor
3	Kundayi-Chakkiparambu	52	48	Fair
4	Murikingal-Thaloopadam	100	0	Failed
5	Mupliyam-Vellarampadam	23	77	Very good
6	Palapilly-Vellikulangara	88	12	Very poor
7	Kavanadu-Chattilampadam	0	100	Excellent
8	Kodakarakavil-Blachira	12	88	Excellent
9	Inchapuri-Cherumanjal	86	14	Very poor
10	Kurakonam - Karthikaparambu	100	0	Failed
11	Kanamppally-Chepod Road	100	0	Failed
12	Chakrapany-Chattukallumthara	62	38	Poor

Some of the roads had gone to the final stage of failure and is not able to be made serviceable with maintenance and needs to be reconstructed. Had there been routine maintenance, the roads could have lasted a bit longer and could have had a good serviceability life.

27. *Axle Load Studies for Periodically Distressed Road Stretches in Thiruvananthapuram*

At the instance of Kerala Highway Research Institute (KHRI), NATPAC carried out an axle load survey at Ch. 0/800 of the Aryanad – Palode road in Thiruvananthapuram District where the pavement has been found to be deteriorating in spite of various treatments. The study aimed at determining the Equivalency Factor of various categories of commercial vehicles passing through the location.

The methodology adopted consisted of field reconnaissance survey, traffic count survey, axle load survey, data analysis and determination of Equivalency Factor to determine an average equivalency factor (EF) for each type of vehicle in the survey.

Classified traffic count and axle load survey were carried out for a period of 24 hours at thespecified location viz., Ch. 0/800 of Aryanad – Palode road. Traffic count analysis revealed that the daily traffic through the road was 3,435 vehicles comprising of more than 2,000 two wheelers and about 450 cars. The number of trucks was 43 and number of minitrucks was 92. Axle load survey was done on sample basis.

Plate 9: Axle Load Survey

The determination of Equivalency Factor (EF), Equivalent Single Axle load (ESA) and total daily loading for each direction is shown in **Table 23**.

Table 23: Results of Axle Load Survey

Direction	Type	EF	Total Volume	ESA	Daily Loading (ESA/Day)
Aryanad to Parandode	Truck	0.3759	25	9.3982	35.1821
	Mini truck	0.1176	46	5.4074	
	Bus	0.4331	47	20.3563	
	Mini bus	0.0017	12	0.0203	
Parandode to Aryanad	Truck	0.2257	18	4.0633	25.5685
	Mini truck	0.0042	46	0.1946	
	Bus	0.4331	49	21.2225	
	Mini bus	0.0063	14	0.0882	

The total traffic through the road was found to be 2672 PCU. Analysis of axle load survey showed that the maximum total daily loading was 35.2 ESA which was found in the Aryanad – Parandode direction.

28. *Development of Thiruvalla – Puthuppalli – Kottayam (Manarkad) Combined Bypass*

At the instance of Public Works Department (NH), Government of Kerala, NATPAC prepared a project report for developing the route from Thiruvalla to Kottayam via Thenganal and Puthuppalli (**Figure 24**) to two lane standards which will decrease the cost and time for commuters. NATPAC conducted engineering and traffic surveys to improve the alignment to two lane standards.

The methodology adopted for the study includes:

i. Detailed inventory of the alignment

ii. Undertaking of traffic studies on the existing route and estimating the potential divertible through traffic on the proposed route once the new road is developed to standards

iii. Collection of soil sample from the field at subgrade level and laboratory testing of the collected samples to understand the characteristics of the subgrade

iv. Design of pavement for the new road based on the projected traffic and the subgrade strength expressed in terms of CBR

v. Topographic survey using modern survey techniques including GPS and Total Station

vi. Geometric design of the alignment to enable smooth, safe and efficient flow of traffic

vii. To prepare a cost estimate for the proposed route.

It was seen that the daily traffic flow in the links varies from 4,700 PCU to 11,200 PCU. Based on Origin – Destination (O-D) surveys, it was found out that the most likely traffic that may get diverted through the project road was 12,820 passenger vehicles and 2,501 goods vehicles amounting to a total of 17,008 PCU. Thus the route from Thiruvalla to Kottayam/Manarakadu *via* Perumthuruthy, Nalukodi, Thenganal, Vakathanam and Puthuppalli was found to be developed as a combined bypass to Changanassery and Kottayam towns. The cost for development has been worked out to be ₹ 84.50 Crores for Perumthuruthy-Manarkad section and ₹ 20.68 Crores for Puthuppalli-Kanjikuzhy section, the total cost being ₹105.19 Crores.

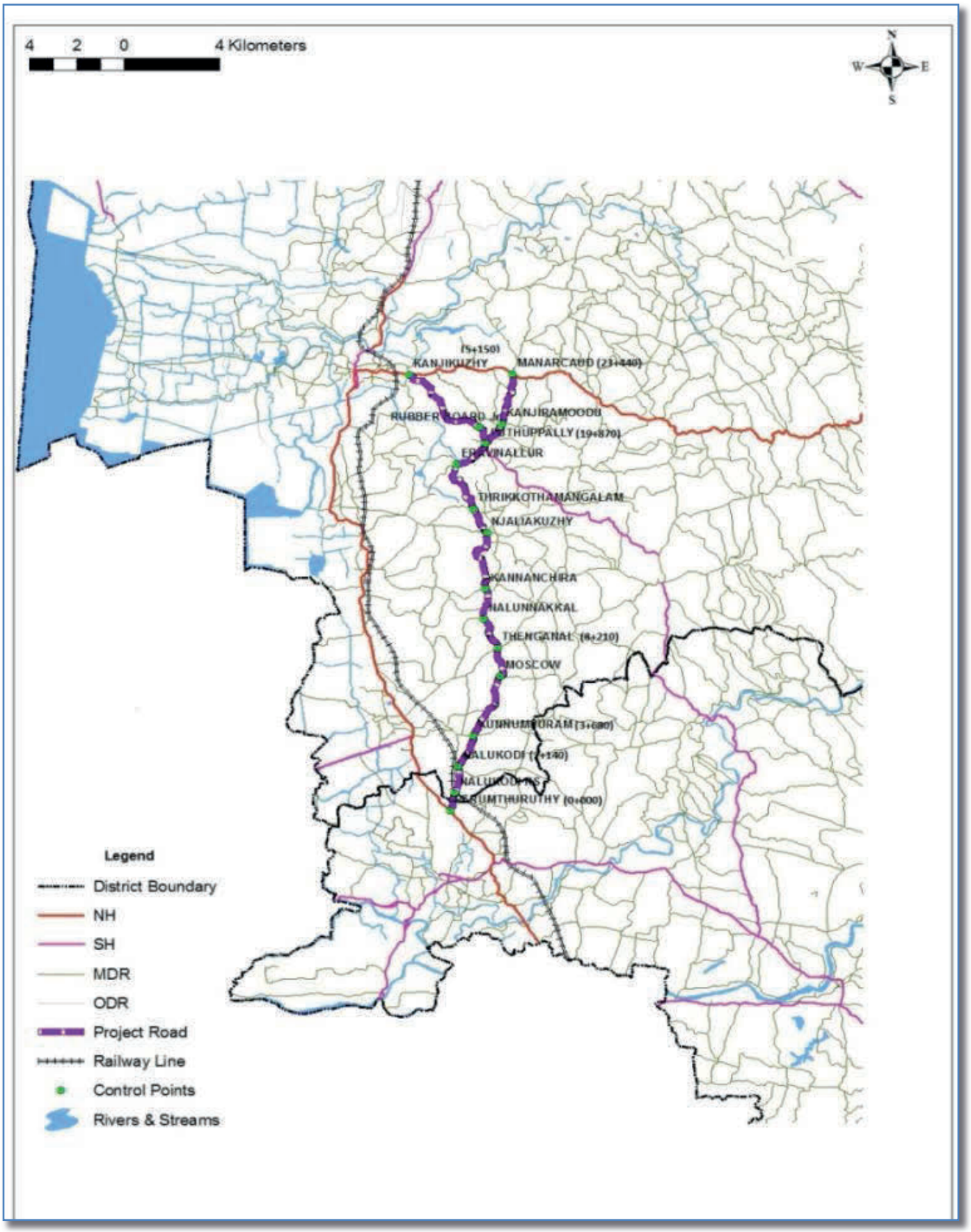


Figure 24: Map Showing the Project Road

29. Development of Outer Ring Road Between Kodungallur and Cherthala

Developments that have taken place in Kochi and its hinterland during the last two decades, show that the influence region around the city extends up to the towns of North Paravur and Kodungallur in the North-West, Angamali town (transcending the towns of Kalamassery and Aluva) in the North-East, and Cherthala town in Alappuzha district in the South. A study was conducted by NATPAC emphasizing the need of outer ring road connecting the above regions. The proposed outer ring road to the city will start from Kodungallur, connecting Angamali, Kalady, Perumbavoor, Kolenchery, Piravom, Thalayolaparambu and ends at Cherthala or Thuravoor and spread over Thrissur, Ernakulam, Kottayam and Alappuzha districts.

The study aimed at exploring the most feasible alignment for developing an outer ring road corridor between Kodungallur and Cherthala connecting the growth centres of Angamali, Perumbavoor, Kolenchery, Piravom and Thalayolaparambu in Central Kerala.

Findings

Detailed reconnaissance were done along the node points and five alternative options were identified which satisfy the requirements.

Alignment 1 - Entirely through undeveloped hinterlands

Alignment option which passes entirely through undeveloped hinterlands of Kochi City, starts near to Kottappuram bus stop on NH-66 at Kodungallur and ends on NH 66(at km 390.900 of old NH- 47) near to the X - ray junction at Cherthala having a length of 103.640 km and is passing through mixed terrain ranging from plain to hilly terrain. The civil construction cost of this option was approximately ₹ 2060 crore. LA & RR cost was ₹1320 crore when RoW was limited to 45 m and ₹1815 crore when RoW was 60m.

Alignment 2 - Improvement along the existing roads

This alignment option starting from Keezhthali Valavu junction on NH 66 at Kodungallur, passes through the existing roads connecting the node points including National Highways, State Highways, Major District Roads and Village roads and ending at X - ray Junction on NH 66 at Cherthala, having a length of about 122.07 km. The civil construction cost of this option was

approximately ₹ 2040 crore. LA and RR cost was ₹ 2916 crore when RoW was 45 m and ₹4205 crore when RoW was 60m.

Alignment 3 - New alignment with National Highway 544 and MC road

This option was a combination of alignment options 1 and 2 and is having a length of 100.365 km. The civil construction cost of the option 3 was approximately ₹ 2080 crore and LA and RR cost was ₹ 1440 crore when RoW was 45 m and ₹ 2070 crore when RoW was 60m.

Alignment 4 - Alignment through new routes

This alignment option starts from Chandappura junction on NH 66 at Kodungallur in Thrissur district where the Kodungallur bypass starts and ends at NH 66 (at km 390+900 of old NH- 47) near to the X - ray junction at Cherthala and is having a total length of 105.540 km. This alignment option passes through mixed terrain ranging from plain to hilly. The civil construction cost of option 4 was approximately ₹ 2138 crore. LA and RR cost was ₹ 1505 crore when RoW was 45 m and ₹ 1995 crore when RoW was 60m.

Alignment 5 - Entirely through undeveloped hinterlands

The possibility of an entirely new alignment that connects the node points and utilising the bridges which were under construction/proposed over the Vembanadu Lake and its tributary were analysed as an option 5 based on the comments of the meeting held at Chief Town Planner office, Trivandrum. This alignment option starts near to Kottappuram bus stop on NH-66 at Kodungallur and ends at Thuravoor junction on NH-66 (at km 378+900 of old NH-47) having a length of 96.478 km. The civil construction cost of the option 5 was approximately ₹ 1850 crore. LA and RR cost was ₹ 1350 crore when RoW was 45 m and ₹ 1825 crore when RoW was 60m.

The alignment option 1 which affects the minimum number of buildings without compromising the geometry and having minimum construction and LA and RR costs having a total length of 103.622 km was recommended for construction of outer ring road for Cochin City.

30. Evaluation of Accident Black Spots on Roads Using Geographical Information System and Remote Sensing

To compact road accidents and related deaths is an urgent need of the hour. NATPAC reviewed the accident scenario in the State of Kerala by selecting the districts that tops in road related accidents in three zones viz., South, Central and North. The accident details of the selected districts were collected for detailed study.

The purpose of the study is to:

- develop a methodology to identify and prioritize hazardous locations and to find out the most vulnerable accident stretch using past three years accident data.
- conduct road and traffic study in the most frequent accident occurring spots in the selected three districts
- analyze the road and traffic data on GIS platform to access the most vulnerable accident spots in the districts
- identify various traffic and road related factors causing accidents and suggest remedial measures to prevent accidents in future.

The methodology adopted for the study is illustrated in **Figure 25.**

The study area consists of a number of accident locations. Some of them are highly prone to accidents and that was the prime consideration for the study from a road safety perspective. For identifying such spots Weighted Severity Index (WSI) method was applied on three years secondary data. Based on WSI values, six spots in Alappuzha District and ten spots each in Ernakulam and Kozhikode Districts were identified and selected for primary data collection and further GIS analysis **(Table 24).**

Traffic and road data required for GIS analysis were collected from the identified spots. The analysis was carried out by considering eleven factors ranked based on their influence in causing an accident. Ranks for the eleven factors were aggregated and the final weights were calculated for each location.

Plate 10: Accident Black Spot identified in Ernakulam(Mulanthuruthy)

Then the prioritization was done using a prioritization scheme and the accident black spots were identified.

Kalavoor in Alappuzha district, Kalamassery and Mulanthuruthy in Ernakulam district and Elathoor and Moodadi in Kozhikode district were identified as the accident black spots.

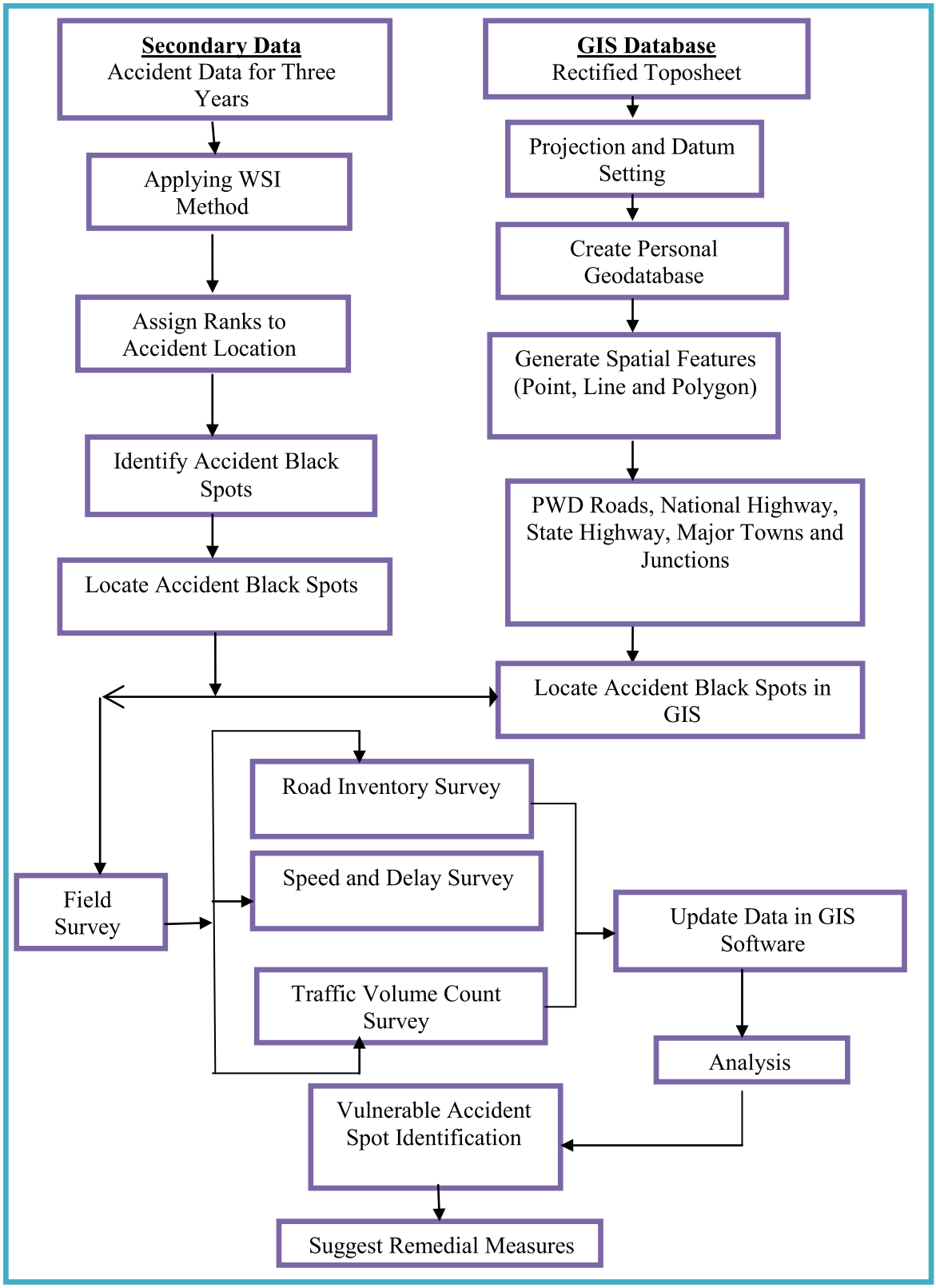


Figure 25- Methodology Adopted for the Study

Table 24: Accident Spots Identified for Study

District	Accident Spots Identified
Alappuzha	Eramalloor
	Karuvatta
	Chandiroor
	Kalavoor
	Aroor
	Purakkade
Ernakulam	Kalamassery
	Edappally
	Kakkanad
	Palarivattom
	Vyttila
	Angamaly
	Aluva
	Perumbavoor
	Karukkutty
	Mulanthuruthy
Kozhikode	Ramanattukara
	Feroke Petta
	Thondayadu
	West Hill
	Elathoor
	Koyilandy
	Vadakara
	Balusserry
	Moodadi
	Azhiyoor

From the light of the study, GIS was found to be the most powerful tool for the accident black spot analysis. Most of the accident black spots are identified along the National Highways, State Highways and PWD roads. The absence of median, deficiency of road alignment, over speed of vehicles and the distresses present on roads are the main causes of accidents in these locations. Median openings and frequent T – junctions are some of the other reasons identified. Improvement measures were suggested as per IRC guidelines to mitigate accident occurrence infuture in these locations.

