



DETAILED PROJECT REPORT
SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

VOLUME II - MAIN REPORT
(PART A)

CHAPTER 4
TRAVEL DEMAND FORECAST



**SILVER
LINE**

CONNECTING THIRUVANANTHAPURAM
TO KASARAGOD IN JUST 4 HOURS

4 TRAVEL DEMAND FORECAST

As part of the DPR Study of Semi High Speed Rail (SilverLine), connecting Thiruvananthapuram and Kasaragod, detailed study of existing transportation system and travel characteristics of Kerala State has been undertaken. Information on the demographic and Socio-Economic factors, influencing the travel pattern have also been compiled. Review of earlier traffic studies have been carried out, along with the methodology adopted and salient findings. The same is summarised in this section.

This section of the DPR provides the details of primary and secondary traffic surveys and ridership forecast of SilverLine for different horizon years.

4.1 STUDY AREA PROFILE

4.1.1 Introduction – The Study Area

Kerala, the greenest State, located on the Southernmost tip of India, blessed with excellent tropical weather and networked by 44 rivers, 34 lakes, canals, ponds, and paddy fields, is popularly known as *God's Own Country*. This lush green strip of land lying between the Arabian sea and the steep Western Ghats has an area of about 38,863 Sq.Km and is inhabited by about 33.41 million people as per 2011 Census.

Kerala stretches for about 580 km along the Arabian Coast, varying in width from roughly 30 km to 120 km. It is bordered by the States of Karnataka in the north, Tamil Nadu in the east and Arabian Sea in the west and south. The administrative capital of Kerala is Thiruvananthapuram, which is a major destination for tourists. Kochi and Kozhikode are the other two major cities with lot of industrial developments.

The proposed SilverLine project envisage Semi High Speed Rail connectivity between Thiruvananthapuram and Kasaragod, with intermediate stops at key economic centres of the districts, such as Kollam, Kottayam, Ernakulam, Thrissur, Calicut, Kannur etc. **Figure 4-1** given below presents the study area map of the proposed SilverLine project and its indicative alignment.

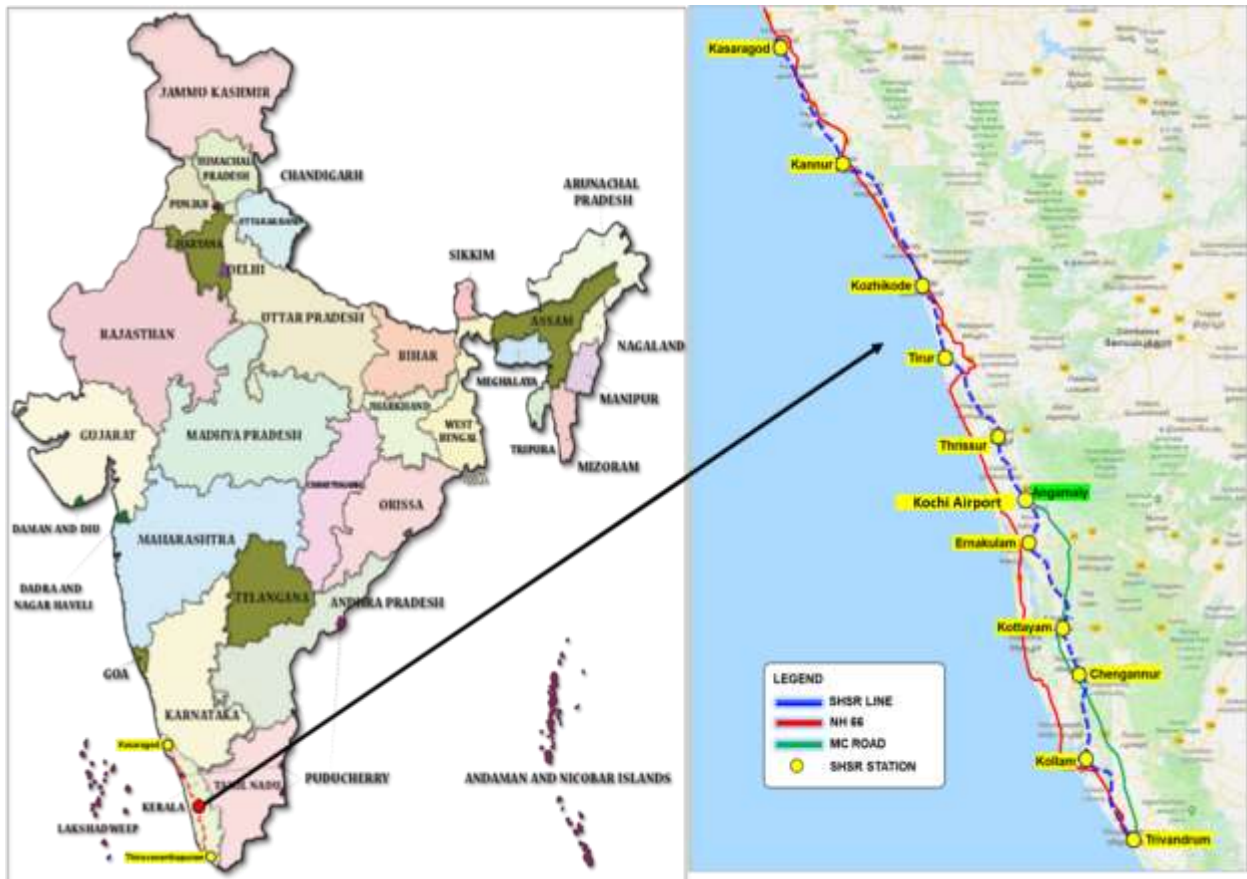


Figure 4-1: Study Area.

The major competing highway running almost parallel to proposed alignment is NH66. Another competing highway is Main Central Road (MC Road) which starts at Kesavadasapuram in Thiruvananthapuram district and ends at Angamaly in Ernakulam district. M C Road is parallel to proposed SilverLine alignment up to Ernakulam.

4.1.1.1 Rationale for SilverLine Station Locations

Public transport terminals such as Railway station or inter-state bus terminals have always been places of central importance in the structure of a city through which people orient and identify themselves. Key in this role, is the location of the transit nodes. As evidenced by the locations of railway stations in Kerala, these have generally been in the centre of the city that allows it to not only serve its role in terms of place making but also satisfying ideal transit requirements of even dispersal to the city while doubling as an interchange point.

However, as cities have developed in size and population, practical issues of land availability and congestion adversely affecting accessibility has made newer transit nodes to be shifted to the suburbs of the city. While this has served the transportation purposes of railway stations & bus terminals in terms of easier accessibility for rail and buses, it has almost reduced the role of terminal as a node.

Considerations:

There are a number of considerations in deciding the best location. The location should be where routes should logically connect or terminate, as determined by passenger demand patterns. If the station is used as an intermediate stopping point on routes passing through, it should be conveniently located for passengers joining or leaving vehicles. New transport terminals are also located outside central areas to avoid high land costs and congestion. But this shall be conflicting with increasing dispersal trip length within the city which causes inconvenience to users. So, the parameters for selection of station location can have different dimensions with regards to perspective of SilverLine commuter and SilverLine operator.

To determine the location for a new bus terminal, the following indicative criteria are considered. Depending on the project objectives and complexity the criteria can be adopted. They are:-

- a) Distance from Catchments (Average Trip Length of Pax within City) – mainly user perspective
- b) Scope of Multimodal Integration (Other Modes within walking distances) – user perspective
- c) Proximity of the Land with the other rail, bus, air and water modes – user perspective
- d) Land Price / Real Estate Value – operator perspective
- e) Commercial Development Potential / TOD Potential – Operator perspective
- f) Environmental / R&R Consideration – Operator perspective

From the above parameters, there must be a balance between both the perspectives in finalisation of the ideal locations.

For the SilverLine station location, the following parameters have been considered based on the priority: -

- 1) Alignment: the route was decided based on the existing railway line, practicality to build new line and the topography of Kerala. The cities and towns for stations were selected based on the proximity to the macro-level tentative alignment fixed during pre-feasibility stage.
- 2) Catchments in terms of population: if a tier 1 city is along the alignment, then priority was given to that particular city, followed by towns under tier II and tier III.
- 3) Administrative headquarter – if the city or town is district headquarter, priority was given to district HQ for location of Silverline station.
- 4) One district one station principle – in a district, if one location has been identified as SilverLine station, no other city may be considered. But, station for airport connectivity may be considered.
- 5) Station-wise passenger handled and earnings – the performance of the existing railway stations along the tentative alignment based on number originating

passengers and passenger earnings is also considered. The best performing stations and respective cities or towns will be given higher priority.

- 6) Secondary Data: Consideration from previous studies as follows:-
- a. Kerala High Speed Rail Corridor between Thiruvananthapuram and Kannur Detailed Project Report - June 2016 prepared by DMRC suggested ten stations proposed in the first phase which includes Thiruvananthapuram, Kollam, Chengannur, Kottayam, Kochi, Thrissur, Valanchery, Kozhikode, Kannur, and Kasaragod. One more station is planned in the next phase at Nedumbassery.
 - b. Traffic & Transportation Study for preparation of DPR for Kerala High Speed Rail – 2017; updated traffic report prepared by iMacS suggested Thiruvananthapuram, Kollam, Chengannur, Kottayam, Kochi, Thrissur, Valanchery, Kozhikode, Kannur, Kasargod and Mangalore as Station locations.

Based on the above, for each major sections along the alignment, following major urban agglomerations and towns were considered.

Table 4-1: Urban Centres Considered for SilverLine Stations

Sl. No.	Sections (District to District)	Major Urban centres for probable station locations
1	Thiruvananthapuram - Kollam	Thiruvananthapuram UA, Varkala, Aatingal, Paravoor
2	Kollam - Alapuzha/Pathanamthitta	Kollam UA, Adoor, Pandalam,
3	Alapuzha/Pathanamthitta - Kottayam	Chenganoor, Tiruvalla, Changanassery
4	Kottayam - Ernakulam	Kottayam UA, Piravam, Tripunithara, Vaikom
5	Ernakulam - Trissur	Ernakulam UA, Aluva, Angamaly, Chalakudy
6	Trissur - Malapuram	Trissur UA, Kunnamkulam, Kuttipuram, Edappal
7	Malapuram - Kozhikode	Tirur, Tirurangadi, Feroke, Parappanagandi
8	Kozhikode - Kannur	Kozhikode UA, Quailandy, Vadakara, Thalassery
9	Kannur - Kasaragod	Kannur UA, Payyanur, Kanjagad UA, Kasaragod UA
10	Airport connectivity	Thiruvananthapuram, Kochi, Karippur, Kannur

Catchment and Population

The population of each city and town considered for stations are provided in the table below along with their ranking within the class or tier towns.

Table 4-2: Urban centres & Population

SI.No.	Rank	City/Towns	Population (Census 2011)	Class (Tier)
1	1	Kochi UA	1,355,972	I
2	2	Thiruvananthapuram UA	889,635	I
3	3	Kozhikode UA	880,247	I
4	4	Kannur UA	498,207	I
5	5	Kollam UA	380,091	I
6	6	Thrissur UA	330,122	I
7	7	Alappuzha UA	282,675	I
8	9	Kottayam UA	172,878	I
9	13	Kanhangad UA	129,367	I
10	14	Vadakara UA	124,083	I
11	3	Kasaragod UA	75,968	II
12	5	Quilandy (M)	68,982	II
13	6	Payyannur (M)	68,734	II
14	10	Thiruvalla (M)	56,837	II
15	12	Tirur (M)	53,654	II
16	13	Changanassery (M)	51,967	II
17	14	Kunnamkulam (M)	51,592	II
18	2	Chalakyady (M)	48,380	III
19	8	Varkala (M)	40,728	III
20	9	Paravoor (M)	38,652	III
21	13	Attingal (M)	35,693	III
22	22	Adoor (M)	28,952	III
23	30	Chengannur (M)	25,397	III
24	31	Vaikom (M)	22,641	III

From the above table, from Thiruvananthapuram, Kollam, Kottayam, Ernakulam, Trissur, Kozhikode and Kannur, the urban agglomerations are selected for station locations. It is also observed that, they also serve as district HQs. As the alignment do not pass through Alapuzha UA, it cannot be selected. The towns from Alapuzha, Pathanamthitta, Malapuram and Kasaragod as station locations will have to finalised based on the performance of existing railway stations as there are multiple towns other than district HQs along the alignment which are probable for having stations.

Performance of Existing Railway Stations

The performance of existing railway stations in terms of passenger handled and earnings are considered in this section. The top 20 station based on the ranking based on passenger earnings from each station are provided in the table below for Thiruvananthapuram and Palakad Division.

Table 4-3: Station-wise performance – Thiruvananthapuram Division

Rank	Station Name	Station Code	No. of Actual Passenger	Annual Earnings (In Rs.)	No. of Actual Passenger (per Day)	Earnings per day (In Rs.)
1	Thiruvananthapuram Central	TVC	14604759	1918713232	40908	5270627
2	Ernakulam Jn	ERS	10282088	1656309076	28170	4537833
3	Trissur	TCR	6887232	1079227597	18869	2956788
4	Ernakulam Town	ERN	4119857	667006491	11287	1827415
5	Kollam Jn	QLN	8412506	642310800	23048	1759756
6	Aluva	AWY	4439930	621608174	12164	1703036
7	Kottayam	KTYM	4769050	579294371	13066	1587108
8	Nagarcoil Jn	NCJ	2692661	506849949	7377	1388630
9	Chengannur	CNGR	2736961	480557142	7499	1316595
10	Kayankulam Jn	KYJ	3162376	344784651	8664	944615
11	Kochuveli	KCVL	627652	243243266	1720	666420
12	Alappuzha	ALLP	2385518	215015730	6536	589084
13	Kanniyakumari	CAPE	756294	196672113	2072	538828
14	Tiruvalla	TRVL	1663781	193374981	4558	529794
15	Chenganasseri	CGY	1526575	109335208	4182	299549
16	Varkala Sivagiri	VAK	3964010	104254286	10860	285628
17	Tripunittura	TRTR	858280	80571256	2351	220743
18	Valliyur	VLY	293696	78359811	805	214684
19	Angamali for Kaladi	AFK	1833706	69626465	5024	190757
20	Cherthala	SRTL	1513948	67785629	4148	185714

Source: Southern Railway – Thiruvananthapuram Division: Annual originating passengers & earnings for the year 2017-18

From the above table, Chengannur can be finalised as station location between Alappuzha/Pathanamthitta – Kottayam section when compared with Tiruvalla and Changanassery.

Similarly, the station-wise ranking based on performance for Palakad division is provided in table below.

Table 4-4: Station-wise performance – Palakad Division

Rank	Station Name	Code	Originating Passengers	Originating Earnings	Average Passengers per day	Average Earnings per day
1	Kozhikkode	CLT	10388999	1141636403	28463	3127771
2	Mangaluru Central	MAQ	5716180	815443543	15661	2234092
3	Kannur	CAN	7251566	717299105	19867	1965203
4	Palakkad Jn	PGT	4042031	616930828	11074	1690221
5	Shoranur Jn	SRR	4063152	478074537	11132	1309793
6	Thalassery	TLY	4442403	324970020	12171	890329
7	Mangaluru Jn	MAJN	667096	317108702	1828	868791
8	Tirur	TIR	3565350	236951671	9768	649183
9	Vadakara	BDJ	3638020	201174724	9967	551164
10	Kasaragod	KGQ	2453877	195369393	6723	535259
11	Payyannur	PAY	2859033	187748867	7833	514380
12	Kanhangad	KZE	2480074	151408582	6795	414818
13	Quilandi	QLD	1797984	111806551	4926	306319
14	Ottappalam	OTP	1025690	111574412	2810	305683
15	Kuttipuram	KTU	2168702	106144079	5942	290806
16	Parapanangadi	PGI	1333136	66553812	3652	182339
17	Ferok	FK	1126176	45311798	3085	124142
18	Nilambur Road	NIL	965016	45168962	2644	123751
19	Nileshwar	NLE	1147906	41421776	3145	113484
20	Pattambi	PTB	863608	41400541	2366	113426

Source: Southern Railway – Palakad Division: Annual originating passengers & earnings for the year 2017-18

From the above table, Tirur between Malapuram and Kozhikode and Kasaragod between Kannur and Kasaragod can be finalised for station location. Kanhangad is also a major UA within the region and also performing similar to Kasaragod in terms of passenger and earnings but being the District HQ, Kasaragod can be finalised.

Regarding connectivity to airports, Kochi may be considered for connectivity as it is along the alignment and is also major international airport. Other airport connectivity may be decided based on the daily ridership.

Summary of finalised SilverLine Station locations

Based on the above assumptions and considerations, the station locations finalised for SilverLine are provided in the table below.

Table 4-5: Identified Urban centres considered for SilverLine stations

Sl. No.	Sections (District to District)	SilverLine Station Locations
1	Thiruvananthapuram - Kollam	Thiruvananthapuram UA
2	Kollam - Alapuzha/Pathanamthitta	Kollam UA
3	Alapuzha/Pathanamthitta - Kottayam	Chenganoor
4	Kottayam - Ernakulam	Kottayam UA
5	Ernakulam - Trissur	Ernakulam UA
6	Trissur - Malapuram	Trissur UA
7	Malapuram - Kozhikode	Tirur
8	Kozhikode - Kannur	Kozhikode UA
9	Kannur - Kasaragod	Kannur UA, Kasaragod UA
10	Airport connectivity	Kochi Airport

4.1.1.2 SilverLine Distance and Time

The 11 SilverLine Stations proposed along the alignment and corresponding codes with SilverLine Distance and time are shown in **Table 4-6**.

Table 4-6: SilverLine Distance - Time Chart: From Thiruvananthapuram (TVM)

Sl. No	Station Name	Station (Code)	Chainage (In Km - Distance From TVM)	Run Time (In Hrs: Min)
1	THIRUVANANTHAPURAM	TVM	0.000	0:00
2	KOLLAM	KLM	55.338	0:24
3	CHENGANNUR	CNGR	102.900	0:46
4	KOTTAYAM	KTM	136.108	1:01
5	ERNAKULAM	EKM	195.329	1:27
6	KOCHI AIRPORT	KAP	212.318	1:36
7	THRISSUR	TSR	259.117	1:57
8	TIRUR	TIR	320.562	2:24
9	KOZHIKODE	KKD	357.868	2:42

Sl. No	Station Name	Station (Code)	Chainage (In Km - Distance From TVM)	Run Time (In Hrs: Min)
10	KANNUR	KNR	446.095	3:20
11	KASARGOD	KGD	529.450	3:56

4.1.2 District & City Profile

In this section, major districts and cities are detailed which are along the SliverLine alignment. The profile in terms of activity and activity centres, social (cultural), and connectivity within the district and city is provided in subsequent sub-sections.

4.1.2.1 Thiruvananthapuram

The capital city of Kerala with Government offices, educational institutions, headquarter to Kerala public sector undertakings and notably academic, IT and research hubs. The place is also known for hosting various cultural events of national & international stature and the diverse ethnic populace of the city celebrates several local festivals. Out of the local festivals, Atukal Pongala (which normally happens in early March of the year) is most famous and bring in lakhs of devotees from across Kerala to Thiruvananthapuram.

With nearly 80% of the state's software exports, Thiruvananthapuram is a major IT hub with the Techno Park and the Techno city. It is an academic and research focal point in the country. Being India's largest city in the deep south, it is strategically prominent and has the Southern Air Command headquarters of the Indian Air Force, the Thumba Equatorial Rocket Launching Station and the upcoming Vizhinjam International Deepwater Motherport.

Thiruvananthapuram is a major tourist centre, known for the Padmanabhaswamy Temple, the famous beaches of Kovalam and Varkala, the backwaters of Poovar and Anchuthengu and its Western Ghats tracts of Ponmudi and the Agastyamala. It is consistently ranked among the best cities to live in Kerala as well as India. The location map of Thiruvananthapuram is provided in the figure below.



Source: <http://indiannewsreader.blogspot.com/2009/12/kerala-tourism-trivandrum.html>

Figure 4-2: Thiruvananthapuram District

Regarding connectivity, the NH 66 and NH 544 (old NH 47) connects the city with Salem and Kanyakumari in Tamil Nadu. The Main Central Road is an arterial road in the city and is designated as State Highway 1.

There are five railway stations in the city namely, the Thiruvananthapuram Central, Thiruvananthapuram Pettah, Kochuveli, Kazhakuttom and Nemom. Thiruvananthapuram Central is the major railway station serving the city. It falls under the Southern Railway zone of the Indian Railways and is the head quarter of the Thiruvananthapuram Railway Division. Thiruvananthapuram is served by the Thiruvananthapuram International Airport. The airport is just 6.7 kilometres from the city centre.

Some of the major institutional area within the city are – Secretariat, Palayam - Corporation office, Legislative Assembly and Kazhakuttam – Technopark. Major educational institutional area includes Medical College, Srikaryam, Palayam - Kerala University Campus etc.

4.1.2.2 Kollam

Kollam is the fourth largest city in Kerala and situated 66Km away from State Capital – Trivandrum and is one of the oldest settlements in Kerala. Thangassery and Neendakara ports triggered the development activities in the region and led to the growth of settlements around these ports and thus Kollam developed as an important commercial

center in the southern part of Kerala. Historically a trading town and presently a commercial and business centre. The city also have major fishing harbours both for sea and backwater fisheries sector.

The route through Punalur to Tamil Nadu is used for daily movement of goods and passengers. As per the recent publication by UN through Economic Intelligent Unit has placed Kollam as the 10th fastest growing city in the world with 31.1% urban growth. The Kollam district map is provided in the figure below.



Source: <https://maps.newkerala.com/Kollam-District-Map.php>

Figure 4-3: Kollam District

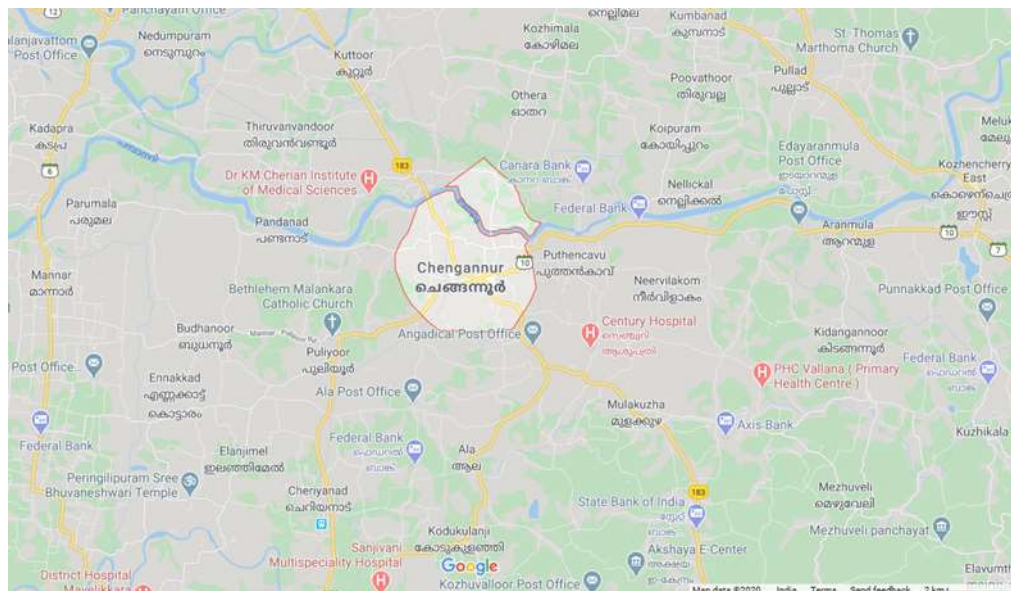
The city of Kollam is connected to almost all the cities and major towns in the state, including Trivandrum, Alappuzha, Kochi, Palakkad, Kottayam, Kottarakkara, and Punalur, and with other Indian cities through the NH 66, NH 183, NH 744 - and other state PWD Roads. Road transport is provided by state-owned Kerala State Road Transport Corporation (KSRTC) and private transport bus operators. Kollam is one among the five KSRTC zones in Kerala. Road transport is also provided by private taxis and auto rickshaws, also called autos. There is a city private bus stand at Andamukkam. There is a KSRTC bus station beside Ashtamudi Lake. Buses to various towns in Kerala and interstate services run from this station.

The city also has Kollam Junction Railway Station and all the trains have halt at this station. MEMU service to Ernakulam and services to Senkottai through Arayankavu is also a prominent rail service.

The major commercial & institutional area within the district are Kollam City Centre, Punalur, Paravur and Kottarakara. It is also famous for religious activities and the famous are Karunagapally mosque and the related festivals and Kottarakara temple. The tourism locations include island and resorts situated around the Astamudi Lake. The Munroe Island, and related backwater tourism is a major activity.

4.1.2.3 Chengannur

The town is situated on the southernmost tip of Alapuzha District and along the river Pamba. It is close to major religious places in Kerala and Sabarimala Temple is accessed from Chengannur while travelling by Rail and also by Road. Sabarimala temple is visited by approximately 3 crores of devotees a year and maximum in 3 months of duration from November to January. The major boat race such as the Aranmula Boat race happens close to Chengannur town. The famous Maramon convention is also hosted near to changanoor town. Major commercial & institutional area within the town includes – Chengannur, Adoor and Pandalam. Major tourism/religious locations within the proximity are Sabarimala, Aranmula, Pandalam, Parumala and the Maramon, where Maramon convention takes place. The location of chengannor town is provided in the figure below:-



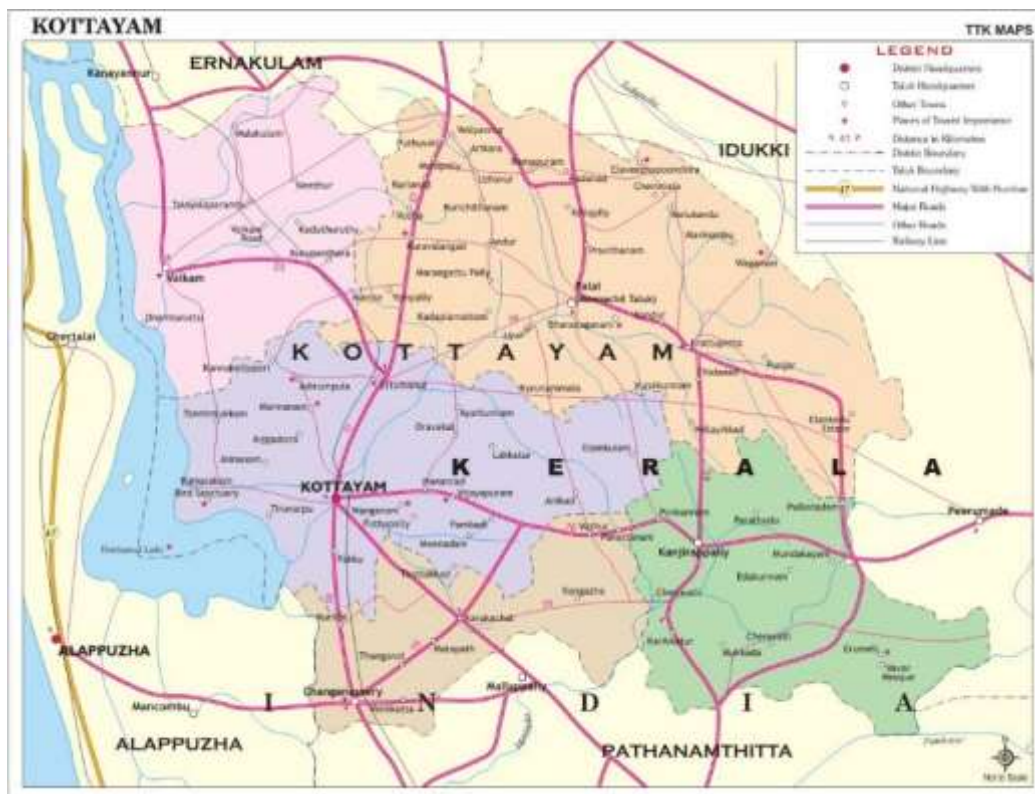
Source: <https://www.google.com/maps/place/Chengannur>

Figure 4-4: Chengannur Town

Chengannur is well connected to cities and towns in the north and south of Kerala through State Highway (SH 1 – Main Central Road or MC Road). NH 183A and SH 67 in the east-west direction connects the town with Sabarimala. The town also have a railway station with all the major express trains having stop at the station.

4.1.2.4 Kottayam

The city is located at the centre of the state and is one of the flag bearers of literacy mission in Kerala. It is the first district with 100% literacy in India. The city is an important trading center of spices and commercial crops, especially rubber. A number of small and medium-sized enterprises in and around the town are engaged in the processing of rubber latex and manufacturing of rubber products. The location map of Kottayam district is provided in the figure below.



Source: <https://maps.newkerala.com/Kottayam-District-Map.php>

Figure 4-5: Kottayam District

Many religious & tourist destinations are in the proximity of Kottayam town such as Kumarakom, Wagamon, Ettumanoor, Vaikom, Erumeli and other main tourist destinations along western ghats. The major commercial and institutional area in the district is the Kottayam town itself.

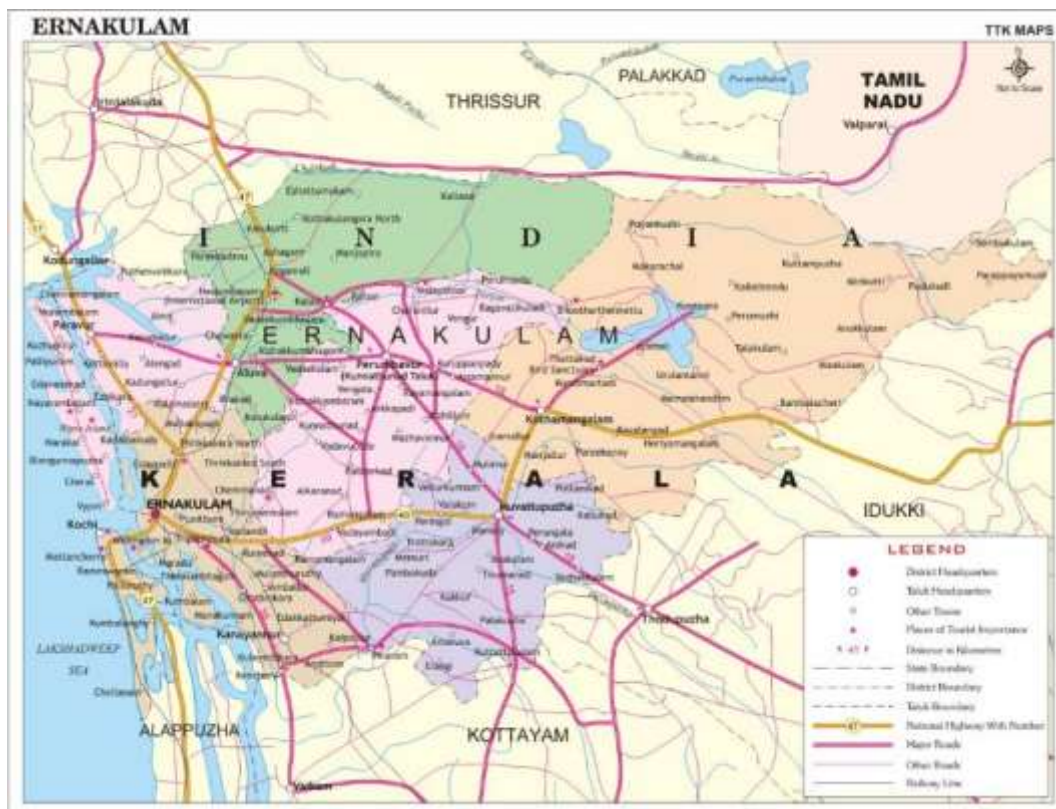
Kottayam is connected to Ernakulam by SH 15, to Chertala by SH 40, and by NH 183, which connects to Dindigul. The SH 1 (MC Road) connects Kottayam to Thiruvananthapuram in the South and Angamali in the North of Kerala.

The major railway station is the Kottayam railway station and is well connected to other parts of Kerala and India.

4.1.2.5 Ernakulam

Kochi is a major port city on the west coast of Indian Peninsula and also one of the most densely populated cities in the state of Kerala. In the past decade, Kochi has witnessed increased economic growth with improved investments in projects such as Vallarpadam International Container Terminal (VICT), port based Special Economic Zone, and Industrial parks like Smart City, Info City etc. All these strategic investments have given a boost to the regional economy and employment. Several other projects are also proposed in Kochi city and region, some of them being of national importance, with an anticipation of further encouraging the economy. As per the Census of India 2011, the city (Kochi Municipal Corporation) has a population of about 6.4 lakh, spread over an area of 94.86 Sq. km.

The City of Kochi is the nerve center of trade and commerce of Kerala and is considered as the 'Gateway of South India'. Kochi with its wealth of historical associations and its unique setting perfectly reflects the historical blend of Kerala. Kochi is one of India's important ports and a major naval base. Kochi consists of mainland Ernakulam, the Islands of Willington, Bolghatty and Gundu in the Harbour, Fort Kochi and Mattancherry on the southern peninsula and Vypin Island, north of Fort Kochi. Kochi Municipal Corporation was formed in 1967, incorporating three municipalities (Fort Kochi, Mattancherry and Ernakulam), Willington Islands and few surrounding areas in the suburbs. Greater Cochin Development Authority (GCDA) and Goshree Islands Development Authority (GIDA) have delineated the development area which is considered as Greater Cochin Region comprising Kochi Municipal Corporation, 9 Municipalities and 29 Panchayats. The total area under Greater Cochin Region is 632 sq.km with a population of 20.01 lakhs (as per Census 2011). The location map of Ernakulam District is provided in the figure below.



Source: <http://tourismindia03.blogspot.com/2011/01/ernakulam-town-ernakulam-map-ernakulam.html>

Figure 4-6: Ernakulam District

Three major national highways connect Kochi with other parts of the country. NH 66 (old NH 17) from Kochi to Mangalore, connects Kochi with Mumbai via most of the major towns in the Malabar area, the west Karnataka port town of Mangalore and the State of Goa. The NH 544 (old NH 47) from Kanyakumari to Salem connects Thiruvananthapuram with Kochi and continues to connect to Coimbatore and Salem in Tamil Nadu via Palakkad and Thrissur. NH 49 connects Kochi with Rameswaram in Tamil Nadu and passes through Madurai via the hill resort of Munnar. Kochi is well connected to other parts of state through various state highways.

It also has an MRTS network connecting Aluva to Thykudam (to Petta under construction) connecting two major railway stations and major bus terminals – Vytilla Mobility hub, Aluva municipal bus stand etc.

Kochi is well connected to major urban centres in the state as well as to other places through major railway lines namely Thiruvananthapuram – Palakkad railway line via Kottayam and Thiruvananthapuram – Kozhikode. Ernakulam Town and Ernakulam junction are the main Railways stations in the region. Kochi has a good network of inland waterway system consisting of backwaters, canals and lagoons. National waterway No. 3 connecting Kollam and Kottappuram pass through the region.

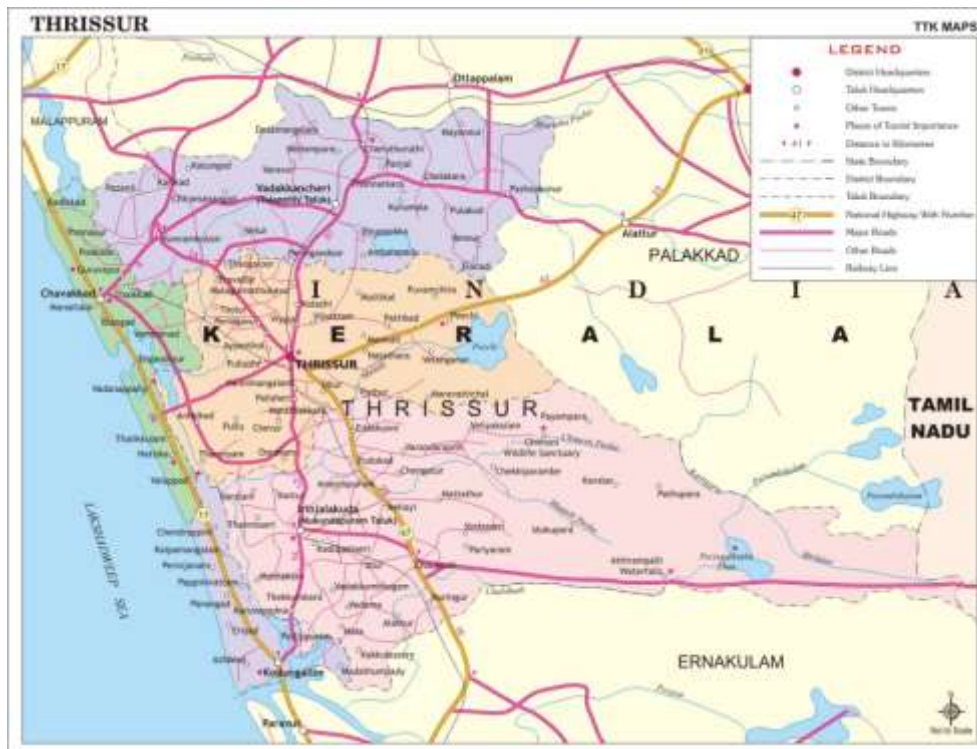
Cochin International Airport at Nedumbassery (near Angamali town), 28 km from the city, is the largest airport in Kerala in terms of passengers and number of flights. The airport is well connected by many international & national carriers that operate regular flights to the Middle East and elsewhere in Asia. Many direct chartered services from Europe and the US reach Kochi during tourist seasons. Domestically the airport is well connected to the other main cities in India.

It is also well-connected to the sea port and the airport is approximately 25 km from the junction. The National Waterway 3 is also located very near to the site, and it is connected to Kollam and Kottapuram.

The major commercial & institutional towns within the region are Ernakulam (CBD), Kakkanadu, Aluva, Angamali, Fort Kochi, Paravur, Triakara and Tripunithara. There are many famous churches, temples and mosques in the region which attract lakhs of devotees during the annual festivals. The Kochi-Muziris Biennale, hosted by the city during the month of December, January and February is also becoming a major cultural event in the city attracting, domestic and international tourist just visiting the city for the event.

4.1.2.6 Thrissur

Thrissur is known as the cultural capital of Kerala and is also a commercial and financial hub. The city is the largest in manufacturing plain gold and other gold jewellery in Kerala with major and minor units. It is also headquarter to most of the commercial banks in Kerala. The main activity centre is the Trissur town and is famous for the Trissur Pooram. The festival attracts lakhs of devotees in three days of a year. The district is also famous for other church, mosque and temple festivals. Some of the well-known temples and churches are Vadakkumnathan temple, Guruvayur temple, the Our Lady of Lourdes Syro-Malabar Catholic Metropolitan Cathedral and the Our Lady of Dolours Syro-Malabar Catholic Basilica, the largest Christian church in India. India's first mosque, the Cheraman Juma Masjid is also situated in the district. The famous Kerala Kalamandalam, a hub of art and culture is also situated in the district along the banks of Barathapuzha river. The location map of Trissur is provided in the figure below.



Source: <https://maps.newkerala.com/Thrissur-District-Map.jpg>

Figure 4-7: Thrissur District

The NH 544 (old NH 47) is the main highway that connects the city and district with other parts of Kerala and South India. The SH 69: Thrissur-Kuttippuram Road, SH 22: Kodungallur – Shornur Road, SH 75: Thrissur – Kanjani – Vadanappally Road are the three state highways which connect city with nearby towns.

The Thrissur railways station is a major station with halt to all the major trains operating in Kerala.

4.1.2.7 Malappuram & Tirur

As per census 2011, Malappuram is the most populous district in Kerala (approximately 13%). As per the recent publication by UN through Economic Intelligent Unit has placed Malappuram as the fastest growing city in the world with 44% urban growth from 2015 to 2020. As per State planning board, Malappuram is also the district with maximum emigrants in the state. The district also has highest number of schools in Kerala. The district is home to most of the notable poets and artists in Kerala. The Mappila dance forms like Oppana, Kolkali, Duffmuttu, and Aravana muttu are popular in the district. One of the main centre for Ayurveda in Kerala is situated in the district near Kottakal.

Most of the commercial activities are centered around Manjeri in the District. Other major towns and activity centres are Ponnani, Perinthalmanna, Tirur, Eranad, Tirurangadi, Kondotty, and Nilambur. The location map of the Malappuram district is provided in the figure below.



Source: <https://maps.newkerala.com/Malappuram-District-Map.php>

Figure 4-8: Malappuram District

Tirur: It is one of the business centres of Malapuram District and is a stoppage point for access to other religious centres in the proximity. The main items of trade includes mobile gadgets, electronic items and betel leaf.

The major commercial & institutional area in Tirur is the Tirur Town and the major religious temple of Tirunavaya is situated in the proximity.

The district is connected through NH 66 and NH 966 to other major cities and towns in the North and South of Kerala. The major towns and cities within the district are connected through SHs - SH 23, SH 60, SH 69, SH 70 etc.

The major railways stations are Kuttipuram, Angadipuram, Tirur and Nilambur (which connects to Shornur as separate line).

4.1.2.8 Kozhikode

Kozhikode, also known as Calicut, is a city in the state of Kerala in southern India on the Malabar Coast. Kozhikode is the largest urban area in the state and 195th largest urban area in the world. As per the recent publication by UN through Economic Intelligent Unit has placed Kozhikode as the 4th fastest growing city in the world with 34.5% urban growth from 2015 to 2020. The greater Calicut urban area in the Malabar Coast is the part of the ninth biggest urban area in the world and the second biggest in India after the greater Kolkata urban area, which constitute of the northern Kerala region or the Malabar Coast.

In terms of urban agglomeration (UA), it is the second largest UA in Kerala and also an commercial hub in the state. A culturally rich region which is different from other regions and has produced many famous celebrities from the field of dance, move, classical instruments etc. Major premier institutes such as NIT and IIM is located in the region. An international airport is also operational from the region. IT park in line with Technopark and Infopark, which is known as Cyberpark is also under development stage.

The major commercial & institutional establishments are centred around Kozhikode city and the major tourist locations are Kozhikode beach, Kappad and Kuttiyadi.

The location map of Kozhikode is provided in the figure below.



Source: <https://keralainformations.wordpress.com/kozhikode-india-kerala/>

Figure 4-9: Kozhikode District

NH 66 connects Kozhikode to Mumbai via Mangaluru, Udupi and Goa to the north and Kochi and Kanyakumari near Thiruvananthapuram to the south. NH 766 connects Kozhikode to Bangalore through Kollegal in Karnataka and NH 966 connects Kozhikode to Palakkad through Malappuram. The major SHs are SH 29, SH 34 and SH 54 that connects other major towns within the region.

The major railway station is the Kozhikode and all the trains passing through the station has a halt for passenger movement.

For intra-city travel, LRT is under consideration and technical studies are conducted by KRTL (Kerala Rapid Transit Corporation Limited) and the proposed alignment connects all the major transport hubs and commercial in the city.

The International Airport at Karipur serves the city with international connectivity especially with the countries in Middle-east.

4.1.2.9 Kannur

It is the 6th most urbanised district in Kerala and historically a trading town. Most of the commercial and institutional activities are centred around Kannur town. Other than diversive culture such as theyyams, it is also a politically active district. The Ezhimala Naval Academy is situated in the region. The region is also an educational hub due to the presence of institutions like NIFT, Indian Coast Guard Academy, Kannur University, Government Engineering college and Brennan College. The location map of Kannur district is provided in figure below.



Source: <https://maps.newkerala.com/Kannur-District-Map.php>

Figure 4-10: Kannur District

The major commercial & institutional are in Kannur Town and in Thallassery. The major tourist destination in the region is Muzappilangadu beach.

Kannur is connected via NH 66 to Mumbai via Mangaluru, and Goa to the north and Kochi and Kanyakumari near Thiruvananthapuram to the south. The major railway station is Kannur railway station.

Kannur is also connected via Air through the international Airport located at Mattanur.

4.1.2.10 Kasaragod

It is the northernmost district of Kerala and an important border district that have linkages with neighbouring State – Karnataka, especially Mangaluru. Kasaragod is renowned for its hills, forts and water bodies. The famous Bekal fort in Kasaragod is the most visited place by tourists in the district. The coir and handloom industry here also famous. The major towns and activity centres are Kasaragod town and Kanhangad town. The location map of district is provided in the figure below.



Source: <https://destinationkasaragod.wordpress.com/tag/kasaragod/>

Figure 4-11: Kasaragod District

Kasaragod is connected via NH 66 to Mumbai via Mangaluru, and Goa to the north and Kochi and Kanyakumari near Thiruvananthapuram to the south. SHs such as SH 55 and SH31 connects to Kerala-Karnataka state border. The major railway station is Kasaragod railway station.

4.1.3 Demographic Profile

As per Census 2011, the population of Kerala State was recorded as 33.41 million persons with a decadal growth rate of 4.81%, which is lowest amongst the States of India. The district-wise population in Kerala is presented in **Table 4-7**. Malappuram District has the highest population of about 44.4 lakhs in the year 2017, followed by Kerala’s capital city, Thiruvananthapuram with 33.47 lakhs; while the lowest population is observed in Wayanad district with a population of about 8.4 lakhs. As per Census 2011, the density of population of Kerala is 860 persons / sq. km as compared to 382 persons/ sq. km at an all India level.

Table 4-7: Population of Kerala

District	1991	2001	2011	2017*
Kasaragod	1071508	1204078	1307375	1379091
Kannur	2251727	2408956	2523003	2602238
Wayanad	672128	780619	817420	842536
Kozhikode	2619941	2879131	3086293	3226115
Malappuram	3096330	3625471	4112920	4439921
Palakkad	2382235	2617482	2809934	2931854
Thrissur	2737311	2974232	3121200	3225843
Ernakulam	2817236	3105798	3282388	3407138
Idukki	1078066	1129221	1108974	1094573
Kottayam	1828271	1953646	1974551	1982082
Alappuzha	2001217	2109160	2127789	2143334
Pathanamthitta	1188332	1234016	1197412	1175608
Kollam	2407566	2585208	2635375	2655423
Thiruvananthapuram	2946650	3234356	3301427	3347613
Total	29098518	31841374	33406061	34453369

* Source: Vital Statistics Division, DES, Kerala & Census of India

The decline in growth rate may act as detrimental factors to patronage. But, more employment generation, especially in the field of IT sector may increase in-migration. The IT companies are shifting their base to next tier cities from metro cities of India and many cities in Kerala are in the potential list. Kerala is also witnessing an in-migration in the primary sector due to shortage of labour.

4.1.4 Socio-Economic Profile

Kerala has the highest quality of life index in the country, a high literacy rate at 94% against country’s literacy rate of 74% and has a good socio – economic status compared to other Indian States. Kerala’s health indicators and life expectancy are close to those of developed countries. Achievements in health and education fronts were to a large extent possible through infrastructure investments. It also has had an edge over many other States in social and economic infrastructure, such as road transport, medical institutions and healthcare facilities.

Kerala is a Consumer State and the economy mainly depends on agriculture, fisheries, tourism, service sector and with a very few industries. Tourism has grown to be the fund generating industry. As per the Kerala State Planning Board, *‘The upcoming of IT and allied industries coupled with small and agro-based has a lot to look forward in future in terms of economy of Kerala which are willing to exploit the yet-to-be tapped resources. The State has witnessed significant migration, especially to the Gulf Cooperation Council (GCC) Countries region during the Kerala Gulf boom and is thus heavily dependent on the remittances from the large expatriate community, which contributes more than a fifth of GSDP. Certain Socio-Economic aspects of the State are discussed below’.*

4.1.4.1 Economy

As per the Kerala Economic Review 2018, *‘Kerala’s Gross State Domestic Product² (GSDP) grew at 7.18% in 2017-18 at constant (2011-12) prices, which is higher than the 6.22% growth recorded in 2016-17. At current prices (@2011-12 prices), the growth rates of GSDP in 2017-18 and 2016-17 were 11.42% and 9.67% respectively. The growth rates of Gross State Value Added³ (GSVA) at basic prices in constant (2011-12) prices were 5.94% and 4.67% in 2017-18 and 2016-17 respectively. The GSVA growth rate in current prices was 10.37% in 2017-18 and 8.62% in 2016-17. Per capita GSDP in real terms grew at 6.65% in 2017-18 as against 5.70% in 2016-17.*

In 2017-18, the contribution from primary, secondary, and tertiary sectors to the GSVA at constant prices (2011-12) was 10.85%, 27.40% and 61.75% respectively. At current prices, the primary, secondary, and tertiary sectors contributed 13.20%, 24.24% and 62.56% respectively to the GSVA during this period’.

