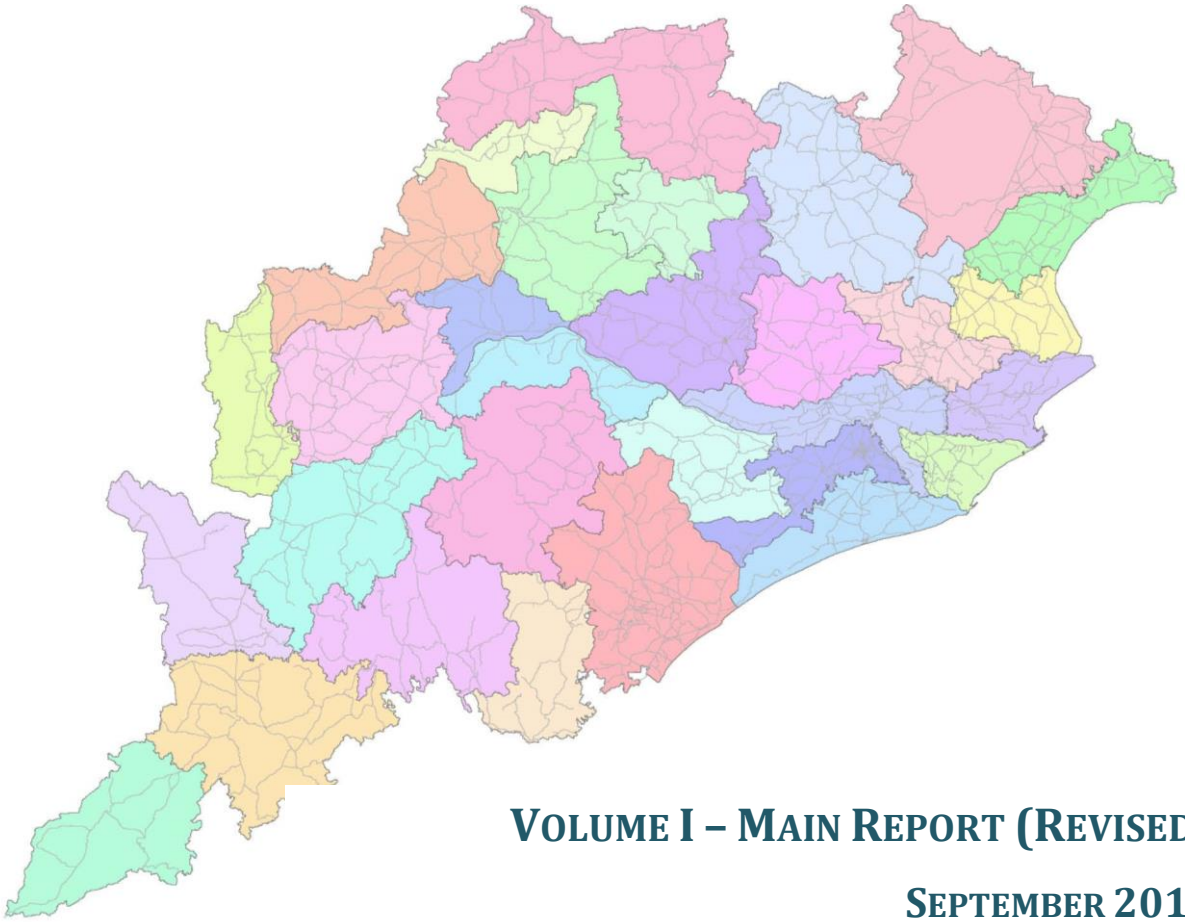
COMPLETION REPORT ON INAUGURAL

MASTER PLAN FOR MAIN ROAD NETWORK IN ODISHA



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Odisha Works Department

The World Bank

Intercontinental Consultants and Technocrats Pvt. Ltd.

In joint venture with

Grant Thornton
An instinct for growth™

In association with

ARKITECHNO
CONSULTANTS (INDIA) PVT. LTD.

Government of Odisha
Chief Engineer, World Bank Projects, OWD
Odisha State Roads Project

Consultancy Services for
Road Sector Institutional Development

Loan # 7577-IN

Completion Report on Inaugural
'Master Plan for Main Road Network in Odisha'

September 2014

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Abbreviation

AADT	Average Annual Daily Traffic
AAI	Airport Authority of India
ADT	Average Daily Traffic
AMC	Asset Management Consultant
ASM	Asset Management System
BHQ	Block Head Quarter
CBA	Cost Benefit Analysis
CDP	City Development Plan
DHQ	District Head Quarter
DL	Dual Lane (2-lane undivided carriageway)
DLPS	Dual Lane with Paved Shoulder (2-lane undivided carriageway)
DPR	Detailed Project Report
DSV	Design Service Volume
EIRR	Economic Internal Rate of Return
ESA	Equivalent Standard Axle
EXP	Expressway
FEED	Front End Engineering & Design
GDDP	Gross District Domestic Product
GDP	Gross Domestic Product
GIS	Geographical Information System
GOI	Government of India
GOO	Government of Odisha
GPHQ	Gram Panchayat Head Quarter
GSDP	Gross State Domestic Product
HCV	Heavy Commercial Vehicle
HDI	Human Development Index
HDM	Highway Development & Management
HQ	Head Quarter
IDS	Institutional Development Strategy
IL	Intermediate Lane
IOC	Indian Oil Corporation
IRC	Indian Roads Congress
ISAP	Institutional Strengthening Action Plan
LASA	LEA Associates South Asia Pvt. Ltd.
LCV	Light Commercial Vehicle
LOS	Level of Service
LR	Link Road
MAE	Multiple Account Evaluation
MAV	Multi Axle Vehicle
MDR	Major District Road
MoRTH	Ministry of Road Transport and Highways

MSA	Million Standard Axle
MSME	Micro, Small and Medium Enterprises
MTPA	Metric Ton Per Annum
NALCO	National Aluminum Corporation
NDDP	Net District Domestic Product
NH	National Highway
NHAI	National Highways Authority of India
NPV	Net Present Value
NSDP	Net State Domestic Product
OD	Origin Destination
ODR	Other District Road
ORSAC	Odisha Space Applications Centre
OSRP	Odisha State Roads Project
OSTM	Odisha Strategic Transportation Model
OWD	Odisha Works Department
PC	Passenger Car
PCU	Passenger Car Unit
PMC	Project Management Consultant
PMGSY	*Pradhan Mantri Gram Sadak Yojana*
PMU	Project Management Unit
RIDF	Rural Infrastructure Development Fund
RNMP	Road Network Master Planning
RR	Rural Roads
RSID	Road Sector Institutional Development
RTDM	Regional Travel Demand Model
SH	State Highway
SHQ	State Head Quarter
SL	Single Lane
SSI	Small Scale Industry
TAZ	Traffic Analysis Zones
TCP	Town and Country Planning
TL	Two Lane
ToR	Terms of Reference
TR	Through Road
V/C	Volume Capacity Ratio
VAL	Vedanta Aluminum Limited
VOC	Vehicle Operating Cost
VOT	Value of Time
VR	Village Road
WB	World Bank

Executive Summary

The Government of Odisha (GOO) appointed Intercontinental **Consultants and Technocrats Pvt. Ltd (ICT), New Delhi, in joint venture with Grant Thornton Advisory Pvt. Ltd. (GTA), UK and in association with ARKITECHNO Consultants (India) Pvt. Ltd., Odisha**, to undertake the Road Sector Institutional Development (RSID) Project. The RSID Project included preparation of a Road Network Master Plan (RNMP) that forecast the future requirement on road improvements to support future growth of the State. This task of RSID Project envisages developing the State's 'Road Network Master Plan' (RNMP) to support the ISAP process. The RNMP preparation process was commenced in 2013.

As per the 'Terms of Reference (TOR)' the RNMP the Primary Objective of the RNMP was as follows:

- Development of comprehensive master planning for Odisha road network with multi-year plans and annual plans for roads development and management
- Capitalization of the GIS-based main road network information system and database, established through other agencies;
- Preparation of a draft inaugural Master Plan in line with the new Road Sector Policy considering the current network status and road conditions;
- Assessment of the emerging state-level trends in road transport demand, and potential investment and funding outlook in Odisha;
- Assessment of relevant aspects of the state's plans and priorities for socio-economic development;
- Identification of relevant steps to build capacity within OWD; and
- Development of a proposed new 'road classification' system for GOO endorsement and assistance to OWD with its implementation.

The RNMP evaluates three future horizons i.e. short term scenario (2020), midterm scenario (2025) and long term scenario (2035). The RNMP task was targeted to accomplish a number of specific independent areas that constituted the followings:

- Development of travel demand forecast under 2020, 2025 and 2035 horizon years;
- Ensure efficient transportation operations Statewide under the short term, midterm and longer term horizons to support planned growth of the State and to meet the stated objectives of Road Sector Policy;
- Achieve the targets set in the 'Road Development Plan Vision: 2021', published by IRC in 2001, including the development of the future network to meet the State's overall development vision with an enhanced road network through re-classification;
- Augment capacities for meeting future demand including establishing major strategic road corridors across the State to ensure efficient freight movements;
- Identify the need of road connectivity for varying levels ensuring efficient movement along corridors as well as to enhance connectivity among different levels including improving rural and backward area accessibility;
- Develop recommendations that identify future road improvement needs to ensure mobility and accessibility, while providing enhanced road safety for all road users; and
- Develop a road improvement priority list for implementation of such improvements in coming twenty years until 2035.

In addition to achieving the set targets, an exhaustive effort was undertaken to develop a robust GIS based road network incorporating locations of all categories of the roads, primarily emphasized on State's main road network. In addition, approximately 52,000 villages have been identified in the State with their existing connectivity status in reference to the main road network.

The 'Secondary Objectives' of the RNMP task was to provide specific input to other on-going tasks to ensure effective incorporation of the RNMP recommendations over the short term, midterm and long term scenarios. The Secondary Objectives are listed below:

- Input to 'Road Sector Funding' task to establish twenty years capital budgeting for road improvement implementation based on the RNMP recommendations;
- Input to 'Institutional Development' of 'Organizational Development' task for identifying the best way of integrating RNMP processes, methods and recommendations to enhance project planning and Front End Engineering processes; and
- Input to 'Road Sector Policy' task for identifying the ways to integrate RNMP recommendations in line with the road sector development policies of the State.

The targets under the primary objective were basically two-fold:

- The first target was to develop a robust transportation demand model that captures the major road corridors of the entire main road network, which accommodates the significant portion (or most) of the traffic demand across the State; and
- The second one was to develop a comprehensive road network that caters to efficient interstate and intrastate road connectivity mobility, including achieving the targets set in Vision 2021.

Traffic need based network improvement strategies were developed in various stages to reflect various traffic operation issues under existing and future traffic conditions. Recommendations on mitigation measures enhancing capacities through varying road improvement options were developed as required. The various options included 'no road improvement' ("Do Nothing"), as the base scenario followed by staged implementation of identified road network improvements. This report also identifies the tasks that need to be continued for successful implementation of the recommended network improvement strategies in achieving the long term transportation objective for the State of Odisha.

This RNMP assignment has been completed through three distinct phases i.e. Phase-I, Phase-II and Phase-III. Phase-I was primarily focused on data collection, data processing and data analysis; Phase-II was steered more towards developing the road improvement options based on varying parameters, and a road classification system based on future road functionality/connectivity; and Phase-III was more prone towards identifying areas and material RNMP recommendations tying into other RSID tasks for proper future implementations and achieving long term objectives.

Phase-I emphasis was on developing a 'Problem and Opportunity' statement, confirming the study approach and methodology, developing a detailed 'Work Breakdown Structure' and establishing milestones and project delivery schedule. The other area of consideration was to identify enhanced connectivity needs to all the existing disconnected/improperly connected villages, tribal or backward areas including establishing new/enhanced connections among important interstate and intrastate locations.

A robust GIS based road network was developed utilizing a detailed GIS map supplied by the Odisha Space Application Centre (ORSAC) in phases. The robust GIS Network was developed specially for master planning task utilizing the main road network developed by the Asset Management Consultant (AMC) of OWD, and the ORSAC map data. The development of the robust network was done utilizing systematic steps and involved a herculean effort. The developed GIS Network was used to develop a Strategic Transportation Modelling Network, to complete necessary traffic analyses, and development of a base case traffic operation assessment under existing, short term, midterm and long term traffic scenarios.

The Strategic Transportation Model captured the existing travel pattern in the State on existing roads classified as National Highway (NH), State Highway (SH), Major District Road (MDR), Other District Road (ODR) and a limited portion of Village Road (VR). This 'Strategic Model', henceforth termed as the Odisha Strategic Transportation Model (OSTM) in this report was developed based on total 326 'Traffic analysis Zones' (TAZs). The State of Odisha was represented by 314 Internal TAZs, whereas twelve (12) External TAZs represented the neighbouring States and covering the entire Country. The length of road network covered under OSTM was approximately 20,000 (+) Km.

Transportation modelling analyses were undertaken to capture various Odisha bound trip assignments and also to establish a virtual travel desire pattern of all internal, external and travel through the State. The OSTM was calibrated and validated with respect to the existing traffic flows, recorded at various traffic survey points under the RNMP task, and count data made available from the 'Asset Management Consultancy'. The calibrated OSTM was utilized to develop future traffic scenarios under short term, medium term and long term horizons. The base case scenario assumed "Do Nothing" development alternative, i.e. all the road attributes considered under the model development and calibration (i.e. the existing road network) will remain the same.

The study findings from Phase-I covered two target areas, which were planned to be achieved through the RNMP task. The primary target area was 'Performance Measure Evaluation' of the road network covered under OSTM; and the other target area was to identify missing connectivity between the nearest existing road network and the existing villages across the State. An extensive data collection effort was undertaken, which involved primary surveys and data collection from available secondary sources. The data collection included collection of the GIS Maps from ORSAC in different phases, traffic surveys, road conditions surveys, and various initiatives to collect background development data. Secondary data sources included various output from AMC, and various departments of the Goo. The findings from traffic analysis and analysis based on the robust GIS Maps are summarized below:

Performance Measure Evaluation: Traffic assignments were estimated based on the OSTM run, and available vehicular capacities on various links included in the OSTM were also estimated based on IRC Standards. The following points summarize the traffic operation issues:

- Under existing traffic conditions approximately a total of 2,941Km road length has been operating under capacity constrained conditions (V/C>0.5) and the Levels of Service (LOS) for the constrained corridors vary from LOS 'C' (i.e. 0.5<V/C<0.7) or worse;
- With 'Do Nothing" alternative two scenarios were evaluated, which considers 'Vehicular Growth' only and 'Vehicular Growth plus Planned Developments'. The performance measures under the two scenarios are summarized below:

i. With Vehicular Growth only: approximately 6,094 Km road length will become capacity constrained under 2020 traffic conditions, whereas under 2025 and 2035 traffic conditions a total length of 8,608 Km and 12,346 Km will become capacity constrained; and
ii. With Vehicular plus Planned development: approximately 6,687 Km road length will become capacity constrained under 2020 traffic conditions, whereas under 2025 and 2035 traffic conditions a total length of 9,190 Km and 12,978 Km will become capacity constrained

- The results clearly reflected that under the future traffic conditions the capacity deficient road network will affect a significant portion of the State mobility. This is worth noting that approximately a total length of 1,216 Km of VR will also become capacity constrained under 2035 traffic conditions under the "Do Nothing" scenario.

Missing Connectivity: The ORSAC map was rigorously improved based on varying data sources[1] to capture locations of the existing Block Head Quarters (BHQ), Gram Panchayat Head Quarter (GPHQ), Village Boundaries, Villages containing Tribal populations and Villages in Backward Areas. This robust GIS map was utilized in identifying lack of connectivity for villages, tribal and backward areas from the neighbouring existing road network.

- Based on the ORSAC data sources, under existing conditions, a total of 1,965 villages are missing any connectivity with the neighbouring road network, 986 villages are connected by walking tracks, and 11,202 villages are afforded connections by unpaved/kutcha road only.

Phase-II of this study completed updating the OSTM integrating the future planned developments across the State followed by developing mitigation alternatives to address the forthcoming traffic operation issues. The future planned developments primarily included 'Industrial', 'Power Sectors', 'New Ports', 'Port Expansion' etc. All these development data were collected during Phase-I of the study. All these planned development data were integrated in the OSTM based on their respective potential year of occurrence. Traffic operation issues of all these developments were identified with respect to the planned future horizons.

Mitigation measures, in terms of network development, were developed based on the horizon years under the short term, medium term and long term scenarios. Planned road improvements by NHAI identifies approximately 1,243 Km of NH will be implemented by 2018 and further 478 Km by 2023. The OSTM road network was first updated incorporating all these improvements planned and implemented for NHs. Even with all these NH improvements, a significant length of OSTM road network will still remain as capacity constrained under the traffic scenario of 2020 horizon, which will require further capacity augmentation.

Further mitigation alternatives were developed considering two distinct steps. The first step was to achieve the targets set in the Vision 2021; and the other was capacity augmentation of the capacity constrained corridors. In addition to the above further strategic road corridors across the State were identified to facilitate efficient freight movements. These corridors included already planned Ranchi-Vijaywada road corridor and two more corridors based on the intrastate travel desires identified through OSTM. These two corridors were Keonjhar to Kirtania Port and Dhamra Port road corridor, which will facilitate efficient freight movement from the existing mining/industrial areas to the

[1] i) Google Earth and Google Map; ii) Election Commission Data; iii) Asset Management Study.

Kirtania and Dhamra Ports, located at the northeast coast of the State, and Bhubaneswar-Koraput road corridor, which will facilitate vehicular travel from Bhubaneswar to Koraput and Malkangiri, avoiding the capacity constrained NH-5 corridor.

The OSTM was updated incorporating all the planned background land-use developments that are scheduled to occur by 2020, as per the State Plan. The strategic road network improvements that were considered based on achieving the Vision 2021 targets, were then incorporated in the OSTM at the first step. The estimated performance measures of the OSTM road network under the 2020 horizon reflected that with the recommended strategic improvements implemented and all the planned developments instituted a total length 1,711 Km of the OSTM road network will still remain congested and will require further capacity augmentation.

Traffic analysis was continued towards further capacity augmentation through incorporation of necessary road improvements in the OSTM. The traffic findings with the proposed staged mitigations are summarized as follows:

- Short Term Scenario (Horizon Year 2020)
  i. Strategic Road Improvement: Approximately 5,063 Km of SH, 1,204 Km of NH, 1,090 Km of MDR, and 218 Km of ODR should be widened under 2020 traffic conditions to adhere to the Vision 2021. Three new bridges were also proposed to be included under Strategic Improvements for including the missing links; one of which is along the proposed Ranchi-Vijaywada corridor and the other two were to facilitate crossing of Mahanadi River in Khurda District. Notwithstanding implementation of the strategic improvements, a total length of 1,711 Km will still continue to remain as capacity constrained under 2020; and
  ii. With all these recommended improvements, further 1,711 km of OSTM road network will require capacity augmentation. Capacity augmentation under 2020 horizon included corridor widening of 1,185 Km and installation of bypass links around 13 major towns and cities.
- Medium Term Scenario (Horizon Year 2025): With further institution of planned improvements and continuous vehicular growth, 2,110 Km of the OSTM road network will further become capacity constrained, which will require capacity augmentation through corridor widening; and
- Long Term Scenario (Horizon Year 2035): OSTM incorporates further planned developments in the State including continuous vehicular growth, and under the long term horizon 3,787 Km of road length will further become capacity constrained, which will require further capacity augmentation.

Simultaneous to capacity augmentation of the network to relieve congestion, a detailed road reclassification study was undertaken while considering implementing the Strategic Road Improvement plans. The road classification study approach was primarily guided by the Vision 2021 policies. Based on the policies a considerable length of MDR, ODR and VR will be upgraded. Based on the targeted connectivity with the GPHQ, approximately 19,487 Km of VR will be required to be upgraded to ODR, whereas approximately 96 Km and 436 Km will be upgraded from VR to higher categories i.e. SH and MDR, respectively. 599 km of ODR will require upgradation to MDR, and approximately 395 Km of ODR will be upgraded to SH. MDR of an approximate length of 1,238 km will require to be upgraded to SH. It is worth noting that reclassification of any minor road class to

SH augments capacity due to the change of the existing cross-section to a DLPS section, and these upgraded sections of SH were included in the OSTM.

A detailed macro level economic analysis was undertaken using HDM4 to evaluate Net Present Value (NPV) and Economic Internal Rate of Return (EIRR). The NPV and EIRR values were very promising for most of the road sections; however the values were less than the cut-off criteria (i.e. 12%) for some of the road sections. The primary reasons for this could be low volume of traffic and consequent less benefit estimated for such links. Further, this might be worth noting that economic analysis should not be the only way to decision making, as this procedure does not account for various other parameters that are important to identify the need of developments. This report, therefore, included a multi-criteria account evaluation (MAE) process to establish a year-wise priority list identifying the priority of required road improvement implementations. The recommended road improvements are included in this Completion Report of Inaugural Master Plan for immediate reference. A tentative[2] funding/ capital budget requirement was also developed for implementation of the identified road improvements during the next two decades until 2035.

Phase-III focused on identifying areas in the Road Policy, Institutional Development/Restructuring, and Road Fund tasks, where an effective integration of the RNMP processes and recommendations should facilitate rational and cost effective implementation of future developments and road network improvements in the State of Odisha.

Road Policy must put emphasis on integration of OSTM in the proper planning process to enhance individual future detail project preparation and development of DPR. Proper utilization of OSTM will facilitate development of sub-area modelling, which could be best utilized in identification of any local hotspots within the project area. The subarea models should be utilized to estimate traffic assignments on all project area roads up to the level of VR, and any traffic flow related mitigation measures shall be developed, if necessary. Road Policy should mandate development of a concept design study, which should be introduced at the interim stage utilizing the RNMP findings, prior to preparation of DPR, where design issues e.g. road cross-sections, lane configurations, at grade junctions and surface area drainage including identifying utility corridors etc. must be addressed.

Institutional Development/Restructuring must consider developing an independent 'Road Planning and Design' division while recommending restructuring the OWD/GOO organization structure. The primary task of this 'Planning and Design' division shall be development of the interim Concept Design package, prior to moving towards preparation of DPR. This division shall be manned by Senior Transportation Planners, Senior Traffic Modellers and Senior Roadway Design Engineers consisting of Highway Design Engineers, Storm Water Management Specialists, Municipal Service Specialists, Electrical and Mechanical Engineers to facilitate development of an effective Concept Design (CD) of the potential development schemes, which should be carried forward to preparation of Preliminary Design, Detail Design and the DPR package. Immediate integration of such Planning and Design Department in the existing/proposed OWD/GOO organization shall result in development of value added cost effective development schemes and must save significant throw-away cost due to upfront planning of underground utilities.

[2] The cost estimate prepared for individual road improvement is very high level and could vary considerably during preparation of Detail Project Report (DPR). The cost estimates do not consider any land acquisition or any incidental costs, and do not include project preparation and construction supervision costs.

Estimated capital cost for implementation of the recommended road improvements is estimated to be around INR 24,000 crore, INR 4,000 crore, and INR 10,000 crore for State Roads under short term, medium term and long term horizon respectively. Whereas, these figures for National Highways are INR 8,000 crores, INR 1,800 crores, and INR 6,400 crores for respective three horizons. A study of the prospective budget allocation over future years reveals that there will be a gap between capital cost for road improvements and budget allocation for the short term horizon, whereas for medium term and long term horizons the budget allocation is in surplus of the requirement.

Road Funding should include the capital costs of road improvement, associated with the identified road improvements to be implemented each year starting from 2015 to 2035. The annual road improvement requirements are summarized under the priority list. It would be worth noting that a project preparation cost of approximately 5% of the capital improvement cost should be allocated for the proposed individual road improvement schemes. Another 10% cost should also be allocated towards undertaking construction supervision of all such road schemes. The budgetary allocation should include this additional 15% cost for individual road improvement scheme, and emphasis should be made to allocate the cost of project preparation/front end engineering design study in the previous year to the year of anticipated project implementation.

1 Introduction

The GOO has been working to accomplish an Institutional Strengthening Action Plan (ISAP) for the period 2008–2018 to initiate restructuring and strengthening of State's Road Sector Division including necessary 'Institutional Developments'. The project envisages developing the State's 'Road Network Master Plan' (RNMP) to support the ISAP process. The Road Network Master Plan will identify potential road improvements in the State to augment capacity for better accommodation of future traffic demand and also to provide enhanced road network connectivity to disconnected hamlets as well as tribal and backward areas. The RNMP study is also expected to ensure better freight transportation connecting the potential high trip generators to the existing and potential future intermodal facilities, and to support better interstate road connectivity. The historical statistics reveal that Odisha grew at a rate faster than the national average rate of growth, which results in significant growth in motor vehicles and increase in transportation demand of goods, personnel and services through its road network; however necessary infrastructure update could not follow causing higher congestion on many road links, resulting in reduced road safety outcome.

It has well been recognized within the GOO that the road network infrastructure should be developed to meet the future transportation challenges and to support the intended social and economic growth in Odisha. The GOO has identified that the **lack of a Road Network Master Plan** will seriously impede accomplishing the development goals of the State, and therefore, emphasized the same under the current RSID Project.

This 'Complete Report of Inaugural Master Plan of Odisha's main road network captures and highlights major transportation related issues/hotspots with respect to traffic operations under existing and future road conditions and identifies the lack of road network connectivity. The 'Interim Report on Preparation of Inaugural Master Plan' highlighted the basic problem and opportunity statement including necessary tasks to be undertaken for successful completion of the preparation of the RNMP task under the RSID project. The planned tasks were undertaken in a chronological order, which resulted into identifying issues, followed by recommended mitigation measure development. The mitigation measures primarily focused on the capacity augmentation of the existing links and potential future corridors likely to be constrained. The available planning data/ land-use and the planned future developments in the State were considered and analyzed. Strategic road improvements, mostly adhering to Road Development Plan, Vision 2021 were considered for capacity augmentation including enhancing road connectivity to the ports, industrial hubs, tourist places and neighbouring States. Internal road connectivity to existing villages, backward and tribal areas including hamlets was closely reviewed and their respective connectivity status including missing connectivity was identified. The improvement options have been evaluated through a 'Multi-Criteria Approach' incorporating different parameters, e.g. economic rate of return (EIRR), socio-economic criteria, and transportation and network function. A priority list identifying necessary road improvement have been developed based on the Multi-Criteria Approach, which summarizes the priority list of road improvement projects, tentative respective cost of such road improvement including the respective year of implementation under the next 20 years horizon.

1.1 Project Background

During the mid to late 1990s, GOO had initiated the Odisha State Roads Project (OSRP), funded by the World Bank (WB), to upgrade the major road network in Odisha. This project was intended to enhance both the major road transport infrastructure as well as the institutional capacity of the Odisha Works Department (OWD) which has primary responsibility for the State's main road network.

A third party consulting team was originally commissioned to review the prevalent institutional and financial structures and processes associated with the OWD and to develop an Institutional Development Strategy (IDS) which would be focused on the OWD operations and its linkages with other road sector agencies. The ISAP recommendations were built largely on the ideas of the IDS. Based on the recommendations of ISAP, the OWD called for consultancy services for Odisha Road Sector Institutional Development (RSID) Study that includes the undertaking of developing a '**Road Network Master Plan**' in addition to other various tasks.

1.2 Project Goals

Project goals were clearly defined by the OWD in the TOR. The targeted goals were:

- Development of comprehensive master plan for Odisha road network with multi-year plans; and
- Development of comprehensive annual plans for roads improvement and road management capitalizing on the GIS-based main road network information system and a targeted database being established via a separate Asset Management System (AMS) consultancy.

The targeted goals were accomplished through completion of the following tasks:

i. Preparation of an Inaugural Master Plan (consistent with the new Road Sector Policy) that identifies current road network status including existing and emerging transportation modes; development of future transport demand forecast; and a road condition inventory of the main road network;
ii. Future roads investment and funding outlook in Odisha to expedite State's plans and priorities for socio-economic development including multi-year plans and annual plans for roads development and management in place;
iii. Development of a proposed new 'road classification' system; and a 'responsibility framework' for GOO endorsement and assistance to OWD with its implementation.

2 Socio Economics

Geographically Odisha is situated in the east coast of the Country. The State is bordered by West Bengal and Jharkhand to the North, Jharkhand and Chhattisgarh to the West and Andhra Pradesh to the South. The State possesses more than 480 km long coastline that facilitates a significant maritime transportation opportunity in addition to some other significant activities. There are 30 districts in the State of Odisha, which is further divided into 58 sub-divisions, 316 tehsils, 314 blocks, 6,234 Gram Panchayats and 51,349 villages including 47,529 inhabited and 3,820 uninhabited villages.

2.1 Existing Demographics

Odisha is the 9th largest State with an area of 155,707 km^2, and 11th largest in terms of population with 41.94 million people, which represents approximately 3.47% of India's population, based on the provisional estimates of 2011 census. It has a population density of 269 persons per km^2 in 2011. It contributes about 2% of the national income. Its decadal population growth rate in 2011 was approximately 13.97%, although there were wider inter-district variations. The district wise decadal growth of population is shown in **Figure 2-1**.

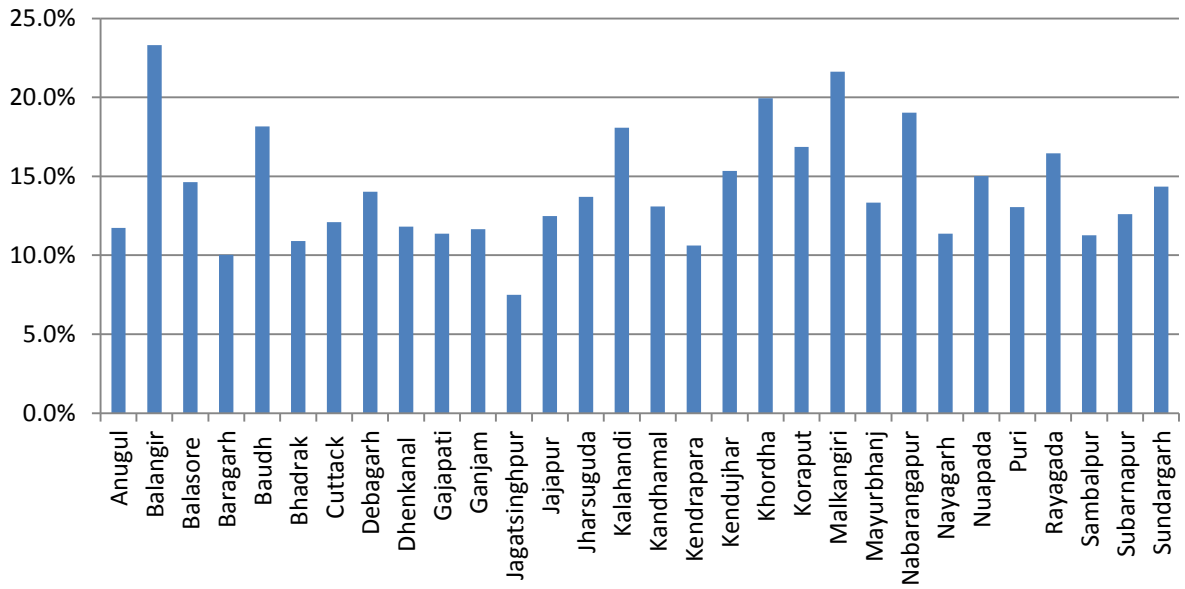


Figure 2-1: District wise Decadal Growth of Population (2001 to 2011)

Source: 2011 Odisha Census Data, Directorate of Census, Odisha.

As per 2011 census, a significant percentage (83%) of people lives in rural area, while the remaining 17% live in urban areas in Odisha. The urban component of population over the course of the last two decades (1991 to 2011) has increased from nearly 13.4% to about 17%. The urban population has increased by about 1.7 times over the same period. The change in living trend from rural and urban population from 1981 to 2011 is illustrated in **Figure 2-2**.

The rural–urban distribution of all 30 districts in Odisha is illustrated in **Figure 2-3**. The Figure reflects that the districts Ganjam, Khurdha, Cuttack and Sundargarh have higher number of people living in urban areas compared to the rest of Odisha.

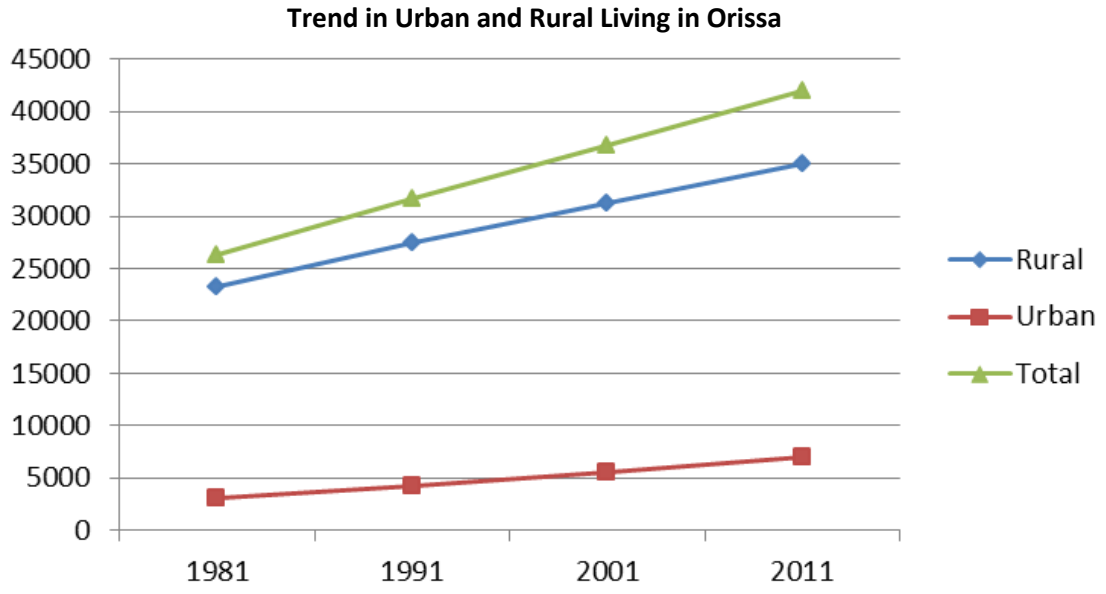


Figure 2-2: Change in Living Trend from 1981 to 2011

(Source: 2011 Odisha Census Data, Directorate of Census, Odisha)

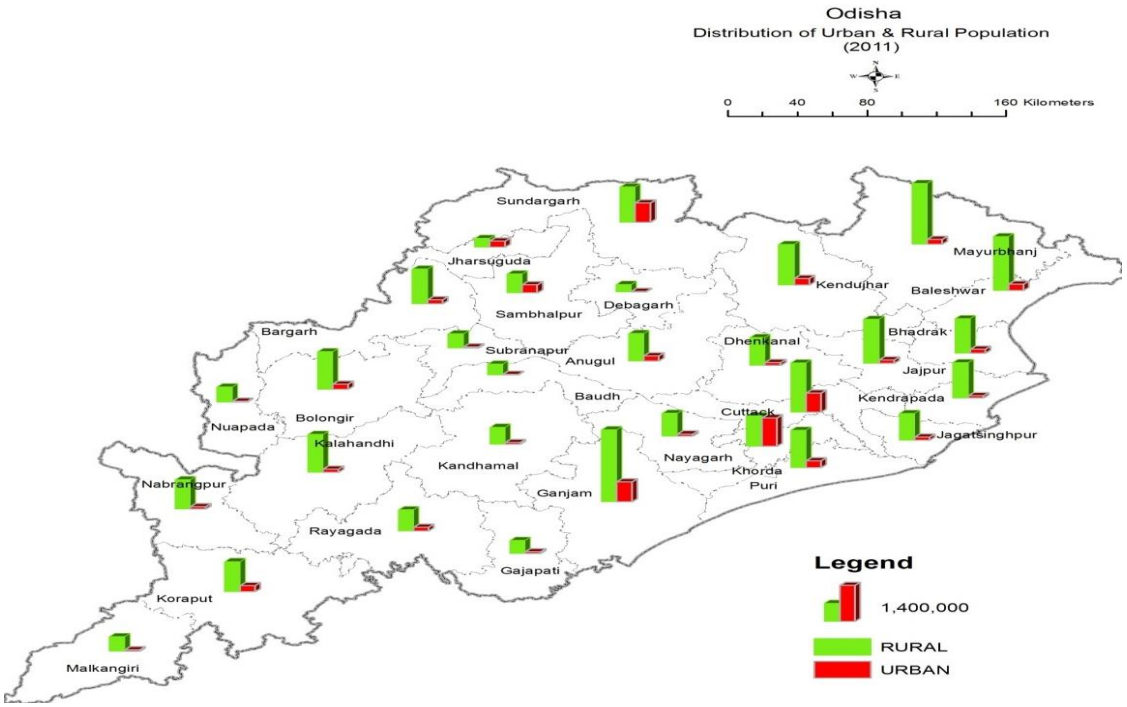


Figure 2-3: District wise Rural and Urban Population of Odisha

Source: 2011 Odisha Census Data, Directorate of Census, Odisha.