Plate 11: Accident Blac Spot identified in Kozhikode (Elathoor)

31. *Integrated Rural Accessibility Planning – Micro Level Interventions in Hilly Areas of Northern Kerala*

Integrated Rural Accessibility Planning (IRAP) incorporates mobility and locality aspects of access. NATPAC evaluated the mobility needs of marginalized communities who are socially and economically backward and are residing in hilly and mountainous terrains. The Centre arrived at long term solutions, which are cost effective and labor intensive and can be implemented with initiatives under the developmental schemes of local bodies. More importance were given to intra – settlement movements, to meet subsistence based travel needs over inter settlement movements.

The objectives of the study are:

- To study the household and demographic characteristics of selected communities
- To study the socio economic characteristics that have a bearing on transportation needs of these people
- To study the existing transportation facilities especially road transport
- To suggest cost effective solutions aimed at improving mobility of people
- To suggest appropriate cost effective and labor intensive technologies and applications to improve mobility and accessibility in transportation sector locally.

The IRAP planning methodology is shown in **Figure 26.**

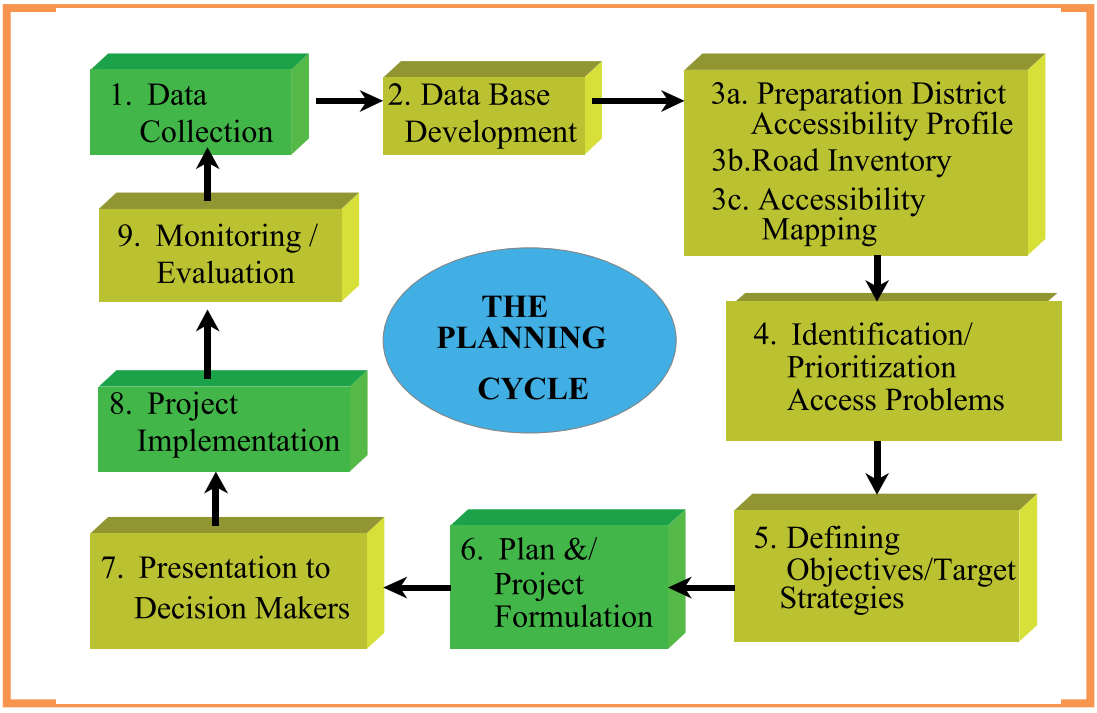


Figure 26: IRAP Planning Methodology

The recommendations suggested for improving the mobility needs of marginalized communities include:

- Accessibility improvements to trails, footpaths and trekking paths
- Introduction of appropriate transport means
- Management of services with local level participation to ensure reasonable viability

32. *Preparation of Inventory of Roads for 13 Grama Panchayaths in Kannur District*

The State Government has initiated action to revise the existing Core Network Plans for the implementation of Central Schemes like PMGSY and Bharath Nirman. The Core Network Plan prepared earlier was found to be defective due to omission of many important existing links and roads identified for new connectivity/ improvement. Of the three models considered for the purpose (Rural Development Dept. / Town Planning Dept. / NATPAC), the model presented by NATPAC was selected for adoption for the purpose.

The study aimed to develop a scientific spatial database for rural roads by involving the Grama Panchayaths. The study area for this exercise was 13 Grama Panchayaths in Kannur District and has developed up-to-date and scientific data-base (digitized spatial maps in GIS format with inventory and settlement particulars) of roads under the control of various Grama Panchayaths.

The scope of the study is limited to rural roads coming under the rural local bodies comprising of Grama Panchayaths, Block Panchayaths and District Panchayath. Within the scope, the objectives of the study are:

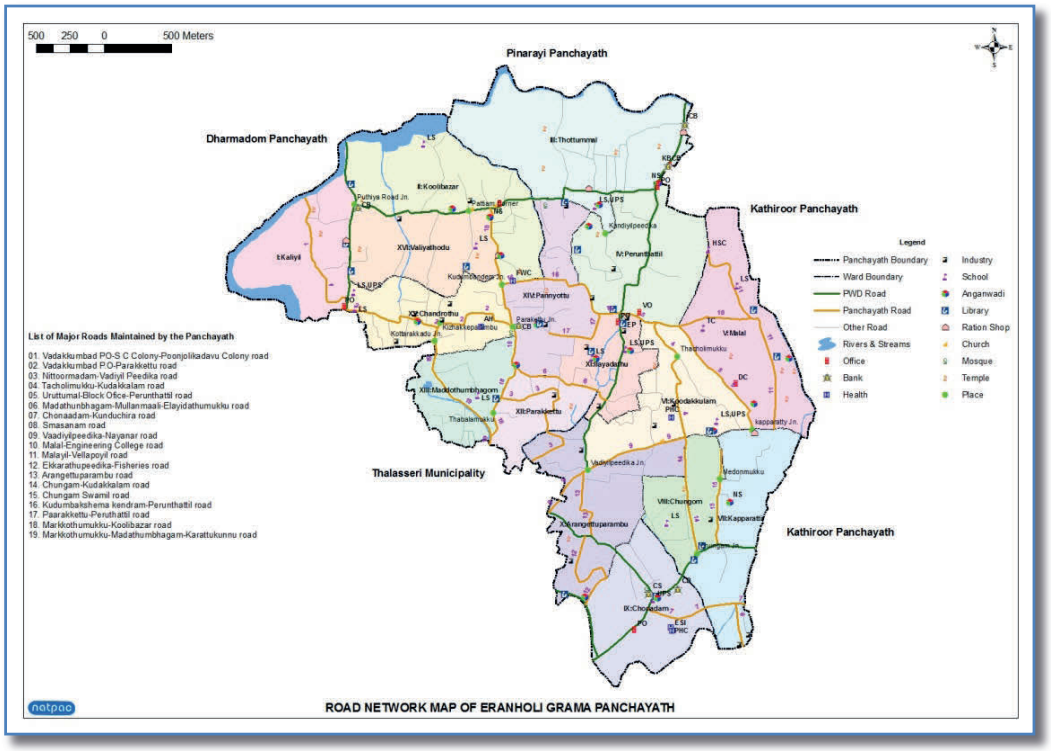
- Identification of all sub settlements (wards) within each Grama Panchayath in the study area;
- Listing of all roads passing through the settlements (all categories);
- Inventory of Grama Panchayath roads (roads having a minimum width of six metres that can be developed to motorable standards and a minimum length of 500 metres);
- Preparation of digitized road maps with supporting data for each Grama Panchayath in the GIS format.

The following data were collected from various sources:

- *Settlement level data* - sub settlement (within each Panchayath) identification, road availability, location of facilities
- *Road level data* - connecting settlements, population benefited, facilities along the road
- *Road inventory* - length, width, surface type, settlements connected
- *Road mapping* - base maps (cadastral) provided by the Kerala State Land Use Board were further modified by Digitizing, mosaicing, Geo-referencing, Scaling using GIS and development of attribute tables.

The study developed an authentic spatial database on Grama Panchayath roads together with supporting information required for the development of plan documents and rural road management system in GIS platform. Updated road details along with settlement level data can be used for the preparation of Road Development Plan required for PMGSY, Bharath Nirman or

NABARD funded road development schemes. Sample maps generated in GIS Platform is shown in **Figure 27**.



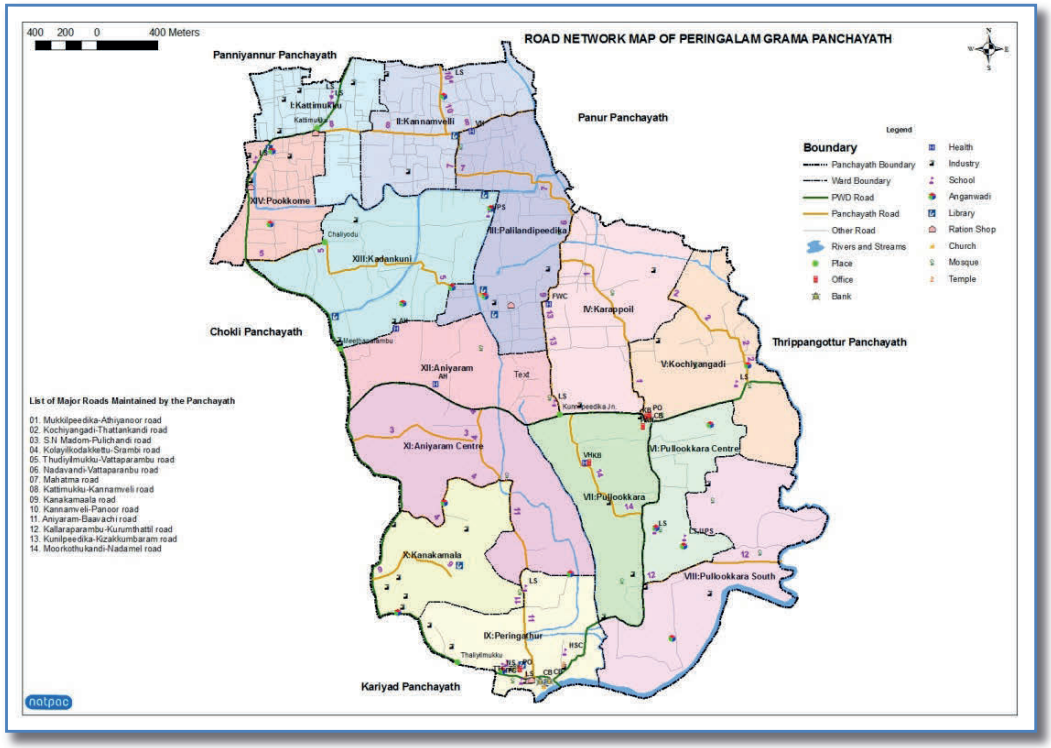


Figure 27: Road Network Maps of Eranholi and Peringalam Grama Panchayaths in Kannur District

33. *Constraints in Developing West Coast Canal in Kerala – Case Study of Selected Stretches in North Kerala*

The declaration of Kollam-Kottapuram stretch of West Coast Canal (including Champakara and Udyogamandal Canal) by Inland Waterways Authority of India (IWAI) has attracted investment to the tune of about ₹ 200 crores to the State for its development. NATPAC prepared revised Techno Economic Feasibility study for the extension of National Waterways III (NW-III) beyond Kollam in the south and Kottappuram in the north. In 2011-'12 NATPAC identified the actual status of development of NW-III and suggested necessary measures for enhancing this mode of transport.

The study was extended by NATPAC to the West Coast Canal passing through Kozhikode, Kannur and Kasargod Districts. The major constraints and anticipated difficulties in developing the waterway were identified by the Centre.

Objectives

- Identify the extent of developments undertaken with respect to physical and monetary terms by various agencies
- Identify the problems encountered during development, if any
- Study the present status of the study stretch in terms of cargo movement and suggest measures for improving the same

At present navigation in Northern Kerala is restricted to the Valiyaparambu waterways. River navigation for the purpose of passenger movement has ceased. In the Korapuzha River in Kozhikode District, house boat operation for tourists exists at present.

Nileswaram in Kasargod District and Payyannur in Kannur District are served by navigable rivers and backwaters. The State Water Transport Department of Government of Kerala operates boat schedules for meeting the travel needs of the Parasanikadavu – Valapattanam and also Valiyaparambu group of Islands. The boat service includes both ferries and also point to point services.

The stretch of waterway formed by the confluence of the Karingote, Nileswaram, Kavvayi Rivers constitute the navigation facility for the Valiyaparambu region which falls in Kannur and Kasargod districts. Presently the waterways have a number of constraints when it comes to navigation. Under water hazards in the form of rocky beds exist between Kavvayi island and Punnakkad. Boulders are strewn across the waterbed on the Kottapuram – Karyankode Jetty route. The Valiyaparambu waterway has sufficient depth across several stretches, but some stretches have sandbars and shallow reaches.

WATER TRANSPORT

The State Water Transport Department (SWTD) operates 11 schedules from Aiyitti station to various destinations such as Yedalakad, Kotti, Valiyaparambu island etc. between 0600 hrs and 1900 hrs. Besides tourist boat, house boat facilities for recreation is also available here. In the past the operation extended from Punnakad to Kottapuram where the navigation route length was 25 kms. At present due to insufficient depth the operation of boats is restricted to 20 km between Punaakkad and Mavilakadapuram. The stake nets across the waterway are also an obstacle to smooth navigation.

Kerala State has a number of rivers, backwaters, lakes etc. The potential of the waterways need to be exploited in a manner that paves the way for sustained development of the State. IWT operations in Kerala faces problems posed by shallow channels, resulting from siltation which in turn is due to deforestation in the Eastern hill ranges, and loss of water due to off take for irrigation. The encroachments of the waterway by bank side dwellers, and cross drainage structures have reduced the operational width of the canals across several stretches.

Plate 12(a) Nambiyakal Anicut (Ch.141.17 km)

Plate 12(b) View of Canal near Payyoli(Ch. 2.10 km)

Plate 12(c) Foot Bridge near Taj Hotel (Ch.167.78 km)

Plate 12(d) Mangamuzhi Lock (Ch. 5.18 km)

34. Route Network Planning of Inland Water Transport for Central Kerala

Central Kerala including Ernakulam, Kottayam, Alappuzha and Kollam Districts has a dense network of feeder canals, well connected with NW-III. Improving navigation across the canal system of Central Kerala will change the very socio-economic scenario of the region. A comprehensive planning of the water transport system will help in achieving an efficient and well integrated transport system for the region.

NATPAC assessed the utilization of waterway network for transport and identified new routes for boat trips that will help to establish an efficient and integrated transportation system within Ernakulam, Kottayam, Alappuzha and Kollam districts.

Objectives

- Assess the existing water transportation scenario in Central Kerala to obtain the details of the available waterways and its utility
- Find out the traffic pattern, demand and identify traffic potentials in terms of cargo movement, passenger and tourism
- Assess the adequacy of the existing water transportation facilities for the area and identify the constraints
- Evolve strategies for efficient utilization of the existing waterways for transport and to investigate the scope for integration with road and rail

The methodology for the study consisted of detailed survey of the waterways in Ernakulam, Kottayam, Alappuzha and Kollam Districts in order to take stock of the existing condition. The details regarding boat operation, number of trips, number of passengers, location of jetties and connectivity to road etc. were collected from primary surveys as well as sources like Tourism Department, Inland Waterways Authority of India, District Tourism Promotion Council (DTPC),

Plate 13
Chembokkadavu Foot Bridge across Edappally Canal (Ernakulam)

Plate 14
Starting of Thevara –Perandoor Canal from Perandoor Puzha

local bodies and private operators. O-D Survey and questionnaire survey were conducted for finding out the travel demand.