Table 4-8 presents the GSDP of Kerala from year 2011-12 to year 2017-18.

Table 4-8: GSDP of Kerala

Gross State Domestic Product of Kerala							
Item	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17(P)	2017-18(Q)
GSDP at Current Prices (Rs. In Lakhs)	36404788	41231300	46504121	51256405	56199361	61635704	68676443

² GSDP: Gross State Domestic Product (GSDP) is defined as a measure, in monetary terms, of the volume of all goods and services produced within the boundaries of the State during a given period of time, accounted without duplication. – reference: <https://data.gov.in/keywords/gsdp>.

³ GSVA: Gross value added (GVA) is an economic productivity metric that measures the contribution of a corporate subsidiary, company or municipality to an economy, producer, sector or region. – reference: <https://www.investopedia.com/terms/g/gross-value-added.asp>

Gross State Domestic Product of Kerala							
Item	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17(P)	2017-18(Q)
GSDP at Constant (2011-12) Prices (Rs. In Lakhs)	36404789	38769346	40278133	41995555	45121002	47928990	51369589
NSDP at Current Prices (Rs. In Lakhs)	32802112	37138412	41726497	46061432	50590997	55595370	61923259
NSDP ⁴ at Constant (2011-12) Prices (Rs. In Lakhs)	32802112	34861581	36470677	38213426	41115015	43839422	46988233
Per Capita GSDP at Current Prices (Rs.)	108666	122471	137515	150824	164554	179580	199101
Per Capita GSDP at Current Prices (Growth rate in %)		12.70%	12.28%	9.68%	9.10%	9.13%	10.87%
Per Capita GSDP at Constant (2011-12) Prices (Rs.)	108666	115158	119105	123573	132116	139645	148927
Per Capita GSDP at Constant (2011-12) Prices (Growth rate in %)		5.97%	3.43%	3.75%	6.91%	5.70%	6.65%
Per Capita NSDP at Current Prices (Rs.)	97912	110314	123388	135537	148133	161981	179523
Per Capita NSDP at Current Prices (Growth rate in %).		12.67%	11.85%	9.85%	9.29%	9.35%	10.83%
Per Capita NSDP at Constant (2011-12) Prices (Rs.)	97912	103551	107846	112444	120387	127729	136225
Per Capita NSDP at Constant (2011-12) Prices (Growth rate in %)		5.76%	4.15%	4.26%	7.06%	6.10%	6.65%

Source: Department of Economics and Statistics Kerala, 2017

⁴ NSDP: Net State Domestic Product (NSDP) is defined as a measure, in monetary terms, of the volume of all goods and services produced within the boundaries of the State during a given period of time after deducting the wear and tear or depreciation, accounted without duplication. – reference: <https://data.gov.in/keywords/nsdp>

Kerala has been ahead of other Indian States in achieving demographic and human development indicators. In achievement of Sustainable Development Goals (SDGs 2018) by the States in India as computed by the NITI Aayog, Kerala ranks first along with Himachal Pradesh, with a score of 69 against national average of 57. Kerala ranks first in SDGs relating to health, education, and gender equality. Public investment in educational infrastructure and quality is a priority and as a consequence the enrolment of students in Government and Government aided schools has increased.

Table 4-9 presents the GSDP of all States of India for year 2016-17(Q). **Figure 4-12** shows the comparison of percentage growth rate of Kerala & India (by economic activity) at constant prices. **Figure 4-13** presents the per capita income of Kerala and India.

Table 4-9: GSDP of All States

SI No.	State/UT	2016-17(Q)				
		GSDP (Rs Crs)		Per Capita Income (Rs.)		Growth Rate of GSDP at (2011-12) Prices (%)
		At Current Prices	At Constant (2011-12) Prices	At Current Prices	At Constant (2011-12) Prices	
1	Goa	62661	51847	375554	308827	12.50
2	Delhi	616826	514871	300793	249555	8.60
3	Chandigarh	31823	26631	237599	207000	6.30
4	Sikkim	20020	15339	27552	206178	6.70
5	Haryana	547396	434608	180174	143211	8.70
6	Puducherry	27739	21629	174743	137088	7.80
7	Uttarakhand	195606	162451	161102	133246	6.90
8	Maharashtra	2257032	1826296	165491	133141	10.00
9	Gujarat	1162287	984453	156527	131853	10.10
10	Kerala	621700	481839	163475	128550	7.40
11	Telangana	659074	511482	159856	122684	10.10
12	Karnataka	1132393	874395	157436	120496	7.50
13	Himachal Pr.	126020	109564	150285	119386	6.40
14	Tamil Nadu	1270490	1009145	150036	117806	4.30
15	A & N islands	6649	5566	136824	113796	9.30
23	Nagaland	21488	15511	90168	63568	5.80
24	West Bengal	879167	657883	83126	61245	7.90
25	J & K	126847	102206	78163	59924	5.40
26	Meghalaya	27228	22051	73291	58826	6.80
27	Madhya Pr.	647304	469393	74590	53047	12.30
28	Assam	254341	200790	67303	52416	5.10
29	Jharkhand	235560	194475	59799	49174	11.20
30	Manipur	21066	16989	58501	46756	3.40
31	Uttar Pradesh	1250213	974120	51014	38934	7.30

SI No.	State/UT	2016-17(Q)				Growth Rate of GDP at (2011-12) Prices (%) (%)
		GSDP (Rs Crs)		Per Capita Income (Rs.)		
		At Current Prices	At Constant (2011-12) Prices	At Current Prices	At Constant (2011-12) Prices	
32	Bihar	487628	361504	34409	28485	11.30
	All India	15253714	12196006	103870	82229	7.10

Source: Department of Economics and Statistics, Government of Kerala, 2017

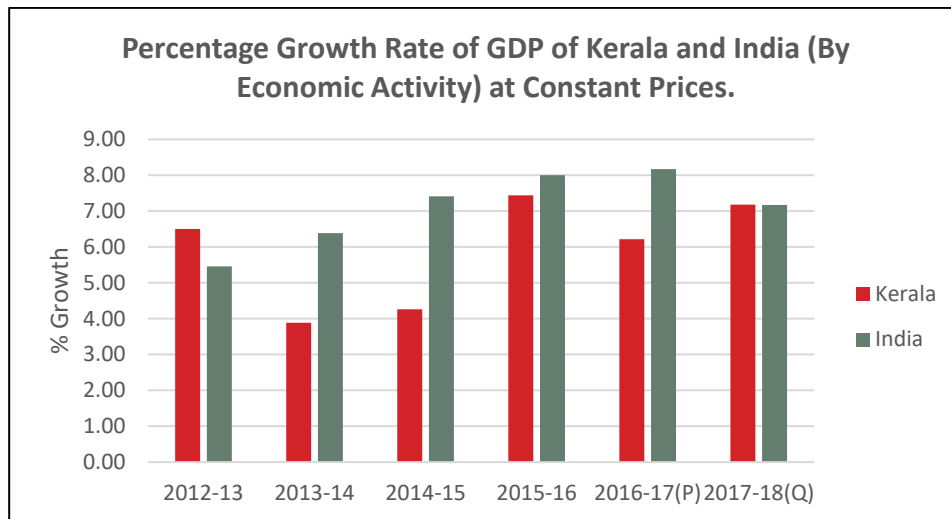


Figure 4-12 Percentage Growth Rate of Kerala & India

Source: Department of Economics and Statistics, Government of Kerala, 2017

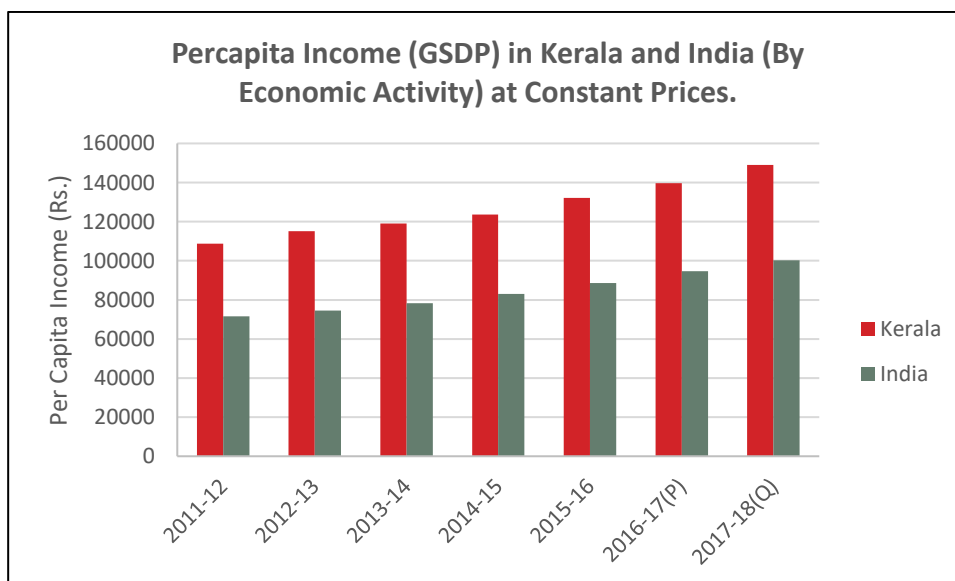


Figure 4-13 Per Capita Income in Kerala & India

Source: Department of Economics and Statistics, Government of Kerala, 2017

4.1.4.2 Sector-wise distribution of GSDP

The sector-wise annual growth rate of GSDP at constant prices is provided in the table below. For details of the Sectorial Distribution of Gross State Value Added (GSVA), please refer to Volume III, Part 3A – Annexure V.

Table 4-10: Sector Wise Annual Growth Rate of GSDP - Kerala

Base Year 2011-12		Percentage Change over Previous Year		
		At Constant Prices		
Sl.	Industry of Origin/Year	2016-17	2017-18 (P)	2018-19 (Q)
1.	Agriculture, forestry and fishing	-0.6	1.7	-0.5
1.1	Crops	1.8	0.4	-2.1
1.2	Livestock	-7.6	1.8	-0.3
1.3	Forestry and logging	5	-0.2	0
1.4	Fishing and aquaculture	1.8	11.1	6.6
2	Mining and quarrying	45.4	18.9	-14.6
	<i>Primary</i>	1.2	2.7	-1.4
3	Manufacturing	18.2	3.7	11.2
4	Electricity, gas, water supply & other utility services	-13.2	27.2	12
5	Construction	7.8	4	6.3
	<i>Secondary</i>	11.5	4.6	8.8
6	Trade, repair, hotels and restaurants	1.7	13.3	7
6.1	Trade & repair services	1.2	13.9	7.2
6.2	Hotels & restaurants	6.6	6.6	5.1
7	Transport, storage, communication & services related to broadcasting	4.2	-2.3	-1
7.1	Railways	5	20.1	20.1
7.2	Road transport	3.2	-4.5	-3.9
7.3	Water transport	37.6	7.1	16.6
7.4	Air transport	3.1	-0.9	-3.9
7.5	Services incidental to transport	57.8	16.5	18.8
7.6	Storage	52	11.6	17.8
7.7	Communication & services related to broadcasting	1.7	-2.5	-0.8
8	Financial services	4.6	0.8	0.8
9	Real estate, ownership of dwelling & professional services	7.9	10.6	8.7
10	Public administration	9	11.2	14.7
11	Other services	12.6	9.5	17
	<i>Tertiary</i>	6.3	8.6	8.4
12	TOTAL GSVA at basic prices	7.1	6.8	7.5
13	Taxes on Products	7.5	11.8	6.4
14	Subsidies on products	-23.3	19.6	-0.3
15	Gross State Domestic Product	7.6	7.3	7.5
16	Population ('00)*	0.5	0.5	0.5

Base Year 2011-12		Percentage Change over Previous Year		
		At Constant Prices		
Sl.	Industry of Origin/Year	2016-17	2017-18 (P)	2018-19 (Q)
17	Per Capita GSDP (₹)	7	6.7	6.9

P- provisional, Q- Quick Estimate

Source: Economic Review 2019, Volume II, Kerala State Planning Board.

From the above table, it is understood that in Primary sector, mining and quarrying was contributing higher and has decreased by -14.5 % due to banning of the activity due to recent floods. The only sector with a positive growth rate is fishing and aquaculture. It is observed that the growth rate of primary sector in terms of GSDP has decreased in the last two years. In secondary sector, manufacturing and utility segments has shown a significantly higher growth rate. The construction sector also indicated a positive growth rate. Overall, the secondary sector has fared well compared to other sectors.

In tertiary sector, all transport related segments such as railways, water transport, services incidental to transport, public administration, etc., are contributing higher. But, road transport is indicating a negative growth rate. This can also be attributed to floods and the losses it added to the road sector. The contribution from railways sector is commendable as it has shown a steady and higher growth rates and also indicates that taking up of SilverLine project from its initial stage itself will contribute well for the GSDP of Kerala.

4.1.4.3 Employment in the Organized & Unorganised Sector

Employment in organized sector: As per the Economic Review 2018, *'In Kerala, employment in the organized sector has remained more or less stagnant, showing only a marginal increase from 10.89 lakh in 2012 to 12.14 lakh in 2018. The reason behind this trend is due to the movement of the labor force to the public sector which provides more employment in the State.'*

The organized sector comprises private and public sectors and it is noteworthy that private sector employment is steadily increasing since 2011 onwards. In 2018, out of 12.14 lakh persons employed in the organized sector, 5.54 lakh (46%) are in the public sector and 6.60 lakh (54%) are in the private sector. Within the public sector employment 46% are employed in State Government, 11% in Central Government, 24% are in State quasi-institutions, 4% in LSGIs and 15% are in Central quasi-institutions.

In private sector, the employment is distributed between 21 sectors and citizens are mostly employed in manufacturing sector which 26.6%, followed by education (22.5%), administrative and support (9.8%), agriculture/forestry/fishing (8.3%), Information and communication (7.9%) etc.

Data on District-wise employment as on March 2018 reveals that Ernakulam and Wayanad are the two Districts which respectively accounted for the highest and lowest employment. Total organized sector employment in Ernakulam District is 2.47 lakh persons, which accounted for 20% of the total employment of the State. Whereas in Wayanad, the employment under the organized sector is 0.35 lakh persons, which accounted for 3% of the total employment. In Kerala, men outnumbered women in public sector employment and women outnumbered men in private sector employment. The share of men is 66% of public sector employment while that of women is 51% of total private sector employment. Thiruvananthapuram and Idukki are the two Districts which respectively accounted for the highest and lowest women participation in public sector employment. In Thiruvananthapuram, 31,037 women are employed in the public sector followed by Ernakulam (22,849), Thrissur (21,891) and Kollam (18,783). Whereas in Idukki, 3,387 women are employed in the public sector followed by Kasaragod (6,502), Wayanad (6,814), and Pathanamthitta (8,266)'.

Employment in unorganized Sector: As per economic review 2019, 'More than 90 per cent of workforce and nearly 50 per cent of the Gross Domestic Product is attributable to this sector. A high proportion of socially and economically weaker sections of society are engaged in the unorganised economic activities in India and Kerala. As per the PLFS 2017-18 report published by Gol, based on usual status (ps+ss) approach, it is estimated that self-employed workers in Kerala constituted 40.7 per cent of the total workers, while the share of regular wage/ salaried employee was 24.7 per cent'. As per census 2011, the main worker population in Kerala constitute to 93,29,747 workers.

4.1.4.4 Remittances - Contribution to Kerala Economy

As per the world bank, the top remittance recipients were India with \$79 billion, followed by China (\$67 billion), Mexico (\$36 billion), the Philippines (\$34 billion), and Egypt (\$29 billion). In 2019, remittance flows to low- and middle-income countries were predicted to reach \$550 billion, to become their largest source of external financing. In India, Kerala State accounts for the highest remittance with 19%.

The Centre for development studies (CDS), Kerala; conducted Kerala Migration Survey and the results were published through the working paper – 483, Emigration and Remittances: New Evidences from the Kerala Migration Survey (KMS), 2018. The working paper was published in 2019 and the major outcomes of the survey are as follows:-

- a) There are 2.1 million emigrants from Kerala across the world, and among the 14 districts, four (Malappuram, Kannur, Thrissur, and Kollam) account for 50% of the emigrants.

- b) The estimated total remittances to Kerala are Rs 85,000 crore as per KMS 2018. Within Kerala, one-fifth of the total remittance is to Malappuram (21%), followed by Kollam (15%) and Thrissur (11%).
- c) Remittances as percent of NSDP was 25.5% in 1998, 30.7% in 2008 and increased to 36.3 in 2014 and suddenly declined to 19.3% in 2018.
- d) Emigration figures showed a constant increase during the period 1998-2013 (34.9%) but declined thereafter till 2018 and indicated negative growth of 11.6% compared to 2013. The main reasons for the decline are as follows:-
 - (1) Demographic advances have decreased the population in the migration-prone age group (15-29 years) since Kerala attained replacement-level fertility as early as 1987.
 - (2) Wage levels in the Gulf economies have not improved after the global financial crisis.
 - (3) Wages in the domestic economy have increased compared to other states; Kerala has the highest wage rate in the informal sector in India.
 - (4) Prices of oil have been declining since 2010 and construction and other services are not as vibrant as it used to be.
 - (5) Due to Nationalisation policies such as Nitaqat and recently introduced family taxes in Saudi Arabia, the Gulf economies are not conducive for current and prospective migrants.
 - (6) Decades of investment in education have made Keralites skilled. High-skilled labour migrates to other parts of the world, mainly to the developed economies in the West.
- e) The emigrants are now concentrating more on investing in buying a car, starting an enterprise, and for education purposes, which increased by a percentage growth rate of 283.9% from 2013 to 2018. There was also increase in usage of remittance for household consumption (increased by 29%). A reduction in real estate in 2018 by 49.9% was also observed. This may be due to decline in real estate prices.

4.1.4.5 Proposed Projects and Investments in Kerala

The development in manufacturing sector and IT sector which will generate employment and is expected that a percentage of regional trips to shift to SilverLine. As per the Ascend 2020 conducted by the Government of Kerala, the investment in each sector and probable employment generation envisaged are provided in the **Table 4-11** below:

Table 4-11 Investment and employment generation in Manufacturing Sector

Sl. No.	Sector	Projects (in No.s)	Investment (in INR Cr.)	Direct Employment	Indirect Employment
1	Industrial Park, Logistics and MSMEs	34	26384	164010	332125
2	Infrastructure: Aeropolis and Ports	13	27565	8226	106300
3	Life science in Healthcare and Ayurveda	3	1575	25100	
4	Tourism and Hospitality	36	20586	17400	
5	Agro and Food Processing	5	377	750	
6	Mobility development and Electric Vehicles	10	73759	800	
	Total	101	150245	216286	438425

From the above table, it is observed that 1.5 lakh crore of investment and 2 lakhs direct employment and double the times in-direct employment. From the above, atleast 70% of the developments are proposed along SilverLine alignment.

Apart from manufacturing sector, IT sector is also expected for developments as technopark, infopark and cyberpark is envisaged for extension. The locations and SilverLine alignment are provided in the Figure 4-14 below and the area earmarked for development along with employment generation is provided in Table 4-6 below.



Figure 4-14 Proposed IT sector development area & SilverLine alignment

Table 4-12: Area and Employment generation in IT Sector

Sl. No.	Projects (in No.s)	Area (in Sq.ft)	Direct Employment	Indirect Employment
1	Technopark Phase III	5000000	35000	75000
2	Technocity	25000	3000	10000
3	World Trade Centre (Tvm)	2500000	15000	
4	Kollam Technopark	100000	1000	
5	Infopark Phase II Kochi	8000000	80000	
6	Infopark Trissur	330000	3000	15000
7	Infopark Chertala	240000	1500	
8	Cyberpark Kozhikode	300000	2000	
9	UL Cyberpark Kozhikode	62000	1500	
10	Cyberpark Kannur	250000	2500	
11	Cyberpark Kasaragod	25000	2500	
	Total	16832000	147000	100000

IT sector is expected to generate approximately 1.5 lakh employment.

The above development due to development of manufacturing sector and IT sector will also have impact on the GSDP and NSDP of the State and as the growth in GDP, GSDP and NSDP is already considered in estimated growth rate, the trips from development traffic due to other developments may not be considered to avoid duplication.

4.1.5 Tourism in Kerala

Kerala is one of the most popular tourist destinations in the country. Kerala is a leader in India when it comes to destination management, tourism promotion as well as tourist arrivals. Kerala tourism map is shown in **Figure 4-15**. The total annual tourists to Kerala constitute 48% of Kerala population.



Figure 4-15 Kerala Tourism Attraction Map

Source: Kerala's Approach to Tourism Development: A Case Study Ministry of Tourism & Culture, Government of India

The trends in annual domestic and foreign tourist arrivals in Kerala are shown in **Table 4-13**. About 0.42% and 6.35% increase was observed during 2017-18 for foreign and domestic tourist arrivals respectively.

Table 4-13: Yearly Tourist Arrival

Year	No. of Domestic Tourist Visits (in Lakhs)	% of Increase	No. of Foreign Tourist Visits (in Lakhs)	% of Increase	Total No. of Tourists (in lakhs)	% of Increase
2006	62.7	5.47	4.3	23.68	67.0	6.47
2007	66.4	5.92	5.2	2.37	71.6	6.84
2008	75.9	14.28	6.0	16.11	81.9	14.41
2009	79.1	4.25	5.6	-6.96	84.7	3.43
2010	86.0	8.61	6.6	18.31	92.5	9.25
2011	93.8	9.15	7.3	11.18	101.1	9.29
2012	100.8	7.41	7.9	8.28	108.7	7.48
2013	108.6	7.75	8.6	8.12	117.2	7.78
2014	117.0	7.71	9.2	7.6	126.2	7.71
2015	124.7	6.59	9.8	5.86	134.4	6.53
2016	131.7	5.67	10.4	6.23	142.1	5.71
2017	146.7	11.39	10.9	5.15	157.7	10.94
2018	156.0	6.35	11.0	0.42	167.0	5.94

Source: Kerala Tourism Statistics; Dept. of Tourism, Government of Kerala

The district wise tourist arrivals have been detailed in the **Table 4-14**. This data highlights the regional locations where the highest and lowest shares of tourists are attracted to. Maximum share of tourists (both Foreign and Domestic) are attracted to Ernakulam District (44.5% and 22.1% respectively).

Table 4-14: District-Wise Foreign and Domestic Tourist Arrivals

S No	District	Foreign Tourists (in 000's)			Domestic Tourists (in 000's)		
		2018	2017	% Variation over 2017	2018	2017	% Variation over 2017
1	Thiruvananthapuram	342.8	420.7	-18.53%	2712.4	2505.3	8.26%
2	Kollam	9.1	6.2	45.91%	400.2	381.8	4.82%
3	Pathanamthitta	2.0	2.0	-2.50%	192.8	164.5	17.22%
4	Alappuzha	95.5	75.0	27.30%	511.5	433.5	18.00%
5	Kottayam	43.3	32.4	33.81%	524.8	468.6	12.00%
6	Idukki	44.8	42.3	6.03%	1257.4	1090.1	15.35%
7	Ernakulam	488.2	454.0	7.53%	3446.9	3285.1	4.93%
8	Thrissur	11.3	10.8	5.18%	2497.3	2642.5	-5.50%
9	Palakkad	2.0	1.7	14.96%	509.9	474.2	7.53%
10	Malappuram	17.6	18.5	-4.56%	565.9	520.8	8.66%
11	Kozhikode	18.4	13.1	40.30%	1052.8	932.3	12.92%

S No	District	Foreign Tourists (in 000's)			Domestic Tourists (in 000's)		
		2018	2017	% Variation over 2017	2018	2017	% Variation over 2017
12	Wayanad	11.6	9.0	29.04%	888.1	815.6	8.89%
13	Kannur	5.8	5.1	12.49%	768.0	695.7	10.41%
14	Kasaragod	4.1	1.1	269.69%	276.6	263.5	4.99%
Total		1096.4	1091.9	0.42%	15604.7	14673.5	6.35%

Source: Kerala Tourism Statistics; Dept. of Tourism, Govt. of Kerala

The growth rate from 2017 to 2018 is minimal due to the State-wise flood during the months of August 2018. This may be the main reason for low footfall for foreign tourist. The details are provided in the Table 4-15 below:-

Table 4-15: Months-wise Arrival Details of Foreign Tourist (in 000's)

Sl. No	Month	2012	2013	2014	2015	2016	2017	2018	% of variation over previous year
1	January	106.3	113.6	119.9	130.5	136.5	150.8	168.0	11.39
2	February	103.2	115.4	127.2	132.9	141.1	135.1	152.0	12.52
3	March	75.5	86.0	93.2	100.2	107.0	107.1	120.7	12.67
4	April	61.3	66.4	72.4	76.7	78.1	82.6	85.5	3.46
5	May	30.5	32.6	36.3	39.6	38.0	49.1	45.4	-7.43
6	June	28.3	29.8	33.9	35.5	37.4	44.0	36.7	-16.56
7	July	43.0	45.8	48.6	51.7	56.7	72.6	68.9	-5.08
8	August	59.9	64.5	69.9	74.7	81.1	73.7	60.1	-18.46
9	September	47.4	51.0	54.2	57.6	62.6	54.7	44.8	-18.16
10	October	63.7	67.7	71.6	76.1	82.6	80.0	73.3	-8.37
11	November	78.8	83.5	87.7	89.9	96.2	107.0	99.3	-7.25
12	December	95.7	101.9	108.5	112.2	121.2	135.1	141.8	4.92
Total		793.7	858.1	923.4	977.5	1038.4	1091.9	1096.4	0.42

Source: Kerala Tourism Statistics; Dept. of Tourism, Govt. of Kerala

From the above table, it is observed that August and September witnessed foreign tourist footfall reduction in the range of 18% and continued till November.

4.1.6 Transport Characteristics

4.1.6.1 Vehicle registration growth

Table 4-10 and Figure 4-7 present the growth in motor vehicles in Kerala since 2011 to 2018. Table 4-11 presents the district wise vehicle registration and Figure 4-8 indicates the composition of registered motor vehicles as on 31st March 2018.

Table 4-16: Growth of Motor Vehicles in Kerala Since 2011 to 2018

Category-wise Growth of Motor Vehicles in Kerala since 2010 to 2018									
Sl. No	Type of Vehicles	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
I	GOODS VEHICLES								
1	Four Wheeler and above	294395	322450	354296	373218	411347	419813	438709	452535
2	Three Wheelers including tempos	117266	128452	206901	140278	154610	136938	142792	147542
II	BUSES								
1	Stage Carriages	19897	21457	34161	28386	31286	42707	44291	43575
2	Contract Carriages/Omni buses	119150	124290	137731	132144	145645	64051	68036	71557
III	CARS AND STATION WAGONS								
1	Cars	1060861	1226691	1358728	1538246	1702926	2070665	2264904	2500994
2	Taxi Cars	163407	175638	128250	194358	214214	107567	118661	127011
3	Jeeps	73700	73700	74167	73700	73700	0	0	0
IV	THREE WHEELERS INCLUDING TEMPOS								
1	Autorickshaws	518741	575763	602547	663241	730999	610235	630609	649612
2	Motorized Cycle rickshaws	61	0	0	0	0	0	0	0



Category-wise Growth of Motor Vehicles in Kerala since 2010 to 2018									
Sl. No	Type of Vehicles	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
V	TWO WHEELERS								
1	Motorized Cycle	1017	0	0	0	0	0	0	0
2	Scooter/Motor Cycles	3610838	4127227	5041495	5288529	5828816	6472335	70771039	7796669
VI	TRACTORS	12224	13740	14183	15030	15297	14213	14236	14798
VII	TILLERS	5335	5399	5399	5414	5967	187	0	0
VIII	TRAILORS	2324	2407	2744	2411	2657	699	699	720
IX	OTHERS	46106	68325	88071	93011	103781	232403	236061	237678
	TOTAL	6045322	6865539	8048673	8547966	9421245	10171813	11030037	12042691
	Percentage increase over the previous Year	18%	14%	17%	6%	10%	8%	8%	9%

Source: RTO

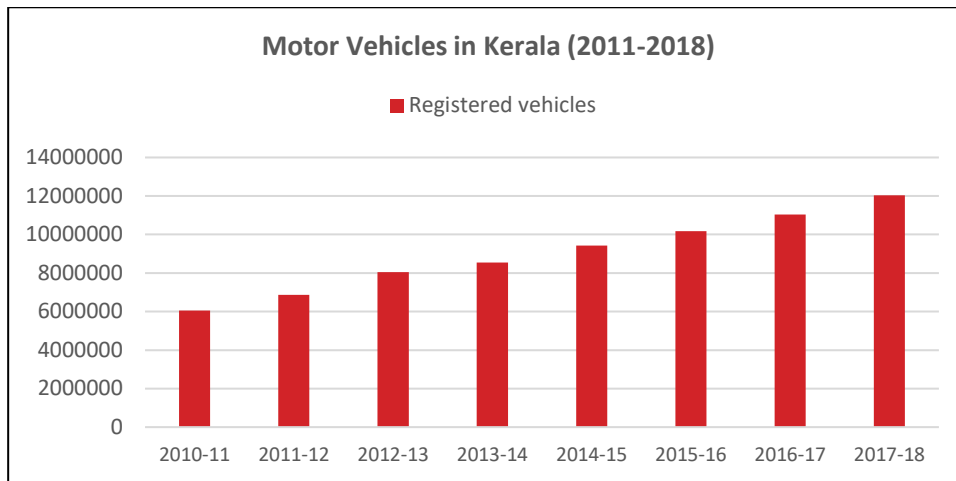


Figure 4-16 Motor Vehicles in Kerala (2011-18)

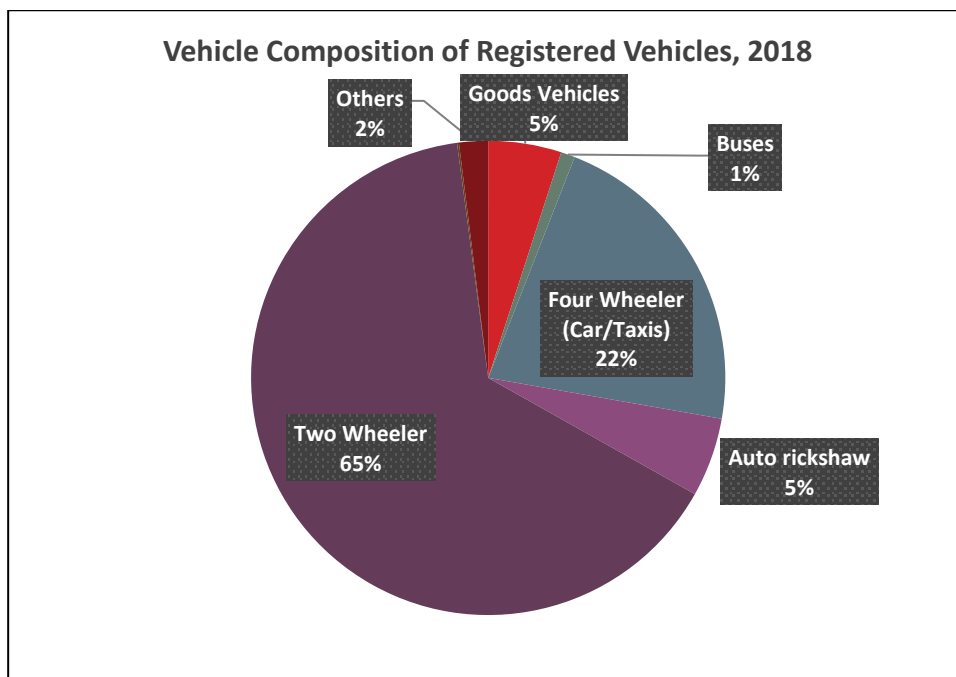


Figure 4-17 Vehicle Composition of Registered Motor Vehicles, 2018

Table 4-17: District Wise Vehicle Registration as on 31st March 2018

Sl. No.	District	Goods Vehicles	Buses	Four Wheeler (Car/Taxis)	Auto rickshaw	Two Wheeler	Tractors/Trailers	Others	Total
1	Thiruvananthapuram	52755	25374	340933	79687	998005	908	25752	1523414
2	Kollam	41143	6046	180542	52723	571909	685	15029	868077
3	Pathanamthitta	22248	3383	134246	26287	304492	364	11012	502032
4	Alappuzha	37239	6234	154028	29764	589315	757	13453	830790
5	Kottayam	41196	8362	213793	42957	418277	712	19520	744817
6	Idukki	16128	3175	61153	23171	129877	442	7677	241623
7	Ernakulam	92393	15360	419485	61079	1165472	2292	40787	1796868
8	Thrissur	56635	12522	252011	63050	840537	2347	21215	1248317
9	Palakkad	39980	6461	131449	46852	577799	3475	12601	818617
10	Malappuram	72895	8410	225172	80122	685834	1685	22940	1097058
11	Kozhikode	52530	7934	205424	55146	777561	485	15411	1114491
12	Wayanad	12426	1528	38854	14044	103784	755	4702	176093
13	Kannur	47531	8167	180593	49170	437227	330	16577	739595
14	Kasaragod	14978	2176	90322	25560	196580	281	11002	340899
	Total	600077	115132	2628005	649612	7796669	15518	237678	12042691

Source: RTO

4.1.6.2 Transport Sector Projects and Initiatives

The Govt. of Kerala has been a front runner in promoting public transport. However, in the recent past, a trend towards the personalised transport has been observed and therefore the Govt. has decided to revitalise public transport, and improve the road & rail infrastructure with focus on modern transportation systems and globally recognised best practices. The projects and initiatives can be divided into categories such as initiatives at Policy level, Urban transport, road infrastructure, rail infrastructure etc. The projects and initiatives are the following:-

At Policy Level:-

- **Approval of Kerala Metropolitan Transport Authority (KMTA) Bill:** As per the KMTA Act, Metropolitan Transport Authorities will be formed in three major cities - Thiruvananthapuram, Kochi and Kozhikode - and they will be declared urban mobility areas. The authority will be the umbrella body which is responsible for the development, operation, maintenance, monitoring and supervision of urban transport in urban mobility areas. As per the union government's Metro Rail policy, the formation of a Unified Metropolitan Transport Authority (UMTA) is a pre-requisite for Metro Rail projects. Integration of different modes of transport, seamless ticketing, fare revision, renovation of the bus transport system and other activities come under KMTA. Parking policy, intelligent transport facility and other amenities also come under the purview of authority. The main responsibility of KMTA are:-
 - Bring an integration of various departments related to the urban transport sector
 - Better, effective solutions to issues in urban transport sector
 - KMTA to prioritise actions based on future transport requirements
 - Overseeing urban transport policy for urban mobility areas
 - Managing network of integrated transport, including rail, boats, buses, cabs, rickshaws
- Draft Electric Vehicle (EV) Policy for Kerala is prepared
- Public Transport Policy for Kerala is under preparation
- Road Safety Action Plan is under preparation
- Private Participation in Passenger Trains: Ministry of Railways and National Institution for Transforming India (NITI) Aayog, Government of India are spearheading participation of private entities in operation of passenger trains on 100 routes. It is presently under tendering stage.
- Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) Scheme: The National Electric Mobility Mission Plan (NEMMP) 2020 is a National Mission document providing the vision and the roadmap for the faster adoption of electric vehicles and their manufacturing in the country. As part of the NEMMP 2020, Department of Heavy Industry formulated a Scheme viz. Faster

Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) Scheme in the year 2015 to promote manufacturing of electric and hybrid vehicle technology and to ensure sustainable growth of the same. Phase I focused on (i) Demand Creation, (ii) Technology Platform, (iii) Pilot Project and (iv) Charging Infrastructure. Phase II is expected to support adoption of 7000 EV buses through incentives and subsidy in operation.

The above policies and frameworks are required for improving the modal share of public transport in the state and also for promoting sustainable mobility. The policies also try to bring efficiency in operation of public transport.

Urban Transport Initiatives:

- **Expansion of Kochi Metro Rail:** the KMRL is operating MRTS in Kochi from Aluva to Thykudam as on March 2020. The work on the stretch from Thykudam to Petta is under construction and further extension up to Tripunithara is also under execution stage. The line from JLN Stadium to Kakkanad is under planning stage. K-Rail is also planning to have SilverLine Ernakulam Station at Kakkanad. This will have positive impact on the ridership of SilverLine due to addressing of first and last mile connectivity issues. The extension of line from Aluva to Kochi Airport and Angamali is also under planning stage (DPR stage).
- **Kochi Water Metro Project:** the project is under execution stage and will be implemented in two phases. Phase I with 7 routes and phase II with 9 routes connecting various islands in Kochi Region. The total length will be 76 Km and the line from Fort Kochi-Thevara-Vytilla-Kakkanad is expected to be operational by 2021.
- **Light Rail Transit (LRT)/MetroLite for Thiruvanthapuram:** Kerala Rapid Transit Corporation Limited (KRTL) is a Special Purpose Vehicle (SPV) of the Government of Kerala, set up for the implementation and subsequent operation and maintenance of the Metro Rail Systems in the city of Thiruvananthapuram. Presently the project is under planning stage. The City centre will be connected to Technocity in Pallipuram and there are also proposal to connect Thiruvanthapuram International Airport.
- **Light Rail Transit (LRT)/MetroLite for Kozhikode:** this project is also under planning stage is under the SPV – KRTL. The project is proposed to connect all major activity centres and mobility hubs in the city.
- **National Common Mobility Card (NCMC):** In line with central governments ‘one nation one card’, the GoK is in the process of enhancing the usage of NCM card as Driving Licence and to rebrand the card as “God’s Own Travel card (GOT?)” for Travel, Shopping and as a Driving Licence for the state of Kerala.

- **Other Urban Transport projects under Rebuild Kerala Initiative (RKI):** other urban transport projects under RKI are provided in the table below.

Table 4-18: Urban Transport Projects under RKI

Sl. No.	Key Activities	Status	Funding requirement* (INR Cr.)
1	Institutionalization of Green mobility corridors for promotion of Public Transport along National Highway (NH-66) – Kodungalloor to Eramalloor (52 km)	Feasibility Study Completed	580.35
2	Development of E- Bus corridors – Poothotta-Angamaly, 48 km (SH 15)	Feasibility Study Completed	677.51
3	Development of E- Bus Corridor as part of the Carbon Neutral Sabarimala (19 km)	Feasibility Study Completed	10 (Civil & EV Charging)
4	Constitution of “Kerala Bus Port Limited” & “Kerala Logistics Port Limited”	Concept note Planned	45
5	Development of Multimodal Logistics Port at Kalamassery	Concept note prepared	50
6	Development of e-Bus Corridor - Munambam-Goshree (link to Paravoor)	Concept note prepared	160
7	Development of New Generation Tram (LRT) between Thoppumpady and Goshree	Feasibility Study Completed	1000
8	Development of ICTT Rail Bus Project	Pre-Feasibility Study Completed	31

Most of the urban transport projects are focused on the three main cities of Ernakulam, Thiruvanthapuram and Kozhikode and may impact positively to the increase in ridership of SilverLine as it addresses the issue of first mile and last mile connectivity.

Road Infrastructure projects

As per the Hon. Chief Minister, GoK web portal, the major announcement for the road infrastructure projects are as follows:-

- Following international standards, National Highways will be widened an extra 45 metres, to ensure safety and security.
- A Special Safety Corridor (SSC), aiming at reducing road accidents by 30%, from Kazhakkuttam to Adoor (80 km) in the MC Road is being conceived initially, to be followed throughout the state at the next level.

- Flyovers in busy traffic junctions, such as Pattom, Sreekaryam and Ulloor, are under consideration and Rs. 2.73 Billion has been allocated to the construction of a flyover at Thampanoor.
- **Kerala Sustainable Transport Project (KSTP) Phase II:** this is World Bank funded project and the Stretches identified under the KSTP-II and the status of project are as provided in the table below.

Table 4-19: Road Projects under KSTP

Sl.No	Name of work	Revised contract amount (in Cr.)	Physical Progress (%)	Remarks
1	UG – 1 Kasaragod – Kanghai Road (27.78 km)	114	99	Only finishing work left
2	UG – 2 Pilathara – Pappinisserry Road (20.90 km)	102	99	Only finishing work left
3	UG – 3A Thalassery – Kalarode Road (28.80 km) (Re-arranged)	156	62	Re arranged
4	UG – 3 B-Kalarode – Valavupara Road (25.20 km) (Re-arranged)	200	86	Re arranged
5	UG – 4-Chengannur Ettumanoor Road (45.40 km)	288	100	Completed
6	UG – 4 A Thiruvalla By pass (2.3 km)	37.03	46	Being Re arranged
7	UG -4B: Thiruvalla Town (Re-arranged) (2 Km)	7.7	84	Being Re arranged
8	UG – 6-Ponkunnam – Thodupuzha Road (50 km)	270	100	Completed
9	UG – 7-Perumbilavu – Perintalmanna Road (41 km)	210	100	Completed
10	UG -5-Ettumanoor – Muvattupuzha Road (40.96 km)	115.69	100	Completed
11	Safe Corridor Demonstration Project Kazhakuttam – Adoor	142.67	35	Work in progress

Source: KSTP

- Road infrastructure projects under RKI: the RKI has also identified projects for the improvement of transportation sector and the road projects are as provided in table below.

Table 4-20: Road Projects under RKI

Sector	Brief Description: Project/Investment (including key components/elements)	Department	Estimated Outlay in Rs. Crore
Rural Roads	Reconstruction and Rehabilitation of LSGD Roads using PMGSY standards covering 8 Districts. Construction contracts shall have 4-year maintenance period.	LSGD - Gram Panchayats	247.94
Urban Roads	Reconstruction and Rehabilitation of LSGD Roads using PMGSY standards covering 7 Municipalities. Construction contracts shall have 4-year maintenance period.	LSGD - Urban Local Bodies (ULBs)	86.9
Corporation Roads	Reconstruction and Rehabilitation of LSGD Roads using PMGSY standards covering 1 Municipal Corporation. Construction contracts shall have 4 year maintenance period.	LSGD - Thrissur Municipality	7.53
	Sub Total A		342.37
State highways and key Feeder roads	Mukkada Edamon Athikkayam Kakkudumon Mandhamaruthy Road	PWD	80
	Pathanamthitta- Ayroor- Muttukudukka Illathupadi - Muttukudukka Prakkanam - Prakkanam Elavumthitta - Kulanada Ramanchira - Thannikuzhy Thonnamala	PWD	112.46
	Edathua - Thayamkary- Kodupunna-Ramankary- Mancombu Kavalam Vikas Marg Road- Kannady Jn - Thattasserry- Neelamperoor-Kurichi Road	PWD	108
	Gandhinagar-Medical College-Babu Chazhikadan Road-Kottayam-Parippu Road-Athirampuzha Liessue-Kaippuzha-Mannanam-Pulikkuttissery-Parolickal-Muttappally Road	PWD	87.8
	Improvements to Painavu Thannikandom Asoakkavala road	PWD	84
	Idukki Neriymangalm road	PWD	96.2
	Improvements to riding quality of Chemmannar Gap road	PWD	83.4
	Thrissur Kuttippuram Road (SH 69)	PWD	119.92
	Rahabilitation of Nenmara-Nelliampathy Road	PWD	122.84
	Improvements to Koyilandy Thamrassery Mukkam Areekode Edavanna (KTMAE- SH 34)	PWD	204.8
	Rehabilitation of Vythiri- Tharuvana road	PWD	83
	Mananthavady LAC- Improvements to Mananthavady - Vimalanagar - Kulathada - Valad HS - Periya road	PWD	99.2

Sector	Brief Description: Project/Investment (including key components/elements)	Department	Estimated Outlay in Rs. Crore
	Edoor – Companynirath - Angadikkadavu– Charal - Valavupara - Kacherikkadavu - Palathumkadav road	PWD	88
	Other key damaged highways and feeder roads and bridges in the districts of Idukki, Alappuzha and Patthinamthitta	PWD	630
	Sub Total B		1,999.62
	Grand Total		2,341.99

Source: Rebuild Kerala Development Programme, 2019

Improvement to all the NH, SH and other roads which are perpendicular to the alignment of the SilverLine shall have a positive impact on the ridership.

Rail Infrastructure Projects:

The major rail infrastructure projects proposed in Kerala are provided below in brief as the details are provided in chapter 1 and chapter 3 of this project.

- Sabari Railway Project - The new line connecting Angamali-Sabarimala.
- Doubling of line between Kayamkulam and Ernakulam via Allepy along with improvement in operating speed
- Doubling of line between Kottayam and Chingavanam
- Third line between Thiruvananthapuram and Thrissur
- New Line between Thirunavaya – Ponnani
- New Line from Nilambur to Nanjankode
- New siding at Kanjikode
- New line from Thalassery to Mysore: Project under the purview of K-Rail
- Electrification between Thiruvananthapuram and Kanniyakumari: The Cabinet Committee has also approved the construction of double line with electrification between Thiruvananthapuram in Kerala and Kanniyakumari in Tamil Nadu. The total length of the line will be 86.56 km while the estimated cost of the Project will be Rs.1431.90 crore and completion cost of Rs.1552.94 crore with 5% escalation per annum.

4.1.6.3 Impact of Transport Sector Projects and Schemes on Silverline

Impact of Road Projects on SilverLine

The improvement projects of NHs and SHs such as road widening and bundling of bypasses to NH 66, NH 766, SH 69, Kasaragod- Kanjagad Road etc., which are parallel to the alignment of the SilverLine shall have a negative impact on the ridership of SilverLine. This is mainly due to achieving higher journey speed and less journey time by private modes as well as buses that reduces the travel time savings. This in turn result in

negative shift due no change in cost savings. But, if the NHs and SHs are made to toll roads, due to higher costs, it may lead to positive shift to SilverLine.

In case of other NHs and SHs such as NH – 544, 85, 744, 966, 183, 183 A & 185 and SH perpendicular to SilverLine may act as feeder network. Any improvements such as widening will improve the travel time of first mile and last mile journey either by private vehicle or public transport. This may have a positive impact on the ridership of the SilverLine with additional provisions of inter-modal and interchange facilities with park and ride facilities.

So overall, the improvement to road project and the impact on the ridership assessment may not be significant and if considered will have only positive impact.

Impact of Operations of Electric Vehicles

India is embarking on the path of adopting electric vehicles in the country with the target of all electric vehicles fleet by 2030 as per the NITI Aayog. This seems quite ambitious considering at present the electric vehicle fleet is less than one percent. A review of global research and practices in electric mobility shows that electric vehicles are very costly as compared to conventional vehicles while the technology is also comparatively new to reach a significant level in the vehicular fleet in any country. As stated earlier, FAME was introduced by the Central Government and phase II focuses on deployment and operation of EV Buses in Indian cities through private operators and STUs shall remain regulators. The subsidy shall be disbursed based on per kilometer operational charges and only when STUs have introduced Gross Cost, Net Cost or Hybrid operational models involving private player for operations. In Kerala, the KSRTC invited tender for selection of private operators for wet leasing and operation of buses. But, did not materialize.

At present the KSRTC is operating 8-9 buses on wet lease for 10 years duration. The 9-metre-long eBuzz K9 buses were manufactured by Olectra Greentech in a tie-up with BYD. The wet lease bid was won by the Mumbai-based Maha Voyage LLP with a quote of ₹ 43.20 per km (lowest). As per cost analysis of KSRTC, it is anticipated to get a net balance of ₹6,500 per bus daily after electricity cost and wet lease amount.

The trial/pilot was done on route from Nilakal (a place near Sabarimala 20Km away and hilly terrain) to Sabarimala during the previous Sabarimala season. Based on the data from transport department, on an average, the BEVs operated 360 km daily on the Nilackal-Pampa corridor. From the services, the KSRTC got a profit of ₹57 a km, including the electricity cost, out of the fare collection of ₹110 a km. Only 0.8 unit of electricity is needed for the BEV to run a kilometer. Compared to the operational cost of ₹31 a km for HSD-powered buses, the BEVs operational cost is ₹6. All these factors worked on trial basis but daily operations with large fleet and charging infrastructure is yet to be assessed to know the actual benefits.