The east coast of the State possesses denser population, whereas significantly higher density of population was noticed in the districts of Khurdha, Cuttack, Jajpur, Balasore, Jagatsingpur and Bhadrak. The approximate population densities in these districts are generally greater than 600 persons per km^2. The density of population on all 30 districts is illustrated in **Figure 2-4**.

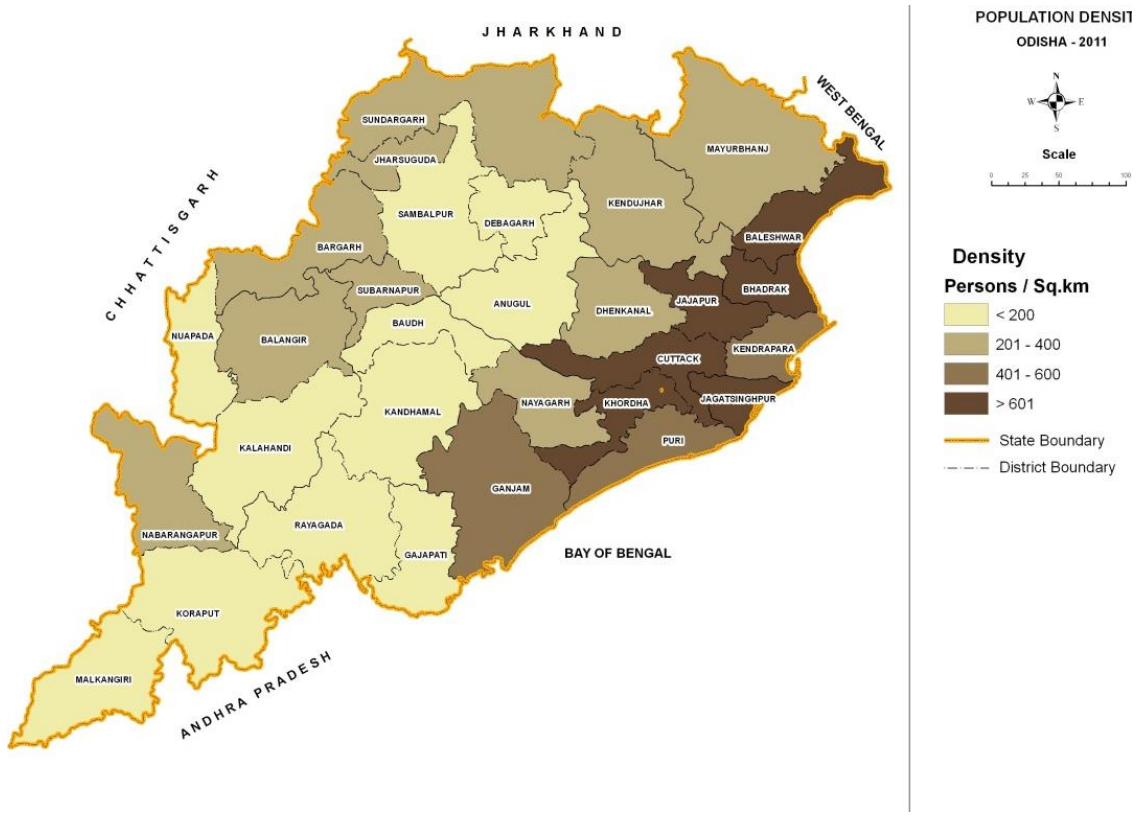


Figure 2-4: District wise Population Density of Odisha

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

2.2 Employment Situation

The following areas are noted to be the predominant employment sectors for the State:

- **Agriculture Sector** – includes agriculture, animal husbandry, fisheries and forestry subsectors
- **Industry Sector** – includes manufacturing, mining, quarrying and electricity-gas-water supply
- **Service Sector** – comprises of banking and insurance, real estate, public administration, trade, hotels and restaurants, construction, transport and communications and other services.

Main workers are those who participated in any economically productive activity for not less than six months during the year preceding the date of enumeration.

Marginal workers are those who participated in any economically productive activity for less than six months during the reference period.

The employment census classifies workers as main and marginal workers. The workers are further classified into cultivators, agricultural labourers, household industry workers and others.

According to 2011 census data, the total numbers of main and marginal workers were approximately 1.1 million and 0.70 million, respectively. The data indicates that, among the above three sectors, the employment has steadily been increasing in services sector and depleting in agriculture sector. However, it could be noted that agriculture sector still directly or indirectly provides employment and sustenance to more than 60 percent of the population. The proportion of main and marginal

workers against the corresponding total population in all districts in Odisha, as per 2011 census, is illustrated in **Figure 2-5.**

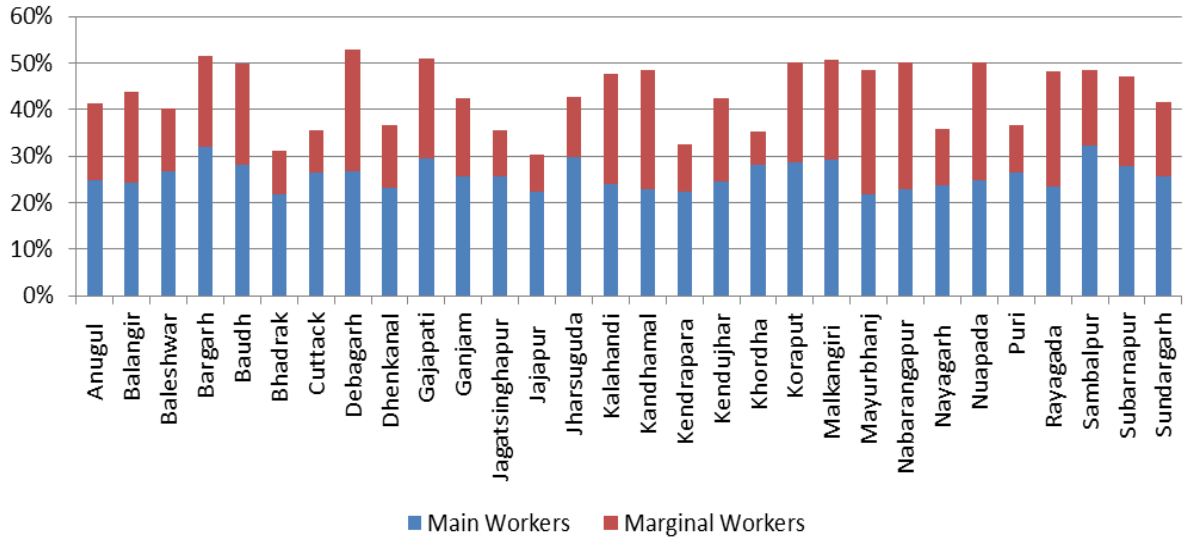


Figure 2-5: Percent Combination of Main and Marginal Workers

Source: 2011 Census Data, Census Department, India.

2.3 Connectivity to Backward and Tribal Areas

The total road length in the State was approximately 2.43 lakh km by the end of 2008-09. A large number of villages are still not connected to growth and service centres by all-weather roads. The State Government is determined to improve the road connectivity in the State. Road construction/improvement works are taken up on a massive scale through different programs, namely: Pradhan Mantri Gram Sadak Yojana (PMGSY), Rural Infrastructure Development Fund (RIDF), Finance Commission grants and other programs funded out of State's own resources. Odisha is also deficient in NHs and rail networks. The State had 2,339 km of railway route, including 54 km narrow gauge railways by the end of 2009-10. The railway route length in the State per thousand sq. km of area comes to 15.00 km. The following **Table 2-1** summarizes the road connectivity status for the entire State.

Table 2-1: Road Connectivity Status

Sl. No.	Indicator	Reference Year	Odisha
1	Length of Road per 1,000 sq. km.	1998-1999 2001-2002 2009-2010	1,447 1,527 1,559
2	Length of Railway per 1,000 sq. km.	2001-2002 2004-2005 2006-2007 2009-2010	14.90 15.02 15.02 15.00
3	Villages Connected by Roads	1996-1997	49.00%
4	Villages Connected by All Weather Roads	2007-2008	40%

Source: Annual Plan, 2011-12, Volume I.

This study has undertaken a detail investigation of identifying missing links to hamlet, tribal and backward areas based on the available GIS Maps obtained from Odisha Space Application Centre

(ORSAC). The study findings include identification of missing links in regards to the existing connectivity to villages, backward and tribal areas. The study analysis identifies possible connectivity of respective areas with the nearing road network.

2.4 Economic Indicators

2.4.1 Gross State Domestic Product

Odisha's economy is expected to have an anticipated growth rate of 9.14 percent as per the advance estimates of Gross State Domestic Product (GSDP) of Odisha for 2012-13. The higher growth of the State's economy is due to the higher estimated growth rates of the agriculture sector and the service sector which are approximately 16.11% and 10.09%, respectively. The growth rates were estimated in real terms at 2004-05 prices during 2012-13, over the previous year. The service sector indicates robust growth rates in its sub sectors like trade, hotel and restaurants (12.41%), transport (12.47%), communications (17.60%), banking & insurance (18.57%) and public administration (15.39%) during 2012-13. Furthermore, the agriculture and animal husbandry sub-sector were expected to achieve a record growth rate of 19.87 percent in 2012-13 with bumper crop production.

Another feature of the growth of GSDP is that the secondary sector has also shown cyclical growth in different years. It ranged from 23.94% to 12.92% from 2004-05 to 2006-07, the highest growth of 23.94% being recorded in 2004-05 over the previous year. The growth of 'tertiary' and 'finance and services' sectors during this period has been fairly consistent being about an average of 11% and 5% respectively. The annual GDDP for the respective districts of Odisha is summarized in **Table 2-2.**

Table 2-2: Gross District Domestic Product (At Current Prices in Rs.)

Sl. No.	District	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
1	Anugul	5,69,079	5,96,806	6,98,218	8,91,688	10,47,335	10,84,907
2	Balasore	3,25,117	3,51,089	4,21,405	5,41,040	6,14,129	6,95,226
3	Bargarh	2,04,507	2,21,628	2,59,766	3,29,248	3,79,129	4,22,673
4	Bhadrak	1,85,546	2,01,733	2,34,149	2,91,865	3,32,391	3,85,289
5	Balangir	2,43,039	2,64,819	3,15,162	4,06,888	4,50,690	5,24,043
6	Boudh	64,251	73,240	86,323	1,11,253	1,19,699	1,37,051
7	Cuttack	5,75,675	6,03,083	7,11,692	8,63,641	9,83,716	11,17,467
8	Deogarh	47,760	53,759	62,884	75,325	85,103	97,600
9	Dhenkanal	2,00,510	2,21,598	2,62,087	3,33,644	3,64,989	4,15,220
10	Gajapati	93,448	99,104	1,17,004	1,44,963	1,64,687	1,87,134
11	Ganjam	5,50,109	6,00,536	7,19,621	8,77,897	10,09,072	11,60,029
12	Jagatsinghpur	2,48,082	2,65,235	3,27,959	4,12,528	4,78,627	5,04,483
13	Jajpur	3,35,018	3,83,633	4,60,859	5,96,066	6,84,345	6,50,911
14	Jharsuguda	2,18,995	2,41,745	2,75,883	3,45,532	4,22,647	4,70,417
15	Kalahandi	2,05,229	2,29,848	2,58,048	3,41,363	3,91,421	4,44,542
16	Kandhamal	1,75,579	1,89,798	2,30,750	2,95,701	3,34,284	4,26,581
17	Kendrapara	1,77,602	1,92,118	2,15,619	2,65,518	2,95,931	3,36,249
18	Kendujhar	4,83,935	5,76,193	7,04,804	10,41,317	12,42,469	12,15,010
19	Khordha	5,46,715	6,13,301	7,40,727	8,76,611	10,11,251	11,26,746

Sl. No.	District	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
20	Koraput	2,48,925	2,73,462	3,44,715	4,12,132	4,61,801	5,28,526
21	Malkangiri	80,860	82,525	99,730	1,25,793	1,31,160	1,48,299
22	Mayurbhanj	3,37,809	3,63,253	4,27,941	5,47,957	6,11,711	6,75,335
23	Nabarangpur	1,34,789	1,42,710	1,71,377	2,02,421	2,27,714	2,61,475
24	Nayagarh	1,14,244	1,24,952	1,46,985	1,75,823	1,90,672	2,19,641
25	Nuapada	82,921	89,903	1,07,621	1,40,246	1,50,659	1,71,731
26	Puri	2,40,366	2,64,139	2,79,139	3,36,365	3,76,198	4,37,836
27	Rayagada	1,54,734	1,72,290	2,11,960	2,68,957	2,98,402	3,35,915
28	Sambalpur	2,50,728	2,81,631	3,32,973	4,16,263	4,84,217	5,21,420
29	Subarnapur	75,891	84,322	1,00,944	1,27,386	1,39,844	1,72,879
30	Sundargarh	6,01,481	6,51,194	8,57,603	11,32,011	13,64,780	14,20,007
	Odisha	**77,72,944**	**85,09,647**	**1,01,83,948**	**1,29,27,442**	**1,48,49,073**	**1,62,94,642**

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

2.4.2 Net State Domestic Product & Per Capita Income

The state contribution to the national income at current prices in 1995-96 was approximately 2.8%. The per capita income in the State at current prices was increased from INR 4896.00 in 1993-1994 to INR 9281 in 2000-2001 and further to INR 10,208 in 2002-2003.

The per capita real Net State Domestic product (NSDP) of Odisha was estimated to be INR 25,584 in the advance estimates of Odisha for 2012-2013 with a noticeable growth rate of 6.01% over 2011-2012. By the end of the 11th Plan in 2011-12, the per capita income of the State was INR 24,134 as compared to INR 20,194 in 2006-07, at the beginning of the 11th Plan, thus registering a growth of 19.51% in five years. The standard of living in the State has risen over the years, although, it is still below with respect to the national average since 1950-1951, while Odisha's real per capita income was about 90 percent of the national average. The real per capita NSDP of Odisha in 2010-2011 (provisional estimates) at 2004-2005 prices was INR 23,875, which was higher than that of Bihar, Uttar Pradesh, Assam, Madhya Pradesh, Jharkhand and Manipur. The per capita NSDP of Odisha for past 8 years is shown in **Table 2-3.**

Table 2-3: Per Capita NSDP

Year	@ current prices in Rs.	@ constant prices in Rs.
2004-2005	17,650	17,650
2005-2006	18,846	18,194
2006-2007	22,237	20,194
2007-2008	27,735	21,640
2008-2009	31,416	22,963
2009-2010 (P)	34,361	24,275
2010-2011(Q)	40,412	25,708
2011-2012 (P)	46,150	26,900

Q-Quick Estimate; P-Provincial Estimate

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

The district-wise per capita Net District Domestic Product (NDDP) is summarized in **Table 2-4**.

Table 2-4: District-wise Per Capita NDDP

Sl. No.	District	At Current Prices in Rs.					
		2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
1	Anugul	4,46,350	4,48,021	5,25,946	6,59,879	7,83,547	7,23,330
2	Balasore	2,83,124	2,99,407	3,58,836	4,58,407	5,19,912	5,66,044
3	Bargarh	1,81,903	1,94,331	2,27,914	2,88,647	3,32,109	3,60,631
4	Bhadrak	1,67,872	1,83,137	2,12,192	2,65,620	3,02,625	3,50,044
5	Balangir	2,20,378	2,41,047	2,86,458	3,72,184	4,11,106	4,77,556
6	Boudh	59,643	68,121	80,198	1,04,207	1,11,462	1,27,348
7	Cuttack	5,13,335	5,37,538	6,31,780	7,64,416	8,73,141	9,79,552
8	Deogarh	43,898	49,498	57,902	69,750	78,811	90,672
9	Dhenkanal	1,79,645	1,97,516	2,32,814	2,97,045	3,24,949	3,67,244
10	Gajapati	86,831	92,147	1,08,716	1,35,383	1,53,584	1,74,671
11	Ganjam	5,01,033	5,47,684	6,55,984	8,02,594	9,22,694	10,63,765
12	Jagatsinghpur	2,09,035	2,17,548	2,68,560	3,32,087	3,85,918	3,72,410
13	Jajpur	2,88,344	3,24,540	3,90,886	5,00,889	5,76,030	5,29,635
14	Jharsuguda	1,83,708	1,98,371	2,27,853	2,83,270	3,46,862	3,64,868
15	Kalahandi	1,86,241	2,08,193	2,33,761	3,11,327	3,56,873	4,03,786
16	Kandhamal	1,64,293	1,77,711	2,16,151	2,78,634	3,13,148	3,99,578
17	Kendrapara	1,62,079	1,75,901	1,97,176	2,44,173	2,72,408	3,11,058
18	Kendujhar	4,11,949	4,81,720	5,87,669	8,67,604	10,27,378	9,53,502
19	Khordha	4,72,595	5,27,327	6,39,496	7,49,536	8,71,262	9,52,477
20	Koraput	2,23,391	2,43,841	3,03,805	3,62,324	4,05,635	4,57,492
21	Malkangiri	74,454	76,207	91,768	1,16,530	1,21,069	1,36,843
22	Mayurbhanj	3,07,231	3,30,107	3,88,824	5,01,156	5,58,205	6,13,701
23	Nabarangpur	1,24,219	1,30,001	1,57,020	1,85,794	2,08,285	2,37,566
24	Nayagarh	1,04,937	1,14,867	1,35,056	1,62,245	1,75,728	2,02,614
25	Nuapada	76,567	82,241	98,795	1,29,408	1,38,301	1,56,642
26	Puri	2,17,806	2,39,926	2,53,029	3,05,980	3,42,794	4,00,872
27	Rayagada	1,40,657	1,52,657	1,87,596	2,38,004	2,62,881	2,89,558
28	Sambalpur	2,18,114	2,40,113	2,85,120	3,54,391	4,13,505	4,28,865
29	Subarnapur	69,946	78,125	93,308	1,18,724	1,29,703	1,60,233
30	Sundargarh	4,79,123	4,97,114	6,57,512	8,50,716	10,31,694	9,31,123
	Odisha	**67,98,702**	**73,54,957**	**87,92,125**	**1,11,10,924**	**1,27,51,619**	**1,35,83,680**

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

The growth profile represented in per capita NDDP, GSDP and NSDP is shown in the **Figure 2-6.**

The trend of Odisha's economy clearly reflects that the State economy has been becoming less agricultural, more industrial and more service-oriented over time. In 2011-2012, agriculture represented only 16.44% of Odisha's GSDP. The service sector and the industry sector represented 57.78% and 25.78%, respectively. During the year 2012-13, the share of the service sector was expected to be 58.28% and that of the industry sector and the agriculture sector to be 24.23% and

17.49% in real terms at 2004-2005 prices. **Figure 2-7** illustrates the dynamics of the composition of Odisha's economy from the year 2004-2005 to 2012-2013.

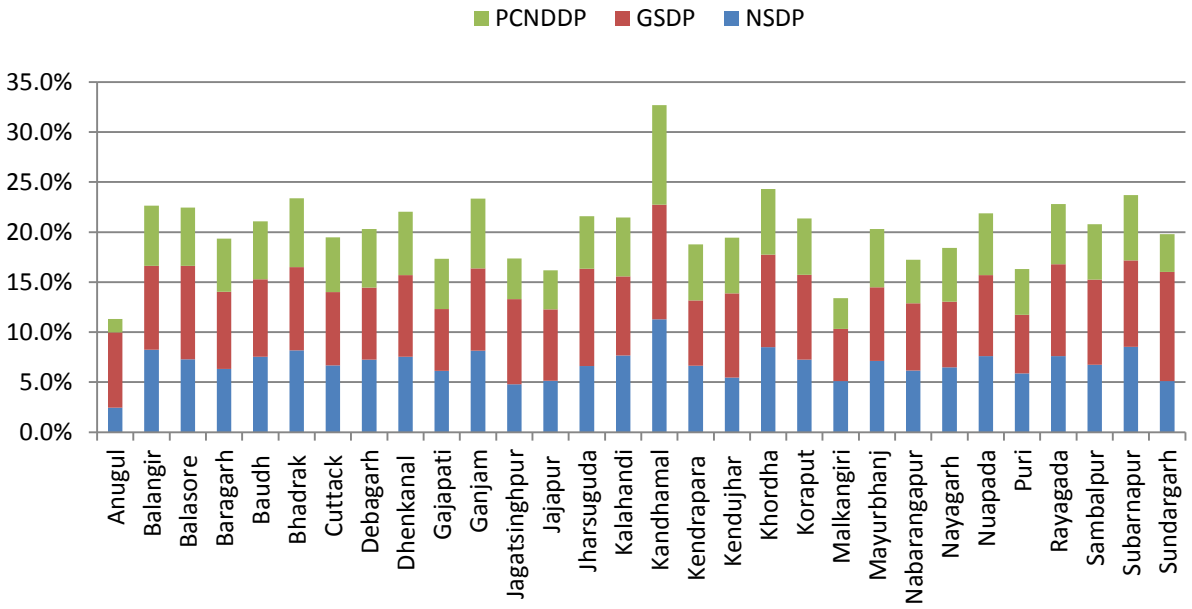


Figure 2-6: District-wise Growth of Economic Indicators

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO

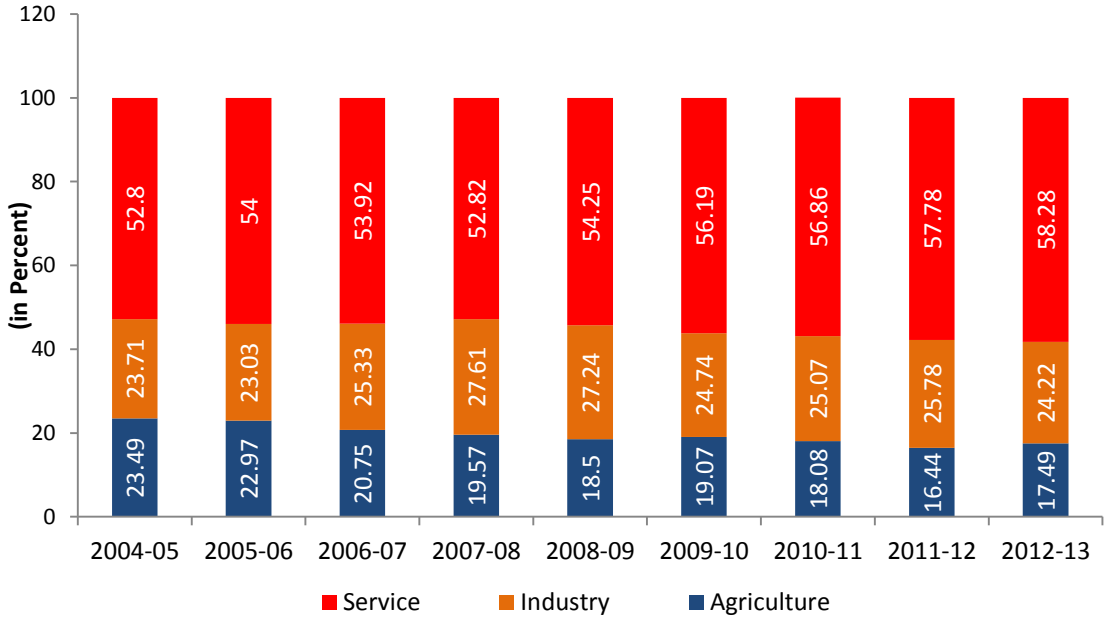


Figure 2-7: Sectorial Composition of Odisha's Economy

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO

2.5 Industries and Mines

Industries in Odisha are classified into five categories on the basis of investment - heavy industries, large scale industries, small and medium scale industries, handicraft and cottage industries and khadi and village industries. The industry sector contributes approximately 25% share to the Odisha's GSDP in real terms. Large scale industries generally include producers of iron and steel,

cement, aluminum, ferromanganese, fertilizers, chemicals, aeronautical, heavy water, textiles, refractory, ceramic glass and paper. Most large-scale industries in Odisha are mineral-based. Maps showing the locations of industries and mines within Odisha, and district wise comparison of number of industries are given in **Appendix 2.1**.

Steel industry in Odisha could be called the backbone of industry structure in the State. Until recently, Odisha has had about 10% of the entire Country's steel production capacity, while total iron ore reserve is approximately 25% of that of the entire Country. The Rourkela Steel Plant has been the largest of all steel plants operating in the State. There are new large-scale-level potential entrants into steel such as Vedanta, Jindal, Posco, Tata and Essar. By the end of 2010-11, the State Government had signed 89 'Memoranda of Understanding' (MoU) on various industry sub sectors with a total investment of approximately INR 4, 61,182 crores. Out of these, 33 projects have gone into partial production and have generated approximately 80,561 jobs. Forty-six other projects including 20 steel, two cement, two aluminum, one Titanium and one oil refinery of Indian Oil Corporation (IOC), have been under progress.

Odisha's aluminum production capacity and actual production, with recent commencement of production by Vedanta Aluminum Limited (VAL) and National Aluminum Corporation (NALCO), ranks as the topmost aluminum producing State in India. The total aluminum production in Odisha during January 2010 was approximately 48% with respect to that of the national production.

Small and medium scaled enterprises grouped together are called 'Micro, Small and Medium Enterprises' (MSME). The Directorate of Industries, Odisha is the nodal agency for promoting MSME and plays a vital role in identifying entrepreneurs and assisting them in setting up Industry units. It is encouraging to note that the number of small scale industry (SSI)/MSME units, and total investments therein, have been increasing over the years. Sundargarh District reported maximum number of industries followed by Cuttack, Khordha and Ganjam during 2010-2011.

With vast mineral resources and abundant raw materials, the State has immense potential for industrialization. The industrialization process till the Ninth Plan was quite slow. As per a survey conducted in 1990-91, Odisha had a share of only 3.19% of the total investment, 1.33% of total number of factories, 1.85% of factory workers and 2.24% of value addition in the manufacturing sector of the country. Per capita investment in industry stood at INR 1,961 as compared to national average of INR 2,303. The industrialization process has, however, picked up in the State during the Tenth Plan and thereafter, after the launching of the Industrial Policy Resolution, 2001 and 2007.

According to Indian Bureau of Mines, Odisha's deposits in respect of chromite, nickel, bauxite, and iron ore are 95%, 92%, 55% and 33%, respectively of the total deposits of the country. Other mineral deposits include limestone, china clay, quartz, precious and semi-precious stones, copper and vanadium. The details of total known reserves of different important minerals of the State and their rate of exploitation are given in **Table 2-5**. The State has recently taken several steps to increase utilization of its mineral resources.

Table 2-5: Mineral Reserves and Rate of Utilization in Odisha

Sl. No.	Ore/mineral	Total reserve in 2009-10 (million tons)	Utilization During 2009-10 (million tons)	Utilization rate % to total reserves
1	Iron ore	5,074	79.68	1.37
2	Chromite	170	3.41	2.00
3	Coal	65,121	105.49	0.16
4	Bauxite	1,806	4.88	0.27
5	Lime stone	1,004	2.71	0.27
6	Dolomite	330	1.32	0.40
7	Fire clay	175	0.06	0.04
8	Quartz	70	0.14	0.20
9	Mineral sands	226	0.25	0.11
10	Graphite	4.4	0.02	1.58
11	Manganese ores	119	0.60	0.51

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

Odisha is rich in minerals and their utilization level has been increasing over the years. The rate of utilization of minerals/ores in the State has been less than 1% in all cases till 2009-2010 except for chromite and iron ore. While iron ore production has increased during 2009-2010 by 3.21%, chromite production has increased by 22.22%. The **Figure 2-8** illustrates the chronological growth of the value of mineral production in the State.

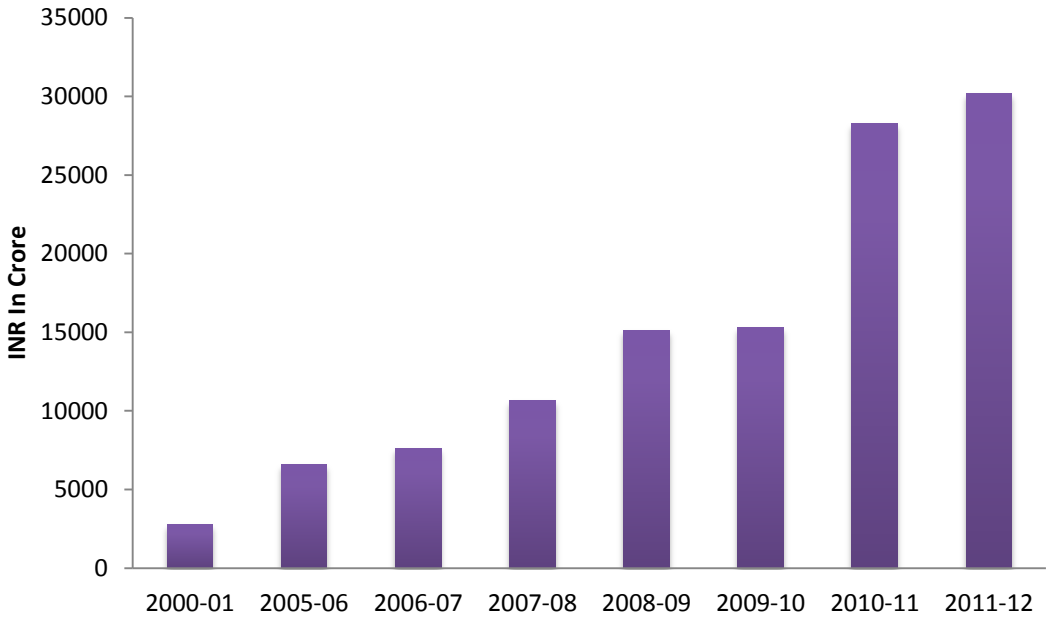


Figure 2-8: Value of Mineral Production

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

2.6 Tourism

Odisha is very well recognized as one of the prime tourist destination of the Country. Odisha's major attraction is its 500 km long coastline and beaches. Natural scenario such as Chilika Lake, the largest brackish water lake in Asia, forms another major attraction. There is an important bird sanctuary for millions of birds, and is also noted for its population of Irrawaddy Dolphin, the only known population of Irrawaddy dolphins in India. It is one of only two lagoons in the world that are home to this species. Major beaches in Odisha include Gopalpur, Puri, Chandipur and Chandrabhaga and the waterfalls of Barehipani and Joranda, Badaghagra, Sanaghagra and Khandadhar are common attractions. The hot springs at Atri, Deulajhari, Taptapani and Tarabalo also attract tourists. The state has rich flora and fauna inhabited the lush green forest and is home to the Royal Bengal Tiger. Eco-tourism is important in Odisha and notable wildlife sanctuaries include Bhitar Kanika, Chandaka, Chilika, Simlipal, Tikarpada, Gahirmatha and Nandan Kanan. The other attractions include Darjeeng, Daringbadi, Barunei, Dhamra, Chandbali, Tensa, Narayani and Saptasajya.

The total tourist arrivals during 2011 were 8,331,979 tourists out of which approximately 1% was foreign tourists. The maximum tourist generating area was West Bengal (domestic), UK (international). **Table 2-6** below summarizes the visiting tourist volume in Odisha during last five years.

Table 2-6: Tourist Visit in Odisha during 2007-2012

Year	Domestic Tourist in Nos.	Foreign Tourist in Nos.	Grand Total in Nos.
2007-08	6,210,586	43,311	6,253,897
2008-09	6,482,213	42,303	6,524,516
2009-10	7,104,079	47,105	7,151,184
2010-11	7,770,741	53,212	7,823,953
2011-12	8,271,257	60,722	8,331,979

Source: Draft Annual Plan 2011-2012, Tourism Department, GOO, Volume-I.

A Tourist Profile Survey was conducted by the Department of Tourism, GOO during 2004-2005. The average duration of stay was found to be 12.7 days in case of a Foreign Tourist and 3.9 days in case of a Domestic Tourist. Similarly the average per capita spending (expenditure) was found to be INR 1,944/- for a Foreign Tourist and INR 1,275/- for a Domestic Tourist.

In the year 2008-2009 another Tourist Profile Survey was conducted by the Department of Tourism to find out the changes, if any, occurred in the Tourist Profiles. The average duration of stay was found to be increased to 14.2 days in case of a Foreign Tourist and reduced to 3.7 days in case of a Domestic Tourist. Similarly the average per capita expenditure was found to be INR 2,255/- in case of Foreign Tourist and INR 1,357/- in case of Domestic Tourist. The inflow of money through tourist expenditure for the year 2011 is estimated on the basis of changed figures as mentioned above. **Table 2-7** summarizes the inflow of money through tourist spending (Expenditure) in Odisha.