NATPAC prepared an integrated transportation plan including suggestions to develop the waterways so as to make them fit for navigation, by provision of navigational aids, jetties, landings and other infrastructure facilities. Proposals for integration of the waterways with other modes like road and rail etc. were also worked out so as to make the transportation system more efficient. Tourism potential of the area was studied and sustainable improvement proposals prepared (**Figure 28**).

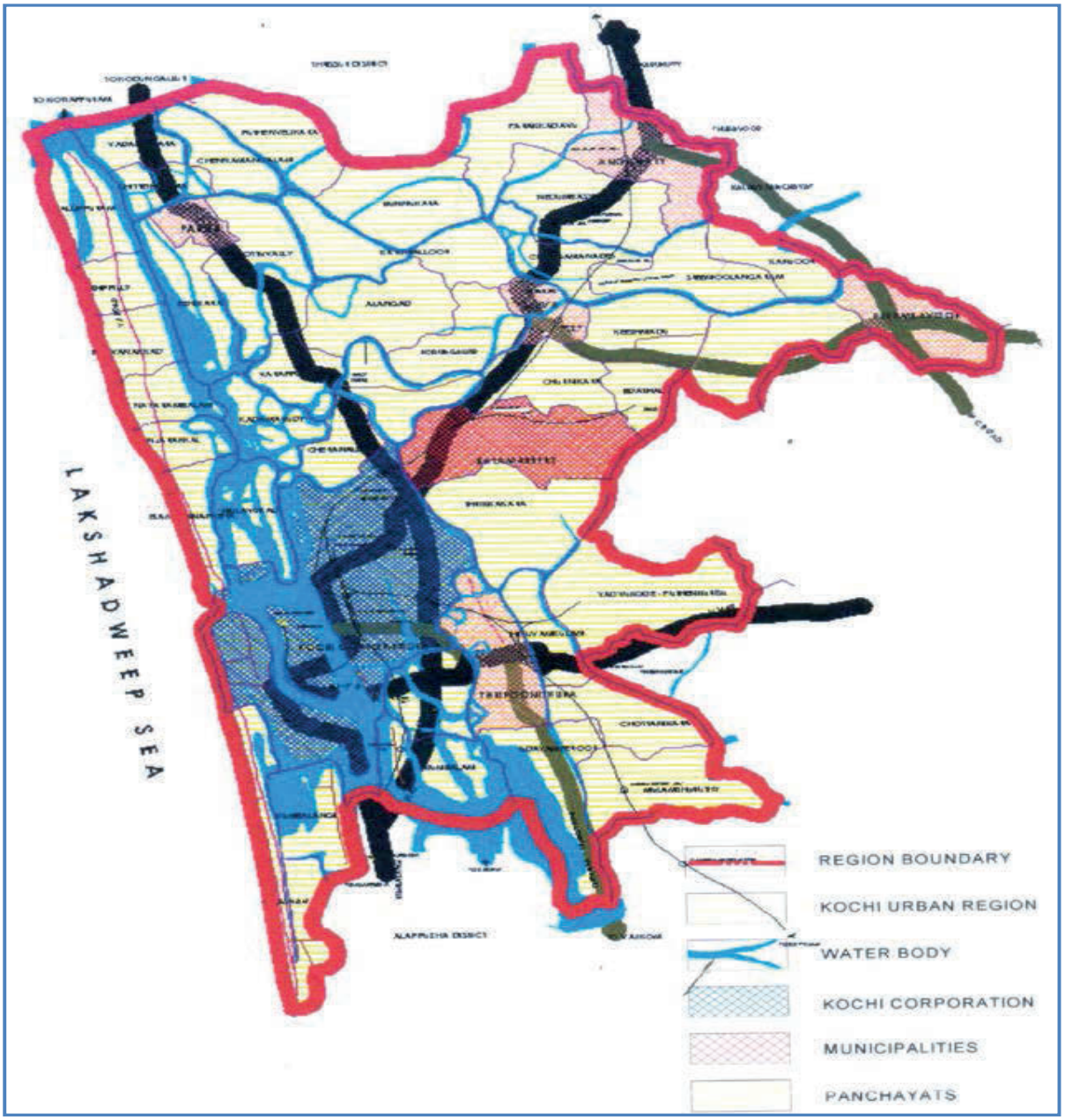


Figure 28: Map Showing Canals in Kochi CDP Area

Proposals put forward by NATPAC as part of strengthening the Waterway

1. In order to strengthen the waterway network of Alappuzha – Kottayam region a proposal has been put forward for operating a boat service between Alappuzha main station and Kumarakom via Muhamma. The proposal includes deploying a boat with facility for transporting 8 to 10 motor bikes and an equal number of bicycles.

2. The Kidangara Pallithodu road bridge on the Alappuzha - Changanassery waterway imposes a severe constraint for navigation. Both the vertical and horizontal clearance at the site of this bridge is critically below standard dimension required for navigation. The bridge needs to be reconstructed in order to ensure safe navigation across this waterway stretch.

3. The Pallinkunnam Bridge linking Pallikuttam and Pullinkunnam on the Nedumudy -Kidangara waterway which has a vertical clearance of 4 meters also needs to be reconstructed.

4. The Chalachira foot bridge across the Chalachira creek, the Pallithodu road bridge, the foot bridges at Kuttamangalam, Venattukad, Kainakary church, Kainakary West and Kuppapuram requires to be reconstructed.

5. The problems posed by the water hyacinth are severe. These aquatic plants are found in the waterways of the study area. Steps must be taken for removing these weeds

6. The boat trip between Nedumudy and Edathua take the route through Champakkulam. An alternative route to Edathua via Neerattupuram and Kidavoor is also available. This waterway route has favourable conditions for recreational boating.

An integrated transport network plan for Central Kerala will help the Government as well as private operators in the unorganized sector to efficiently plan their services. Improved water transport network will enhance the connectivity as well as economy of the region as a whole and will also result in increased tourism revenue.

35. *Details of Existing Cross Structures along National Waterway – III in Kerala*

Inland Water Transport (IWT) is globally recognized as cost effective, fuel efficient and an eco friendly mode of transportation compared to roads. The growth of Inland Water Transport is inevitable with the increased pressure on rail and road modes of transportation. At the instance of Inland Waterways Authority of India (IWAI), NATPAC studied the details of existing cross structures along National Waterway – III and suggested modifications.

NATPAC prepared database on the details of existing cross structures, electric poles, telephone poles, water pipe lines across NW-III and proposed modification with financial implication.

The NW-III in Kerala has a total length of 230 km (as per Navigational charts, IWAI) consisting of three sections:

1. West coast canal (Kottapuram - Kollam)
2. Udyogmandal canal (Kochi Pathalam bridge)
3. Champakara canal (Kochi - Ambalamugal)

Terms of references

1. Identify the type, nature, location and navigational clearances available at each structure including bridges, pipeline, electrical/telephone cables, locks etc.
2. Critically examine the adequacy of navigational clearances at these structures including horizontal, vertical, bend radii etc. for safe navigation and recommend suitable methods for its modification/re-construction etc.
3. Work out cost estimate for modification/reconstruction of each structure along with details based on State Government schedule of rates
4. Work out reasonable timeline for implementation of various recommendations
5. Justify the investment suggested with Financial Internal Rate of Return (FIRR) & Economic Internal Rate of Return (EIRR).

The methodology adopted for the study consisted of reconnaissance survey and inventory and condition survey.

For attracting a sizeable volume of cargo to the inland waterways, it is necessary to provide a safe and clear stretch of waterway devoid of any navigational hazards. Removing the obstructions like bridges, locks, electric lines and other cables will make NW – III a safer and hazard free waterway.

Rehabilitating the cross structures to 20x7 m dimension will involve an amount of ` 799 crores. The project for rehabilitation of all cross structures falling below 40x7m when upgraded will

involve a cost of ₹ 1,254 crores. The rehabilitation project is proposed to be implemented in three phases, 1-5 years, 5-10 years and 10-15 years.

The economic feasibility study shows that the project under which the entire cross structures will be upgraded to 20x7 m is viable from the economic point of view. The project which involves rehabilitation of all cross structures to 40x7 m dimension falls below the feasibility zone. The financial feasibility analysis indicates that in 25 years of operation, the project FIRR is 30.87%, and the equity FIRR is 42.44%. The average depth coverage ratio is 3.68%.

Cost of Improvement

The total cost of improvement of NW –III is shown in **Table 25.** The cost has been worked out based on the prevailing Schedule of Rates for Kerala.

Table 25: Total Cost of Improvement of NW –III

Sl. No.	Item	Total No.	No. to be reconstructed	Total Cost (in ₹ Crores)
Kottappuram Kollam Section				
1	Road Bridge	18	7	258.51
2	Foot Bridges	4	2	1.50
3	Railway Bridge	2	2	60.51
4	Lock	3	2	107.00
5	Electric line	LT – 64 ,HT - 11	LT – 63, HT - 3	1.62
			Total	429.14
Champakkara Canal				
1	Road Bridge	**10**	**8**	194.24
2	Pipeline Bridge	**4**	**3**	3.96
3	Railway Bridge	**6**	**5**	78.47
4	Electric line	**LT – 9, HT - 17**	LT – 8, HT - 10	1.36
			Total	278.03
Udyogamandal canal				
1	Electric line	**LT – 5, HT - 2**	LT – 5, HT - 1	22.00
			Total Cost	729.17

There are seven bridges in Kollam - Kottappuram section and eight bridges in Champakkara canal, which is to be reconstructed following the standards of NW-III. The major share of cost of development goes for improvement of road bridges with estimated cost of ₹ 452.75 crores. Another important item is the construction of Thanneermukkom and Thrikkunnapuzha locks with estimated cost of ₹ 107 Crores. Railway bridges are one of the main obstructions in waterway with less navigational clearances and the cost of reconstruction is ₹ 134.98 crores. Less clearance for electric lines makes it more dangerous and the cost for modifications of electric lines and other cables are ₹24.98 crores. The total cost for improvement is ₹ 729.17 crores.

36. Improvement of Kovalam – Channankara Stretch of T.S.Canal

Water Transportation has several advantages namely sustainable means of transport, better mechanism for flood control, preservation of ecosystem, enhancing the recreational activities and tourism potential of the region, besides decongestion of heavily trafficked corridors in the city. A study was taken up to improve Kovalam – Channankara Stretch of the T.S canal in Thiruvananthapuram District for enhancing inland navigation, tourism and recreational purposes (**Figure 29**).

Objectives

- Conduct inventory on canals
- Conduct inventory on roads to obtain details like type, width and condition of roads, its accessibility to canal and constraints (if any)
- Identify sources of water pollution and solid waste
- Assess the water and sediment quality of the canal
- Suggest the improvement methods for road connectivity to canal and side protection measures
- Suggest suitable modifications of cross structures like bridges, foot bridges, culverts, pipeline etc.
- Suggest appropriate methods for disposal of sewage, municipal solid waste, industrial effluents etc.
- Suggest suitable options for funding the project and prioritization of schemes for implementation

The methodology adopted for the study consisted of secondary data collection, reconnaissance, inventory and condition surveys, environmental survey to assess environmental status and issues, hydrographic survey using ultra sound technique, identifying development proposals to make the canal navigational and estimation of project implementation cost.

The total length of the study section is 28.98 kms. Missed links were observed at Chainage 1.67 km and 2.75 km and the lengths are 172m and 298m respectively. The estimated dredging and cutting quantities are 938535 m^3 and 900204 m^3 respectively. There are total 32 existing cross structures which consist of 20 road bridges, 3 rail bridges and 8 foot over bridges. The entire cross structures are not within the permissible limits of NW – III standards. Bank protection is

needed for 4.53 kms and for that random rubble masanory type is recommended. Water sample was collected from various locations along the study stretch. The physical, chemical and biological parameters were analysed and it was found that the water stagnation, weed growth and other existing wastes in the canal caused the higher levels of pollutants and this can be rectified by providing sewage pipeline and suitable solid waste disposal methods like incineration, land filling and composting.

The estimated cost for improvement of Kovalam-Channankara canal is ₹ 150.83 crores. This includes earth work, dismantling/reconstruction of cross structures, construction of bank protection etc. for inland navigation with NW –III standards.

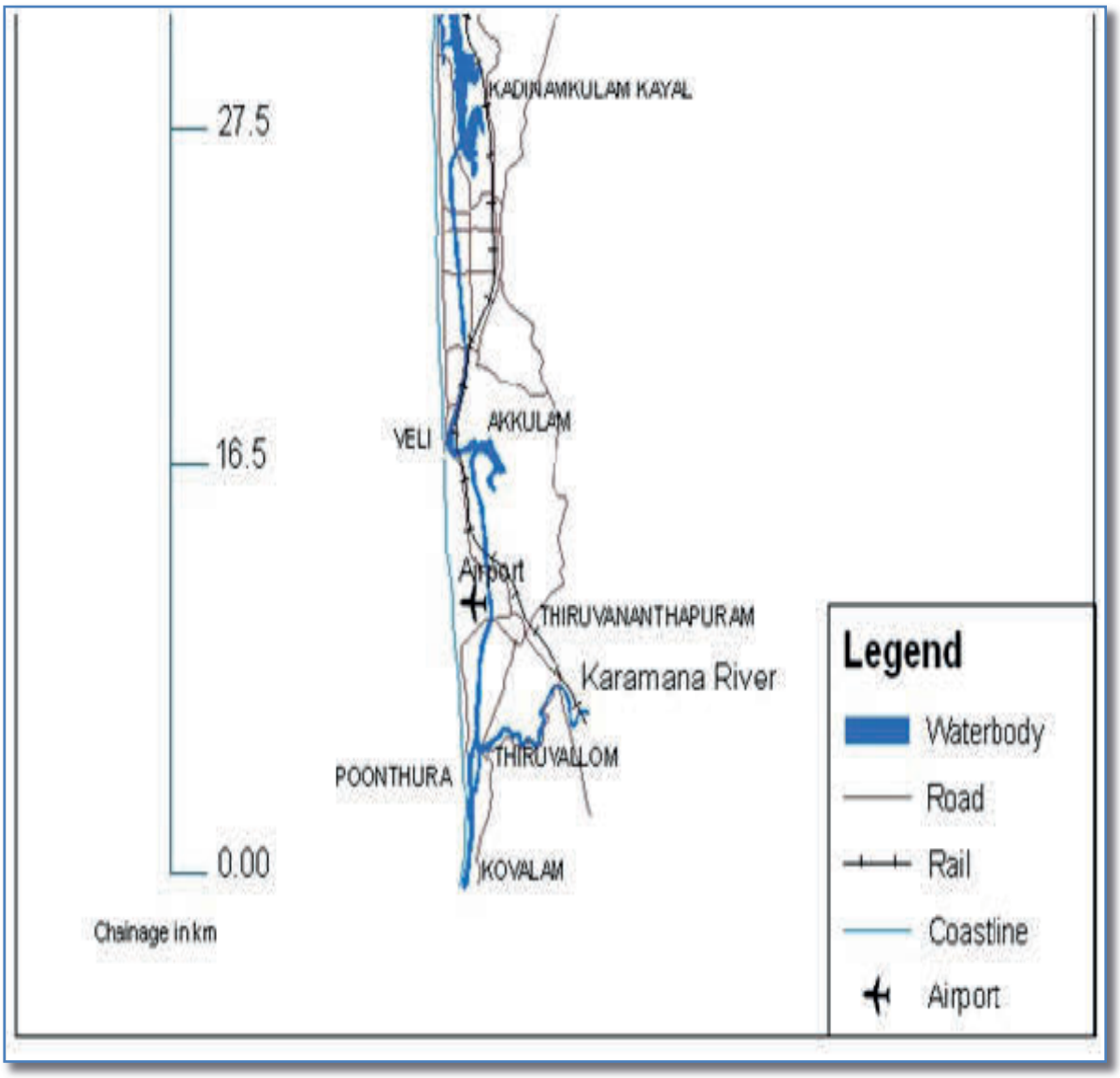


Figure 29: Map of Kovalam-Kadinamkulam Stretch of TS Canal in Thiruvananthapuram District

37. *Revival of Inland Canals and Waterways in Kerala-Case Study of Selected Canals*

The Inland Water Transport (IWT) system in Kerala can be revived for the movement of freight, passenger and tourist traffic. It is necessary in the present scenario of our growth to utilize the vast networks of waterways and navigable canals to reduce the pressures on the traffic system. It will help to provide an integrated mass and rapid transport network for all over Kerala. Development of IWT is essential not only for inland navigation but also to harness the enormous potentials in other sectors of the economy.

NATPAC identified the canals which have the potential for solving the transportation problem and suggested measures for rehabilitation and for making it suitable for navigation.