As per UITP, the acceptance of electric and hybrid buses is slow in India, mainly due to cost factor. The average cost of hybrid or electric buses is 3-4 times higher than diesel

buses. Further, with the decrease in the cost of diesel, there is not much incentive for the operators to shift to hybrid or electric buses. The details of the buses under each segment and their cost is provided in the table below.

Table 4-21: Road Projects under KSTP

Segment	Diesel Buses		CNG	Hybrid Electric	Pure Electric
Model	Volvo 8400 (AC)	Tata STARBUS SLF 44 (AC/Non-AC)	Tata STARBUS LE CNG 18 (AC/Non-AC)	Tata STARBUS Hybrid (AC/Non-AC)	BYD K9 (AC)
Seats	32	44	18	32	31
Fuel Efficiency	2.2 Km/L	3.5 Km/L	2-3 Km/Kg	2.2-4 Km/L	1.5 kWh/Km
Fuel Cost	INR 23/Km	INR 15/Km	INR 13-19/Km	INR 10-17/Km	INR 10/Km
Range	484	560	260-390	286-520	249
Charging Time					3-6 Hr
Cost of Bus (in INR)	88 Lakhs	33 Lakhs	30 Lakhs	1.2-1.4 Cr.	2-3 Cr.

Source: UITP, 2019

From the above table, it is observed that the efficiency of buses and cost of operation is low but, the initial investment on the buses are atleast 3 times higher than normal ICE buses. So, regarding the impact of electric bus operations on SilverLine, it is also to be noted that the buses may have to operate on congested network in future and may reduce the benefits received from reduction in operational cost and ultimately fares. So the impact can be accounted only when the bus operations are stabilized and fares are reduced/subsidized by the STUs considerably.

Regarding private EVs such as cars, the capital cost is very high and the segments are under R&D stage. The electric cars are expected to launch with reduced cost from end of 2020. But, the infrastructure provision such as charging points are in nascent stage and may take longer duration to get stabilized. Also, as stated earlier, the vehicles have to use the same congested network in future. So, any benefits from the operational cost to the user is reduced by higher journey time.

Impact of Privatisation of Train Operations

This may bring efficiency and punctuality in operations, but may increase the fares. So, any impact on the SilverLine ridership due to operation of trains by private player is based on the fare setting.

Impact of Rail Infrastructure Projects

The doubling of lines, addition of 3rd line and improvement to curves and improving speed on the exiting railway operations will have impact on the ridership of the SilverLine. With no increase in fares, the passengers travelling by sleeper and 3rd AC class may not be willing to shift to SilverLine. But, if fares are increased, then no impact is expected as SilverLine provides higher travel time savings and cost savings to user is also low.

4.1.6.4 Issues and challenges in Road Transport Sector

As per the Department of Economics and Statistics, Kerala, *“most of the roads in the State do not have adequate width to address the existing level of traffic, only one fourth of the roads have either two lanes or four lane capacity while most of the other roads have single lane or intermediate lane capacity. In the case of National Highways also, only about 12 per cent of the roads have four lane capacities while the remaining roads have only two lanes or intermediate lane capacity. Bulk of the inter-city and interstate traffic is carried out by the National and State Highways which constitutes only 8 per cent of the total network. Considering the demand supply gap, there is a huge need for up gradation of existing road network. The existing road network has to undergo a qualitative improvement with the aim to reduce traffic congestion and delay, easy access to destinations and reduction in accident risks. Most of the PWD roads have to undergo massive upgradation with widening duly incorporating road safety features”.*

Post Flood Scenario in Kerala:

As per the Kerala State Planning Board, *“About 2004 km of State Highways and 13,246 km of MDR across 14 districts have suffered varying degree of damages during the recent floods. The NH wing has estimated damage of about 580 km of NHs. The post flood impact analysis indicates heavy damages due to land slide/slips in the roads in four hill Districts of Idukki, Wayanad, Pathanamthitta and Palakkad, whereas roads in the seven Districts of Alappuzha, Thrissur, Ernakulam, Kozhikode, Malappuram, Kollam and Kottayam have sustained flash floods, erosion, water stagnation and other flood induced damages. The roads in Thiruvananthapuram, Kasaragod and Kannur Districts have also sustained minimal damage.*

1,090 km of State Highways and 6,527 km of MDRs have sustained light damages and would largely require pavement rehabilitation through patching, shoulder repairs and limited debris clearance. 734 km of State Highways and 6,463 km of MDRs have sustained medium to heavy pavement damages and would require re-laying of surfacing and limited repair of drainage, cross drainage and protection works. 179 km of SH and 256 km of MDR have been fully damaged and would require full pavement reconstruction, significant repair/reconstruction of drainage, cross drainage and slope protection works and limited road raising and new cross drainage works.

The overall cumulative damages for State Highways and MDR are estimated to be ₹7,647 crore and for NHs an additional need of ₹911 crore has been assessed. The State

Government has started providing immediate short-term repair of pavements and cross drainage structure, clearance of debris and temporary protection works to restore the access and keep the roads traffic worthy. The rehabilitation of the lightly damaged roads is largely through measures like pothole patching, to keep the roads traffic worthy.

7,197 km of roads (734 km of State Highways and 6,463 km of MDR) are severely damaged but are recoverable. 36 major and 178 minor bridges, 362 culverts, 43 km length of retaining wall and 169 km of roads side drainage works are severely damaged. Reconstruction of bridges/culverts needs to be assigned priority followed by adequate hill slope protection and flood protection works”.

4.1.7 Road Accidents

Road accidents in the State are among the Nation’s highest. Kerala stands third in terms of road accidents. Even though several initiatives have been taken by the Police to enforce road discipline and enforcement of rules by Motor Vehicles Department, road accidents are increasing. The bigger States like Uttar Pradesh, Gujarat and Rajasthan report far less number of accidents compared to Kerala.

Rapid motorization in the number of vehicles registered in the State, has created an intense pressure on the road infrastructure. In addition, the increased number of accidents in the State is also a growing concern. Most of the accidents are attributable to the fault of drivers as per records available with traffic police. However, deficiencies in road design also affect motor vehicles, a fact generally overlooked as bad road conditions. Road safety training for various categories of road users, rectification in road design, deficiencies in inclusion of road safety aspects in the planning and operation stages of road construction are the primary facts to be taken up for reducing accidents.

The trend of road accidents in Kerala since 2001 is shown in **Figure 4-18** . District wise road accident details for year 2018(1st January to 31st December) is presented

Table 4-22. Details of cause of accidents in the year 2018 are given in **Table 4-23**.

The details of road accident by vehicle type involved is given in **Table 4-24** and **Figure 4-19**.

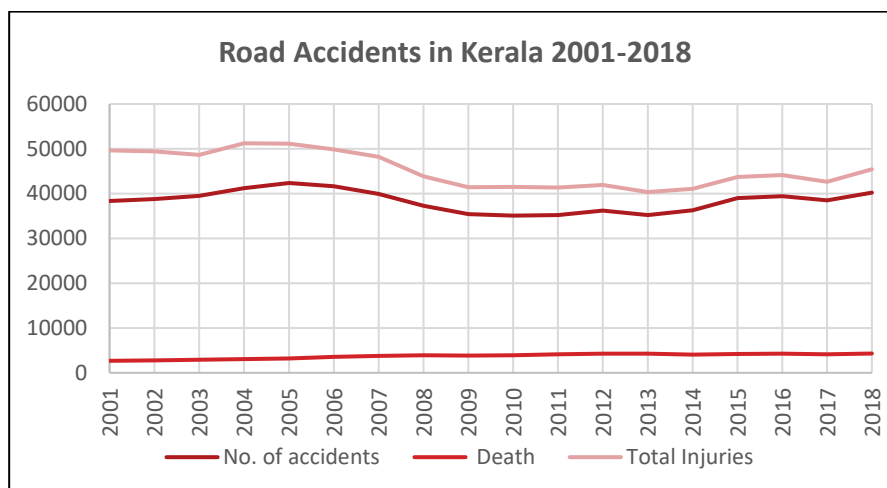


Figure 4-18 Trend of Road Accidents in Kerala 2001-2018

Source: keralapolice.org

Table 4-22: District Wise Road Accident Details (Year 2018)

District	Accident Type					Persons Involved			
	Fatal	Grievous	Minor	Non Injury	Total	Death	Grievous	Minor	Total
Thiruvananthapuram city	195	1880	178	53	2306	202	2033	714	2949
Thiruvananthapuram Rural	332	2728	124	39	3223	342	3068	592	4002
Kollam city	226	1526	140	48	1940	241	1691	306	2238
Kollam rural	220	1179	110	29	1538	228	1299	289	1816
Pathanamthitta	139	1190	197	1	1527	149	1320	456	1925
Alappuzha	348	2571	546	24	3489	373	2840	1294	4507
Kottayam	268	2023	467	166	2924	279	2289	915	3483
Idukki	82	808	241	51	1182	91	931	606	1628
Ernakulam city	131	1651	436	193	2411	141	1753	725	2619
Ernakulam rural	305	2650	617	13	3585	317	2800	1031	4148
Thrissur city	207	1538	364	113	2222	218	1670	923	2811
Thrissur rural	221	1554	338	72	2185	231	1695	807	2733
Palakkad	329	1456	537	89	2411	347	1574	1048	2969

District	Accident Type					Persons Involved			
	Fatal	Grievous	Minor	Non Injury	Total	Death	Grievous	Minor	Total
Malappuram	346	1677	217	183	2423	367	1911	690	2968
Kozhikode city	144	966	205	108	1423	154	1062	490	1706
Kozhikode rural	173	1210	183	108	1674	187	1372	549	2108
Wayanad	67	404	123	40	634	74	445	336	855
Kannur	217	1205	579	69	2070	233	1348	1243	2824
Kasaragod	119	498	369	28	1014	129	571	772	1472
Total	4069	28714	5971	1427	40181	4303	31672	13786	49761

Source: keralapolice.org

Table 4-23: Cause of Accidents (Year 2018)

Accidents Classified According to Type of Traffic Violation-2018									
Traffic Violation	No. of Accidents					No. of Persons			
	Fatal	GI	MI	NI	Total	Killed	GI	MI	Total
Over Speeding	2806	21613	4280	1077	29775	2985	23831	10158	36965
Jumping Red Light	8	74	17	6	105	8	81	32	121
Driving on Wrong Side	106	1035	250	64	1455	115	1161	552	1828
Unknown	560	2779	707	144	4191	582	3048	1482	5112
No Violation	567	3171	641	119	4498	589	3498	1446	5531
Drunken driving	22	42	76	17	157	25	53	116	194
Total	4069	28714	5971	1427	40181	4303	31672	13786	49761

Source: keralapolice.org



Table 4-24: Motor Vehicles Involved in Road Accidents in Kerala during 2018

Category-wise details of Motor Vehicles Involved in Road Accidents in Kerala during FY 2018 (April 2017- March 2018)											
Sl. No	District	KSRTC Buses	Other Buses	Goods Vehicles	Motor Cars	Jeeps	Auto Rickshaws	Two wheelers	Miscellaneous vehicles	Class not known	Total
1	Thiruvananthapuram City	100	43	88	679	12	313	2114	70	6	3425
2	Thiruvananthapuram Rural	127	87	201	847	31	372	3271	102	5	5043
3	Kollam City	45	101	158	638	11	165	1824	133	8	3083
4	Kollam Rural	64	81	124	453	27	174	1322	57	2	2304
5	Pathanamthitta	63	87	99	590	22	199	1318	59	9	2446
6	Alappuzha	99	147	342	956	12	320	3104	322	10	5312
7	Kottayam	95	223	236	1217	55	330	2290	117	19	4582
8	Idukki	54	95	89	450	106	181	761	30	4	1770
9	Ernakulam City	68	237	232	895	11	265	2203	135	9	4055
10	Ernakulam Rural	81	216	376	1037	44	368	3207	161	10	5500
11	Thrissur City	24	156	122	523	12	188	1260	71	1	2357
12	Thrissur Rural	66	218	282	935	25	325	2634	202	12	4699

Category-wise details of Motor Vehicles Involved in Road Accidents in Kerala during FY 2018 (April 2017- March 2018)

Sl. No	District	KSRTC Buses	Other Buses	Goods Vehicles	Motor Cars	Jeeps	Auto Rickshaws	Two wheelers	Miscellaneous vehicles	Class not known	Total
13	Palakkad	33	213	276	707	49	332	2252	113	14	3989
14	Malappuram	56	230	343	919	56	338	1778	85	11	3816
15	Kozhikode City	37	255	124	512	27	149	1219	49	13	2385
16	Kozhikode Rural	41	208	171	524	44	206	1395	69	3	2661
17	Wayanad	29	55	69	251	29	97	494	22	4	1050
18	Kannur	50	208	189	628	46	346	1361	72	10	2910
19	Kasaragod	29	57	113	403	21	123	666	33	5	1450
	Total	1161	2917	3634	13164	640	4791	34473	1902	155	62837
	Percentage to Total	1.85	4.64	5.78	20.95	1.02	7.62	54.86	3.03	0.25	100

Source: State Crime Records Bureau

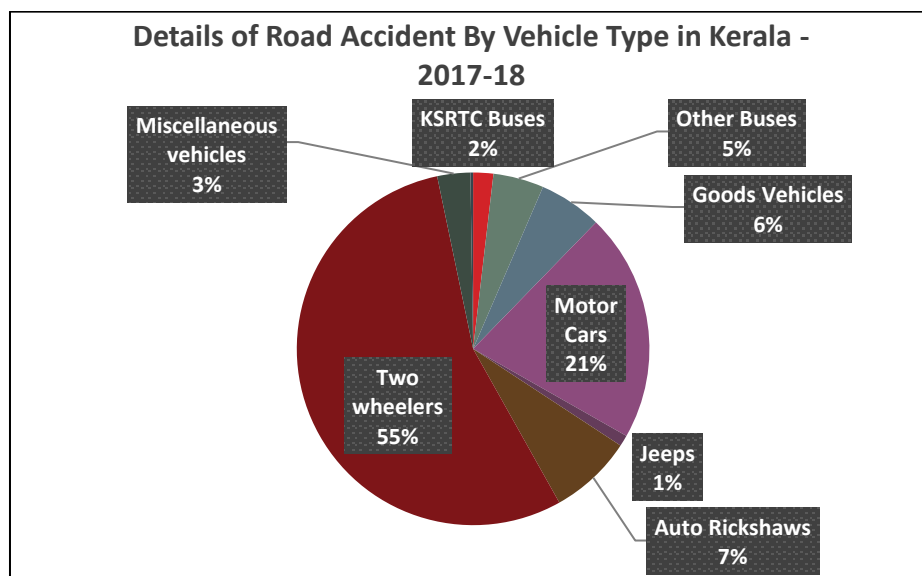


Figure 4-19 Details of Road Accident by Vehicle Type in Kerala, 2017-18

Infrastructure-wise accidents

Infrastructure-wise accidents can be categorised into road accidents, rail accidents and accidents at railway crossings. The details of road accidents are provided in the above sections. Regarding railway crossing accidents, as per NCRB, 2019 report, maximum railway crossing accidents were reported in Uttar Pradesh accounting for 44.3% (656 out of 1,481 cases) followed by Bihar (15.0%) (222 cases) and Kerala (12.2%) (180 cases). These States have also reported highest fatalities in railway crossing accidents, accounting for 46.0% (693 out of 1,507 deaths), 14.7% (222 deaths) and 11.8% (178 deaths) respectively during 2018.

Maximum railway accidents were reported in Maharashtra accounting for 23.0% (6,349 out of 27,643 cases) followed by Uttar Pradesh (11.8%) (3,272 cases). These two States have also reported highest fatalities in railways accidents, accounting for 15.5% (3,801 out of 24,545 deaths) and 12.6% (3,095 deaths) of total deaths in railways accidents respectively. Kerala railway figure stands at 16th position at 0.97%.

the comparative statement of road accident, railway accident and accident at railway crossing in Kerala is provided in the table below.

Table 4-25: Kerala - Infrastructure-wise accident 2018

Type	Road			Rail			Rail Crossing			Total		
Location	Cases	Injured	Died	Cases	Injured	Died	Cases	Injured	Died	Cases	Injured	Died
KERALA	40181	45458	4303	258	16	253	180	2	178	40619	45476	4734
(in %)	99	99.96	90.9	1	0.04	5.3	0	0.00	3.76	100	100	100

Source: NCRB, 2019

From the above table, in case of accident cases, it is observed that maximum accident cases are observed on road which is 99% followed by railway accidents (near to 1%). But in case of fatality, 90.9% is observed on road, 5.3% due to railway accident and 3.76% at railway crossing. It clearly indicates that, even though the cases are lower by railway accident or at crossing but fatalities rate is marginally higher.

4.2 DATABASE DEVELOPMENT

4.2.1 Approach and Methodology in Brief – Traffic Surveys

The aim of this report is to understand characteristics of existing transportation systems by conducting traffic surveys in the project corridor. The estimation of candidate traffic and patronage forecast requires well-defined traffic database containing relevant information concerning traffic flow characteristics. The broad methodology followed for the traffic surveys and analysis is presented in Figure 4-11. Candidate traffic for rail and car are also estimated in this report. Secondary data required for estimation of candidate traffic from bus is being collected from major bus depots and private bus operators.

Reconnaissance survey done along the project corridor helped in understanding general characteristics of the traffic along the corridor. It helped in identifying survey locations, and provided valuable insight during analysis.

Secondary data such as railway reserved passenger data, bus trips, toll traffic, fuel sales, railway goods traffic etc were collected .

Primary traffic surveys are conducted at pre-planned locations to identify existing demand on transportation systems and characteristics of existing traffic.

Data collected from primary and secondary sources are analysed in detail and used as the input for assessment of candidate traffic and SilverLine patronage forecast.

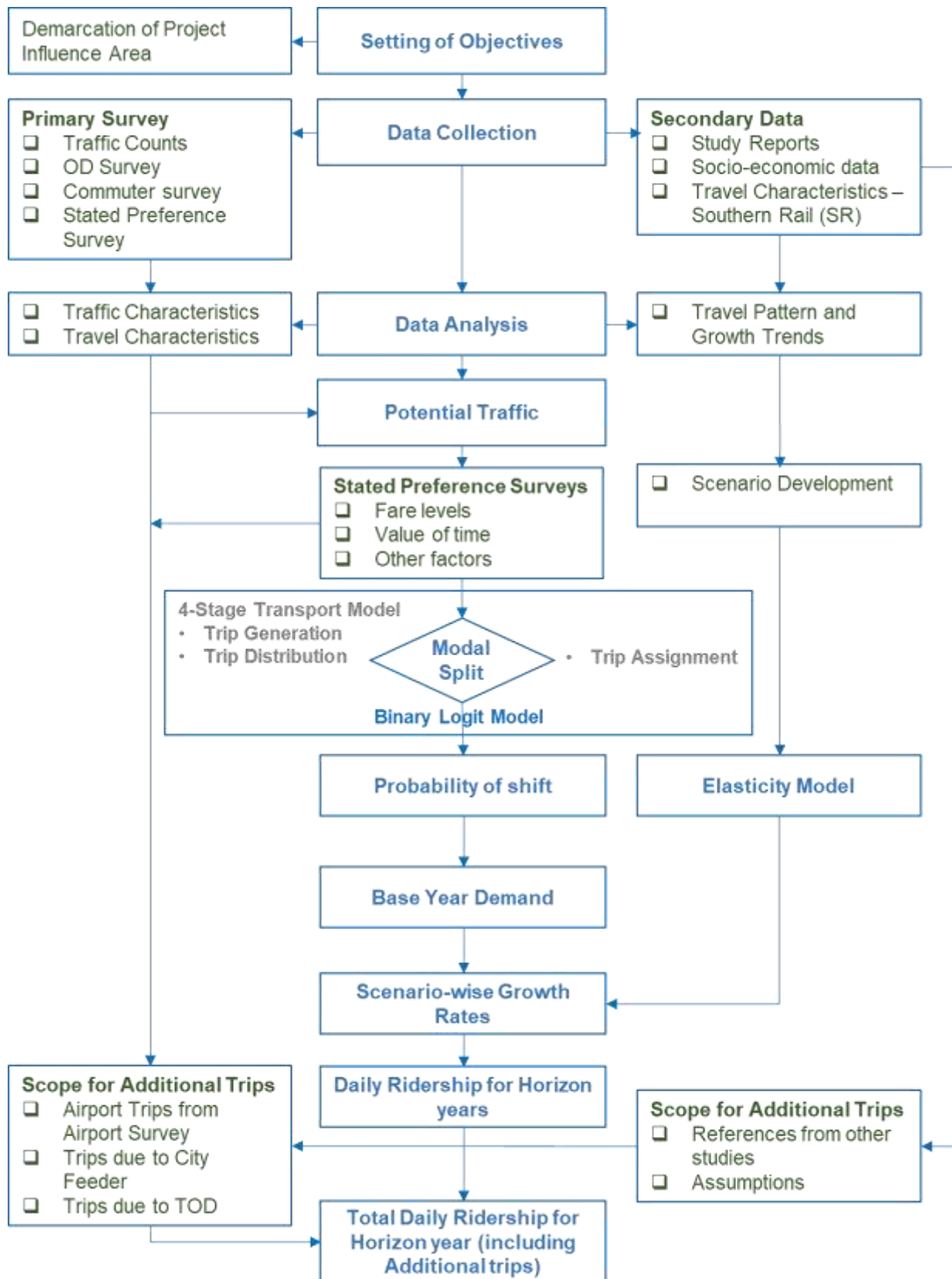


Figure 4-20 Approach and Methodology - Traffic Surveys

The growth rates were estimated based on the socio-economic data and also the vehicle registration data available from secondary data sources. The base year is considered as 2019-20, commissioning year as 2025-26 and horizon year as 2052-53. Apart from the above, for financial estimations, the projections was done till 2074-75 (FY 50). The growth rates projections was based on the assumption that, the growth rates during the 2052-53 was moderately reduced by 0.5% in successive 10 year interval.

The methodology was compared with other regional studies done in India and Kerala and the reports used as reference are:-

- Report 1: DPR for Mumbai-Ahmedabad High Speed rail Corridor
- Report 2: Updation of Transport model Study for RRTS corridor – NCRTC
- Report 3: Traffic Study for High Speed Rail from Thiruvananthapuram to Kasaragod – DMRC
- Report 4: RRTS Study for Trivandrum – Chengannur

The results are provided in the table below.

Table 4-26: Comparison Between Other DPRs

Parameters	Report 1	Report 2	Report 3	Report 4
Project	Mumbai -Ahmd HSR	RRTS – NCR (DGM)	HSR - Kerala	RRTS - TVM-CHNR
Year of Study	2015	2018	2017	2013
Catchment Population	17.2 Cr	5.9 Cr	3.3 Cr	0.7 Cr
Length (Km)	500	90	540	125
Mode Choice	Multinomial Logit	Binary Logit	Multinomial Logit	Not Mentioned
BY Ridership	40,000 (2023)	7,99,094 (2024)	85,332 (2020)	67,787 (2021)
HY Ridership	2,02,000 (2053)	13,13,914 (2051)	2,33,042 (2051)	1,56,462 (2051)
Feeder	Metro	Metro - 8 to 12% additional trips	Nil	Nil
TOD	No	7% Additional Trips	Nil	Nil
Operating Speed	320	100	300	
Fare / Km	4.61	1.82 - 2.73	5	0.80 - 2.0

It is observed that all the study has used the same methodology and processes for estimating the daily ridership. In this study, instead of a detailed transport demand model using various tools, excel-based mode choice modelling was used.

4.2.2 Secondary Data Collection

Secondary data such as Railway reserved passenger data, Bus trip details from major bus depots & private bus operators, Trip details of goods trains, Monthly traffic data at major toll plaza, Fuel sales along project corridor etc., are being collected from various departments. This chapter provides overview of the details of secondary data collected.

4.2.2.1 Railway Reserved Passenger Data

Railway passenger data were collected through Railways Datawarehouse, Centre for Railway Information Systems (CRIS) Reports. The data collected were compiled to identify candidate traffic from railways. Only trains crossing at least 3 SilverLine station were considered. Passenger traffic corresponding to only one direction has been compiled and demand in opposite direction is considered same. Also only AC, Sleeper and Chair Car passengers were considered as potential users. The passenger traffic data corresponds to the year 2018 (1st January to 31st December 2018).

Origin and Destination (OD) matrix were formulated based on data collected. Origin and destination of trips were classified as Internal or External based on their location. Locations within Kerala were termed internal and locations outside Kerala are termed External.

Both Internal to Internal and Internal to External traffic are included in candidate traffic. External to External traffic has been discarded.

4.2.2.2 Trains Considered for Analysis

List of trains passing through Kerala are considered for estimation of candidate traffic as shown in **Table 4-27**.

Table 4-27: List of Trains Considered.

SI No.	Train No.	Train Name
1	10216	Madgaon Express
2	11098	Poorna Express
3	12076	Thiruvananthapuram Central-Kozhikode Jan Shatabdi
4	12081	Thiruvananthapuram- Kannur Janshatabdi
5	12202	LTT Garib Rath. KCVL to LTT
6	12217	Sampark Kranthi Exp. KCVL to Chandigarh
7	12224	Ernakulam - Mumbai LTT Duronto
8	12258	Yesvantpur Exp (Garib Rath). KCVL to YPR
9	12283	Ernakulam - Hazrat Nizamuddin Duronto

SI No.	Train No.	Train Name
10	12431	Rajdhani Exp. TVC to NZM
11	12483	Amritsar Exp. From KCVL
12	12512	Rapti Sagar Express
13	12601	MGR Chennai Central - Mangaluru Central Mail (PT)
14	12617	Mangala Lakshadweep
15	12624	Chennai Mail From TVC
16	12625	Kerala Exp. TVC to Delhi
17	12643	Nizamuddin Exp.
18	12659	Gurudev SF Express (PT)
19	12685	MGR Chennai Central - Mangaluru Central SF Express (PT)
20	12696	TVC Chennai Exp.
21	12698	Thiruvananthapuram Central - MGR Chennai Central Weekly SF Express (PT)
22	12778	Kochuveli - Hubballi Weekly SF Express (PT)
23	12977	Maru Sagar Express
24	16302	Venad Express
25	16303	Vanchinad Express
26	16305	Cannanore Express
27	16307	Cannanore Express
28	16312	KCVL SGNR Exp.
29	16313	Cannanore Express
30	16316	Banglore Express From KCVL
31	16317	Himsagar Express (PT)
32	16319	Kochuveli - Banaswadi Humsafar Express
33	16332	Mumbai Express
34	16338	Okha Express
35	16342	Guruvayur Express

SI No.	Train No.	Train Name
36	16343	Amritha Express (Via Palakkad Town) (PT)
37	16346	Netravathi Exp. TVC to LTT
38	16347	Mangalore Exp. From TVC
39	16349	Kochuveli - Nilambur Road Rajya Rani Express (PT)
40	16382	Kanniyakumari - Mumbai CSMT (Jayanti Janata) Express (PT)
41	16525	Kanniyakumari - KSR Bengaluru (Island) Express (PT)
42	16528	Kannur - Yesvantpur Express (PT)
43	16566	Mangaluru Central - Yesvantpur Weekly Express
44	16604	Maveli Express
45	16606	Ernad Exp. Nagercoil Jn. To Manglore
46	16629	Malabar Express (PT)
47	16650	Parasuram Exp. From Nagercoil to Manglore
48	16687	Navyug Express (PT)
49	16724	Ananthpuri Express QLN to Chennai Egmore
50	16855	Puducherry - Mangaluru Central Express (Via Salem) (PT)
51	16857	Puducherry - Mangaluru Central Express (Via Tiruchchirappalli) (PT)
52	17229	Sabari Express (PT)
53	17605	Mangaluru Central - Kacheguda Express (PT)
54	18568	Kollam - Visakhapatnam Weekly Express (PT)
55	19259	KCVL Bhavnagar Terminus Exp.
56	19261	Porbandar Express from KCVL
57	19331	KCVL Indore Exp. Train
58	19423	Tirunelveli - Gandhidham Humsafar Express
59	19577	Tirunelveli Jamnagar Express
60	22114	KCVL LTT Superfast Exp.
61	22149	Ernakulam - Pune Super-Fast Express

SI No.	Train No.	Train Name
62	22208	Thiruvananthapuram - Chennai Duronto Express
63	22609	Mangaluru Central - Coimbatore Intercity SF Express
64	22620	Tirunelveli - Bilaspur Express
65	22633	Nizamuddin Exp. TVC to NZM
66	22637	West Coast SF Express (PT)
67	22640	Chennai Express
68	22641	Shalimar Express
69	22646	Ahilyanagari Express
70	22648	Thiruvananthapuram Central - Korba SF Express (PT)
71	22653	Nizamuddin Exp.
72	22655	TVC NZM Express
73	22659	Dehradun Exp. From KCVL
74	22678	Kochuveli- Yashwantpur AC Exp.
75	22851	Santragachi - Mangaluru Central Vivek Express (PT)

4.2.2.3 Traffic Data at Toll Plaza

Toll traffic data at Paliyekkara Toll Plaza is collected from NHAI through K-Rail for a period of three years. Mode wise traffic data, viz. LMV, LCV, Truck, Bus and MAV, were collected for FY17, FY18 and FY19.

Paliyekkara toll plaza lies on Thrissur- Edapally stretch on NH-544 (Old NH 47). It has a tollable length of 64.94 km. Operation of toll is under concessionaire, M/s Guruvayoor Infrastructure Private Limited.

Similar data was collected for Kumbalam Toll Plaza on Edapally- Vytilla- Aroor Section from January 2017 to October 2019 from NHAI through K-Rail. Mode wise traffic data, viz. Car, LCV, Bus, Truck, 3- Axle and 4-6 Axle/HCM/EME/MAV were collected. Kumbalam Toll plaza has a tollable length of 31.483 km. Concessionaire for Kumbalam toll is M/s Kochi Aroor Tollways Pvt Ltd.

4.2.2.4 Bus Passenger Trips Data

Bus Passenger trips data from Thiruvananthapuram Central were collected from KSRTC (Kerala State Road Transport Corporation) through K-Rail. Data were collected for the month October, 2019. About 1891 trips were operated in the month October, 2019.

All Fast, Superfast and Express Services are operated from Thiruvananthapuram Central. Whereas, only ordinary schedules are operating from Thiruvananthapuram city. Data collected includes Schedule number, Service type, Scheduled Kilometre, Operated Kilometre, Route, Total collection (in Rs.), total number of passengers, Earnings per Km and Earnings per bus. This data can be utilised in establishing candidate traffic from bus and potential shift from Bus.

Similar data is being collected from other major bus depots and private bus operators and can be used for establishing candidate traffic from bus.

4.2.2.5 Railway Goods Traffic data

Goods traffic data in Thiruvananthapuram division were collected from Ministry of Railways through K-Rail. The data collected have details of goods traffic data from April to October, 2019. Data collected includes Commodity, Station and consignor wise breakup of goods traffic originating from Thiruvananthapuram division. Details of destination stations to which goods traffic were booked from Thiruvananthapuram division and inward goods traffic are also compiled.

Details collected includes Number of Railway receipts, Number of Wagons, Weight in Tonnes, Freight charge and Net Tonne Kilometre of corresponding trips.

Similar data is being collected for Palakkad railway division also. This data will give insights on goods traffic currently being transported by rail.

4.2.2.6 Fuel Sales Data

Seasonal Correction Factors (SCF) can be derived based on fuel sales along the project corridor, in the absence of other reliable sources. Hence fuel sales at 47 petrol pumps throughout the project corridor were collected. Monthly sales for both petrol and diesel were collected. Fuel sales were noted in terms of Kilolitres. SCF derived from fuel sales can be used in estimation of Annual Average Daily Traffic (AADT) from ADT (Average Daily traffic) accommodating seasonal variation. SCF were calculated for September and October separately and used for surveys conducted in respective months.

4.2.3 Primary Traffic Surveys

Primary traffic surveys were conducted in the month of September and October 2019 by the Survey Agency, M/s P K Engineers, appointed by K-Rail. The results of these surveys form the basis for demand estimation and SilverLine patronage forecast.

4.2.3.1 Traffic Surveys Conducted

The following surveys were conducted in the months of September and October, 2019:

- Classified Traffic Volume Count (TVC) through Videography
- Vehicle Occupancy Surveys
- Origin and Destination (OD) surveys for Passenger and Goods vehicles

- Survey of Truck Operators, Cargo Forwarding Agencies and Railway Parcel Services
- Passenger Terminal OD Survey at identified Airport, Bus and Train Terminals
- Stated Preference/Willingness to Pay (WTP) Survey.

4.2.3.2 Reconnaissance Survey

Reconnaissance survey were done by Traffic Engineers along the project corridor, before conducting traffic surveys. Reconnaissance surveys helped in understanding general characteristics of the traffic along the corridor. It helped in identifying survey locations, and provided valuable insight during analysis. **Figure 4-21** to **Figure 4-23** shows pictures taken during reconnaissance.



Figure 4-21 Paliyekkara Toll Plaza



Category of Vehicle	2018	2019	2020	2021
Two-Wheeler (1000 cc and below)	35	55	1210	20
Light Commercial Vehicle (LCV) (1000 cc and below)	60	90	1935	30
Medium Weight Vehicle (MWB) (1000 cc and above)	125	185	4100	60
Heavy Commercial Vehicle (HCV) (1000 cc and above)	135	200	4470	65
Special Category Vehicle (SCV) (1000 cc and above)	195	290	6425	95
Overweight Vehicle (OV) (1000 cc and above)	235	350	7825	115

Figure 4-22 Toll Rate at Kumbalam Toll Plaza



Figure 4-23 Muzhapilangad Toll Plaza

4.2.3.3 Traffic Survey Schedule and Format

Schedule of surveys conducted as part of the study is shown in **Table 4-28**.

Table 4-28: Traffic Survey Schedule

Sr. No.	Location Name	Road	Traffic Volume Count		Occupancy Survey		OD Survey		Terminal (Bus, Rail/ Air) Survey		
			Start date	End date	Start date	End date	Start date	End date	Location Name	Start date	End date
1	Thottakadu	NH-66	18/9/19	21/9/19	19/9/19	20/9/19	20/9/19	21/9/19	Thiruvananthapuram Bus Stand	20/9/19	21/9/19
2	Kilimanoor	MC Road	18/9/19	21/9/19	19/9/19	20/9/19			Vytila Bus Stand	25/9/19	26/9/19
3	Karunagapally	NH-66	22/9/19	25/9/19	23/9/19	24/9/19	23/9/19	24/9/19	Thrissur Bus Stand	30/9/19	1/10/19
4	Sasthacotta	SH-37	18/9/19	21/9/19	19/9/19	20/9/19			Kozhikode Bus Stand	30/9/19	1/10/19
5	Adoor Bypass	MC Road	22/9/19	25/9/19	23/9/19	24/9/19			Thiruvananthapuram Railway Station	20/9/19	21/9/19
6	Ezrinjillam	MC Road	22/9/19	25/9/19	23/9/19	24/9/19	24/9/19	25/9/19	Kollam Railway Station	23/9/19	24/9/19
7	Cherthala	Cherthala-Thanneermukkom Road	26/9/19	29/9/19	26/9/19	27/9/19			Ernakulam South Railway Station	25/9/19	26/9/19
8	Udayamperoor	SH-15	15/9/19	18/9/19	25/9/19	26/9/19			Kozhikode Railway Station	30/9/19	1/10/19
9	Kumbalam Toll Plaza	NH-16	26/9/19	29/9/19	26/9/19	27/9/19	27/9/19	28/9/19	Thiruvananthapuram Airport	10/10/19	11/10/19
10	Kumaranalloor	MC Road	15/9/19	18/9/19	25/9/19	26/9/19			Kochi Airport	27/9/19	28/9/19
11	Paliyekkara Toll Plaza	NH-544	26/9/19	29/9/19	26/9/19	27/9/19	27/9/19	28/9/19	Kozhikode Airport	28/9/19	29/9/19



Sr. No.	Location Name	Road	Traffic Volume Count		Occupancy Survey		OD Survey		Terminal (Bus, Rail/ Air) Survey		
			Start date	End date	Start date	End date	Start date	End date	Location Name	Start date	End date
12	Moothakunnam	NH-66	15/9/19	18/9/19	25/09/19	26/9/19			Kannur Airport	29/9/19	30/9/19
13	Gurupadapuri	NH-66	29/9/19	2/10/19	30/9/19	1/10/19	30/9/19	1/10/19			
14	Edappal	SH-69	15/9/19	18/9/19	25/9/19	26/9/19					
15	Cheruvannur	SH-28	15/9/19	18/9/19	25/9/19	26/9/19					
16	Azhinjillam	NH-66	29/9/19	2/10/19	30/9/19	1/10/19	30/9/19	1/10/19			
17	Muzhapilangad Toll Plaza	NH-66	3/10/19	6/10/19	3/10/19	4/10/19	3/10/19	4/10/19	Survey of Truck Operators, Cargo Forwarding Agencies & Railway Parcel Services	14/9/19	6/10/19
18	Kanhangad	NH-66	3/10/19	6/10/19	3/10/19	4/10/19	4/10/19	5/10/19	WTP (On Board Survey)	20/9/19	4/10/19

4.2.3.4 Classified Traffic Volume Count (TVC) Survey

Classified Traffic Volume Count Surveys were carried out at 18 identified locations across the study corridor. The surveys were organised during the month of September & October 2019. The traffic count surveys were conducted on 24 hours basis for 3 days (including a weekend). Videography were used for traffic count and vehicles were counted at 15 minutes interval. Directional classified traffic volume counts were analysed to study Average Daily Traffic (ADT), Peak Hour Flows and Traffic Composition. A map showing the location of traffic count and OD Surveys is shown in **Figure 4-24**.

Details of TVC survey locations are shown in **Table 4-29**. **Table 4-30** gives vehicle classification adopted for volume count survey.

Table 4-29: Traffic Volume Count Survey Locations

Sl. No.	Location	Description	Road	Between SilverLine Stations	Type of Survey	Landmarks Nearby
1	Thottakadu	Near Chathampara	NH 66	TVM- Kollam	TVC and OD	Near Royal Garden Supermarket
2	Kilimanoor	Kilimanoor	MC Road	TVM- Kollam	TVC	Syndicate Bank, Kilimanoor. HP Petrol Pump (AK Fuels)
3	Karunagapally	Karunagappally, Near Pulliman Junction	NH 66	Kollam- Chengannur	TVC and OD	Indian Oil (Swagath Fuels). KC's Race Motors. Mozart Homes Store
4	Sasthamcotta	Between Bharanikavu and Sasthamcotta.	SH 37	Kollam - Chengannur	TVC	Near Vijaya Castle Hotel
5	Adoor Bypass	On Adoor Bypass	MC Road	Kollam - Chengannur	TVC	Travancore Support Services PVT. Ltd., City Building. Madathilazhikathu Tyres (MRF Franchisee)
6	Ezhinjilam	Between Thiruvalla and Changanassery	MC Road	Chengannur- Kottayam	TVC and OD	Near SBI, Ezhinjilam Branch
7	Cherthala	Between Cherthala and Kokoathamangalam	Cherthala- Thanneermukkam Road	Kottayam- Ernakulam	TVC	Reliance Petrol Pump. Woodland's Restaurant
8	Udayamperoor	Near IOC Junction	SH 15	Kottayam- Ernakulam	TVC	Indian Oil Petrol Pump. Buddys Beauty Parlour and Salon. Anandhu Supermarket
9	Kumbalam Toll Plaza	Near Kumbalam Toll Plaza (NHAI)	NH 66	Kottayam- Ernakulam	TVC and OD	Kumbalam Toll Plaza
10	Kumaranalloor	Between Kottayam and Ettumanoor	MC Road	Kottayam- Ernakulam	TVC	Vajra Marbles and Granites. JB Timbers. IG Used Furniture Store
11	Paliyekkara Toll Plaza	Near Paliyekkara Toll Plaza (NHAI)	NH 544	Ernakulam- Thrissur	TVC and OD	Paliyekkara Toll Plaza

Sl. No.	Location	Description	Road	Between SilverLine Stations	Type of Survey	Landmarks Nearby
12	Moothakunnam	Between North Paravoor and Kodungalloor	NH 66	Ernakulam - Thrissur	TVC	Near Moothakunnam Bridge. Sree Govind Bharat Gas Agency
13	Gurupadapuri	Between Chavakkad and Thiruvathra	NH 66	Thrissur - Tirur	TVC and OD	Sree Viswanatha Temple. Jyothi Hotel
14	Edappal	Between Edappal and Naduvattom	SH 69	Thrissur - Tirur	TVC	Kumar Steels
15	Cheruvannur	Between Cheruvannur and Modern Bazar	SH 28	Tirur- Kozhikode	TVC	Ajantha Granites and Marbles
16	Azhinjillam	On Kozhikode Bypass	NH 66	Tirur- Kozhikode	TVC and OD	Le Sugar Dates and Chocolates. ChicHut. Coolmate Air Conditioning
17	Muzhapilangad Toll Plaza	Before Muzhapilangad Toll Plaza (Toll plaza for ROB)	NH 66	Kozhikode- Kannur	TVC and OD	Muzhapilangad Toll Plaza
18	Kanhangad South	Between Kanhangad and Kurundoor	NH 66	Kannur- Kasaragod	TVC and OD	Krishna Complex. Souhrida Vanitha Hotel. Pallikandathil Ayurvedic Centre

Table 4-30: Vehicle Classification Adopted

Motorized Traffic - Passenger	Motorized Traffic - Commercial
2 wheelers	Goods Auto
Auto Rickshaw	Light Commercial Vehicle (LCV)
Private Car (White Number Plate) : Car, Jeep, Van	Truck (2 – Axle Truck, 3 – Axle Truck)
Taxi (Yellow Number Plate) : Car, Jeep, Van	Multi Axle Truck (MAV), Container Trucks & Oil Tankers
KSRTC Bus AC	Tractor, Tractor with Trailer
KSRTC Bus Non AC	Others Goods
Private Bus AC	
Private Bus NON AC	
School Bus	
Mini Bus	
Others	



Figure 4-24 Locations of Traffic Volume Count and OD Surveys

4.2.3.5 Vehicle Occupancy Survey

Vehicle Occupancy surveys conducted as part of Traffic study, provided an insight about the number of passengers travelling by various modes at different locations. Vehicle occupancy surveys were conducted simultaneously with traffic count survey for 24 hours at all the 18 TVC locations on a typical working day. Survey was conducted by manual counting on random sampling basis and mode wise occupancy of vehicle were recorded for passengers travelling in both directions. For each direction, a minimum of 30% samples were collected.

4.2.3.6 Origin and Destination (OD) Survey

The Origin – Destination (OD) survey was conducted to understand the existing travel pattern on the project corridor and MC Road. OD survey of the passengers was conducted at 9 locations along the project corridor. The study area has been divided into 197 Traffic Analysis Zones (TAZ), based on which the analysis had been carried out.

OD Survey for both Passenger and Goods vehicles are conducted simultaneously with traffic counts on a week day for 24 hours. During this survey Trip Details viz. Origin and Destination, Trip length, Travel Cost, Travel Time, Occupancy, Purpose, Willingness to Shift to SilverLine, Extra Fare Willing to Pay for SilverLine etc are collected from passengers. In case of OD survey for Goods vehicles the drivers are asked about their Trip Details including Origin and Destination, Trip length, Commodity being carried, Tonnage, Transportation cost, Willingness to use Roll-On- Roll-Off (RORO) services on proposed SilverLine etc. These data is useful in determining travel pattern/characteristics and willingness to shift to SilverLine of passenger and goods vehicles.

4.2.3.7 Stated Preference/ Willingness To Pay (WTP) Survey

Onboard Willingness to Pay survey were carried out on Buses & Trains that ply on the identified study corridor and at Airports. This survey was conducted to understand the user perception, Travel Characteristics and Willingness to Shift to SilverLine System. Using the questionnaires, the user was enquired regarding their socio-economic characteristics and travel pattern. Designed as a Stated Preference Survey, WTP would help in assessing the user’s willingness to shift to SilverLine with several important factors such as Cost, Time and Frequency, that may affect the decision to choose the mode of transport for commuting. The response of the same is being used for evaluating the shift to SilverLine from other competing modes.

The trains and buses that ply on the study corridor were identified for the purpose and surveyed. Each Scenario in the questionnaire refers to a set or combination of Travel Cost, Time and Frequency for both SilverLine and the present mode, *for a trip length of 200 km (based on approximate distance between Thiruvananthapuram & Ernakulam and Ernakulam & Kozhikode)*. Each of the six scenarios consists of variations in Travel Time, Travel Cost and Frequency of SilverLine Service. The six scenarios considered for the survey are given in **table 4-26**.

Table 4-31: WTP Survey Scenarios for Average Trip Length of 200 Km

Scenario	Mode	Fare (Rs)	Frequency (Minutes)	Travel Time (Minutes)
Mode	AC Train/ AC Bus	300	120	240
Mode	Sleeper/ Non AC Bus	150	90	240
1	SilverLine	500	30	90
2	SilverLine	500	60	

Scenario	Mode	Fare (Rs)	Frequency (Minutes)	Travel Time (Minutes)
3	SilverLine	700	30	
4	SilverLine	700	60	
5	SilverLine	900	30	
6	SilverLine	900	60	

The user was asked to respond to the scenarios, whether under the particular scenario he/she would be willing to Shift to SilverLine from their present mode. The responses are classified into following distinct categories:

- 1 Definitely travel by present mode,
- 2 Probably Travel by present mode,
- 3 Indifferent,
- 4 Probably by HSR,
- 5 Definitely by HSR,
- 6 No response.

4.2.3.8 Passenger Terminal OD Survey

The interview of passengers at identified terminals (4 Airports, 4 Bus Terminals and 4 Train Terminals) were conducted to establish existing Travel Pattern of Commuters. Details like Trip Origin, Destination, Access/ Dispersal Mode Used (Last Mile Connectivity), Willingness to Shift to SilverLine, personal details like Occupation etc of Air, Bus and Rail Passengers are collected. Separate questionnaires were used for Boarding and Alighting passengers and survey was conducted for 24 hours on a typical working day. **Table 4-32** gives the list of locations where passenger OD Survey was conducted

Table 4-32: Passenger Terminal OD Survey Locations

Sl. No.	Terminal Survey Location
1	Thiruvananthapuram Airport
2	Thiruvananthapuram KSRTC Bus Terminal
3	Thiruvananthapuram Railway Station
4	Kollam Railway Junction
5	Cochin International Airport
6	Ernakulam South Railway Station

Sl. No.	Terminal Survey Location
7	Ernakulam – Vytīla Bus Terminal
8	Thrissur KSRTC Bus Terminal
9	Kozhikode Airport
10	Kozhikode Railway Station
11	Kozhikode Private Bus Terminal
12	Kannur Airport

4.2.3.9 Survey of Truck Operators, Cargo Forwarding Agencies and Railway Parcel Services

Survey of truck operators and cargo forwarding agencies, located in Kerala and border districts of Tamil Nadu and Karnataka, was conducted to collect information on the operational characteristics of goods vehicles. The information being collected includes type and volume of cargo transported, Origin - Destination, Operational Cost and Willingness to Shift to RORO facilities at specified rates. To identify characteristics of existing cargo being transported by Railway, surveys are being conducted at Railway Parcel Services at 5 major cargo handling stations in Kerala.

The objective was to cover at least 100 truck operators and 20 freight forwarding agencies located in Kerala, and Border districts of Tamil Nadu and Karnataka. 114 truck operators and 27 freight forwarding agencies were covered during survey

Details of Railway Parcel Service were collected from the following stations:

- Central Railway Station, Thiruvananthapuram
- Kollam
- South Ernakulam
- Kozhikode
- Kasaragod
- Thrissur
- Kannur

4.3 DATA ANALYSIS – TRIP CHARACTERISTICS

Analysis of Traffic surveys conducted and secondary data collected as part of DPR preparation are summarized in this chapter. The results of these analysis form the basis of candidate traffic estimation and patronage forecast of SilverLine.

4.3.1 Classified Traffic Volume Count (TVC) Survey

Classified Traffic Volume Count Surveys were carried out across the study corridor. Traffic Volume counts conducted at 18 locations along the project corridor provided an insight to the traffic intensity and composition on various stretches of the corridor. **Table 4-33** presents the average 24 hours traffic volume, Average Daily Traffic (ADT) (year 2019) observed at all the 18 locations.