Tourist Locations: The state can be broadly divided into four natural regions, i.e. (a) hilly areas in the north and the northwest, (b) the Eastern Ghats, (c) the central and the western plateau and (d) the coastal plains.

Table 2-7: Inflow of Money through Tourist Spending in Odisha

Year	From Domestic Tourist (Million INR)			From Foreign Tourist (Million INR)	Grand Total (Million INR)
	Odisha	Other States	Total		
2007	1,617.24	1,338.85	2,956.09	103.39	3,059.48
2008	1,912.67	1,249.06	3,161.73	108.54	3,270.27
2009	2,078.37	1,381.77	3,460.14	146.28	3,606.42
2010	2,290.91	1,520.76	3,811.67	161.49	3,973.16
2011	2,338.44	1,814.48	4,152.92	194.44	4,347.36

Source: Draft Annual Plan 2011-2012, Tourism Department, GOO, Volume-I.

Tourism pattern indicates that visiting tourists target some major tourist locations in a row prior to moving from one region to the other. The chain of such consecutive tourist locations are known as tourist circuit. The existing major tourist circuits include:

- Sambalpur–Samaleswari–Hirakud Dam–Huma–Ushakothi–Bargarh
- Chilka–Barkul–Banpur
- Ratnagiri–Udayagiri–Lalitgiri
- Similipal–Jashipur–Deokunda–Khiching–Baripada–Balasore–Chandipur–Bhadrak
- Bhubaneswar–Konark–Puri (The Golden Triangle)
- Berhampur–Gopalpur–Taptapani–Taratarini
- Bhitarkanika–Dangmal–Gahirmatha
- Ghatagaon–Ghagra–Khandadhar

Apart from the above, a general reconnaissance survey was undertaken to identify future potential tourist spots. Some potential tourist spots that were identified as the result of the reconnaissance survey include Pathrajpur, Langudi Hill, Bindu Sagar Sarovar, Shanti Stupa, Dhabaleshwar Shiva Temple, State Museum, Barabati Fort, Netaji Subhas Chandra Bose Memorial, Chandrabhaga Beach, Shankaracharya Math, Raghurajpur Village.

3 Existing Transportation Scenario

An efficient transportation network forms the spine of the overall growth of a State, and delivers a crucial role in enhancing the Gross Domestic Product (GDP) including progression of various socio-economic activities. The GOO has, therefore, conferred a high priority to develop and promote the transportation infrastructure to encourage development of backward areas and to establish connections to remote areas.

The ratio of the total length of existing roads in a State with respect to the State's land surface area represents the quantitative density of the road network (i.e. total length of the roads per 100^2 km. The quantitative density, however considers all roads including surfaced and non-surfaced road consisting of varying standards and right-of-way widths. The quantitative density of Odisha Road Network stands as approximately 160.36 km per 100 sq. km of Odisha land surface area, whereas the quantitative density of the surfaced road in the State stands as about 28.60, with respect to the National average.

3.1 Existing Road Network – Overview

The existing road network of Odisha primarily consists **of National Highways (NH), State Highways (SH), Major District Roads (MDR), Other District Roads (ODR), Village Roads (VR), Panchayat Roads, Urban Roads and roads managed by Irrigation and Forest department**. The State has a total road length of **250,328 km** by the end of financial year 2011-12. The structural composition of these roads are generally categorized as pucca roads (metaled road either asphalt or concrete), kutcha roads (earthen roads with basic ground formation). Roads are also categorized as basic road or all-weather roads based on their measures of effectiveness. The various length of different road categories based on their operational importance are summarized in **Table 3-1**.

Table 3-1: Length of Road Network in Odisha

Sl. No.	Road Classification	Length (Km)	Sl. No.	Road Classification	Length (Km)
1.	National Highways	3,594	7.	Rural Roads	28,159
2.	State Highways	3,664	8.	Panchayat Samiti Roads	25,703
3.	Expressways[3]	72	9.	Gram Panchayat Roads	145,368
4.	Major District Roads	3,973	10.	Forest Roads	7,518
5.	Other District Roads	6,653	11.	Irrigation Roads	6,277
6.	Urban Roads	18,591	12.	GRIDCO Roads	88

Source: for Sl.1-5 AMS Consultant, and for Sl.6-12 Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

The primary configuration of the existing roads generally consists of 'Single Lane' (SL); 'Intermediate Lane' (IL); 'Two-Lane' (TL) and multilane roads. The basic attributes of the various configurations, extracted from IRC, are summarized below:

SINGLE LANE ROADS: Single-Lane bi-directional roads are of common occurrence in low volume corridors. A SL road under ideal condition should have 3.75 meter wide paved carriageway with

[3] The roads classified as Expressways have been converted to National Highways from year 2014 onwards

good quality shoulders of minimum 1.0 meter width on either side. The recommended Design Service Volume (DSV) for SL roads is considered to be 2,000 PCU/day under ideal condition; the DSV could reduce by about 20-30 percent for a non-metalled surface and up to approximately by 50 percent in case of softer (earthen) shoulder.

INTERMEDIATE LANE ROADS: IL roads are those which have a pavement width higher than a SL road but lower than two-lane road. The ideal pavement width of an IL road is approximately 5.5m with good usable shoulders on either side. The recommended DSVs for these roads vary from 4,500 to 6,000 PCU/day based on the existing road and terrain geometrics.

TWO LANE (TL) ROADS: Two-lane roads are comprised of two traffic lanes, approximately 3.5m wide each, accommodating one-way opposite directional flow on each lane. The DSV for two-lane road is 15,000 PCU/day under ideal conditions. The capacity of TL roads can be increased by providing paved shoulders of at least 1.5m wide on each side. With 1.5m wide shoulder each way the capacity increases to 18,000 PCU/day. This increase is primarily due to the hard shoulders, which could accommodate additional slow moving traffic. The hard shoulders also accommodate bicycles and pedestrian which improves safety of vulnerable road users.

MULTI-LANE ROADS: A Multilane road is a road having two or more lanes accommodating each directional traffic flow. A basic multilane road generally starts from four-lane road (2-lane each way) to six/eight lane road (3-lane/4-lane each way). **Table 3-2** summarizes the ideal lane/road width for various lane configurations.

Table 3-2: Road Width for Various Lane Configurations

Single Lane	Intermediate Lane[4]	Two Lane	Two Lanes with paved shoulders	Multilane Road
3.75m	5.5m	7.0m	10m	3.5m/lane

In addition to efficient utilization of road connectivity program developed by the GOI, GOO has initiated several rural and strategic road development programs. During 2010–11 the State has developed approximately 19,775 km of paved roadway, out of which approximately 17,416 km consists of asphalt concrete and the rest 2,359 km consists of cement concrete. Despite of all State's initiatives, the extent of rural connectivity in Odisha is still far less than the desired level and expectations. Only 62 percent villages possess all-weather road connectivity to the existing State Road network system.

3.1.1 Road Classification and Ownership

The road network in Odisha is classified based on their functions as defined in IRC guidelines. The road classification, ownership of each category of road and the road length is summarized in **Table 3-3**.

[4] Intermediate Lane is no longer an IRC Standard road width. However, 3.5m wide single-lane road when added with paved shoulder of 1.0m on either side makes it 5.5m wide to cater for additional traffic.

Table 3-3: Road Classification and Ownership

Sl. No.	Road Classification	Length (Km)	Managing Agency
1.	National Highways	2,131	National Highway Authority of India (NHAI)
		1,463	Ministry of Road Transport & Highways (MoRTH) through Odisha Works Department (OWD)
2.	Expressways	72	OWD
3.	State Highways	3,664	OWD
4.	Major District Roads	3,973	OWD
5.	Other District Roads	6,653	OWD
6.	Urban Roads	18,591	Urban Authorities
7.	Rural Roads	28,159	Rural Department
8.	Panchayat Samiti Roads	25,703	Panchayat Department
9.	Gram Panchayat Roads	145,368	Panchayat Department
10.	Forest Roads	7,518	Forest Department
11.	Irrigation Roads	6,277	Irrigation Department
12.	GRIDCO Roads	88	GRIDCO

Source: for Sl.1-5 AMS Consultant, and for Sl.6-12 Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

The State level major road network, consisting of SH, MDR and ODR, is managed and operated by OWD through their different sub-divisional departments. The sub-divisional departments generally comprise of seven circles and 31 divisions that are headed by a Superintending Engineer (SE) and Executive Engineer (EE), respectively. The NHAI manages 2,131 km of NHs, while the Ministry of Road Transport and Highways (MoRT&H) manages the remaining NHs through OWD. IRC: 73-1980 defines the components of the major road network as follows:

National Highways (NHs) – are the highways running through the length and breadth of the country connecting interstates, state capitals, major cities, ports, large industrial locations and tourist centres etc. The length of NHs constitutes approximately two percent of the entire length of the road network in Odisha, which carries approximately 40% of the total vehicular road traffic of the State.

State Highways (SHs) – are arterial routes within a state, connecting districts to/from NHs linking district headquarters and important internal cities including highways of the neighbouring States. Out of 3,713 km length of the existing SH, 917 km length is two-lane, and the IL and SL road lengths are approximately 1,056 Km and 1,740 km, respectively. The total paved and unpaved lengths of SHs in the State are 3,619 km and 94 km respectively. The total length of SHs based on their lane configuration and the existing surface conditions covering all seven circles of OWD is illustrated in **Figure 3-1**.

Major District Roads (MDRs) – are major roads within a district that connects to SHs and serve areas of production and markets, and connecting these with each other or with the main highways. Out of a total length of 3,900 km of MDR, 412 km length is two-lane, while the lengths of intermediate and SL are approximately 1,481 km and 2,007 km, respectively. The distribution of total length of MDRs

based on their road width, and the length of the paved and unpaved sections in all seven circles of OWD are illustrated in **Figure 3-2**.

Other District Roads (ODRs) – are other thorough fares, which connect district headquarters and linked to MDRs. Out of a total length of 6,592 km of ODRs, 313 km length is two-lane, while intermediate and SL lengths are approximately 1,455 km and 4,824 km, respectively and approximately 6170 km length of ODR is paved and the rest 422 km is unpaved. **Figure 3.3** illustrates the existing distribution of road width and surface condition of the ODRs in Odisha.

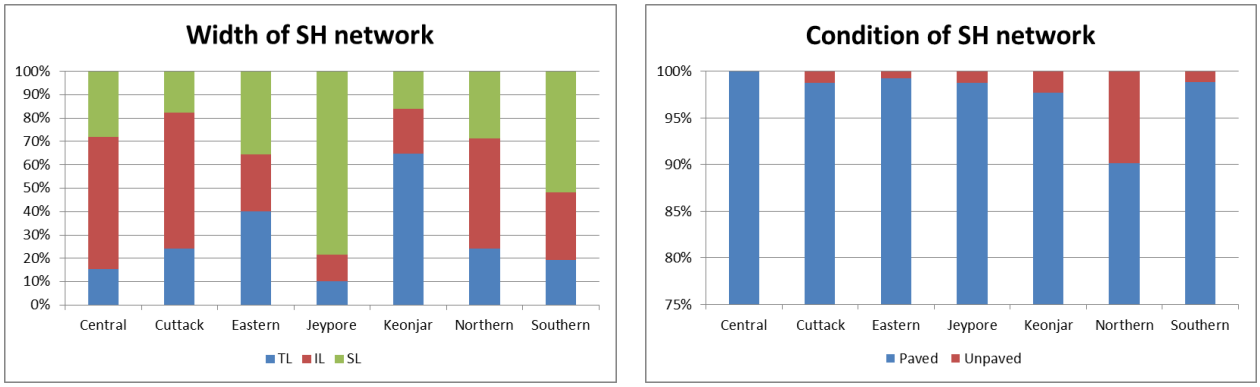


Figure 3-1: State Highway Configuration and Condition in Odisha

Source: Secondary Data, LASA, Asset Management Consultants, OWD.

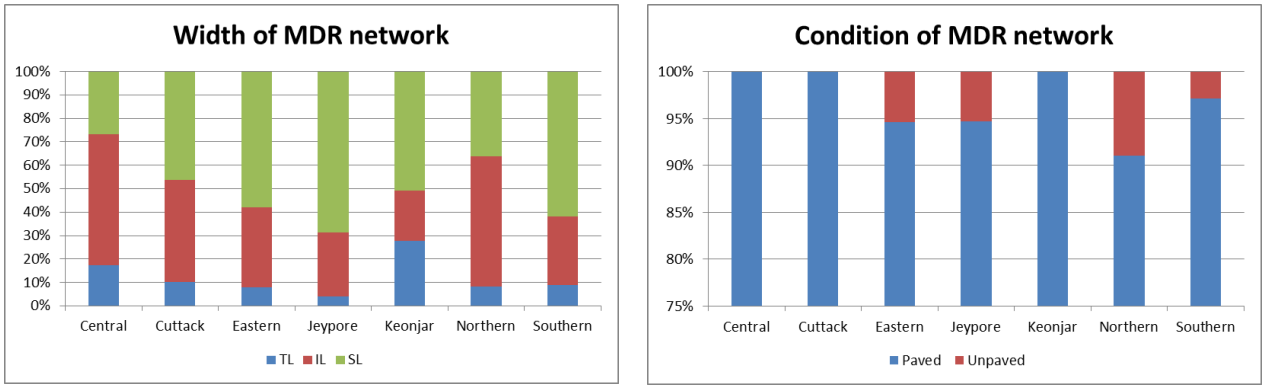


Figure 3-2: Major District Road Configuration and Condition in Odisha

Source: Secondary Data, LASA, Asset Management Consultants, OWD.

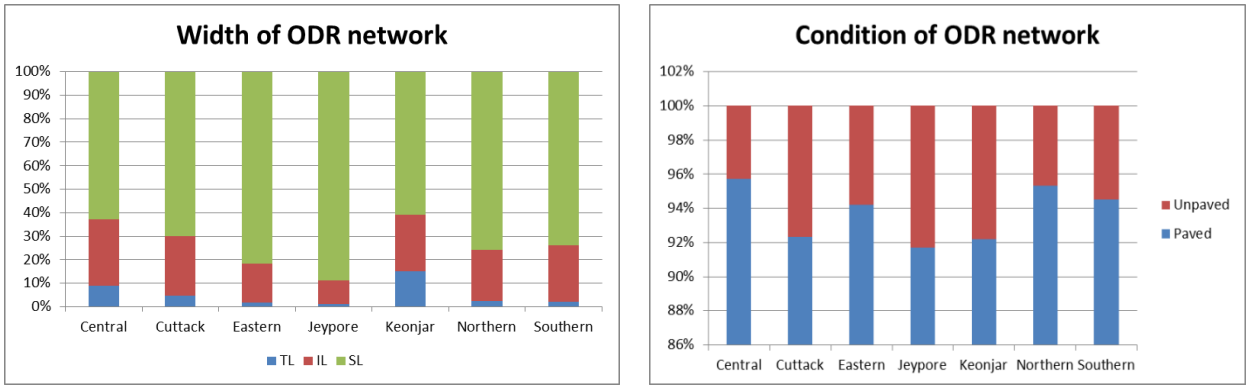


Figure 3-3: Other District Road Configuration and Condition in Odisha

(Source: Secondary Data, LASA, Asset Management Consultants, OWD)

Though there is a large length of road network in Odisha, there is a noted imbalance in the distribution of major road network in different districts, as can be seen from the **Figure 3-4**.

Among the urban roads, 2,139 km of road is managed by three major municipal corporations (Bhubaneswar, Cuttack and Berhampur); 8,387 km of road by 37 municipalities and the remaining segment of approximately 7,500 km of road are managed by 63 notified area councils.

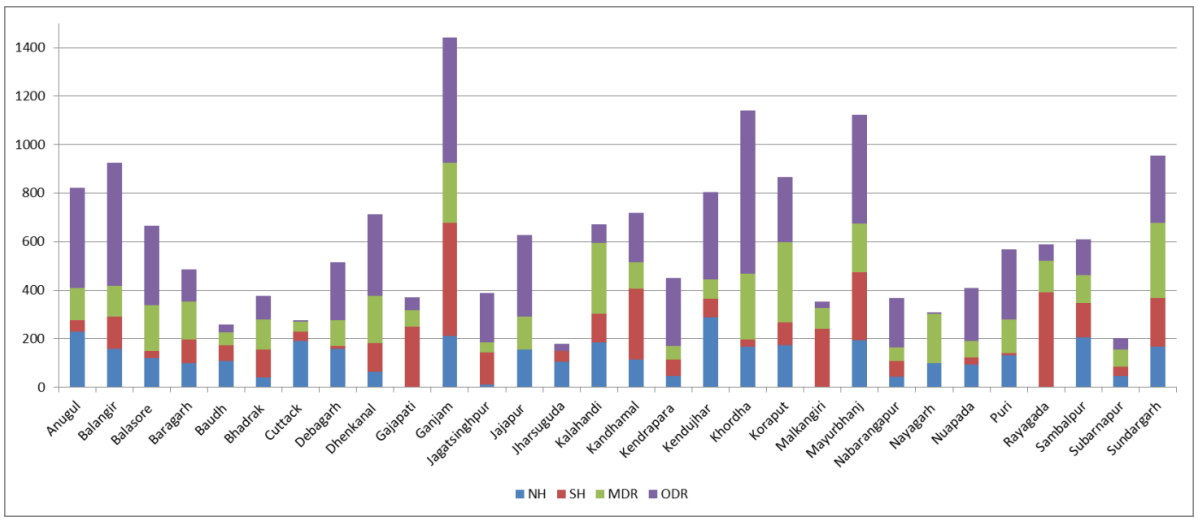


Figure 3-4: Major Road Distribution in 30 Districts

Source: Secondary Data, LASA, Asset Management Consultants, OWD.

Rural Roads (RRs)/Village Roads (VRs) – connect different neighbouring villages with the nearest major road network (NH, SH, MDR and ODR). RRs/VRs are generally classified as 'Link roads' (LR) and 'Through roads' (TR) under PMGSY. These RRs are either metalled or non-metalled roads. TRs are the roads that travel and connect a number of villages to the major road network and LR serves the connector between the TR and any village. The RRs are managed by Rural Development (RD) department. These roads are mostly SL paved or unpaved roads. The State has total 3,762 pieces of RRs that constituted approximately 28,159 km length by the end of 2011-2012, of which 17,340 km (61.9%) was asphalt and 2,365 km (8.4%) was cement concrete roads.

Panchayat Roads are generally located within a village/habitation and are managed by Panchayat Raj department. Panchayat Roads consist of all-weather roads, kutcha roads and walking/bicycling tracks. The existing length of such Panchayat Roads represents a significant percentage of the total road network in Odisha, which serve a physical connectivity but lack any set of standards.

Irrigation roads are managed by Irrigation department and these roads are mostly placed along the river banks. Though the roads are primarily used for irrigation purposes, a significant length of these roads is a combination of two-lane and SL paved roads and used by motorized traffic for passenger and freight transportation.

Figure 3-5 illustrates all categories of roads in the existing road network within the State.

3.1.2 Road Density

Road density of India and Odisha in the terms of, (i) road length per lakh population and (ii) road length per 100 sq km of land area is presented in Table 3-4 below.

Table 3-4: Comparison of Road Density of Odisha and National Average Road Density in India[5]

Road Classification	Road length in Km (till 31st March 2012)	
	India	Odisha
National Highways (NHs)	76,818	3,704
State Highways (SHs)	1,64,360	3,654
Other PWD (OPWD) Roads	10,22,287	11,376
Rural Roads	28,38,220	1,94,151
Urban Roads	4,64,294	19,042
Project Roads	2,99,415	22,781
Total Road Length	**48,65,394**	**2,54,709**
Population	1,20,81,16,000	4,28,15,000
Area (sq km)	32,87,590	1,55,707
A: Road Density (All Roads)		
per lakh population	403	595
per 100 sq km of land area	148	164
B: Road Density (NH, SH, and PWD Roads)		
per lakh population	105	44
per 100 sq km of land area	38	12
C: Road Density (Rural, Urban, and Project Roads)		
per lakh population	298	551
per 100 sq km of land area	110	152

It is observed in the above table that the road density considering all roads of Odisha is more than country's average road density. However, Odisha's road density considering the major road network (NH, SH, and PWD Roads) is lower than country's average road density. This is because Odisha has got much higher density of Rural, Urban and Project Roads than country's average road density.

[5] Source: Basic Road Statistics of India 2011-12, MoRTH GoI

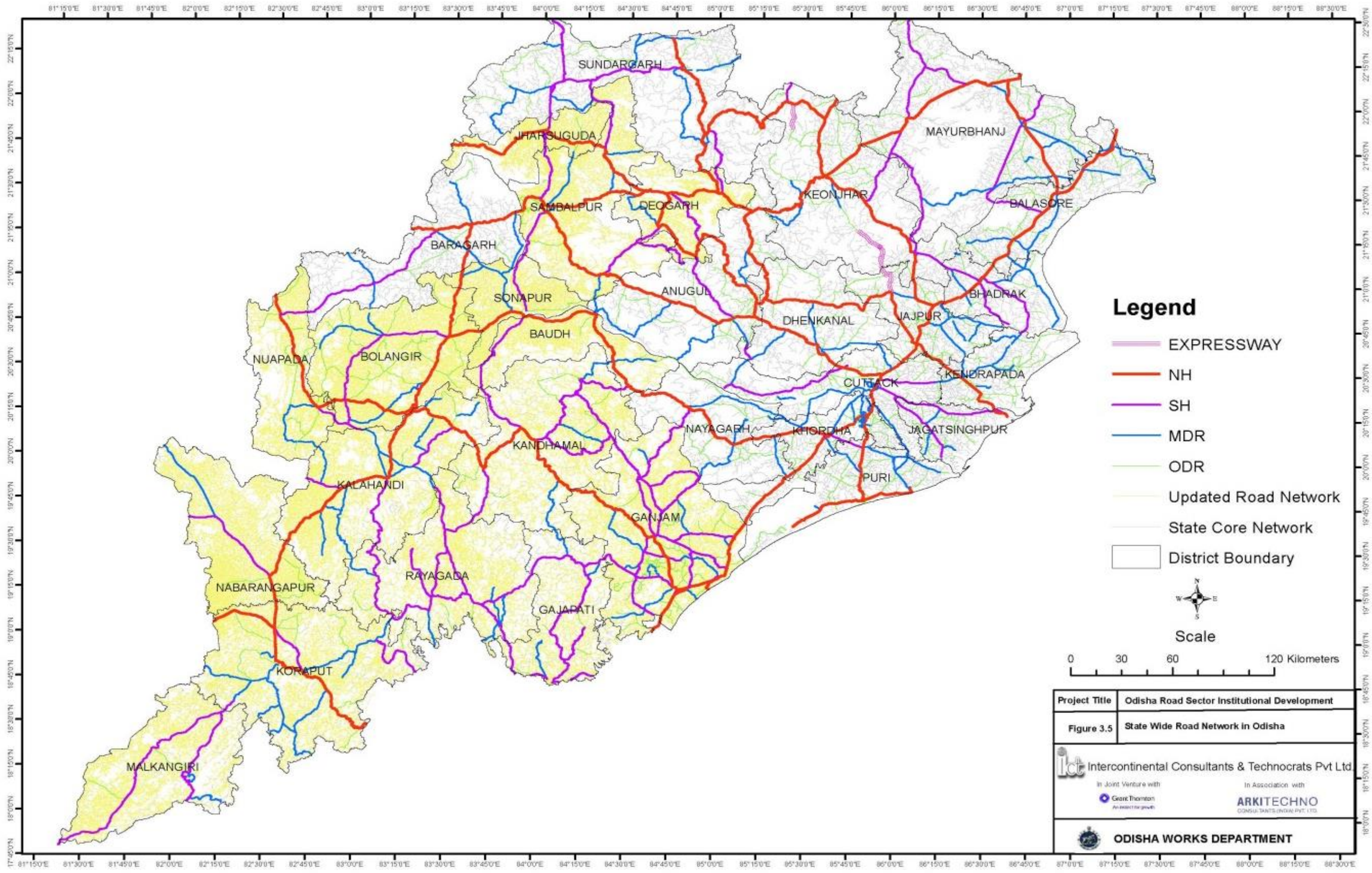


Figure 3-5: District wise Road Network in Odisha

3.2 Road Transportation

The State of Odisha in addition to the OWD and Rural Roads Departments possesses 132 cities/ towns, which are managed by Urban Local Bodies. The total numbers of such local government bodies consists of approximately 40 agencies that accommodate three (Bhubaneswar, Cuttack and Berhampur) municipal corporations and thirty seven municipalities. There is Department of Town & Country Planning (TCP), which plans for development of towns and cities, operations of which are managed by the local bodies. The TCP Department has been undertaking City Development Planning (CDP) for the designated urban areas. Currently, there are 30 CDPs considered, out of which five studies have been completed. During 2007-2008, the state has developed a transport policy, the major feature being the evolution of an improved urban transport system. Since then, several studies have been initiated to improve mass transit systems in twin cities of Bhubaneswar and Cuttack and other selected municipalities.

The average trend of road transportation reflects dominance of captive modes in the State. The primary modes constitute passenger cars, buses, three-wheelers and two-wheelers in addition to non-motorized traffic. The total number of registered vehicles in the state for year 2011-12 is 34,54,436. The motorized public transportation modes are generally comprised of buses, intermediate public transport modes and multi utility vehicles like taxis, multi-passenger vehicle e.g. trekkers, three-wheelers i.e. auto-rickshaws etc. The multi-passenger vehicles operate in urban and rural areas for commuter transport. It is worth noting that the volume of two-wheelers represents approximately 80% of the total vehicle fleet in the State. **Figure 3-6** represents the composition of registered motor vehicles on the road during 2011-2012.

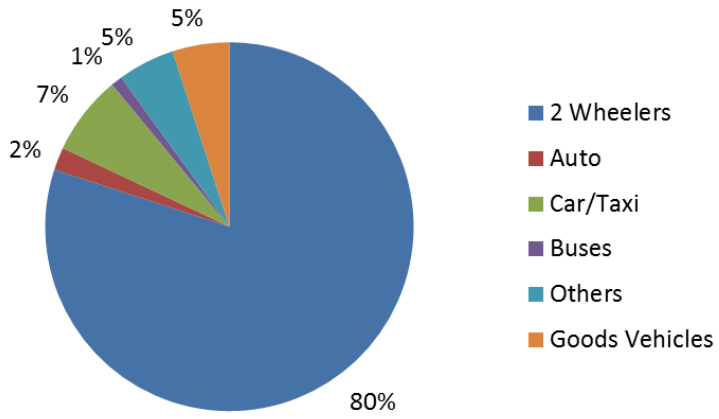


Figure 3-6: Percentage Representation on Road Vehicles during 2011-2012

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

Buses are the major means of road transport for predominant commuters in the State. During 2011-2012, a total of 13,565 buses comprising of fleets run by both public and private agencies, was plying on the rural and urban road network of Odisha to support passenger transportation. This number reflects that there are approximately 29 buses for 100,000 populations. It is worth noting that although there is an immense opportunity to enhance public transit operation to support such a high ridership volume, the total number of public sector buses is much lower than that operated by private agencies. It was noted that the total number of public sector buses were only 230, which

were increased to 367 during the last decade. **Figure 3-7** shows the number of passengers served during 2005-2006 to 2011-2012 by public sector buses.

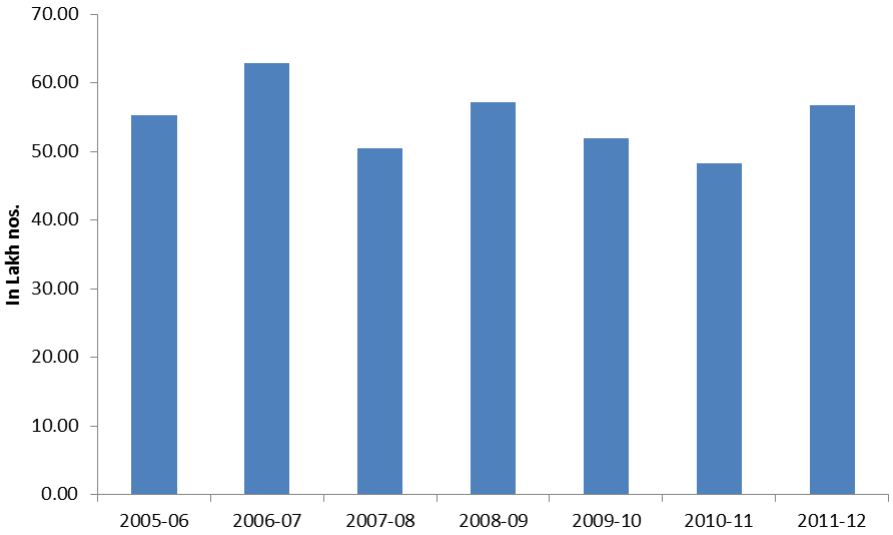


Figure 3-7: Passenger Traffic Served by Public Sector Buses, 2006 to 2012

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

3.3 Rail Transportation

The State of Odisha contains a significant length of rail network which services approximately 23 Districts of the State. The districts of Boudh, Deogarh, Kandhamal, Kendrapara, Malkangiri, Nabrangpur and Nayagarh are devoid of any rail services. By the end of 2010–11, Odisha had 2,417 km of railway lines including 54 km of narrow gauge lines. The quantitative density of the existing railway route length in the State is approximately 16 km per 1,000 km^2, while the national average quantitative density is approximately 20 km. The District-wise railway coverage is shown in **Fig. 3-8**.

3.4 Water Transportation

3.4.1 Inland Water Transport

The State does not possess significant inland water transport. Some minor operations are present, which primarily cater for passenger transportation. Some of such water transportation accommodates commercial freight, however only a few passenger services available in remote areas that generally use motorized launches. The ferry services are present in eight different water routes in different sectors of the State:

- Chandabali sector provides ferry services from Chandabali to Aradi, Talachuan and Rajnagar. The fleet size consists nine motor boats;
- Balugaon sector provides services from Balugaon to Krushnaprasad, Kalijai, Nuapada and Satapada, with a fleet size of eight motor boats; and
- Astaranga sector provides services from Nayagarh to Sribantapur, with a minimal fleet.

3.4.2 Ports

Odisha is a maritime State with an approximate coastline length of 480 km. Paradeep Port is one of the major ports in the State, which has been functioning as one of the major national ports in the

Country. Paradeep Port is ranked as the eighth major port in India, which functions as the prime major port in the east coast since commissioned. The port is located between two major coastal cities, and situates approximately 210 nautical miles south of Kolkata, the State Capital City of the neighbouring State of West Bengal and approximately 260 nautical miles north of Visakhapatnam in Andhra Pradesh. During 2010–2011, approximately 56 million tonnes of cargo were handled at this port, making this port as one of the busiest ports at the east coastline of the Country. The total cargo handled through Paradeep Port during past decade is illustrated the **Figure 3-9.**

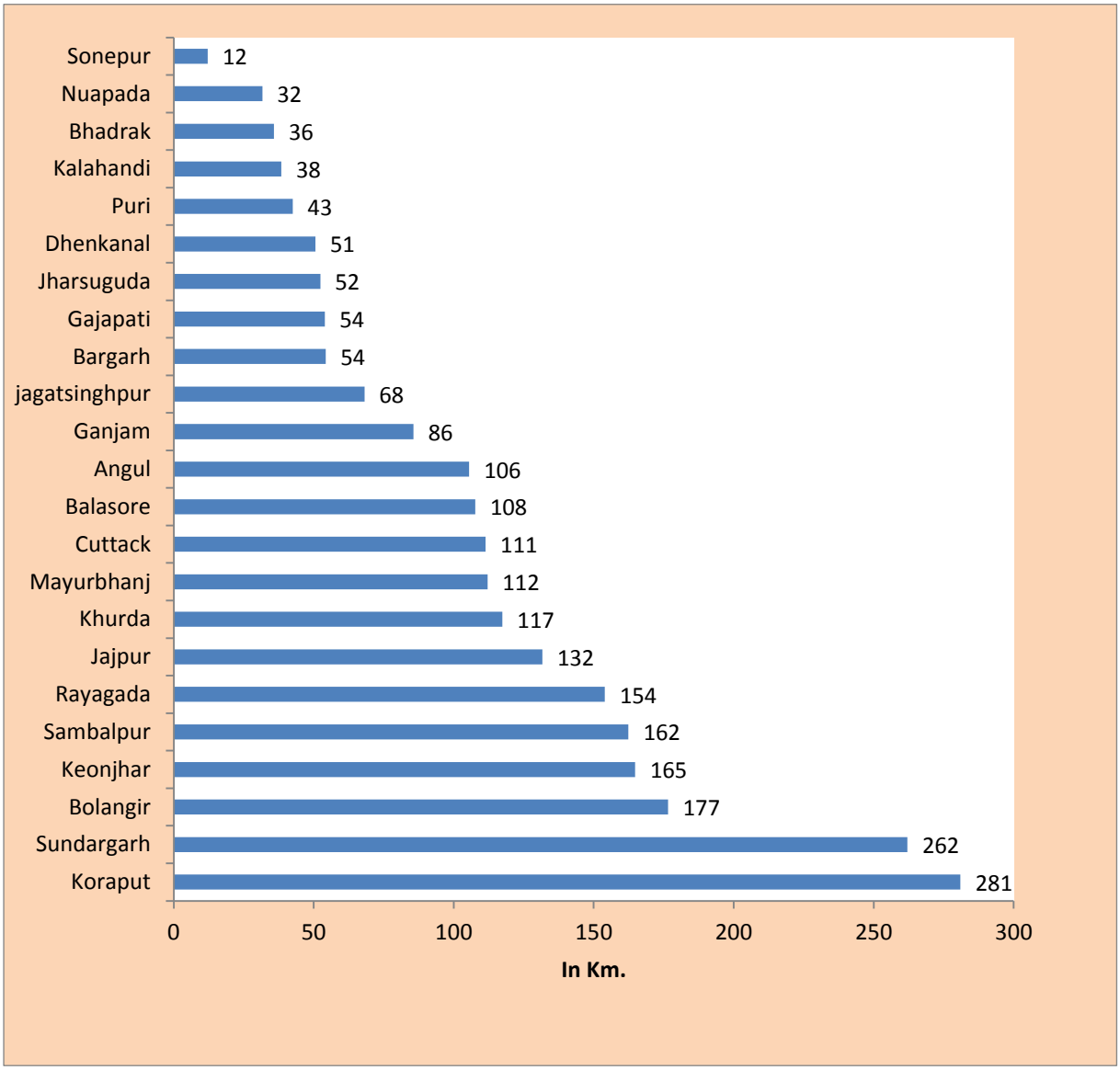


Figure 3-8: District wise Railway Coverage in Odisha

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

The GOO has identified 14 more potential sites for development of minor ports to enhance the marine cargo handling, out of which some of the sites have been converted to accommodate active port operation. Out of these locations Gopalpur operates as the second largest port in Odisha, and has been in operation since January 2007. Further to these operating facilities, the State Government has signed concessional agreement/Memorandum of Understanding with various organizations to develop the following minor Ports along the eastern coast:

- Dhamara Port
- Kirtania Port in Balasore
- Astaranga Port in Puri
- Chudamani in Bhadrak

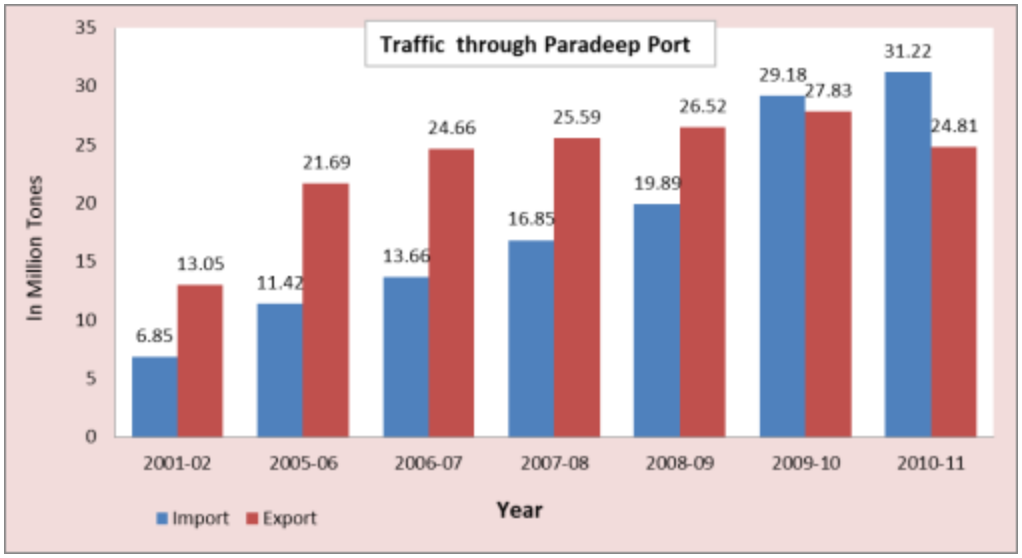


Figure 3-9: Total Cargo Handled by Paradeep Port (in Metric Ton)

Source: Economic Survey, 2012-13, Published by Planning & Coordination Department, GOO.