Objectives

- To study the present condition of the waterways identified
- To suggest measures for enabling navigation application across the waterway
- To estimate the cost for rehabilitation of the waterway
- To estimate the benefits to the local community

The study region consisted of the region falling within the districts of Ernakulam and Thrissur

The canals and waterways identified as a part of the study were Anapuzha Canal, Paliam canal, Gothurth Canal, Paravur Market Canal, Kottapuram Market Canal, Kottapuram Vijayan Canal, Sringapuram Canal, Thiruvanchikulam Canal and Kavilkadavu Canal.

A detailed survey was conducted on these canals and the present situation was assessed. New proposals were prepared to develop the waterways giving emphasise to tourism and passenger transport. Required amenities for these purposes are also proposed. A detailed plan for improvement of the canals were prepared after studying the requirements in each location and the cost estimate was prepared for each items. The economic benefits due to the improvement of the canal and waterways were quantified into monetary units.

38. *Extension of National Waterway No.III towards North of Kottappuram and South of Kollam*

NATPAC has been authorised by Inland Waterways Authority of India (IWAI) for conducting a techno-economic feasibility study for the extension of National Waterway III up to Kasargod in North and Kovalam in South. The waterway is divided into three stretches. The Kollam-Kovalam reach of the West Coast Canal is having a length of 80.67 km. The section from Kottappuram to Vadakara runs almost parallel to the sea and NH-17 and the canal section extends to 220.40 km. The Vadakara – Kasargod reach of the West Coast Canal is having a length of 175.00 km.

The major navigation bottlenecks in the Kollam - Kovalam Stretch are the two tunnels at Varkala. Narrow and shallow canals, cross structures with low clearances including aqueducts and locks are the major bottlenecks in Kottappuram - Vadakara and Vadakara - Kasargod sections. The Canoli Canal needs widening. Since the extension of NW-3 to Kovalam and Kasaragod should pass the design vessel of NW-3 for economical operation, improvement of the canal as per the present existing width of NW-3, ie., 32 m bed width in narrow sections and 38 m bed width in wider sections have been considered. The depth of water adopted for calculation of quantities is 2.2 meters and under water slope of 1:2.5 is considered.

The quantities of dredging, bank protection and other developments are calculated based on the data collected through inventory survey. As per the proposed Inland Water Canal classification all the bridges having horizontal clearance less than 32 m (2 spans of 16 m) and vertical clearance less than 5.0 m are proposed to reconstruct along with development of approach road.

The size of design vessel is taken as 50 meters overall length, 8.5 meters moulded breadth for self propelled barges of 500 tonnes Dead Weight Tonnage. For safe operation of this vessel two parallel lock chambers with length 82 m, width 12 m and vertical clearance of 7m and 40 m length 6.5 m width and vertical clearance of 7m is required. Similarly all locks which do not have these dimensions are proposed to be reconstructed. Eight locks to be constructed in Kottappuram - Vadakara section and one lock to be constructed in Kollam - Kovalam section. Nine locks are to be constructed in Vadakara - Kasargod section. The 50 m width of land for cquisition has been calculated based on the additional width

a required to develop the canal to have a base width of 32 m in narrow sections and side slope of 1:2.5. Wherever widening isrequired, the actual number of structures is considered by observation to be compensated. In the portions of missing links, structures are to be compensated and dismantled. In selection of terminals, the locations identified in the previous studies and the traffic projection of the present study was considered. Terminal facilities are proposed at:

- Kasargod, Hosdurg, Taliparambu, Kannur and Thalassery in Vadakara - Kasargod section
- Vadakara, Kozhikode, Thirur, Ponnani, Chavakkad and Kandassankadavu in Kottappuram - Vadakra section and
- Thiruvananthapuram, Chirayinkil in Kollam - Kovalam section

Phasing of various activities of canal development, fleet acquisition, terminal operation and maintenance of these facilities along with policy guidelines for revenue collection, realizing IWT traffic and creation of training facilities were discussed in detail.

The total cost for extending the NW- 3 towards North up to Vadakara and towards South up to Kovalam works out to Rs. 3188.07 crores and from Vadakara up to Kasargod works out to be Rs. 1647.702 Crores.

The procedures for conducting economic and financial feasibility analysis involved deriving a design volume of cargo for each of the waterway stretches. The economic feasibility analysis of the investment on Vadakara - Kasargod section at 20% cargo diversion the EIRR is 4.42% which falls below the critical minimum. However with a 40% cargo the EIRR is 14.96%. The EIRR of investment on Kollam - Kovalam and Kottappuram - Vadakara stretch with 20% cargo diversion is 4.42%, which falls below the critical minimum of 8 to 10%. However with a 40% cargo diversion the EIRR is 14.96%.

By virtue of the higher EIRR the Kottappuram – Vadakara stretch has an advantage over the Varkala –Kozhikode stretch. However based on the criteria of the number of cross structures to be demolished the Varkala – Kozhikode stretch has an edge over the Kottappuram-Vadakara stretch. Reconstruction of cross structures stands as a stumbling block against waterway development, hence this criteria was adopted for selecting a viable stretch. Recommendations are in favour of developing the Kottappuram – Kozhikode waterway stretch on a first priority basis.

39. *Identification of Accident Prone Locations and Improvement Measures in Northern Kerala*

The study aimed at delineating accident locations in National Highway 212 and National Highway 17 in Northern Kerala. NH 212 connects Kozhikode with Wayanad and further traverses to Kollegal in Karnataka. The road is an inter-state corridor. National Highway 17, the most arterial corridor of Northern Kerala links Cochin with Panavel in Maharashtra. NH 17 is now undergoing new developments including the commissioning of final phases of bypass for Kozhikode city. Safety Auditing of the accident prone locations has been carried out to prepare improvement plans for accident prone locations.

Accident details pertaining to the past three years were collected and analysed the accident causative factors for evolving a suitable methodology to identify the accident prone locations. A micro-level analysis of the accident prone locations has also been carried out to work out improvement measures for accident prone locations.

The data pertaining to accident frequency and characteristics, geometric features of the road and traffic data were collected. The data was analysed using Quantum of Accident Method and Accident Risk Index (ARI) to identify the accident black spots.

Each section of the road were analysed by using the above three components. Total score of each section has been computed. Higher the total score, higher is the accident proneness, which varied between 0 and 100. Road sections having a score more than 90 were given priority in improvement.

Improvement measures suggested for accident prone locations include:

- Improvement of the sight distance by removing on- street parking
- Installation of signals at the side roads and control of traffic
- Relocation of bus stops and auto parking from the junction
- Improving the sight distance and vertical geometry at curves
- Control of speed of vehicles by traffic calming techniques
- Provision of signages, road markings and guard rails to guide the motorist during night time drive.

Identification of accident prone locations and improvement measures in NH 212 & NH 17 will be useful to Public Works Department (NH) and Local authorities including District Administration, Police, Motor Vehicle Department and Stakeholders in implementing road safety measures.

40. *Effect of Speed Restriction Measures on Road Safety and Level of Service*

Speed is a causation factor in around one third of fatal accidents and it is an aggravating factor in the severity of all accidents. Imposing speed restrictions like installation of speed breaker, check barriers, rumble strips, narrowing the road space etc. are commonly adopted speed reduction measures. Large number of speed breakers so constructed in the country does not follow any standards and the design is based on forcing the vehicles to slow down as much as possible. Though speed breaker on highways is not advisable as per the guidelines of MORTH, the Police and Local authorities are unsuccessful in curbing this practice due to local pressure. Speed breakers cause discomfort to the motorists and the fellow passengers and can be dangerous if not seen early enough. In such a scenario, it becomes necessary to look at the issue in a scientific manner and evolve traffic calming techniques that suit both the local conditions and the need of people. It is in this context, a research study to analyse the effect of speed control measures on the safety and level of service was taken up.

Scope and Objectives

The aim of the study was to evaluate various speed control measures followed in India and its impact on road safety and level of service of the road. The scope of this study was confined to Vizhinjam- Kaliakavilai section of road (26 km) in Trivandrum district.

In the study section, there are 13 locations where speed restriction measures are put up. Out of these there are 7 rumble strips and 6 speed humps. Other than speed humps and rumble strips, reflectors are put up in a row of three layers across the road for restraining over speeding of vehicles. The speed limit assigned on the study stretch considered was 40 kmph .

The objectives of the study are the following:

- To identify the road sections where speed control measures are in force
- To assess the effect of speed control measures on the level of service
- To conduct before and after effect accident analysis of the identified road sections where speed control measures are enforced

- To assess the effectiveness of speed restriction measures on the section by using a micro-simulation tool called VISSIM
- To recommend appropriate guidelines on speed management measures in Kerala.

Findings

A Scientific assessment of the impact of speed restriction measures enforced along the Vizhinjam- Kaliakavilai section of coastal Highway in Thiruvananthapuram district was carried out and the salient findings of the study is given below:

- Motor vehicles ply at desired speed in the straight sections and it suddenly gets reduced at hump sections. From the spot speed analysis, the speed at straight section is twice that of the speed near the humps
- Field experiments on passing vehicles have shown that statistically significant relationships could be established between hump-crossing speeds and hump geometry characterized by area to width ratio. These relationships provide a useful tool for field engineers to design hump geometry for speed control
- Average speed of the entire section is 40 kmph and the speed gets reduced at the sections having speed restriction measures. Speed hump has no effect in the reduction of average speed in the entire section
- From the analysis, it is clear that travel time increases by 10 to 20 seconds more in the section having speed restriction measures than those section without speed breakers
- From the accident analysis, it is clear that there is no significant reduction in the number of accidents reported in the section with the installation of speed breakers. Although more traffic is attracted to this stretch, there is evidence to prove that speed control measures resulted in improved safety.

41. Safety Auditing of Public Transport System in Kerala

Public transportation services are the way to transport large number of passengers at a relatively low cost on a relatively fixed route at scheduled times. Road transportation is one of the major modes among public transportation. Buses, the mode of public transportation system through roads comprise two types: Stage carriages and Contract carriages.

In 2011, KSRTC buses were involved in 1,368 accidents out of which 222 people were killed and 1,167 were injured and private buses were involved in 4003 accidents. It is in this context, a research study to analyse the causes and related factors of bus accidents in detail and safety aspects of bus passengers was taken up.

Scope and Objectives

- To study the accident trend in Kerala
- To analyse the accidents pertaining to KSRTC, private and institutional buses
- To study safety practices of different type of public transport buses
- To analyse the safety attitude of bus drivers and bus conductors
- To study the bus condition with respect to safety of passengers
- To carry out an inter – firm analysis by comparing the performance of KSRTC with other State Transport Undertakings (STUs) in India
- To carry out an intra – firm analysis by comparing the performance of different units of KSRTC and
- To suggest improvement measures for improving the safety of public transport buses

The methodology adopted for the study consisted of primary and secondary data collection to study the accident situation in Kerala, sample survey of buses, analysis of bus transport system in Kerala and safety auditing of bus stations, bus stops, bus condition and crew behaviour.

The study was conducted in two Districts, Thiruvananthapuram and Kozhikode. The present condition of bus depots, bus stops, driver and conductor behaviours and condition of buses in Thiruvananthapuram and Kozhikode is well revealed. Majority of bus stations had inadequate facilities and the condition of buses was also poor. The bus stops in Thiruvananthapuram District compared to Kozhikode District were miserable.

Most of bus accidents occur due to brake failure and axle breakdown, so mechanical condition of buses should also be considered. Implementation of efficient traffic control system by strict enforcement of traffic rules and regulations can reduce road accidents especially bus accidents. These will certainly help to improve State Road Transport Corporation, thereby improving the road safety conditions.

1 International Level Cross Awareness Day

NATPAC observed the 'International Level Cross Awareness Day 2012 (ILCAD)' on 7th June 2012 at Sasthra Bhavan, Thiruvananthapuram. The purpose of the programme was to educate the public on the risks involved in crossing unmanned crossings and make them understand the potential hazards. The programme was formally inaugurated by Shri.Aryadan Mohammed, Hon'ble Minister for Power and Transport, Government of Kerala.

Plate 15
Smt.B.G.Sreedevi, Director, NATPAC welcoming the participants at the inaugural session of ILCAD

Plate 16
Inauguration of ILCAD by Hon'ble Minister for Power and Transport, Govt. of Kerala

The Programme was attended by Prof.V.N.Rajasekharan Pillai; Executive Vice President, KSCSTE, Shri.C.P.John; Member, State Planning Board, Kerala, Shri.Rajesh Agarwal; Divisional Railway Manager, Thiruvananthapuram Division, Shri.M.N.Prasad; Former Chairman, Railway Board, Government of India, Officers representing various departments and students from Schools and Colleges in the Region.

Hon'ble Minister for Power and Transport also released NATPAC's three leaflets on "*Railway Safety*" and two booklets on "*Road Safety*".

Plate 17(a)

Plate 17(b)

Releasing of the leaflets and booklets

In the technical session that followed, presentations on "Safety Aspects of Unmanned Level Crossings" were made by Shri.T.K.Selvan; Senior Divisional Safety Officer,

Thiruvananthapuram Railway Division and Dr.Mahesh Chand; Head, Traffic Safety Division, NATPAC.

Plate 18(a)
Presentation by Dr.MaheshChand, Head Traffic Safety Division

Plate 18 (b)
Presentation by Shri.T K Selvan, Senior Divisional Safety Officer, Thiruvananthapuram Railway Division

The Programme resulted in lively discussion on various issues related to safety at level crossings. Reducing the number of unmanned level crossings, building more Rail Over Bridges and under passes in the State and conducting awareness programmes on a continuous basis to reduce the number of accidents were highlighted during the feedback session.

2 *National Seminar on Transport Vision Kerala-2030*

NATPAC organised a two day 'National Seminar on Transport Vision Kerala -2030' on 20th - 21st August 2012 at Thiruvananthapuram. The aim of the Seminar was to have wider consultation of Transport Development and to evolve Transport Vision Kerala 2030. The focus of the Seminar was to deliberate on the present transportation development, its shortfalls and deficiencies and to assess future transportation requirements of Kerala and recommend a 'Multi-model Transportation System' for Kerala. The National Seminar was inaugurated by Shri.Oommen Chandy, Hon'ble Chief Minister of Kerala on 20th August 2012 at Thiruvananthapuram.

Plate 19(a) *Plate 19(b)*
Inauguration of National Seminar on Transport Vision Kerala 2030 by Hon'ble Chief Minister of Kerala

The Seminar was attended by Shri.Aryadan Mohammed; Hon'ble Minister for Transport and Power, Shri.K.Babu; Hon'ble Minister for Fisheries, Ports and Excise, Shri.P.J.Joseph; Hon'ble Minister for Water Resources, Shri.V.K.Ebrahim Kunju; Hon'ble Minister for Public Works, Shri.M.A.Vahid; MLA, Shri.K.Muraleedharan; MLA, Prof.V.N.Rajasekharan Pillai; Executive Vice President, KSCSTE, Government Secretaries, Divisional Railway Manager; Thiruvananthapuram, Decision-makers, Transportation Planners, Experts in logistic and transport sector, service providers, senior Government Officials and Stakeholders in the Transport sector.

In the technical session that followed, presentations in the areas of Transport Development, Road Safety, Coastal Shipping, Water Transport and Air Port Development were made.

Plate 20
Presentation by Shri. T.Balakrishnan, CMD Kerala High Speed Rail Company Ltd.

Plate 21
Presentation by Shri. T.P.Senkumar,IPS, ADGP & Intelligence, GoK

On the whole nearly 200 participants representing the Departments of PWD, Tourism, KSRTC, Kerala Road Safety Authority, Kerala High Speed Rail Company Ltd., Kerala Shipping and Inland Navigation Corporation, Cochin International Airport Ltd., Town Planning, LSGD Institutions, Police, Motor Vehicle Department, Planning Board, IWAI, KSTP, NUALS; Cochin, KRFB, Harbour Engineering Department, KSUDP etc., participated.

Eminent persons who addressed the meet include: Shri.M.N.Prasad; Former Chairman, Railway Board, Shri.T.P.Senkumar; ADGP & Intelligence, GoK, Shri.K.G.Mohanlal, IFS; CMD, KSRTC, Shri.K.S.Balasubramanian, IPS; State Road Safety Commissioner, KRSA, Shri.T.Balakrishnan; CMD, Kerala High Speed Rail Company Ltd., Shri.K.Mohandas; Chairman, Kerala Shipping & Inland Navigation Corporation, Shri.V.J.Kurian, IAS; MD, Cochin International Airport Ltd., Shri.R.M.Nair; Former Member, IWAI, Shri.Rajesh Agrawal; Shri.P.H.Kurian, IAS; Principal Secretary, GoK, and Dr.K.Balakrishnan; Director, NUALS, Cochin.

Plate 22. View of the participants

Posters depicting the achievements of NATPAC and its Publications on Road Safety were exhibited. Experts who attended the Seminar recommended that the road network comprising of Expressways, Modern National Highways, State Highways and District Roads should be developed in an integrated and time bound manner. A multi-modal form of transport development, minimizing the number of personal vehicles by giving priority to public transport system and financial strengthening of public transport undertakings such as the KSRTC were among the various recommendations emerged at the conclusion of the Seminar.