Table 4-33: Average Daily Traffic (ADT)

Sl.No	ID	Location Name	Road Stretch (Direction):	Direction Wise Vehicles	Total Vehicles	Direction wise PCU	Total PCU
1	TVC 01	Thottakadu	Towards Kollam	19,561	38,673	20,063	39,736
			Towards Thiruvananthapuram	19,112		19,673	
2	TVC 02	Kilimanoor	Towards Kollam	15,498	32,713	15,066	32,009
			Towards Thiruvananthapuram	17,215		16,943	
3	TVC 03	Karunagapally	Towards Chengannur	31,495	61,759	27,032	53,716
			Towards Kollam	30,264		26,684	
4	TVC 04	Sasthamcotta	Towards Chengannur	11,344	22,448	9,029	17,957
			Towards Kollam	11,104		8,928	
5	TVC 05	Adoor Bypass	Towards Chengannur	9,396	18,145	9,490	18,478
			Towards Kollam	8,750		8,988	
6	TVC 06	Ezhinjillam	Towards Chengannur	13,939	28,473	14,637	29,930
			Towards Kottayam	14,535		15,293	
7	TVC 07	Cherthala	Towards Ernakulam	10,365	20,447	7,881	15,641
			Towards Kottayam	10,083		7,761	
8	TVC 08	Udayamperoor	Towards Ernakulam	17,080	32,801	14,645	28,235
			Towards Kottayam	15,720		13,590	
9	TVC 09	Kumbalam Toll Plaza	Towards Ernakulam	29,488	59,014	29,319	59,410
			Towards Kottayam	29,526		30,092	
10	TVC 10	Kumaranalloor	Towards Ernakulam	23,010	45,229	23,759	46,609

Sl.No	ID	Location Name	Road Stretch (Direction):	Direction Wise Vehicles	Total Vehicles	Direction wise PCU	Total PCU
			Towards Kottayam	22,218		22,850	
11	TVC 11	Paliyekkara Toll Plaza	Towards Thrissur	38,822	77,639	45,321	90,382
			Towards Ernakulam	38,816		45,061	
12	TVC 12	Moothakunnam	Towards Thrissur	18,816	36,764	17,294	33,760
			Towards Ernakulam	17,947		16,465	
13	TVC 13	Gurupadapuri	Towards Tirur	6,445	13,213	6,114	12,751
			Towards Thrissur	6,769		6,638	
14	TVC 14	Edappal	Towards Tirur	18,701	38,352	16,272	33,717
			Towards Thrissur	19,651		17,445	
15	TVC 15	Cheruvannur	Towards Kozhikode	21,555	42,827	19,841	39,432
			Towards Tirur	21,272		19,591	
16	TVC 16	Azhinjillam	Towards Kozhikode	25,942	51,484	26,596	52,824
			Towards Tirur	25,542		26,228	
17	TVC 17	Muzhapilangad Toll Plaza	Towards Kannur	14,342	28,702	16,748	33,465
			Towards Kozhikode	14,360		16,717	
18	TVC 18	Kanhangad South	Towards Kasaragod	12,306	25,047	15,000	30,313
			Towards Kannur	12,740		15,313	

It can be observed from the **Table 4-33** that the highest traffic flow of 77,639 vehicles (90,382 PCUs) was observed at Paliyekkara Toll Plaza (Ernakulam to Thrissur-Location TVC 11). The lowest flow of 13,213 vehicles (12,751 PCUs) was observed at Gurupadapuri (Tirur to Thrissur-Location 13).

Figure 4-25 represents traffic intensity along the corridor based on ADT in PCUs.



Figure 4-25 Representation of Traffic Intensity along Project Corridor

The Passenger Car Unit (PCU) values adopted for the study are as per Guidelines of Indian Roads Congress and the same is shown in **Table 4-34**.

Table 4-34: PCU Values for Different Vehicle Classification

Car/Taxi	Mini-Bus	Bus	School Bus	2 Wheeler	Passenger/ Goods Auto	LCV	Truck	MAV/ Tractor+ Trailer	Others
1	1.5	3	3	0.5	1	1.5	3	4.5	6

4.3.2 Seasonal Correction Factor (SCF)

Seasonal Correction Factors which are derived considering fuel sales at petrol pumps throughout the project corridor are used for estimation of Annual Average Daily Traffic (AADT). The estimated SCF at various petrol pumps is presented in **Table 4-35**. SCF are calculated separately for petrol and diesel vehicles for the month of September and October 2019.

Table 4-35: Seasonal Correction Factors (SCF)

SI No.	Petrol Pump	September		October	
		SCF Petrol	SCF Diesel	SCF Petrol	SCF Diesel
1	Abdhul Vaheed Fuels, Navikulam	1.03	1.03	1.07	1.00
2	Anandam Fuels Center, Mannglapurm	0.99	1.02	0.99	0.98
3	Asoka Fuels Thalikulam, Thrissur	1.00	1.01	1.02	1.00
4	Bala krishana Fuels, Kottiamkulam	0.98	0.99	1.02	1.01
5	Benzy Fuels, Ayyottihira	1.01	0.99	1.02	1.01
6	Calicnt Mananthalathazham, Palazhr	1.00	1.00	1.00	0.99
7	Charanga TTU Fuels S.L Puram	0.99	1.00	1.03	1.00
8	Daya Petroleum, Koyilandy	0.99	1.01	1.01	0.99
9	Dev Fuels, Sakthikulangara, Kollam	0.98	1.04	1.01	0.95
10	Dilkhus Petroleum, Calicut	0.99	0.99	1.02	1.02
11	Emcee Fuels, Pilathara	1.02	1.10	1.03	1.03
12	Emmey Fuels, Triprayar	1.01	0.99	0.98	1.00
13	Frince Fuels, Acoppuzha	0.98	0.99	0.97	0.98
14	Hi point Fuels, Pathirapally	0.99	0.99	1.01	1.00
15	IBP Auto Services, Vettichira	1.04	1.09	0.93	0.89
16	K.K Mohamad and Company, Haripad	1.04	0.99	1.02	1.01
17	Kandoth, Payyanur	1.07	0.97	1.05	1.00
18	Karivellur Fuels	1.03	1.13	1.01	1.00
19	KM. Poothukaran Fuels, Engandiyur	0.98	0.99	1.02	1.00
20	Kolappuram Petroleum Agency	1.03	1.04	1.01	0.99
21	Koyilandy	1.03	1.17	1.06	1.18
22	KV Fuels, Purakkad	1.00	1.01	1.01	0.98
23	Laila Agencies , Pallippuram	0.99	0.96	0.97	1.08
24	Laxmi Selas, Calicut	1.00	1.01	0.99	0.99
25	M.S George and Company, Purakkad	1.04	1.02	1.00	0.99

SI No.	Petrol Pump	September		October	
		SCF Petrol	SCF Diesel	SCF Petrol	SCF Diesel
26	MadhavamVam Fuels, Puthupanam, Vadakara	0.99	1.00	0.98	1.00
27	Mambra Fuels, Edamuttam	0.99	1.00	1.03	1.01
28	Masteris Service Station	1.00	1.01	1.00	0.99
29	Matesh Fuels, Kalavoor	1.01	0.99	1.01	1.02
30	Modern Fuels, Kayamkulam	1.00	0.99	1.00	0.99
31	Nada Purayil Fuels, Nangiar kulangara	1.01	1.01	0.99	1.00
32	Nass Fuels, Kalam Kullam	1.00	1.01	0.99	0.99
33	Panannakkad	1.09	1.08	1.06	1.00
34	Royal Fuels, Chathannoor	1.02	1.00	0.97	1.01
35	Saeeram Petroleum	1.00	1.00	1.00	0.99
36	Shanti Fuels, Karuvatta	1.01	1.00	0.99	0.98
37	Shree Vinayaka Fuels, S.N Puram	1.00	0.98	0.99	0.99
38	T.C Fuels, Alappuzha	1.00	0.98	1.00	1.00
39	Thariyal Fuels, Athirthhi	1.00	1.00	0.98	0.99
40	United Trading Corporation, Monvpeedika	0.99	1.07	0.98	1.07
41	Vava Fuels, Eramallore	1.00	1.00	1.01	1.01
42	Visham Fuels Kochubila, Alamcode	1.00	0.99	0.99	1.00

Average of SCF obtained at all the fuel stations is considered as representative value for the study and adopted SCF values are given in **Table 4-36**.

Table 4-36: Adopted SCF Values

SI No.	Sections	September		October	
		SCF_Petrol	SCF_Diesel	SCF_Petrol	SCF_Diesel
1	Kozhikode - Kannur	1.00	1.03	1.02	1.03
2	Chengannur - Kottayam	1.01	1.00	1.00	0.99
3	Ernakulam - Thrissur	0.99	1.01	1.00	1.01
4	Kannur - Kasaragod	1.05	1.07	1.04	1.01
5	Kottayam - Ernakulam	0.99	0.99	1.01	1.01

SI No.	Sections	September		October	
		SCF_Petrol	SCF_Diesel	SCF_Petrol	SCF_Diesel
6	Kollam - Chengannur	1.00	1.00	0.99	0.99
7	Tirur - Kozhikode	1.02	1.04	0.96	0.94
8	Thrissur - Tirur	1.01	0.99	1.01	1.00
9	Thiruvananthapuram - Kollam	1.00	1.01	1.00	1.00

4.3.3 Average Annual Daily Traffic (AADT)

Annual Average Daily Traffic (AADT) was estimated considering the seasonal correction factors which are derived considering fuel sales along the corridor. AADT estimated is given in **Table 4-37**

Table 4-37: Annual Average Daily Traffic

Sl. No.	Location ID	Location	Vehicles		PCU Vehicles	
			ADT	AADT	ADT	AADT
1	TVC 01	Thottakadu	38673	38955	39736	40107
2	TVC 02	Kilimanoor	32713	32948	32009	32298
3	TVC 03	Karunagapally	61759	61759	53716	53716
4	TVC 04	Sasthamcotta	22448	22448	17957	17957
5	TVC 05	Adoor Bypass	18145	18145	18478	18478
6	TVC 06	Ezhinjillam	28473	28561	29930	29974
7	TVC 07	Cherthala	20447	20243	15641	15485
8	TVC 08	Udayamperoor	32801	32473	28235	27952
9	TVC 09	Kumbalam Toll Plaza	59014	58424	59410	58816
10	TVC 10	Kumaranalloor	45229	44776	46609	46142
11	TVC 11	Paliyekkara Toll Plaza	77639	77858	90382	91007
12	TVC 12	Moothakunnam	36764	36776	33760	33920
13	TVC 13	Gurupadapuri	13213	13212	12751	12689
14	TVC 14	Edappal	38352	38320	33717	33555
15	TVC 15	Cheruvannur	42827	44089	39432	40783

Sl. No.	Location ID	Location	Vehicles		PCU Vehicles	
			ADT	AADT	ADT	AADT
16	TVC 16	Azhinjillam	51484	53154	52824	54742
17	TVC 17	Muzhapilangad Toll Plaza	28702	29464	33465	34420
18	TVC 18	Kanhangad South	25047	25546	30313	30740

4.3.4 Vehicle Composition

Classified Traffic Volume Counts also provided valuable insight into the vehicular composition of the traffic in the study area. The overall traffic composition in terms of AADT (total number of vehicles) is shown in **Figure 4-26**

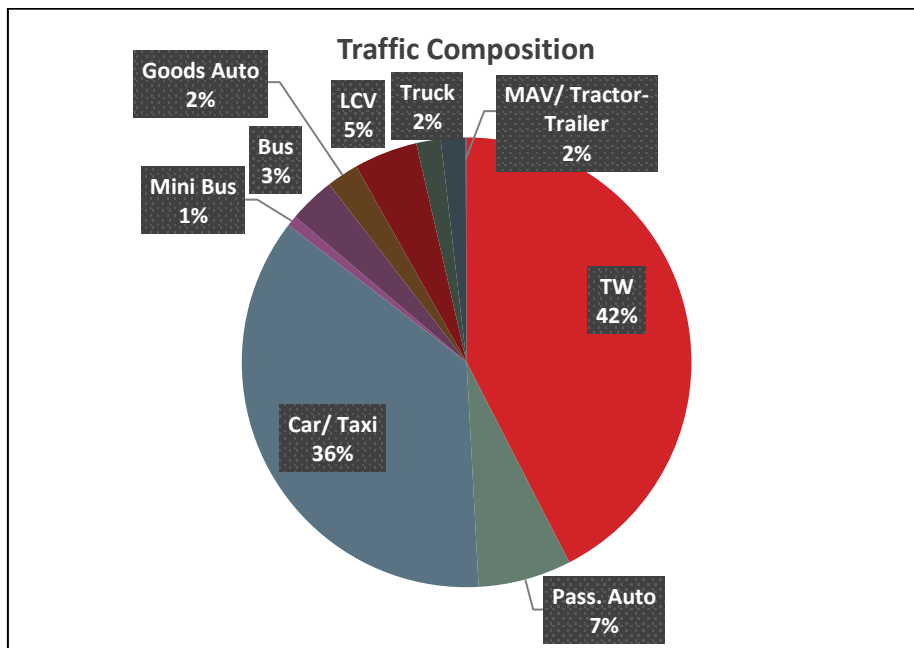


Figure 4-26 Overall Traffic Composition

Vehicular composition recorded at all locations during the traffic volume count showed that majority of the traffic comprised of cars and two-wheelers (Cars-36% and TW-42%).

Table 4-27 shows details of the classified vehicular traffic volume observed at each of the survey Locations



Table 4-38: Location Wise Vehicular Composition (%) -AADT

Sl. No.	ID	Location Name	TW	Pass. Auto	Car/ Taxi	Mini Bus	Bus	Goods Auto	LCV	Truck	MAV/ Tractor- Trailer	Others
1	TVC 01	Thottakadu	12423	2030	18618	379	1676	1456	1283	679	495	10
			31.8%	5.2%	47.7%	1.0%	4.3%	3.7%	3.3%	1.7%	1.3%	0.0%
2	TVC 02	Kilimanoor	10557	2596	15905	293	1198	1096	733	396	251	3
			32.0%	7.9%	48.2%	0.9%	3.6%	3.3%	2.2%	1.2%	0.8%	0.0%
3	TVC 03	Karunagapally	32208	3722	19613	345	1605	2067	1269	749	724	2
			51.7%	6.0%	31.5%	0.6%	2.6%	3.3%	2.0%	1.2%	1.2%	0.0%
4	TVC 04	Sasthamcotta	13880	1238	5430	88	754	681	299	142	120	5
			61.3%	5.5%	24.0%	0.4%	3.3%	3.0%	1.3%	0.6%	0.5%	0.0%
5	TVC 05	Adoor Bypass	5320	677	9931	159	137	102	1260	427	250	60
			29.0%	3.7%	54.2%	0.9%	0.7%	0.6%	6.9%	2.3%	1.4%	0.3%
6	TVC 06	Ezhinjillam	8860	1182	13992	254	1178	1316	852	595	520	3
			30.8%	4.1%	48.7%	0.9%	4.1%	4.6%	3.0%	2.1%	1.8%	0.0%
7	TVC 07	Cherthala	12591	2032	4389	91	397	672	255	122	66	5
			61.1%	9.9%	21.3%	0.4%	1.9%	3.3%	1.2%	0.6%	0.3%	0.0%
8	TVC 08	Udayamperoor	16225	2187	11416	306	1061	1073	433	216	174	1



Sl. No.	ID	Location Name	TW	Pass. Auto	Car/ Taxi	Mini Bus	Bus	Goods Auto	LCV	Truck	MAV/ Tractor- Trailer	Others
			49.0%	6.6%	34.5%	0.9%	3.2%	3.2%	1.3%	0.7%	0.5%	0.0%
9	TVC 09	Kumbalam Toll Plaza	27070	2326	19132	471	1531	2954	2662	1720	1695	6
			45.4%	3.9%	32.1%	0.8%	2.6%	5.0%	4.5%	2.9%	2.8%	0.0%
10	TVC 10	Kumaranalloor	15896	3378	20157	294	2549	232	2052	530	527	43
			34.8%	7.4%	44.1%	0.6%	5.6%	0.5%	4.5%	1.2%	1.2%	0.1%
11	TVC 11	Paliyekkara Toll Plaza	28036	3601	28886	603	3025	680	7951	2086	3439	99
			35.8%	4.6%	36.8%	0.8%	3.9%	0.9%	10.1%	2.7%	4.4%	0.1%
12	TVC 12	Moothakunnam	17878	1772	12871	371	1071	311	1851	478	478	14
			48.2%	4.8%	34.7%	1.0%	2.9%	0.8%	5.0%	1.3%	1.3%	0.0%
13	TVC 13	Gurupadapuri	6569	1776	2976	172	411	529	252	307	340	0
			49.3%	13.3%	22.3%	1.3%	3.1%	4.0%	1.9%	2.3%	2.6%	0.0%
14	TVC 14	Edappal	17690	3702	13371	407	1383	289	1740	55	32	28
			45.7%	9.6%	34.6%	1.1%	3.6%	0.7%	4.5%	0.1%	0.1%	0.1%
15	TVC 15	Cheruvannur	22678	3122	11225	123	2356	703	2149	594	229	26
			52.5%	7.2%	26.0%	0.3%	5.5%	1.6%	5.0%	1.4%	0.5%	0.1%



Sl. No.	ID	Location Name	TW	Pass. Auto	Car/ Taxi	Mini Bus	Bus	Goods Auto	LCV	Truck	MAV/ Tractor- Trailer	Others
16	TVC 16	Azhinjillam	19616	2020	22386	331	512	372	4032	1073	1534	103
			37.7%	3.9%	43.1%	0.6%	1.0%	0.7%	7.8%	2.1%	3.0%	0.2%
17	TVC 17	Muzhapilangad Toll Plaza	10011	2463	9592	226	1102	419	2854	1078	1055	37
			34.7%	8.5%	33.3%	0.8%	3.8%	1.5%	9.9%	3.7%	3.7%	0.1%
18	TVC 18	Kanhangad South	8337	2188	9128	152	1099	177	1948	900	1188	48
			33.1%	8.7%	36.3%	0.6%	4.4%	0.7%	7.7%	3.6%	4.7%	0.2%
Average			42.4%	6.7%	36.3%	0.8%	3.3%	2.3%	4.6%	1.8%	1.8%	0.1%

4.3.5 Peak Hour

The peak hour traffic details (year 2019) observed at all the traffic count survey locations, including their observed peak hour time, its associated traffic and the peak hour factor at the particular location are shown **Table 4-39**. The average peak hour factor was observed to be 6.68% and the observed average peak hour PCU is 2419.

Table 4-39: Peak Hour Traffic Characteristics

Sl.No.	ID	Location	Road Stretch	Peak Hour			Total		Peak Hour Factor
				Time	Vehicles	PCU	Vehicles	PCU	
1	TVC 01	Thottakadu	Thiruvananthapuram-Kollam	17:00-18:00	2,609	2,495	38,673	39,736	6.28%
2	TVC 02	Kilimanoor	Thiruvananthapuram-Kollam	17:00-18:00	2,271	2,133	32,713	32,009	6.66%
3	TVC 03	Karunagapally	Kollam-Chengannur	10:00-11:00	4,512	3,595	61,759	53,716	6.69%
4	TVC 04	Sasthamcotta	Kollam-Chengannur	11:00-12:00	1,835	1,449	22,448	17,957	8.07%
5	TVC 05	Adoor Bypass	Kollam-Chengannur	10:00-11:00	1,238	1,223	18,145	18,478	6.62%
6	TVC 06	Ezhinjilam	Chengannur-Kottayam	17:00-18:00	2,047	1,887	28,473	29,930	6.30%
7	TVC 07	Cherthala	Kottayam-Ernakulam	18:00-19:00	1,670	1,171	20,447	15,641	7.48%
8	TVC 08	Udayamperoor	Kottayam-Ernakulam	08:00-09:00	2,680	2,084	32,801	28,235	7.38%
9	TVC 09	Kumbalam Toll Plaza	Kottayam-Ernakulam	08:00-09:00	4,870	3,898	59,014	59,410	6.56%
10	TVC 10	Kumaranalloor	Kottayam-Ernakulam	10:00-11:00	3,109	3,093	45,229	46,609	6.64%
11	TVC 11	Paliyekkara Toll Plaza	Ernakulam-Thrissur	17:00-18:00	5,368	5,385	77,639	90,382	5.96%
12	TVC 12	Moothakunnam	Ernakulam-Thrissur	17:00-18:00	2,693	2,309	36,764	33,760	6.84%
13	TVC 13	Gurupadapuri	Thrissur-Tirur	16:00-17:00	990	941	13,213	12,751	7.38%

Sl.No.	ID	Location	Road Stretch	Peak Hour			Total		Peak Hour Factor
				Time	Vehicles	PCU	Vehicles	PCU	
14	TVC 14	Edappal	Thrissur-Tirur	09:00-10:00	2,503	2,106	38,352	33,717	6.25%
15	TVC 15	Cheruvannur	Tirur-Kozhikode	17:00-18:00	3,071	2,646	42,827	39,432	6.71%
16	TVC 16	Azhinjillam	Tirur-Kozhikode	17:00-18:00	3,555	3,191	51,484	52,824	6.04%
17	TVC 17	Muzhapilangad Toll Plaza	Kozhikode-Kannur	17:00-18:00	1,971	1,951	28,702	33,465	5.83%
18	TVC 18	Kanhangad South	Kannur-Kasaragod	17:00-18:00	1,927	1,995	25,047	30,313	6.58%
Average					2,718	2,419	37,429	37,131	6.68%

4.3.6 Directional Split

Directional split observed at all the survey location based on both vehicles and PCU is given in **Table 4-40**. No major variation in directional flow is observed. Maximum variation observed is 47:53 at TVC 02.

Table 4-40: Directional Split (%)

Sl.No.	TVC No.	Location	Direction (Down)	Directional Split-Vehicles(Down: Up)	Directional Split-PCU(Down: Up)
1	TVC 01	Thottakadu	Thiruvananthapuram-Kollam	51:49	50:50
2	TVC 02	Kilimanoor	Thiruvananthapuram-Kollam	47:53	47:53
3	TVC 03	Karunagapally	Kollam-Chengannur	51:49	50:50
4	TVC 04	Sasthamcotta	Kollam-Chengannur	51:49	50:50
5	TVC 05	Adoor Bypass	Kollam-Chengannur	52:48	51:49
6	TVC 06	Ezhinjillam	Chengannur-Kottayam	51:49	51:49
7	TVC 07	Cherthala	Kottayam-Ernakulam	51:49	50:50
8	TVC 08	Udayamperoor	Kottayam-Ernakulam	52:48	52:48
9	TVC 09	Kumbalam Toll Plaza	Kottayam-Ernakulam	50:50	49:51
10	TVC 10	Kumaranalloor	Kottayam-Ernakulam	51:49	51:49

Sl.No.	TVC No.	Location	Direction (Down)	Directional Split-Vehicles(Down: Up)	Directional Split-PCU(Down: Up)
11	TVC 11	Paliyekkara Toll Plaza	Ernakulam-Thrissur	50:50	50:50
12	TVC 12	Moothakunnam	Ernakulam-Thrissur	51:49	51:49
13	TVC 13	Gurupadapuri	Thrissur-Tirur	49:51	48:52
14	TVC 14	Edappal	Thrissur-Tirur	49:51	48:52
15	TVC 15	Cheruvannur	Tirur-Kozhikode	50:50	50:50
16	TVC 16	Azhinjillam	Tirur-Kozhikode	50:50	50:50
17	TVC 17	Muzhapilangad Toll Plaza	Kozhikode-Kannur	50:50	50:50
18	TVC 18	Kanhangad South	Kannur-Kasaragod	49:51	49:51

4.3.7 Hourly Variation

Hourly variation of traffic is also analysed from the survey data. **Figure 4-27 to Figure 4-31** show hourly variation in terms of total vehicles and PCUs at some of the important survey locations.

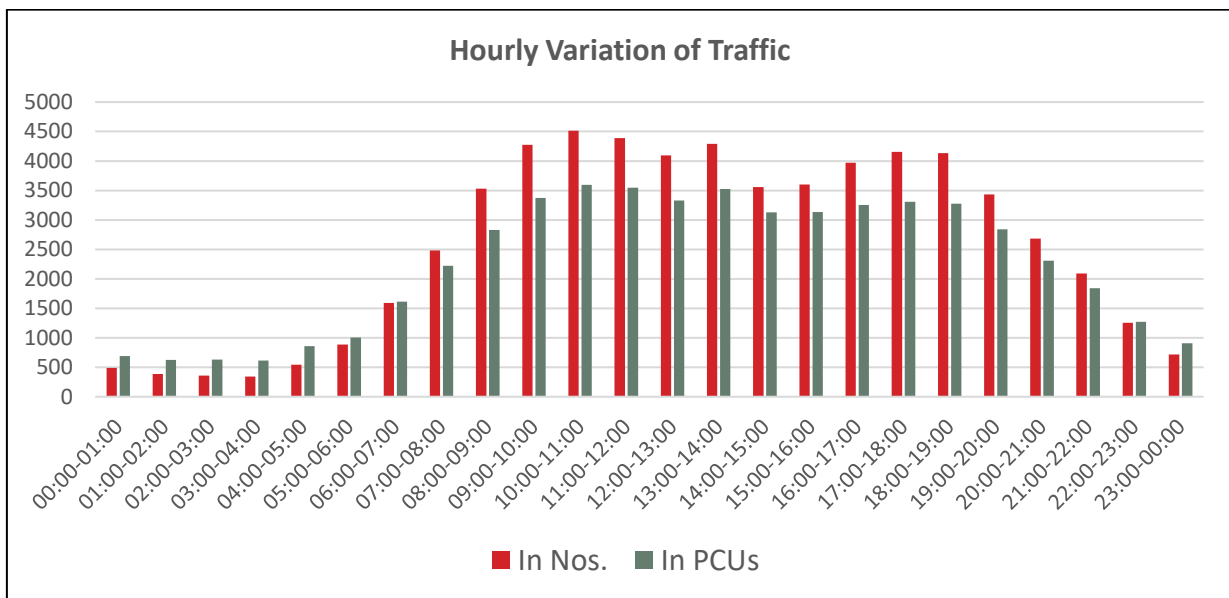


Figure 4-27 Hourly Traffic Variation at Karunagapally

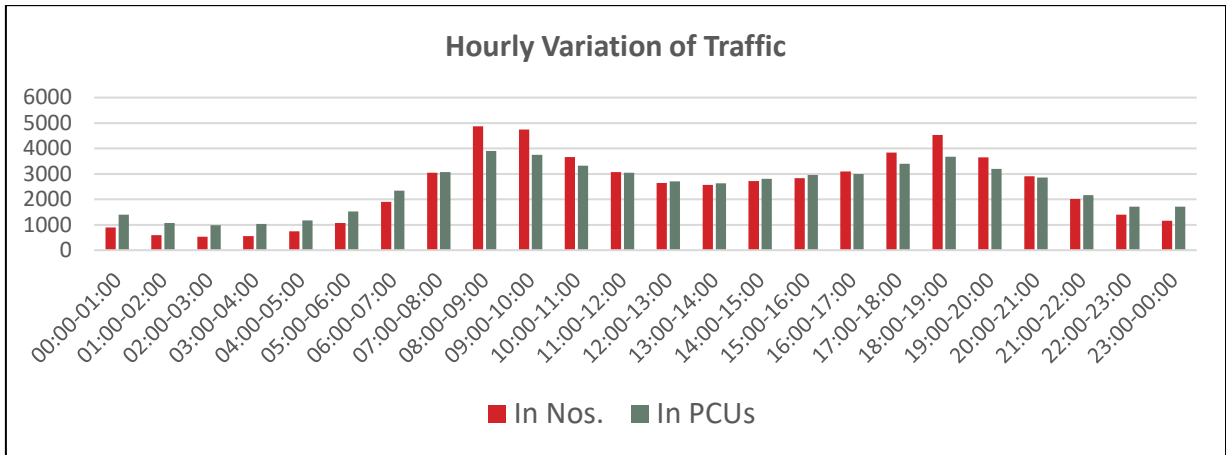


Figure 4-28 Hourly Traffic Variation at Kumbalam

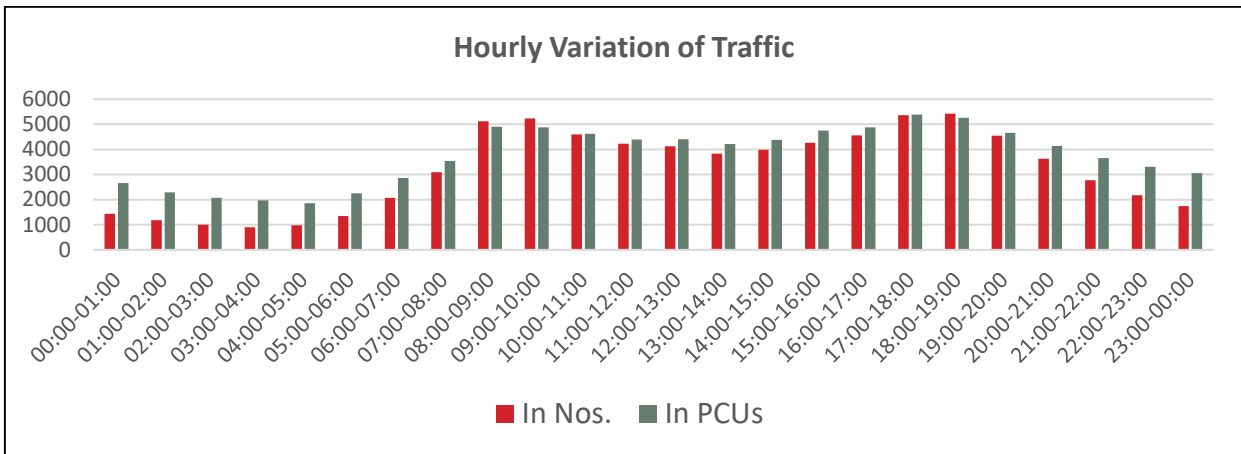


Figure 4-29 Hourly Traffic Variation at Paliyekkara

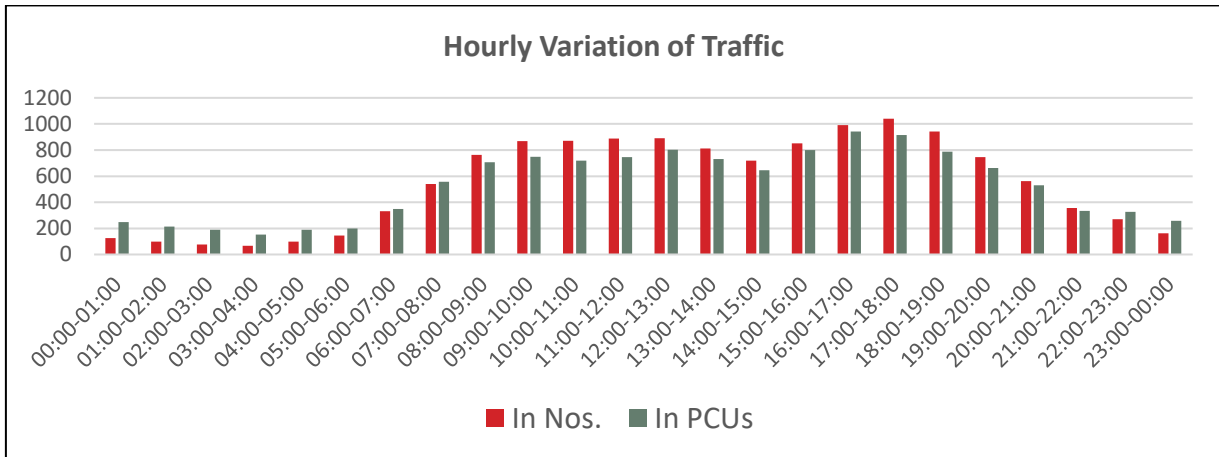


Figure 4-30 Hourly Traffic Variation at Gurupadapuri

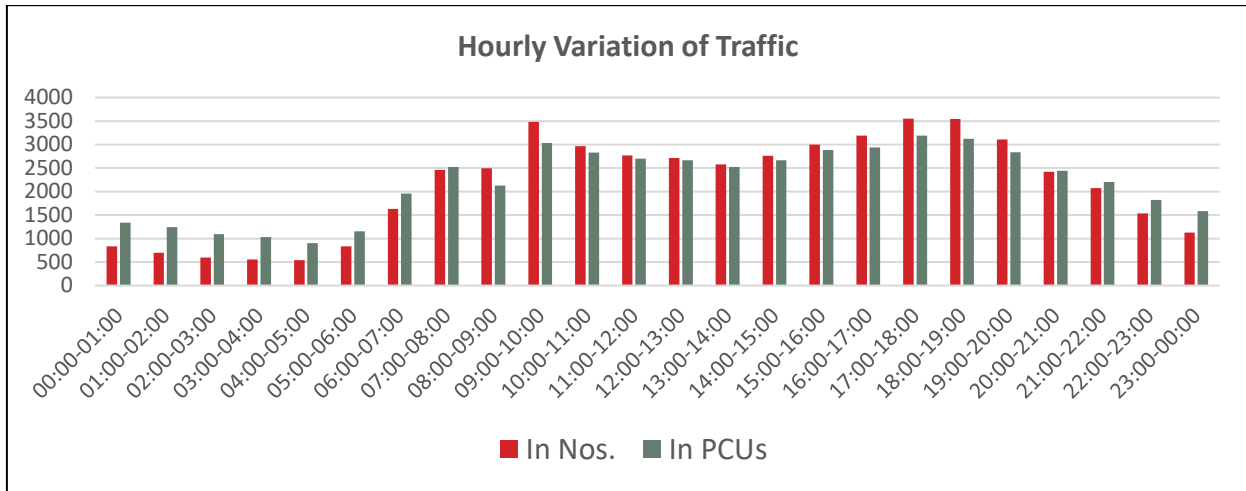


Figure 4-31 Hourly Traffic Variation at Azhinjillam

It can be observed that traffic volume is higher from 8 am to 8 pm and lower at other hours of the day at all locations.

4.3.8 Daily Variation of Traffic

Daily variation of traffic was analysed from the survey data. The daily variation of passenger and goods traffic in terms of total vehicles and PCUs at some of the important survey locations is provided in Volume III – Part 3A Annexure VI. From the data, no general trend in passenger traffic volumes on week and weekend were observed, and not much variation were observed between weekend and week day traffic. But in case of goods traffic weekend traffic was found to be less than week day traffic. There is distinguishable variation between week and weekday goods traffic.

Maximum variation in inter-day traffic at various location is given in **Table 4-41**.

Table 4-41: Maximum Inter-day Traffic Variation (%)

Sl. No.	Location ID	Location	Maximum variation in inter-day traffic (%)	
			Vehicles	PCU
1	TVC 01	Thottakadu	4.96	5.67
2	TVC 02	Kilimanoor	1.61	1.40
3	TVC 03	Karunagapally	9.86	8.51
4	TVC 04	Sasthamcotta	7.27	6.69
5	TVC 05	Adoor Bypass	4.11	3.79
6	TVC 06	Ezhinjillam	5.32	5.75
7	TVC 07	Cherthala	8.36	5.16
8	TVC 08	Udayamperoor	4.67	5.86

Sl. No.	Location ID	Location	Maximum variation in inter-day traffic (%)	
			Vehicles	PCU
9	TVC 09	Kumbalam Toll Plaza	3.16	3.36
10	TVC 10	Kumaranalloor	8.10	8.29
11	TVC 11	Paliyekkara Toll Plaza	5.00	2.25
12	TVC 12	Moothakunnam	9.54	8.32
13	TVC 13	Gurupadapuri	9.49	10.24
14	TVC 14	Edappal	2.46	3.45
15	TVC 15	Cheruvannur	10.75	9.83
16	TVC 16	Azhinjillam	7.26	8.70
17	TVC 17	Muzhapilangad Toll Plaza	3.78	4.39
18	TVC 18	Kanhangad South	3.93	2.10

Maximum variation in inter-day traffic was observed at TVC 15, Cheruvannur (10.75% for Vehicles and 9.83% for PCUs)

4.3.9 Vehicle Occupancy Survey

The average occupancy observed for various modes, Car, Taxi, Mini Bus and KSRTC Bus, Private Bus was 2.27, 2.5, 13.82, 28.58 and 29.13 respectively. The average mode-wise occupancy observed at the traffic count locations is shown in **Table 4-42**.

Table 4-42: Average Occupancy at Traffic Count Locations

Location	Car/ Jeep/ Van	Taxi	Autorickshaw	2 - Wheeler	Mini Bus	KSRTC Bus	Private Bus	School Bus
TVC 01	2.60	2.78	2.35	1.42	13.17	25.20	21.96	16.68
TVC 02	2.35	2.72	2.42	1.46	14.21	41.38	37.45	18.94
TVC 03	2.02	2.21	2.04	1.44	11.32	28.35	21.54	16.74
TVC 04	1.74	2.17	2.39	1.35	12.34	26.83	26.56	18.17
TVC 05	2.02	2.27	1.99	1.27	9.32	14.50	24.32	12.97
TVC 06	2.32	2.91	2.28	1.42	14.50	30.71	35.25	23.24
TVC 07	2.11	2.32	2.22	1.39	12.45	31.45	27.93	18.67

Location	Car/ Jeep/ Van	Taxi	Autorickshaw	2 - Wheeler	Mini Bus	KSRTC Bus	Private Bus	School Bus
TVC 08	2.29	2.51	2.60	1.56	13.85	25.43	25.30	13.13
TVC 09	2.48	3.02	2.45	1.42	16.16	34.72	35.38	18.34
TVC 10	2.22	2.63	2.00	1.41	14.35	22.59	27.67	22.37
TVC 11	2.28	2.51	2.44	1.38	12.67	25.86	27.23	17.90
TVC 12	2.29	3.00	2.31	1.45	21.11	36.75	36.40	27.72
TVC 13	2.29	2.27	2.13	1.39	11.54	28.05	32.67	13.80
TVC 14	2.23	2.05	1.97	1.67	16.45	28.05	28.13	23.58
TVC 15	2.68	2.36	2.19	1.38	13.44	30.33	32.45	15.83
TVC 16	2.56	2.82	2.48	1.49	16.63	32.86	29.46	15.38
TVC 17	2.40	2.23	2.20	1.38	15.38	28.22	29.25	22.99
TVC 18	1.97	2.21	2.01	1.33	9.86	23.23	25.32	12.04
Average	2.27	2.50	2.25	1.42	13.82	28.58	29.13	18.25

Based on vehicle occupancy data and traffic volume count, total daily passenger trips at each location are calculated as given in **Table 4-43**. The total passengers include only those travelling by Car, Taxi and Bus.

Table 4-43: Daily Passenger Trips (Car, Taxi and Bus)

TVC No.	Location	Passenger Trips - Car, Taxi & Bus	Ranking
TVC 01	Thottakadu	255757	5
TVC 02	Kilimanoor	249837	6
TVC 03	Karunagapally	235198	7
TVC 04	Sasthamcotta	83927	15
TVC 05	Adoor Bypass	67973	16
TVC 06	Ezhinjillam	204196	9
TVC 07	Cherthala	59092	17
TVC 08	Udayamperoor	151602	13

TVC No.	Location	Passenger Trips - Car, Taxi & Bus	Ranking
TVC 09	Kumbalam Toll Plaza	284511	4
TVC 10	Kumaranalloor	320296	2
TVC 11	Paliyekkara Toll Plaza	423308	1
TVC 12	Moothakunnam	196679	10
TVC 13	Gurupadapuri	48803	18
TVC 14	Edappal	196139	11
TVC 15	Cheruvannur	305776	3
TVC 16	Azhinjillam	211713	8
TVC 17	Muzhapilangad Toll Plaza	155156	12
TVC 18	Kanhangad South	129041	14

4.4 DATA ANALYSIS – TRAVEL CHARACTERISTICS

4.4.1 Origin and Destination (OD) Survey

OD survey was conducted at 9 identified locations, where the Classified Traffic Volume Surveys were conducted. The study area has been divided into 197 Traffic Analysis Zones (TAZ). The list of Zones and numbers are provided in Volume III – Part 3A, Annexure III.

Based on the Origin Destination Survey, separate mode wise OD matrices for car and taxi are developed. Both car and taxi passengers have been considered as potential users for SilverLine.

OD matrix for Car and Taxi were formulated by combining data at all the OD survey locations. While combining the data, due consideration was given in avoiding duplication of vehicles. Vehicles which have already passed another OD survey location earlier during its trip were discarded while combining data.

4.4.1.1 OD Sample Size

OD samples size for various vehicle categories at all the survey location is given in **Table 4-44**.

Table 4-44: OD Sample Size (%)

TVC No.	Location	Car	Taxi	Mini Bus	Bus	LCV	Truck	MAV	Total Passenger	Total Goods	Total Vehicles
TVC 01	Thottakadu	29.6	53.6	10.5	24.9	32.3	64.6	38.9	30.1	38.8	31.5
TVC 03	Karunagapally	19.0	40.4	43.0	60.6	27.5	45.7	43.2	23.0	32.6	24.9
TVC 06	Ezhinjillam	26.5	66.8	35.4	36.1	16.4	36.5	49.6	29.2	25.1	28.3
TVC 09	Kumbalam Toll Plaza	23.5	58.8	7.6	44.6	27.4	40.1	27.9	27.0	29.8	27.9
TVC 11	Paliyekkara Toll Plaza	21.2	35.9	31.2	21.4	15.4	60.2	16.3	22.4	22.3	22.4
TVC 13	Gurupadapuri	27.0	33.7	12.9	46.8	35.8	40.7	40.1	28.9	37.8	31.9
TVC 16	Azhinjillam	29.9	56.1	40.1	78.1	24.3	40.9	33.4	32.2	28.6	31.3
TVC 17	Muzhapilangad Toll Plaza	26.5	35.1	33.0	90.4	39.6	66.2	38.7	33.1	44.4	36.9
TVC 18	Kanhangad South	48.6	44.1	27.3	76.3	62.2	72.6	47.5	50.9	60.4	53.7

4.4.2 Trip Characteristics- Car/Taxi Trip

This section discusses trip length, trip purpose and trip frequency distribution of car/taxi passengers. Trip length distribution of Car/ Taxi trips is shown in the **Figure 4-32**.

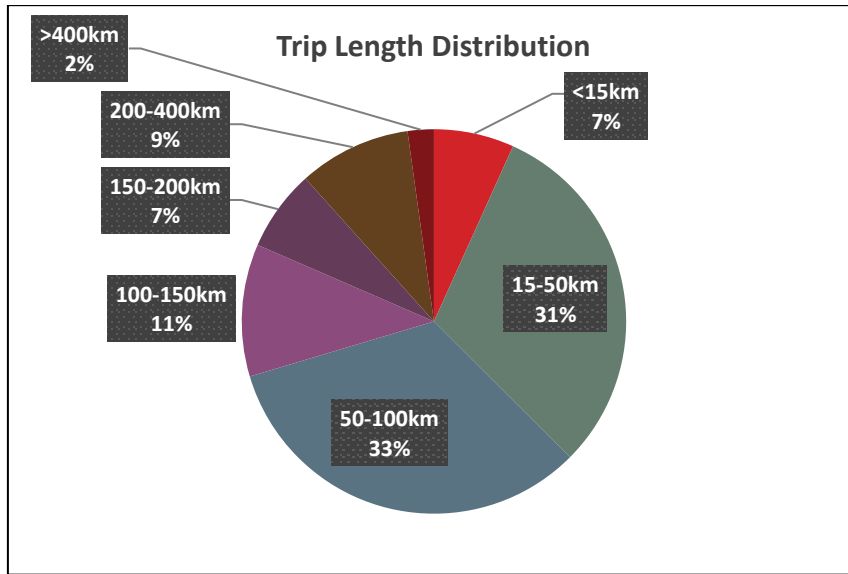


Figure 4-32 Trip Length Distribution- Car/ Taxi Trips

Trips less than 50 km consists of 38% and 50- 150 km trips constitute 44% of total trips. Trip characteristics and their attributes are considered to vary across trip purposes, hence understanding the nature of trip purpose is important for demand assessment. The trip purposes have been broadly categorized into four major trip purposes, viz. Work Business, Education, Social, Tourist and Other trips. The respective share of each category, as obtained from Road side OD Survey is shown in **Figure 4-33**.

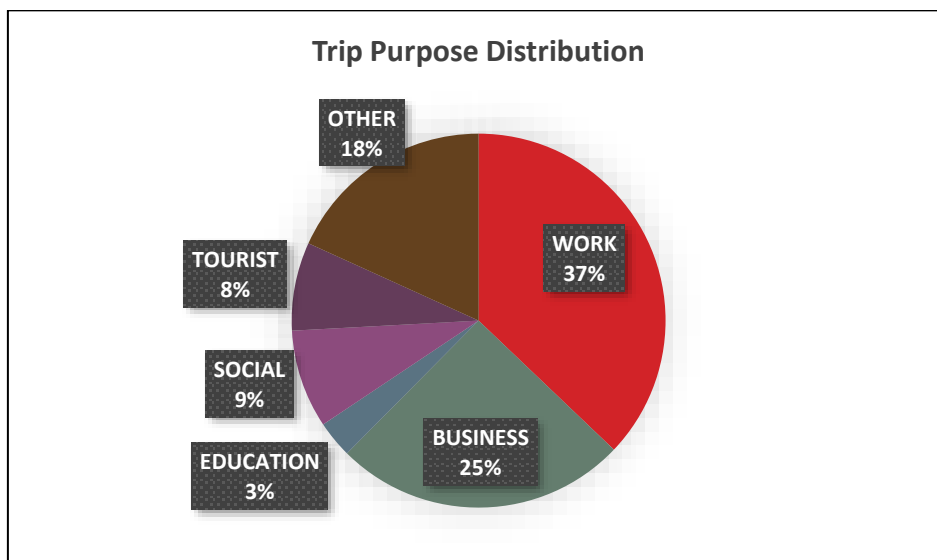


Figure 4-33 Trip Purpose Distribution- Car/ Taxi Trips

Maximum trips were seen to be performed under the categories of Work and Business Trips. While the least recorded share as observed from the Road-side OD survey was for Education. Tourist trips form 8% of the total.

Trip frequency is also a descriptive characteristic which aids in analysing the nature of trips that occurs within the study corridor. The trip frequency has been captured as daily,

weekly, monthly or occasionally. The respective share of each category, as obtained from Road side OD Survey, is shown in **Figure 4-34**.

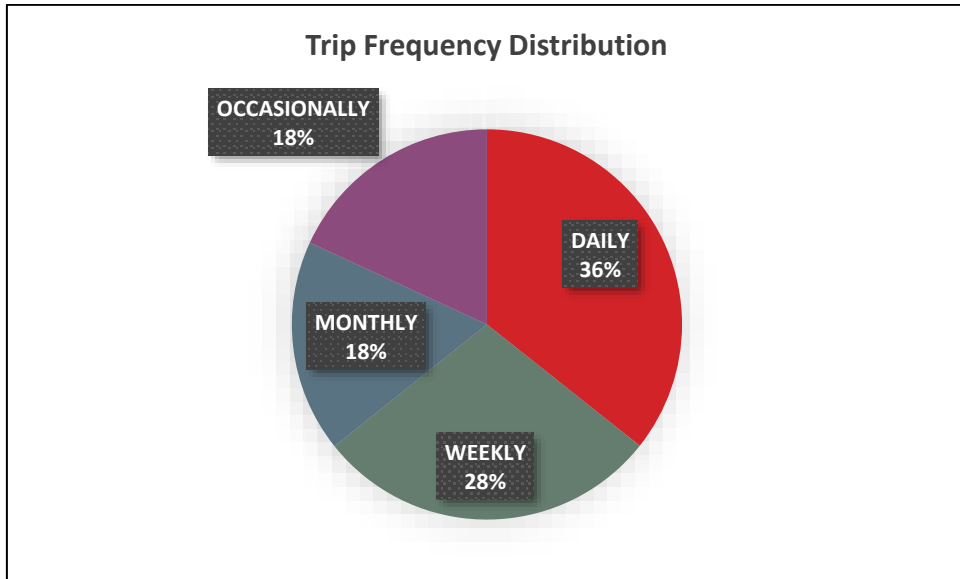


Figure 4-34 Trip Frequency Distribution- Car/ Taxi Trips

It can be seen that the majority of the trips are Daily or Weekly (36 % and 28% respectively).