3.5 Air Transportation

Odisha has one domestic airport (Biju Patnaik Airport) situated in Bhubaneswar, the State Capital of Odisha. Bhubaneswar is connected to almost all major cities in India. Airport Authority of India (AAI) had plans to expand Bhubaneswar airport to a modern International airport. The status of this expansion plan is still not evident yet.

AAI in 2012 ranked Bhubaneswar Airport as the 19th busiest airport in India. Bhubaneswar registered an approximate 19.9% traffic growth over the last year. During the financial year of 2012-2013, the airport handled approximately a total 1,389,552 passengers and 3400 Metric Ton cargo.

In addition to the Biju Patnaik Airport, there are 12 airstrips and 16 helipads in the State, a summary of which is presented in **Table 3-5.**

Table 3-5: Location of Existing and Proposed Airstrips

Sl. No.	Existing Air Strips		Sl. No.	Proposed Air Strips	
	Air Strip	District		Air Strip	District
1.	Jeypore	Koraput	8.	Jharsuguda	Jharsuguda
2.	Rangeilunda	Ganjam	9.	Rourkela	Sundargarh
3.	Gudari	Kandhamal	10.	Bhadrasahi	Keonjhar
4.	Tusra	Bolangir	11.	Raisnan	Keonjhar
5.	Gotma	Nuapada	12.	Rairangpur	Mayurbhanj
6.	Sativata	Baragarh	13.	Sukinda	Jajpur
7.	Jamaderpali	Sambalpur	14.	Utkela	Kalahandi

Source: Directorate of Mines, GOO

The entire rail network, existing and future port locations, existing Bhubaneswar Airport including locations of all the existing and future air strips are illustrated in the **Figure 3-10**.

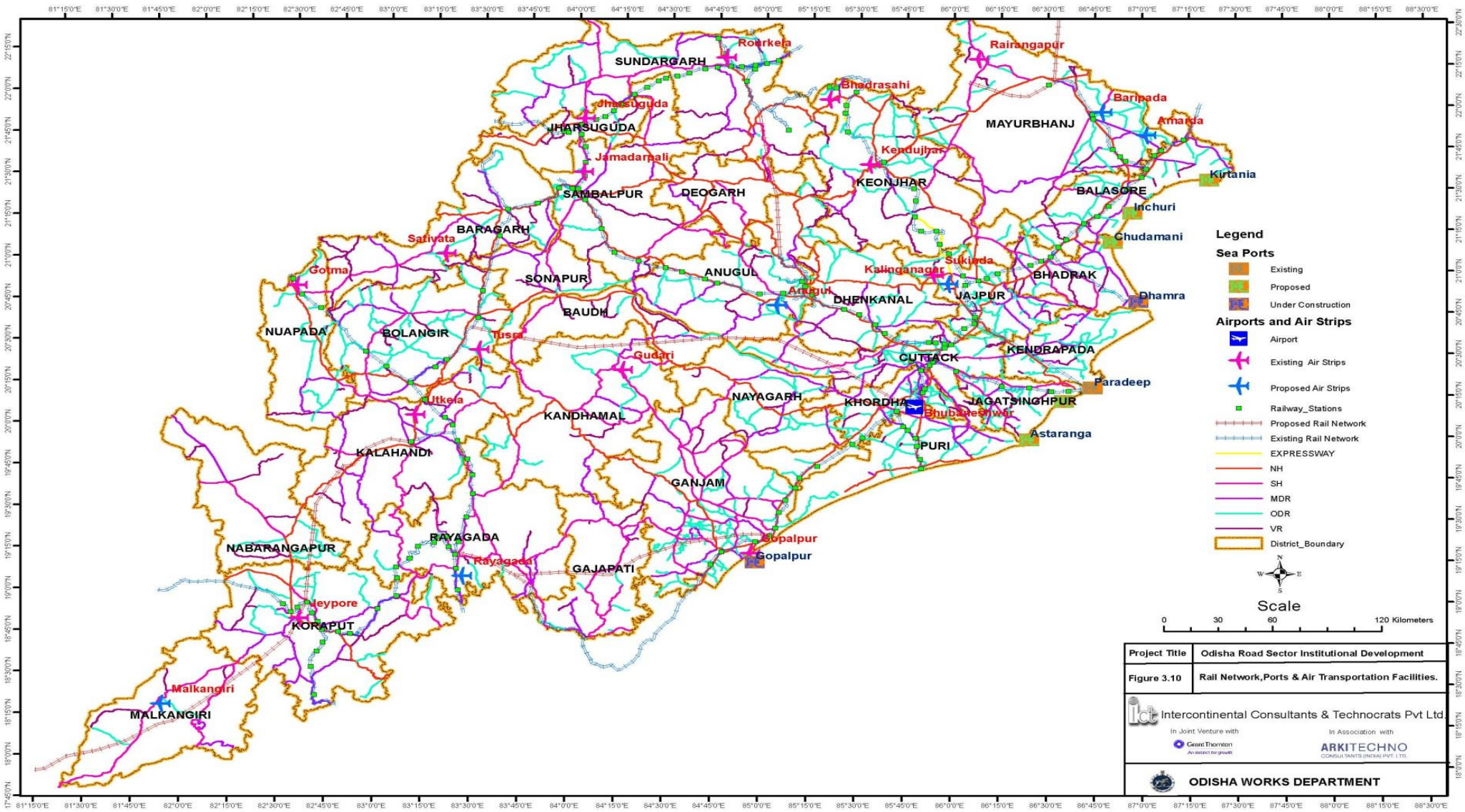


Figure 3-10: Rail Network, Ports & Air Transportation Facilities

Source: Directorate of Mines, Steel Department, GOO.

4 Project Work Plan

4.1 Project Approach and Methodology

Based on the objectives and scope of the consultancy services, the entire Road Master Planning process was divided into, three tentative phases. The individual phases primarily consist of the followings:

Phase-I: During this phase the primary focus was to complete the data collection, data processing and data analyses tasks, to identify any issues and develop mitigation alternatives. Data collection activity was accomplished through collection of the GIS Map covering entire 'State Road Network'; followed by processing the GIS Map identifying road attributes, connectivity and other pertinent details available. This task was the most significant initial step to successfully accomplish the study objective.

Further to acquiring of the GIS maps an approximate 3,000 km of representative sample road network was identified in consultation with the PMU, OWD to start necessary data collection and other relevant information. Data available from the secondary sources were also pursued simultaneously to develop an enriched database for proper facilitation to necessary traffic analyses. The targeted data included information on existing/historic traffic volumes, relevant statistics on socio-economic parameters of 30 districts, roadway and other inventories.

A transportation macro planning model was developed using CUBE software package. The primary road network for the transportation model development was based on the enhanced GIS Map that integrated other relevant attributes obtained from available information like Asset Management System consultancy and the primary data collected for the sample network. Traffic Analysis Zones (TAZs) were developed covering all Blocks (314 Blocks in 30 districts) with their head-quarters as the zone centroid. The traffic information and other road condition data collected were used to evaluate existing traffic conditions and identification of issues related to connectivity, accessibility and mobility; development of traffic projection and future demand; identification of capacity issues with respect to future demand.

Phase-II: This phase primarily focused on developing mitigation measures based upon ongoing road improvements by NHAI, State Development Plans and Strategic Road Infrastructure Improvement set out under the Transportation Vision 2021 and capacity constrained corridor; undertake a detailed economic analysis to identify the preferred development alternatives followed by developing a road development priority list. During this phase, necessary initiatives had been taken for development of a road classification system for approval and implementation on the basis of well-defined parameters provided in the Vision 2021 document and in due consultation with OWD.

Phase-III: During this phase activities were more focused on identifying areas in the organizational structure and operation that needs to be strengthened including processes/procedures to augment capacity building within GOO to manage updating and implementation of RNMP. The activities are discussed in detail in the forthcoming paragraphs below.

The flow chart covering the methodology adopted to deliver the road network master plan for the Odisha main road network is illustrated in **Figure 4-1**. The details and status of work schedule is presented in **Appendix 4.1**

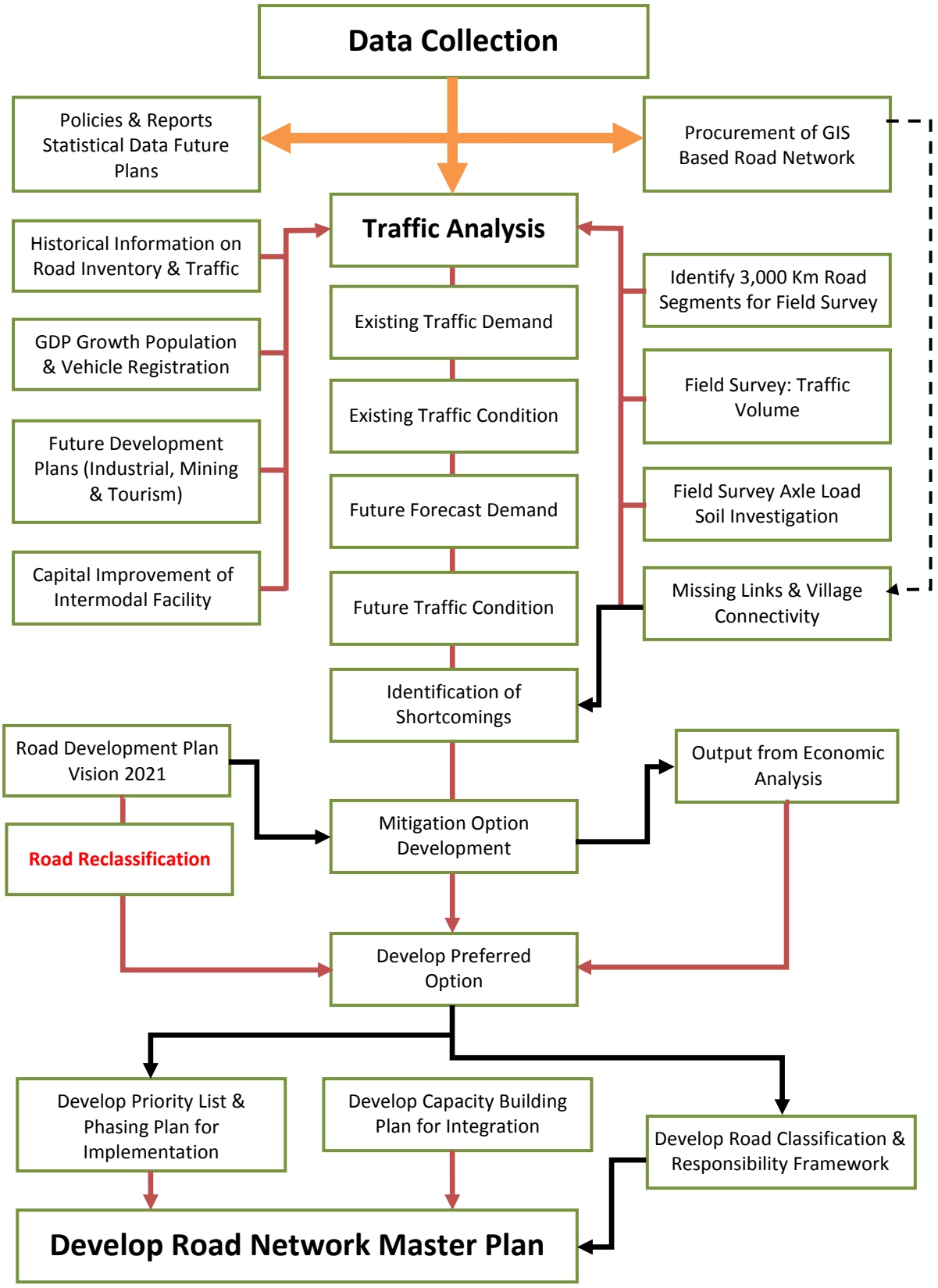


Figure 4-1: Work Methodology – Road Network Master Planning

4.2 Data Collection

Project data collection activities were completed by procuring data through ground surveys etc. and collecting available historic data from other study reports or other relevant sources. The data collected through surveys were called as 'Primary Data' and data obtained from other sources were termed as 'Secondary Data'. The 'Primary Data' set mainly consists of i) Traffic Volume Data; ii) Axle Load Data; iii) Road Inventory Data; and iv) Road Subgrade Condition Data; whereas the 'Secondary Data' collection primarily related to i) Collection of GIS Maps; ii) Traffic Volumes survey results collected by others; iii) Origin-Destination Data from others; iv) Road Network Inventory survey done by others, and v) all other relevant information pertaining to statistical information extracted from 'Economic Survey', Road Policies etc. The following sections discuss in detail about the primary and secondary data collection activities.

4.2.1 Primary Data Collection

A core road network, representing all categories of roads, was identified in consultation with the OWD and PMU officials for identifying survey locations. Representative road sections were identified based on segmental length of selected roads adhering to the guidelines provided in the TOR. A representative **194 road sections amounting to 3,000 km** was identified in consultation with the OWD and PMU officials for identifying survey locations. It would be worth noting that representative road sections included in the selected network are mainly ODR and RR/VR, with some links of higher category of roads, since road inventory, condition, traffic and axle load survey information for NHs, SHs, and MDRs had already been collected by AMS Consultants, which were available for the subject RNMP task.

Traffic Volume Survey: The primary goal was to identify representative sample of roads within individual districts based on their strategic locations with respect to the existing villages/land-uses/ population density, intersection/connectivity with other category of roads, connections with the major/minor corridors and also previous survey locations that were utilized for traffic survey by the AMC, and the data were made available. Primary data collections were carried out by undertaking traffic volume survey at the midblock locations of the identified 194 road sections. A map of the road network showing the traffic volume count surveys and axle load survey locations including a summary of traffic volume count data in 194 locations is given in **Appendix 4.2**.

Axle Load Survey: As per the 'TOR' axle load surveys were performed at 50 locations. Detailed interaction with OWD and PMU officials were held towards identification of proposed axle load survey locations. The primary focus of axle load survey was along higher load corridors connecting/leading to ports, industrial areas, agricultural produce areas, markets and other areas. The axle load survey locations were also guided by historical axle load survey locations that were selected by the AMS Consultant to avoid any duplication (and the data were made available). The third party survey locations were primarily at 30 locations distributed over SHs or MDRs and therefore, in order to capture a comprehensive pattern of loading, the axle load survey points were considered primarily on NHs and ODRs, although some locations were selected on SHs and MDRs also.

Road Inventory and Roughness Survey, Structural Condition and Subgrade Investigation: Following considerations were adopted to identify road links for field investigations to develop a representative sample to cover all the road attributes:

- SHs and MDRs were avoided since the road inventory and road condition information had already been verified by AMS Consultants and the surveyed data from the 3rd party consultant was available for further analysis;
- The road links were, therefore, primarily selected from ODRs or lower category roads. Most of the links that were considered for traffic count stations were also included for field investigations;
- The selection of links was also focused on existing demographics and significant trip generators as well as representing and connected to the block level major towns; and
- Best utilizing the information already available on SHs and MDRs, representing typical road links across the road network in the State.

Road inventory data were collected in every 250m interval for the identified road segments. **Roughness** data were collected using **Roughometer-III**[6]. The roughness readings were recorded at every 25m interval. Geotechnical explorations were carried out using Dynamic Cone Penetrometer to collect subgrade strength and sample for individual road sections, which were further tested in laboratory to identify necessary geotechnical attributes. A map showing all the survey links on Odisha Road Network and the summary of various field investigations are given in **Appendix 4.3**.

The following **Table 4-1** summarizes the type of data collected through the Primary Survey including the total number of survey locations for each data category.

Table 4-1: Primary Data Information

Sl. No.	Type of Data Collected	Number of Survey Locations
1.	Traffic Volume Counts	194 locations
2.	Road Inventory Information	191 links (covering 3000 km)
3.	Road Condition Information – Roughness & Deflection	191 links (covering 3000 km)
4.	Subgrade Investigations	191 links (covering 3000 km)
5.	Axle Load Information	50 locations

4.2.2 Secondary Data Collection

Secondary Data were another important source of data information for successful progress of the RNMP. Numerous consultations/meetings with various stakeholders were carried-out, since April 2012 in serious attempts to collect necessary data to be used for the development of master plan. Collection of a detailed GIS Maps to develop a State-wide base road network was extremely important to proceed with the RNMP process. The entire road network data was in WGS 84 format, geo-referenced and GIS compatible. This GIS Map was owned by ORSAC. Due to some administrative impediments, the delivery of the GIS Maps was delayed resulting in postponing the project progress and submissions by approximately ten months from the original schedule.

[6] Developed by Australian Road Research Board (ARRB)

Rigorous data collection activity included collection of the following 3rd party data (significant data), without which the RNMP recommendations will not be complete. The following **Table 4-2** summarizes the significant secondary data collected for the RNMP. The details of these background developments are discussed in the forthcoming sections of this chapter.

Table 4-2: Secondary Data from Secondary Sources

Sl. No.	Missing Data	Significance	Potential Data Owners	Utilization
1.	Industrial development plans, existing location and their outputs	The potential future trips expected to be generated by background developments were included in the model	IDCO & IPICOL	Trip generation estimated utilizing data from similar sites.
2.	Port development plans	The potential future trips to be generated by such background developments were included in the model	Various	Multimodal Trip generation forecasted based on Paradeep Port Data

The secondary data presently used for the RNMP, were primarily consisted of the followings:

4.2.3 Road Network Map

The following three separate GIS maps of road network were used for the preparations of master plan:

- Road network (NH, SH, MDR and ODR) of all 30 districts provided by AMS consultants;
- VR network of 30 districts provided by ORSAC, which is part of the core road network of Rural Development Department (RDD); and
- Lower level roads - Pucca Roads, Kutcha Roads, Cart Tracks and Footpaths – provided by ORSAC for 30 districts, which is presumed to include all roads including panchayat roads.

While the road network including NHs, SHs, MDRs, ODRs and selected VRs were considered for transportation modeling, the lower level roads were used to assess the village connectivity and to identify the missing links.

4.2.4 Link Volume Counts & Road Inventory Information

A third party AMS Consultant has carried out traffic volume counts on 202 locations spread across different SHs and MDRs on the road network in Odisha to develop a 'Road Asset Management System' for the OWD. The available information extracted from the AMC data was one of the significant data source to progress with the RNMP task and developing the transportation modeling of the Odisha road network. The road inventory data on SH and MDR network collected by the AMC were also incorporated to develop road network map that was prepared in GIS environment. The summary of link volume counts available from the secondary source is given in **Appendix 4.4.**

4.2.5 Socio Economic Data

The socio economic data of the State was collected from the *Census Department* and the publication '*Economic Survey 2012-13*'. The following data were used for identification of survey locations and further input for traffic assessment and transportation modeling.

- Population
- Employment (Main and Marginal workers)
- Gross Domestic Product
- Net District Domestic Product (current prices)
- Number of households

4.2.6 Vehicle Registration Data

The vehicle registration data (2004 to 2011) were collected from the *Transport Department* and the same were used for traffic growth analysis. The vehicle registration data collected for the 2007 to 2012 are given in **Appendix 4.5**.

4.2.7 City Development Plans

Consultations with the Department of Town & Country Planning were carried-out to gather an overall impression on existing planning process that is followed in the State. Further endeavour was made to collect information on completed or on-going City Development Planning exercise undertaken by the TCP Department for various cities/towns in Odisha. Comprehensive Development Plans for Bhubaneswar, Cuttack Urban Complex, Berhampur, Cuttack and Sambalpur were reviewed for inclusion of any specific recommendations.

4.2.8 Port Development Plan

Development information of future and evolving ports was collected from the Department of Ports, Odisha. Though 14 locations are identified for development of new ports, only 5 ports are expected to be built and likely to be in operation by 2020. The expected time of completion of constructions of these are given in **Table 4.3**.

Table 4-3: Realistic Port Development Plan

Sl. No.	Ports	Expected time Completion
1.	Dhamra	Commissioned
2.	Gopalpur	2014 – 2017
3.	Astaranga	2017 – 2022
4.	Suvarnarekha/Kirtania	2017 – 2022
5.	Chudamani	2022 – 2027
6.	Paradeep	In operation

Detailed Project Reports (DPRs) for all the above upcoming ports and details of the existing port expansion plans were collected. **Table 4-4** summarizes the data on 'Commodity Movements' through upcoming ports, i.e. commodity types and its distribution within the State.

Table 4-4: Commodity Movements – Upcoming Ports in Odisha

Sl. No.	Cargo	Total Cargo Movement (MTPA)				Cargo Movement by Road (MTPA)			
		2014 -17	2017 - 22	2022 - 27	2027 - 32	2014 -17	2017 - 22	2022 - 27	2027 - 32
Dhamra Port									
1	Iron Ore	6	9	14	14	3	4.5	7	7
2	Steel	3	6	6	6	1.5	3	3	3
3	Thermal Coal	3	4	4	4	-	-	-	-
4	Coking Coal	10	15	20	20	-	-	-	-
5	Limestone	4	4	4	4	2	2	2	2
					Total >>	6.5	9.5	12	12
Astranga Port									
1	Iron Ore	0	0	1	3	-	-	0.5	1.5
2	Thermal Coal	12	18	28	41	-	-	-	-
3	Steel Products	0	1	2	6	-	0.5	1	3
4	General Cargo	2	2	8	12	1	1	4	6
5	Aluminum	0.5	1	1	1	-	-	-	-
6	Containers	0.2	0.3	0.3	0.3	-	-	-	-
7	Coking Coal	3	4	6	8	-	-	-	-
					Total >>	1	1.5	5.5	10.5
Subarnarekha Port									
1	Thermal Coal	3	4	6	3	-	-	-	1.5
2	Iron Ore	4	2	2	41	2	1	1	-
3	Coking Coal	10	14	20	6	-	-	-	3
4	Lime Stone	2	4	6	12	1	2	3	6
5	General Cargo	3	3.5	3.5	1	3	3.5	3.5	-
6	Containers	3	7.5	17.5	0.3	-	-	-	-
					Total >>	6	6.5	7.5	7.5
Chudamani Port									
1	Thermal Coal		2	3	5	-	-	-	-
2	Iron Ore		1.45	2.1	2.1		0.7	1	1
3	General Cargo		1.05	1.15	2		0.5	0.6	1
4	Break Bulk		0.5	0.75	1		0.25	0.35	0.5
					Total >>		1.45	1.95	2.5

*Note: MTPA = Million Tonnes per annum

Based on the port commodity movements data the additional number of truck trips have been estimated and added in the OD matrices for respective horizon to assess additional road traffic likely to come due to port development. Of course, possible share of rail in all these developments are also duly accounted for.

4.2.9 Development of Industries and Mines

Several new industries are planned in the short and medium term future. The expansions of the existing industries during the next few years have also been considered as part of the development

plan to be implemented. **Table 4.5** below summarizes the remaining production targets to achieve respective total capacities of individual industries within next five years.

Table 4-5: Details of Industrial Remaining Capacities

Sl. No.	Name of the Company	Capacity (MTPA)	Material/Production Output	MTPS to be Achieved
1	Bhusan Power Steel Ltd	2.80	Sponge Iron	0.40
2	Aarti Steels Ltd.	0.50	Steel Billet & Ferro Alloys	0.25
3	Adhunik Metaliks Ltd.	3.20	Sponge Iron	2.79
4	Narbheram Power & Steel (P) Ltd. (Scaw Industries (P) Ltd.)	0.80	Sponge Iron & Steel	0.75
5	SMC Power Generation Ltd.,	1.00	Sponge Iron & Power	0.75
6	VISA Steel Ltd.	1.00	Mild Steel & Power	0.45
7	Shyam DRI Power Ltd.	0.27	Steel	0.00
8	SPS Steel & Power Ltd.	0.54	Sponge Iron	0.25
9	Odisha Sponge Iron & Steels Ltd.	0.95	Steel Bilets	0.85
10	Maheshwary Ispat Pvt. Ltd.	0.25	Sponge Iron	0.12
11	MAL Industries Ltd. (Maithan Ispat Ltd.)	0.60	Stainless Steel	0.40
12	OCL Iron & Steel Ltd.	0.95	Sponge Iron	0.87
13	Sree Metaliks Ltd.	0.98	Sponge Iron	0.70
14	Action Ispat & Power (P) Ltd.	0.80	Sponge Iron	0.55
15	MSP Metallics Pvt. Ltd.	1.00	Sponge Iron	0.74
16	Aryan Ispat & Power (P) Ltd.	0.30	Steel Plant	0.15
17	Patnaik Steel & Alloys Ltd.	0.27	Sponge Iron	0.17
18	BRG Iron & Steel Co. (P)Ltd.	1.20	Sponge Iron	1.06
19	Jain Steel & Power Ltd.	0.30	Sponge Iron	0.20
20	Rathi Steel & Power Ltd	0.30	Steel	0.15
21	Viraj Steel & Energy Ltd.	0.30	Steel	0.15
22	Deepak Steel & Power Ltd.	0.25	Sponge Iron	0.05
23	Beekay Steel & Power Ltd.	0.28	Sponge Iron	0.18
24	JSL Limited	3.20	Stainless Steel	0.00
25	Eastern Steel & Power Ltd.	0.25	Sponge Iron	0.15
26	Jai Balaji Jyoti Steels Ltd.	0.33	Sponge Iron	0.21
27	Rungta Mines Ltd.	2.00	Sponge Iron	0.02
28	Bhushan Steel Ltd.	6.00	Steel Plant	3.00
29	Crackers India Ltd	0.25	Sponge Iron	0.20
30	Surendra Mining Industries Pvt. Ltd.	0.25	Sponge Iron	0.20
31	Deo Mines & Minerals (P)Ltd.	0.33		0.33
32	Maharastra Seamless Ltd.	0.48	Sponge Iron	0.48
33	Sterlite Industries (India) Ltd.	5.00	Steel	5.00
34	Tata Steel Ltd.	6.00	Steel Plant	6.00
35	Essar Steel Odisha Ltd.	6.00	Steel Plant	0.00
36	Konark Ispat Ltd.	0.25	Steel Plant	0.25
37	Jindal Steel & Power Ltd.	6.00	Steel	6.00

Sl. No.	Name of the Company	Capacity (MTPA)	Material/Production Output	MTPS to be Achieved
38	POSCO- India Pvt. Ltd	12.00	Steel	12.00
39	Welspun Power & Steel Ltd.	3.30	Steel	3.30
40	Arcelor Mittal India Ltd	12.00	Steel	12.00
41	Monnet Ispat & Energy Ltd.	0.25	Steel	0.25
42	SSL Energy Ltd.	3.35	Steel	3.35
43	MGM Steel Ltd.	0.25	Sponge Iron	0.15
44	Pradhan Steel & Power Ltd	0.50	Steel	0.50
45	Tecton Ispat Ltd	0.25	Steel	0.25
46	Atha Mines Ltd	0.25	Steel	0.25
47	Brahmani River Pellet Ltd.	4.00	Pellets	4.00
48	Brand Alloys Ltd.	0.27	Steel	0.21
49	Uttamgalva Steel Ltd.	3.00	Steel	3.00
50	Amtek Metal & Mining Ltd.	2.00	Steel	2.00

MTPA – Metric Tonne per annum
MTPS – Metric Tonne per Season

These industries procure raw materials from mines located in surrounding areas within the State and other parts of the Country. The finished products produced from these industries are transported to multiple destinations in the Country. Thus, the future development of these industries will result in increasing truck traffic on the road network of Odisha. Some of these industries use rail also for transporting both raw materials and finished goods, and therefore, share of rail has been accounted for. The additional numbers of truck trips to and from these industries have been estimated and added onto the road network during the respective horizon years to represent the future background traffic volumes to be generated by the planned industrial developments.

5 Existing Traffic Conditions (2013)

The existing traffic conditions were evaluated through undertaking the sequential tasks as listed below:

- Developing a road network utilizing GIS based maps including integrating all necessary and available attributes i.e. number of lanes, road width etc.;
- Integrating all the network attributes, the screen-line information containing the traffic survey data points;
- Developing a coded road network for onward utilization to develop a transportation model using CUBE software package;
- Developing TAZs and zone centroids based on block headquarter, village and district boundary levels and preparation of a transportation macro model incorporating all necessary attributes;
- Running the macro model and undertaking iterative calibrations to develop a representative traffic assignment along all the road links within the coded road network including undertaking further refinement of the model to ensure the assignment volume remains within an acceptable ±20% limit of the observed volumes at the screen-lines; and
- Developing volume to capacity ratios for individual links and identifying capacity constrained road links including capacity deficient corridors.

The listed tasks are discussed in detail in the following sections.

5.1 GIS Network Coding

ORSAC supplied the digital data of GIS Maps for all the Districts of the State in phases and different parcels. The primary road network was identified by the Asset Management Consultant also for the entire State of Odisha. This network included all existing NHs, SHs, MDRs, ODRs. ORSAC during last 3-5 years, at the instance of Rural Development Department, mapped on GIS platform the updated road network for all districts which included all village level roads i.e. Kutcha Roads, Pucca Roads, Footpath and Tracks in addition to the components included in the primary road network. The GPS tracked primary road network obtained from Asset Management Consultant was integrated to the lower level road network obtained from ORSAC. Thus, the GIS Map of the road network was prepared based on the enhanced primary road network, which included polygon data of Village boundaries, Gram Panchayat boundary, Block boundary, District and State boundaries; polyline data of rail network in the State; polygon data covering canals and streams; and polygon data of tentative land-use, which is currently outdated.

5.2 Transportation Demand Modeling

The RNMP assignment primarily called for developing a State-wide road network master plan to accomplish the following objectives:

1. Develop a road network for the entire State of Odisha based on the available GIS Map;
2. Identify issues related to traffic capacity constraints on existing roads and identify missing links to any villages, tribal areas and backward areas from the road network; and

3. Develop necessary mitigation measures to address such issues including providing necessary road connections to villages, as well as tribal and backward areas.

A GIS based road network was developed based on the maps including all other necessary and relevant information prepared by ORSAC and facilitated by OWD. The network was utilized to develop an integrated transportation model for undertaking a high level vehicular traffic assignment. The integrated model was targeted to represent a strategic transportation model of the State, and henceforth termed as OSTM (Odisha Strategic Transportation Model) throughout this report.

TAZs were developed covering all the Blocks in all 30 Districts of the State and external TAZs were integrated to capture internal-external and through trips utilizing the road network of the State. The Block Headquarters were developed as the centroid of the TAZs. Trip productions and attractions from all the identified traffic zones were estimated utilizing available home based trip equations, prepared for a neighbouring State. 'Origin-Destination' (OD) matrices for all the TAZs were populated based on the initial trip estimation. Trip distribution was estimated based on the traffic volume counts carried-out at different traffic survey locations.

The TAZs and the base road network were integrated to form the OSTM (modelling) network. The OSTM was run to develop traffic assignment in terms of average daily traffic (ADT) volume along all the links based on the estimated OD matrices. The OSTM was then calibrated through a number of iterations to reflect an acceptable representation of link volumes which were comparable to the recorded traffic volumes extracted either from primary traffic count data or secondary traffic count data. Based on the robustness of the model a standard deviation of 20% (±) of the calibrated volumes to counted volumes was assumed acceptable.

Respective capacities of roads of different lane configurations were extracted from applicable IRC Code, which were used to develop a detail volume-capacity (V/C) ratio analysis under existing conditions. The hotspots under the existing traffic conditions were identified based on the V/C analysis. Traffic forecast for the future horizon years developed for the short term horizon (2020), medium term horizon (2025) and far term horizon (2035) were evaluated based on the estimated traffic growth factors in Chapter-6. Further V/C ratio analyses were carried out for all the future horizon years, assuming 'Do Nothing' alternative in Chapter-7. Traffic capacity issues were identified and processed for further consideration in developing road improvement schemes in Chapter-8.

5.2.1 OWD Road Network

The existing road network of the State constitutes approximately 250,000 km length of road, out of which OWD operates and maintains a major road network that generally represents the length of roads that are classified from NHs, SHs, MDRs, and ODRs. This OWD road network is connected with all the existing block headquarters either directly or through lower category of roads (say VRs). The OWD road network including some VRs were, therefore, identified as the optimum road network for this assignment to develop the State level OSTM network. The primary emphasis was on capturing the primarily roads with vehicular traffic to identify any those with capacity constraints. The following section elaborates the coded road network.