3 Panel Discussion on Coastal Shipping and Inland Water Transport

NATPAC organised a 'Panel Discussion on Coastal Shipping and Inland Water Transport' on 14th November 2012 at Ernakulam as a follow up of National Seminar on Transport Vision Kerala -2030. Dr. Jacob Thomas IPS, Director of Ports, Government of Kerala presented the lead paper.

Plate23.
Dr.Jacob Thomas IPS presenting the lead paper in the panel discussion on Coastal Shipping and Inland Water Transport

Plate 24
Panel discussion in progress

Participants representing the Departments of CUSAT, Indian Maritime University, Kochi Port, Central Marine Fisheries Research Institute (CMFRI), Central Institute of Fisheries Technology (CIFT), Central Institute of Fisheries Nautical and Engineering Training (CIFNET), Shipping Agents Association etc. participated.

4 *Road Safety Week – 2013*

NATPAC observed 'Road Safety Week – 2013' by organizing a series of activities from January 1-7, 2013. The programme was sponsored by Kerala Road Safety Authority. Activities during the road safety week included:

- Road Safety Awareness Programme for various Departmental Staff on 2nd January 2013. The programme was inaugurated by Shri.V.K.Ebrahim Kunju, Hon'ble Minister for Public Works, Government of Kerala at Sasthra Bhavan, Pattom, Thiruvananthapuram.

Plate 25
Smt.B.G.Sreedevi, Director, NATPAC welcoming the participants

Plate 26
Inaugural Address by Hon'ble Minister for Public Works, Govt. of Kerala

Plate 27
Class on 'Road Accident Trends and Causative factors in Kerala' by Dr.Mahesh Chand, Scientist-G and Head, Traffic Safety Division, NATPAC

Plate 28
View of the participants

- Road Safety Awareness Programme for School Students at selected schools.

1.	Sree Saraswathy Vidyalayam, Ooruttambalam	-	03.01.2013
2.	Govt. U.P.School, Poovachal	-	03.01.2013
3.	Arya Central School, Pattom	-	04.01.2013

Plate 29
Class on 'Pedestrian Safety', by Smt.Brinda Sanil, AMVI, Thiruvananthapuram in the Road Safety Awareness Programme at Arya Central School

Plate 30
Students at Arya Central School listening to class on 'Road Safety'

- Panel Discussion on 'Pedestrian Safety' at Sasthra Bhavan, Pattom, Thiruvananthapuram on 4th January 2013. The programme was inaugurated by Smt.Remani.P.Nair, District Panchayath President, Thiruvananthapuram. The discussion was moderated by Shri.N.T.Nair, Consultant, Knowledge House & Microprocessor based pedestrian system developer. The main objective of the Panel Discussion was to allow participants of diverse professional background to share their perspectives and actions needed for enhancing Road Safety in the State of Kerala.

Plate 31
Inauguration of Panel Discussion on Pedestrian Safety' by Smt.Remani P Nair, District Panchayath President

Plate 32
Shri.N.T.Nair giving his opening in the pannel discussion on `Pedestrian Safety'

- Road Safety Awareness Programme for School Bus Drivers at Sasthra Bhavan, Pattom, Thiruvananthapuram on 5th January 2013. The programme was inaugurated by Shri.K.Muraleedharan, M.L.A.

- Painting and Elocution Competition for Students at Sasthra Bhavan, Pattom, Thiruvananthapuram.

Plate 33
Painting Competition

Plate 34
Elocution Competition

- Exhibition of banners with Road Safety Slogan at different locations in Thiruvananthapuram District.

NATPAC Regional Office, Kozhikode organised the following programmes as part of Road Safety Week - 2013.

i. District level inauguration of 'Road Safety Week -2013' on 1st January 2013.

ii. Distribution of road safety literature on 2nd January 2013 at Karanthur, Kunnamangalam in Kozhikode.

iii. Road Safety Awareness Programme for Students on 3rd January 2013 at Govt. Model Model High School for Boys, Kozhikode and Seva Sadan Higher Secondary School, Ramanattukara, Kozhikode.

Plate 35
Inauguration of Road Safety Awareness Programme for Students at Seva Sadan HSS by Shri T T Hamza Koya, President, Ramanattukara Grama Panchayath

iv. Road Safety Awareness Programme for Students on 4th January 2013 in Wayanad District.
    - St.Marys' Higher Secondary School, Sulthan Bathery
    - Green Valley Public School, Moolankave, Noolpuzha Panchayath

v. Distribution of road safety literature on 5 -6th January 2013 at major transport terminals in Kozhikode city.

vi. Distribution of road safety literature on 7th January 2013 at NH 17 bypass Toll Plaza, Azhinjilam in Malappuram District.

Plate 36(a)

Plate 36b)

Distribution of road safety literature at NH 17 bypass Toll Plaza in Malappuram District

5 *Safe Community Programme for Panchayaths*

The 'Safe Community Programme for Panchayaths' has been designed by NATPAC with the intention of adopting the zero-accident policy. NATPAC in association with Kerala Road Safety Authority organised the State level inauguration of Safe Community Programme for Panchayaths (SCP) at Pallichal Panchayath on 3rd August 2012. The programme was inaugurated by Shri.Stephen, Joint Transport Commissioner and addressed by Shri.K.Rakesh, President, Pallichal Panchayath and Shri.S.Noohu, Deputy Director, Panchayaths.

Plate 37
Inauguration of the SCP by Shri.Stephen, Joint Transport Commissioner

Plate 38
Class by Dr.Mahesh Chand, Scientist-G, NATPAC

The second programme was organised at Vakkom Panchayath on 8th September 2012. The programme was inaugurated by Shri.Alex Paul, Joint Transport Commissioner.

Plate 39
Inauguration of the SCP by Shri.Alex Paul, Joint Transport Commissioner

Plate 40
View of the participants

The programme included training session on various aspects of road safety and interactive sessions. Participants representing Panchayath including Anganvadi Teachers, Health Workers, Head Masters of Schools, representatives of voluntary organizations, Kudumbasree, Asha Workers, Staff of Engineering section of Panchayath etc., participated.

The programme is aimed at creating a community partnership that will reduce injuries in the community and make an area safe to live and work.

6 *Safe Road to School*

NATPAC in association with Kerala Road Safety Authority organised one day programme on 'Safe Road to School (SRS)' at selected schools. They are:

1. Mother India Higher Secondary School, Kollampuzha, Thiruvananthapuram - 24.07.2012
2. Government Boys High School, Kilimanoor, Thiruvananthapuram - 26.07.2012
3. Raja Ravi Varma Higher Secondary School, Kilimanoor, Thiruvananthapuram - 27.07.2012
4. Vakkom Govt. Higher Secondary School, Thiruvananthapuram - 24.09.2012

Plate 41
SRS Programme at Mother India HSS, Kollampuzha

Plate 42
SRS Programme at Raja Ravi Varma HSS, Kilimanoor

7 Road Safety Youth Leadership Programme

NATPAC launched a new programme –'Road Safety Youth Leadership Programme (RSYLP)' to train youth in road safety and related aspects. The Centre in association with Kerala Road Safety Authority organised one day Road Safety Youth Leadership Programme at Velavoor, Thiruvananthapuram on 18th October 2012.

Plate 43
Dr.G.Ravikumar, Scientist-F, NATPAC taking class in the Youth Leadership Programme at Velavoor

Plate 44
View of the participants

8 Training

a) In-house Training

i. Presentation on "Emerging Retro Reflective Technology and Traffic Control Devices to improved Road Safety", by M/s 3M India Limited, Indian subsidiary of 3M Company USA for Scientists and Technical Staff on 19th July 2012.

ii. Technical presentation on "Latest Technology on Vehicle Tracking System", developed by Sreedepam info-tech, Technopark for Scientists and Technical Staff on 17th September 2012.

iii. Talk on "Traffic Demand Management and Congestion Pricing", by Shri.P.K.Sarkar, Delhi School of Planning & Architecture on 4th October 2012.

Plate 45(a) *Plate 45(b)*

Talk by Shri.P.K.Sarkar on 'Traffic Demand Management and Congestion Pricing'

iv. Training Programme on "GIS and Advance Features of ArcGIS 10.1 Software" for Scientists and Technical Staff on 4th March 2013.

b) Road Safety Training for Various target Groups

NATPAC organised and conducted the following training programmes during the year.

i. 'Road Safety and Traffic Management' Classes at Police Training College, Thiruvananthapuram on 17th October 2012

ii. 'Road Safety Education Programme' at Government Girls High School, Pattom on 23rd January 2013.

iii. Training on Road Safety at Sree Chitra Thirunal College of Engineering (SCT), Pappanamcode on 22nd March 2013.

c) Training for Students

i. 10 days Study Camp for Post Graduate Students of Transport Planning from School of Planning & Architecture, New Delhi on "Mass Transport Planning for Trivandrum Capital Region", organised by Traffic and Transportation Division, NATPAC from 01-10 October 2012.

9 Exhibitions

i. Poster Exhibition on 'Trivandrum Monorail Project' in connection with "Emerging Kerala 2012" at Kochi, 12th -14th September 2012.

ii. Road Safety Exhibition and audio-visual programmes in the science exhibition at Sree Narayana Central School, Kollam, 22nd -24th November 2012.

iii. Road Safety Exhibition and audio-visual programmes in the science exhibition conducted by Swasrya Bharath at Kochi, 30th November 2012 - 5th December 2012.

iv. Road Safety Exhibition and audio-visual programmes in connection with 'Road Safety Week 2013'.

v. Road Safety Exhibition and audio-visual programmes in connection with 25th Kerala Science Congress at Technopark Campus, Thiruvananthapuram, 29th -31st January 2013.

10 *Participation in Workshops, Seminars/Conferences and Other Training Programmes*

Name of Programme	Organised by	Date	Venue	Participants
Workshops				
"Consultative Workshop on Health System Strengthening for Trauma Care"		23.08.2012	State Health Systems Resource Centre (SHSRC), Thycaud, Thiruvananthapuram	B .G.Sreedevi
Public Consultation Workshop on 'State Action Plan on Climate Change'	Dept. of Environment & Climate Change	06.09.2012	Thiruvananthapuram	P.Kalaiarasan
Workshop on Translation (from English –Malayalam)	Kerala Samskara – Institute of Culture and Media in collaboration with the Kerala Bhasha Institute, GoK	14.11.2012 – 30.11.2012	Thiruvananthapuram	Veena.K. S D Shaju R Lekha Arya S K Deepa V D Veena S Muhd.Naseerudeen C Sangeetha T S Ramdas M
Workshop on Science Communication and Journalism	KSCSTE	07.01.2013	Mascot Hotel, Thiruvananthapuram	Veena.K.S Shyama .C
Workshop on 'Preparation of District Rural Plan'	MORD, GoI and LSGD, GoK,	15.03.2013	Govt. Guest House, Thycaud, Thiruvananthapuram	M.S.Saran
Seminars/Conferences				
Kochi Security Review 2012		25.05.2012	Kochi	Dr.G.Ravikumar
197th All India Council Meeting of Indian Roads Congress	IRC	31.05.2012 – 02.06.2012	Kohima (Nagaland)	T.Elangovan
Prof.C.Karunakaran Endowment Lecture Series		10.08.2012	Centre for Earth Science Studies (CESS), Aakkulam, Thiruvananthapuram	Tomy Cyriac, Shaheem.S P.Kalaiarasan K. C.Wilson
Eighth Kerala Environment Congress	Centre for Environment and Development in association with Rajiv Gandhi Centre for Biotechnology	16.08.2012 - 18.08.2012	Thiruvananthapuram	P.Kalaiarasan

EXTENSION SERVICES

Name of Programme	Organised by	Date	Venue	Participants
Emerging Kerala, 2012 –A Global Meet	Government of Kerala	12.09.2012 – 14.09.2012	Kochi	Director & 10 Scientists
Trimble Mapping and GIS Data Collection	Trimble Company	28.09.2012	Taj Vivanta, Trivandrum	M.S.Saran
GIS for Water, Waste Water and Transport	ESRI India	12.10.2012	SP Grand Days Hotel, Trivandrum	M.S.Saran
5th Urban Mobility India Conference		05.12.2012 - 08.12.2012	Manekshaw Centre, New Delhi	Tomy Cyriac
International Seminar and Exhibition on 'Energy Secure India'	Energy Management Centre, Kerala; Japan Cultural and Information Centre, Tvpm; Alumni Society of AOTS, Tvpm; International Non-Governmental Cooperation Organisation for Renewable Energy (INGCORE) & Society of Energy Engineers and Managers (SEEM)	13.12.2012 - 15.12.2012	Mascot Hotel, Thiruvananthapuram	B.G.Sreedevi Dr.G.Ravikumar
Infrastructure Conference	Public Works Department, GoK	06.12.2012- 08.12.2012	Kochi	Shaheem.S V.S.Sanjay Kumar Sabitha.N.M
73rd Annual Meeting of Indian Roads Congress		07.01.2013 - 11.01.2013	Coimbatore (Tamil Nadu)	T.Elangovan V.S.Sanjay Kumar Wilson.K.C Arun Chandran
Highway Research Board Meeting of IRC		08.01.2013	Coimbatore (Tamil Nadu)	T.Elangovan
25th Kerala Science Congress	KSCSTE	29.01.2013 - 01.02.2013	Technopark Campus, Thiruvananthapuram	Scientists of NATPAC
National Conference on E-resources and E-learning: Challenges and Opportunities for Libraries	Dept. of Library and Information Science, University of Calicut and C.H.M.K. Library, University of Calicut	01.02.2013 – 02.02.2013	Calicut University	Veena.K.S Shyama.C
Seminar Cum Workshop on Kerala Vision 2030	State Planning Board	11.02.2013 - 12.02.2013	IMG, Thiruvananthapuram	B.G. Sreedevi Dr.G.Ravikumar
Seminar on Delhi Metro – A Success Story – Seminar series on Infrastructure Development		02.03.2013	Institution of Engineers (India), Thiruvananthapuram	B.G. Sreedevi
Training Programmes				
Training on Design, Construction and Maintenance of roads in Kerala		17.08.2012 – 18.08.2012	College of Engineering, Thiruvananthapuram	Shaheem.S Salini P.N
Statistical Software for Data Analysis		24.09.2012 – 28.09.2012	Norma School, Thiruvananthapuram	B.G.Sreedevi
Road Safety Engineering		27.09.2012 – 29.09.2012	College of Engineering, Thiruvananthapuram	Shaheem.S Salini P.N P.Kalaiarasan K.C.Wilson

Name of Programme	Organised by	Date	Venue	Participants
Training on GPS Applications	Aimil Limited	28.09.2012	Thiruvananthapuram	P.Kalaiarasan
Short term training on CUBE -6 Software		04.11.2012 - 08.11.2012	School of Planning & Architecture, New Delhi	Shaheem S Arun Chandran T Ramakrishnan
One day Refresher Course on RTI Act, 2005 for Major Departments	The Institute of Management in Government (IMG), Thiruvananthapuram	03.12.2012		D.Robinson Veena K S Muhd.Naserudeen C Sangeetha T S
Course on Advances in Highway Materials, Mix Design and Construction		03.12.2012 - 07.12.2012	College of Engineering, Thiruvananthapuram	Salini.P.N Wilson.K.C
International Training on Air Pollution Dispersion Models AERMOD and CALPUFF	LAKES Environmental Ltd., Canada	10.12.2012 - 13.12.2012	Hyderabad	P.Kalaiarasan
4 days Training Course on Hydrological Investigations for Conservation and Management of Lakes		15.01.2013 - 18.01.2013	National Institute of Hydrology (NIH), Roorkee	Sabitha.N.M

11 Guidance to Students' Project Work and Thesis

Students from various National Institutes and reputed Professional Colleges have undertaken their Project Works/Thesis under the guidance of NATPAC Scientists. The list of guidance provided by the Scientific Divisions is given below:

Name of the Institution	Course	No. of Students	Topic
Director's Office			
Rajiv Gandhi Institute of Technology, Kottayam	M.Tech (Tptn.)	1	Study on Pavement Performance and Overlay Design using HDM - 4
Rajiv Gandhi Institute of Technology, Kottayam	M.Tech (Tptn.)	1	Pavement Performance Modeling Using Fuzzy Logic
Gandhigram Rural Institute, Gandhigram	M.Sc Geoinformatics	1	Development of GIS based Intelligent Network Level Road Maintenance and Rehabilitation System
Traffic and Transportation Division			
College of Engineering, Thiruvananthapuram	M.Tech	4	Improving Pedestrian Safety in Thiruvananthapuram CBD Areas (Industrial Training)
National Institute of Technology, Surathkal, Karnataka	M.Tech (Tptn.)	4	Transport Modeling for Thiruvananthapuram
Rajiv Gandhi Institute of Technology, Kottayam	M.Tech	2	Impact of Surveillance Cameras installed in Thiruvananthapuram City (Industrial Training)