4.4.3 Trip Characteristics - Goods Traffic

Analysis of goods traffic along project corridor provides insight into the type of commodity being transported, trip length and trip frequency of the candidate traffic. **Figure 4-35** shows trip length distribution of goods traffic observed during the OD Survey.

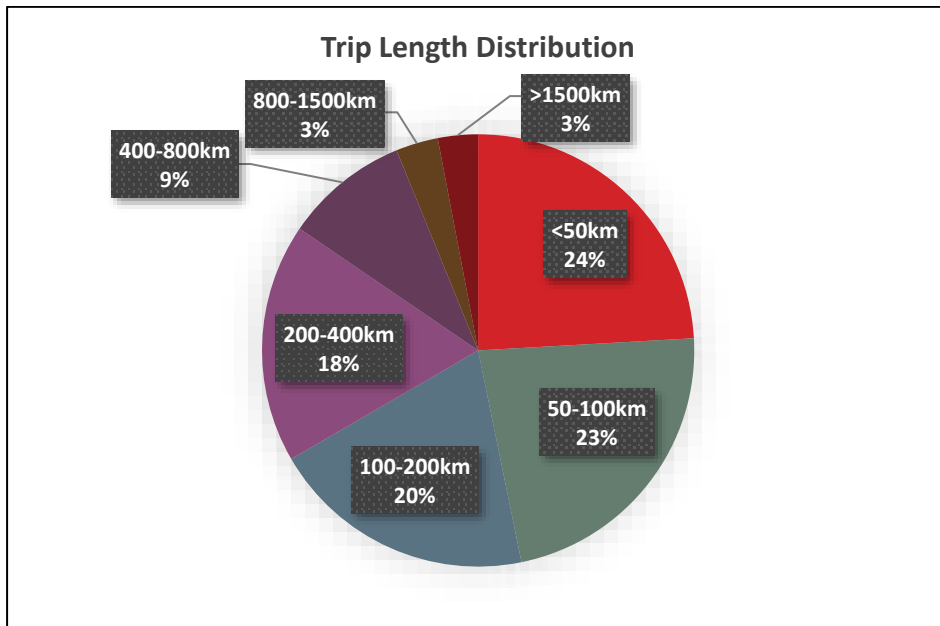


Figure 4-35 Trip Length Distribution- Goods Vehicles

Trips less than 100 km consists of 47% and more than 100 km trips constitute 53% of total trips. Type of commodity being transported along project corridor is important in deciding possible diversion to proposed RORO system. 14 different categories of commodities are considered in the analysis. **Figure 4-36** shows commodity distribution of goods traffic.

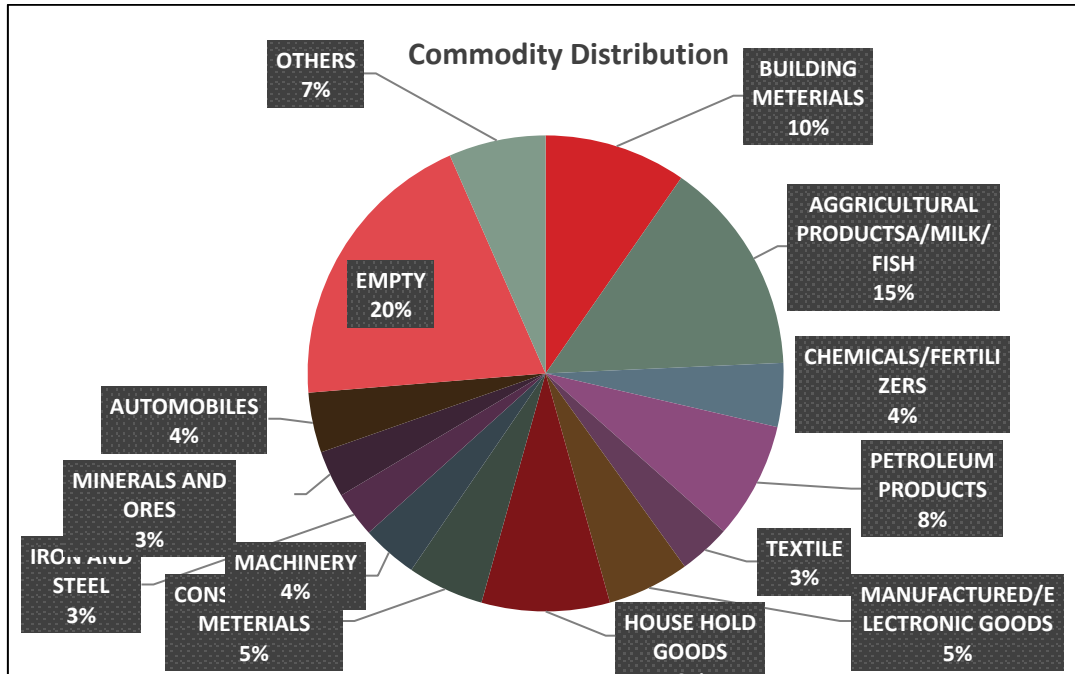


Figure 4-36 Trip Purpose Distribution- Goods Vehicles

20% of the trucks are travelling empty. Major goods being transported are Agricultural products/Milk/ Fish, Building materials, Household goods, and petroleum products.

Analysis trip frequency aids in analysing the nature of trips that occurs within the study corridor. The trip frequency has been captured as daily, weekly, monthly or occasionally. The respective share of each category, as obtained from OD Survey, is shown in **Figure 4-37**.

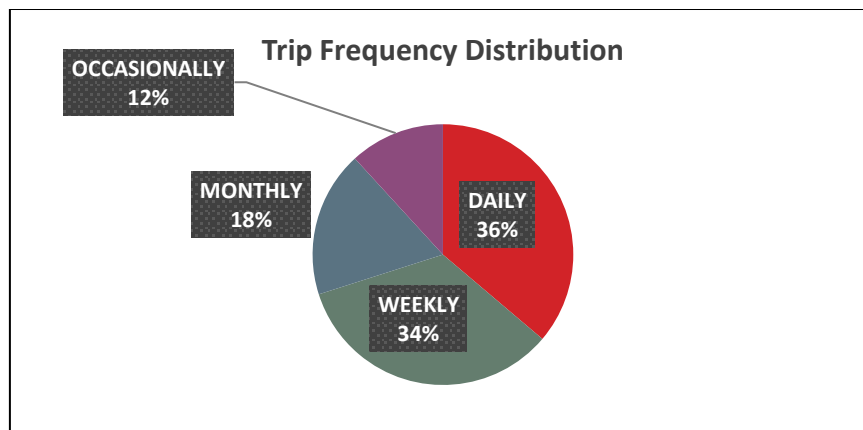


Figure 4-37 Trip Frequency Distribution- Goods Vehicles

It can be seen that the majority of the trips are Daily or Weekly (36 % and 34% respectively).

4.4.4 Trip Contribution

Contribution of trips on the project corridors, from Kerala and neighbouring States, gives proper insight in forecasting of trips. Table below shows the contribution of passenger and goods trips from Kerala and neighbouring States.

Table 4-45: Trip Contribution- Passenger Trips (%)

Category/ State	Kerala	Tamil Nadu	Karnataka	Puducherry	Rest of India
AC BUS-KSRTC	98.3%	0.8%	0.7%	0.1%	0.0%
AC LOW FLOOR BUS-KSRTC	96.1%	2.5%	0.7%	0.4%	0.3%
AC BUS-PVT.	93.5%	5.0%	0.4%	0.0%	1.0%
CAR/JEEP/VAN	97.2%	1.5%	0.4%	0.6%	0.3%
DELUXE BUS	87.4%	3.2%	8.0%	0.1%	1.3%
EXPRESS BUS	98.3%	1.5%	0.0%	0.0%	0.2%
FAST PASSENGER BUS	95.7%	3.6%	0.0%	0.6%	0.1%
MINI BUS	97.1%	1.7%	0.7%	0.3%	0.2%
ORDINARY BUS	98.1%	1.1%	0.3%	0.3%	0.0%
SUPER FAST BUS	97.6%	2.2%	0.0%	0.2%	0.0%
TAXI	96.4%	2.3%	0.4%	0.5%	0.4%

Majority of the passenger trips are within Kerala. In Deluxe Buses category, contribution of Other States is higher compared to other categories.

Table 4-46: Trip Contribution- Goods Trips (%)

Category/ State	Kerala	Tamil Nadu	Karnataka	Puducherry	Rest of India
TEMPO	98.1%	0.9%	0.3%	0.4%	0.4%
LCV	92.0%	4.5%	1.2%	1.0%	1.3%
2-3 AXLE TRUCK	85.1%	7.1%	4.1%	0.9%	2.7%
MULTI AXLE TRUCK	77.1%	7.1%	5.7%	2.2%	8.0%

Along the PIA, in goods vehicles, majority of the trips is within Kerala. Second major contribution is from Tamil Nadu followed by Karnataka.

Major OD pairs identified for Goods trips are:

- Thrissur City- Ernakulam (5.29%)
- Ernakulam- Thiruvananthapuram City(2.76%)
- Kochi- Kollam City (2.53%)
- Kollam City- Thiruvananthapuram City (2.17%)
- Rest of India- Kochi (1.91%)
- Kannur city – Kozhikode City (1.88%)

4.4.5 Passenger Terminal OD Survey at Identified Airport, Bus and Train Terminals

The interview of passengers at identified terminals (4 Airports, 4 Bus Terminals and 4 Train Terminals) were conducted to establish existing travel pattern of commuters. This section describes characteristics of the data collected at Airport, Bus and Rail Terminals separately.

4.4.5.1 Airports

Survey of passengers was conducted at Thiruvananthapuram, Kochi, Kannur and Calicut International airports. This section combines data at all the airports and provides details of general characteristics as observed (**Figure 4-38 to Figure 4-45**).

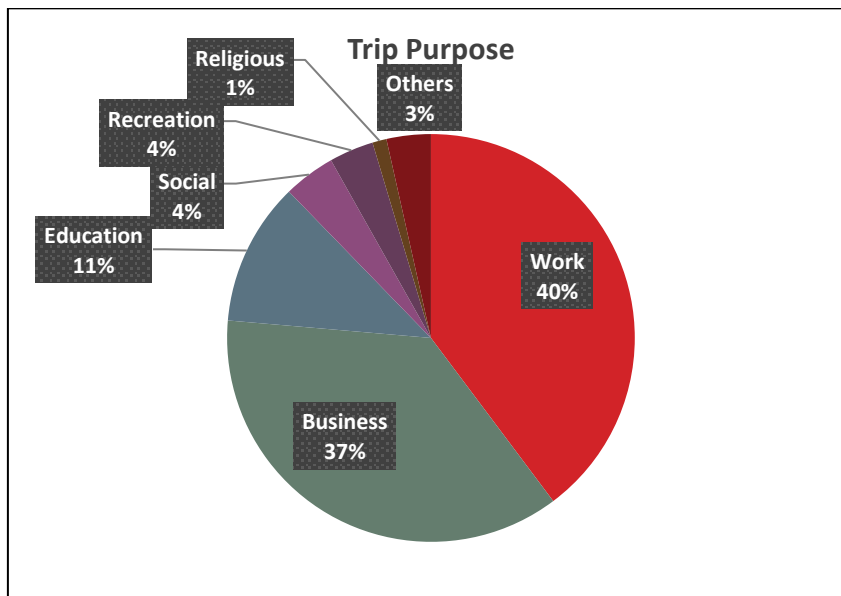


Figure 4-38 Trip Purpose Distribution- Airport

Majority of the trips are work trips followed by Business trips (together constituting 77%). Recreational trips are only 4%.

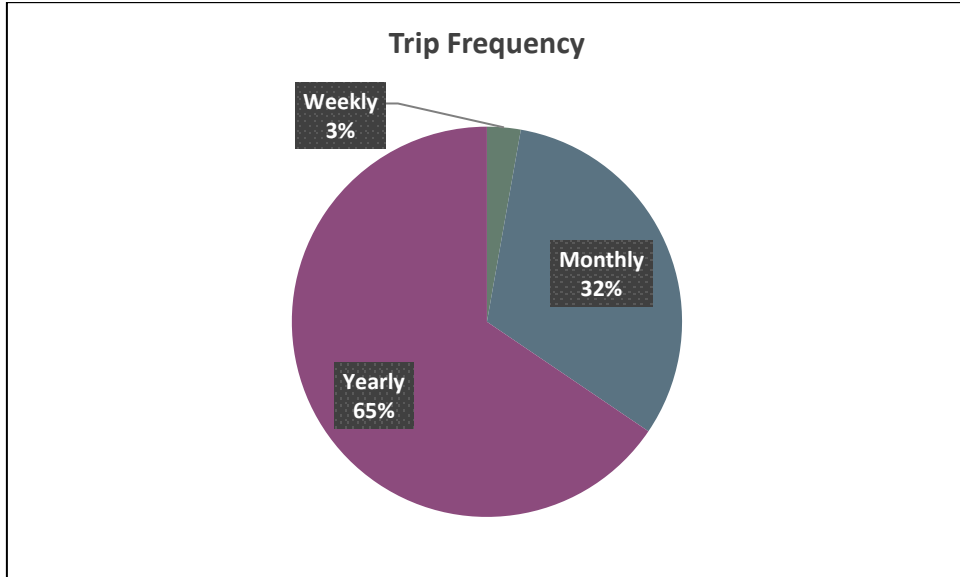


Figure 4-39 Trip Frequency Distribution- Airport

Majority of the trips are of yearly trips (65%). Monthly trips constitute 32% and weekly trips are only 3%.

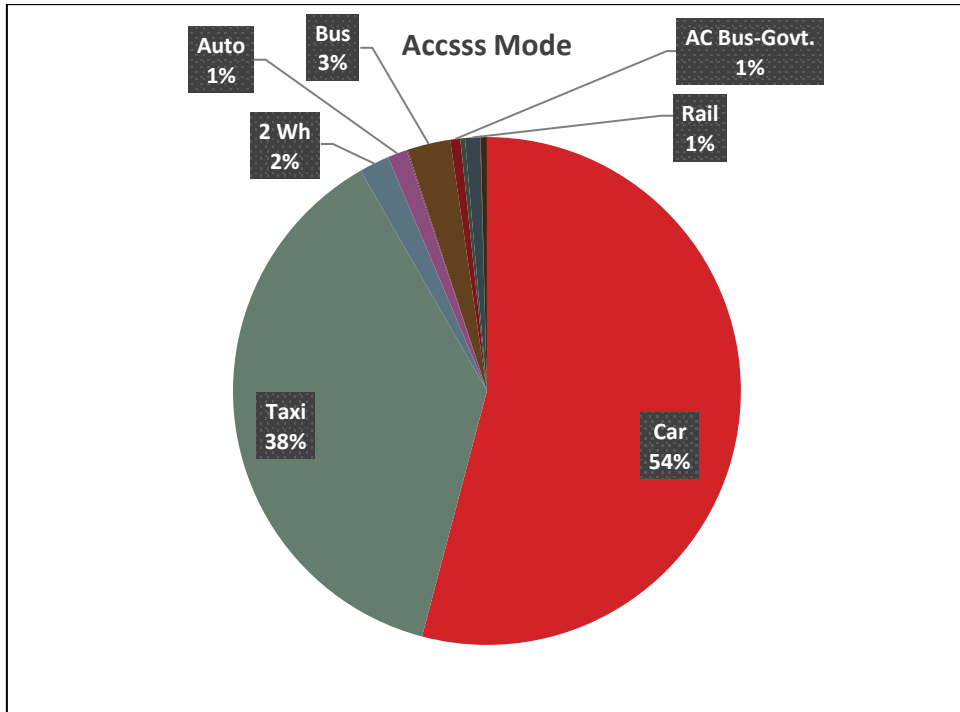


Figure 4-40 Access Mode - Airport

Car is the major mode of access to Airport (54%) followed by Taxi (38%).

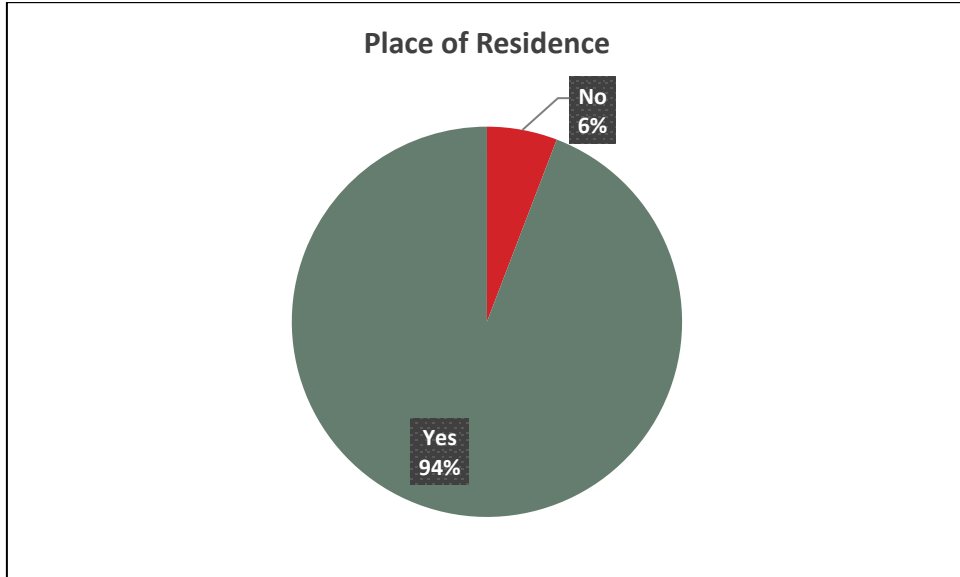


Figure 4-41 Place of Residence - Airport

Majority of the respondents are Keralites (94%).

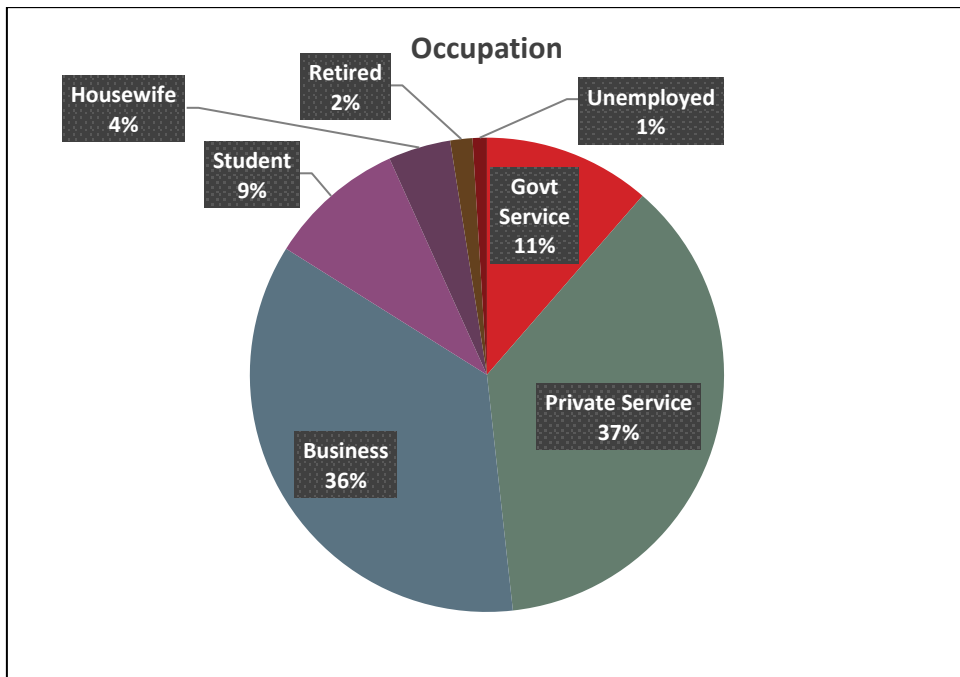


Figure 4-42 Occupation Distribution- Airport

Occupation of majority of the respondents is Private Service and Business (37% and 36% respectively).

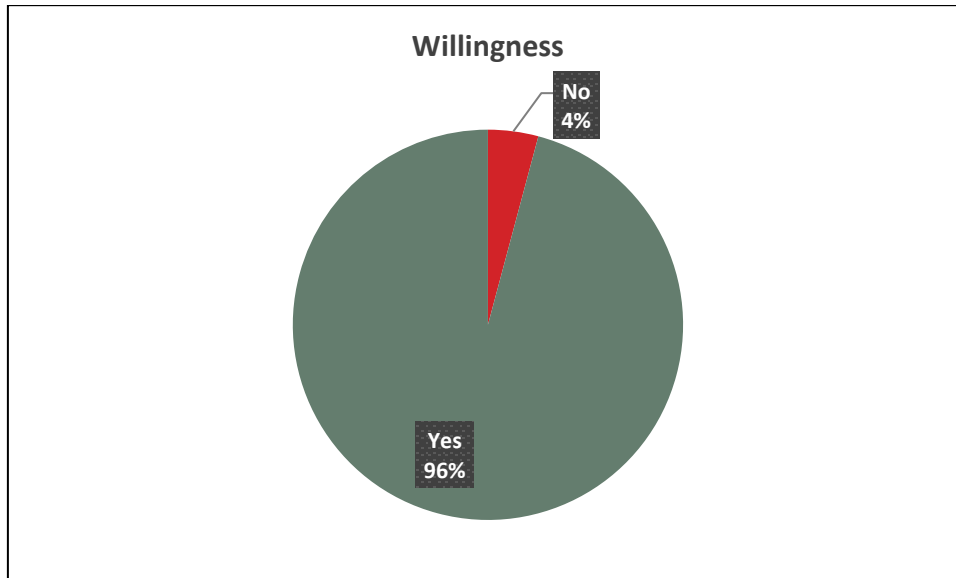


Figure 4-43 Willingness To Shift- Airport

96% of the total respondents showed willingness to shift to SilverLine.

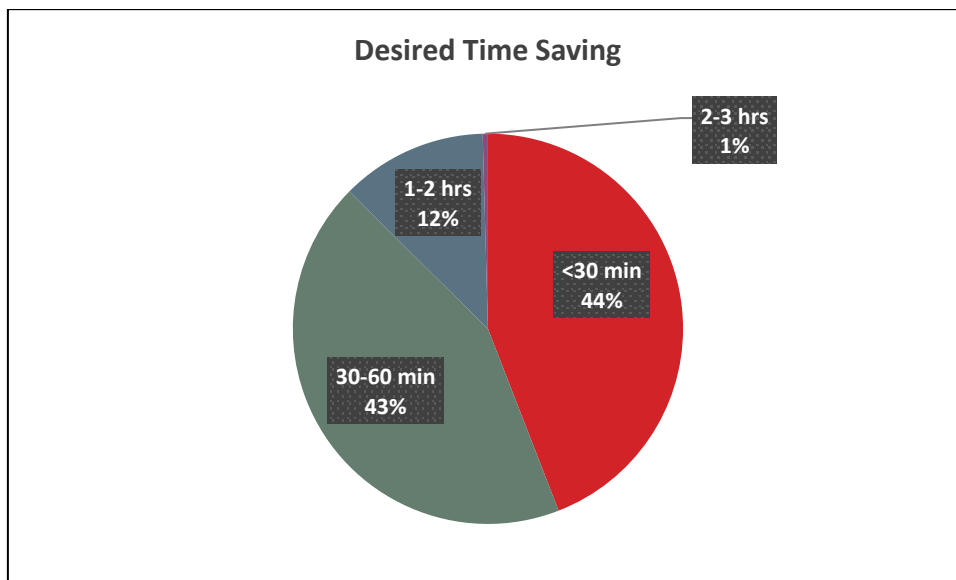


Figure 4-44 Desired Time Saving- Airport

Desired time saving for majority of the respondents was less than 30 minutes and 30-60 minutes (44% and 43% respectively).

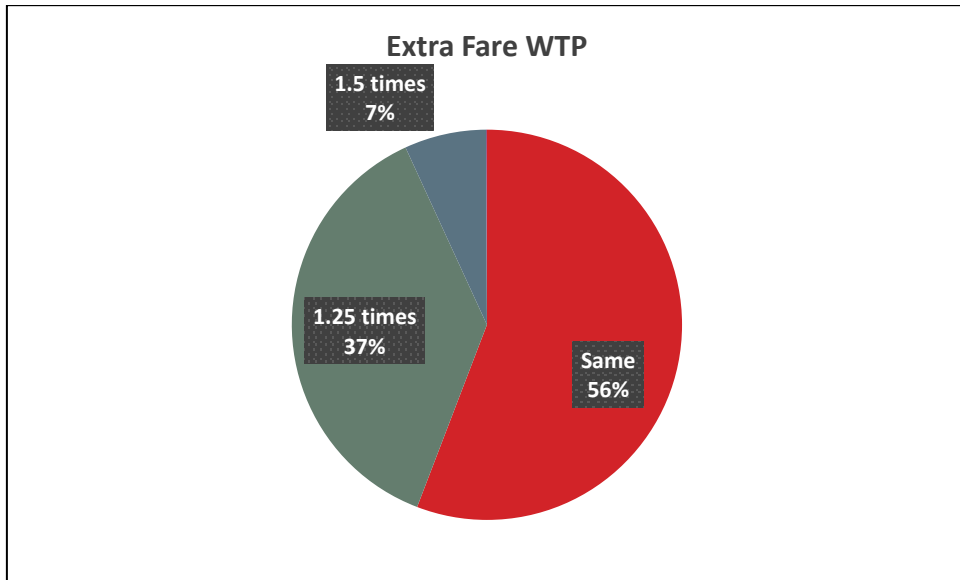


Figure 4-45 Extra Fare Willing To Pay - Airport

Most of the respondents were only willing to pay same fare (56%). 37% and 7% expressed willingness to pay 1.25 and 1.5 times respectively.

4.4.5.2 Bus Terminal

Survey was conducted at Thiruvananthapuram KSRTC Bus Station, Ernakulam – Vyttila Bus Terminal, Thrissur KSRTC Bus Terminal and Kozhikode Private Bus Terminal. Data at all the locations are combined and general characteristics of passengers at Bus are given in **Figure 4-46** to **Figure 4-53**.

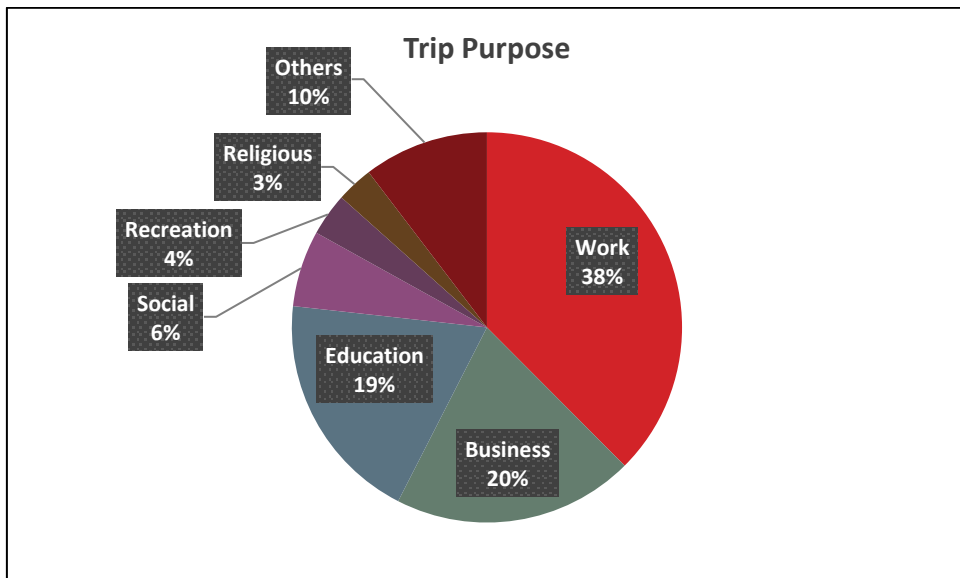


Figure 4-46 Trip Purpose Distribution- Bus Terminal

Majority of the trips are work trips followed by Business Trips (together constituting 58%). Recreational trips are only 4%.

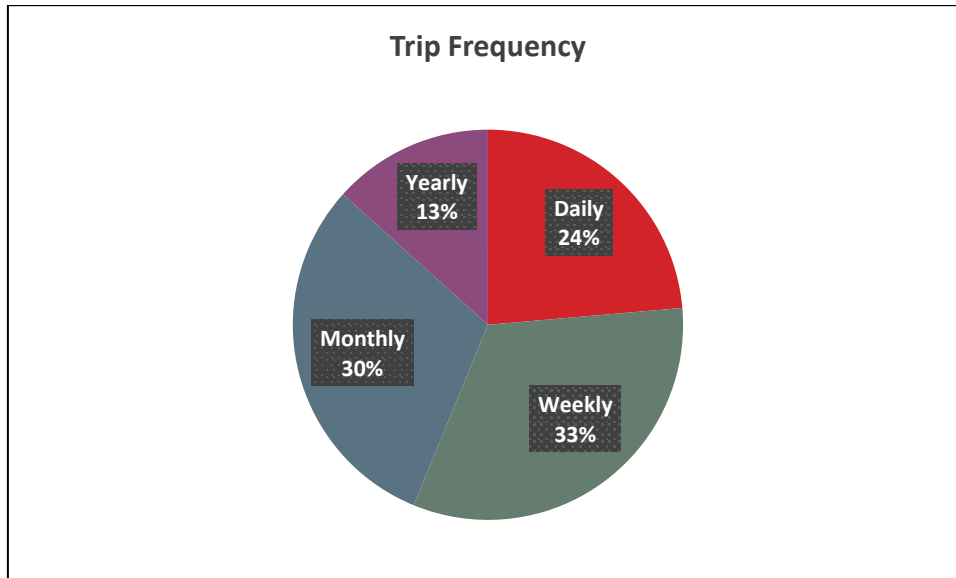


Figure 4-47 Trip Frequency Distribution- Bus Terminal

Majority of the trips are of Weekly trips (33%). Monthly trips constitute 30% and daily trips are 24%.

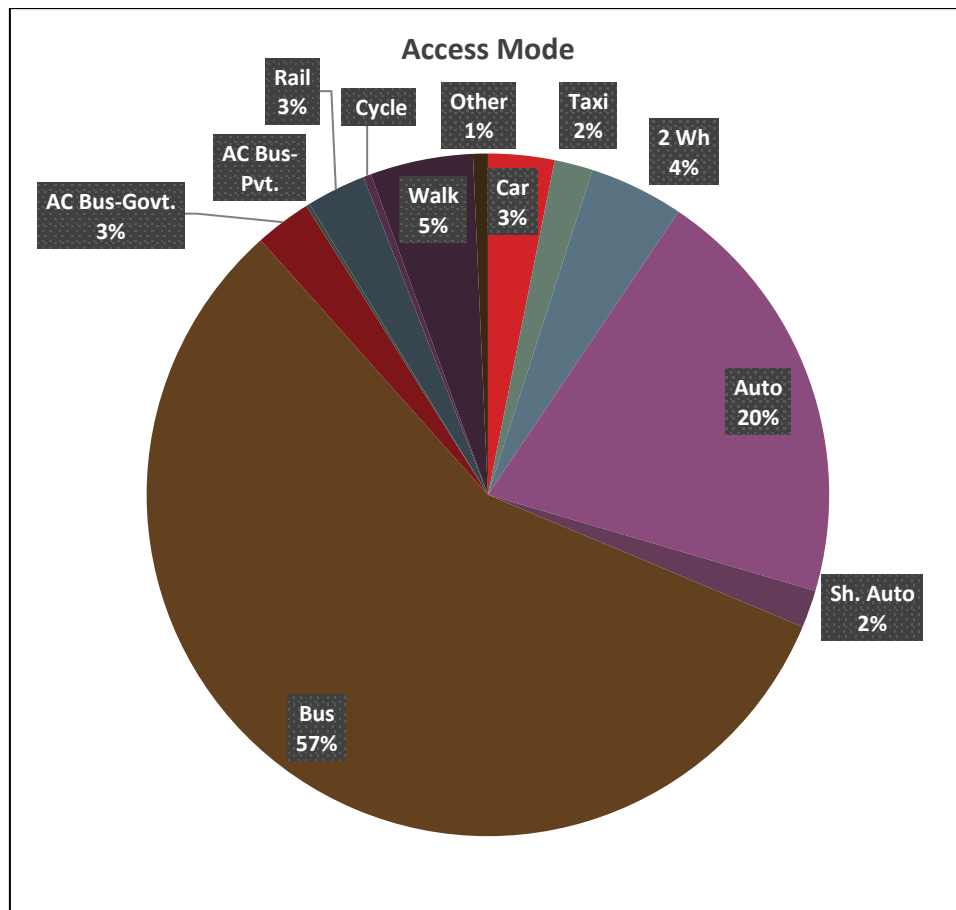


Figure 4-48 Access Mode - Bus Terminal

Ordinary Bus is the major mode of access mode to Bus Terminal (57%) followed by Auto Rickshaw (20%).

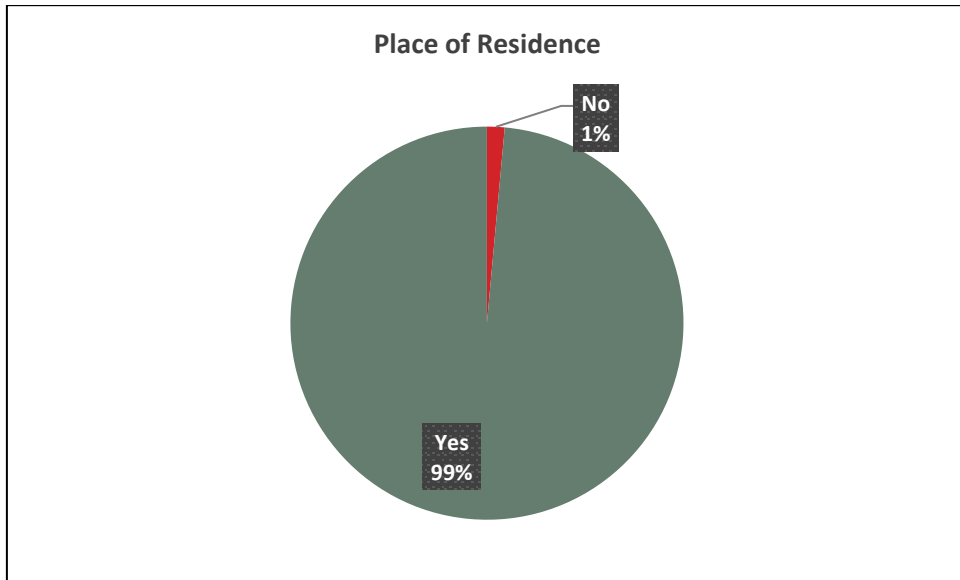


Figure 4-49 Place of Residence - Bus Terminal

Majority of the commuters are Keralites (99%).

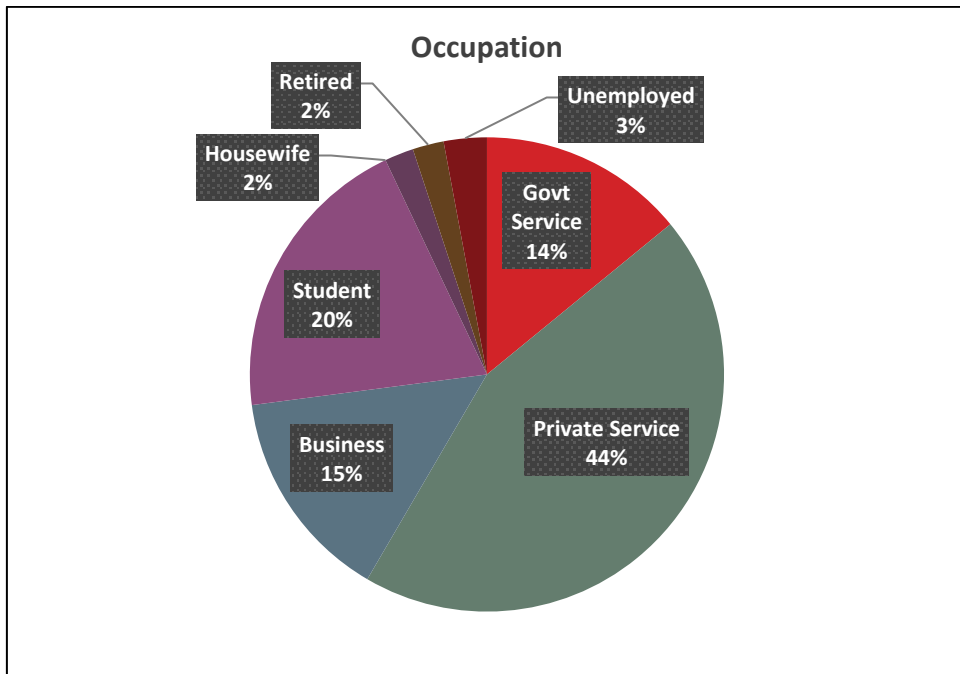


Figure 4-50 Occupation Distribution- Bus Terminal

Occupation of majority of the Bus passengers are private services (44%).

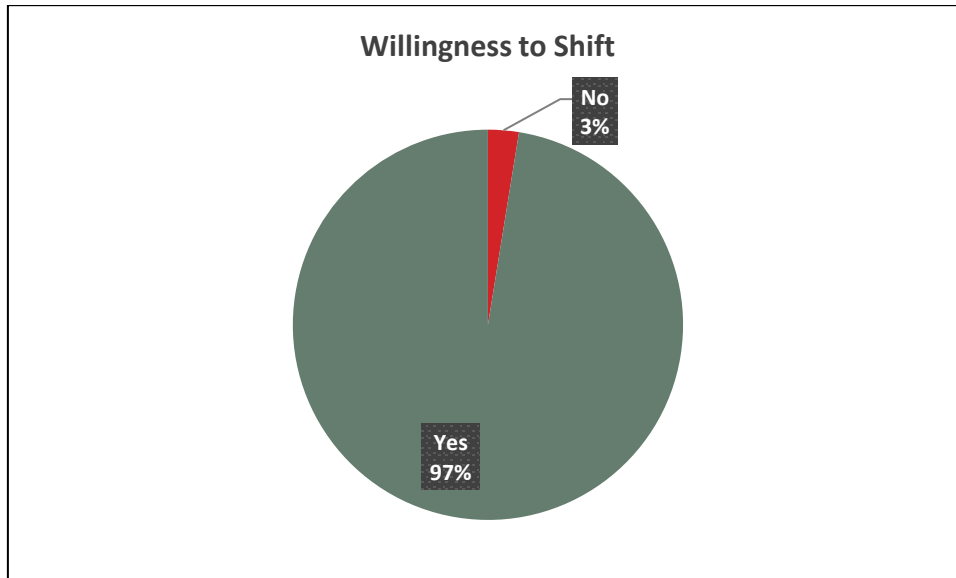


Figure 4-51 Willingness to Shift- Bus Terminal

97% of the total commuters showed willingness to shift to SilverLine.

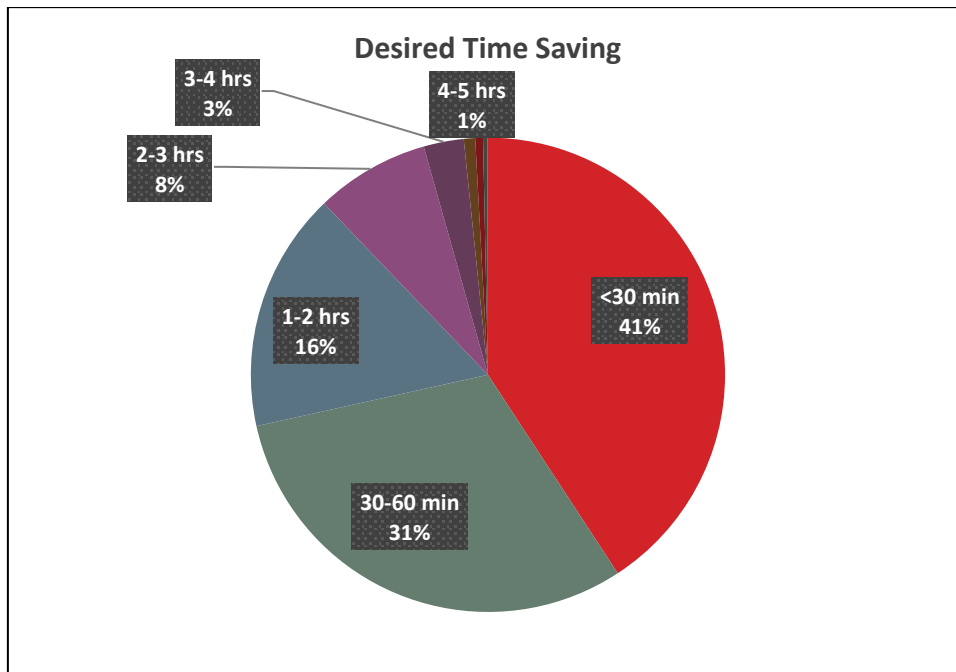


Figure 4-52 Desired Time Saving- Bus Terminal

Desired time saving for majority of the commuters is less than 30 minutes and 30-60 minutes (41% and 31% respectively).

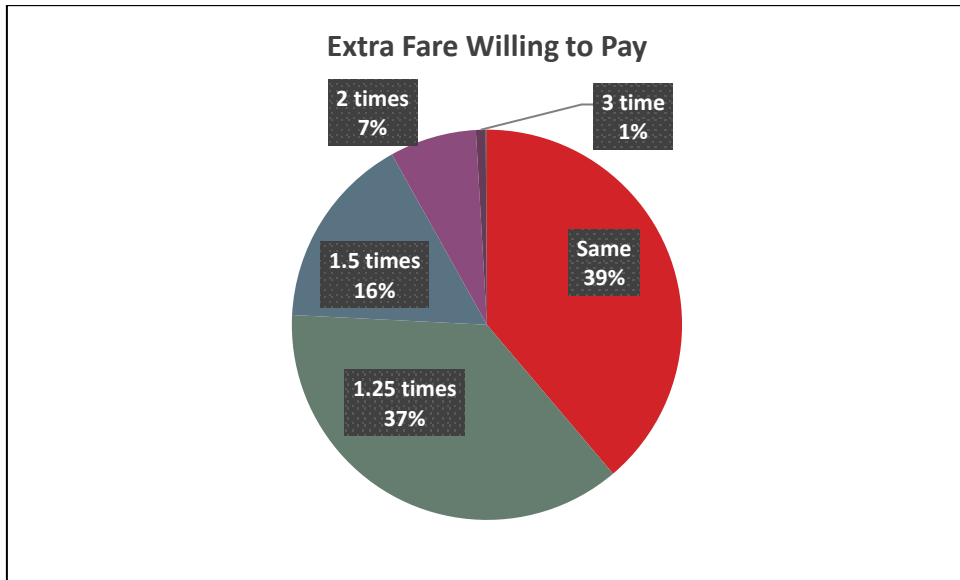


Figure 4-53 Extra Fare Willing To Pay- Bus Terminal

Most of the commuters are only willing to pay same fare as their existing mode (39%). 39% and 16% of respondents expressed willingness to pay 1.25 and 1.5 times of the fare respectively.

4.4.5.3 Railway Terminals

Survey of rail passengers was conducted at Thiruvananthapuram, Kollam, Ernakulam South and Kozhikode railway stations. Data of all the 4 locations are combined and general characteristics as observed are given in **Figure 4-54** to **Figure 4-61**.

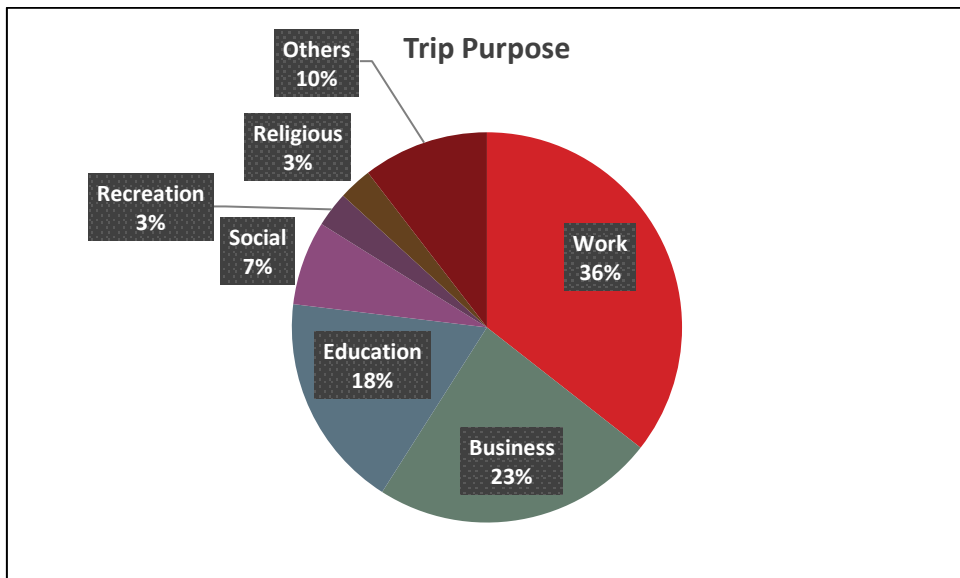


Figure 4-54 Trip Purpose Distribution- Railway Terminal

Majority of the trips are work trips followed by Business trips (together constituting 59%). Recreational trips are only 3%.

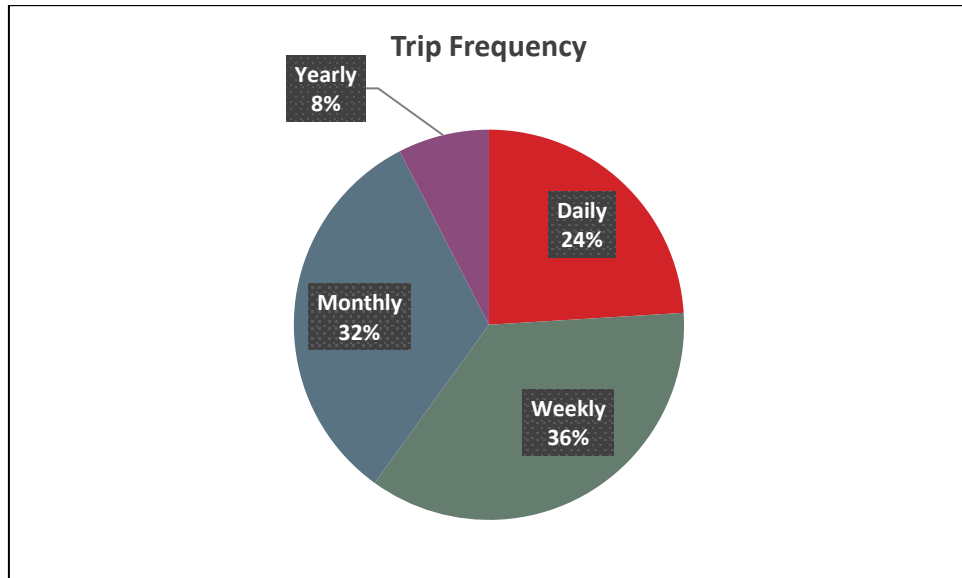


Figure 4-55 Trip Frequency Distribution- Railway Terminal

Majority of the trips are of weekly trips (36%). Monthly trips constitute 32% and daily trips are only 24%.