5.2.2 Coded Road Network for Transport Demand Model

The modeling for travel demand estimation was undertaken using a coded road network in the OSTM and estimated OD matrices. The road network of the State was coded in terms of various types of links for representing NHs, SHs, MDRs, ODRs and few important VRs as well as the network nodes (representing road intersections) and zone centroids. The characteristics of each link gathered from field survey of road inventory were used for coding the road network.

The base year OSTM network was coded with about 12,000 links and 5,300 nodes. The road network inventory survey data provided vital inputs for coding various characteristics of each road link. The important road links were inventoried during the primary data collection stage. The characteristics like divided/undivided carriageway, number of lanes, surface type (paved or unpaved) etc. were attached to each road link by creating various link attributes. **Table 5-1** summarizes the different carriageway type considered and their respective capacities.

Table 5-1: Type of Carriageway and Respective Capacity

Carriageway Type	Capacity in PCU/Day
8-lane divided	160,000
6-lane divided	120,000
4-lane divided	80,000
2-lane with paved shoulder	36,000
2-lane without paved shoulder	30,000
Intermediate lane (5.5m wide)	12,000
Single lane	4,000

Note: Capacity of 6-lane and 8-lane roads are estimated in proportion of 4-lane road, as it is not specified in IRC codes and standards. Source: IRC: 64-1990.

The capacity for each road type was adopted as per 'IRC: 64 - 1990 'Guidelines for Capacity of Roads in Rural Areas'. The list of attributes attached to each road link of the network is illustrated in **Figure 5-1**.

Type of road in the OSTM was defined in *'TYPE'* as NH, SH, MDR, ODR, or VR and respective highway number was given in *'ROAD_NO'* field. For the purpose of validating the base year model with volume counts, the volume count location numbers were given in the field called as *'SCREENLINE'*.

In order to incorporate the modes which are not modeled such as non-motorized vehicles, two wheelers and three wheelers in the assignment, their volume was given as preload to each road link in the *'PRELOAD'* field.

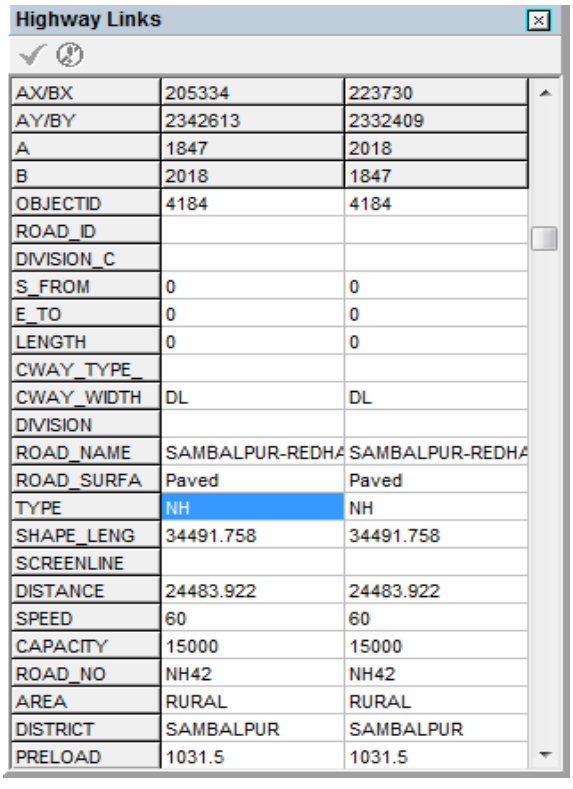


Figure 5-1: Coding of Link attributes

The average daily volumes of these preload vehicles were calculated based on the traffic survey data collected at site. The quantities of preload were calculated based on the lane configurations (width of carriageway in terms of lanes) and road classifications e.g. NH, SH, MDR, ODR etc. and for individual districts in the State. This preloading was applied on different road types for each and every district of the State of Odisha separately, as considered in the model.

The OSTM road network for the base year generally consists of all roads down to ODR classification, although some VRs were included in the model to ensure the coverage of all the screen-lines/survey points included during the traffic survey. The CUBE Voyager model considers a total length of approximately 21,028 Km road network to develop the OSTM.

Table 5-2 summarizes the respective lengths of individual road categories considered to build the OSTM for the State of Odisha. The ***coded road network*** is illustrated in **Appendix 5.1.**

Table 5-2: Length of Road Network in Km adopted in OSTM

Road Classification	Lane Configuration[7]							
	8-lane	6-lane	4-lane	2-lane + paved shoulder	2-lane	Intermediate lane	Single lane	Total
National Highway	-	62	541	6	1,769	1,229	-	**3,607**
State Highway	-	-	8	73	893	1,112	1,565	**3,651**
Major District Road	4	21	19	36	433	1,478	1,869	**3,860**
Other District Road	-	0	17	29	295	1,423	4,602	**6,367**
Village Road	-	-	-	-	-	-	2,966	**2,966**
Expressway	-	-	2	8	35	13	5	**63**
Total	**4**	**84**	**588**	**151**	**3,425**	**5,255**	**11,008**	**20,514**

5.2.3 Development of Traffic Zones

The formulation of a traffic zone system is the basis of developing necessary attributes of traffic and travel characteristics within and across the study area. The travel demand model represents the travel pattern of respective vehicle classes from one zone to the other covering the entire region. The travel pattern generally consists of local travel (short distance), intra-state travel (medium to long distance), and interstate travel (long distance). The vehicular trips on different road types (on hierarchical road network) represent travel volumes from the origin to destination. Based on the robustness of the subject transportation model the modeling approach included all the Blocks, which were designated as internal traffic zones within Odisha State. The available socio-economic data, such as Block level population and number of employment were utilized to estimate the travel demand for each traffic zone. The external traffic zones were formulated by suitably combining the States outside Odisha orienting along the major access points of inter-state traffic. There were 314 internal traffic zones and 12 external traffic zones.

The details of the zoning allocations in each of the 30 Districts of the State are summarized in **Table 5-3. Figure 5-2** illustrates the internal zones and **Figure 5-3 shows the external zones**. Complete list of traffic zones is enclosed in **Appendix 5.2**.

[7] The lane configuration for National Highway has been adopted from multiple sources including NH Design Study Reports and Google Earth. Lane configurations for all other road categories are based on data provided by the Asset Management Consultant.

Table 5-3: List of Internal and External Traffic Zones

Internal Zones								
Zone Nos.	**District Code**	**District**	**Zone Nos.**	**District Code**	**District**	**Zone Nos.**	**District Code**	**District**
1-7	1	Malkangiri	8-21	2	Koraput	22-31	3	Nabarangapur
32-42	4	Rayagada	43-55	5	Kalahandi	56-60	6	Nuapada
61-72	7	Baragarh	73-86	8	Bolangir	87- 92	9	Sonapur
93- 95	10	Baudh	96-107	11	Kandhamal	108-114	12	Gajapati
115-136	13	Ganjam	137-147	14	Puri	148-157	15	Khordha
158-165	16	Nayagarh	166- 179	17	Cuttack	180-187	18	Dhenkanal
188- 195	19	Anugul	196-198	20	Deogarh	199- 207	21	Sambalpur
208- 212	22	Jharsuguda	213-229	23	Sundargarh	230-242	24	Keonjhar
243-268	25	Mayurbhanj	269-280	26	Balasore	281-287	27	Bhadrak
288-297	28	Jajpur	298-306	29	Kendrapada	307-314	30	Jagatsingpur

External Zones								
Zone Nos.	**Zone Name**	**State**	**Zone Nos.**	**Zone Name**	**State**	**Zone Nos.**	**Zone Name**	**State**
315	West Bengal	West Bengal	316	Jharkhand	Jharkhand	317	Bihar	Bihar
318	North Chhattisgarh	Chhattisgarh	319	Central Chhattisgarh	Chhattisgarh	320	South Chhattisgarh	Chhattisgarh
321	Andhra Pradesh	Andhra Pradesh	322	South India	Karnataka, Tamil Nadu, Pondicherry, Kerala	323	Central India	Madhya Pradesh, Maharashtra
324	West India	Rajasthan, Gujarat	325	North India	Uttar Pradesh, Delhi, Haryana, Punjab, Uttaranchal, Himachal Pradesh, Jammu and Kashmir	326	North-Eastern India	Sikkim, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Arunachal Pradesh

5.2.4 Development of OD Matrices

The existing travel characteristics and travel pattern of a transport corridor or a targeted area are the most useful and credible information for developing a demand assessment. The travel parameters are measured by number of trips, whereas numbers of trips are represented by trip origin and destination matrix. The trip generation matrix is generally termed as Origin Destination matrix, and represented as OD matrix.

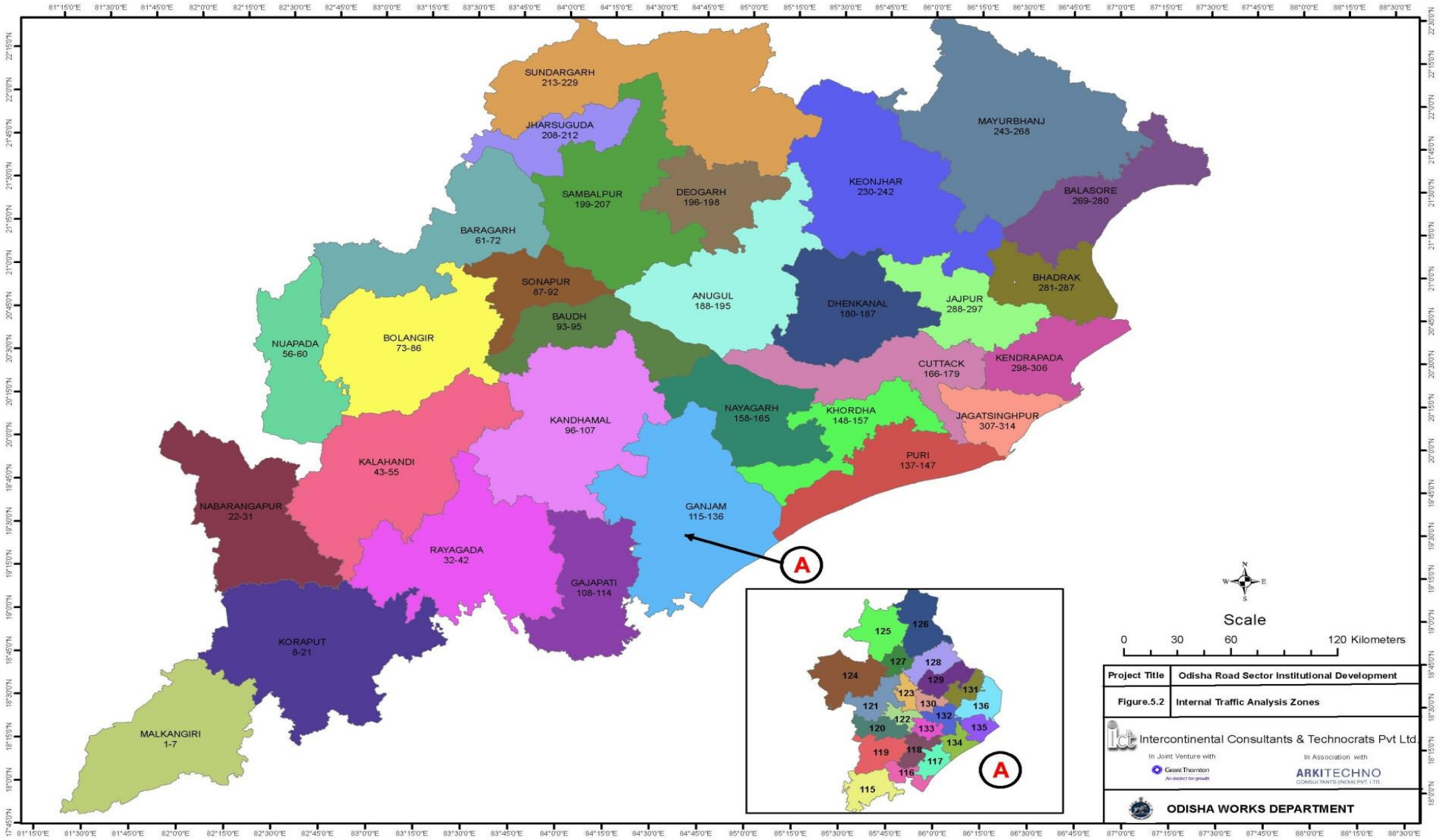


Figure 5-2: Internal Traffic Zones

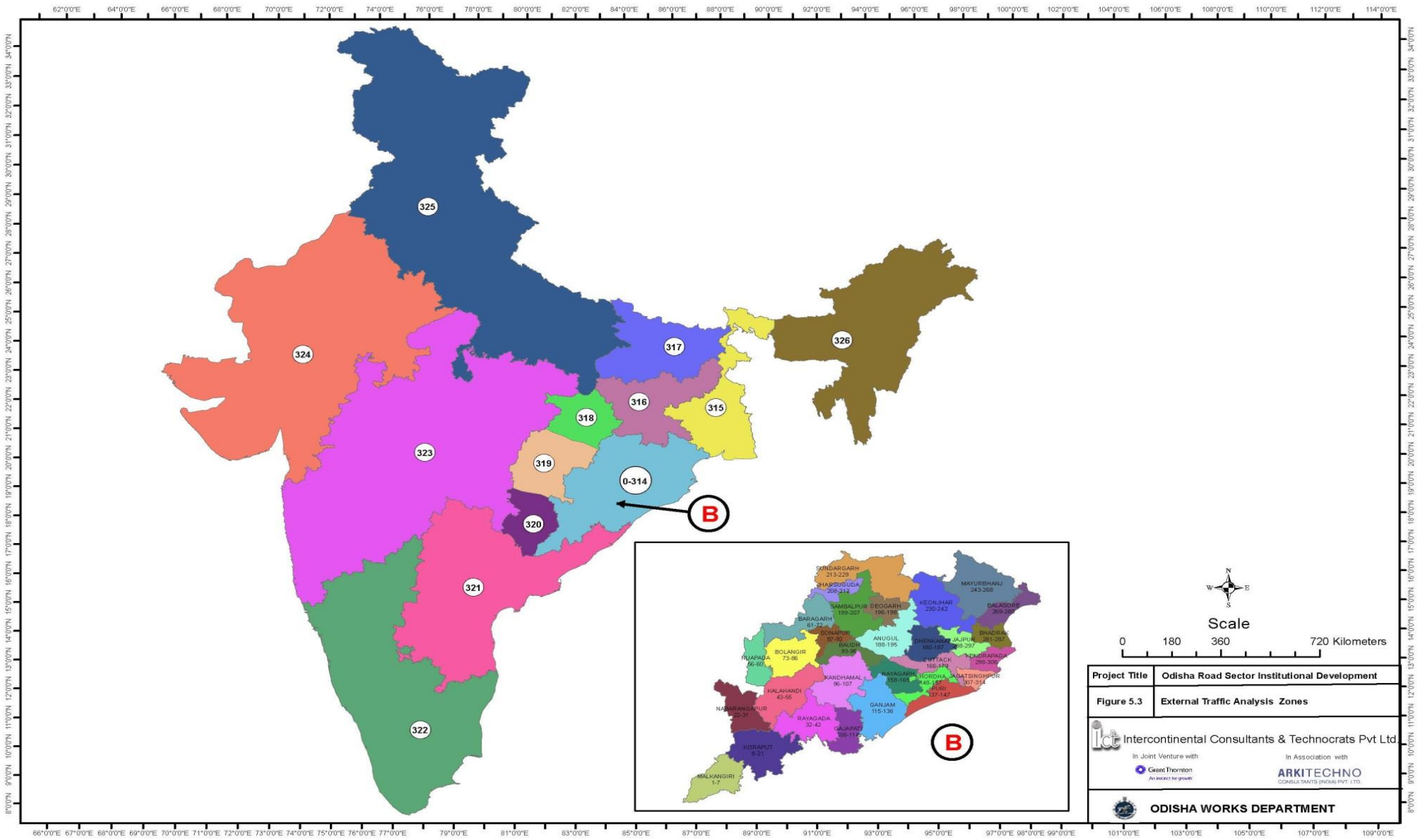


Figure 5-3: External Traffic Zones

Developing a highly reliable transportation macroscopic assignment model generally requires OD survey at a closely and uniformly spaced survey points. Sporadically distributed OD survey points to cover an extremely large study area, like a State, could be misleading, and therefore avoided in the present case. Based on the terms of contract, identifying very widely spaced OD survey points were possible. However due to the large number of link volume counts available for the study area, this assignment involved a reverse OD Matrix estimation approach, and therefore, did not include any OD survey. The reverse OD Matrix estimation (OD from link counts) is a process that utilizes the midblock link counts, as the traffic distribution parameters, whereas the trip-ends due to production and attraction are generally developed utilizing trip generation equations developed for a similar area/neighbouring State of Odisha. This section describes development of a representative matrix through the method of link counts.

The method of developing OD matrix utilizing link counts is primarily based on the 'maximum likelihood technique'. For the current study the 'CUBE Analyst' model had been utilized for estimation of matrices for four vehicular modes, viz. Cars, Buses, Light Commercial Vehicles and Trucks. The process involves the following input data:

- Network characteristics – Road network with applicable attributes that represent travel deterrence, such as distance and time;
- Screen-lines – Traffic survey points on various road links containing observed traffic volumes;
- Seed matrix – OD matrix developed from past traffic studies in the region; and
- Trip ends – Trip generation in the form of 'productions' and 'attractions' for each zone.

Screen-lines Development: Screen-lines and their observed volumes are the essential input in matrix estimation procedure. During an assignment run, the model estimates number of trips between each pair of origins and destinations through several iterations. The primary target is to reduce the difference between estimated trips and observed traffic volume at each screen-line of the road network. For a robust Regional Model, a variation range of ±20% has been found to be acceptable. At the end of this procedure a report file is generated by the software, which shows the number of estimated trips (or traffic volume) at each screen-line location for comparison with the observed traffic volume. It has been observed that the more the iteration, the lesser the variation.

Screen-lines were formed based on the locations of the survey including the recorded traffic volumes derived from primary data survey; traffic survey database prepared by the AMC; and other regional traffic studies conducted on major corridors (NHs and SHs). The traffic volume data from historical regional traffic studies were adjusted applying a growth rate of 5% per annum for integration with the recent data. **Table 5-4** summarizes the screen-line information adopted under different road categories.

Table 5-4: Details of Screen-lines Information

Database	No. of Screen-lines	Road Categories	No. of Locations under each Category
Traffic surveys during Primary Data Collection	113	NH	1
		SH	7
		MDR	8
		ODR	69
		VR	27
		EW	1
Traffic surveys conducted by 3rd Party Consultant on other project	171	NH	-
		SH	76
		MDR	90
		ODR	4
		VR	0
		EW	1
Historical Regional Transportation Studies	19	NH	18
		SH	1
Total Screen-lines	**303**	**All**	**303**

Seed Matrix Development: Seed matrix is an important input in the procedure although not essential. In order to represent a true regional (long distance) travel demand on the major corridors of Odisha, the seed matrix was however developed and incorporated in the transportation model. The matrices of different past studies were converted to the zoning system of the current project and then grouped to form a single OD matrix. Separate OD matrix was prepared to cover each mode. The specific OD cell values of the matrices obtained from survey at various locations, located on parallel routes (or alternative routes between a pair of origin and destination) were added up to get a combined OD between the pair of origin and destination. On the other hand, the OD cell values of matrices obtained from survey locations located on the same route, were combined by taking the maximum cell value as the travel in the particular OD, in order to avoid double counting of the long distance trips captured at more than one survey location. The seed matrix thus obtained contained trips in only few cells as it represents partial travel demand and not the full travel pattern of the State, but the matrix estimated through CUBE Analyst has got trips in all the cells and it represents the travel pattern of the entire region.

Trip End Estimation: Trip ends in the form of productions and attractions for each zone is an important input in the process of matrix estimation, but not essential. The number of trips originating and destined in each zone represents the travel demand of study area across different zones. Trip generation is the first step to develop travel demand forecast. The standard method of traffic generation (trip generations stage) was not adopted due to limitation of data for such a robust study area.

OD matrix estimation can accommodate surrogate measures to estimated trip ends in absence of actual trip ends generated to/from each zone. Hence, the initial trip ends were developed based on the data from regional studies of similar nature and size, conducted in the State of Uttar Pradesh, and Gujarat. In these regional studies the trip ends for each district area were estimated based on the extensive origin-destination surveys and traffic counts. The zone-wise trip ends were developed utilizing the relationship between dependent variable i.e. trip ends (for each mode of vehicle) and

the independent variables i.e. population, GDDP, and number of employments or per capita income etc.

Table 5-5 summarizes the trip generation equations utilized for the transportation modeling purpose.

Table 5-5: Details of Trip Generation

Mode	Trip Generation Equation	R Square
Trip Productions Rates		
Car	$T_{Cars\_P} = 0.5725 \times GDDP - 0.00028 \times Population + 345.29$	0.70
Mini Buses	$T_{Mini\ Buses\_P} = 0.0058 \times Per\ Capita\ Income + 0.00058 \times Population - 143.31$	0.52
Buses	$T_{Buses\_P} = 0.2251 \times GDDP - 97.17$	0.62
LGVs	$T_{LGV\_P} = 0.1452 \times GDDP - 0.00005 \times Population + 46.82$	0.69
Trucks	$T_{Trucks\_P} = 1.1676 \times GDDP - 0.00033 \times Workers + 177.56$	0.65
Trip Attractions Rates		
Car	$T_{Cars\_A} = 0.5629 \times GDDP - 0.00027 \times Population + 271.19$	0.72
Mini Buses	$T_{Mini\ Buses\_A} = 0.0051 \times Per\ Capita\ Income + 0.00048 \times Population - 119.82$	0.43
Buses	$T_{Buses\_A} = 0.2404 \times GDDP - 131.286$	0.57
LGVs	$T_{LGV\_A} = 0.14585 \times GDDP - 0.00007 \times Population + 89.581$	0.76
Trucks	$T_{Trucks\_A} = 1.1025 \times GDDP - 0.00030 \times Workers + 332.81$	0.65

The following **Table 5-6** summarizes the initial trip end estimates for the individual districts of the State.

Table 5-6: Estimated Initial Trip-ends (PCU per Day)

Sl. No.	District	Car		Bus and Mini Bus		Light Commercial Vehicles		Truck	
		P	A	P	A	P	A	P	A
1	Khordha	4,588	4,468	1,994	2,068	1,168	1,182	9,908	9,530
2	Jagatsinghpur	2,161	2,070	803	822	530	558	4,442	4,364
3	Cuttack	4,300	4,189	1,917	1,987	1,102	1,111	9,520	9,164
4	Jajapur	2,536	2,446	1,049	1,078	639	657	5,560	5,421
5	Balasore	2,601	2,515	1,140	1,172	665	677	5,907	5,751
6	Bhadrak	1,512	1,435	566	571	372	395	3,299	3,285
7	Kendrapara	1,334	1,259	483	485	326	349	2,915	2,923
8	Puri	1,695	1,617	677	687	423	442	3,758	3,720
9	Ganjam	4,022	3,926	1,924	1,989	1,050	1,045	9,405	9,058
10	Subarnapur	831	755	161	145	182	216	1,462	1,548

Sl. No.	District	Car		Bus and Mini Bus		Light Commercial Vehicles		Truck	
		P	A	P	A	P	A	P	A
11	Jharsuguda	2,178	2,080	838	842	523	560	4,172	4,108
12	Dhenkanal	1,709	1,625	625	633	417	443	3,552	3,523
13	Baragarh	1,626	1,547	612	620	401	424	3,486	3,464
14	Balangir	1,968	1,885	792	806	491	512	4,292	4,223
15	Nayagarh	973	899	257	250	225	255	1,935	1,996
16	Mayurbhanj	2,396	2,316	1,092	1,118	617	625	5,620	5,480
17	Nabarangapur	1,072	999	332	328	255	281	2,263	2,306
18	Kendujhar	3,989	3,874	1,587	1,658	1,007	1,027	8,494	8,191
19	Sundargarh	3,274	5,406	1,439	2,433	832	1,425	7,174	11,316
20	Anugul	4,667	4,535	1,909	1,982	1,169	1,197	9,618	9,251
21	Kalahandi	1,623	1,545	628	636	402	423	3,558	3,530
22	Sambalpur	2,212	2,119	841	857	541	571	4,473	4,394
23	Nuapada	875	799	179	168	193	228	1,558	1,638
24	Koraput	2,098	2,010	818	834	519	543	4,410	4,335
25	Baudh	756	679	113	96	160	196	1,225	1,324
26	Rayagada	1,449	1,367	481	483	346	376	2,904	2,911
27	Gajapati	904	827	197	185	200	235	1,593	1,672
28	Debagarh	644	569	55	31	129	167	940	84
29	Malkangiri	772	697	138	120	167	201	1,337	1,430
30	Kandhamal	1,868	1,776	710	709	448	481	3,647	3,611

***P** – Trip Production* ***A** – Trip Attractions*

These initial estimated trip ends were further distributed to develop block level (traffic zones) trip generation volumes based on share of population and number of workers of each block in corresponding district.

The seed matrix was updated incorporating the weighted screen-line traffic counts, initial estimated trip ends, and weighted initial seed matrix. A screenshot of the module developed in CUBE Analyst for estimation of matrix from link counts is illustrated in **Figure 5-4.**

Base Year Matrix Calibration & Validation: The matrix estimation process takes into account weighted observed link volumes, seed matrix, trip ends and based on the maximum likelihood technique the estimated trip cell values are determined. The estimated values get validated with respect to the observed screen-line counts.

The weightage associated with screen-lines, trip ends and the seed matrix were calibrated so that the maximum numbers of screen-lines can be validated with GEH[8] between 0-5. The weightages, associated with each screen-line count and the seed matrix, were altered during several iterations to achieve the best fit between the estimated and observed values. The results of the validation with

[8] An empirical formula that has been proven useful for a variety of traffic analysis purposes $GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$

screen-lines achieved during iteration of the entire State level models are summarized below in **Table 5-7**.

The above validation data reflects proximity of the estimated modal trip-ends with observed trip-ends at all the screen-line locations. The respective modal matrices, estimated through the validation process, were utilized in carrying the traffic assignment forward. The base year matrices validation is discussed in the following section.

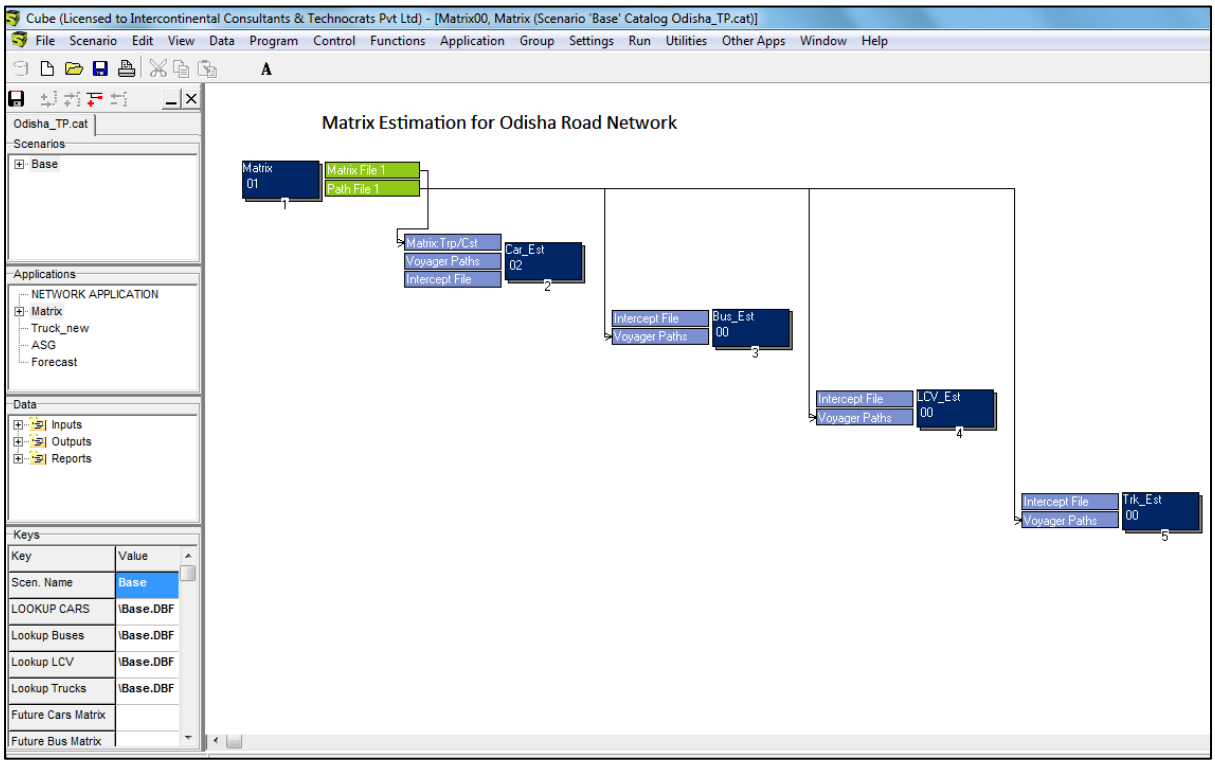


Figure 5-4: Screen shot from CUBE Voyager

Table 5-7: Validation Results of OD Matrix

Modes	GEH Range	Number of Screen-lines[9]	Compliance Percentage
Car	0-5	460	77%
	5-10	140	23%
Bus	0-5	467	78%
	5-10	133	22%
LCV	0-5	495	83%
	5-10	105	17%
Truck	0-5	390	65%
	5-10	210	35%

Base Year Traffic Assignment Validation: For the purpose of validating the traffic volume assignment, various screen-lines have been chosen out of the total screen-lines considered in the entire road network of Odisha. A total of 102 screen-lines were selected out of the total number of

[9] Each screen-line location represents two numbers of screen-lines, one in each direction of traffic movement,

locations with volume data, which are considered for matrix validation that captures assignment volumes and validate the assigned volumes with the observed volumes, covering each district and all categories of roads in the State.

The traffic volumes observed across these screen-lines were compared with the assigned traffic on the network at the stage of model calibration. Due to the strategic nature of the model, and other project stringencies in regards to budget and completion time, a ±20% (for each vehicle mode) variation of the observed volumes were considered to be a good fit. The assignment volumes were generated through several iterations, adjusting the network and deterrence parameters of each mode, until the assigned volumes are within the ±20% variation envelop. The network parameters that were adjusted included identification of any missing links in the robust road network, network speed and the respective capacities of the individual links. There are many data gaps and other factors, primarily related to the driving behaviour and other attributes, which are difficult to model with a reasonable accuracy etc. This non-inclusion might generate over ±5% variation by itself between the observed and assigned traffic volumes. Even under such situation also, the majority of the screelines are matched with less than ±10% or around 10% variation with the observed volumes. The following **Table 5-8** summarizes the result of the traffic assignment.

Table 5-8: Results of Traffic Assignment Validation

Sl. No.	District	Screen-line No.	Road Category	Road No.	Screen-line Volume in PCU (assigned)	Screen-line Volume in PCU (observed)	Variation Percentage
1	ANUGUL	CP-009	MDR	_	988	890	11%
2		CP-011	MDR	_	1,480	1,648	-10%
3		TC-118	MDR	_	1,103	1,074	3%
4		TC-122	ODR	_	2,400	2,746	-13%
5	BALASORE	CP-085	MDR	_	2,917	2,687	9%
6		CP-087	MDR	_	2,246	2,176	3%
7		TC-173	ODR	_	5,252	5,793	-9%
8		TC-175	ODR	_	1,405	1,507	-7%
9		CP-104	SH	_	2,539	2,833	-10%
10	BARAGARH	CP-058	MDR	_	785	885	-11%
11		TC-057	MDR	_	4,050	4,120	-2%
12		TC-053	VR	_	1,492	1,696	-12%
13	BHADRAK	CP-111	MDR	_	1,603	1,698	-6%
14		CP-112	SH	_	1,664	1,839	-10%
15	BOLANGIR	CP-061	MDR	_	995	1,021	-3%
16		TC-061	ODR	_	1,114	1,040	7%
17		CP-057	SH	_	1,356	1,366	-1%
18	BOUDH	TC-073	SH	_	771	797	-3%
19		TC-077	VR	_	990	945	5%
20	CUTTACK	TC-103	MDR	_	6,415	5,890	9%
21		TC-201	NH	NH5	42,527	42,466	0%
22		TC-232	NH	NH42	15,900	16,480	-4%

Sl. No.	District	Screen-line No.	Road Category	Road No.	Screen-line Volume in PCU (assigned)	Screen-line Volume in PCU (observed)	Variation Percentage
23		TC-105	ODR	_	1,905	2,145	-11%
24		CP-003	SH	_	7,340	8,222	-11%
25		CP-013	SH	_	1,604	1,740	-8%
26	DEOGARH	TC-208	NH	NH6	8,150	7,838	4%
27		TC-223	NH	NH6	7,584	7,628	-1%
28		CP-076	SH	_	1,691	2,067	-18%
29	DHENKANAL	CP-023	MDR	_	2,183	2,336	-7%
30		TC-214	NH	NH23	12,763	13,405	-5%
31		TC-233	NH	NH42	19,454	19,762	-2%
32		TC-114	ODR	_	1,639	1,633	0%
33	GAJAPATI	CP-155	MDR	_	1,053	1,112	-5%
34		TC-018	ODR	_	487	498	-2%
35		CP-147	SH	_	1,233	1,100	12%
36		CP-159	SH	_	1,958	2,081	-6%
37	GANJAM	CP-211	MDR	_	3,396	3,685	-8%
38		CP-142	SH	_	3,403	3,708	-8%
39		CP-148	SH	_	1,208	1,285	-6%
40		CP-151	SH	_	2,374	2,661	-11%
41	JAGATSINGHPUR	CP-006	SH	_	3,123	3,305	-5%
42		TC-099	SH	_	1,817	2,086	-13%
43	JAJAPUR	CP-008	MDR	_	712	872	-18%
44		CP-026	MDR	_	1,761	1,668	6%
45		TC-211	NH	NH200	17,458	14,797	18%
46		TC-221	NH	NH5	21,897	21,410	2%
47	JHARSUGUDA	TC-138	NH	NH200	20,836	24,273	-14%
48		TC-137	SH	SH10	23,489	28,628	-18%
49		TC-139	VR	_	4,999	5,206	-4%
50	KALAHANDI	CP-163	MDR	_	1,511	1,719	-12%
51		CP-170	MDR	_	744	792	-6%
52		CP-215	MDR	_	1,021	1,249	-18%
53		CP-167	SH	_	1,535	1,518	1%
54	KANDHAMAL	CP-121	SH	_	1,276	1,204	6%
55		CP-124	SH	_	1,459	1,306	12%
56	KENDRAPADA	CP-002	MDR	_	5,411	6,221	-13%
57		TC-229	NH	NH5A	15,426	13,754	12%
58	KEONJHAR	CP-037	MDR	_	1,137	1,018	12%
59		TC-206	NH	NH6	8,461	9,977	-15%
60		TC-153	ODR	_	491	595	-17%
61		TC-154	ODR	_	1,112	1,307	-15%
62		CP-040	SH	_	1,934	1,827	6%

Sl. No.	District	Screen-line No.	Road Category	Road No.	Screen-line Volume in PCU (assigned)	Screen-line Volume in PCU (observed)	Variation Percentage
63	KHURDHA	CP-197	MDR	_	5,787	6,428	-10%
64		TC-200	NH	NH5	30,516	32,433	-6%
65		TC-088	ODR	_	2,476	2,830	-13%
66		TC-089	ODR	_	1,986	2,149	-8%
67		TC-090	SH	_	5,368	5,878	-9%
68	KORAPUT	CP-190	MDR	_	1,015	1,123	-10%
69		TC-008	ODR	_	1,185	1,316	-10%
70		TC-007	VR	_	656	709	-7%
71	MALKANGIRI	TC-003	SH	_	2,310	2,587	-11%
72		TC-002	VR	_	447	491	-9%
73	MAYURBHANJ	CP-088	MDR	_	1,390	1,538	-10%
74		CP-102	MDR	_	480	484	-1%
75		TC-203	NH	NH6	7,696	8,329	-8%
76		TC-166	ODR	_	533	530	1%
77		CP-096	SH	_	2,066	2,092	-1%
78	NABRANGPUR	CP-168	MDR	_	1,972	2,212	-11%
79		CP-169	SH	_	2,256	2,066	9%
80	NAYAGARH	CP-202	MDR	_	1,400	1,546	-9%
81		TC-081	ODR	_	115	133	-14%
82		TC-085	ODR	_	735	771	-5%
83	NUAPADA	CP-162	MDR	_	430	418	3%
84		TC-050	NH	NH217	5,592	6,003	-7%
85	PURI	CP-192	MDR	_	1,072	1,197	-10%
86		CP-195	MDR	_	5,227	5,367	-3%
87		TC-215	NH	NH203	8,762	7,835	12%
88		CP-196	SH	_	3,271	3,348	-2%
89	RAYAGADA	CP-171	SH	_	1,706	1,842	-7%
90		CP-172	SH	_	1,120	1,210	-7%
91		CP-177	SH	_	6,582	7,101	-7%
92	SAMBALPUR	CP-070	MDR	_	1,398	1,442	-3%
93		CP-068	SH	_	2,496	2,714	-8%
94		TC-131	SH	SH10	22,738	20,410	11%
95		TC-132	VR	_	1,812	1,995	-9%
96	SONEPUR	CP-062	MDR	_	965	997	-3%
97		CP-055	SH	_	2,138	1,890	13%
98	SUNDARGARH	CP-047	MDR	_	8,607	10,340	-17%
99		CP-049	MDR	_	12,469	10,588	18%
100		TC-149	MDR	_	1,611	1,940	-17%
101		CP-073	ODR	_	811	791	3%
102		TC-147	SH	SH10	19,828	21,757	-9%

5.3 Existing Traffic Volumes

The calibrated OSTM with the calibrated OD matrix was run to develop traffic assignment along all the roads considered under the coded road network. The base year traffic volumes along the coded road network are illustrated in varying ranges. The range of traffic volumes were developed based on the available capacity ranges for different lane configurations, which considered ranges starting from ≤4,000 PCUs, 4,000+ to 12,000, 12,000+ to 30,000, 30,000+ to 36,000, 36,000+ to 80,000 and 80,000+. A figure illustrating the existing traffic volume ranges is given in **Appendix 5.3**.