EXTENSION SERVICES

Name of the Institution	Course	No. of Students	Topic
National Institute of Technology, Tirichirappalli	M.Tech	2	Impact of Vehicular Emission on Police Person (Industrial Training)
Cochin University of Science & Technology, Cochin	B.Tech (Civil)	5	Comprehensive Mobility Plan for Kalamasserry
Mar Baselios College of Engineering and Technology, Thiruvananthapuram	B.Tech (Civil)	5	Pedestrian friendly Medical College - Thiruvananthapuram
Regional Transportation Division			
Rajiv Gandhi Institute of Technology, Kottayam	M.Tech	1	Measurement of Variations in Accessibility to Public Transportation Opportunities
Rajiv Gandhi Institute of Technology, Kottayam	M.Tech	1	Four Stage Transportation Model for Thiruvananthapuram City – Scenario Analysis with the Proposed Monorail System
Rajadhani Institute of Engineering and Technology, Thiruvananthapuram	B.Tech	6	Traffic Analysis of Kunnamkulam Municipality
Carmel Engineering College, Pathanamthitta	B.Tech	5	Topographic Survey and Pavement Design of Thiruvalla – Manarcadu Bypass
Travancore Engineering College, Oyyur	B.Tech	5	Traffic Studies for Kottayam Bypass
Marian Engineering College, Kazhakkuttom	B.Tech	5	Traffic Analysis of Kazhakkuttom Area
SCMS School of Engineering, Ernakulam	B.Tech	5	Traffic Improvement Proposal for Kunnamkulam Town
PSN College of Engineering, Tirunelveli	B.Tech	3	Assessment of Bypassable Traffic for Kodungalloor Town
PSN College of Engineering, Tirunelveli	B.Tech	3	A GIS based Road Information System for Kodungalloor Municipality
Gandhigram Rural Deemed University, Tamil Nadu	M.Sc Geoinformatics	1	Evaluation of Accident Black Spots in Kozhikode District using Geographical Information system
Rajiv Gandhi Institute of Technology, Kottayam	M.Tech (Trpn. Eng.)	1	Evaluation and Treatment of Accident Black Spots in Alappuzha and Ernakulam Districts using Geographic Information System
Highway Engineering Division			
Sree Buddha College of Engineering for Women, Elavamthitta	B.Tech	6	Performance Evaluation of a road stretch from Kazhakkoottam to Chengannur
M.A College of Engineering, Kothamangalam	B.Tech (Civil)	6	Study on Ambient Air Quality and Pollution due to Vehicular Emission in Ernakulam District
St.Joseph's College of Engineering and Technology, Palai	B.Tech (Civil)	4	Study on Ambient Air Quality and its Effects in Kottayam District

12 Presentation of papers in Seminar/Workshops

B G Sreedevi, Satheish B Nair, Sabitha N M, *"Inland Water Transportation in Urban Area – a Case Study of Water Ways in Kochi City"*. 13th National Conference on Technological Trends (NCTT 2012), organised by Department of Electrical Engineering, College of Engineering, Thiruvananthapuram, at CET, 10th -11th August 2012. (Proceedings Pg.1375-1383, Vol -2).

B G Sreedevi, *"Road Development in Coastal & Hilly areas"*. National Seminar on Transport Vision Kerala -2030, organised by NATPAC, at Harmony Hall, Mascot Hotel, Thiruvananthapuram, 20th -21st August 2012.

B G Sreedevi, P Kalaiarasan, *"Atmospheric Pollution and its Correlation with transportation sector in South Kerala"*. National Conference on Conservation and Management of Wetland Ecosystems (LAKE 2012), conducted by M G University, Kottayam, 6th -8th November 2012.

B G Sreedevi, *"Transport Development"*. Seminar organised by Kerala Sahrudayavedi, at Press Club, Thiruvananthapuram, 20th December 2012.

Dr.Mahesh Chand, *"Road Safety Action Plan"*. National Seminar on Transport Vision Kerala -2030, organised by NATPAC, at Harmony Hall, Mascot Hotel, Thiruvananthapuram, 20th -21st August 2012.

T Elangovan, *"Development of Waterways and Inland Navigation in Kerala – Policies and Legal Issues"*. Proceedings of 'National Seminar on Infrastructure Policy and Law', organised by National University of Advanced Legal Studies, Kochi, 24th March 2012.

T Elangovan, *"Applications of Intelligent Transport System in Kerala"*. Proceedings of 'National Conference on Innovations in Civil Engineering', at SCMS College of Engineering and Technology, Ernakulam, 19th -20th April, 2012.

T Elangovan, *"Sustainable Transportation Development"*. National Seminar on Transport Vision Kerala -2030, organised by NATPAC, at Harmony Hall, Mascot Hotel, Thiruvananthapuram, 20th -21st August 2012.

T Elangovan, *"Problems in Development of Transport Sector in Kerala"*. National Seminar, organised by EMS Chair, at Calicut University, 8th -9th October 2012

Dr.G Ravikumar, *"Public Private Participation in Transport Sector"*. National Seminar on Transport Vision Kerala -2030, organised by NATPAC, at Harmony Hall, Mascot Hotel, Thiruvananthapuram, 20th -21st August 2012.

Tomy Cyriac, *"Mass Rapid Transport System"*. National Seminar on Transport Vision Kerala -2030, organised by NATPAC, at Harmony Hall, Mascot Hotel, Thiruvananthapuram, 20th -21st August 2012.

D Robinson, *"Regional and Rural Road Connectivity".* National Seminar on Transport Vision Kerala -2030, organised by NATPAC, at Harmony Hall, Mascot Hotel, Thiruvananthapuram, 20th -21st August 2012.

Sanjay Kumar V S, Sabitha N M, *"Conservation and Management of Aakkulam-Veli Lake for Inland Navigation and Tourism".* National Conference on Conservation and Management of Wetland Ecosystems (LAKE 2012), conducted by M G University, Kottayam, 6th -8th November 2012.

Sanjay Kumar V S, *"Traffic Potentials of Cochin – Coimbatore Industrial Corridor".* National Conference on Technological Trends (NCTT 2012), organised by College of Engineering, Thiruvananthapuram, 10th -11th August 2012.

Salini P N, Satheish B Nair, B G Sreedevi, *"Traffic and Engineering Studies for Modernisation of Interstate Checkpost at Walayar in Kerala".* 13th National Conference on Technological Trends (NCTT 2012), organised by Department of Electrical Engineering, College of Engineering, Thiruvananthapuram, at CET, 10th - 11th August 2012.

Saran M.S. *"Shortest Path Analysis and Service Area Allocation for Ambulance Services in Thiruvananthapuram Corporation – a GIS Approach".* The India Geospatial Forum on 'Towards Geo Enabled Economy', conducted by Geospatial Media and Communications, Hyderabad, 22nd -25th January 2013.

Papers Published in Referred Journals

Elangovan T, Parvathy M Nair, Impact of speed restriction measures – A case study of selected corridors. International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), Vol.2 (2013)

Popular Articles

B.G.Sreedevi. Article on 'NATPAC' (in Malayalam) in City Times, 31st January 2013.

13 Invited Talks/Media Interactions

B.G.Sreedevi

Media Interactions

1. '*Samvadam*' on Metro Project. Doordarsan on 24th October 2012.
2. *'Road Safety'*. Discussion in Kairali Channel on 28th December 2012.
3. *'Panel Discussion on Road Safety'*. Kairali People on 7th January 2013.
4. *'Phone-in Programme on Road Safety'*. Thiruvananthapuram Dooradarshan on 11th January 2013.
5. *'Live Railway Budget Discussion'*. Thiruvananthapuram Dooradarshan on 25th – 26th February 2013.
6. Discussion on *'Safety'*. Doordarsan on 4th March 2013 in connection with 'National Safety Day'
7. '*Road Safety – Four laning of NH'*. Mathrubhumi News Channel on 23rd March 2013.

T.Elangovan

Invited Talk

1. *'Problems in Development of Kerala –Transport Sector'.* Talk delivered at the National Seminar organised at Calicut University, Kozhikode, 8th -9th October 2012.
2. *'Traffic Demand Forecasting for PRT System in Trivandrum City'.* Talk delivered at NIT, Calicut, 9th October 2012.
3. *'Strategies for Development of Cochin City'.* Talk delivered at Kochi Metro Rail Ltd., Ernakulam, 20th October 2012.
4. *'Formation of Unified Metropolitan Transport Authority for Kochi'.* Talk delivered at Cochin Corporation, Ernakulam, 26th November 2012.

Dr.G.Ravikumar

Invited Talk

1. Talk delivered at K.S.R College of Engineering, organised by K.S.R College of Engineering in the Staff Development Programme (SDP) for All India Council for Technical Education, at Thiruchengode, Tamilnadu, 29 -30th May 2012.

P.Kalaiarasan

Invited Talk

1. *Keynote Address on Waste to Energy.* In the Staff Development Programme (SDP), organised by K.S.R College of Engineering, at Thiruchengode, Tamilnadu,(for All India Council for Technical Education (AICTE)) 29 -30th May 2012.

Salini P N

Invited Talk

1. Talk delivered in the course on 'Advances in Highway Materials, Mix Design and Construction', sponsored by the Directorate of Technical Education, GoK at College of Engineering, Thiruvananthapuram, 3rd -7th December 2012.

14 Nominations to Technical Committees/Advisory Bodies

B G Sreedevi

- Member, Working group on Climate Change Monitoring and Networking related to Science and Technology-KSCSTE
- Member, Kerala Road Safety Authority
- Member, Board of Studies in Environmental Studies, CUSAT (2011-'15)
- Memer, Internal Assessment Committee of KSCSTE
- Member, 24th Kerala Science Congress Committee
- Member, State Level Working Group of National Transport Policy Committee
- Member, Technical Committee for Roads and Road safety, State Planning Board, Kerala

- Member, Technical Advisory Committee for Formulation of Development Schemes for Attukal and adjoining areas
- Member, State Executive Committee of Disaster Management, Govt. of Kerala
- Member, High Level Committee on Coastal Shipping, State Planning Board, Kerala
- Member, Director Board of Kerala State Road Transport Corporation (KSRTC)
- Expert Member, Trivandrum Development Authority (TRIDA)

T.Elangovan

- Council Member, Indian Roads Congress, New Delhi, representing Institutions primarily engaged in Road Transport and Transportation Research in India
- Director on the Board of Directors of Kerala Shipping & Inland Navigation Corporation – A Public Sector Undertaking under the Coastal Shipping & Inland Navigation Dept., Govt. of Kerala (since 2007)
- Member, Highway Research Board of Indian Roads Congress, New Delhi
- Member, Identification, Monitoring and Research Applications (IMRA) Committee of IRC, New Delhi
- Approved Trainer for training State/Local Self Government officials on 'Urban Transport and Infrastructure Planning' nominated by Ministry of Urban Development, Govt. of India
- Academic Council Member, Noorul Islam University, Kumaracoil, Kanyakumari District, Tamil Nadu
- Member, Technical Committee of Karamana River Scientific Management (KRSM) Project and Independent Engineer for Technical Sanction of KRSM Pilot Project
- Member, Monitoring Committee of Transport Engineering and Research Centre (TRC), College of Engineering, Trivandrum
- Member, Kerala State Fare Revision Committee under the Chairmanship of Justice M.Ramachandran constituted by Govt. of Kerala
- Member, Educational Standing Committee, Institute of Town Planners (India), New Delhi
- Member, Expert Committee for 'Preparation of Unified Bill for Kerala State by amalgamation of Travancore/Cochin/Madras Public Canals and Public Ferries Act' constituted by Law Department, Government of Kerala
- Member, Review Committee for modification of Syllabus, Curriculum, Rules and Regulations for M.Tech (Transportation Engineering) Course, University of Kerala
- Advisor, PT Board, Union Public Service Commission
- Chairman, Capital Purchase Committee, NATPAC

Dr.G.Ravikumar

- State Nodal Officer for Draft Transport Policy for the State

15 Road Safety Education Materials

Films

1. Savari, A Documentary Film on Road Safety – For Autorickshaw Drivers

2. Gathy, A Short Film on Two Wheeler Safety
3. IRC Film (English and Malayalam) – For School Children
4. Right Step (English and Malayalam) – For School Children
5. VIC Roads, Australia – For School Children
6. A Picnic on Pedals - For School Children
7. Vazhikkannumai - On Pedestrian Safety
8. Sradhha - On Safe Transportation of Goods Vehicles
9. The Open End - Railway Level Cross Safety

Booklets

1. Safe Road to School (English & Malayalam)
2. Preventing Accidents
3. Two Wheeler Driving Manual
4. Road Safety Manual for Goods Vehicle
5. All about Lane Driving and Road Safety
6. Safe Cycling
7. Autorickshaw Driving Manual (English & Malayalam)
8. Defensive Driving
9. Teachers Manual (English & Malayalam)
10. Safe Community Programme for Panchayats (English & Malayalam)
11. Helping Road Accident Victims (English & Malayalam)
12. Rules of Road Regulations,1989
13. On Car and Safe Driving
14. Defensive Bus Driving and Road Safety Guide
15. Road Safety Slogan
16. Vehicle Upkeep and Safety
17. Alphabets of Road Language
18. Road Safety Quiz
19. Safe and Responsible Parking
20. Road Safety and Youth Leadership Programmes
21. Safety Rules for Railway Level Crossing and Around Tracks
22. Safe and Secure Travel by Train

Student Badges

1. Be Careful and Be Safe
2. Don't Be Safety Blinded Be Safety Minded
3. Follow Traffic Rules and Be Safe
4. You Can't Fix Your Brain at a Body Shop – Buckle Up!
5. While Driving Put off Mobile! Put on Seat Belt!
6. Better to Arrive Late Than Never
7. Courtesy and Common Sense Promote Road Safety
8. Road Safety is a Mission, Not an Intermission
9. Before Crossing Stop! Think! Then Act

10. Kindness is Giving the Right of Way
11. Look Carefully and Drive Safely
12. Be smart, think, then Start
13. Leave sooner, drive slower, live longer
14. Drive as if every child on the street were your own
15. Be careful and be safe
16. At work at play let safety lead the way
17. Safety is a simple ABC- Always Be Careful
18. Safety on road, Safe tea at home
19. The safe way is the best way
20. നിൽക്കൂ!ശ്രദ്ധിക്കൂ!റോഡ് മുറിച്ച് കടക്കൂ!
21. സൂക്ഷിച്ച് വാഹനമോടിക്കൂ, റോഡിലെ തിരക്കിൽ നിങ്ങളുടെ കുട്ടികളും ഉണ്ടായിരിക്കാം
22. വേഗതയിലല്ല സ്മാർട്ടാകേണ്ടത്, സുരക്ഷയിലാണ്
23. ശ്രദ്ധിച്ച് നോക്കൂ, സുരക്ഷിതമായി ഡ്രൈവ് ചെയ്യൂ
24. സുരക്ഷിതത്വം മഹത്വമാണ്
25. വീഥിയിലൂടെ വേഗത വേണ്ട
26. ശ്രദ്ധിക്കൂ സുരക്ഷിതരായിരിക്കൂ
27. അശ്രദ്ധ അപകടമാണ്
28. നേരത്തെ ഇറങ്ങൂ, നേരെ ഓടിക്കൂ, നേരായവിധം ജീവിക്കൂ
29. ശ്രദ്ധയുള്ളിടത്ത് സുരക്ഷ ഉണ്ട്
30. പാഞ്ഞു പോകരുത്, പ്രാണൻ എടുക്കരുത്
31. സുഗമമായ പാത നിങ്ങളുടെ മാത്രം സ്വന്തമല്ല

Calenders

1. Steps to Use Bus safely
2. Safe Road to school – Crossing the Road Safely
3. Safe Road to School – Kerb Drill
4. Safe Road to school – Lessons from Animals
5. Road Signs
6. Important Road Safety Tips for Children
7. കുട്ടികൾക്കു വേണ്ടിയുള്ള പ്രധാനപ്പെട്ട റോഡ് സുരക്ഷാ സൂചനകൾ

Leaflets

1. Who is Walking on the Wrong Side
2. Police Hand signals
3. Safe and Correct Ways of Parking
4. Protect your Child from Injury
5. Spot the Hidden Dangers
6. Two Wheeler Driving
7. Follow this Simple Kerb Drill
8. School Safety – A Checklist for Parents
9. Understanding Traffic Rules and Regulations (English & Malayalam)
10. Don't Be Rash and End in Crash (English & Malayalam)

11. Helmets (English & Malayalam)
12. Golden Rules for Defensive Driving (English & Malayalam)
13. Untied Duppatta/Saree – Risks and Remedies (English & Malayalam)
14. Safe Travel by Bus
15. Safe Bus Driving
16. Safe Car Driving
17. Safety Precautions for Two-Wheeler Drivers
18. Safe and Responsible Parking
19. Traffic Control Devices
20. Don't find out the hard way…
21. Trains of thought- Use Extreme caution when crossing
22. Trains of thought- Safety Slogans - Just Think
23. Trains of thought- Safety Slogans - Just Think over these
24. Railway level Crossings- Safety Tips for Vehicle Drivers
25. Safe Crossing of Railway Tracks-Tips for Pedestrians and Cyclists
26. Railway Level Crossing- Safety Tips for School Buses
27. Railway Level Crossing- Safety Tips for Truck drivers

Display Boards

1. Railway Level Crossing – Safety Tips for Vehicle Drivers
2. Railway Level Crossing – Safety Tips for Pedestrians and Cyclists
3. Do not play near Track
4. Safety at Railway Level Crossing
5. Trains of thought
6. Railway Level Crossings Safety Tips
7. Safety Rules while waiting at Railway Stations
8. Indian Railways at your Service
9. Indian Railways- Lifeline of the Nation
10. Precautions for Bicyclists around Tracks
11. Precautions for Pedestrians
12. Children Safety around tracks
13. Take care at Crossings
14. Precautions at Crossings
15. Never Try to Beat a Train
16. Railway Level Crossing Signs
17. Safe Crossing of Railway Tracks
18. Know and Remember
19. തീവണ്ടിയെകുറിച്ചുള്ള ചില ചിന്തകൾ
20. റെയിൽവെ ലെവൽ ക്രോസ്സിംഗ് സുരക്ഷാ സൂചനകൾ
21. റെയിൽവെ സ്റ്റേഷനിൽ കാത്തു നിൽക്കുമ്പോൾ പാലിയ്ക്കേണ്ട സുരക്ഷാ നിയമങ്ങൾ
22. നിങ്ങളുടെ സേവനം ഇന്ത്യൻ റെയിൽവേയുടെ ലക്ഷ്യം
23. ഇന്ത്യൻ റെയിൽവെ രാജ്യത്തിന്റെ ജീവനാഡി
24. സുരക്ഷിതമായി റെയിൽപ്പാത മുറിച്ചു കടക്കൽ
25. അറിയൂ ! ഓർമ്മിക്കൂ !