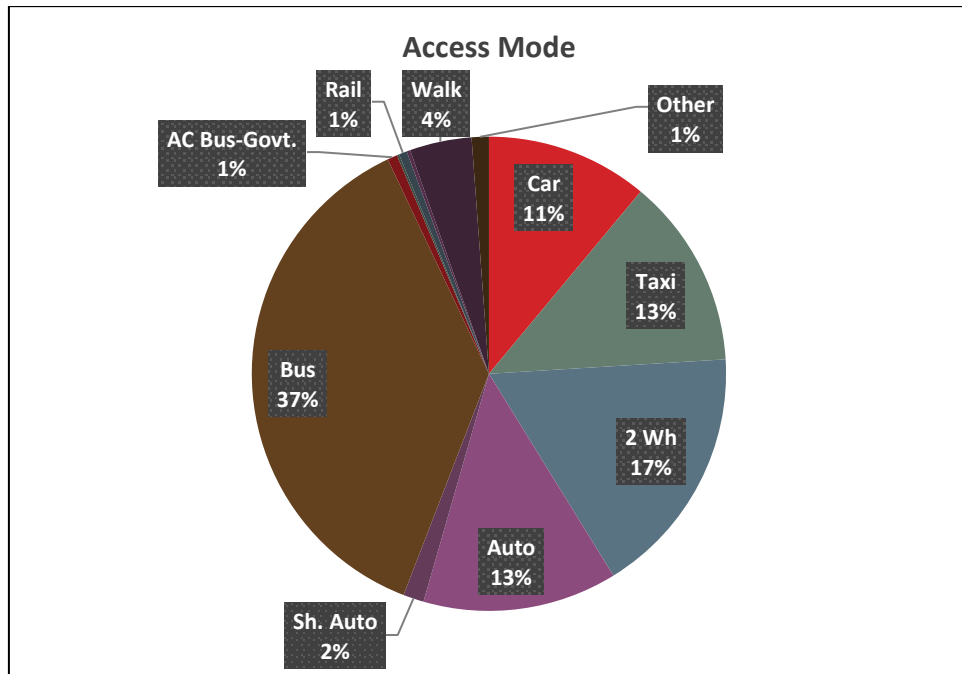


Figure 4-56 Access Mode - Railway Terminal

Ordinary Bus is the major access to Railway Station (37%) followed by two wheeler (17%).

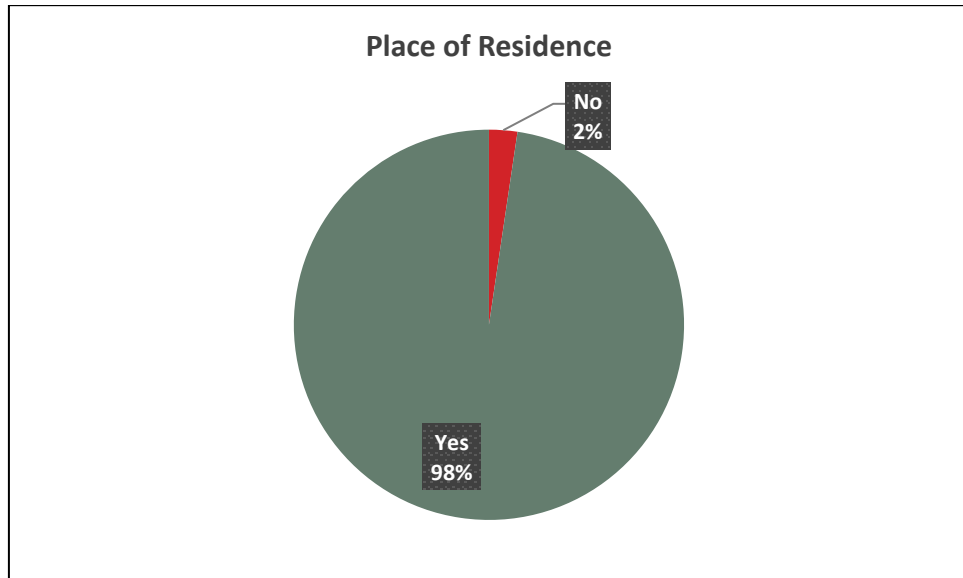


Figure 4-57 Place of Residence - Railway Terminal

Majority of the commuters are Keralites (98%).

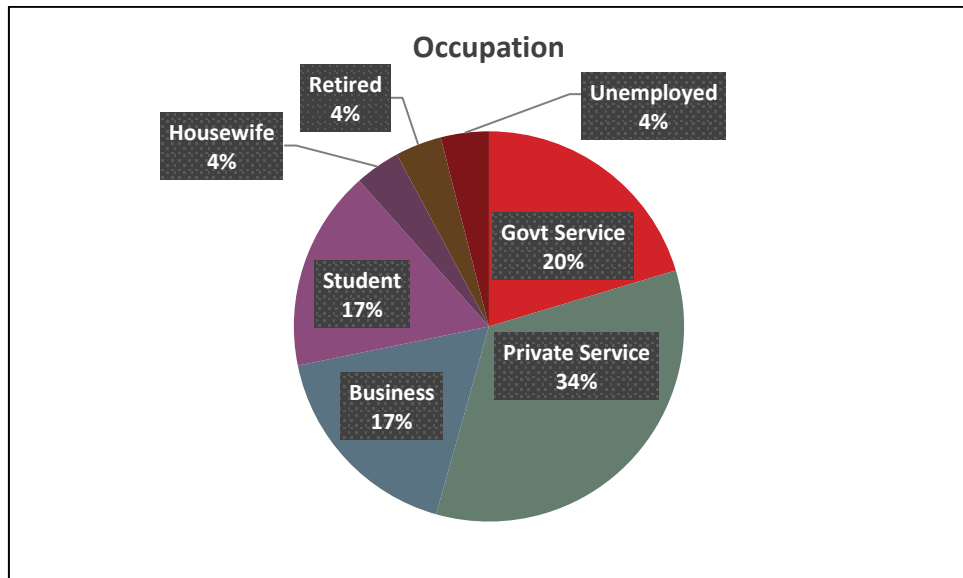


Figure 4-58 Occupation Distribution- Railway Terminal

Occupation of majority of the rail passengers are Private Service and Government Service (34% and 20% respectively).

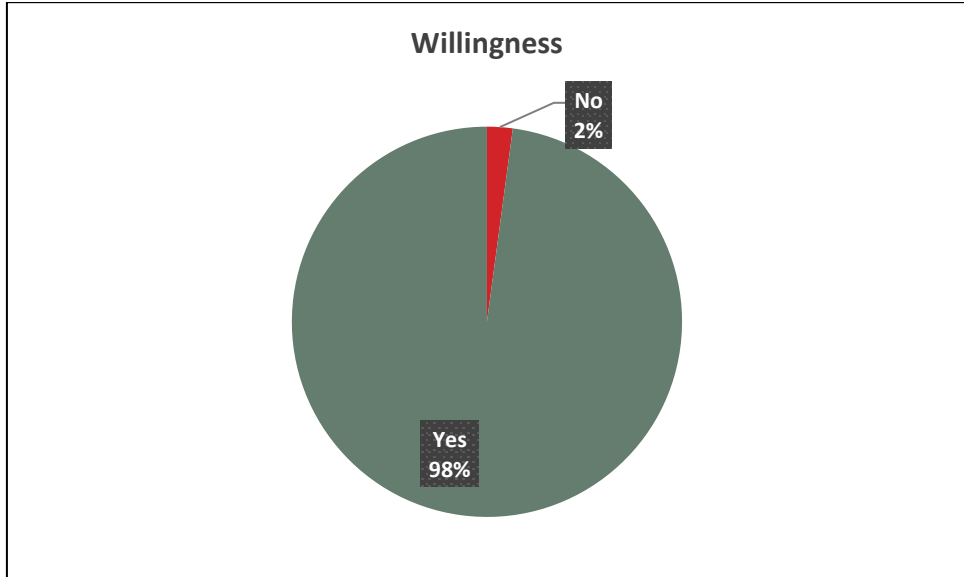


Figure 4-59 Willingness to Shift- Railway Terminal

98% of the rail passengers showed willingness to shift to SilverLine.

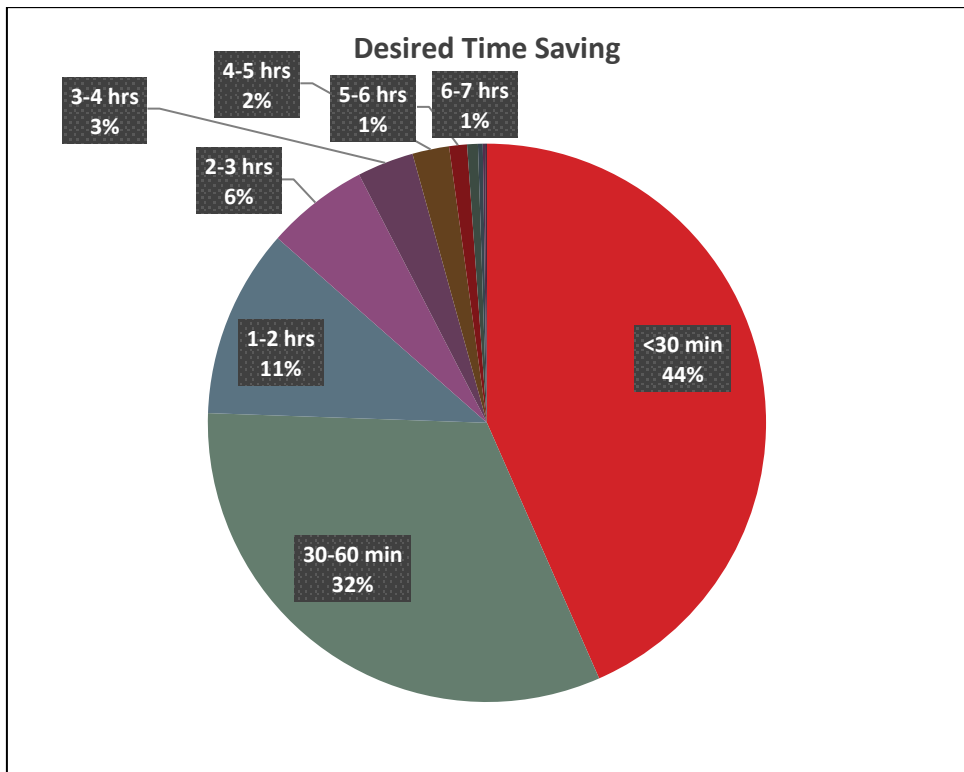


Figure 4-60 Desired Time Saving- Railway Terminal

Desired time saving for majority of the rail users are less than 30 minutes and 30-60 minutes (44% and 32% respectively).

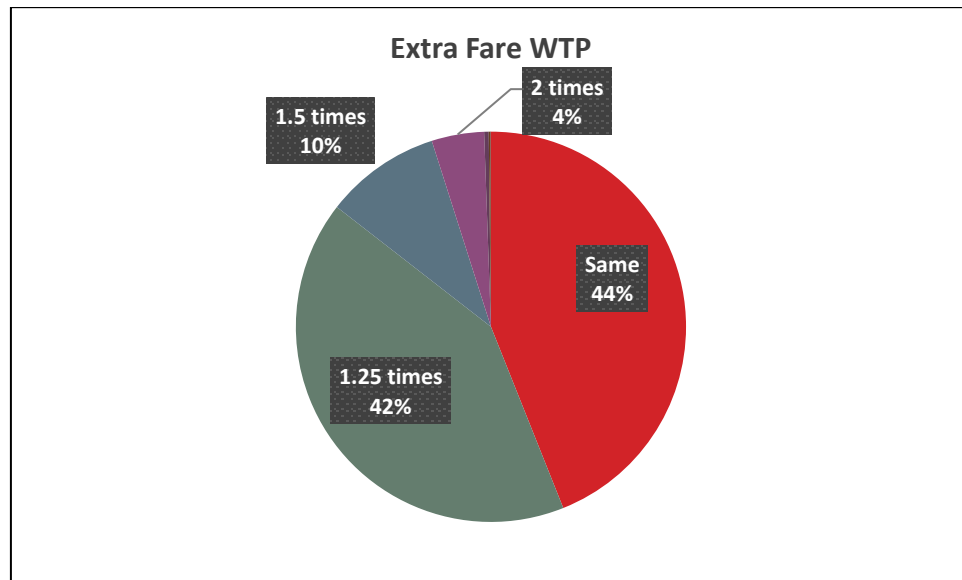


Figure 4-61 Extra Fare Willing To Pay- Railway Terminal

Most of the rail passengers are only willing to pay same fare (44%). 42% and 10% expressed willingness to pay 1.25 and 1.5 times respectively.

4.5 DATA ANALYSIS FROM SECONDARY SOURCES – PASSENGER TRIPS

4.5.1 Railway Reserved Passenger Data

Railway reserved passenger data were collected through *Reserved Passenger Data Warehouse of Indian Railways*. Trains crossing at least 3 SilverLine stations are considered and only AC, Sleeper and Chair Car passengers are treated as potential users. The reserved rail passenger data collected corresponds to the year 2018 (1st January to 31st December). List of trains considered is given in Table 4-27.

Origin Destination matrix of category-wise rail passengers matrix was developed and Origin & destination of the trips are classified as *Internal* or *External* based on their location. Locations within Kerala are termed *internal* and locations outside Kerala are termed *External*.

4.5.2 Major OD Pairs

Major OD pairs are identified for trains plying through Kerala.

Internal (I) - Stations within Kerala ; External (E)- Stations outside Kerala

Major OD Pairs - within Kerala (Internal to Internal)

- Thiruvananthapuram Central- Ernakulam (1.94% of total, 6.66% of I-I)
- Thiruvananthapuram Central- Kozhikode(1.48% of total, 5.08% of I-I)
- Thiruvananthapuram Central- Thrissur (1.39% of total, 4.78% of I-I)
- Ernakulam Junction-Kozhikode (0.85% of total, 2.92% of I-I)

Major OD pairs- Internal to External

- Chennai Central- Kozhikode (1.48% of total, 3.42% of I-E)
- Thrissur- Chennai Central (1.05% of total, 2.42% of I-E)
- Ernakulam town- Chennai Central (0.83% of total, 1.93% of I-E)
- Thiruvananthapuram Central-Chennai Central (0.70% of total, 1.62% of I-E)

Major OD pairs- External to External

- Chennai Central- Mangalore Central (0.98% of total, 3.54% of E-E)
- Coimbatore Junction- Chennai Central (0.72% of total, 2.61% of E-E)

Distribution of Internal -Internal, Internal - External and External - External rail passengers trips are shown in **Figure 4-62**.

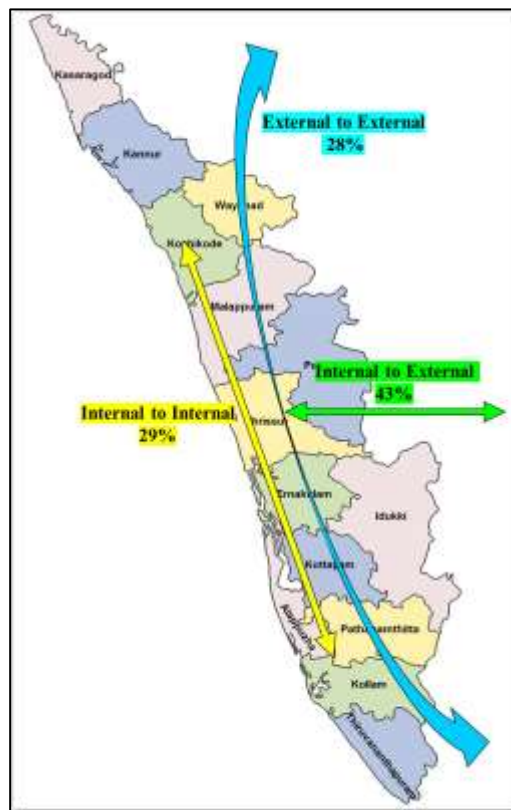


Figure 4-62 Distribution of Railway Reserved Passengers

4.6 TOLL TRAFFIC DATA - SCF ESTIMATION

Monthly tollable traffic at Paliyekkara and Kumbalam toll plaza are used in assessment of Seasonal Correction Factors. The estimated SCF for Paliyekkara and Kumbalam toll plaza are given in tables below. However, these SCF are not used for AADT estimation, since data of only two stretches/ toll plazas is available and it cannot be considered as representative of entire corridor.

Table 4-47: Seasonal Correction Factors- Paliyekkara Toll Plaza

Month	SCF					
	LMV	LCV	TRUCK	BUS	MAV	TOTAL
Sep-16	0.94	0.97	1.01	1.00	1.01	0.95
Oct-16	0.92	0.88	0.95	0.95	0.95	0.92
Sep-17	1.09	1.07	1.07	1.11	1.10	1.09
Oct-17	1.16	1.03	1.06	1.00	1.09	1.13
Sep-18	1.20	0.98	0.91	1.08	0.92	1.13
Oct-18	1.05	0.93	0.94	1.09	0.95	1.03
Sept.- Average	1.08	1.01	1.00	1.07	1.01	1.06
Oct.- Average	1.05	0.95	0.98	1.01	0.99	1.03

Table 4-48: Seasonal Correction Factors- Kumbalam Toll Plaza

Month	SCF						
	Car	LCV	BUS	Truck	3Axle	4-6 Axle HCM/EME/MAV	Total Vehicles
Sep-17	0.93	1.11	1.09	1.07	1.12	1.03	0.97
Oct-17	1.07	1.02	1.01	0.96	1.06	0.98	1.05
Sep-18	1.08	0.93	1.02	0.96	0.98	0.90	1.04
Oct-18	1.09	1.00	1.00	0.89	0.96	0.91	1.05
Sep-19	0.98	1.18	1.16	1.14	1.24	1.15	1.02
Oct-19	1.06	1.10	1.06	1.02	1.12	1.06	1.07
Sept.- Average	1.00	1.08	1.09	1.06	1.11	1.03	1.01
Oct.- Average	1.07	1.04	1.02	0.96	1.05	0.98	1.06

4.7 BUS PASSENGER TRIPS DATA - THIRUVANANTHAPURAM CENTRAL

Bus Passenger trips data from Thiruvananthapuram Central were collected for the month of October, 2019 from KSRTC (Kerala State Road Transport Corporation). The data is

compiled to obtain route wise summary for October 2019 and the same is given in **Table 4-49**.

Table 4-49: Route Wise Summary - October,2019

Route	No. of Schedules	Scheduled Km	Operated Km	Total Collection	Total Passengers	Earnings per Km	Earnings per Bus
Additional Services	42	23479	20071	835895	13487	41.65	19902
Thiruvananthapuram-Bangalore	115	185719	185445	10137896	17097	54.67	88156
Thiruvananthapuram-Cape	30	15540	14429	452125	12786	31.33	15071
Thiruvananthapuram-Coimbatore	294	236558	246622	11852103	119138	48.06	40313
Thiruvananthapuram-Erumely	26	15392	13638	520365	12056	38.16	20014
Thiruvananthapuram-Katapana	31	19065	19060	815816	11683	42.80	26317
Thiruvananthapuram-Kannur	24	25320	25302	1433217	3003	56.64	59717
Thiruvananthapuram-Kanyakumari	62	32116	30574	971534	26126	31.78	15670
Thiruvananthapuram-Kowayam	26	15808	13982	445809	13041	31.88	17147
Thiruvananthapuram-Kozhikode	179	152288	153153	5733428	60784	37.44	32030
Thiruvananthapuram-Kumily	31	14477	14472	548913	11976	37.93	17707
Thiruvananthapuram-Mangalapuram	21	28623	27331	1338461	3146	48.97	63736
Thiruvananthapuram-Mattupetty	29	18270	18293	789335	12879	43.15	27218
Thiruvananthapuram-Mookambika	31	50623	49415	2666427	4676	53.96	86014
Thiruvananthapuram-Munnar	31	18662	19242	749942	12840	38.97	24192
Thiruvananthapuram-Mysore	40	50982	50039	2983897	5523	59.63	74597
Thiruvananthapuram-Nedumkandam	87	48588	47814	1788060	37482	37.40	20552
Thiruvananthapuram-Nilambur	30	24270	24275	782323	4680	32.23	26077
Thiruvananthapuram-Palakkad	178	127796	127405	4836117	67043	37.96	27169
Thiruvananthapuram-Palani	44	41360	41361	1666976	25243	40.30	37886
Thiruvananthapuram-Pamba	31	11284	11648	490504	13064	42.11	15823
Thiruvananthapuram-Pengamukku	27	18171	18337	975033	15851	53.17	36112
Thiruvananthapuram-Sulthanbathery	31	32922	32674	1085932	7161	33.24	35030
Thiruvananthapuram-Thenkasi	243	120048	119551	4574666	120789	38.27	18826

Route	No. of Schedules	Scheduled Km	Operated Km	Total Collection	Total Passengers	Earnings per Km	Earnings per Bus
Thiruvananthapuram-Thiruvilwamal	28	19628	19190	895607	14589	46.67	31986
Thiruvananthapuram-Thrissur	151	88315	88328	3741586	64161	42.36	24779
Thiruvananthapuram-Vazhikkadavu	29	24911	25155	1084850	16842	43.13	37409

Maximum number of bus trips and passengers are on Thiruvananthapuram- Tenkasi and Thiruvananthapuram- Coimbatore routes. Details of total bus trips in Thiruvananthapuram Central is given in **Table 4-50**.

Table 4-50: Total Bus Trips Summary - October, 2019

Total trips	Total Scheduled Km	Total Operated Km	Total Collection	Total Passengers	Earnings per Km	Earnings per Bus
1891	1460215	1456806	64196817	727146	44.07	33949

4.8 DATA ANALYSIS FROM SECONDARY SOURCES - GOODS

Survey of truck operators and cargo forwarding agencies, located in Kerala and border districts of Tamil Nadu and Karnataka, was carried out, to collect information on the operational characteristics of goods vehicles. To identify characteristics of existing cargo being transported by Railways, surveys are conducted regarding Railway Parcel Services, at 5 major cargo handling stations in Kerala. This section details the characteristics of trips as observed from data collected.

4.8.1 Data Analysis of Truck Operators

Characteristics of truck operator trips analysed from the data collected are given in **Figure 4-63** to **Figure 4-69**.

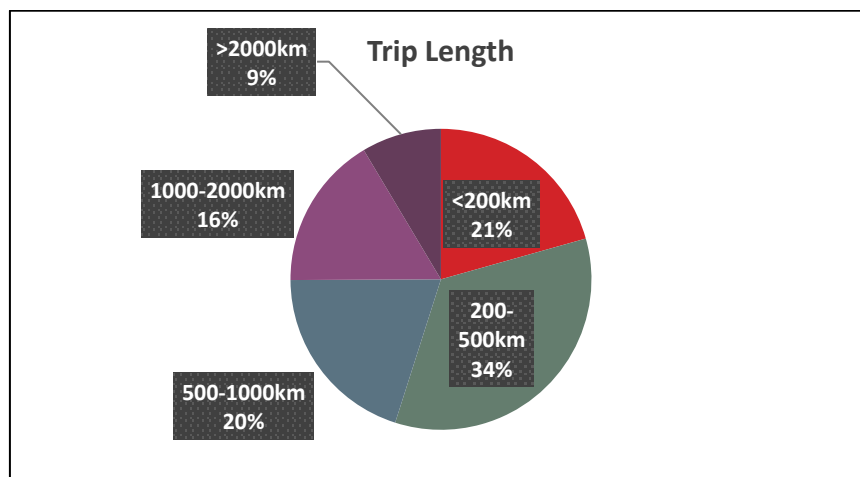


Figure 4-63 Trip Length Distribution- Truck Operator Data

Majority of the trips has a trip length between 200 and 500 km (34%). Trip length greater than 2000 km is only 9%.

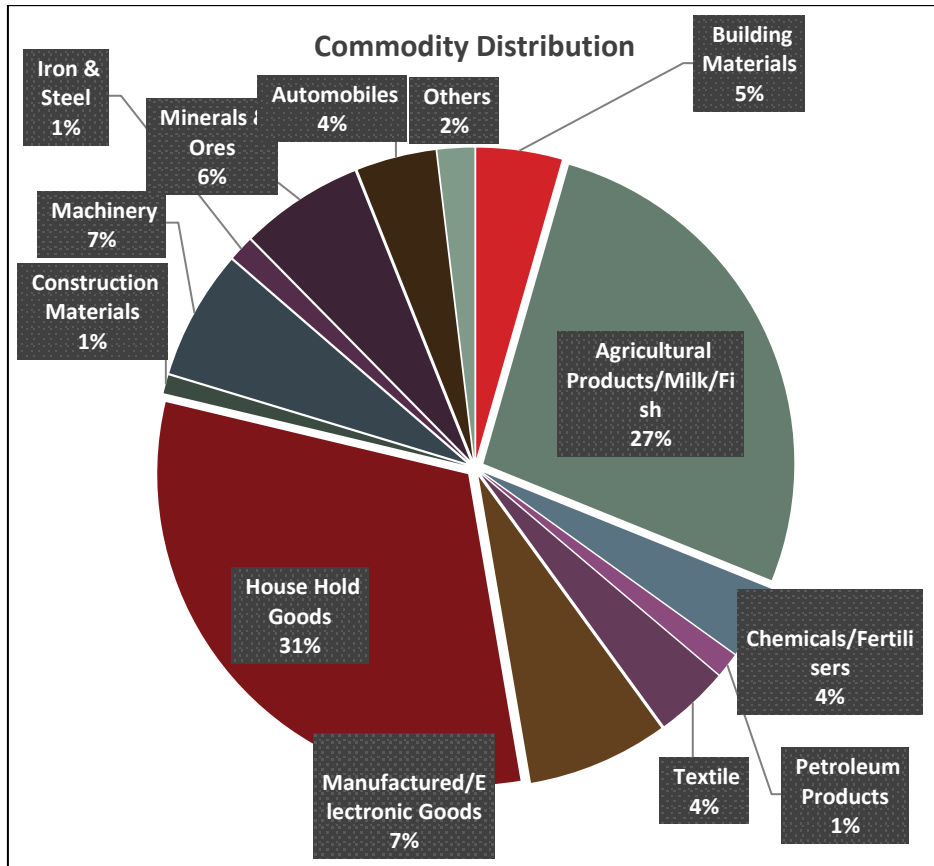


Figure 4-64 Commodity Distribution- Truck Operator Data

Majority of the goods being transported are Building materials (31%) and Agricultural products/ Milk/ Fish (27%).

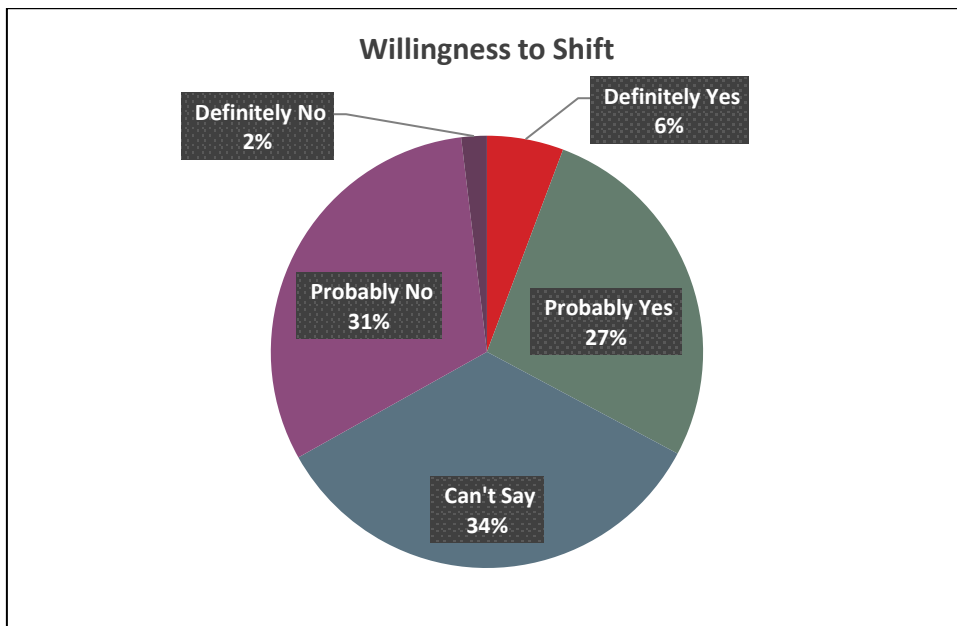


Figure 4-65 Willingness to Shift to RORO - Truck Operator Data

Only 6% respondents expressed *Definitely Yes* to Shift to RORO service.

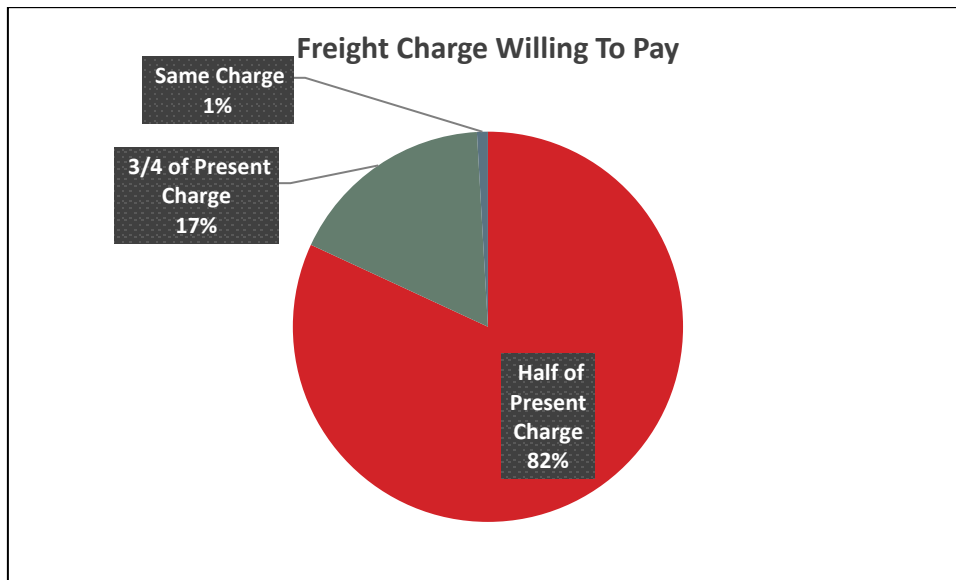


Figure 4-66 Freight Charge Willing To Pay - Truck Operator Data

82% of the respondents expressed Willingness to Pay half of the present charge they are paying. Only 1% showed willingness to pay existing charge.

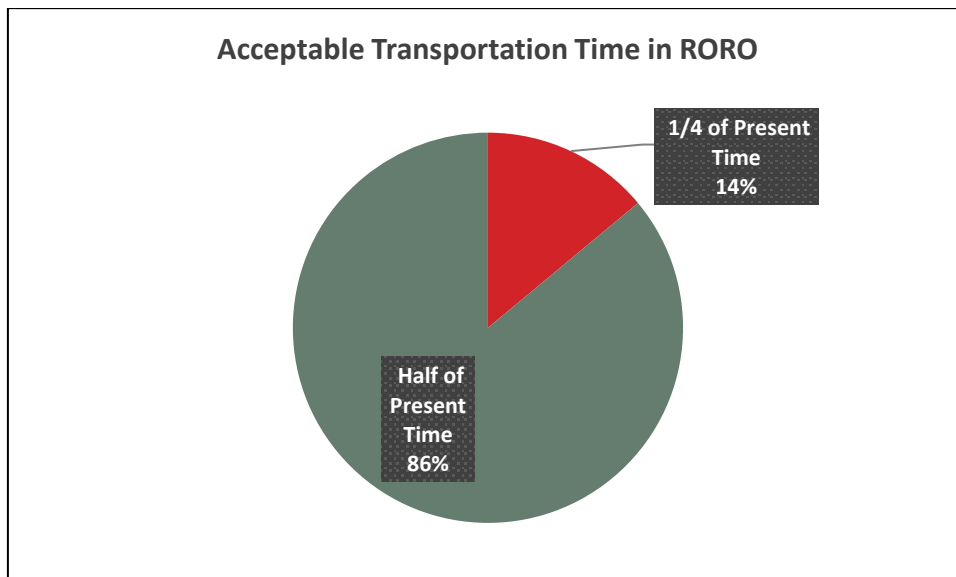


Figure 4-67 Acceptable Transportation Time in RORO - Truck Operator Data

86% of respondents expressed half the present time as acceptable time of transportation in RORO.

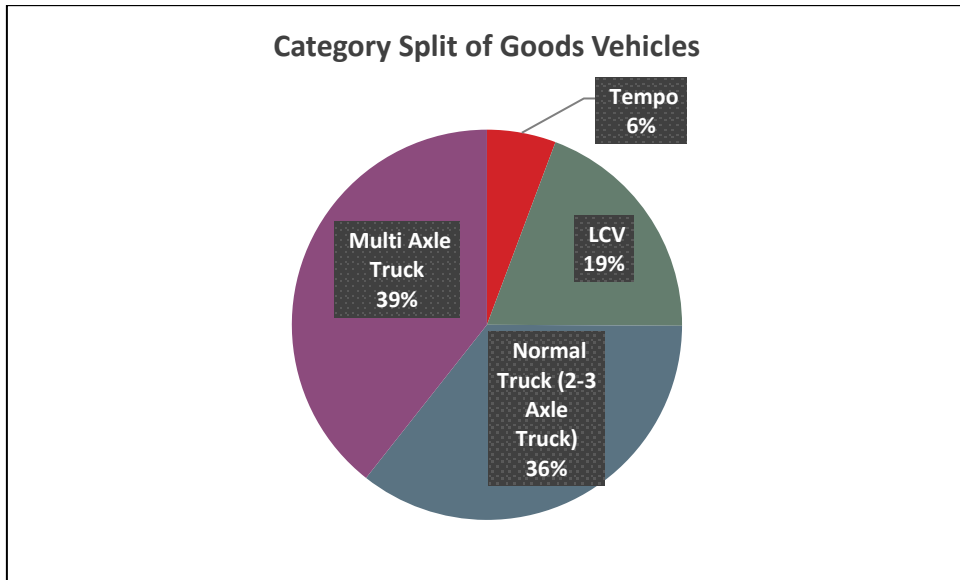


Figure 4-68 Category Split of Goods Vehicles - Truck Operator Data

Major category of goods vehicles used for transport is Multi Axle Trucks (39%), followed by 2-3 Axle trucks (36%).

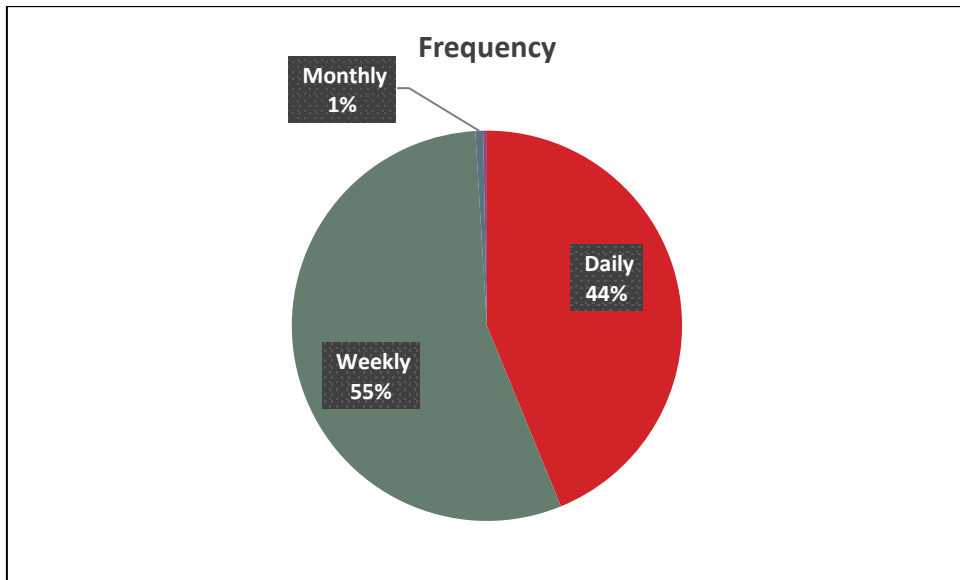


Figure 4-69 Frequency Distribution- Truck Operator Data

Majority of the trips are of *weekly* (55%), followed by *Monthly* trips (44%).

4.8.2 Data Analysis of Cargo Forwarding Agencies

Characteristics of trips by cargo forwarding agencies identified from data collected are given in **Figure 4-70** to **Figure 4-75**.

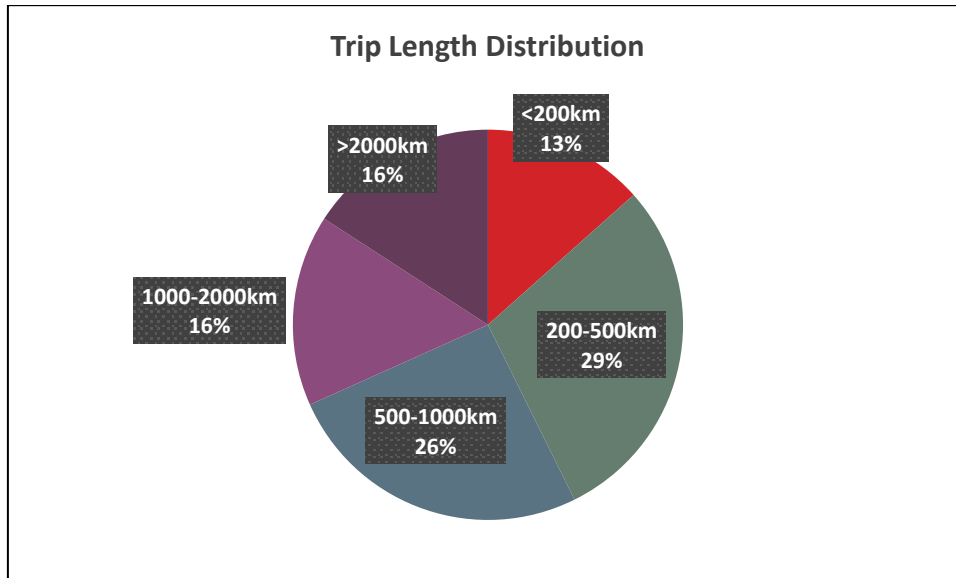


Figure 4-70 Trip Length Distribution - Cargo Forwarding Agencies

Majority of the trips (29%) has a trip length between 200 and 500 km and trip length greater than 2000km is only 16%.

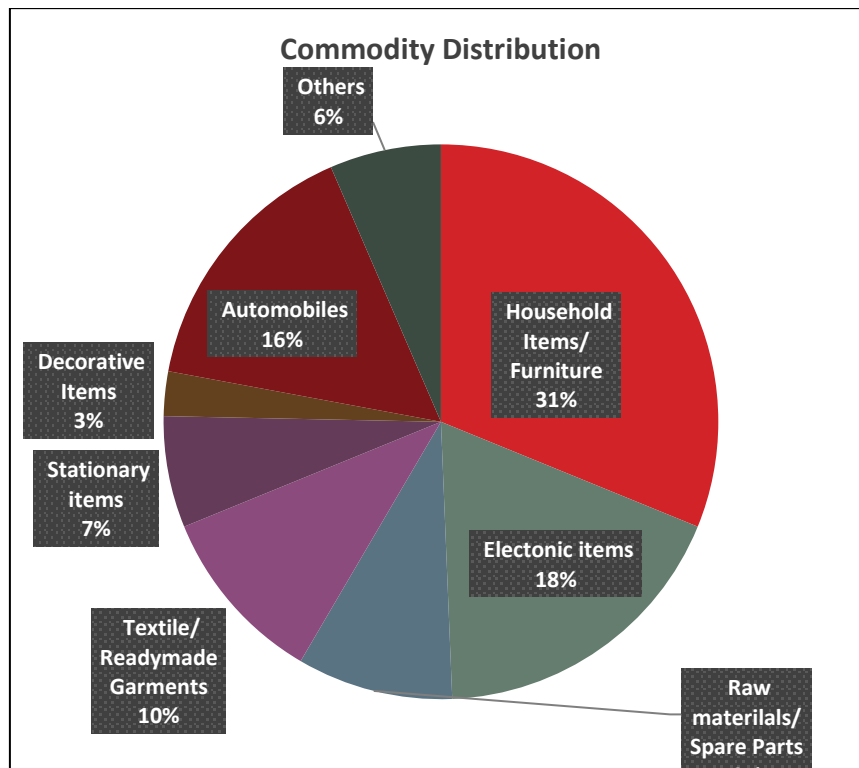


Figure 4-71 Commodity Distribution- Cargo Forwarding Agencies

Majority of the goods being transported are Household Items/Furniture (31%) and Electronic Items (18%).

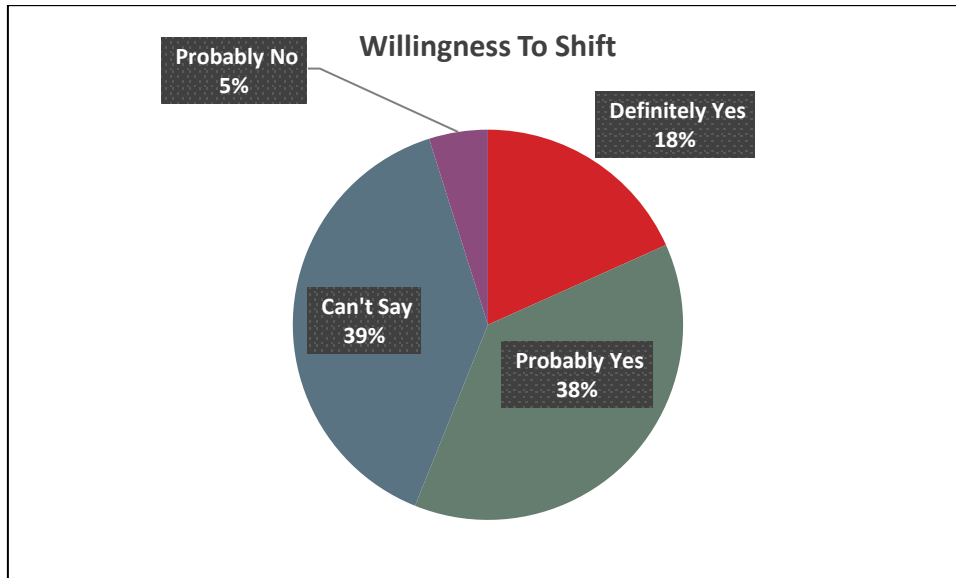


Figure 4-72 Willingness to Shift to RORO- Cargo Forwarding Agencies
Only 18% of respondents indicated *Definitely* Yes to shift to RORO service.

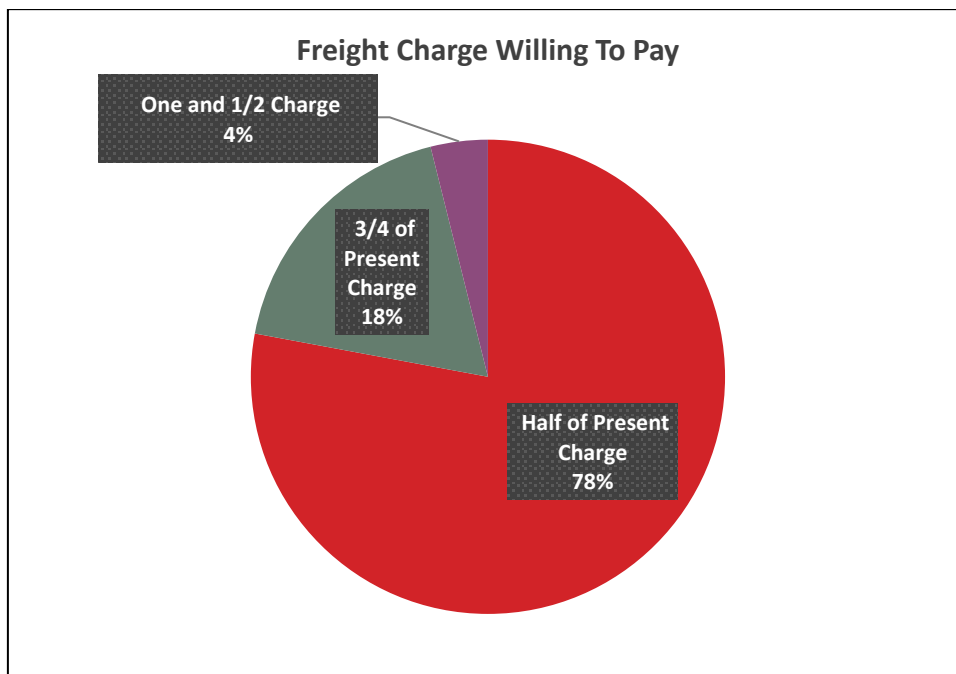


Figure 4-73 Freight Charge Willing To Pay - Cargo Forwarding Agencies
72% of the respondents expressed willingness to pay half of present charge. Only 4% showed willingness to pay one and half times present charge.

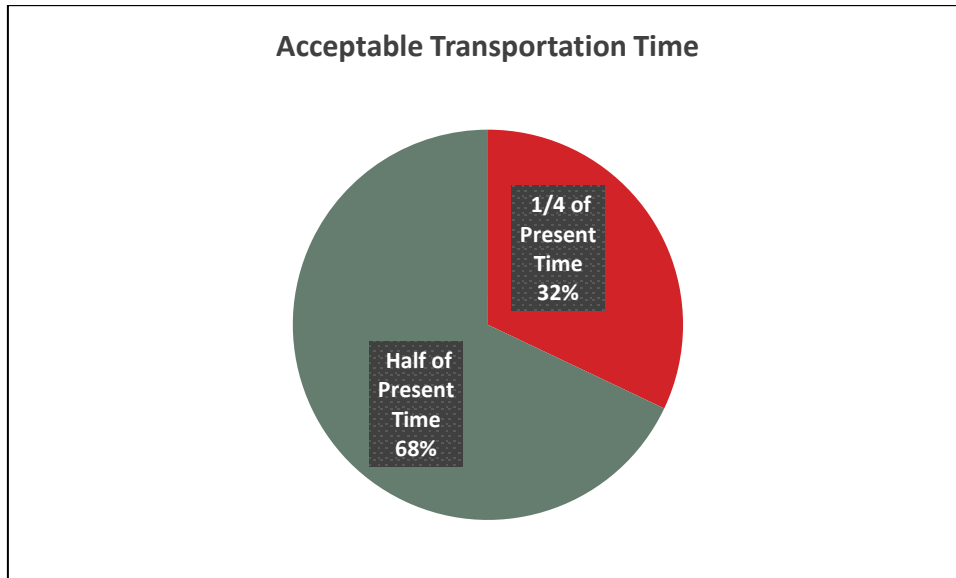


Figure 4-74 Transportation Time in RORO- Cargo Forwarding Agencies

68% of respondents expressed half the present time as acceptable time of transportation in RORO Service.

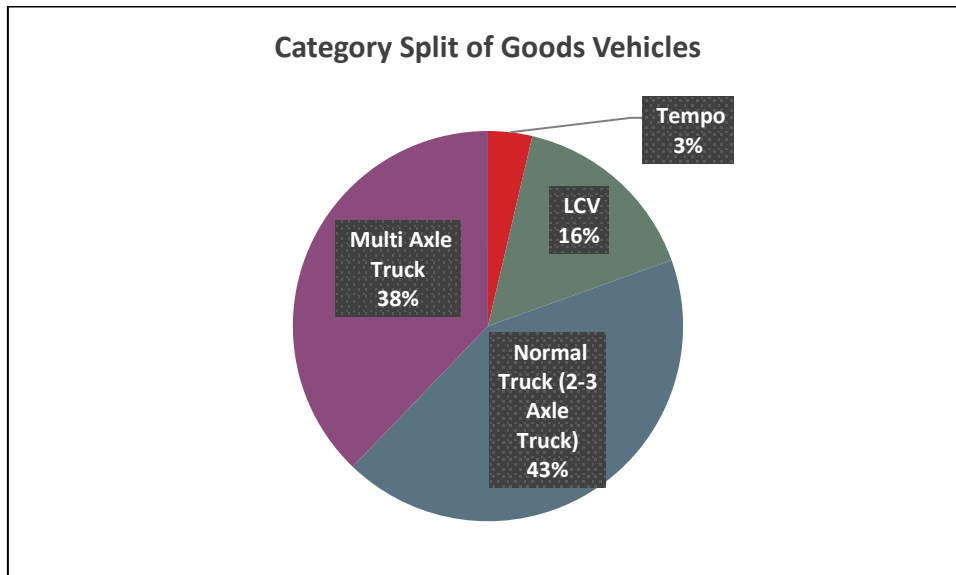


Figure 4-75 Category Split of Goods Vehicles - Cargo Forwarding Agencies

Major category of goods vehicle used for transport is 2-3 Axle trucks (43%) followed by Multi Axle trucks (38%).

4.8.3 Data Analysis of Rail Parcel Services

Characteristics of Railway Parcel Services identified from data collected are given in Figure 4-76 and Figure 4-77.