5.4 Traffic Findings

The 'IRC: 64-1990 Guidelines for Capacity of Roads in Rural Areas', has been utilized to determine the DSV and capacity of the road links in Odisha. The guideline presumes rural highways, as all-purpose roads, with no control of access, and with heterogeneous mix of fast and slow moving vehicles, which are the features generally observed in all categories of roads in Odisha.

The guideline recommends that on major arterial roads Level of Service (LOS) B should be adopted for design purposes, while on all other roads, under exceptional circumstances, LOS C could also be adopted for design. For LOS C, DSVs can be taken as 40 percent higher than those for LOS B. For rural (non-urban) roads, the guidelines recommend to adopt daily traffic volumes for capacity analysis instead of hourly volumes. The respective capacities of different road categories in a level terrain are summarized in **Table 5-9**:

Table 5-9: Summary of Available Capacity

Sl. No.	Road Classification	Standard Width (m)	Respective Capacity in PCU/ day
1	*Single Lane*	3.75	4,000[i]
2	*Intermediate Lane*	5.5	12,000
3	*Two-Lane/Two-Lane with Paved Shoulder*	7.0/7.0 + 1.5 shoulder both ways	30,000/36,000
4	*4-Lane Road*	3.5 per Lane + Shoulder	80,000
5	*6-Lane Road*	3.5 per Lane + Shoulder	120,000

i. Values applicable to paved roads only, design service volume will be lower by about 20-30 percent in case of non-paved road.

Network assessment under existing traffic conditions summarize the existing demand to capacity ratios i.e. volume/capacity ratios (V/C) for all the road links. The existing condition analysis also includes existing missing connectivity of all the villages in the State. The missing link analysis was done based on the GIS information and detailed village level maps procured from ORSAC. The following assumptions were made to carry out the V/C analysis:

- Preload traffic (excluded in the assignment model) consists of - 2-wheelers, 3-wheelers, tractors, and non-motorized vehicles;
- Preload traffic volumes are average of preloads observed (from traffic count data) for each road category for each district. The only exception was the preload volumes for rural SL roads, which was considered as 500 PCUs; and

- Traffic assigned on internal links within urban area (city streets) may not be reliable as the zone centroid placement and traffic distribution parameters might be different.

5.4.1 Capacity Issues

Traffic analyses were carried out using a spread sheet approach. The traffic volumes in terms of PCU along the coded road links under the existing traffic conditions were obtained from the calibrated and validated traffic assignment model. The road configuration information i.e. SL/IL/two-lane or multilane was also extracted from the model. The capacity of the road links were considered based on the traffic capacity related IRC guidelines. The analysis flagged all road links on which V/C ratio exceeds 0.5. **Table 5-10** summarizes the demand capacity ratios that exceed the V/C of 0.5 for varying road configurations.

Table 5-10: Road Links with Volume-Capacity Ratio V/C > 0.5

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane
Length of Road Links with V/C > 0.5							
NH	0	568	446	0	21	9	-
SH	539	218	130	34	-	-	-
MDR	349	187	18	-	-	-	-
ODR	261	32	-	-	-	-	-
VR	128	-	-	-	-	-	-
Total	**1,278**	**1,005**	**594**	**34**	**21**	**9**	**0**

5.4.2 Missing Connectivity

ORSAC through OWD provided GIS Maps, which were the basis for the base map prepared to develop the OSTM network and identifying missing links between existing major road network and habitations i.e. villages/hamlets/ backward class and tribal areas in all 30 districts in the State.

Available digital data was analyzed using 'ARC-GIS' software package through 'Query based and Overlay techniques'. The analysis was carried out based on the GIS map and data developed by the AMC for the core road network, and the village level ORSAC data received for all 30 districts, containing updated road network and village boundaries. As per 2001 census data, total number of villages and towns were 51,349 and 138. Based on the GIS analysis of ORSAC data, a total of 51,856 villages including towns were identified in the State. The overall percentage connectivity of the villages by pucca roads are 72.71%. In addition to pucca road connection, approximately 21.60% villages are connected by kutcha roads and approximately 1.9% by track roads. Approximately 3.79% villages do not have any road connection at all. Majority of such villages that do not have any connections are tribal villages, located in hilly areas, where the density of population is also very low.

The road connectivity analysis results are summarized in **Table 5-11**. District wise maps of village connectivity status are given in **Appendix 5.4(A)** and the information in tables is given in **Appendix 5.4(B).**

Table 5-11: Missing Road Connectivity information at Village Level for Odisha

Sl. No.	District	Number of Villages connected by,				
		No Road	Track Road	Kutcha Road	Pucca Road	Total
1	Angul	19	26	393	1474	1912
2	Baleswar	143	64	226	2573	3006
3	Bargarh	8	6	143	1057	1214
4	Bhadrak	18	1	62	1240	1321
5	Bolangir	4	12	102	1682	1800
6	Boudh	19	37	568	560	1184
7	Cuttack	37	8	199	1789	2033
8	Deogarh	65	26	206	547	844
9	Dhenkanal	20	14	221	957	1212
10	Gajapathi	158	45	779	646	1628
11	Ganjam	209	65	427	2587	3288
12	Jagathsinghpur	21	9	214	1056	1300
13	Jajpur	47	31	287	1421	1786
14	Jharsuguda	2	5	95	260	362
15	Kalahandi	152	39	770	1297	2258
16	Kandamal	207	59	1230	1052	2548
17	Kendrapara	36	9	293	1207	1545
18	Keonjhar	61	14	298	1757	2130
19	Khurda	28	22	149	1418	1617
20	Koraput	88	70	584	1272	2014
21	Malkangir	104	41	416	481	1042
22	Mayurbanj	48	18	436	3467	3969
23	Nawarangapur	13	10	291	597	911
24	Nayagarh	52	12	287	1350	1701
25	Nuapada	29	31	148	477	685
26	Puri	45	55	219	1408	1727
27	Rayagada	177	169	1061	1280	2687
28	Sambalpur	82	5	388	862	1337
29	Sonepur	16	48	300	601	965
30	Sundergarh	57	35	410	1328	1830
	Total Villages	**1965**	**986**	**11202**	**37703**	**51856**

The tentative lengths of link roads that will be necessary to connect these disconnected villages were estimated. The necessary road length to connect the villages that are currently linked by walking-track was also calculated based on the actual length of existing track, whereas connection lengths for villages that do not have any connections were estimated based on the aerial distance between the centre of the village and the nearest road. The lengths of required such road connectivity in individual districts were estimated based on ORSAC map data and summarized in **Table 5-12**.

Table 5-12: Tentative Length of Road Required for Villages with No Connection & Track Road

Sl. No.	District	Type of Road	No. of Villages	New/Upgrade Length in KM
1	Angul	No Road	19	9.44
		Track Road	26	26.18
2	Baleswar	No road	143	72.25
		Track Road	64	47.63
3	Bargarh	No Road	8	7.09
		Track Road	6	14.47
4	Bhadrak	No Road	18	11.8
		Track Road	1	0.572
5	Bolangir	No Road	4	4.81
		Track Road	12	11.39
6	Boudh	No Road	19	17.1
		Track Road	37	78.52
7	Cuttack	No Road	37	25.25
		Track Road	8	6.25
8	Deogarh	No Road	65	44.23
		Track Road	26	24.26
9	Dhenkanal	No Road	20	11.49
		Track Road	14	11.79
10	Gajapathi	No Road	158	147.8
		Track Road	45	61
11	Ganjam	No Road	209	152.94
		Track Road	65	68.94
12	Jagathsinghpur	No Road	21	12.01
		Track Road	9	8.79
13	Jajpur	No Road	47	31.16
		Track Road	31	26.19
14	Jharsuguda	No Road	2	1.73
		Track Road	5	4.39
15	Kalahandi	No Road	152	104.72
		Track Road	39	59.24
16	Kandamal	No Road	207	165.58
		Track Road	59	93.98
17	Kendrapara	No Road	36	31.4
		Track Road	9	9.86
18	Keonjhar	No Road	61	43.43
		Track Road	14	13.59
19	Khurda	No Road	28	9.01
		Track Road	22	20.3
20	Koraput	No Road	88	81.75
		Track Road	70	117

Sl. No.	District	Type of Road	No. of Villages	New/Upgrade Length in KM
21	Malkangiri	No Road	104	71.41
		Track Road	41	73.22
22	Mayurbanj	No Road	48	33.15
		Track Road	18	14.57
23	Nawarangapur	No Road	13	16.85
		Track Road	10	14.97
24	Nayagarh	No Road	52	38.16
		Track Road	12	15.41
25	Nuapada	No Road	29	34.39
		Track Road	31	80.87
26	Puri	No Road	45	42.94
		Track Road	55	66.68
27	Rayagada	No Road	177	172.8
		Track Road	169	275.09
28	Sambalpur	No Road	82	97.16
		Track Road	5	6.31
29	Sonepur	No Road	16	6
		Track Road	48	54.27
30	Sundergarh	No Road	57	47.72
		Track Road	35	74.85
		Total	**2951**	**2926.15 km**

The approach for prioritizing the improvement of roads connecting villages to their respective Gram Panchayat HQ and a demonstration (sample) of the same for Baudh block (of Baudh District) is presented in **Appendix 5.5**.

6 Traffic Growth Analysis

Transportation demand is proven to be a direct derivative of the economic activities including their spatial manifestation and the intensity of their operations. The variation of traffic demand has been found to be closely correlated with major economic attributes e.g. 'GDP' or other independent variables, i.e. vehicle registration etc. Home based trips could also be estimated based on population intensity or employment etc., which in turn could identify the traffic demand growth based on projected population or employment data.

The most preferred ways of estimation of traffic growth along a corridor are primarily the historical traffic volumes recorded for three to five years or more in terms of 'Average Annual Daily Traffic' (AADT) along the corridor. Historical turning movement counts could also be very reliable data to estimate traffic growth along any specific corridor or for a specific study area. However, future demand forecasting of potential traffic growth at Regional or State level basing on local variables, e.g. historical volumes or turning movement volumes at intersections etc. could not be possible. Global variables primarily based on economic attributes i.e. 'Number of Registered Motor Vehicles', 'GDP' etc. might be considered to develop an acceptable growth rate. The traffic growth analysis across the entire State was carried out based on the available annual vehicle registration data and other global variables, e.g. GDP, 'NDDP' or 'Gross District Domestic Product' (GDDP) etc. The vehicle registration data showed a high correlation with GDDP.

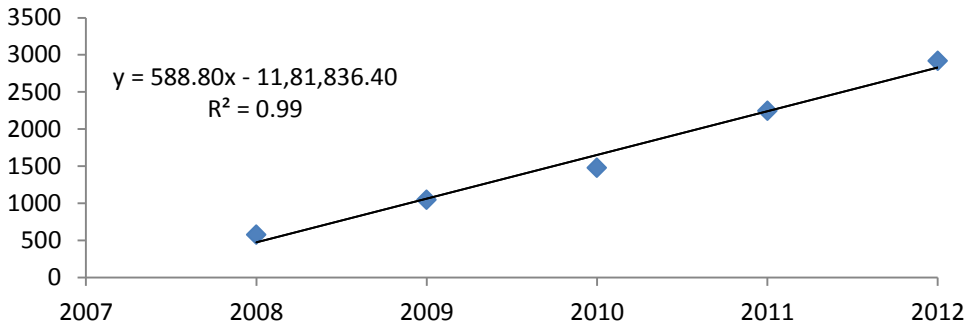
Generally for estimation of growth rates, the time horizons are set. In a Master Planning task, the plan is required to be for 20 years, and therefore, the short, medium and long term horizons can be set as 5, 10 and 20 years. In Odisha Road Network Master Plan a large part of the data from primary and secondary sources are available for base year 2013. However, in view of the preparation time of the Master Plan and the preparation for the implementation of the Master Plan recommendations, it will be possible to be implemented in a framework of 2015-2020, 2020-2025 and 2025-2035 as short, medium and long term horizons. Thus, the growth will be estimated in short term for 2013-2018, in medium term for 2018-2025 and for 2025-2035 in long term horizon, to match with master plan implementation in three horizon periods. This strategy assumes that the economic growth rate of the State will remain sustainable for the short term (5 years i.e. up to 2018), medium term (7 years i.e. 2018-2025) and long term (10 years i.e. 2025-2035) scenarios. Under such situation the vehicle registration growth rate could be presumed to be sustainable over time. The following section discusses the details of the traffic growth estimation adopted for the current study.

6.1 Vehicular Growth Analysis

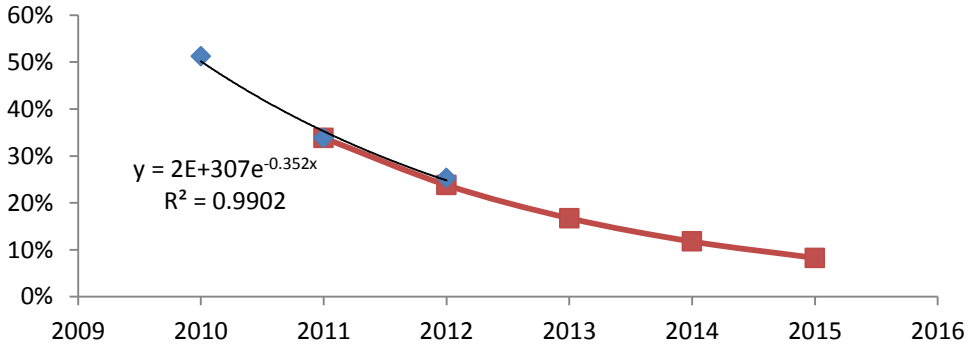
The vehicular volume growth analysis was carried out for individual districts of the State and the analysis was conducted for the distinct travel modes relating to passenger and freight transportation to understand the modal growth trend across the State. The annual vehicle registration data for individual districts were extracted from the data obtained from the Odisha Motor Vehicle Department[10], and were summarized separately for growth analysis of individual modes for individual districts. While the general growth analysis approach remains the same for all the districts, the following paragraph summarizes the approach and findings for **Balasore District**.

[10] Table II – Number of Different Categories of Motor Vehicles Registered in the State

Heavy Vehicles: The following graph illustrates the linear trend of growth in heavy vehicle registration in Balasore District. The simple growth was estimated as 51% with respect to the registered vehicular volumes during 2009, whereas the annual variable growth rates were noted as 51% during 2010, and 34% and 25% during 2011 and 2012, respectively.



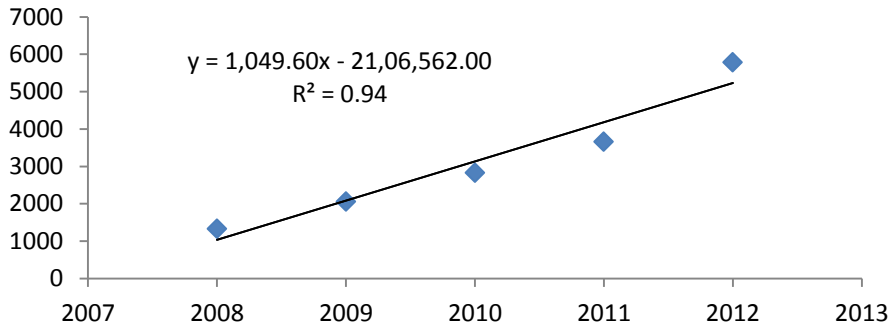
A linear growth rate of 51% was not expected to be sustainable, whereas a non-linear growth rate representing a variable growth rate seemed to be more meaningful and sustainable. The growth analysis was therefore carried out based on the variable growth rate calculated based on vehicle registration recorded for individual year.



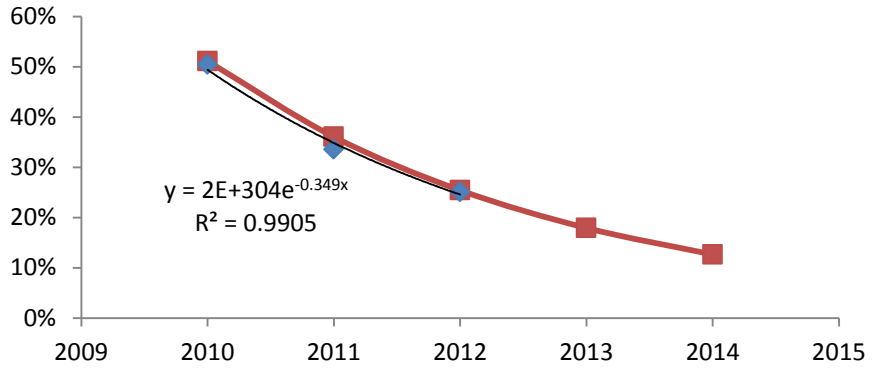
The above graph illustrates the actual variable growth trend and the calibrated growth curve that was developed to forecast heavy vehicle growth for the short term, midterm and far term scenarios. The exponential curve clearly depicts that the growth rate will keep reducing steadily with passage of time, while the regression analysis results reflect that the growth rate of heavy vehicles will remain approximately 9% per annum during the short term period, while the growth rate[11] will saturate and stabilize to 5-6% under the medium term and long term horizons. This is based on Consultant's experience in many States in India and particularly in States surrounding Odisha.

Light Commercial Vehicles: The following graph illustrates the linear growth of light commercial vehicles (LCV). Again, the linear growth rate was not a sustainable growth rate, whereas the variable growth rate reflected 50% growth for 2010 and the growth rate during 2011 and 2012 were 34% and 25%, respectively.

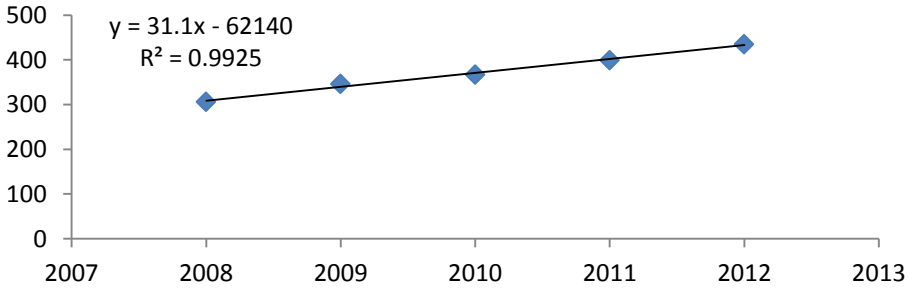
[11] In case the growth rate reduces under longer term, the stabilized growth rate will still remain above 4-5%.



The variable growth rate and the calibrated growth curve are illustrated below. The short term growth rate was estimated to be 10%, while the growth rates under medium term and long term scenarios will saturate and stabilize at 5-6%, as seen in many States in India including the surrounding States.

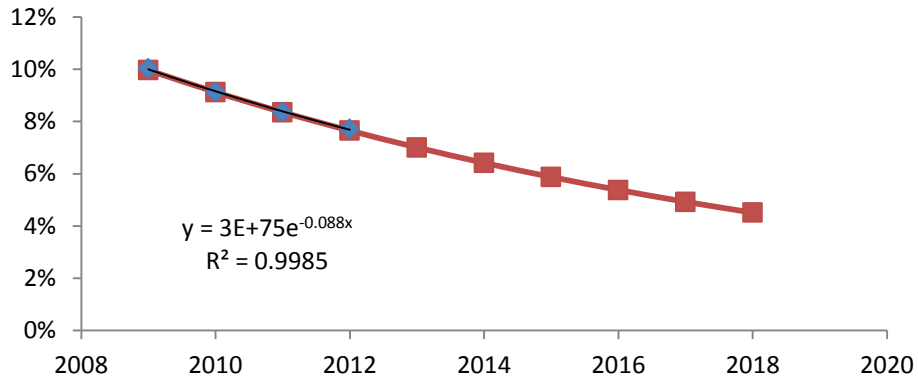


Buses: The linear growth rate for buses reflected a 10% uniform growth over last few years, which is illustrated below:

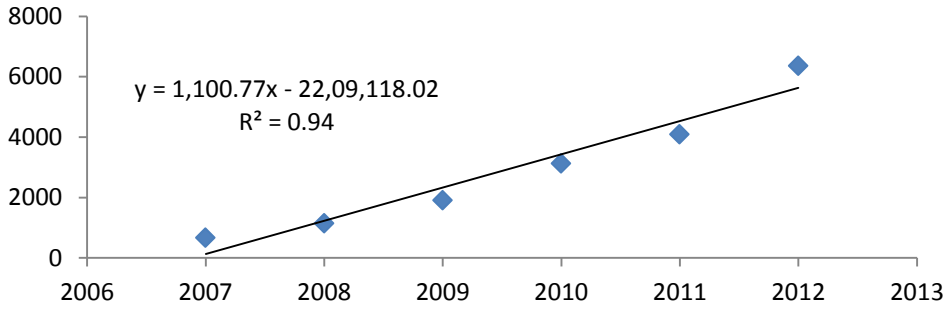


The year to year growth rate represented a growth varying from 10% to 8% from 2009 to 2012.

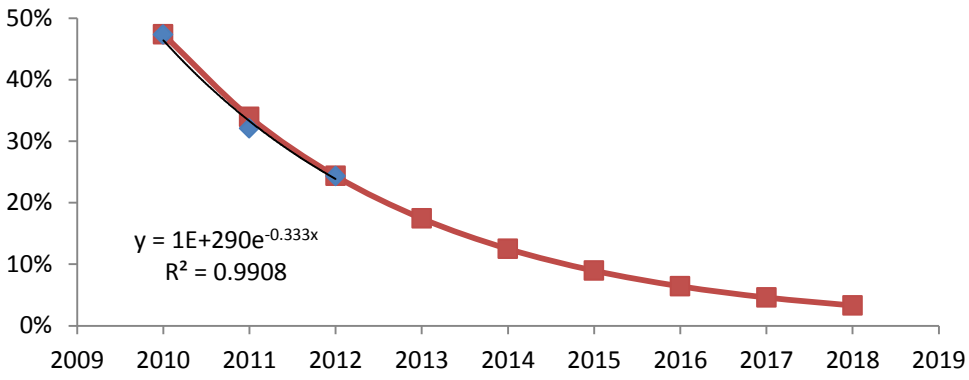
The variable annual growth rate for buses depicts an average 6% growth for the short term horizon, whereas an annual average growth rate of 4-5% will be the stabilized growth rate under the medium term and far term horizon years, respectively. The following graph illustrates the potential variable growth pattern for the coming years.



Passenger Cars: The linear growth rate of passenger cars was estimated as 90% with respect to the base year of 2008, whereas the variable growth rate with respect to the respective previous years were found to be reducing from 90% down to 24% in the year of 2012. The following graph illustrates the linear trend of simple growth.

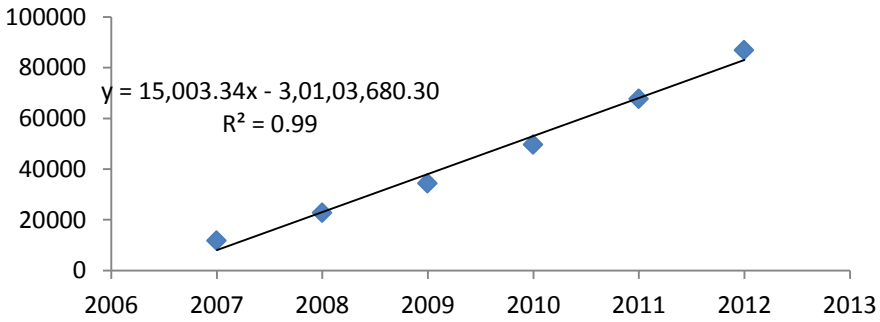


The calibrated exponential curve closely replicating the variable growth is illustrated below:

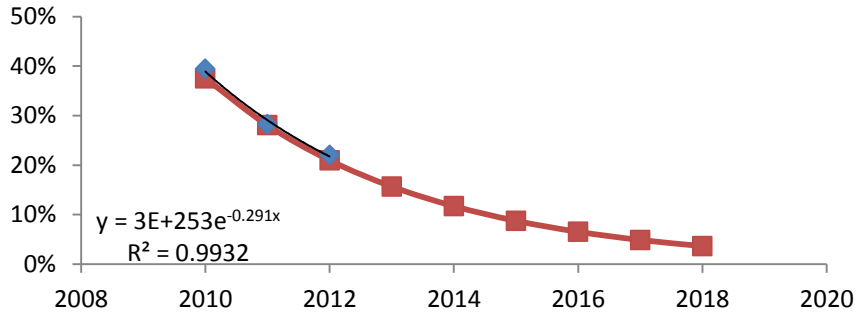


The calibrated growth curve depicts an annual average 10% growth rate under the short term horizon, whereas the annual average growth rate under the medium term and the far term horizon years is expected to be saturating first and then stabilizing to 7-8%. This is based on Consultant's experience in many States of India as well as other surrounding States near Odisha.

Two Wheeler: Two-wheeler growth was found to be almost similar to the passenger car, as expected, although the linear growth rate with respect to two wheeler volumes during 2008, was found to be approximately 65%, whereas the variable annual growth rate varies from 65% down to 22% over a four year period. The following graph illustrates the linear growth trend.

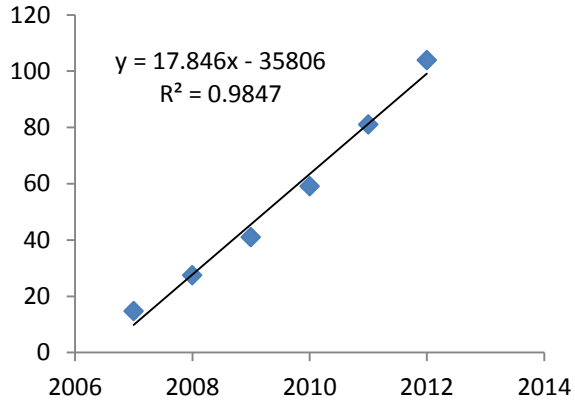


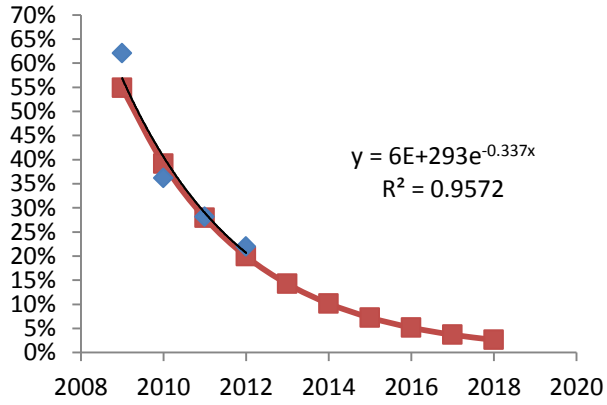
The calibrated growth rate curve replicating the variable growth rate is illustrated below:



The projected variable growth rate depicts an average annual growth rate of 10% during the short term scenario and it is likely to saturate during the medium term and long term horizons to stabilize to about 7-8% in the long term.

All Vehicles Consolidated: Traffic growth was also estimated combining all vehicle types inclusive of passenger and commercial vehicles. The following graphs illustrate the linear simple growth and the variable growth for all vehicles for the district of Balasore. The average variable growth rates for all vehicles were estimated as 9% for the short term, which is likely to saturate and stabilize for the medium term and far term scenarios.





The vehicular growth estimation for other districts was carried out following similar approach. The graphs illustrating the details of the growth prediction for all the districts have been enclosed in the **Appendix 6.1**, and the following **Table 6-1** summarizes the estimated growth forecast for individual districts for specific vehicular categories. The OD matrices were adjusted incorporating the vehicular growth as that estimated for the study horizons.

6.2 Future Development Plans

Necessary information pertaining to future development programs were obtained from different agencies in the State. The primary sources were IPICOL, and Directorate of Ports. The proposed planned developments are supposed to generate considerable additional vehicular trips, which will significantly impact the road network of Odisha based on their respective years/horizons of occurrence. Based on the respective development horizons, additional trips were estimated and the OD matrices were adjusted accordingly. Future demand including the generated trips due to the background developments was assigned onto the road network under corresponding horizon years. The future development that were considered for developing the future total demand, included:

- Port development
- Industrial and mining development
- Tourism development

Table 6-1: Estimated Growth Forecast for Individual District for Specific Vehicular Categories

Sl. No.	District	Heavy Goods Vehicles (HGV)			Light Commercial Vehicle (LCV)			Bus			Passenger Cars			Motorized Two-wheelers		
		2015-2020	2020-2025	2025-2035	2015-2020	2020-2025	2025-2035	2015-2020	2020-2025	2025-2035	2015-2020	2020-2025	2025-2035	2015-2020	2020-2025	2025-2035
1	Balasore	10%	6%	5%	10%	7%	6%	6%	5%	4%	10%	8%	6%	10%	8%	7%
2	Sonepur	10%	6%	5%	10%	7%	6%	8%	5%	4%	12%	8%	6%	10%	8%	7%
3	Khordha	9%	6%	5%	10%	7%	6%	10%	5%	4%	10%	8%	6%	10%	8%	7%
4	Bolangir	10%	6%	5%	10%	7%	6%	8%	5%	4%	12%	8%	6%	10%	8%	7%
5	Jajpur	10%	6%	5%	10%	7%	6%	11%	5%	4%	12%	8%	6%	10%	8%	7%
6	Kendrapara	10%	6%	5%	10%	7%	6%	11%	5%	4%	12%	8%	6%	10%	8%	7%
7	Cuttack	10%	6%	5%	12%	7%	6%	9%	5%	4%	10%	8%	6%	10%	8%	7%
8	Dhenkanal	11%	6%	5%	10%	7%	6%	10%	5%	4%	10%	8%	6%	10%	8%	7%
9	Ganjam	11%	6%	5%	10%	7%	6%	9%	5%	4%	10%	8%	6%	10%	8%	7%
10	Kalahandi	8%	6%	5%	10%	7%	6%	9%	5%	4%	10%	8%	6%	10%	8%	7%
11	Keonjhar	6%	6%	5%	10%	7%	6%	8%	5%	4%	9%	8%	6%	9%	8%	7%
12	Koraput	10%	6%	5%	9%	7%	6%	8%	5%	4%	10%	8%	6%	10%	8%	7%
13	Malkangiri	10%	6%	5%	9%	7%	6%	8%	5%	4%	10%	8%	6%	10%	8%	7%
14	Mayurbhanj	10%	6%	5%	9%	7%	6%	9%	5%	4%	10%	8%	6%	9%	8%	7%
15	Phulbani	12%	6%	5%	8%	7%	6%	9%	5%	4%	8%	8%	6%	9%	8%	7%
16	Baudh	12%	6%	5%	8%	7%	6%	9%	5%	4%	8%	8%	6%	9%	8%	7%
17	Puri	12%	6%	5%	10%	7%	6%	8%	5%	4%	12%	8%	6%	10%	8%	7%
18	Sambalpur	7%	6%	5%	9%	7%	6%	9%	5%	4%	9%	8%	6%	6%	8%	7%
19	Deogarh	7%	6%	5%	9%	7%	6%	9%	5%	4%	9%	8%	6%	6%	8%	7%
20	Sundargarh	12%	6%	5%	11%	7%	6%	12%	5%	4%	14%	8%	6%	11%	8%	7%
21	Bargarh	12%	6%	5%	10%	7%	6%	10%	5%	4%	11%	8%	6%	10%	8%	7%
22	Raygada	10%	6%	5%	8%	7%	6%	6%	5%	4%	10%	8%	6%	10%	8%	7%
23	Angul	10%	6%	5%	12%	7%	6%	10%	5%	4%	10%	8%	6%	10%	8%	7%
24	Gajapati	12%	6%	5%	9%	7%	6%	11%	5%	4%	10%	8%	6%	10%	8%	7%

Sl. No.	District	Heavy Goods Vehicles (HGV)			Light Commercial Vehicle (LCV)			Bus			Passenger Cars			Motorized Two-wheelers		
		2015-2020	2020-2025	2025-2035	2015-2020	2020-2025	2025-2035	2015-2020	2020-2025	2025-2035	2015-2020	2020-2025	2025-2035	2015-2020	2020-2025	2025-2035
25	Jagatsinghpur	10%	6%	5%	10%	7%	6%	11%	5%	4%	11%	8%	6%	10%	8%	7%
26	Bhadrak	9%	6%	5%	8%	7%	6%	11%	5%	4%	12%	8%	6%	10%	8%	7%
27	Jharsaguda	8%	6%	5%	9%	7%	6%	9%	5%	4%	10%	8%	6%	10%	8%	7%
28	Nabrangpur	10%	6%	5%	10%	7%	6%	10%	5%	4%	10%	8%	6%	10%	8%	7%
29	Nayagarh	8%	6%	5%	10%	7%	6%	8%	5%	4%	10%	8%	6%	10%	8%	7%
30	Nuapada	10%	6%	5%	10%	7%	6%	9%	5%	4%	8%	8%	6%	10%	8%	7%

Note: Values are *Average Annual Simple Growth Rate during the horizon periods.*

In absence of future expected growth of vehicle registrations or the GDP data of Odisha, the growth rates have been adopted varying from 5% to 8% for medium term horizon and 4% to 6% for long term horizon for various vehicle types. These are quite reasonable for the economy of Odisha and based on Consultant's experience with other States in India.