1. Testing Facilities and Equipments

NATPAC is well equipped with the state of the art equipments for testing of highway materials, pavement evaluation and mix design. There are facilities for aggregate testing, bitumen and emulsion testing, testing of bituminous mixes, and pavement evaluation. There is also a geotechnical lab for soil testing, which houses all the equipments for routine testing of soil.

NATPAC has also got a traffic engineering lab and has noise-level meter and speed radar gun and several software useful for traffic modelling and analysis.

The Environmental lab includes equipments for air quality monitoring, noise level measurement and measurement of meteorological parameters.

NATPAC has also got facilities for conducting topographic survey and has modern surveying instruments including DGPS and total station apart from echo sounder used for hydrographic surveying. The list of equipments/ softwares available with NATPAC is given below:

Sl. No.	Item
a) Highway Engineering Laboratory	
I.	**Soil Testing Equipments**
1.	Soil sieves
2.	Mechanical sieve shaker(motorized)
3.	Liquid limit test apparatus
4.	Shrinkage limit test set
5.	Compaction test equipment-light & heavy
6.	Automatic motorized universal compactor
7.	Core cutter for field density test
8.	Sand pouring cylinder (10cm,15 cm&20 cm dia) for field density test
9.	CBR test equipment
10.	Rapid moisture content - Infrared moisture meter
11.	Rapid moisture content - Calcium carbide test apparatus
12.	Post hole auger
13.	Direct Shear Test
14.	Triaxial Shear Test
15.	Unconfined Compression Test
16.	Consolidation Test
17.	Permeability Test
II.	**Aggregate Testing Equipments**
18.	Aggregate sieves
19.	Aggregate Impact Value test equipment

Sl. No.	Item
20.	Los angles abrasion testing machine
21.	Stripping value test equipment
22.	Specific gravity test - Density basket
23.	Shape test - Thickness gauge & Length gauge, Angularity number test mould
III.	**Bitumen & Emulsion**
24.	Penetration test equipment
25.	Flash & fire point Test apparatus
26.	Softening point test - Ring & ball apparatus
27.	Ductility testing machine
28.	Standard Tar Viscometer
29.	Specific gravity - Pycnometer
30.	Dean and Stark apparatus - water content
31.	Distillation test apparatus
32.	Wax content test apparatus
33.	Solubility test equipment
34.	Particle charge test apparatus - emulsion
35.	Residue on 600 micron sieve test apparatus - emulsion
36.	Coagulation test apparatus - emulsion
37.	Settlement test apparatus – emulsion
IV.	**Tests on Mixes**
38.	Marshall stability test equipment.
39.	Motorized centrifuge extractor
40.	Core cutting machine - (100mm dia. core bit)-undisturbed sampling of bituminous pavement.
V.	**Test on Pavement and Evaluation**
41.	Fifth Wheel type Bump Integrator
42.	MERLIN - Machine for evaluating roughness using low cost instrumentation
43.	Benkelman beam test equipment
44.	Portable wheel weigh bridge/pad
45.	Portable Skid Resistance Tester
46.	Sand Patch method test set
b)	***Traffic Engineering Laboratory***
47.	Noise level meter
48.	Speed Radar
c)	***Topographic Survey***
49.	DGPS
50.	Single Frequency GPS-5 Nos.
51.	Total stations-3 Nos.
52.	Automatic levels-2 Nos.
53.	Theodolite
54.	High end plotters -2 Nos.

Sl. No.	Item
d) ***Environment Laboratory***	
55.	CO Analyzer
56.	CO_2 Analyzer
57.	NO_2 Analyzer
58.	CH_4 Analyzer
59.	Cup Anemometer
60.	Wind vane
61.	Wind logger
62.	RH meter
63.	Thermo couple sensor
64.	Spectro photo meter
65.	Respirable Dust Sampler (APM 460)-2 Nos.
e) ***Water Transport Laboratory***	
66.	Echo sounder
67.	Portable cantilever scale
68.	Distometer
f) ***General Accessories for Laboratory***	
69.	Thermostatically controlled drying oven 0-150^{0}C
70.	Thermostatically controlled water bath
71.	Electronic balances – 200 g, 2 kg, 50 kg
72.	Soaking tank
73.	Heater
74.	Semiautomatic balance 10 kg – 2 nos.
75.	Traffic safety appurtenances
76.	Power generator- 2 nos.
77.	External car battery-3 nos.
78.	Digital Thermometer
g) ***Application Softwares***	
79.	MX ROAD
80.	AUTO CAD
81.	ARC GIS
82.	3D MAX
83.	TALLY
84.	STAD PRO
85.	HDM IV
86.	SPSS

2. *Library and Information Services*

The NATPAC Library is mandated with the responsibility of providing assistance to the scientists, researchers, and students in their scientific and academic activities. The Library continued to cater to the information needs of the institute and students. The Library has a vast collection of books on Transportation, Traffic Engineering, Transport Economics, Urban and Regional Planning, Environment, Management, Operations Research, Geography and allied subjects. In addition to this the Technical Reports prepared by NATPAC are also available for reference purpose. The library has a good collection of the publications by Indian Roads Congress (IRC). This collection is being updated regularly. A number of new journals, both National and International, have been added to the library during this year.

An in-house database of books, periodicals, bound volumes of journals, reports, etc., is being updated. For computerization of the Library, NATPAC uses LIBSOFT. Bibliographic records of books available in the library can be accessed through Online Public Access Catalogue (OPAC). The Library also took up updating of Library Automation Software as a special initiative.

The major services rendered to users by the library are reference service and literature search. Clippings from newspapers, web resources, etc. are maintained in the library for the benefits of users. E-mail alerts are sent to scientists and technical staff for new arrival of books and publications. NATPAC has been extending academic support and other R&D facilities to Researchers as well as Professionals to carry out their research and project works. During this year many Research scholars / students from different institutions undertook project works using the facilities available in NATPAC library.

More than 100 students visited the library from institutions like National Institute of Technology, Kozhikode and Surathkal, College of Engineering, Thiruvananthapuram, B S Abdur Rahman University, Chennai, Gandhigram Rural Institute, Dindigul, Sardar Vallabhbhai National Institute of Technology, Surat, St. Joseph's College of Engineering and Technology, Palai, Rajiv Gandhi Institute of Technology, Kottayam, Younus College, Kollam, Mar Baselious College of Engineering, Thiruvananthapuram, Milad E. Sherif Memorial College, Kayamkulam, Pankajakasthuri College of Engineering, Thiruvananthapuram, Rajadhani Institute of Engineering and Technology, Thiruvananthapuram, etc.

National Transportation Planning and Research Centre (NATPAC) is an Institution of Kerala State Council for Science, Technology and Environment, which is fully supported and funded by Government of Kerala.

I. KERALA STATE COUNCIL FOR SCIENCE, TECHNOLOGY AND ENVIRONMENT

i. The Members of the State Council consist of the following:

1. Chief Minister of Kerala	-	President
2. Minister for Industries, Govt. of Kerala	-	Vice President
3. Minister for Finance, Govt. of Kerala	-	Vice President
4. Minister for Agriculture, Govt. of Kerala	-	Vice President
5. Minister for Health, Govt. of Kerala	-	Vice President
6. Minister for Education, Govt. of Kerala	-	Vice President
7. Minister for Forests, Govt. of Kerala	-	Vice President
8. Minister for Water Resources, Govt. of Kerala	-	Vice President
9. Vice Chairman, State Planning Board, Kerala	-	Vice President
10. The Chief Secretary to Government of Kerala	-	Vice President
11. The Executive Vice President, KSCSTE	-	Member
12. The Secretary, Department of Science and Technology, Government of India	-	Member
13. The Vice Chancellor, Cochin University of Science and Technology	-	Member
14. The Vice Chancellor, Kerala Agricultural University	-	Member
15. The Secretary to Government, Finance Department, Govt. of Kerala	-	Member
16. The Secretary to Government, Planning and Economic Affairs Department, Govt. of Kerala	-	Member
17. The Director, Vikram Sarabai Space Centre, Thiruvananthapuram	-	Member

18. The Director, NIST, Formerly (RRL-T), Thiruvananthapuram - Member

19. The Director, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram - Member

20. The Member Secretary (nominated by Government) - Member

21. Director, TBGRI, Trivandrum - Member

22. Director, KFRI, Peechi, Thrissur - Member

The Five eminent persons nationally known for their expertise in S & T, Industry and Environment (nominated by Government).

ii. Executive Committee of KSCSTE

1. Executive Vice President (Ex-officio) - Chairman

2. Secretary, Department of Science & Technology, Government of India or his/her nominee (Ex-officio) - Member

3. Secretary, Planning & Economic Affairs, Government of Kerala (Ex-officio) - Member

4. Additional Chief Secretary, Finance, Government of Kerala (Ex-officio) - Member

5. Director, TBGRI, Trivandrum - Member

6. Director, KFRI, Peechi, Thrissur - Member

7. One representative each of Science and Technology, Industry and Environment Departments nominated to the Council by Government of Kerala - Members

8. Member Secretary, KSCSTE - Member

iii. Research Council of NATPAC

1. Dr. C. E. G Justo - Chairman
   334, 25th Cross, 14th Main,
   Banashankari 2nd Stage,
   Bangalore

2. Dr. B. P. Chandrasekhar - Member
   Director (Technical),
   National Rural Roads Development Agency
   (Ministry of Rural Development, Govt. of India)
   5th Floor, 15 –NBCC Tower
   Bhikaji Cama Place, New Delhi 110 066
   New Delhi – 110 066

3. Dr. P.K. Sarkar - Member
   School of Planning & Architecture
   Department of Transport Planning
   4-Block-B, Indraprastha Estate
   New Delhi – 110 002

4. Sri.R.M.Nair - Member
   Formerly Member (Tech.) IWAI
   304/28, East End Apartments
   Mayoor Vihar, Phase – 1
   Extension, New Delhi – 110 096

5. Dr. Kuncheria P Issac - Member
   Member Secretary,
   AICTE, 7th Floor
   Chanderlok Building, Janpath
   New Delhi -110 001

6. The Secretary to Government - Member
   Public Works Department
   Govt. of Kerala

7. Member Secretary - Member
   KSCSTE

8. T.Elangovan
   (Former Director), Scientist-G, NATPAC - Permanent Invitee

9. Director, NATPAC - Member Convenor
   Thiruvananthapuram

iv. Management Committee of NATPAC

1. Director, NATPAC - Chairman
2. Director, TBGRI
   Palode, Thiruvananthapuram - Member
3. Member Secretary
   KSCSTE - Member
4. Special Secretary to Govt. Law Department
   Government of Kerala - Member
5. Shri. T. Elangovan
   Scientist G, NATPAC - Member
6. Registrar, NATPAC - Member Convenor

v. Information Officers as per the Right to Information Act

Public Information Officers	:	Shri. D.Robinson Scientist - E2 *(Scientific and Technical Matters)* Shri. P C. Sivadas Deputy Registrar (Administration) *(Administrative Matters)*
Asst. Public Information Officer	:	Smt.T.S.Sangeetha Office Assistant
Appellate Authority, RTI Act	:	Smt.B.G.Sreedevi Director

vi. Internal Committees

a. Library Committee

Shri.D.Robinson Scientist – E2	Chairperson
Dr.G.Ravikumar Scientist - F	Member
Shri.Tomy Cyriac Scientist - E2	Member
Shri.K.Mohanakumar Deputy Registrar (Finance)	Member
Shri.D.Sunder Scientist - E1	Convenor

b. Capital Purchase Committee

Shri.T.Elangovan, Scientist - G	Chairperson
Shri.D. Robinson, Scientist - E2	Member
Registrar	Member
Shri.K.Mohanakumar, Deputy Registrar (Finance)	Member
Shri.P.C.Sivadas, Deputy Registrar (Administration)	Convenor

vii. General Administration

Adoption of Malayalam Language

Efforts are on to introduce Malayalam language in the official correspondence and notes as far as possible. The Staff of NATPAC administered the official language pledge on 1st November 2012 (Kerala Piravi Day).

Research Council Meeting

The 14th meeting of the Research Council was held on 30th November 2012 at NATPAC under the chairmanship of Dr.C E G Justo.

Management Committee Meeting

The Management Committee met on 24th April 2012, 17th August 2012 and 18th September 2012 at NATPAC under the chairmanship of Director, NATPAC.

NATPAC Staff –as on 31.03.2013

Smt.B.G.Sreedevi	Scientist G & Director

Scientific Staff

1	T. Elangovan	Scientist-G (Head, Traffic & Transportation Dn.)
2	Dr. Mahesh Chand	Scientist- G (Head, Traffic Safety Dn.)
3	Dr. G. Ravikumar	Scientist-F (Head, Extension Services Dn.)
4	N. Vijaya Kumar	Scientist-E2(Head, Regional Office, Kozhikode)
5	Tomy Cyriac	Scientist-E2(Head, Highway Engineering Dn.)
6	D. Robinson	Scientist-E2(Head, Regional Transportation & Central Support Systems Dn.)
7	Satheish B. Nair	Scientist-E2(Head, Water Transportation Dn.)
8	D. Sunder	Scientist-E1
9	S.Shaheem	Scientist-E1
10	V.S. Sanjay Kumar	Scientist-C
11	P.Kalaiarasan	Scientist-B
12	B.Subin	Scientist-B
13	P N Salini	Scientist-B
14	M S Saran	Scientist-B
15	N.M.Sabitha	Scientist-B
16	K.C.Wilson	Scientist-B
17	Arun Chandran	Scientist-B
18	Veena.K.S	Scientist-B

Technical Staff

19	K. M. Syed Mohammed	Principal Technical Officer
20	C. Anbalagan	Technical Officer Grade -5
21	S. Ramachandran	Technical Officer Grade -5
22	T. Ramakrishnan	Technical Officer Grade -5
23	V. Ajith Kumar	Technical Officer Grade -5
24	C. Muraleedharan Pillai	Technical Officer Grade -4
25	O. Sugatha	Technical Officer Grade -4
26	V. Jayawardhanan	Technical Officer Grade -4
27	K. Satheesan	Technical Officer Grade -3
28	V.G. Sasi	Technical Officer Grade -2
29	M.S. Radhakrishnan	Technical Officer Grade -2
30	K. Devadethan Nair	Technical Officer Grade -2
31	E. P. Surendran Pillai	Technical Officer Grade -2
32	T. Mohan	Technical Assistant Grade-2
33	S. Geetha	Technical Assistant Grade-2
34	R. Radhakrishnan Thampi	Technical Assistant Grade-2
35	Shyama.C	Jr.Library Assistant Grade-1

Administrative Staff

36	K.George Koshy	Registrar
37	P.C. Sivadas	Dy. Registrar (Admn.)
38	K. Mohanakumar	Dy. Registrar (Finance)
39	J.Krishnamoorthy	P.A. to Director Grade-4
40	T. Vijayan	P.A. to Registrar Grade-1