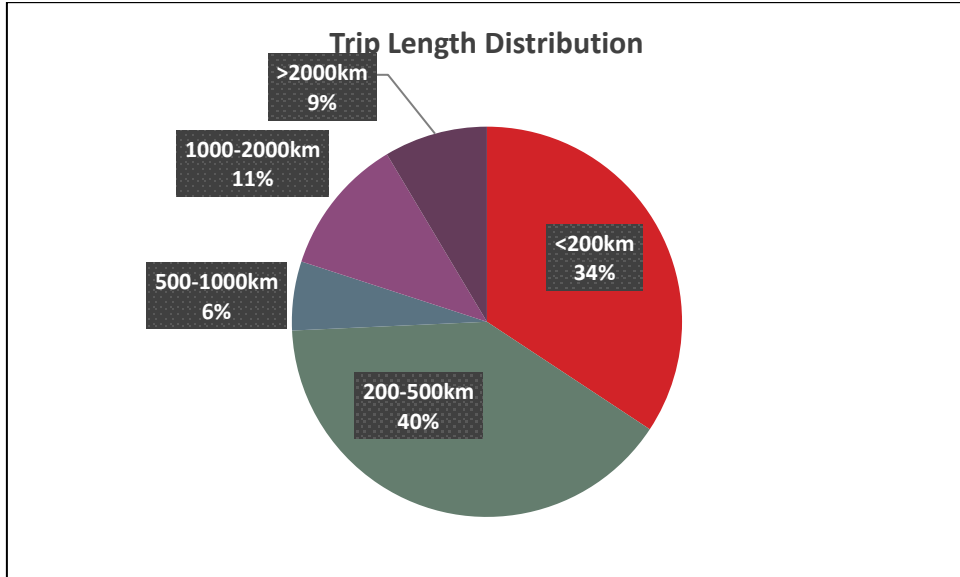


Figure 4-76 Trip Length Distribution- Rail Parcel Service

Majority of the trips has a trip length of 200 and 500 km (40%) and trip length greater than 2000 km is only 9%.

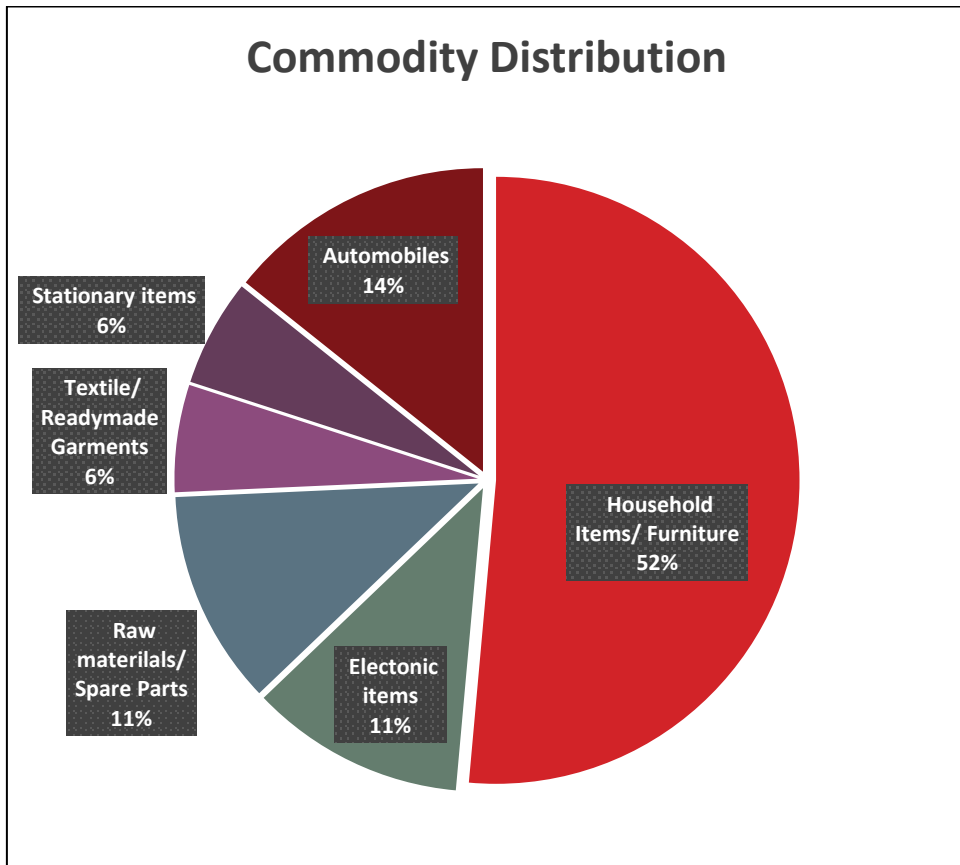


Figure 4-77 Commodity Distribution- Rail Parcel Service

Majority of the goods being transported are Household Items/ Furniture(52%) and Automobiles (14%).

4.8.4 Railway Goods Traffic at Thiruvananthapuram Division

Goods/ freight traffic data in Thiruvananthapuram division is collected from Ministry of Railways through K-Rail. The data collected have details of freight trips during April to October, 2019. Analysis of the data is presented in this section. Summary of originating traffic in Thiruvananthapuram division is given in **Table 4-51**.

Table 4-51: Originating Traffic - Summary

No. of Railway Receipts	1686
No. of wagons	36090
Invoice Weight in tonnes	2097601
Freight Charge collected, Rs.	2325033120
Net tonne kilometre, NTKM	1163773391

Summary of inward traffic in Thiruvananthapuram division is presented in **Table 4-52**.

Table 4-52: Inward Traffic - Summary

No of Wagons unloaded	16464
No of bags	15265900
Weight in tonnes	1045062

Major destination stations and corresponding percentage of weight of goods are given below:

- The Ramco Cements Ltd siding, Ariyalur- 7.41%
- Devangonthe Oil Siding- 11.86%
- The Ramco Cements Limited, siding, Ichchangadu - 4.42%
- Indian Oil Corporation, siding Feroke - 14.04%
- Tirunelveli- 8.41%

Major Receiving Stations of inward traffic and corresponding percentage of weight of goods are given below:

- Aluva- 12.97%
- Chalakudi- 10.49%
- Kalamassery- 17.60%
- Kottayam- 7.72%
- Nagercoil Junction- 7.45%

Commodity distribution of originating traffic based on weight in tonnes is given in **Figure 4-78**. Major goods transported are Aviation turbo fuel(27%), Fertilisers (24%) and Diesel (24%).

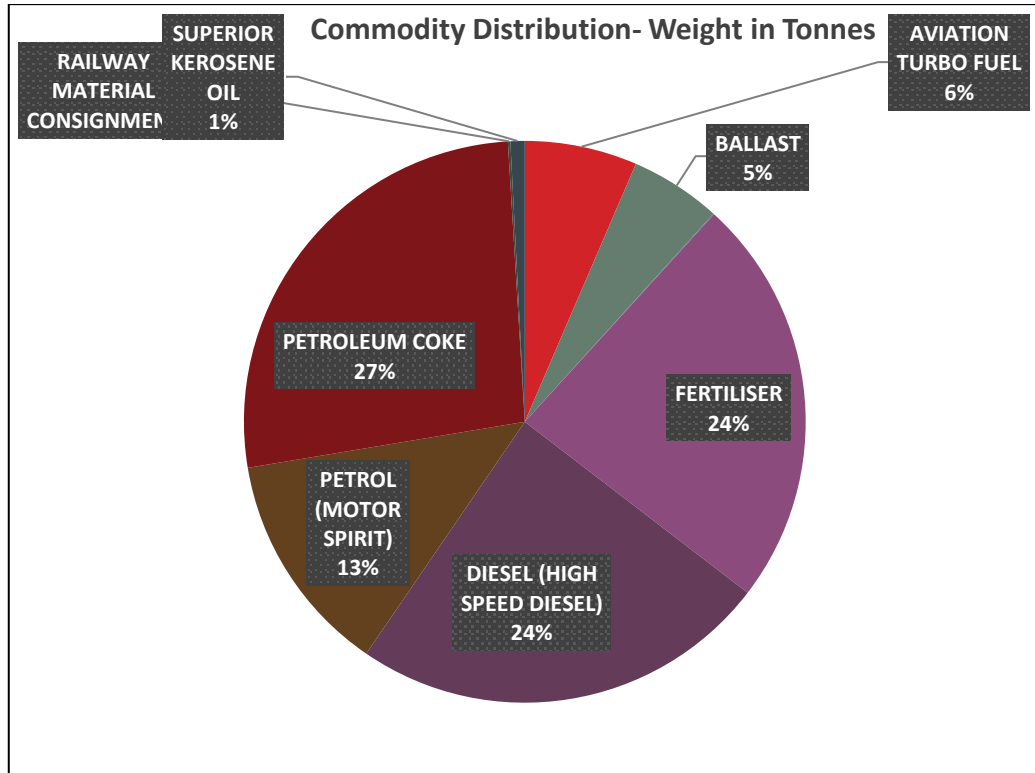


Figure 4-78 Commodity Distribution based on Weight - Originating Traffic

Commodity distribution of originating traffic based on Net Tonne Kilometre (NTKM) is given in **Figure 4-79**. Major goods transported are Aviation turbo fuel (27%), Fertiliser (36%) and Diesel (19%).

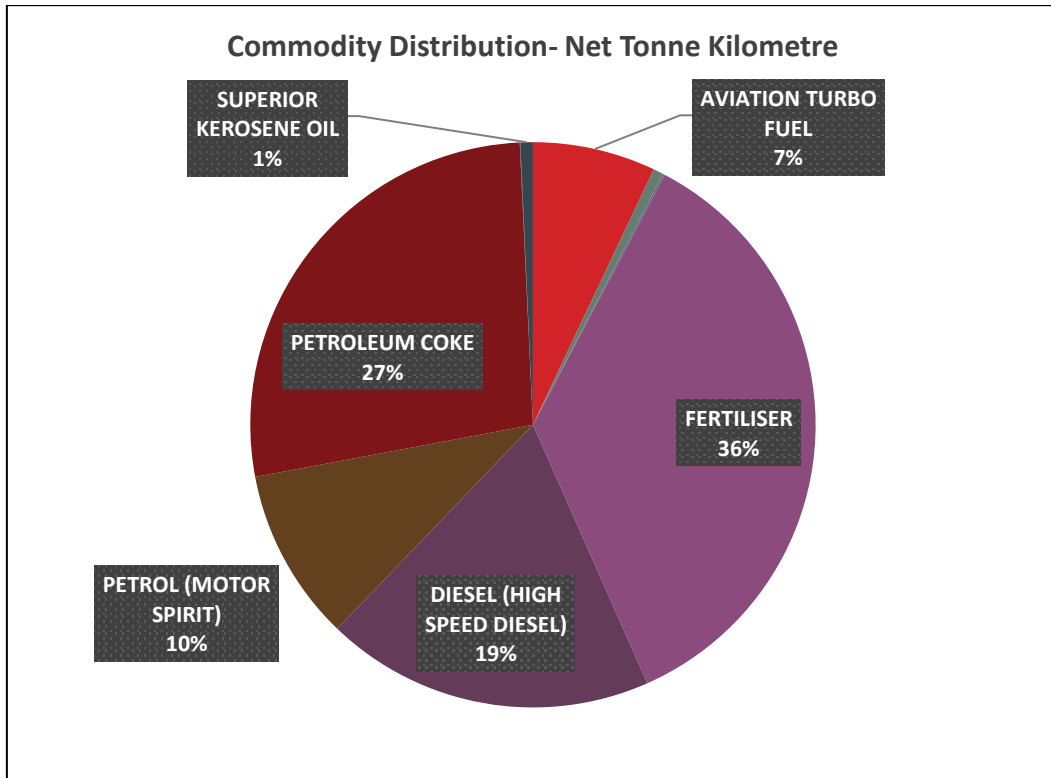


Figure 4-79 Commodity Distribution based on NTKM- Originating Traffic

Consignor distribution of originating traffic based on weight in tonnes is given in **Figure 4-80**. Major consignors are BPCL with 71% contribution.

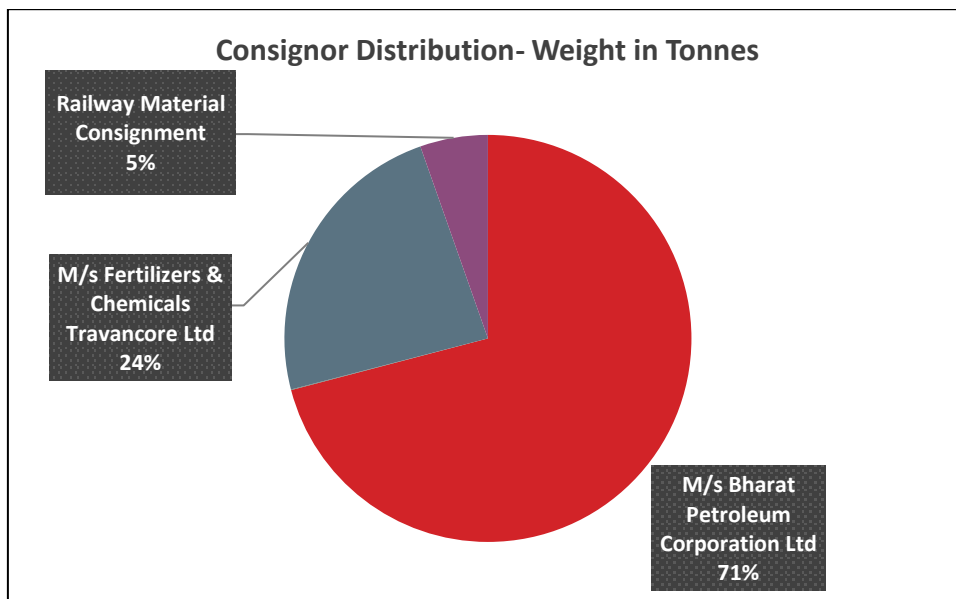


Figure 4-80 Consignor Distribution based on Weight- Originating Traffic

Origin distribution of originating traffic based on weight in tonnes is given in **Figure 4-81**. Major origin stations are BPCL, Irimpanam (44%) and BPCL, Kochi Refinery (27%).

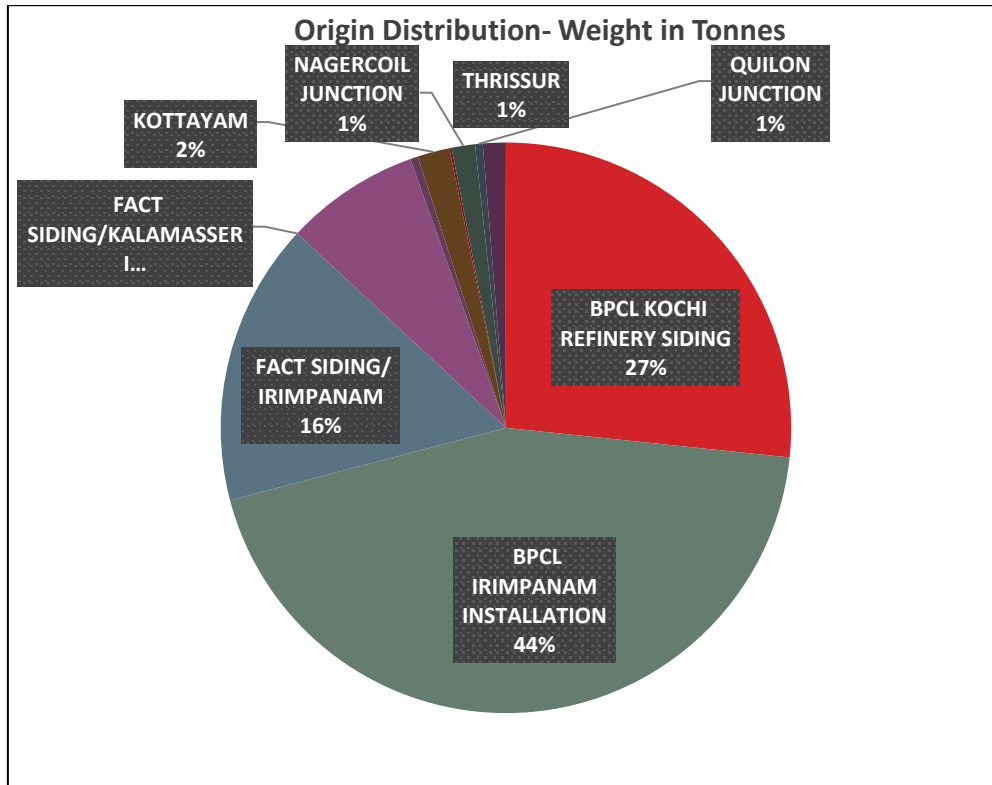


Figure 4-81 Origin Distribution based on Weight - Originating Traffic

4.9 ESTIMATION OF POTENTIAL TRIPS

Potential trips are the most probable passengers who are potential to use SilverLine. This section describes estimation of potential trips from Train, Car/ Taxi, bus and potential airport trips. In case of train only AC Class, Sleeper and Chair Car passengers are considered as potential users. In case of car/ taxi and bus passengers, the trips are filtered from total traffic based on trip length. Details and criteria of potential trips estimation is given in subsequent sections.

The potential trips from airport is estimated based on the terminal OD survey conducted at each of the airport and based on the trip lengths and main mode of travel from and to airports.

4.9.1 Potential Trips - Railway Passengers

Data of passengers travelling under reservation obtained through Railways Datawarehouse, Centre for Railway Information Systems (CRIS) Reports and Unreserved Ticketing System (UTS) data from Thiruvananthapuram and Palakkad divisions of Southern Railway was used in estimation of potential trips from railway.

4.9.1.1 From CRIS Data

Data corresponding to trains crossing at least 3 SilverLine station were collected. Only AC, Sleeper and Chair Car passengers were considered as potential users. The

passenger traffic data corresponds to the year 2018 (1st January to 31st December). Details of the trains considered is given in Table 4-27.

Reserved Railway Passenger Data compiled from *Data Warehouse* is used in preparing the OD matrix of passenger trips. Origin and destination are classified as *Internal* and *External* based on their locations. Stations within Kerala are classified as *Internal* and Outside Kerala as *External*. External to External trips are discarded in candidate traffic estimation.

Potential candidate traffic from Railway Passengers for the year 2018 is **70320**. Category wise number of railway passengers is given in **Table 4-53**.

Table 4-53: Category Wise Rail Passengers

OD Pair	1A	2A	2S	3A	CC	SL	All Classes
Internal –Internal	21	739	11615	2914	2734	10220	28242
Internal –External	96	2355	769	9546	311	29001	42077
External –External	57	1505	59	4646	56	20561	26885
Total	174	4599	12443	17105	3101	59782	97204
Candidate traffic (I-I + I-E)	116	3094	12384	12459	3045	39221	70320
% of Total Candidate traffic	0.2%	4.4%	17.6%	17.7%	4.3%	55.8%	100.0%

Internal (I) - Stations within Kerala ; External (E)- Stations outside Kerala

Candidate traffic = Internal – Internal(I-I) Passengers + Internal – External(I-E) Passengers.

Apart from the above data, UTS data was also collected and analysed and the details are provided below.

4.9.1.2 From UTS Data

Unreserved ticketing data from Palakkad and Thiruvananthapuram division for the month of November 2019 was collected from the Southern Railways. The data included source station, destination, fare, class type and number of tickets issued from each of the stations. A normal week data was then extracted for further analysis. During analysis following were the assumptions considered:-

- 1) Trips with fare greater than Rs. 45/- per ticket was extracted. This is based on assumption that a passenger may be travelling on an express train.
- 2) Season tickets were removed from the data for analysis
- 3) The minor stations within the major stations were made as clusters, they are:-
 - a. Thiruvananthapuram - TVM, TVP, KCVL, KZK
 - b. Kollam - QLN, VAK
 - c. Kottayam - KTYM, ETM

- d. Ernakulam - ERS, ERN, TRTR, IPL, KLMR
 - e. Trissur - TCR, PUK, WKI
 - f. Tirur - TIR, TUA, KTU, TA, PGI
 - g. Kozhikode - CLT, KUL, VLL, WH
 - h. Kannur - CAN, CS
 - i. Kasargode - KGQ, KZE, BFR, MJS
- 4) All stations beyond Neyantinkara, Shornur, Manjeshwaram was considered as external to SilverLine main line
- 5) All small stations along the project corridor coded as AGGREGATOR

Based on the above assumptions, the potential trips from UTS data is as follows:-

Table 4-54: Category Wise Rail (UTS) Passengers

ORIGIN/DESTINATION	THIRUVANANTHAPURAM	KOLLAM	CHENGANNUR	KOTTAYAM	ERNAKULAM	TRISSUR	TIRUR	KOZHIKODE	KANNUR	KASARGODE	GRAND TOTAL
THIRUVANANTHAPURAM	0	0	0	1242	1594	705	157	388	199	100	4385
KOLLAM	0	0	0	0	1047	360	72	158	61	35	1732
CHENGANNUR	0	0	0	0	0	358	42	82	30	12	523
KOTTAYAM	1200	0	0	0	0	0	39	122	59	38	1458
ERNAKULAM	1702	1183	0	0	0	0	0	1212	617	216	4929
TRISSUR	610	427	329	0	0	0	0	0	393	111	1870
TIRUR	133	89	41	37	0	0	0	0	0	252	552
KOZHIKODE	274	157	73	109	937	0	0	0	0	0	1550
KANNUR	139	83	29	51	502	277	0	0	0	0	1080
KASARGODE	89	52	18	46	204	120	251	0	0	0	780
GRAND TOTAL	4147	1992	489	1485	4285	1819	560	1960	1359	763	18860

The potential traffic (Internal to Internal) is estimated to be 18860 and Internal to external trips such as trips to Chennai, Salem, Erode etc., is estimated to be 2796 trips. So, total potential trips from UTS data is estimated to be **21656** trips.

4.9.2 Potential Trips - Buses

Data collected from OD survey at 9 locations is combined avoiding duplication of data. Combined data is used to form an OD matrix of different type of buses, such as for private AC bus, KSRTC AC and non-AC buses etc.

To avoid vehicles which might have travelled transverse to project corridor, a buffer zone of 15 km radial distance from SilverLine alignment was considered. In order to arrive at the target group of Car/Taxi users, trips with trip length less than 50 km are discarded, if both origin and destination are within buffer zone. Similarly trips with trip length less than 75 km and 100 km are discarded if either origin or destination is outside buffer zone and if both origin and destination is outside buffer zone respectively. Candidate traffic from buses for the year 2019 are provided in the table below:-

Table 4-55: Type-Wise Bus Potential Passengers

Sl. No.	Bus Type	Potential Traffic
1	AC BUS-PVT.	9875
2	AC LOW FLOOR BUS-KSRTC	11433
3	AC BUS-KSRTC	17331
4	DELUXE BUS	15262
5	EXPRESS BUS	11000
6	SUPER FAST BUS	47081
7	FAST PASSENGER BUS	20691
8	ORDINARY BUS	35629
9	MINI BUS	19348
Grand Total	Sl.No. 1 to Sl.No. 7	132673
Grand Total	Sl.No. 1 to Sl.No. 5	64901
Grand Total	Sl.No. 1 to Sl.No. 6	111982

4.9.3 Potential Trips - Cars/ Taxi

Data collected from OD survey at 9 locations is combined avoiding duplication of data. Combined data is used to form an OD matrix of Car and Taxi trips.

To avoid vehicles which might have travelled transverse to project corridor, a buffer zone of 15 km radial distance from SilverLine alignment was considered. In order to arrive at the target group of Car/Taxi users, trips with trip length less than 50 km are discarded, if both origin and destination are within buffer zone. Similarly trips with trip length less than 75 km and 100 km are discarded if either origin or destination is outside buffer zone and if both origin and destination is outside buffer zone respectively. Candidate traffic from Car/Taxi is estimated as **158271** for the year 2019.

4.9.3.1 Major OD Pairs

Major OD pairs in the identified candidate traffic for Car/ Taxi trips are given below. Percentage contribution of each OD pair is also given:

- Thrissur- Ernakulam (5.71%)
- Kollam City- Thiruvananthapuram City (5.23%)
- Kannur city – Kozhikode City (4.01%)
- Ernakulam- Thrissur City (1.76%)
- Ernakulam- Thiruvananthapuram City(1.66%)
- Kasaragod Town- Kannur City(1.56%)

4.9.4 Potential Trips from Airport

Apart from above, the trips from and to airports are also found to be potential as the four airports are accessed by both private and public transport modes by the air travellers. To arrive at potential trips, the airport survey samples were extrapolated to the passenger (by type – International & domestic) handled at each airport. The passenger traffic handled by each of the airport in the month of October 2019 are provided in the Table 4-56 provided below.

Table 4-56: Passenger traffic handled at airports in Kerala – October 2019

Airport	Monthly Traffic		Daily		
	International	Domestic	International	Domestic	Total
Thiruvananthapuram	183076	133949	5906	4321	10227
Calicut	219117	38225	7068	1233	8301
Cochin	387415	423261	12497	13654	26151
Kannur	65776	70503	2122	2274	4396

Source: AAI Passenger handled in 2019 - Annexure IIIA, B & C

From the above table and based on the proposed alignment of SilverLine, there is potential to shift trips from Cochin International Airport (CIAL) and Thiruvananthapuram International Airport (TRV) as it is located along the proposed SilverLine alignment. To arrive at potential trips from airports, following assumptions are considered:-

- a) All trips greater than 150Km trip length are considered as potential trips.
- b) Trips within the trip length of 100Km to 150Km and done by using public transport modes such as Rail and bus are considered as potential trips.
- c) Apart from airport passengers, the trips made by accompanies are also considered as potential trips. With an airport passenger and travelling by car and taxi, additional 2 accompanies are assumed. It is assumed that atleast 2 accompanies will be arriving at airport taxi and car to see-off or pick up airport passenger.

- d) The above assumptions are subject to provision of adequate facilities at airport for passengers by SilverLine Operator (or the Airport Authority) and also by other interventions such as group ticketing and discounts, porter facilities and also check-in facilities at stations. The interventions in terms of facilities to airport passengers are necessary as there is requirement to reduce the interchange penalty for shift of passengers to SilverLine. In absence of the above, there is lower probability of shift from car and taxi.

Based on the above assumptions and analysis of the terminal OD data, the results based on mode-wise distribution of passengers based on trip lengths (Trip Length Frequency Distribution - TLFD) for Kochi airport and Thiruvananthapuram airport are provided in Table 4-57 and Table 4-53 below.

Table 4-57: Mode-wise TLFD of Daily Airport Pax – Kochi Airport

Sl. No.	Mode	TL <100	TL 100-150	TL 151-200	TL 201-400	TL >400
1	Car	10326	3806	881	76	187
2	Taxi	7310	1530	194	14	7
3	2 Wh	249	173	7	0	0
4	Auto	0	0	0	0	0
5	Sh. Auto	0	0	0	0	0
6	Bus	159	7	0	0	0
7	AC Bus-Govt.	470	14	0	0	0
8	AC Bus-Pvt.	90	76	318	0	0
9	Rail	0	0	0	0	0
10	Cycle	0	0	0	0	0
11	Walk	0	0	0	0	0
12	Other	83	152	7	14	0
	Total	18688	5758	1407	104	193

TL* – Trip Length

Table 4-58: Mode-wise TLFD of Daily Airport Pax – Thiruvananthapuram Airport

Sl. No.	Mode	TL <100	TL 100-150	TL 151-200	TL 201-400	TL >400
1	Car	1446	121	0	0	0
2	Taxi	1808	844	0	0	0
3	2 Wh	0	0	0	0	0
4	Auto	0	0	0	0	0
5	Sh. Auto	0	0	0	0	0
6	Bus	964	0	362	0	0
7	AC Bus-Govt.	0	0	0	0	0
8	AC Bus-Pvt.	0	0	0	0	0
9	Rail	362	0	0	0	0
10	Cycle	0	0	0	0	0

Sl. No.	Mode	TL <100	TL 100-150	TL 151-200	TL 201-400	TL >400
11	Walk	0	0	0	0	0
12	Other	0	0	0	0	0
	Total	4580	964	362	0	0

TL* – Trip Length

From the above trip length distribution of passengers and assumptions as Stated above, the potential trips from Cochin and Thiruvananthapuram airport and also the trips from the accompanies are provided in Table 4-59 below.

Table 4-59: Potential Airport Passengers

Location	Daily Pax trips	Daily Pax trips with accompanies
Kochi Airport	1954	4673
Thiruvananthapuram Airport	362	1085
Total	2316	5758

4.9.5 Potential Trips for RoRo

As part of SilverLine, potential for Roll-on Roll-off (RoRo) is also analysed. The data from OD-Survey and secondary data collected from operators, railway parcel offices was analysed to verify the OD data. As the RoRo is for a length of 529.45 Km, the potential traffic is derived based on the following assumptions:-

- All goods vehicle above 2-Axle was only considered. So, 2-3 Axle trucks, multi-axle vehicles (MAVs) are considered.
- Goods vehicles (above 2-Axle), with a trip length of 300Km and upto 800Km are only considered. Trip length of above 300km is considered based on Vehicle Operating Cost (VOC) and travel time of truck with or without RoRo. Less than 300 km trip length, it is observed that there will be negligible travel time savings for the truck operator as boarding and alighting time of RoRo is in the range of 1.5 hrs each respectively. The maximum limit of 800Km is assumed based on the trip length and trucks travelling along the project influence area and maxim of upto 100Km at both the ends (from Thiruvananthapuram & from Kasaragod)
- Trucks with commodities such as building materials, petroleum products, chemical & inflammable items, construction materials and empty and not considered.

The potential traffic for RoRo is provided in the Table 4-60 below:-

Table 4-60: Potential RoRo traffic – Daily Estimate

Trip Length	TEMPO	LCV	2-3 A	MAV	Total
<50km	1162	1599	453	151	3366
50-200km	1225	2075	704	323	4327
200-300km	81	241	185	153	660
300-600km	71	302	163	127	662
600-800km	16	70	67	37	190

Trip Length	TEMPO	LCV	2-3 A	MAV	Total
800-1500km	8	23	15	43	90
>1500km	0	22	21	32	74
Total	2562	4332	1609	867	9369

4.10 STATED PREFERENCE/ WILLINGNESS TO PAY (WTP) SURVEY

Stated Preference survey was conducted at Airports, major bus terminals, on-board buses and major trains and different class of trains along the proposed SilverLine corridor. The regional bus, train AC, train Non AC and AC bus users were interviewed to appreciate the personal characteristics, travel details, willingness to pay and shift to SilverLine and opinion on preference on 6 hypothetical transport scenarios.

The data was used for development of modal equations for determining likely shift to SilverLine. A total of 1000 responses were collected from different users along the proposed SilverLine corridor. Willingness to Pay survey was carried to understand the user perception, travel characteristics and willingness to shift to SilverLine System. Each Scenario in the questionnaire refers to a set or combination of Travel Cost, Time and Frequency for both SilverLine and the present mode, for an average trip length of 200 km. The six scenarios considered for the study are given in

Table 4-31.

Summary of the responses are presented in **Table 4-61**.

Table 4-61: Scenario Wise Response – WTP Survey

Scenario			Response	Vehicle Category (%)						
Sce. No.	Fare	Frequency		AC Bus	Non AC Bus	Sleeper Class	1st AC	2nd AC	3rd AC	Flight
1	500	30	Definitely Prefer Present Mode	0.4	0.4	0.0	0.0	0.0	0.0	1.2
			Possibly Prefer Present Mode	0.0	0.7	0.0	0.0	0.0	0.0	0.6
			Indifferent	0.0	0.0	0.0	0.0	0.0	0.0	0.6
			Possibly Prefer SilverLine	11.9	28.4	4.6	13.4	0.8	6.8	11.0
			Definitely Prefer SilverLine	87.7	70.5	95.4	86.6	99.2	93.2	86.6
			Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	500	60	Definitely Prefer Present Mode	0.4	0.4	0.0	1.2	0.0	0.0	1.2

Scenario			Response	Vehicle Category (%)						
Sce. No.	Fare	Frequency		AC Bus	Non AC Bus	Sleeper Class	1st AC	2nd AC	3rd AC	Flight
			Possibly Prefer Present Mode	0.0	0.7	0.0	0.0	0.0	0.0	0.6
			Indifferent	0.0	0.0	0.0	0.0	0.0	0.0	0.6
			Possibly Prefer SilverLine	17.2	39.6	17.4	18.3	3.1	9.4	16.3
			Definitely Prefer SilverLine	82.4	59.4	82.6	80.5	96.9	90.6	81.4
			Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3	700	30	Definitely Prefer Present Mode	7.0	1.8	8.2	9.8	1.6	0.0	4.2
			Possibly Prefer Present Mode	12.3	17.3	22.7	2.4	7.9	6.0	6.0
			Indifferent	0.0	4.0	5.5	0.0	0.8	0.0	4.8
			Possibly Prefer SilverLine	63.1	65.3	50.0	41.5	52.8	48.7	51.8
			Definitely Prefer SilverLine	17.6	11.6	13.6	46.3	37.0	45.3	33.1
			Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
4	700	60	Definitely Prefer Present Mode	13.9	9.1	22.9	14.8	3.1	0.9	10.9
			Possibly Prefer Present Mode	14.3	32.4	17.4	25.9	8.7	6.0	8.5
			Indifferent	0.0	9.1	4.6	0.0	0.8	0.0	6.7
			Possibly Prefer SilverLine	61.9	41.8	49.5	33.3	50.4	47.9	43.0
			Definitely Prefer SilverLine	9.8	7.6	5.5	25.9	37.0	45.3	30.9
			Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
5	900	30	Definitely Prefer Present Mode	28.4	31.0	41.8	59.4	4.9	16.5	22.6

Scenario			Response	Vehicle Category (%)						
Sce. No.	Fare	Frequency		AC Bus	Non AC Bus	Sleeper Class	1st AC	2nd AC	3rd AC	Flight
			Possibly Prefer Present Mode	53.0	58.6	34.7	10.1	76.4	44.0	43.8
			Indifferent	1.9	4.2	7.1	0.0	2.4	2.8	8.0
			Possibly Prefer SilverLine	15.8	6.1	14.3	27.5	13.8	29.4	19.0
			Definitely Prefer SilverLine	0.9	0.0	2.0	2.9	2.4	7.3	6.6
			Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
6	900	60	Definitely Prefer Present Mode	58.2	61.0	60.9	69.2	67.5	48.6	49.2
			Possibly Prefer Present Mode	25.5	34.4	28.3	0.0	16.3	12.8	16.1
			Indifferent	1.4	1.2	2.2	0.0	0.8	1.8	6.5
			Possibly Prefer SilverLine	14.4	3.5	8.7	27.7	13.0	29.4	21.0
			Definitely Prefer SilverLine	0.5	0.0	0.0	3.1	2.4	7.3	7.3
			Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

A general trend observed from the data collected by M/s P.K Engineers is that as fare increases willingness to shift to SilverLine decreases and people will prefer present mode. People travelling by Flight and AC class are showing more willingness to shift to SilverLine across all scenarios.

Also at same fare, as frequency decreases people are showing less willingness to shift to SilverLine.

As per the preliminary analysis, the results are not logical. For example, the willingness to shift to SilverLine from Sleeper Class Train is about 95% at a fare of Rs 500 (almost 3 times the current fare of Sleeper Class) and frequency of 30 min. There is a similar trend of respondents showing higher willingness to shift to SilverLine for other Scenarios, which seems not logical.

So, samples were selected for further analysis based on logical assumptions, such as:-

- 1) Daily travel commuters with monthly income less than INR 20,000/- and INR 10,000/- and Stated to shift for daily commute were removed.
- 2) The commuters who Stated that at higher fares, willing to shift and at lower fares, not willing to shift were removed. This is because of lack of understating of the scenarios by the commuters.
- 3) The origin and destination of the commuters which are falling majorly outside the PIA and still Stated to shift were also removed from analysis.

Based on the above assumptions, out of 1100 samples collected from various modes, only 380 samples were shortlisted for further analysis.

4.10.1 Mode Shift Analysis

Stated Preference surveys were conducted to determine willingness to pay, potential mode shift and value of time of various users of SilverLine system. A well-structured format was made describing multiple scenarios to the users under varying parameter ranges. Mode wise binary logit models which give the probability of shifting from existing alternatives to SilverLine were developed using the preferences indicated by the respondents. These models are of the following form.

The purpose of Mode Shift analysis is to determine the probability of shift to SilverLine from various modes.

$$P = \frac{e^{(Gx)}}{(1 + e^{(Gx)})} \quad \text{Where } P = \text{probability of shift, } Gx = \text{generalised cost}$$

$$Gx = \text{Constant} + \alpha \text{ STT} + \beta \text{ STC} + \gamma \text{ SWT} + \lambda \text{ STR}$$

Where,

STT = Savings in Travel Time (Including Access & Dispersal Time)

STC = Savings in Travel cost (including access & egress cost)

SWT = Savings in Waiting time

STR = Savings in number of transfer in the journey

$\alpha \beta \gamma \lambda$ = Parameters to be estimated using SP data and

Constant = constant that explains the unobserved effects

The generalised cost of different modes like Car, Bus and Train are estimated based on the travel cost, travel time of the trips and wait time. The wait time was assumed based on the frequency for all modes.

The parameters of the mode wise logit models were calibrated by employing maximum likelihood method of estimation. The results of calibration for different modes w.r.t SilverLine are provided in the table below. The signs of all the parameters are found to be logical. All the variables that entered the model are found to be statistically significant.

The nagelkerke R square value (a robust goodness-of-fit statistic that varies between 0.6 and 0.8) for all the models is found to be reasonably good.

Table 4-62: Results from Logit Models

Mode	Variable	ASC	Travel Time	Travel Cost	% Correct Predictions	Nagelkerke R Square
1AC	Coefficient	-15.277	-0.147	-0.02	90.8	0.759
2AC	Coefficient	-1.87	-0.026	-0.016	85.4	0.680
3AC	Coefficient	-11.19	-0.108	-0.014	89.6	0.593
SL	Coefficient	-31.632	-0.288	-0.025	92.3	0.812
AC Bus	Coefficient	-4.056	-0.076	-0.021	91.3	0.834
Non-AC Bus	Coefficient	-13.651	-0.491	-0.022	90.5	0.784

The detail output and results from the model is provided in the Volume III – Part 3A: Section 3 - iii.3 Results of Stated Preference Survey Analysis.

In case of car users, for every 25% decrease in savings of travel time and travel cost, there will be a decrease of 10% in the shift to SilverLine. It was observed that, Travel cost is the major factor for the mode choice of car passengers. If there is a decrease of 25% in savings of Travel cost alone, there will be a decrease of 12% in the shift.

In case of Non AC bus users, Travel Time has major impact on mode choice compared to travel cost. If there is a decrease of 25% in the savings of Travel cost and wait time, then there will be a decrease of approximately 6% in the shift from existing mode to SilverLine system.

In case of AC bus users, travel time has major impact on mode choice compared to travel cost. If there is a decrease of 25% in the savings of travel time, then there will be a decrease of approximately 11% in the shift from existing mode to SilverLine system.

The table below shows the probability of shift from various modes and the potential trips in the base year:-

Table 4-63: Probability of Shift to SilverLine

Sl.No.	Class Type	Potential Trips	Prob Shift	Base Trips
1	1 AC	116	24.90%	29
2	2AC	3094	34.20%	1058
3	3AC	15535	38.80%	6028
4	SL	73230	10.30%	7543
5	AC Bus	38639	26.00%	10046
6	Non AC Bus	49803	9.70%	4831
7	Car	158271	12.00%	18993

4.11 ESTIMATED GROWTH RATES

For an efficient proposal, existing and proposed facilities are analysed for future. This covers existing, additional and forecasted commuters for proposed SilverLine, existing and future demand on allied infrastructure such as stations, parking etc., due to proposed facilities.

The expected traffic growth due to a transport infrastructure plays a crucial role in operation planning, station design, commuter facilities based on commuter footfall in that region. Since, there are various independent variables affecting the dependent variables. It becomes a challenge to accurately predict/estimate these growth rates. Many uncertainties are associated with the independent variables which go into the procedure of estimating the growth rates. The uncertainties are in the form of changes in National economy, Government policy, socio-economic conditions of the people, changes in land uses and development of another transportation infrastructures.

Planning of SilverLine and its viability is dependent on the projected traffic. In practice, future traffic growth rate is influenced by numerous parameters. Therefore, while carrying out the traffic forecast, it should be kept in mind that all the parameters are assessed at the macro level of the country's economy. Economic indicators like Per capita Income (PCI), Net State Domestic Product (NSDP), Gross State Domestic Product (GSDP) and District Domestic Product (DDP), population and vehicle registration data are associated with the traffic growth in an Economic Model. Recognizing this, efforts are made to carefully assess all the parameters that help in predicting the traffic demand in future which necessitates realistic estimation of traffic growth rates. For this project traffic growth rates are estimated using Elasticity method.

4.11.1 Approach

Future prospects of project influence area are analysed, while past trend in growth is also considered during forecasting traffic for the hub. For long term forecasting elasticity approach of growth rate estimation is used. The approach included following steps:-

1. Potential of Growth of various vehicle categories (car), passengers (in case of rail passengers), and earnings (in case of bus) are separately assessed based on its probable market share in expected multi-modal travel characteristics.
2. Per Capita Income (PCI) of Kerala is considered for determining growth rate of private vehicles like cars and other public transport modes such as bus and rail passengers etc.
3. Regional Economic factors such as Growth in Gross State Domestic Product (GSDP) and Net State Domestic Product (NSDP) is also studied and checked for determining growth rate of different types of rail and bus passengers and also goods traffic.

4.11.2 Growth Rate in Regional Economies

Growth of traffic on the hub depends on existing development and future growth prospects of the connecting regions. The time series data of economic indicators at constant (2011-12) prices for the project influence area derived from the published data by Department of statistics, Government of Kerala are presented below.

Table 4-64 Growth Rate in Regional Economies

Year	Gross State Domestic Product (Rupee in lakhs) @ 2011-12 prices	Net State Domestic Product (Rs. lakhs) @ 2011-12 prices	Per Capita Income (Rs.)
2011-12	36404789	32802112	97912
2012-13	38769346	34861581	103551
2013-14	40278133	36470677	107846
2014-15	41995555	38213426	112444
2015-16	45121002	41115015	120387
2016-17	47928990	43839422	127729
2017-18(Q)	51369589	46988233	136225
CAGR (2011-18)	5.91%	6.17%	5.66%

4.11.3 Transport Demand Elasticity

Since, demand changes are usually because of shifts in the pattern of economic activities in the influence area it is not appropriate to use past traffic growth trend to extend in near future. Therefore, elasticity approach is used for future traffic forecasting which takes into account the elasticity of transport demand and probable pattern of future growth of the economy.

The Elasticity Method relates traffic growth due to changes in the related economic parameters. This method studies, in an appropriate perspective, the changes in observed past traffic volumes in the context of changes in relevant economic indicators in the Project Influence Area (PIA), to which it was closely related in the past. Such parameters include Net State Domestic Product (NSDP), income accruing to the major sectors of the economy, etc. This method takes into account not only the past growth of the major economic indicators, but also the future perspective. The elasticity based econometric model could be derived in the following form:

$$\text{Log}_e P = A_0 + A_1 \text{Log}_e(EI)$$

Where:

P = traffic volume;

- EI = Economic Indicator;
- A0 = Regression constant;
- A1 = Regression co-efficient (Elasticity Index).

Elasticity values for each mode is estimated using the past vehicle registration data and the growth of PIA NSDP. The elasticity's obtained are as presented below.

Table 4-65 Weighted Elasticity Coefficient- Other Vehicles

Weighted Elasticity Coefficient						
Vehicle Type	Car	Taxi	Bus - stage	Rail	Bus - Contract	Car + Taxi
GSDP	2.18	-1.20	1.95	1.53	-2.46	1.92
NSDP	2.08	-2.26	1.85	0.91	-2.34	1.83
PCI	2.26	-1.23	2.01	1.59	-2.55	1.99

The above indicated elasticities for bus and car was observed to be very high and for taxi and contract carriage buses, it was in negative. So, car and taxi vehicle registration data was combined to arrive at revised elasticity. Similarly for bus, stage carriage and contract carriage bus registration data was combined and it was also observed in both cases that the values were on higher side and un-realistic. The higher elasticity values was observed due to the source of the data selected such as vehicle registration data.

So, for car and taxi, data from toll plaza was used (for three years from Paliyekara and Kubalam toll plaza on NH 544 and NH 66 respectively) and was observed with a growth rate of 5.9%. Similarly for bus, the yearly earnings from bus operations received from KSRTC was used for arriving at revised elasticity. The weighted elasticity coefficients adopted for the study are provided in the **Table 4-66** below:-

Table 4-66 Adopted Weighted Elasticity Coeff. - Bus, Rail and Pvt. Veh.

Vehicle Type	Bus	Rail	Car & Taxi
GSDP	0.91	1.53	1.30
NSDP	0.87	0.91	1.30
PCI	0.94	1.59	1.40

Based on the above elasticity and the GDP growth rate forecast for India, growth rates are estimated for each mode and class. For this, scenarios were created and growth rates for each mode was assumed based on the various parameters of the scenarios. The scenarios and the parameters along with their considerations and assumptions are provided in the subsequent sections.

4.11.4 Scenario Development

The patronage for any regional transit system can vary based on multiple factors as there are external factors which impacts the patronage. So, understanding of the best and the worst cases related to ridership is a necessity. For this study, four different scenarios are developed based on four major parameters. The scenarios are optimistic, realistic, business-as-usual (BAU) or Do-nothing and pessimistic scenarios. The assumptions and

considerations for each scenarios varies based on the parameters such as infrastructure developments, India’s and Kerala’s GDP forecast, additional traffic, and changes in probability of shift from potential trips.

The scenarios and parameters are detailed out in the subsequent sections.

4.11.4.1 Pessimistic Scenario:

In this scenario, it is assumed that the infrastructure development, trip pattern and growth estimates may slow down in the future years. The assumptions and considerations are as follows:-

- 1) No additional infrastructure developments and employment generation along the corridor.
- 2) No scope of additional trips from any external developments are considered.
- 3) The GDP growth rate shall be minimal and similar to present condition and shall grow from 4.8% to 5.5% and moderated downwards for the future years. The GDP growth assumed are as follows:-

Table 4-67: India’s GDP – Pessimistic Scenario

Duration	Pessimistic
2016-20	4.8%
2021-25	5.5%
2026-30	5.0%
2031-35	4.5%
2036-40	3.5%
2041-45	3.0%
2046-50	2.5%

- 4) Potential Trips: the potential trips estimated for modes, car, taxi and rail will remain similar to as estimated and for bus, only AC buses and express buses will be considered.

4.11.4.2 Business As Usual – Do-nothing scenario:

In this scenario, it is assumed that the present conditions in terms of infrastructure, trip pattern and growth estimates will prevail in the future years. The assumptions and considerations are as follows:-

- 1) No additional infrastructure developments and employment generation along the corridor: Only existing infrastructure project such as 4-laning and road improvement projects which are under construction stage will be completed.
- 2) No organised feeder service for SilverLine: the feeder service will be operated by IPTs and other private bus operators based on demand and may not be organised. The feeder will form part of the main transit on its own as demand increases. Also, no integration of feeder is expected with the SilverLine system.

- 3) The GDP forecast shall be minimal and similar to present condition and shall grow from 4.8% to 6% and moderated downwards for the future years. The GDP growth assumed are as follows:-

Table 4-68: India's GDP – BAU

Duration	Business as Usual
2016-20	4.8%
2021-25	6.0%
2026-30	5.0%
2031-35	4.5%
2036-40	3.5%
2041-45	3.0%
2046-50	2.5%

- 4) Potential Trips: the potential trips estimated for modes, car, taxi and rail will remain similar to estimated and for bus, only AC buses and express buses will be considered.