Future tourism development plans were not available and therefore not included in the future demand estimation. The additional development trips due to proposed industrial and port development are discussed below in details.

6.2.1 Additional Traffic Demand due to Port Development

Additional traffic demand for new ports were estimated based on the cargo handling capacity of each port. The following five ports were considered to be fully developed and operational within the short term horizon, i.e. by 2020.

1. Dhamra Port
2. Gopalpur Port
3. Astaranga Port
4. Suvarnarekha/Kirtania Port
5. Chudamani Port

The steps adopted in the number of truck trip estimation due to development of these five ports are discussed hereunder:

Step-1: Assumptions for converting Port Cargo (million tons per annum) into number of truck trips per day

- **Number of working days of Port per annum:** 330 days in a year
- **Classification of Cargo vehicles:** The truck fleet will consist of 35% 2-axle Trucks, 40% 3-axle Trucks, and 25% multi-axle vehicles (MAVs). This assumption was made based on the observed truck classification at Paradeep Port, which was 50% of 2-axle, 48% of 3-axle and 2% of MAVs. It is anticipated that in future the share of 2-axle trucks will reduce due to gradual phasing out of old vehicles, and the multi-axle trucks will increase.
- **Pay load of Goods vehicle:** 12 MT for 2-axle Trucks, 17 MT for 3-axle Trucks, and 22 MT for MAVs.

Step-2: Calculate number of truck trips

Based on the assumptions above, the estimated truck traffic for the subject five ports were summarized in **Table 6-2**.

Table 6-2: Estimated Truck Trips for Five Ports

Year	Cargo by Road (MTPA)	No. of Trucks per day			Total PCU
		2-Axle Trucks	3-Axle Trucks	Multi-Axle Trucks	
DHAMRA PORT					
2015-20	6.5	574	463	224	4119
2020-25	9.5	840	677	327	6023
2025-35	12	1061	856	413	7610
ASTRANGA PORT					
2015-20	1	88	71	34	630
2020-25	1.5	133	107	52	954
2025-35	10.5	928	749	362	6660
SUBARNAREKHA PORT					
2015-20	6	530	428	207	3806
2020-25	6.5	574	463	224	4119
2025-35	7.5	663	535	258	4755
CHUDAMANI PORT					
2015-20	0	0	0	0	0
2020-25	1.45	128	103	50	918
2025-35	2.5	221	178	86	1584
GOPALPUR PORT					
Year	**Truck Traffic in PCU/day**	**2-Axle Trucks**	**3-Axle Trucks**	**Multi-Axle Trucks**	
2015-20	4811	561	642	267	-
2020-25	6189	722	825	344	-
2025-35	8519	994	1136	473	-

The port traffic estimated to be generated under the 2020 horizon was added to 2020 demand. Similarly, additional port traffic demand to be generated under 2025 or 2035 horizons had been added to 2025 and 2035 demand matrices, respectively.

Step-3: Calculate passenger car and light commercial vehicle trips

It is worth assuming that with the gradual full build-out of the ports, the surrounding port areas will also be developed simultaneously. Based on relevant data available from secondary sources, it was presumed that a significant development will occur simultaneously, which include ancillary industries, residential townships and service sectors, and other interactive land-uses. This all land-uses will generate considerable traffic in addition to the freight transportation to and from the ports.

Paradeep Port, one of the 12 major ports of India, currently handles around 50 million tonne per annum (MTPA) cargos. NH-5A, a 4-lane road that services Paradeep Port, connects the port with NH-5 at Chandikhol. The traffic volume on NH-5A near Paradeep port was counted in year 2010. The results are summarized in **Table 6-3**.

Table 6-3: Observed Traffic Volume in Year 2010 on NH-5A near Paradip Port

Car	Mini Bus	Bus	LCV	2-W	Auto	Tractor	NMT	2-Axle Trucks	3-Axle Trucks	MAV	Total Vehicle	Total PCU
2398	53	113	647	5773	216	391	2631	2269	2219	92	16824	23854

Source: Feasibility Study for 6-laning of Chandikhole – Paradeep Section of NH-5A.

In regards to the proposed cargo capacity of the planned five ports, the passenger and light commercial vehicle trips are estimated based on the vehicular volumes recorded on NH-5A that is generated by the Paradeep Port. The results are summarized in **Table 6-4**.

Table 6-4: Estimated Passenger and Light Commercial Vehicles Trips for Five Ports

Year	Numbers of Vehicular Trips				Total PCU (in+out)
	Car	Bus	LCV	Total Vehicle (in+out)	
DHAMRA PORT					
2015-20	312	22	84	417	503
2020-25	456	32	123	610	735
2025-35	576	40	155	771	928
ASTRANGA PORT					
2015-20	48	3	13	64	77
2020-25	72	5	19	96	116
2025-35	504	35	136	674	812
SUBARNAREKHA PORT					
2015-20	288	20	78	385	464
2020-25	312	22	84	417	503
2025-35	360	25	97	482	580
CHUDAMANI PORT					
2015-20	0	0	0	0	0
2020-25	70	5	19	93	112
2025-35	120	8	32	161	193
GOPALPUR PORT					
2015-20	363	25	98	486	585

Year	Numbers of Vehicular Trips				Total PCU (in+out)
	Car	Bus	LCV	Total Vehicle (in+out)	
2020-25	467	32	126	625	767
2025-35	643	45	174	862	1,039
Total Vehicular Volumes					
2015-20	1011	70	273	1,354	1,630
2020-25	1377	96	371	1,844	2,221
2025-35	2203	153	594	2,950	3,553

6.2.2 Additional Traffic Demand due to Industrial Development

The details of planned industries including their total targeted capacity during the next five years and existing industries with their future expansion plans are summarized in previous chapter (Chapter 4). The details of estimating the number of truck trips due to development of these five ports are discussed below.

Step-1: Assumptions

- **Number of working days of Port:** 330 in a year
- **Mode share of Goods vehicle:** 35% of 2-axle Trucks, 40% of 3-axle Trucks, and rest of 25% MAVs, the observed fleet distribution at Paradeep port is approximately 50%, 48% and 2% respectively. It is expected that in future the share of 2-axle trucks will reduce due to gradual phasing out of old vehicles, and the multi-axle truck percentage will increase in the fleet.
- **Pay load of Goods vehicle:** 12 MT for 2-axle Trucks, 17 MT for 3-axle Trucks, and 22 MT for MAVs.
- **Share of rail and road in cargo movement:** The mode share of road transport is approximately 40%, based on the rail-road share observed in major industries in Odisha.

Step-2: Truck Trip Estimation

Based on the above assumptions, the numbers of truck trips for year 2020 corresponding to the planned industrial development was estimated. It is to be noted that, part of the transport demand due to these industries is destined to or originating from the Ports which has already been considered in the Development Traffic Estimation of Ports and hence deducted in this estimation (to avoid double counting). The estimated additional number of truck trips for year 2020 is summarized in **Table 6-5**.

Table 6-5: Estimated Additional Truck Trips for Industries

Sl. No.	Name of the Company	Total Capacity of Plant (MTPA)	Remaining Plant Capacity to be Achieved by 2020	2-Axle Truck	3-Axle Trucks	Multi-Axle Trucks
1	Bhusan Power Steel Ltd	2.80	0.40	14	11	6
2	Aarti Steels Ltd.	0.50	0.25	9	7	3
3	Adhunik Metaliks Ltd.	3.20	2.79	98	79	38
4	Narbheram Power & Steel (P) Ltd. (Scaw Industries (P)	0.80	0.75	27	21	10

Sl. No.	Name of the Company	Total Capacity of Plant (MTPA)	Remaining Plant Capacity to be Achieved by 2020	2-Axle Truck	3-Axle Trucks	Multi-Axle Trucks
	Ltd.)					
5	SMC Power Generation Ltd.	1.00	0.75	27	21	10
6	VISA Steel Ltd.	1.00	0.45	16	13	6
7	Shyam DRI Power Ltd.	0.27	0.00	0	0	0
8	SPS Steel & Power Ltd.	0.54	0.25	9	7	3
9	Odisha Sponge Iron & Steels Ltd.	0.95	0.85	30	24	12
10	Maheshwary Ispat Pvt. Ltd.	0.25	0.12	4	3	2
11	MAL Industries Ltd. (Maithan Ispat Ltd.)	0.60	0.40	14	11	6
12	OCL Iron & Steel Ltd.	0.95	0.87	31	25	12
13	Sree Metaliks Ltd.	0.98	0.70	25	20	10
14	Action Ispat & Power (P) Ltd.	0.80	0.55	19	16	8
15	MSP Metallics Pvt. Ltd.	1.00	0.74	26	21	10
16	Aryan Ispat & Power (P) Ltd.	0.30	0.15	5	4	2
17	Patnaik Steel & Alloys Ltd.	0.27	0.17	6	5	2
18	BRG Iron & Steel Co. (P) Ltd.	1.20	1.06	37	30	15
19	Jain Steel & Power Ltd.	0.30	0.20	7	6	3
20	Rathi Steel & Power Ltd	0.30	0.15	5	4	2
21	Viraj Steel & Energy Ltd.	0.30	0.15	5	4	2
22	Deepak Steel & Power Ltd.	0.25	0.05	2	1	1
23	Beekay Steel & Power Ltd.	0.28	0.18	6	5	2
24	JSL Limited	3.20	0.00	0	0	0
25	Eastern Steel & Power Ltd.	0.25	0.15	5	4	2
26	Jai Balaji Jyoti Steels Ltd.	0.33	0.21	7	6	3
27	Rungta Mines Ltd.	2.00	0.02	1	1	0
28	Bhushan Steel Ltd.	6.00	3.00	106	86	41
29	Crackers India Ltd	0.25	0.20	7	6	3
30	Surendra Mining Industries Pvt. Ltd.	0.25	0.20	7	6	3
31	Deo Mines & Minerals (P) Ltd.	0.33	0.33	12	9	5
32	Maharastra Seamless Ltd.	0.48	0.48	17	14	7
33	Sterlite Industries (India) Ltd.	5.00	5.00	177	143	69
34	Tata Steel Ltd.	6.00	6.00	212	171	83
35	Essar Steel Odisha Ltd.	6.00	0.00	0	0	0
36	Konark Ispat Ltd.	0.25	0.25	9	7	3
37	Jindal Steel & Power Ltd.	6.00	6.00	212	171	83

Sl. No.	Name of the Company	Total Capacity of Plant (MTPA)	Remaining Plant Capacity to be Achieved by 2020	2-Axle Truck	3-Axle Trucks	Multi-Axle Trucks
38	POSCO- India Pvt. Ltd	12.00	12.00	424	342	165
39	Welspun Power & Steel Ltd.	3.30	3.30	117	94	45
40	Arcelor Mittal India Ltd	12.00	12.00	424	342	165
41	Monnet Ispat & Energy Ltd.	0.25	0.25	9	7	3
42	SSL Energy Ltd.	3.35	3.35	118	96	46
43	MGM Steel Ltd.	0.25	0.15	5	4	2
44	Pradhan Steel & Power Ltd	0.50	0.50	18	14	7
45	Tecton Ispat Ltd	0.25	0.25	9	7	3
46	Atha Mines Ltd	0.25	0.25	9	7	3
47	Brahmani River Pellet Ltd.	4.00	4.00	141	114	55
48	Brand Alloys Ltd.	0.27	0.21	7	6	3
49	Uttamgalva Steel Ltd.	3.00	3.00	106	86	41
50	Amtek Metal & Mining Ltd.	2.00	2.00	71	57	28
Total Traffic Generation Volume				**2652**	**2138**	**1033**

The additional traffic due to as the planned new port, industries and mining development has been estimated as approximately 6% of the total vehicle volumes inclusive of vehicular growth. The trip distribution and assignment of all this additional development traffic has been discussed in **Chapter 7**.

6.3 Future Intermodal Facility Developments

Necessary information pertaining to any future transportation improvement plans would have been helpful to assess potential traffic diversion from road transportation to other mode of transportation, e.g. water transportation (i.e. merry-go-round) or extended rail transportation. This report will not consider any unauthentic road or intermodal development plans in considering or developing the future mitigation measures through master planning endeavour, in order to develop a conservative trip volumes on the Odisha Road Network.

It is worth noting that inclusion of the future road/intermodal facility will extend further relief to the Odisha Road Network and extend some potential mitigation alternative to address the hotspots identified through the study.

7 Future Traffic Conditions

Future traffic conditions were evaluated through developing traffic forecast volumes based on the calibrated model OSTM for 2013. The future vehicular traffic volumes were developed updating the OD matrix in the OSTM incorporating the calculated total growth based on average annual growth rate for each mode and for each district. The future traffic conditions were evaluated under following three horizons,

a) **Short term horizon (1-5 years):** Forecast traffic volumes under year 2018 traffic conditions included the projected total annual growth for next five years from the base year of 2013. As the recommended road improvements (outcome of this Master Plan study) for the first five years can only be implemented by GOO/OWD beginning from year 2015, the short term road improvements are hereby referred for the period of 2015-2020.
b) **Medium term horizon (6-10 years):** Forecast future traffic volumes for the period 2018 to 2025 (7 years) were estimated adding the growths likely to take place beyond the short term horizon, and the road improvements have been recommended for implementation during five year period of 2020-2025.
c) **Long term horizon (11-20 years):** Similarly, the traffic volumes for long term horizon, i.e. 2025-2035 were estimated adding the growths likely to take place beyond the medium term horizon.

Future development traffic, generated by the planned development consisting of upcoming industries, power sectors and future ports, were estimated based on trip generation estimates and practical assumptions that were discussed in the previous chapter. The future development traffic volumes were estimated under the short term (2020), midterm (2025) and long term (2035) traffic horizons.

Future total traffic volumes were estimated adding the development traffic volumes to the projected future vehicular traffic volumes estimated from the normal economic growth of the State. The future forecast of traffic volumes involved OSTM matrix balancing through Fratar Model.

7.1 Travel Matrices

The estimation of future OSTM travel matrices was completed through two steps, with background vehicular traffic growth only, and planned developments under the short term, medium term and longer term horizons.

A: Background Traffic (Vehicular Growth)

The Fratar Model was used to distribute the trip ends for the respective OSTM OD matrices developed for each mode included in the OSTM. Fratar distribution is the process of modifying a matrix of values based upon a set of production and attraction factors for each of the zones in the matrix. This is an iterative process and involves the following steps:

- In the first iteration, each row in the matrix is factored according to its production factor. At the end of the iteration, the row totals will match the target row values, but the column totals will most likely not match their targets.

- In the second iteration each column in the modified matrix is factored according to its attraction factor. At the end of the iteration, the column totals will match the target column values, but the row totals may not match their targets.
- This process continues for a number of iterations till the row total and column total converge towards the targeted total trip ends. When the criterion for convergence is met, the process is complete. A complete convergence (target row and column totals obtained for all zones) can only be obtained if the target grand totals for rows and columns are the same.

The future trips estimated for any OSTM zone would be distributed to the movements involving that zone in proportion to the existing trips between the zones and in proportion to the growth rate expected on each zone as per the mathematical relationship given as follows:

$$T_{i-j} = t_{i-j} \times \frac{P_i}{p_i} \times \frac{A_i}{a_i} \times \frac{\sum_{k} t_{i-k}}{\sum_{k} \left[A_k / a_k \right] \times t_{i-k}}$$

T_{i-j} = Future Trips from Zone i to Zone j
t_{i-j} = Present Trips from Zone i to Zone j
P_i = Future trips produced at Zone i
p_i = Present trips produced at Zone i
A_j = Future trips attracted at Zone j
a_j = Present trips attracted at Zone j
k = Total Number of Zones

The typical OSTM module developed in CUBE software for distribution of all modal trips using Fratar Method is illustrated hereunder as a snap shot in **Figure 7-1.**

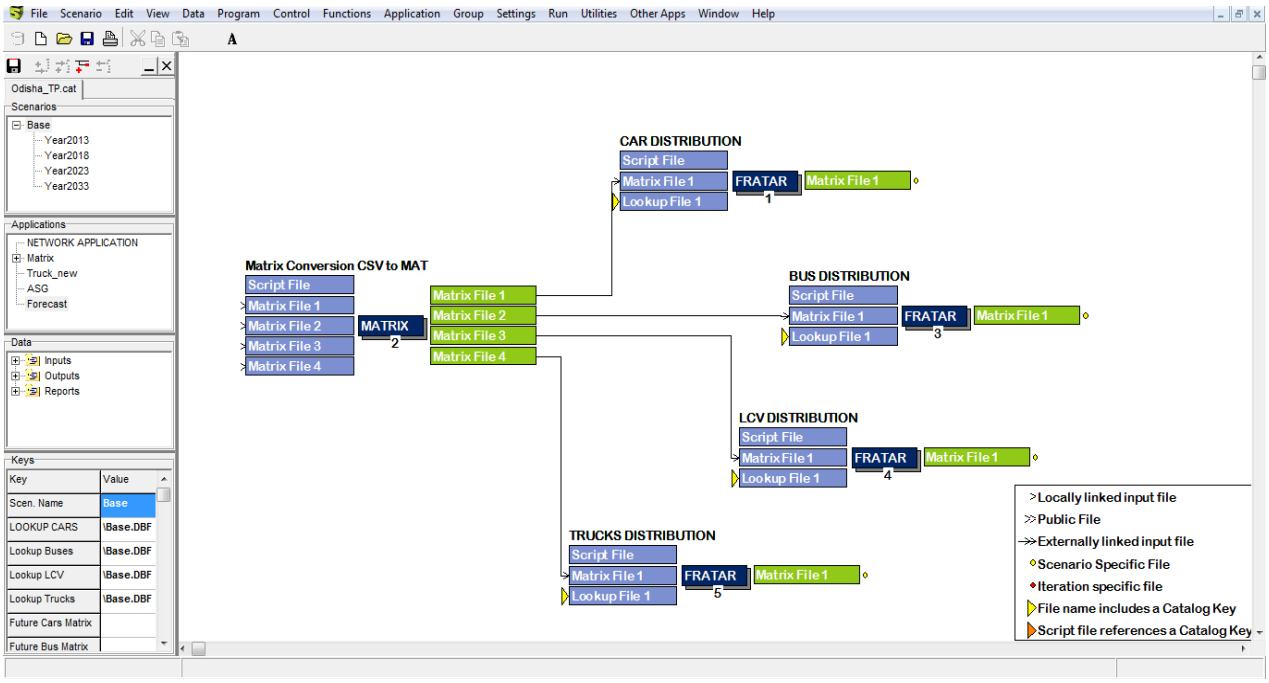


Figure 7-1: OSTM Trip Distribution Module (Fratar Model) Developed in CUBE

The base year trip ends, for all districts of Odisha, used for projection and horizon year trip ends derived based on the growth rates are presented in tabular formats in **Appendix 7.1A**. Further traffic forecasting analyses were continued to develop future traffic volume estimation on the Odisha Road Network, presuming "Do Nothing" alternative. The "Do Nothing" alternative assumes all the road network under existing traffic condition will remain the same and 'No' road improvement will be applied to address any existing and future traffic demands.

B: Development Traffic

The number of trips estimated due to future port and industrial developments were discussed in detail in the previous chapter. The additional trips being generated by all the planned developments were distributed considering the following assumptions:

- **Type of commodities – origins and destinations –** minerals being exported from the ports would originate from the mining areas of Keonjhar, Joda, Barbil, Daitari, etc., similarly steel products that are shipped from the port would originate from Kalinganagar, Rourkela, Tatanagar, etc.
- The proportions of trips to different destinations were estimated assuming the trip volumes would be inversely proportional to the distance between the origins and their destinations;
- Passenger trips, if any, would originate/destined to nearby future residential areas, expected to be built-up around the proposed developments.

The trip distribution assumptions remained typical for all future ports and industries, while the following paragraph summarizes the approach adopted for Dhamra Port.

The estimated traffic for Dhamra Port is summarized in **Table 7-1**.

Table 7-1: Development of Traffic due to Dhamra Port

Year	Type of Commodity	Cargo Movement by Road (MTPA)	2-Axle Trucks	3-Axle Trucks	MAV	Car	Bus	LCV	Total Vehicles
2015-2020	Iron Ore, Steel, and Limestone	6.5	574	463	224	312	22	84	**1,679**
2020-2025		9.5	840	677	327	456	32	123	**2,454**
2025-2035		12	1,061	856	413	576	40	155	**3,100**

The share of trips destined to different zones from Dhamra Port and the number of trips from each zone of origin to Dhamra Port are summarized in **Table 7-2**.

Table 7-2: Number of Trips Distributed to different Origins/Destinations for Dhamra Port

Share of Trips	Origin/destination Zone Number (Name)	Mode	Number of Trips		
			Year 2020	Year 2025	Year 2035
50%	230 (Joda)	Truck	630	922	1,165
25%	288 (Sukinda)	Truck	315	461	582
25%	316 (Tatanagar)	Truck	315	461	582

Share of Trips	Origin/destination Zone Number (Name)	Mode	Number of Trips		
			Year 2020	Year 2025	Year 2035
100%	**Total**	**Truck**	**1,260**	**1,844**	**2,330**
30%	280 (Similia)	Car	94	137	173
30%	277 (Soro)	Car	94	137	173
40%	284 (Bhadrak)	Car	125	182	230
100%	**Total**	**Cars**	**313**	**456**	**576**
25%	273 (Baleswar)	Bus	5	8	10
25%	274 (Remuna)	Bus	5	8	10
50%	284 (Bhadrak)	Bus	11	16	20
100%	**Total**	**Bus**	**22**	**32**	**40**
20%	288 (Sukinda)	LCV	17	25	31
50%	191 (Talcher)	LCV	42	61	78
30%	284 (Bhadrak)	LCV	25	37	47
100%	**Total**	**LCV**	**84**	**124**	**156**

The estimated trip ends due to development traffic for horizon years 2020, 2025, and 2035 covering all the ports and industries, are presented in tabular formats in **Appendix 7.1B**.

C: Future Total Traffic

Future total traffic volumes were estimated adding 'Future Vehicular Growth' volumes and 'Future Development Traffic' volumes. The travel matrices for all modes were updated accordingly to reflect future total traffic trip ends. The combined trip ends for horizon years 2020, 2025, and 2035 are presented in tabular formats in **Appendix 7.1C**.

7.2 Future Background Traffic Volumes–Vehicular growth only

The updated model with the estimated OSTM OD matrices for all the future horizon years of 2020, 2025 and 2035 was run to develop traffic assignment for the respective horizon years along all the roads considered under the coded road network. The forecast traffic volumes for the three forecast horizon years are illustrated reflecting varying ranges starting from ≤4,000 PCUs, 4,000+ to 12,000, 12,000+ to 30,000, 30,000+ to 36,000, 36,000+ to 80,000 and >80,000. Respective figures illustrating the future forecast traffic volume shown in ranges described are given in **Appendix 7.2A**.

7.3 Traffic Findings –Vehicular Growth only

The 'IRC: 64-1990 Guidelines for Capacity of Roads in Rural Areas', has again been utilized to determine the DSV and capacity (V/C) of the road links in Odisha. Also, this analysis for the situation, where the traffic growth is considered to be only from normal socio-economic growth of the State. This will be worth noting that the future road configuration is assumed to remain 'as is' under this "Do Nothing" alternative. Traffic findings under future traffic conditions summarize the future V/C ratios for all the road links under 2020, 2025 and 2035 traffic conditions. The missing connectivity of all the villages in the State was assumed to remain the 'as is'. The following assumptions were again made to carry out the V/C analysis:

- Preload traffic (excluded in the assignment model) consists of 2-wheelers, 3-wheelers, tractors, and non-motorized vehicles; and
- Preload traffic volumes were adjusted assuming an average growth rate of 5% per year (i.e. 2% growth for non-motorized vehicles and calculated growth rate for 2-wheelers) for the 2020 horizon and simple 4-8% per year growth for different modes for the horizon years of 2025 and 2035.

7.3.1 Capacity Issues

Traffic analyses were carried out using a spread sheet approach. The traffic volumes in terms of PCU along the coded road links under the existing traffic conditions were obtained from the calibrated and validated traffic assignment resulted from OSTM run. The road configuration information i.e. SL/IL/two-lane or multilane was also extracted from the OSTM. The capacity of the road links were considered based on the respective road classification as suggested in IRC guidelines. The analysis flagged all road links on which V/C ratio exceeds 0.5. **Table 7-3** to **Table 7-5** summarizes the volume capacity ratios that exceed the V/C of 0.5 for varying road configurations under 2020, 2025 and 2035, respectively.

Table 7-3: Road Length with Volume Capacity Ratio (2020) V/C > 0.5

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	932	1,274	2	231	37	0	**2,475**
SH	835	494	145	45	0	0	0	**1,519**
MDR	553	373	67	0	0	0	0	**993**
ODR	561	82	12	1	0	0	0	**655**
VR	452	0	0	0	0	0	0	**452**
Total	**2,400**	**1,881**	**1,497**	**48**	**231**	**37**	**0**	**6,094**

Table 7-4: Road Length with Volume Capacity Ratio (2025) V/C > 0.5

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	1,041	1,657	6	453	61	0	**3,217**
SH	1,224	720	159	52	0	0	0	**2,156**
MDR	815	530	124	0	0	0	0	**1,469**
ODR	889	181	12	1	0	0	0	**1,082**
VR	683	0	0	0	0	0	0	**683**
Total	**3,611**	**2,472**	**1,951**	**59**	**453**	**61**	**0**	**8,608**

Table 7-5: Road Length with Volume Capacity Ratio (2035) V/C > 0.5

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	1,058	1,768	6	528	62	0	**3,421**
SH	1,419	1,043	406	53	1	0	0	**2,922**
MDR	1,281	1,112	211	1	9	0	0	**2,615**
ODR	1,792	499	35	3	0	0	0	**2,329**
VR	1,059	0	0	0	0	0	0	**1,059**
Total	**5,551**	**3,712**	**2,419**	**63**	**538**	**62**	**0**	**12,346**

The performance analysis results, even without any new developments considered for traffic forecast, clearly reflect that under 2020 a total road length of 6,094 Km will be capacity constrained, whereas under 2025 traffic horizon a further length of 8,608 Km of road length will be added to the constrained road network, and by 2035 a total length of 12,346 Km will operate under capacity constrained condition. The overall findings under "Do Nothing" alternative is given in **Appendix 7.3A**.

7.4 Future Total Traffic Volumes (Vehicular Growth + Development)

The OSTM was updated with combined OD matrices containing future total traffic volumes i.e. vehicular growth plus development traffic under all the future horizons of 2020, 2025 and 2035. The OSTM with updated OD matrices was run to forecast traffic assignment along all the OSTM modeled roads. The forecast traffic volumes are illustrated reflecting varying traffic volume ranges, starting from ≤4,000 PCUs, 4,000+ to 12,000, 12,000+ to 30,000, 30,000+ to 36,000, 36,000+ to 80,000 and >80,000. Figures illustrating the future forecast traffic volume ranges are given in **Appendix 7.2B**.

7.5 Traffic Findings – Future Total Traffic

The 'IRC: 64-1990 Guidelines for Capacity of Roads in Rural Areas', has again been utilized to determine the DSV and capacity of the road links in Odisha. This will be worth noting that the future road configuration remains 'as is' under this "Do Nothing" alternative. Traffic findings under future total traffic conditions summarize the future V/C ratios for all the road links under 2020, 2025 and 2035 traffic conditions, where normal growth and developmental growth are considered together. The missing connectivity of all the villages in the State remains unchanged. The preloading assumptions as reflected in the previous section remain the same.

7.5.1 Capacity Issues

Traffic analyses were carried out using a spread sheet approach. The traffic volumes in terms of PCU along the coded road links under the existing traffic conditions were obtained from the OSTM. The road configuration and respective capacities were considered as discussed before. The analysis flagged all road links on which V/C ratio exceeds 0.5. **Table 7-6, Table 7-7 and Table 7-8** summarize

the length of roads that exceed volume capacity ratio of 0.5 under 2020, 2025 and 2035, respectively.

Table 7-6: Road Length with Volume Capacity Ratio (2020) for Total Traffic, V/C > 0.5

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	58	969	1476	8	325	59	0	**2,843**
SH	865	563	148	45	0	0	0	**1,622**
MDR	583	403	75	0	0	0	0	**1,061**
ODR	604	87	13	1	0	0	0	**704**
VR	459	0	0	0	0	0	0	**459**
Total	**2,516**	**2,023**	**1,711**	**54**	**325**	**59**	**0**	6,687

Table 7-7: Road Length with Volume Capacity Ratio (2025) for Total Traffic, V/C > 0.5

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	1,035	1,732	6	466	61	0	**3,301**
SH	1,246	802	216	52	1	0	0	**2,318**
MDR	850	559	148	0	9	0	0	**1,567**
ODR	994	245	13	1	0	0	0	**1,253**
VR	751	0	0	0	0	0	0	**751**
Total	**3,842**	**2,641**	**2,110**	**59**	**477**	**61**	**0**	9,190

Table 7-8: Road Length with Volume Capacity Ratio (2035) for Total Traffic, V/C > 0.5

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	1,082	1,768	6	528	62	0	**3,446**
SH	1,412	1,070	463	51	0	0	0	**3,037**
MDR	1,326	1,122	228	1	9	0	0	**2,687**
ODR	1,979	521	91	3	0	0	0	**2,593**
VR	1,216	0	0	0	0	0	0	**1,216**
Total	**5,933**	**3,796**	**2,582**	**63**	**539**	**62**	**0**	12,978

The performance analysis results, of future total traffic conditions clearly reflect that under 2020 a total road length of 6,687 Km will be capacity constrained, under a do nothing scenario. Similarly, under 2025 traffic horizon a total length of 9,190 Km of road length will become capacity constrained, and by 2035 a total length of 12,978 Km will operate under capacity constrained condition. The overall findings under "Do Nothing" alternative is given in **Appendix 7.3B**.

Comparing the scenarios pertaining to the background, and future total traffic conditions, it becomes clear that approximately 32% of road length will become capacity constrained under short term horizon, whereas approximately 44% and 62% will become capacity constrained under medium term and long term horizons respectively.

8 Road Improvements

The OSTM was used in developing future traffic assignments under future total traffic conditions in consideration of the socio-economic development and the transportation network development in future. Capacity constrained corridors were identified, and road segments that require capacity augmentation under the short term horizon (2020) were identified at the first step for improvements. Considering the targeted functional attributes of the regional network set under Road Development Plan - Vision 2021, strategic road improvements were developed and incorporated in the OSTM. Despite of such strategic road improvements, further capacity augmentation was necessary to meet respective traffic demands under the future development scenarios and planned socio-economic developments in State economy. Road improvements incorporated in OSTM under short term were carried forward to the medium term, and improvements incorporated under medium term were carried forward to the long term horizon. Based on additional travel demand on the network under respective horizons, additional capacity constrained corridors were identified and further mitigation measures were recommended under the respective horizons.

8.1 Road Network Improvements

The road network improvements that were considered for necessary incorporation in the OSTM included:

- The on-going or planned road (NH) improvements by NHAI;
- The on-going or planned road (State Roads) improvements by GOO/OWD
- Strategic road improvements; and
- Improvements towards capacity augmentation.

On-going or Planned Road Improvements: These road improvements are primarily NH improvements[12] that are either already under implementation or planned to be implemented within the short term horizon. These corridor improvements were directly incorporated in the OSTM under short term horizon. Similarly, all State roads development plans under progress and planned are included in the short term network improvement strategies.

Strategic Road Improvements: In line with the target improvements as suggested in Road Development Plan - Vision 2021[13] document, the following road improvements were considered for implementation for the horizon of 2015-2020:

1. Widening of SHs to TL[14] cross-section all through the State of Odisha;
2. Widening of the NH to a TL^3 cross-section throughout Odisha;
3. Improvement of some of the Inter-State Connectivity links for better mobilization and accessibility;

[12] Source: http://www.nhai.org/ppp.htm, http://www.nhai.org/fundedbot.asp

[13] Road Development Plan Vision 2021 (Indian Roads Congress 2001)

[14] All 2-lane sections are considered as 2-lane plus paved shoulder to ensure better operation and safety.

4. Enhanced connectivity to inter-modal transport hubs like Ports, Airports and Rail heads through upgrading existing connecting link/service roads to Port/Airport/Rail heads to ensure efficient transportation of goods and trades;
5. Upgradation of existing road classes that connect existing Towns and Cities with the major road network;
6. Upgradation of existing road classes that connect major Tourist Places of National and State importance.