41	Abey George	P.A. to Director Grade-1
42	D. Shaju	Section Officer Grade-1
43	R. Lekha	Typist cum Stenographer Grade-4
44	Arya.S.K	Office Assistant Grade – 1
45	Maya Devi.M	Office Assistant Grade – 1
46	Veena.S	Office Assistant Grade – 1
47	Deepa V.D	Office Assistant Grade – 1
48	Muhammed Naserudeen.C	Office Assistant Grade – 1
49	Sangeetha.T.S	Office Assistant Grade – 1
50	Ramdas.M	Stenographer Grade – 1
51	Lajila.K.B	Stenographer Grade – 1
52	Bindu Mole.B.P	Stenographer Grade - 1
53	A. Praveen Kumar	Clerical Assistant Grade -1
54	G.Ragesh	Driver Grade - 1
55	A.Somaraj	Driver Grade - 1
56	Surendran Kulangara	Driver Grade – 1
57	Shijil P R	Driver Grade - 1
58	Sukhdev Kolay	Jr. Assistant / Sr.Helper
59	P. X. Mathew	Jr. Assistant /Sr.Helper
60	C. Viswanathan	Jr. Assistant / Sr.Helper
61	S. Jayakumar	Helper Grade -4
62	P. Lakshmi	Helper Grade -4
63	G. Suresh Kumaran Nair	Helper Grade -2
64	A.Anil Kumar	Helper Grade - 1
65	Athira.S.Kumar	Helper Grade – 1

New Recruitments

Arya S K
Office Assistant Grade-1

Maya Devi M
Office Assistant Grade-1

Veena S
Office Assistant Grade-1

Deepa V D
Office Assistant Grade-1

Muhammed Naserudeen C
Office Assistant Grade-1

Sangeetha T S
Office Assistant Grade-1

Lajila K B
Stenographer Grade-1

Ramdas M
Stenographer Grade-1

Bindumole B P
Office Assistant Grade-1

Shyama C
Jr.Library Assistant Grade-1

Veena K S
Scientist-B

Retirements

Dr.Mahesh Chand, Scientist-G
***Superannuated** on 28th February 2013*

Deepa V D, Office Assistant Grade-1
***Resigned** on 22nd January 2013*

Plan Studies Undertaken During 2012-'13

Sl. No.	Code	Project
1	PR-126/2012-13	Safety Auditing of Public Transport System in Kerala
2	PR-127/2012-13	Preparation of Inventory of Roads for two Block Panchayaths in Kannur District
3	PR-128/2012-13	Identification of Accident Prone Locations and Improvement Measures in Northern Kerala
4	PR-129/2012-13	Route Network Planning of Inland Water Transport for Central Kerala
5	PR-130/2012-13	Constraints in Developing West Coast Canal in Kerala – Case Study of Selected Stretches in North Kerala
6	PR-131/2012-13	Price Index for Stage Carriage Operations in Kerala
7	PR-132/2012-13	Performance of Highways Developed under Kerala State Transport Project
8	PR-133/2012-13	Use of Geotextiles in Road Construction and Embankment Works – A Demonstration Project in Aakkulam Campus
9	PR-134/2012-13	Use of Plastic Waste for Road Construction and Study on its Suitability to Kerala Conditions
10	PR-135/2012-13	Predictive Accuracy of Urban Transport Studies in Kerala
11	PR-136/2012-13	Price Index for Auto Taxi Operations in Kerala
12	PR-137/2012-13	Revival of Inland Canals and Waterways in Kerala
13	PR-138/2012-13	Integrated Rural Accessibility Planning – Micro Level Interventions in Hilly Areas of Northern Kerala
14	PR-139/2012-13	Evaluation of Accident Black Spots on Roads Using Geographical Information System and Remote Sensing
15	PR-140/2012-13	Pavement Deterioration Studies for Highways in Kerala
16	PR-141/2012-13	Pavement Evaluation Studies for Low Volume Roads in Kerala
17	PR-142/2012-13	Application of Congestion Pricing as a Tool for Reducing Traffic Congestion in Cities
18	PR-143/2012-13	Impact of Speed Restriction Measures on Road Safety and Level of Service
19	PR 144/2012-13	a) Revision of Fares for Operation of Boat Services
		b) Integration of Public Transport Services - a Case Study of Thiruvananthapuram City
		c) Improvement of Kovalam -Channankara stretch of T.S Canal
		d) Ascertain and identify the feasibility of a Road Over Bridge Project at Nettoor Railway Station Road
		e) Preparation of Traffic Improvement Plan for Pala region

Consultancy/Sponsored Projects In 2012-'13

Sl. No.	Code	Project	Sponsored by
1	C 00211	Study on existing Cross Structures along National Waterways III	Inland Waterways Authority of India (IWAI)
2	C 00311	Measurement of Air Quality & Noise level at IISER Campus, Vithura in Thiruvananthapuram District	Centre for Water Resources Development and Management (CWRDM)
3	C 00312	Development of Ropeways in Kerala	Tourist Resorts (Kerala) Ltd. (TRKL)
4	C 00412	Traffic Forecasts for the proposed Personal Rapid Transit System (PRTS) in Thiruvananthapuram City	Infrastructures Kerala Limited (INKEL)
5	C 00611	Techno Economic Feasibility Study for extension of NW-3 towards North of Kottappuram and South of Kollam	Inland Waterways Authority of India (IWAI)
6	C 00712	Widening of NH-47 between Kesavadasapuram and Kazhakkuttam in Thiruvananthapuram	Public Works Department (NH), Government of Kerala
7	C 00812	Price Index for Auto Taxi Operations in Kerala	Transport Dept., Government of Kerala
8	C 00811	Feasibility study for the setting up of a Monorail system from TechnoCity (Pallipuram) to Neyyattinkara in Thiruvananthapuram District	Transport Dept., Government of Kerala
9	C 01012	Traffic Management Plan for Kariavattom Green Field Stadium Complex, Trivandrum	Infrastructure Leasing & Financial Services Limited (ILFS)
10	C 01212	Comprehensive Mobility Plan for Kalamassery Town	Roads and Bridges Development Corporation, Kerala (RBDCK)
11	C 00912	Study on estimation of carbon footprint with transportation in and around Government Secretariat building, Thiruvananthapuram	Energy Management Centre, Kerala
12	C 01112	Feasibility study for developing a ropeway at Elaveezhapoonchira	Tourist Resorts (Kerala) Ltd. (TRKL)
13	C 01312	Comprehensive scheme for Tourism Signages on Major Roads and Tourist Centres in Kerala State	Department of Tourism, GoK
14	C 02012	Preparation of Traffic Improvement Plan for Pala Region	PWD
15	C 02412	Measurement of Air Quality and Noise Level at proposed IISER Campus, Vithura in Thiruvananthapuram District -Phase II	Centre for Water Resources Development and Management (CWRDM)

Sl. No.	Code	Project	Sponsored by
16	C 00113	Planning Pedestrian Friendly Urban Transport System for Kochi City	Regional Town Planning Office, Ernakulam
17	C 00213	Traffic and Transportation Study for Pandalam Grama Panchayath	Town & Country Planning, GoK
18	C 00311	Environment Study at IISER Campus, Vithura	Centre for Water Resources Development and Management (CWRDM)
19	C 00313	Feasibility study for development of Outer Ring Road between Kodungallur and Cherthala	Department of Town Planning, GoK
20	C 00143	Providing separate road connectivity to the Special Economic Zone at KINFRA Techno Industrial Park, Kakkanchery	Kerala Industrial Infrastructure Development Corporation (KINFRA)
21	C 02013	Improvement of Kovalam-Akkulam Stretch in Thiruvananthapuram Region for Inland Navigation, Tourism and Recreational Purposes	Coastal Shipping and Inland Navigation Dept.
22	C 00713	Study on Periodically Distressed Road Stretches in Thiruvananthapuram - Conduct of Axle Load Surveys	Kerala Highway Research Institute (KHRI)
23	RP 00110	Study of ambient air quality and its contribution to climate change in Kerala	Directorate of Environment & Climate change, Kerala (EMAK)
24	C 00913	Preparation of GIS Maps: Standard Operating Procedure for Attukal Pongala and Chemical Disasters in Ernakulam District	Institute of Land & Disaster Management, GoK
25	C 01313	Traffic Improvement Plan for Bolgatty Junction in Kochi	M/s Lulu Convention & Exhibition Centre Pvt. Ltd., Cochin
26	C 00512	Relocation of Toll Plazas on NH-7 in Salem District, Tamil Nadu and its Effect on Toll Collection Potentials	National Highways Authority of India (NHAI), Chennai Region
27	Traffic and Transportation Studies for selected Towns		Department of Town Planning, GoK
1	C 01512	Karunagapally	
2	C 01412	Kanhangad	
3	C 01612	Punalur	
4	C 01712	Thaliparamba	
5	C02312	Payyannur	
6	C 01912	Sulthan Bathery	
7	C 02112	Kodungalloor	
8	C 02212	Chalakkudy	
9	C 00513	Cherthala	
10	C 00613	Nileswaram Muncipal Town	
11	C 02212	Kunnamkulam	

NATIONAL TRANSPORTATION PLANNING AND RESEARCH CENTRE, TRIVANDRUM

(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)

Balance Sheet as on 31st March 2013

Liabilities	Sch No	As at 31.03.2013	As at 31.03.2012	Assets	Sch No	As at 31.03.2013	As at 31.03.2012
Reserves & Surplus	4	1,05,51,125	1,06,54,188	Fixed Assets	1	1,05,51,125	1,06,54,188
Current Liablities	5	1,43,89,493	44,41,583	Current Assets	2	2,70,56,879	1,86,53,929
Unspent balance	6	1,69,31,322	1,83,77,089	Loans & Advances	3	7,49,53,936	5,93,54,743
Building Fund Account	4	7,06,90,000	5,51,90,000				
Total		**11,25,61,940**	**8,86,62,860**	**Total**		**11,25,61,940**	**8,86,62,860**

For Mohan & Mohan Associates
Chartered Accountants

R. Suresh Mohan
Partner
Membership No. : 013398
Firm Reg. No.: 002092S

Place : Thiruvananthapuram
Dated :

MOHAN & MOHAN ASSOCIATES ★ CHARTERED ACCOUNTANTS ★ TRIVANDRUM

For National Transportation Planning and Research Centre
Trivandrum

(Dy Regstrar)

K. MOHANAKUMAR
DEPUTY REGISTRAR (FINANCE)
National Transportation Planning
and Research Centre (NATPAC)
Sasthra Bhavan Pattom P.O.
Thiruvananthapuram-695 004

(Regstrar) (Director)

K. GEORGE KOSHY
Registrar
National Transportation Planning
and Research Centre (NATPAC)
Sasthra Bhavan, Pattom P.O
Thiruvananthapuram-695 004

B. G. SREEDE
DIRECTOR
National Transportation
and Research Centre (N
Sasthra Bhavan, P
Thiruvananthapuram-6

Place :Thiruvananthapuram
Dated:

NATIONAL TRANSPORTATION PLANNING AND RESEARCH CENTRE, TRIVANDRUM
(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)
Income & Expenditure Account for the year ended 31/03/2013

Expenditure	Sch No	Year ended 31.03.2013	Year ended 31.03.2012	Income	Sch No	Year ended 31.03.2013	Year ended 31.03.2012
		₹	₹			₹	₹
To Infrastructure Strengthening (Plan)	10	2,34,22,802	2,11,16,411	By Grant from Government of Kerala	7	8,09,28,006	4,07,30,039
To Infrastructure Strengthening (Non Plan)	11	12,54,801	10,50,409	By Other Receipts	8	1,64,476	53,74,866
To Salaries and Allowances (Plan)	12	6,48,293	86,916	By Depreciation written back	1	38,68,171	29,25,228
To Salaries and Allowances (Non Plan)	13	5,57,66,586	2,37,59,239	By Income from Consultancy Project	9	31,89,668	31,05,722
To Depreciation	1	38,68,171	29,25,228	Other Project Expenses			
To Consultancy Project Expenses		31,89,668	31,05,722	Excess of Expenditure over Income			
To Refund to Govt of Kerala			91,930				
Total		**8,81,50,321**	**5,21,35,855**	**Total**		**8,81,50,321**	**5,21,35,855**

For Mohan & Mohan Associates
Chartered Accountants

R. Suresh Mohan
Partner
Membership No. : 013398
Firm Reg. No.: 002092S

Place : Thiruvananthapuram
Dated :

MOHAN & MOHAN ASSOCIATES * CHARTERED ACCOUNTANTS * TRIVANDRUM

(By Registrar)
K. MOHANAKUMAR
DEPUTY REGISTRAR (FINANCE)
National Transportation Planning
and Research Centre (NATPAC)
Sasthra Bhavan Pattom P.O.
Thiruvananthapuram-695 004

For National Transportation Planning and Research Centre
Trivandrum

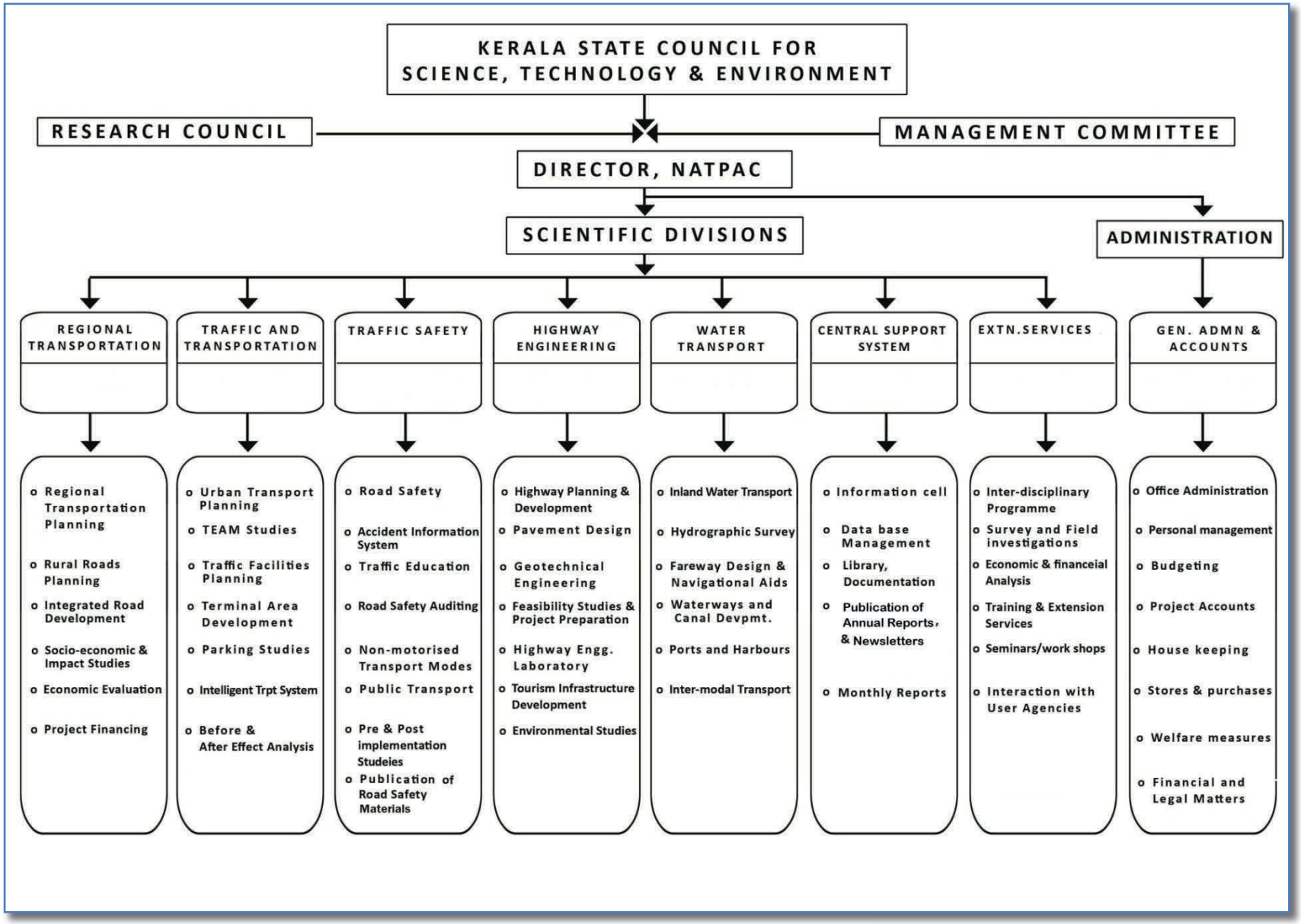
(Regstrar) (Director)

K. GEORGE KOSHY
Registrar
National Transportation Planning
and Research Centre (NATPAC)
Sasthra Bhavan, Pattom P.O
Thiruvananthapuram-695 004

B. G. SREE
DIRECTO
National Transportati
and Research Centre
Thiruvananthapuram

Place :Thiruvananthapuram
Dated:

ORGANISATION



National Transportation Planning and Research Centre
(NATPAC)
'K.KARUNAKARAN TRANSPARK'
Akkulam, Thuruvikkal P.O, Thiruvananthapuram -695 031
Ph: 04712553701, 2554467, 2551282

REGIONAL OFFICE

National Transportation Planning and Research Centre
(NATPAC)
No.19/1429, Chand Nivas
Kothakkal Road, Bajana Koil Jn.,
Chalappuram (Post), Kozhikkode -673 002
Ph: 04942305505

natpac

National Transportation Planning and Research Centre

(An Institution of the Kerala State Council for Science, Technology and Environment)

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