4.11.4.3 Realistic Scenario

In this scenario, developments in infrastructure sector, employment generation and scope for additional traffic is considered. All the developments and assumptions are achievable without much externalities. The assumptions and considerations are as follows:-

- 1) All the existing and proposed road improvement projects will be completed along with other developments in the IT and employment sector.
- 2) Additional traffic from two major sources such as by introduction of feeder service and developments through Transit Orient Development (TOD) is considered. Organised feeder will be operated by K-Rail or managed by K-Rail by integrating with departure and arrival timings of SilverLine trains at stations. Regarding TOD, additional land around the stations will be developed as TOD and a percent will be considered as regional trips shifting to SilverLine. In all the cases, only 50% of the actual trips will be considered.
- 3) The GDP forecast is expected to grow from the present condition up to a rate of 6.5% and moderated downwards. The growth rates are assumed based on the economic survey & IMF forecast of 6.1% till 2021-22. The GDP growth assumed for realistic scenarios are as follows:-

Table 4-69: India's GDP – Realistic Scenario

Duration	Realistic
2016-20	5.0%
2021-25	6.5%
2026-30	6.0%

Duration	Realistic
2031-35	5.0%
2036-40	4.0%
2041-45	3.0%
2046-50	2.5%

- 4) Potential Trips: the potential trips estimated for modes, car, taxi and rail will remain similar as estimated and for bus, AC buses, express buses and 50% of the potential trips from Super-Fast Passenger bus is also considered.

4.11.4.4 Optimistic Scenario

In this scenario, developments in infrastructure sector, employment generation and additional traffic is considered. All the developments and assumptions are assumed at a higher rate based on the various vision document of Government of Kerala and Government of India. The assumptions and considerations are as follows:-

- 1) It is assumed that all highways (NHs & SHs) along the east-west direction in Kerala shall be widened and improved to next level. This shall improve accessibility with catchments on the eastern districts.
- 2) Additional traffic from two major sources such as by introduction of feeder service and developments through Transit Orient Development (TOD) is considered. In this scenario, 100% of the trips generated due to introduction of feeder and TOD development is considered.
- 3) The GDP forecast is expected to grow from the present condition up to a rate of 7.5% and moderated downwards. The higher growth rates are assumed based on the following:-
 - a. For achieving Gol's vision of 5 trillion economy by 2025, the GDP may have to grow at a rate of minimum 7.5% from 2020.
 - b. The Kerala Perspective plan 2030, also envisage a per capita GSDP to grow at 7.5% (compounded annual growth rate) till 2030.
- 4) The GDP growth assumed for optimistic scenarios are as follows:-

Table 4-70: India's GDP – Optimistic Scenario

Duration	Optimistic
2016-20	6.0%
2021-25	7.5%
2026-30	7.0%
2031-35	6.5%
2036-40	4.5%
2041-45	3.0%
2046-50	2.5%

- 5) Potential Trips: the potential trips estimated for modes, car, taxi is assumed with 5% increase from estimated. The potential trips from rail will remain similar as estimated and for bus, AC buses, express buses and 100% of the potential trips from Super-Fast Passenger bus is also considered.

The summary of all the scenario is provided below.

Table 4-71: Summary of India's GDP – All Scenarios

Duration	Pessimistic	Business as Usual	Realistic	Optimistic
2016-20	4.8%	4.8%	5.0%	6.0%
2021-25	5.5%	6.0%	6.5%	7.5%
2026-30	5.0%	5.0%	6.0%	7.0%
2031-35	4.5%	4.5%	5.0%	6.5%
2036-40	3.5%	3.5%	4.0%	4.5%
2041-45	3.0%	3.0%	3.0%	3.0%
2046-50	2.5%	2.5%	2.5%	2.5%

4.11.5 Adopted Growth Rates (Passenger) – Scenario-wise

The adopted growth rates for the modes – rail, bus and car based on each scenario are provided in the tables below:-

Table 4-72 Scenario-wise Adopted Growth Rates – Pessimistic and BAU

Scenario	Pessimistic			Business as Usual			
	Duration	Rail	Bus	Car	Rail	Bus	Car
2016-2020		3.5%	3.6%	4.6%	3.5%	3.6%	4.6%
2021-2025		4.0%	3.7%	4.7%	4.4%	4.1%	5.2%
2026-2030		3.6%	3.0%	4.3%	3.6%	3.0%	4.3%
2031-2035		2.9%	2.2%	3.2%	2.9%	2.2%	3.2%
2036-2040		2.3%	1.7%	2.2%	2.3%	1.7%	2.2%
2041-2051		1.8%	1.0%	1.9%	1.8%	1.0%	1.9%
Average		3.0%	2.5%	3.5%	3.1%	2.6%	3.6%

Table 4-73 Scenario-wise Adopted Growth Rates – Realistic and Optimistic

Scenario	Realistic			Optimistic			
	Duration	Rail	Bus	Car	Rail	Bus	Car
2016-2020		3.6%	3.8%	5.6%	4.4%	4.6%	6.7%
2021-2025		4.7%	4.9%	5.8%	5.4%	5.7%	8.4%
2026-2030		4.4%	4.1%	5.4%	5.1%	5.3%	5.6%
2031-2035		3.3%	2.7%	4.0%	4.7%	4.9%	4.7%
2036-2040		2.6%	2.2%	2.9%	3.3%	3.4%	3.2%
2041-2051		1.8%	1.1%	1.9%	2.2%	2.3%	1.9%

Scenario	Realistic			Optimistic		
Duration	Rail	Bus	Car	Rail	Bus	Car
Average	3.4%	3.1%	4.3%	4.2%	4.4%	5.1%

From the above tables, in all scenarios, the growth rates for the duration is adopted till 2051 instead of the growth rates provided in duration 2041-2051. This is based on the other studies in which, all the DPR has used growth rates near to 2% for the FY 25 to FY 30.

For the airport trips, the growth rates were estimated based on the linear trend of passenger traffic handled at airports, which are in the range of 1.8% to 1.9% annual growth rates. The same is applied to airport trips.

The above growth rates were applied to the base trips arrived based on the probability of shift and the patronage for SilverLine is estimated for each of the scenarios. The daily ridership from the commissioning year to the horizon year is estimated and generated traffic from other sources such as introduction of feeder, TOD/developmental traffic are also to be combined to arrive at the final daily ridership.

4.11.6 Adopted Growth Rates for RoRo

The data used for forecast of RoRo was vehicle registration data and also toll data from two tolls. The growth rates for RoRo is estimated based on the India GDP and Kerala GSDP and the elasticity coefficient observed is 0.55. The coefficient was in the logical range and was adopted for traffic forecast. The adopted growth rates for RoRo is provided in the table below:-

Table 4-74 Adopted growth rates for RoRo

Growth Rates	Truck
2016-2020	2.00%
2021-2025	2.60%
2026-2030	2.40%
2031-2035	2.00%
2036-2040	1.60%
2041-2045	1.20%
2046-2052	1.00%

4.11.7 Developmental Traffic – Trips due to TOD

Developmental traffic is that which would be generated, over and above normal growth, because of new developments in the immediate influence area of the proposed SilverLine stations and corridor. This type of developmental traffic is known as Transit Oriented Development (TOD) in which catchments around the Stations would be developed.

It is proposed to acquire land for Transit Oriented Development around the SilverLine stations. TOD is an urban concept and would generate mostly trips within the city. But, it is also expected to generate few percentage of regional trips based on type of

developments. The duplication impact of TOD in future forecasting has been removed while making forecasts. The major assumptions for arriving at traffic are as follows:-

- a) The catchment is assumed to be 500m radius of land around each station and the TOD details are as provided in the chapter 16.
- b) It is also assumed that the actual development is 30% of the proposed developments.
- c) The FAR is assumed to be 4
- d) Assumed land use break-up area for development:-

Table 4-75: Land use mix- TOD

Land use Mix	% Share
Office	40.0%
Commercial	50.0%
Retail	70.0%
Hotel (Mixed land use)	20.0%
Service Apartment	10.0%
Residential	10.0%
Total Area	100.0%

- e) The modal composition of trips: the modal share is assumed based on the modal distribution in Kochi.

Table 4-76: Modal composition - TOD

Mode	Office
Two Wheeler	26.0%
Car	10.0%
Taxi	0.0%
Private	36.0%
Auto	6.0%
Share Auto	1.0%
IPT (Intermediate Para Transport)	7.0%
City Bus	2.0%
Cycle	3.0%
Cycle Rickshaw	0.0%
Walk	12.0%
NMT & Walk	15.0%
MRTS	10.0%
Bus	30.0%
PT (Public Transport)	42.0%
Total	100.0%

Source: CMP for Greater Cochin Region, KMRL 2016

- f) The trip rates are assumed from Feasibility study of Surat multimodal integration study by IRSDC in 2017 for the traffic impact assessment from TOD:

Table 4-77: Trip rates - TOD

Type of Land use	Trip Rate Per 1000 Sq.ft
Office	19.56
Residential	13.92
Retail	38.34

Based on the above assumptions, the traffic generated based on the land use accounts for approximately ~3267 regional trips per days based on above assumptions. This accounts for ~5% of the total trips generated and in optimistic scenario, 10% of the trips are considered as out of the 10 major stations identified for TOD, all stations are proposed to be developed with TOD concept.

4.11.8 Additional Trips due To Introduction of City Feeder Service

Trips due to introduction of organised feeder service integrating with SilverLine timings and well connected with nearest city centre and settlement areas are also considered. The approach used for estimation of additional trips are as follows:-

- When feeder is introduced, it is considered as increase in length of the transit. The spread of the transit also increase which improves the first and last mile connectivity.
- The study by climatrans - rapid assessment of travel demand model for delhi, RRTS study by NCRTC, and CMP for Puducherry, Nagpur, Lucknow and various other study indicates that as the transit length and spread increases, it attracts additional 10-12% of trips.
- In this study, a hypothetical approach using existing waiting time as travel time savings was adopted. The modal shift based on revised utility equation was generated and applied.
- The waiting time is considered as travel time savings when feeder service is introduced. This waiting time is additional and do not have any correlation with waiting adopted for modal shift using the binary logit model equation for the modal shift provided in 4.10.1.
- The observed and adopted waiting time from the traffic survey are as follows:-

Table 4-78: Adopted Travel Time savings due to City Feeder

Mode	Waiting Time (min)	Adopted WT (min)
AC Train	7.3	6.5
SL	36.9	30.0
AC Bus	13.7	12.0
Non-AC Bus	11.0	10.0

- With the revised travel time savings, revised utility/probability of shift is estimated. The old and new probability of shift and potential trips are provided in table below:-

Table 4-79 Revised trips based on travel time savings

Sl.N o.	Modes	Potential Trips	Shift as per SP Analysis	Total Trips	New Mode Shift	New Base Trips
1	1 AC	116	24.90%	29	26.35%	31
2	2AC	3094	34.20%	1058	34.76%	1075
3	3AC	15535	38.80%	6028	41.40%	6432
4	SL	73230	10.30%	7543	15.09%	11048
5	AC Bus	38639	26.00%	10046	27.75%	10723
6	Non AC Bus	49803	9.70%	4831	12.10%	6026
7	Car	158271	14.00%	22158	14.00%	22158
Total				51692		57493

The above trips accounts for 11.22% increase in trips if feeder service is introduced. But near to 50% trips are considered in realistic scenario due to the assumption that only three major cities – Kochi, Thiruvananthapuram and Kozhikode will be implemented with higher order feeder such as MRTS/LRT/Metrolite etc.

4.11.9 Estimated Daily Ridership

Based on the estimated growth rates for each scenario and inclusion of additional traffic based on assumptions and consideration, the brief of estimated ridership for the forecasted years and for different scenarios, and parameters are provided in the tables below.



Table 4-80 Estimated Ridership – Pessimistic Scenario

Year	Rail	Bus	Car	Total Daily Ridership (from Existing modes)	Total with Airport trips	Total with Airport trips & Feeder	Total with Airport trips, Feeder & TOD
2025-26	11329	15655	25041	52025	54583	-	-
2029-30	13066	17645	29643	60354	63069	-	-
2041-42	17835	22265	41255	81355	84567	-	-
2052-53	21620	24897	50824	97341	101085	-	-

Table 4-81 Estimated Ridership – Business as Usual Scenario

Year	Rail	Bus	Car	Total Daily Ridership (from Existing modes)	Total with Airport trips	Total with Airport trips & Feeder	Total with Airport trips, Feeder & TOD
2025-26	18776	18798	25559	63133	65724	-	-
2029-30	21656	21188	30255	73099	75892	-	-
2041-42	29568	26736	42106	98410	101869	-	-
2052-53	35841	29895	51870	117606	121770	-	-



Table 4-82 Estimated Ridership – Realistic Scenario

Year	Rail	Bus	Car	Total Daily Ridership (from Existing modes)	Total with Airport trips	Total with Airport trips & Feeder	Total with Airport trips, Feeder & TOD
2025-26	19133	19583	26623	65339	71779	76667	79934
2029-30	22695	22954	32829	78478	85421	91150	94672
2041-42	32212	30711	49392	112315	120916	128580	132944
2052-53	39048	34767	60850	134665	145018	153694	158946

Table 4-83 Estimated Ridership – Optimistic Scenario

Year	Rail	Bus	Car	Total Daily Ridership (from Existing modes)	Total with Airport trips	Total with Airport trips & Feeder	Total with Airport trips, Feeder & TOD
2025-26	19944	26430	42986	89360	95800	105828	114764
2029-30	24320	32510	53421	110251	117194	129529	139164
2041-42	38625	52694	84649	175968	184569	204562	216498
2052-53	48965	67502	104283	220750	231103	256713	271080

The summary of the daily ridership estimate including airport trips, additional traffic due to introduction of city feeder service and traffic from TOD is provided in table below:-

Table 4-84 Daily Ridership Estimate - Summary

Scenario	Pessimistic	Business as Usual	Realistic	Optimistic
2025-26	54583	65724	79934	114764
2029-30	63069	75892	94672	139164
2041-42	84567	101869	132944	216498
2052-53	101085	121770	158946	271080

From the above table it is observed that the daily ridership varies between ~54,000 to ~1,14,000 in the commissioning year and ~1,01,000 to ~2,71,000 in the horizon year for each of the scenarios. Based on the approach and initiatives taken by the K-Rail such as discussion with representatives of Airport Authority, TOD land bank project (already under tendering stage), strategies adopted to bring last-mile connectivity, it is expected that the ridership may reach as provided in the realistic scenario. So, for further analysis and estimations of rolling stock, station design etc., the daily ridership estimate of the realistic scenario is considered.

4.11.10 Station-wise Loading: Sectional Load

Station wise boarding and alighting of passengers for the proposed SilverLine, between Thiruvananthapuram and Kasaragod, is estimated considering the probability of shift from the respective mode of transport (i.e. Bus, Train & Car) and the potential traffic estimated based on Stated preference survey and OD survey.

The daily boarding and alighting at SilverLine stations and the section load for horizon years 2025-26, 2029-30, 2041-42 and 2052-53 are presented in table 4-86 to table 4-87. Peak hour boarding and Alighting and Section Load (PHPDT) summary is presented in table 4-88 and table 4-89.



Table 4-85 Daily Boarding and Alighting (inc. Thiruvananthapuram Airport)

Station Name	Boarding (Daily)				Alighting (Daily)			
	2025-26	2029-30	2041-42	2052-53	2025-26	2029-30	2041-42	2052-53
Thiruvananthapuram Airport	710	740	970	1,160	650	680	890	1,100
Thiruvananthapuram	16,100	20,430	29,030	34,700	15,010	18,970	26,950	32,200
Kollam	4,820	5,790	8,390	10,040	4,740	5,690	8,230	9,900
Chengannur	2,530	3,080	4,550	5,500	2,470	3,000	4,430	5,400
Kottayam	5,080	6,130	8,850	10,560	5,140	6,200	8,930	10,700
Ernakulam	14,400	17,340	25,010	29,900	14,240	17,230	24,790	29,600
Kochi Airport	3,480	3,830	5,410	6,440	3,460	3,830	5,400	6,400
Thrissur	8,190	9,380	11,730	14,020	8,320	9,580	12,200	14,600
Tirur	2,700	2,480	3,660	4,390	2,610	2,440	3,600	4,300
Kozhikode	10,790	12,130	15,040	17,920	11,430	12,810	15,820	18,800
Kannur	7,920	9,520	14,150	16,930	8,420	10,110	15,050	18,000
Kasaragod	3,070	3,700	5,990	7,190	3,330	4,010	6,490	7,800
Total	79,800	93,800	131,800	157,600	79,150	93,850	131,900	157,700

From the above indicated line loadings, it was decided by the KRDC Board to construct the Thiruvananthapuram Airport station at later stage based on the future demand. However, the proposed LRT/Metrolite for Thiruvananthapuram city may also be used to bring airport passengers to the Thiruvananthapuram SilverLine station or other systems such as Automated People Movers (APMs), Personalised Rapid transit (PRT – PODS) etc., may also be studied.

Table 4-86 Daily Ridership - Boarding and Alighting

Station Name	Boarding (Daily)				Alighting (Daily)			
	2025-26	2029-30	2041-42	2052-53	2025-26	2029-30	2041-42	2052-53
Thiruvananthapuram	16,030	20,490	29,040	34,720	14,800	18,910	26,800	32,000
Kollam	5,210	5,790	8,710	10,410	5,160	5,690	8,570	10,300
Chengannur	2,530	3,080	5,190	6,270	2,470	3,000	5,120	6,200
Kottayam	5,090	6,130	8,850	10,560	5,150	6,200	8,930	10,700
Ernakulam	14,850	18,020	25,010	29,900	14,730	17,960	24,790	29,600
Kochi Airport	3,490	3,830	5,410	6,440	3,470	3,830	5,400	6,400



Station Name	Boarding (Daily)				Alighting (Daily)			
	2025-26	2029-30	2041-42	2052-53	2025-26	2029-30	2041-42	2052-53
Thrissur	8,200	9,380	11,730	14,020	8,330	9,580	12,200	14,600
Tirur	2,700	2,480	3,660	4,390	2,620	2,440	3,600	4,300
Kozhikode	10,810	12,130	15,040	17,920	11,440	12,810	15,820	18,800
Kannur	7,930	9,520	14,150	16,930	8,430	10,110	15,050	18,000
Kasargod	3,080	3,700	5,990	7,190	3,340	4,010	6,490	7,800
Total	79,900	94,550	132,800	158,750	79,950	94,550	132,750	158,700

Table 4-87 Daily Ridership - Sectional Load

Station Name	Forward				Reverse			
	2025-26	2029-30	2041-42	2052-53	2025-26	2029-30	2041-42	2052-53
Thiruvananthapuram	0	0	0	0	14,800	18,910	26,800	32,050
Kollam	16,030	20,490	29,040	34,720	15,380	20,050	28,420	33,970
Chengannur	16,660	21,720	30,790	36,800	16,140	21,010	29,230	34,970
Kottayam	17,480	22,760	31,670	37,880	15,440	20,160	28,260	33,790
Ernakulam	16,730	21,830	30,610	36,600	16,860	20,890	30,940	37,010
Kochi Airport	18,270	22,630	33,520	40,090	17,130	20,940	31,030	37,090
Thrissur	18,560	22,680	33,620	40,180	15,590	18,560	25,320	30,260
Tirur	16,890	20,110	27,430	32,780	16,640	19,050	26,030	31,080
Kozhikode	18,020	20,640	28,200	33,660	9,040	10,820	16,690	19,970
Kannur	9,790	11,720	18,080	21,640	3,080	3,700	5,990	7,190
Kasargod	3,340	4,010	6,490	7,790	0	0	0	0
Total	18,560	22,760	33,620	40,180	17,130	21,010	31,030	37,090

Table 4-88 Peak Hour - Boarding and Alighting

Station Name	Boarding (Peak Hour)				Alighting (Peak Hour)			
	2025-26	2029-30	2041-42	2052-53	2025-26	2029-30	2041-42	2052-53
Thiruvananthapuram	1,080	1,380	1,950	2,330	990	1,270	1,800	2,150
Kollam	380	420	630	750	370	410	620	740



Station Name	Boarding (Peak Hour)				Alighting (Peak Hour)			
	2025-26	2029-30	2041-42	2052-53	2025-26	2029-30	2041-42	2052-53
Chengannur	200	250	420	510	200	240	410	500
Kottayam	360	430	630	750	360	440	630	760
Ernakulam	1,170	1,420	1,970	2,350	1,160	1,410	1,950	2,330
Kochi Airport	270	300	430	510	270	300	420	500
Thrissur	600	690	860	1,030	610	700	890	1,070
Tirur	170	160	230	280	170	160	230	280
Kozhikode	760	850	1,060	1,260	800	900	1,110	1,320
Kannur	590	710	1,050	1,260	620	750	1,120	1,330
Kasargod	250	300	490	580	270	330	530	630
Total	5,830	6,910	9,720	11,610	5,820	6,910	9,710	11,610

Table 4-89 Peak Hour - Sectional Load

Station Name	Forward				Reverse			
	2025-26	2029-30	2041-42	2052-53	2025-26	2029-30	2041-42	2052-53
Thiruvananthapuram	0	0	0	0	990	1,270	1,800	2,150
Kollam	1,160	1,480	2,090	2,500	1,110	1,440	2,050	2,450
Chengannur	1,350	1,750	2,490	2,970	1,300	1,700	2,360	2,830
Kottayam	1,240	1,610	2,240	2,680	1,090	1,420	2,000	2,390
Ernakulam	1,320	1,720	2,410	2,880	1,330	1,640	2,430	2,910
Kochi Airport	1,440	1,780	2,640	3,160	1,350	1,650	2,440	2,920
Thrissur	1,360	1,660	2,460	2,950	1,140	1,360	1,860	2,220
Tirur	1,080	1,290	1,760	2,100	1,070	1,220	1,670	2,000
Kozhikode	1,270	1,450	1,980	2,370	640	760	1,170	1,400
Kannur	730	870	1,340	1,600	230	270	440	530
Kasargod	270	330	530	630	0	0	0	0
Maximum Section Load (PHPDT)	1,440	1,780	2,640	3,160	1,350	1,700	2,440	2,920

4.12 FARE SENSITIVITY ANALYSIS

Fare sensitivity analysis is carried out to identify the indicate fare for the proposed SilverLine and not for fare box revenue estimation. It is carried out for the base year and commissioning year 2025-26, considering different fares (i.e. from Rs 1 per km to Rs 8 per km) for SilverLine without cost escalation and for the forecasted traffic of 2025-26. Daily ridership for each fare was estimated and corresponding annual fare revenue was calculated. The slab which provide maximum revenue and optimum ridership was considered as the selected fare slab.

The fare was set based on the existing rail and bus fares. The fares are provided in table below:-

Table 4-90 Existing Rail Fares

Sl. No	Class	Fare (in Rs for 200KM)	Per Km (Rs.)
1	1AC	1047	5.24
2	2AC	613	3.07
3	3AC	428	2.14
4	CC	278	1.39
5	SL	120	0.60

Source: Ministry of Railways, 2019

Table 4-91 Existing Bus Fares

Sl. No	Class	Fare (in Rs for 200KM)*	Per Km
1	Volvo	290	1.45
2	Other AC	240	1.20
3	Super Del.	200	1.00
4	Super FP	156	0.78
5	FP	150	0.75

Source: KSRTC, 2019

The per Km fare for private vehicle was observed to be Rs. 8.78 Km. This is based on the IRC SP 30-2009. The private taxi fares are in the range of INR 14/Km. The air fares between Kochi and Trivandrum is in the range of INR 2200/- to INR 4500/- and for Trivandrum to Kozhikode, it is in the range of INR 3500/-.

Average trip length (weighted average of car, rail and bus) of SilverLine, for the commissioning year 2025-26 is considered as 200 km. This is based on the weighted average of trip length of rail, bus and car. The weightage was based on the type of trips selected as potential trips from respective mode. As stated earlier, for rail-based, all trips was considered; while for bus only trips from AC buses, express bus and 50% of super-fast passenger was considered. In case of cars, all the trips which were above 100 Km trip length and within a buffer of 15Km within PIA was considered.

From the trip length frequency distribution and based on the above, the weights for Rail was 69%, Bus 23% and Car was observed to be 8% and average trip length for rail trips

– 202 Km, bus trips – 185Km and Car trips – 56 Km. The weighted average was observed to be 194.56 Km and for future estimation, was rounded off to 200 Km.

The willingness to pay survey also indicates an increase of fare by 1.25 and 1.5 times by approximately 42% AC class passengers and 7% of the sleeper class passengers respectively. Similarly by 16% of non-ac bus users also preferred 1.5 times and 39% of ac bus users by 1.25 times.

Comparison of annual fare revenue and daily ridership for different fares is shown in Table 4-92 and Figure 4-82.

Table 4-92 Fare Sensitivity

Fare of SILVERLINE (Rs/Km)	Daily Rider Ship (000's)	Annual Fare revenue (Rs Cr)
1	137,863	1006
1.5	121,126	1326
2	103,124	1506
2.75	79,934	1605
3	69,933	1532
3.5	55,291	1413
4	39,717	1160
5	30,527	1114
6	24,979	1094
8	17,215	1005

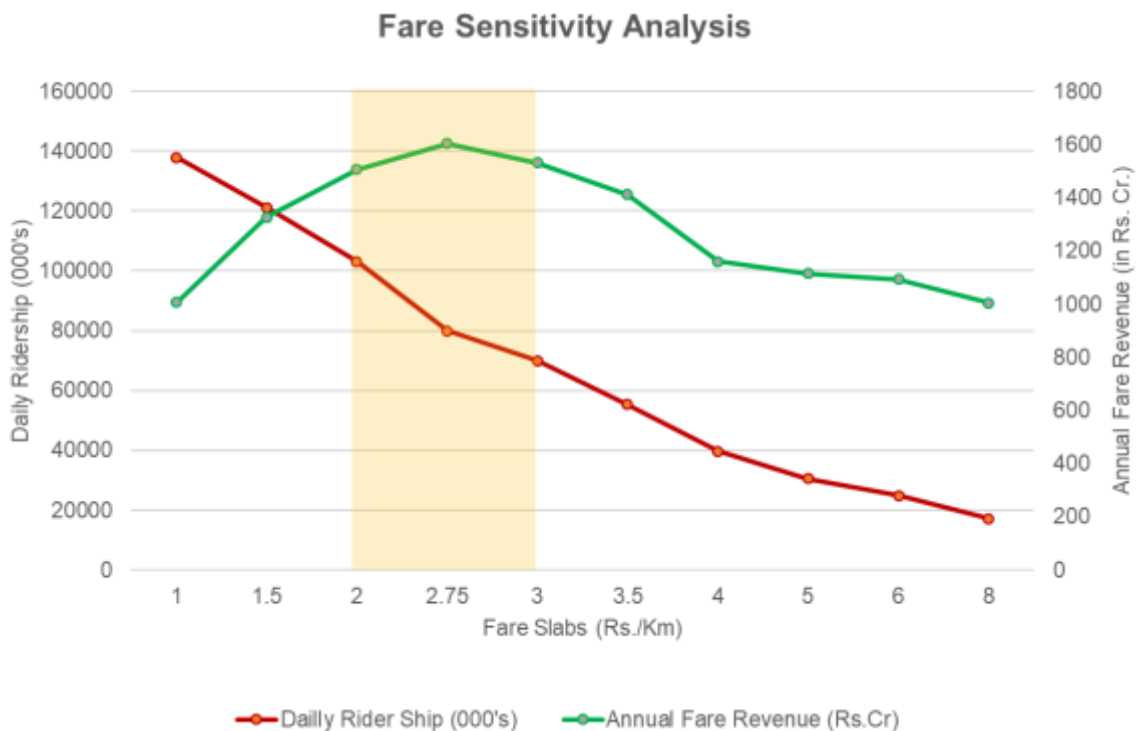


Figure 4-82 Fare Sensitivity Analysis

From the figure, it is observed that maximum fare revenue corresponds to a fare of Rs 2.50 – Rs 3.00 per km. Though the optimum fare for SilverLine is around Rs 2.75 per km, considering the higher ridership at lower fares, the Government/ Authorities may finalise appropriate fare so that the system is effectively utilised to its full capacity.

4.13 TRAVEL DEMAND FORECAST FOR RORO

The traffic forecast for RORO service, in terms of number of trucks (2-Axle and above) based on the adopted growth rates are provided in the table below:-

Table 4-93 Estimated Daily Traffic for RoRo

Year	Estimated Daily Trucks (in No.s)
2025-26	457
2029-30	502
2041-42	620
2052-53	700

From the above figures, based on the operation plan, it is observed that maximum trucks that can be carried by RORO without impacting the passenger operations are 480 per day. So, from 2029, the trucks expected in RORO is capped at 480 till the horizon year.

4.14 ADDITIONAL TRAFFIC SURVEYS

As part of the study, evaluation of different options that could be considered for enhancement of ridership and better utilisation of SilverLine facilities has been undertaken. These are based on the various factors and options considered by other rail operators in India and abroad. Out of the above options, feasibility of operating tourist trains, sleeper trains, restaurant car in trains and feasibility of operating aggregator stations. The traffic surveys were conducted in the month of December 2019 and January 2020 and the results from the analysis are provided in subsequent sections.

4.14.1 Demand Assessment for Operating Tourist Trains

The tourism statistics published by the department of Tourism, Government of Kerala indicates that, there is potential for operating tourist trains in terms of the favourite locations and its proximity to the SilverLine alignment. Out of the top 10 locations visited by the international tourist, 8 locations are along the proposed SilverLine alignment. The corridor and the statistical data is provided in **Figure 4-83** below:-



Sl. No.	Destination	No. of Tourists	Within PIA (Y/N)
1	Kochi City	236870	Yes
2	Kovalam	142914	Yes
3	Fort Kochi	115482	Yes
4	Varkala	103602	Yes
5	Alappuzha	74621	Yes
6	Thiruvananthapuram	64014	Yes
7	Maradu	46034	Yes
8	Kumarakom	35975	Yes
9	Munnar	24293	No
10	Thekkady	19537	No

Source: Kerala Tourism Statistics - 2018

Figure 4-83 Top locations visited by International tourists

The details related to the present trip of the tourists and their willingness to shift to SilverLine Tourist Train were collected through the traffic survey conducted at Thiruvananthapuram, Kochi and Allepy. The information collected includes places visited (in the sequence), landing point, main mode of travel, total cost of the Tour Package. The samples selected were extrapolated to the international and domestic tourist arrival data to arrive at yearly tourist.

The modal distribution of international and domestic tourist is provided in the Figure 4-84 below:-

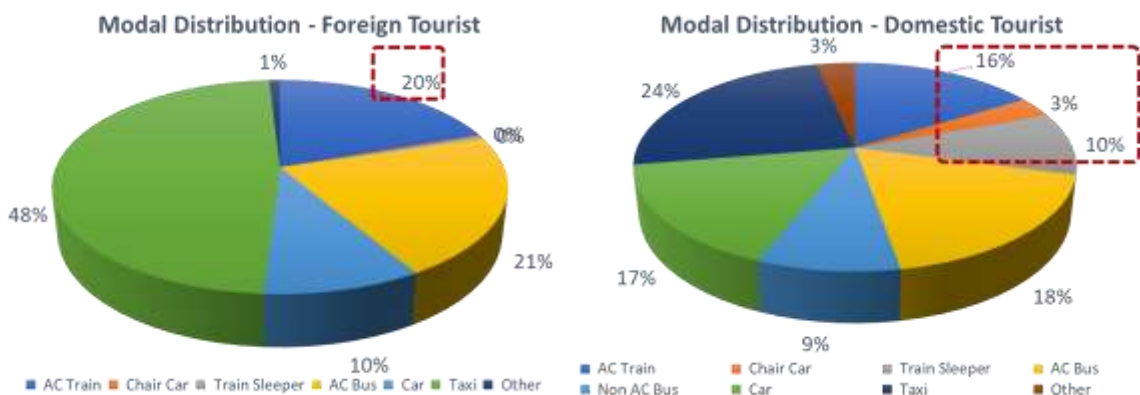


Figure 4-84 Modal Distribution - Tourists

From the above figure, it is observed that 20% of the international tourist and 29% of the domestic tourist uses train as their main mode of travel within Kerala. They are potential trips when only mode is considered.

If affordability is to be considered, then the potential trips may reduce as the tourist trains are proposed to be operated in the same Indian Railways Tourist train model (on lease

model by concerned STC and IRCTC). In this regard, distribution of tourist on the basis of income was also conducted and presented in figure given below.

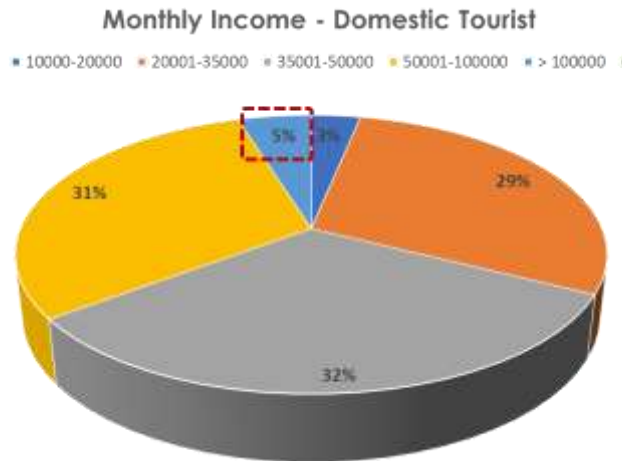


Figure 4-85 Income-wise distribution of Tourists

Income-wise distribution indicates that only 5% of the domestic tourist are above monthly income range of INR 1 lakh and are willing to pay only 2.5 times the existing fare. This shift the focus to the international tourist as they shall be the main target user group when tourist trains are considered. The income distribution of international tourist indicates that more than 48% of the international tourist have monthly income more than \$2000/- (two thousand dollars).

Based on the above results and willingness to shift to SilverLine, the potential trips from international and domestic tourist are provided in the **Table 4-94** below:-

Table 4-94 Potential trips – Yearly Tourist

Sl. No	Mode	Domestic	International	Total
1	AC Train	2207	29090	31297
2	Chair Car	403	541	944
3	Train Sleeper	718	541	1259
4	AC Bus	2319	14071	16390
5	Non AC Bus	820	0	820
6	Car	592	5277	5869
7	Taxi	994	16371	17365
8	Other	82	947	1029
Total		8135	66838	74973

From the above potential trips, the yearly tourist expected to shift to SilverLine is ~32,241 tourists considering international tourist and mode of travel AC train and Chair car. Bus as per the recent discussion with the K-Rail, it is brought to the notice that, the tourism statistics are actually duplicate in terms of the tourists are considered. Each location visited by a tourist is separately counted and there would be duplication. Based on the above analysis was done and found that per tourist, 2.7 was the factor arrived from the tourist survey. So, the tourists are considered as ~11,941 in the base year.

4.14.2 Demand Assessment for Operating Aggregator Services

This survey was organised near all the identified and proposed 26 Aggregator Stations such as Attingal, Kallambalam, Chathannur, Kundara/ Kottarakkara, Bharanikavu, Charummodu/ Mamoodu, Pandalam, Eraviperoor, Karukachal, Ettumanoor, Piravam, Chottanikara/Thrippunithura, Aluva, Nedumbassery Airport, Divine Nagar/ Chalakudy, Irinjalakkuda, Sobha City, Kunnamkulam, Edappal, Parappanangadi, Feroke, Koyilandy, Vadakara, Thalassery, Payyannur, Kanhangad.

The waiting time, existing mode of travel, access and dispersal mode to stations, travel time, travel cost and willingness to shift and pay were recorded from the commuters.

The main approach and steps followed to arrive at ridership to aggregators stations are as follows:-

- a) Potential trips from rail, bus and taxi was identified. From rail, the potential passengers were arrived from UTS data, the commuters travelling by all class and with fare less than 45 per ticket was considered. From CRIS data, shorter distance trips was identified as potential trips which was observed to be negligible.
- b) Potential trips from bus was estimated based on the travellers using fast passenger bus and 50% of the superfast passenger bus.
- c) Car and taxi trips were based on generalised cost and with an average trip length of 15Km to 100Km.
- d) Potential data and for rail, different options for potential trips were prepared based on fare as the data was mainly from source of UTS. Potential Passengers were selected four fare option, they are Option 1: between Rs. 15 & Rs. 45, Option 1: between Rs. 15 & Rs. 30, Option 1: between Rs. 30 & Rs. 45 and Option 4: fare less than Rs. 15.
- e) Mode-wise percentage of shift is estimated from the aggregator survey and applied to the potential trips – Rail (65.1%), Bus (Non-Ac Bus – 25%) and Car & Taxi (5%).
- f) The growth estimates considered were similar to growth rates adopted for realistic scenario.

The daily ridership for the four options are provided in the **Table 4-95** below:-

Table 4-95 Daily Ridership from Aggregator Services

Year	Ridership for Aggregator Services			
	Option 1	Option 2	Option 3	Option 4
2024	60834	48857	37144	33749
2028	71996	57891	44093	40095
2040	104080	83695	63753	57973
2051	126240	101528	77352	70348

From the above options, the daily ridership is varying from ~35,000 to ~60,000 in the commissioning year. As the ridership is comparatively lower against the capital and operating cost, the aggregator stations are proposed to be implemented later based on the future demand and not during the commissioning year.

4.14.3 Demand Assessment for Operating Sleeper Trains.

Option of providing night trains with sleeper class is also analysed. For this, traffic survey was conducted at major stations at both ends of the proposed alignment such as Thiruvananthapuram, Kollam, Chengannur, Kasaragod, Kannur and Kozhikode. The survey was also conducted at Kochi, as it is located at the centre.

The survey targeted the passengers travelling under reservation during the night time both by AC buses and Trains (mostly travelling by 1 AC/ 2 AC/ 3 AC) and the details related to the present trip of the passenger and their willingness to shift to Semi High Speed Sleeper Trains along with their willingness to use sleeper class was recorded.

The figure below provides the desired timings by respondents of arrival at destination station when started the journey at night.

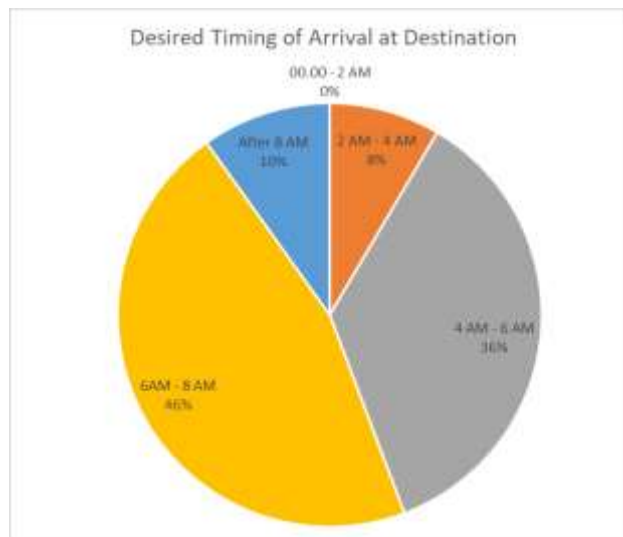


Figure 4-86 Desired Timing of Arrival by Passenger

From the above figure, it is observed that 56% of the passengers wishes to reach the destination station after 6AM and 36% wishes to arrive at destination between 4AM and 6AM.

It is also observed from the survey that the existing passengers travelling by sleeper class are weekly travellers. The details are provided in figure below:-

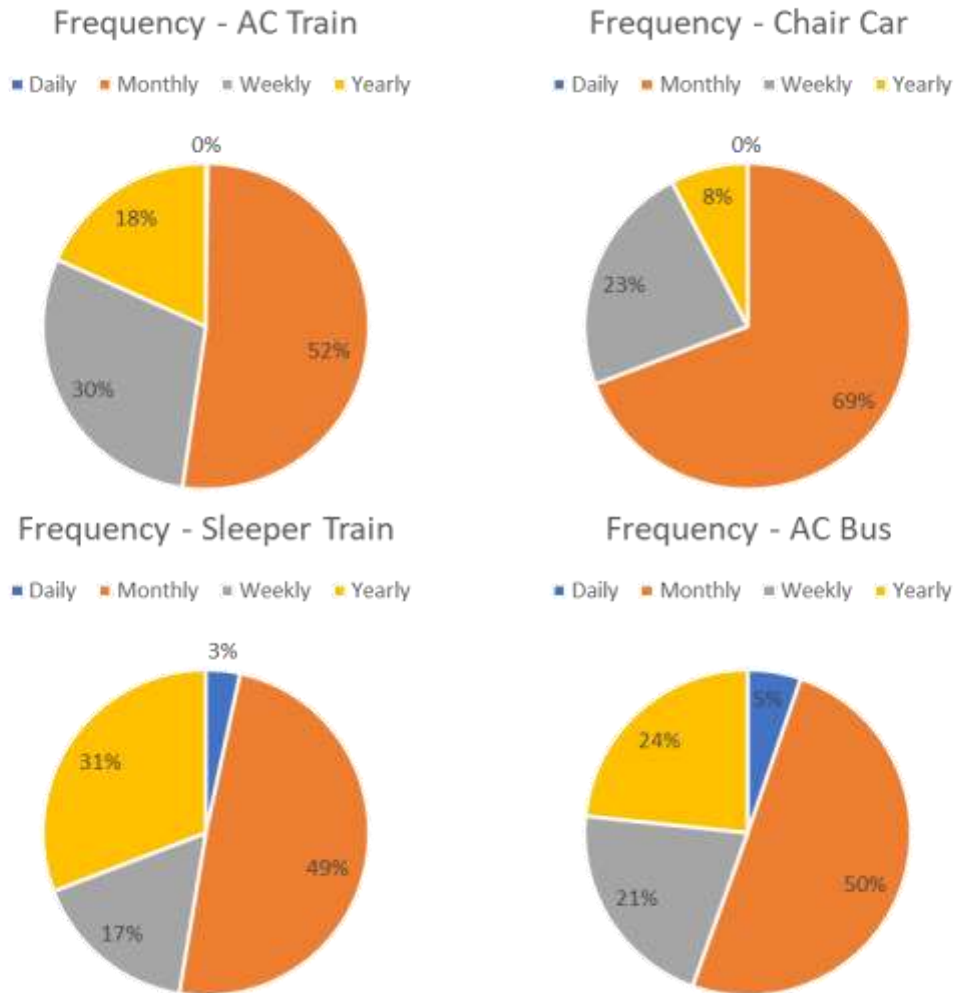


Figure 4-87 Desired Timing of Arrival by Passenger

The above figure clearly indicates that most of the sleeper class travellers are weekly and the likely trips for the SilverLine sleeper trains are provided in the **Table 4-96** below.

Table 4-96 Daily and weekly trips for sleeper trains

Sl. No.	Mode	Daily	Weekly
1	A C Train	0	192
2	CC	0	4
3	Train Sleeper	45	431
4	AC Bus	0	752
5	Non AC Bus	34	405
	Total	79	1785

From the above table, it is observed that on an average, daily trips expected in 255 passengers. So, sleeper trains only on weekends – Friday, Saturday and Sunday are only required if operated as daily expected daily patronage is low.

4.14.4 Demand Assessment for Operating Restaurant Cars

An option to introduce restaurant car within the trains are also analysed to understand whether restaurant cars to be added to the normal coaches. The objective is to provide, high-end Restaurant food to the passengers. The survey was conducted at major rail and bus stations such as Thiruvananthapuram, Kollam, Ernakulam, Kozhikode and Kannur.

The survey was conducted and covered the train passengers travelling by AC Classes. The data like present meal option during journey, issues with present mode, willingness of the passengers to shift to SilverLine and use of Restaurant Cars was recorded. The major results are provided in the Table 4-96 below.

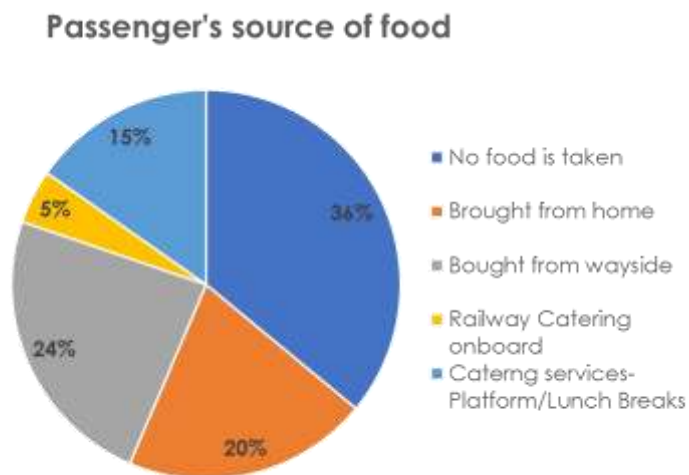


Figure 4-88 Passengers Source of Food during commuting

From the above figure, it is observed that the potential users constitute 44% as they take food from outside. The main reason for not taking food as Stated by the commuters (68%) during journey was due to the hygiene issues.

Potential trips and probable uses of restaurant cars are provided in the Table 4-97 below:-

Table 4-97: Potential users for Restaurant cars

Sl. No.	Mode	Total
1	A C Train	90
2	Chair Car	2
3	Train Sleeper	505
4	AC Bus	1166
5	Non AC Bus	305
	Total	2067

The above figures are inclusive of weekly and daily travellers. So, on daily basis, probable users are expected to be ~295 passenger per day. To make the journey attractive to the SilverLine users, it is necessary to provide good quality and high-end restaurant type food through a reputed catering agencies, that will also increase the non-fare revenue.

4.15 CONCLUSION AND RECOMMENDATIONS

For all the future estimations, base year was considered as 2019-20, commissioning year as 2025-26 and horizon year as 2052-53. The traffic projection covers upto 50 year (2072-73) period for financial estimations. Elasticity approach (elasticity based econometric model) is used for future traffic forecasting which takes into account the elasticity of transport demand and probable pattern of future growth of the economy (regional - India and local - Kerala). The daily ridership was estimated for four different scenarios as Pessimistic, Business-As-usual, Realistic and Optimistic built-up based on variations in parameters such additional infrastructure developments, additional traffic generated, growth rates based on all India GDP and difference in mode-wise probability of shift from potential trips. The daily ridership was observed to be varying between approx. ~54,000 daily trips in worst scenario to ~1,14,000 trips in optimistic scenario in 2025-26. The realistic scenario is expected to generate approx. ~79,934 daily trips in 2025-26 (including trips from airports, feeder service and TOD). This when compared with the traffic study of high-speed rail from Thiruvananthapuram to Kasaragod done by M/s iMacS are provided below.

Table 4-98: Comparison between HSR and SilverLine

Project	HSR - Kerala	SilverLine
Year of Study	2016-17	2019-20
Catchment Population	3.3 Cr	3.3 Cr.
Length (Km)	540	529.45
Mode Choice	Multinomial Logit	Binary Logit
BY Ridership	85,332 (2020)	79,934 (2025)
HY Ridership	2,33,042 (2051)	1,58,946 (2052)
Feeder	Nil	6%
TOD	Nil	5%
Fare / Km	5	2.75

To improve the ridership during the operational years, following planning and policy interventions are recommended: -

- a) Multi-modal integration: All SilverLine stations are recommended to be developed on multi-modal integration concept, in which users from silver-line, road, water, rail and other modes can interchange modes with ease, conflict free and faster transfer.
- b) SilverLine to be part of mobility network: SilverLine is not to be treated as an independent transport system and should be integrated and shall form part of larger mobility network in Kerala involving, rail line, air, road, water and NMT networks. Within the network, SilverLine to be of highest hierarchy. Comprehensive mobility plans/regional mobility plans to be prepared in all districts in line with SilverLine. KMTA is formed for Thiruvananthapuram, Ernakulam and Kozhikode and this shall be the responsibility of the KMTA. The GoK is also taking

initiative to constitute a directorate for mobility. In case the directorate is formed, all the transport planning related activities shall be the responsibility of the directorate.

- c) Provision of park and ride facilities at SilverLine stations. All stations shall be provided with ample parking facility and also with electric charging points. Discounts for park and ride shall be considered during the execution stage.
- d) Provision of city feeders to provide accessibility from SilverLine stations to nearby city centres – Central Business Districts (CBD) and other catchments. The city feeder can be operated by the SPV or by STU (KSRTC) or by the private players. The only requirement is to have integrate timetable and ticketing for feeder and SilverLine.
- e) Conducting periodic traffic surveys: traffic surveys including opinion surveys are to be conducted just before commissioning to re-establish the ridership estimates, fares and also every 3 years (minimum) during operational years. A detailed transport model can be prepared during the next stage and update it frequently based on any changes in the mobility pattern.
- f) Provision of Travel discounts: group discounts, monthly pass, discount on return tickets etc., may also be considered for attracting more users. The discounts provided may be compensated by considering revenue from other non-fare revenue sources such as:-
 - 1) Property development
 - 2) TOD
 - 3) Revenue from lease of infrastructure – telecom towers (intelligent street poles), lease of Optical fibre, lease of utility duct for transporting oil, gas etc.
 - 4) Other commercial development.



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