A map showing the potential major freight corridors has been given in **Appendix 8.1.**

In addition to the above, three strategic corridors have been considered to be of TL[3] cross-section to enhance direct connectivity and to improve efficient freight transport. These strategic corridors are described below:

1. **Vijaywada-Ranchi Corridor:** This is a Nationally Planned North-South corridor that will pass through the State of Odisha. The RNMP ensures that the subject corridor possesses at least a 2-lane[3] to facilitate proper passage of freight and passenger transportation;
2. **Cuttack/Bhubaneswar to Koraput/Jeypore Corridor:** This is an alternative corridor identified based on the desired line diagram, developed during OSTM development. This strategic corridor will facilitate adopting shortest route of travel between the east to west coast of the State avoiding major and widely travelled corridors; and
3. **Keonjhar to Kirtania/Dhamra Port Corridor:** This is another alternative freight corridor that will provide the shortest path between major mining/industrial areas to the existing major ports. This corridor will facilitate freight movements by avoiding major NHs.

Capacity Augmentation: Further to the incorporation of the strategic road improvements in the OSTM, some of the remaining links in the future network will still remain capacity constrained, which require further capacity augmentation. To ensure complete mitigation of all the capacity constrained road segments/corridors as per IRC guidelines, the following steps were adopted. The terminal LOS for the regional road network, as specified under IRC: 64-1990, should be 'B', i.e. a V/C ratio up to 0.5, beyond which capacity augmentation becomes necessary. Based on IRC: SP: 84-2009 widening of four-lane roads becomes warranted when the V/C ratio exceeds 0.75. The capacity augmentation was achieved through:

1. Widening (improvement of) capacity constrained road links*;*
2. Incorporation of alternative routes in the form of Bypasses around major towns/cities; and
3. Incorporation of Missing Links/Bridges for providing shortest path in the network.

8.2 Road Improvements for Short Term (2015-2020)

The road links that warranted improvement under the short term horizon (2020) were identified through the following steps:

Step-1: Identification of congested road links with 'Do Nothing' scenario (vide Chapter 7).

Step-2: Incorporation of the planned road improvements, planned under NHAI/MoRT&H and Odisha Government that are likely to be implemented by year 2020, in the OSTM. Details of such road improvement program under implementation are presented in Table-8 of **Appendix 8.2.**

Step-3: Incorporation of following strategic improvements in the OSTM:

1. **Widening of all SHs to 2-lane[15] cross-section:** Adhering to Road Development Plan - Vision 2021[16], and currently ongoing State initiative all SHs in Odisha should be widened to 2-lane cross-section under the short term horizon. It is worth noting that Vision 2021 recommends widening of all SHs to TLs with some important sections with paved shoulders. Considering better operation and enhanced safety of vulnerable road users all SHs in Odisha are proposed to be TLs and provided with paved shoulders.
2. **Widening of all NHs within the State to 2-Lane cross-section:** Following the recommendations of Road Development Plan - Vision 2021 document all NHs should be widened to 2-lane cross-section throughout the State.
3. **Inter-State Connectivity:** Major interstate routes should be upgraded to SH or NH with 2-lane cross-section. Fifty potential interstate routes crossing the State border were identified, out of which thirty routes, either connecting important towns/cities, or major corridors across the State border, were selected. The selected interstate connectors were considered to be widened to a 2-lane cross-section. These network links have been reclassified to SH category. Table-1 in **Appendix 8.2** provides a detail list of such connector roads**.**
4. **Connectivity to Ports:** The five new ports, Dhamra, Gopalpur, Astaranga, Kirtania/Subarnarekha, and Chudamani are proposed to be connected by a 2-lane road to the nearest NH. All these roads were reclassified to SH category, and shown in Table-2 in **Appendix 8.2,** which provides a detail list of such connector roads.
5. **Towns/Cities Connectivity:** Road Development Plan - Vision 2021 recommends cities or towns with population 5000 or more, should be connected by either SH or with the nearest major road network. One hundred eighty two of such cities and towns were identified in the State based on the Census 2011 data. Out of these identified towns/cities, forty cities/towns were chosen for improvement in higher level network connectivity based on their population. All such connectors were upgraded and reclassified as SH. The existing connectivity status of towns and cities with population 5000 or more is shown in the map given in **Appendix 8.3A**.
6. **Tourist Place Connectivity:** Based on recommendations from Road Development Plan - Vision 2021, major State Tourism Centers of 'National Importance' are proposed to be connected by SHs. Fifteen Tourist Places of National importance were identified and their existing connections were improved to SH. Table-3 in **Appendix 8.2** summarizes the details of such connections, and **Appendix 8.3B** shows the map of connectivity status. *Chapter 11 includes the details of all the proposed connecting link upgradation*.
7. **Widening of MDRs:** Based on the Road Development Plan - Vision 2021 about 40% of total MDRs should be upgraded to 2-lane standard by 2021. 1,250 km out of 2,850km total length of MDR in the State was identified for improvement to 2-lane or widening of existing 2-lane to four-lane cross-section under the short term horizon.
8. **Vijaywada-Ranchi Corridor:** The Vijaywada-Ranchi road corridor was approved in Feb. 2009 for implementation by Govt. of India under a special program for development of roads through the Left Wing Extremism (LWE) affected areas including tribal areas. The corridor, passing through Odisha, connects Vijayawada in Andhra Pradesh with Ranchi in Jharkhand. The total length of the Corridor is approximately 1,632 Km. The length of the corridor within

[15] 2-lane plus paved shoulder for better traffic operation and enhanced road safety

[16] Road Development Plan Vision 2021 (Indian Roads Congress 2001)

the State limit of Odisha is approximately 1,219 Km. Development of this corridor is anticipated to provide a through connection from Vijayawada to Ranchi with potential easier accessibility within Odisha and to the vulnerable areas with improved connectivity. This corridor is proposed to be improved to a 2-lane cross-section under the short term horizon. Table-5 in **Appendix 8.2** summarizes the details of improvement of the National corridor.

9. **Cuttack/Bhubaneswar to Koraput/Jeypore Corridor:** This corridor connects Cuttack on NH-5 and Digapahandi via Simor, Khordha, Nayagarh, and Aska, is located on Berhampur-Govindpur SH on the proposed Vijaywada-Ranchi corridor, which eventually connects Koraput/Jeypore Region. This corridor is also proposed to be a 2-lane road under the short term horizon. Table-6 in **Appendix 8.2** summarizes the details of such widening.
10. **Keonjhar to Kirtania/Dhamra Port Corridor:** This corridor has been strategically recommended to be a 2-lane road under the short term horizon to facilitate direct connections between mines located in Keonjhar with the upcoming ports at Kirtania and Dhamra. This corridor connects Joda in Keonjhar district and Kirtania Port, and -Dhamra Port through Jhumpura, Jharbeda, Karanjia, Rupsa-Basta-Jamjhari-Basudevpur. Table-7 in **Appendix 8.2** summarizes the proposed improvements.

All of these strategic road improvements[17] were incorporated in the OSTM. With all this approximately 2,000 km of additional road network were integrated in the OSTM road network, as lower order roads were upgraded to SH. Updated OD matrices containing the background vehicular growth and planned developments across the State were duly considered in OSTM and model runs were completed to estimate the forecast traffic assignments onto the various road links of the network to identify capacity constrained corridors/links. **Table 8-1** summarizes the length of congested links in the short term horizon despite incorporating all the strategic improvements.

Table 8-1: Congested Road Length in km with Strategic Improvements (Short Term: 2020)

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	0	4	447	545	59	0	**1,054**
SH	0	0	0	148	77	0	0	**225**
MDR	0	15	56	0	0	0	0	**71**
ODR	147	35	1	1	0	0	0	**184**
VR	177	0	0	0	0	0	0	**177**
Total	**324**	**50**	**60**	**596**	**622**	**59**	**0**	**1,711**

Step-4: In order to mitigate the network congestion further capacity augmentation of the road network was considered. The primary target was to improve the links up to 2-lane corridors that

[17] Reclassified SH length was incorporated in OSTM. Entire SH length was assumed to be a 2-lane section with paved shoulder either side. Reclassified MDR and ODR remained in OSTM. The newly reclassified VR of approximately 20,000 Km, upgraded to ODR, was not included in the OSTM due to non-availability of required inventory and traffic survey data.

exceed V/C of 0.5, and 4-lane or 6-lane corridors that exceed V/C of 0.75. The following improvement measures were also considered.

- **Town/City Bypass:** Bypass around a congested city/town was evaluated to ease any congested corridors through a major City/Town that accommodates a significant amount of through traffic. Table-4 in **Appendix 8.2** summarizes such proposed bypasses.
- **Bridging Links:** Bridging locations were identified to provide direct connectivity and develop shortest route of travel that would result in lesser travel time and cost. New bridges were recommended at the following locations,
    a. **Bridge near Banki** in district Cuttack across river Mahanadi, which will provide direct connection between Banki to Nuapatna. The existing road links connecting this bridge were recommended to be reclassified as SH.
    b. **Bridge near Athmalik** in district Angul across river Mahanadi will provide direct connectivity between Athmalik to Puranakatak (on NH224). The existing road links were also recommended to be reclassified to SH.
    c. **Bridge near Chendipada** in district Angul was also identified on the alignment of Vijaywada-Ranchi Corridor to join a missing link between Naktideuli-Angabira-Aunil Road and Chendipada-Bagedia Road. The existing road links connecting the proposed bridge were recommended to be reclassified to SH.

Incorporating all the above network improvements in the OSTM under the short term horizon (2020) all the capacity constrained corridors could be eliminated. The 4-lane and 6-lane roads will still operate with V/C > 0.5, although based on IRC: 84-SP 2009, these multilane roads should be considered for capacity augmentation when V/C exceeds 0.75. **Table 8-2** summarizes the length of road links/corridor that will operate with V/C > 0.5.

Table 8-2: Congested Road Length in km* - beyond Total Improvements (Short Term: 2020)

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	0	0	0	548	55	0	**603**
SH	0	0	0	0	113	0	0	**113**
MDR	0	0	0	0	0	0	0	**0**
ODR	0	0	0	0	0	0	0	**0**
VR	0	0	0	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**661**	**55**	**0**	**716**

**Congested length reflects V/C > 0.5*

The total road improvements that would be necessary under the short term horizon are summarized in **Table 8-3.**

Table 8-3: Total Road Improvements under Short term Horizon (2020)

Road Category	Road length (in Km) recommended for widening to,	
	2-Lane Cross-section with paved shoulder either side, (carriageway width = 10m)	Four-lane with paved shoulder either side, (carriageway width = 17m)
NH	1,126	657
SH	5,065	180
MDR	1,188	2
ODR	427	3
VR	107	5
Total Length	**7,913**	**847**

Note: The length of already planned/ongoing road improvements is not included in the above table.

8.3 Road Improvements for Medium term (2020-2025)

The road links where improvement is required for the horizon 2025 were identified following these steps.

Step-1: The updated OD matrices were estimated including vehicular growth and all other planned developments in the State under the medium term horizon (2025). The OD matrices of travel demand generated by the future scenario were loaded onto the improved OSTM network scenario since 2020. Necessary model runs were undertaken to extract the forecast assignment traffic volumes along the improved road network, after short term horizon. **Table 8-4** given below summarizes the length of road links that will exceed V/C ratio of 0.5 under the medium term horizon of 2025.

Table 8-4: Congested Road Length in km* 2025 – Beyond Short Term Improvements

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	4	0	225	896	59	0	1,184
SH	0	0	0	314	206	0	0	520
MDR	81	17	26	40	11	0	0	174
ODR	41	29	3	59	0	0	0	132
VR	99	0	0	0	0	0	0	99
Total	**222**	**50**	**29**	**638**	**1,113**	**59**	**0**	**2,110**

**Congested length reflects V/C > 0.5*

Step-2: The planned and/or on-going road improvements extracted from the road improvement program of GOO and NHAI/MoRT&H in Odisha. The proposed road improvements were incorporated into OSTM network to represent the base road condition under medium term horizon. Table-8 of **Appendix 8.2** summarizes the planned improvements by NHAI/MoRT&H.

Step-3: Further capacity augmentations were incorporated to mitigate any links up to 2-lane cross-section with V/C > 0.5, and 4-lane+ cross-section with V/C > 0.75 under the future network scenario of 2025 horizon. **Table 8-5** summarizes total link length of the network that will operate with exceeded V/C of 0.5.

Table 8-5: Congested Road Length in km* - with Total Improvements (2025)

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	0	0	0	423	424	0	**847**
SH	0	0	0	0	220	0	0	**220**
MDR	0	0	0	0	11	0	0	**11**
ODR	0	2**	3**	4**	28	0	0	**38**
VR	0	0	0	0	0	0	0	**0**
Total	**0**	**2**	**3**	**4**	**682**	**424**	**0**	**1,116**

**Congested length reflects V/C > 0.5*

*** Congested road sections falling within urban area*

All the additional road improvements considered and incorporated in the OSTM beyond 2020 and requiring capacity enhancement under 2025 horizon are summarized in **Table 8-6**.

Table 8-6: Road Improvements Considered (Medium Term: 2025)

Road Category	Road length (in Km) recommended for widening to,	
	Two-lane with paved shoulders (carriageway width = 10m)	Four-lane (carriageway width = 17m)
NH	-	281
SH	-	310
MDR	260	28
ODR	61	37
VR	177	-
Total Length	**498**	**656**

Note: The length of planned/ongoing road improvements is not included in the above table.

8.4 Road Improvements for Long Term (2025-2035)

The road links where improvements are required beyond the horizon 2025 were identified following these steps.

Step-1: The 2035 OD matrices were updated including all background and planned developments. OSTM was updated with all planned and proposed road improvements for the scenario under medium term 2025 horizon, and was loaded on the updated 2025 road network. Assignment runs were undertaken to extract link traffic volumes for identifying the corridors/road links that becomes capacity constrained (exceed V/C of 0.5) under the demand level scenario of 2035 horizon. **Table 8-7** summarizes the length of road links that exceed V/C of 0.5.

Table 8-7: Congested Road Length in km* 2035 – Beyond Medium Term Improvements

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	7	2	367	1,231	536	2	2,143
SH	0	0	0	644	411	0	0	1,055
MDR	20	20	7	131	43	0	7	220
ODR	75	109	11	42	40	0	11	277
VR	87	0	0	0	5	0	0	92
Total	**182**	**135**	**19**	**1,184**	**1,730**	**536**	**0**	**3,787**

***** Capacity Constrained Corridor represents V/C > 0.5

Step-2: Further capacity augmentations were considered to mitigate any links up to 2-lane cross-section with V/C > 0.5, and 4-lane+ cross-section with V/C > 0.75 under the 2035 horizon. **Table 8-8** summarizes the road length that exceeds V/C of 0.5 after consideration of the improvements.

Table 8-8: Congested Road Length in km* - with Total Improvements (2035)

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
NH	0	7**	2**	0	731	885	0	**1,625**
SH	0	0	0	7**	180	220	0	**393**
MDR	0	5**	1**	6**	13	10	0	**36**
ODR	0	33**	5**	1**	12	0	0	**52**
VR	0	0	0	0	5	0	0	**6**
Total	**0**	**45**	**8**	**15**	**943**	**1,115**	**0**	**2,126**

**Congested length reflects V/C > 0.5*

*** Congested road sections falling within urban area*

All the road improvements considered in OSTM for horizon 2035 are summarized in **Table 8-9**.

Table 8-9: Road Improvements Considered (Long Term 2035)

Road Category	Road length (in Km) recommended for widening to,		
	Two-lane with paved shoulders (carriageway width = 10m)	Four-lane (carriageway width = 17m)	Six-lane (carriageway width = 23m)
NH	-	449	416
SH	-	847	253
MDR	108	155	11
ODR	263	83	0
VR	65	-	-
Total Length	**436**	**1534**	**680**

Note: The length of planned/ongoing road improvements is not included in the above table.

8.5 Summary

Based on the transport demand under the short term, medium term and long term horizons, the capacity constrained corridors were identified under respective horizons. Road improvements including those suggested in the Road Development Plan - Vision 2021, other planned road improvements under State Government and NHAI/MoRT&H were, incorporated in the modeling network of OSTM followed by capacity augmentations of capacity constrained corridors. The following **Table 8-10** summarizes the respective road improvements under the three pre-defined horizon years.

Table 8-10: Summary of Road Improvements from 2015-2035

Road Category	Total length of roads requiring improvement	Length of roads under improvement by NHAI/MoRTH or GOO	Balance length of roads where improvement is proposed under RNMP
Short Term Horizon (2020)			
NH	3,083	1,243	1,839
SH	5,348	160	5,188
MDR	1,190	0	1,190
ODR	430	0	430
VR	113	0	113
Total Length	**10,163**	**1,403**	**8,760**
Medium Term Horizon (2025)			
NH	758	477	281
SH	310	-	310
MDR	288	-	288
ODR	98	-	98
VR	177	-	177
Total Length	**1,631**	**477**	**1,154**
Long Term Horizon (2035)			
NH	865	-	865
SH	1100	-	1100
MDR	274	-	274
ODR	346	-	346
VR	65	-	65
Total Length	**2650**	**-**	**2650**

It becomes apparent that the road improvements required under the short term horizon is significantly higher than that during the following two horizons. The reason of such robust road improvement under the short term horizon is the seriously deficient existing road network, which needs capacity augmentation at the earliest to cope with the existing demand. This might have arisen due to backlog of improvements over last one or two decades. Implementation of strategic road improvement will facilitate eliminating significant traffic congestion issues, whereas further capacity improvements will facilitate augmenting enough capacity to accommodate future demand, which is going to be generated and induced by the social and economic developments planned by the State Government during the next 20 years.

9 Economic Analysis

9.1 Introduction

Effective transportation system in any State/Country is one of the most important components that affects the growth of the State and significantly contributes to the economic, social and environmental uplifts of the State/Country. The economic impacts of transportation can be direct and indirect, where:

- **Direct impacts** effect on accessibility, mobility that enable building-up larger markets and result in travel time and cost savings.
- **Indirect impacts** effect on the economic multiplier for which the price of commodities or services drop and/or their variety increases. The indirect impact extends to the quantity of greenhouse gas emission, as well.

Transportation Economic Analysis yields a comparison of a project costs and benefits over a time period and facilitates the overall evaluation and decision-making process on infrastructure investments including identifying its economic feasibility from a social or government perspective. A detailed economic analysis of the recommended State road network for improvements under the short term, midterm and long term scenarios has been undertaken, and the approach and methodology, and the findings of the economic analysis are presented in this chapter.

The primary objective of this analysis was to identify the feasibility of implementation of the recommended improvements, estimation of Internal Rate of Return (IRR) of the proposed investments and development of a priority road improvement list that identifies potential project implementation during each year for the next 20 years.

9.2 Approach & Methodology

The primary approach adopted for the transportation economic analysis for the RNMP project was a microeconomic approach, as this assesses the impacts of an individual project on the existing transport system. Cost-Benefit Analysis (CBA) was carried out to evaluate all the recommended road improvements proposed to be implemented under the short term, midterm and long term horizons. ***This exercise has been carried out by deploying the Highway Development and Management (HDM-4) Model.*** The HDM-4, which is an analytical tool for economic analysis and testing economic viability of investment alternatives for roads, simulates life cycle conditions, costs and provides economic decision making criteria to choose from multiple alternatives.

The data inputs are drawn from the existing engineering details on the road type, surface condition, geometry, terrain and weather, collected from primary surveys as well as secondary sources. All the costs and benefits for the proposed Odisha road network improvements are estimated and projected, considering the 2013 as the base year for data collection and model development. However, as the Odisha Works Department (OWD) is likely to implement the first five years' development plan from 2015 onwards, the short term horizon for implementation is 2015-2020.

The **'Cost Minimization Approach'** has also been adopted for arriving at the EIRR. The EIRR indicates the rate of return at which the present value of the economic costs and benefits of the project are equal. In other words, it is the discount rate for which the NPV is zero.

The final output of the Economic Analysis includes the **NPV** of the project's economic costs and benefits. This captures the value of today's costs and benefits that occur over the life of the project. The EIRR value is compared with the economically acceptable rate of return, (Currently an EIRR of 12% is considered to be a 'Cut off Rate'). Projects that have an EIRR higher than the economically acceptable rate of return are considered to be worthwhile investments.

The NPV and EIRR provide various information about projects. The NPV provides a decision criterion on whether the project should proceed at all (in general a project with a negative NPV is not encouraged) and also allows direct comparison of actual value between projects. On the other hand, the EIRR is better suited to being a decision criterion only by allowing a project to be compared against a required rate of return, and thus it gives a yes or no answer about economic feasibility of that investment.

The total costs of projects were estimated assuming two scenarios i.e. '**With the Project' (Improvement)** and **'Without the Project' (Do Nothing).** The economic costs relate to the expenditure incurred under "With the Project" condition and the economic benefit would be the savings in cost incurred under "Without the Project" situation which would result in bringing out the net benefit due to implementation of the proposed improvements.

The costs under "With the Project" situation will include both the capital expenditure on the construction of the new roads/widening, and the annual maintenance cost. The benefits in this scenario will be mainly related to **Vehicle Operating Cost** (**VOC**) savings and **Value of Time** (**VOT**) savings. In addition, to these core benefits, there will be significant social (qualitative) benefits like new employments, human developments, greenhouse emission reduction and enhanced road linkages that enhances accessibility and connectivity.

The present analysis considers the costs and benefits associated with Road Network Improvement. The Odisha Road Network was separated into two categories NHs and State Roads (SH, MDR, ODR etc.) and evaluates the three study horizons, i.e. 2020, 2025 and 2035 as part of the 20 year Master Plan.

It has been assumed that all the improvements (Widening/New Construction) suggested in short term will be implemented within during the period 2015-2020. The medium term scenario assumes complete implementation of all recommended road improvements recommended for the short term horizon prior to taking up the improvements recommended for 2020-2025. Similarly, long term scenario assumes that all recommended road improvements implemented by the completion of medium term horizon.

Since a large number of road links in Odisha road network were identified through OSTM assignments for improvements under 2020 horizon, homogeneous sections were developed to undertake the economic analysis. The homogeneous sections of the candidate links were framed based on their similar characteristics. Different links are grouped based on specific ranges of traffic volumes (derived from the OSTM assigned traffic under 2020 horizon); road classes e.g. NH, SH,

MDR etc., existing and proposed road cross-section (proposed widening) for the candidate links e.g. upgradation required for existing SL to proposed 2-lane paved shoulder or 2-lane to 4-lane etc.

The road network links, identified by OSTM as capacity constrained for required improvements, were divided into 118 homogeneous sections for the purpose of analysis. Out of these 118 homogeneous sections/groups, 21 sections/groups were NHs and other 97 sections belonged to SHs/MDR/ODRs.

9.3 Data Inputs for HDM-4

The data inputs for various components, used in HDM-4 analysis are discussed in the following sections.

9.3.1 Vehicle Fleet Characteristics

All fast moving motorized traffic including two wheelers and non-motorized vehicles have been considered. The cost of vehicles and tires were collected from manufacturers and dealers located in Odisha. All the transfer payments such as sales tax and excise duty were deducted from financial costs to arrive at economic costs. The **Table 9-1** presents the vehicle fleet characteristics and economic unit costs for motorized and non-motorized vehicles. Costs pertaining to one representative vehicle were considered for all vehicles categories.

Table 9-1: Motorized Vehicle Fleet Characteristics

Sl. No.	Vehicle Resources	Motorized Two-wheelers	Auto Rickshaw	Car	Mini Bus	Bus
Economic Cost (INR)						
1	New vehicle	43,511	1,19,000	3,23,872	5,84,051	7,78,734
2	Replacement tire	904	904	2,509	8,880	9,657
3	Fuel/liter	33	33	33	35	35
4	Lubricating oil/liter	86	86	86	86	86
5	Maintenance Labor/hour	110	110	110	165	99
6	Crew wages/hour	0	15	0	43	69
7	Annual overhead	1,375	11,000	2,200	11,000	11,000
8	Annual interest	0%	0%	0%	0%	0%
Time Value (INR/hour)						
9	Passenger working time	27	33	53	33	33
10	Passenger non-working time	3	4	6	4	4
11	Cargo	0	0	0	0	0
Other Information						
12	No. of Axles	2	2	2	2	2
13	Annual Km	10,000	24,000	40,000	50,000	80,000
14	Working Hours	300	3,000	1,000	2,000	2,400
15	Avg. Life in years	10	8	10	10	10
16	Avg. No. of Passengers	2	2	2	15	40

Sl. No.	Vehicle Resources	Light Commercial Vehicle	2-Axle Truck	3-Axle Truck	5-Axle Truck	Bicycle	Cycle Rickshaw
Economic Cost (INR)							
1	New vehicle	4,61,052	8,06,544	9,09,711	10,91,653	882	2,016
2	Replacement tire	4,470	9,058	9,058	9,058	0	0
3	Fuel/lit	35	35	35	35	-	-
4	Lubricating oil/lit	86	86	86	86	-	-
5	Maintenance Labor/hour	110	193	193	198	0	0
6	Crew wages/hour	30	40	45	50	0	2
Sl. No.	**Vehicle Resources**	**Light Commercial Vehicle**	**2-Axle Truck**	**3-Axle Truck**	**5-Axle Truck**	**Bicycle**	**Cycle Rickshaw**
7	Annual overhead	33,000	33,000	27,500	22,000	-	-
8	Annual interest	0%	0%	0%	0%	0%	0%
Time Value (INR/hour)							
9	Passenger working time	-	-	-	-	13	15
10	Passenger non-working time	-	-	-	-	2	2
11	Cargo	17	40	40	54		
Other Information							
12	No. of Axles	2	2	3	5		
13	Annual Km	60,000	80,000	90,000	1,00,000	2,500	7,200
14	Working Hours	1,700	2,600	2,800	3,600	150	500
15	Avg. Life in years	10	10	10	12	10	6
16	Avg. No. of Passengers	-	-	-	-	1	3

9.3.2 Road Geometry

The relevant road geometry and traffic characteristic data like operating speeds, carriageway width, number of lanes, capacity, etc. based on the normal IRC standards were used as input to HDM-4. Other geometry data like rise and fall, and curvature were defined based on the type of terrain, i.e. plain, rolling, and hilly**.**

9.3.3 Road Surface Condition

The road surface condition data were extracted from various field investigation results. The availability of detailed data was constrained due to data collection from a sample network, which constitutes a relatively smaller length of road network, and therefore, for the groups of network links aggregate data was used considering the matching characteristics with the observed field data. The aggregate surface condition data were defined with respect to road condition e.g. 'good', 'fair', and 'poor' etc., based on the available data on similar road category within a specific region/district. **Table 9-2** summarizes the aggregate road condition data. Further, the road condition data primary surveys and also those received from the secondary sources (Asset Management Study) are presented in **Appendix 9.1.**

Table 9-2: Aggregated Road Condition Data

Road Condition Details	Good	Fair	Poor
Deflection (mm)	0.7	0.9	1.2
Roughness (IRI m/km)	4	6	10
Total area of cracking (%)	10%	20%	30%
Ravelled area (%)	10%	20%	30%
No. of potholes (no/km)	4	8	12
Edge break (square m/km)	8	10	12
Mean rut depth (mm)	7.5	12.5	25
Texture depth (mm)	0.5	0.7	0.9
Skid resistance (SCRIM 50km/h)	0.4	0.4	0.4

9.3.4 Shadow Pricing Factor

Economic analysis uses economic prices instead of market prices to reflect the true cost. A shadow price factor of 0.9 was considered for the current project to convert the market prices to the economic prices pertaining to construction and maintenance costs.

9.4 Project Costs

Project costs were considered under two scenarios i) "Without the Project" i.e. 'Do Nothing' and ii) "With the Project" i.e. 'Improvement'. The following sections discuss the costs under the two scenarios:

9.4.1 Without the Project (Do Nothing) Scenario

The costs pertaining to "Without the Project" would be the cost of movement of traffic on the existing road under deteriorating traffic conditions. The annual repair and maintenance costs being incurred on the existing roads are also considered under this head. **Table 9-3** summarizes the VOC and VOT values for representative vehicles, for "Do Nothing Scenario" of the project.

Table 9-3: Road User Cost per Vehicle Km. (Do Nothing Scenario)

Vehicle type	Annual Average VOC per vehicle-km (Rs)	Annual Average VOT per vehicle-km (Rs))	Annual Average Road User Cost per vehicle-km (Rs)
State Roads (SH, MDR, ODR, VRs)			
Motorized 2-Wheelers	3.02	1.35	4.37
Auto-rickshaw	3.59	3.31	6.9
Bus	16.48	63.45	79.93
Car	8.18	5.09	13.27
LCV	12.68	1.07	13.74
Mini Bus	13.72	23.79	37.52
Truck 2-Axle	18.05	2.45	20.5
Truck 3-Axle	31.5	2.41	33.91
Truck more than 3-Axle	33.31	3.11	36.42

Vehicle type	Annual Average VOC per vehicle-km (Rs)	Annual Average VOT per vehicle-km (Rs))	Annual Average Road User Cost per vehicle-km (Rs)
National Highways			
Motorized 2-Wheelers	2.75	1.22	3.96
Auto-rickshaw	3.28	2.98	6.25
Bus	15.85	59.51	75.36
Car	7.93	4.78	12.71
LCV	12.29	1	13.29
Mini Bus	13.28	22.32	35.6
Truck 2-Axle	17.61	2.3	19.91
Truck 3-Axle	31	2.3	33.3
Truck more than 3-Axle	34.77	3.13	37.9

9.4.2 With the Project (Improvement) Scenario

Construction Cost **-** The construction cost involves, the cost of (i) surveying, planning and design, (ii) acquisition of land (if any), (iii) construction of roadway improvements, (iv) installation of traffic control devices (if any), (v) cost of supervision, quality control and administrative costs, (vi) installation of other transportation facilities etc.

The construction costs for road improvement were estimated based on the following steps.

Step-1: Based on the number of commercial vehicles (buses, light freight vehicles, and trucks) per day, five groups were created based on the potential traffic loading on roadways. The traffic loading are in terms of Equivalent Standard Axles (ESA)/Million Standard Axle (MSA), and the road groups are as follows:

Group-1: Design traffic up to 10MSA
Group-2: Design traffic over 10 MSA up to 35MSA
Group-3: Design traffic over 35 MSA up to70MSA
Group-4: Design traffic over 70 MSA up to 110MSA
Group-5: Design traffic over 110 MSA up to 150MSA

Step-2: Considering the design traffic loads and various combinations of proposed carriageway widths, the pavement composition was designed. The details of design considerations and recommended pavement compositions are presented in **Appendix 9.2**.

Step-3: Based on the pavement composition designed in previous step the cost estimates were prepared for various combinations of road widening from existing carriageway width to the proposed width (lane configuration). The details of cost estimates are presented in **Appendix 9.3**. **Table 9-4** summarizes the capital cost for various cases of carriageway cross-sections specification.

Table 9-4: Capital Cost – Various Carriageway Cross-Sections

Sl. No.	Group (based on MSA)	Existing Cross-Section	Proposed Cross-Section	Financial Cost/Km (INR)	Economic Cost/km (INR)
1	Group-1 & 2	DL	DLPS	2,83,00,000	2,54,70,000
2	Group-1	IL	DLPS	3,00,00,000	2,70,00,000
3	Group-1	SL	DLPS	3,55,00,000	3,19,50,000
4	Group-1	DL	4L	6,06,00,000	5,45,40,000
5	Group-1	SL	4L	7,15,00,000	6,43,50,000
6	Group-1	DLPS	4L	5,95,00,000	5,35,50,000
7	Group-2	IL	DLPS	3,38,00,000	3,04,20,000
8	Group-2	SL	DLPS	3,96,00,000	3,56,40,000
9	Group-2	DL	4L	6,36,00,000	5,72,40,000
10	Group-2	IL	4L	6,68,00,000	6,01,20,000
11	Group-2	DLPS	4L	6,25,00,000	5,62,50,000
12	Group-3	DL	DLPS	3,36,00,000	3,02,40,000
13	Group-3	IL	DLPS	3,53,00,000	3,17,70,000
14	Group-3	DL	4L	6,68,00,000	6,01,20,000
15	Group-3	IL	4L	7,01,00,000	6,30,90,000
16	Group-3	DLPS	4L	6,56,00,000	5,90,40,000
17	Group-4	DL	4L	7,25,00,000	6,52,50,000
18	Group-5	DL	4L	7,52,00,000	6,76,80,000
19	Group-5	IL	4L	7,74,00,000	6,96,60,000
20	Group-5	4L	6L	8,57,00,000	7,71,30,000

SL, IL and DL represent Single Lane, Intermediate Lane and Double Lane, respectively.

Maintenance cost - The maintenance cost involves the cost of planning and implementation of various maintenance measures implemented on the in-service roads in various time phases. The maintenance costs were estimated as a combination of (i) periodic repair/maintenance (ii) major rehabilitation (iii) operational expenditure of traffic facility, (iv) supervision and installation charges etc. **Table 9-5** summarizes the maintenance cost.

Table 9-5: Maintenance Cost

Description	Financial Cost (INR)	Economical Cost (INR)
Routine maintenance[18]	1,00,000 per lane-km	90,000 per lane-km
Periodic maintenance (Asphalt Surface Course 30mm)	355 per square m	320 per square m
Reconstruction (Asphalt Surface Course 40mm + Asphalt Base Course 50mm)	1,500 per square m	1,350 per square m

[18] Source: Consultancy Services for Providing Technical Assistance to Establish an Asset Management System on the Core State Road Network of Odisha Works Department, Maintenance Plan – Year 1 Final Report, March 2013 prepared by LASA

9.5 Project Benefits

The benefits of a road improvement project are multifold. It improves travel time, ease of journey through providing enhanced road capacity, and on the other hand help significantly reducing congestion costs and curbing GHG gas and other carbon foot print.

The following quantifiable Road User benefits have been considered for the current economic evaluation:

- Savings due to Vehicle Operating Costs (VOC)
- Savings due to Value of Travel Time (VOT)

9.5.1 Savings due to Vehicle Operating Cost

VOCs refer to the travel costs that might vary with vehicle usage and are based on vehicle- km traveled. These costs include fuel, tires, maintenance, repairs, and mileage-dependent depreciation (Booz Allen & Hamilton, 1999). Costs that are not dependent on usage (often called *vehicle ownership costs*) are ignored when estimating VOCs. These may include insurance costs, time-dependent depreciation, financing, and storage

Estimating a change in VOCs can be as simple as using a fixed cost-per-km figure or as complicated as estimating the costs associated with each separate factors affecting VOCs. The average of VOC for the recommended road network improvements derived from the OSTM outputs, was extracted from HDM-4 results.

9.5.2 Savings due to Value of Time

The movement of freight and passenger traffic from deteriorated road conditions to improved road conditions will create economic savings in the form of VOC as well as VOT due to reduced congestion on the roads.

The average of operating cost savings (VOC and VOT) for different categories of vehicles, are summarized in **Table 9-6**.

Table 9-6: Road User Cost Benefits per Vehicle Km

Vehicle Type	Do Nothing (No Improvement)			With Improvement		
	Annual Average VOC per vehicle-km (INR)	Annual Average VOT per vehicle-km (INR)	Annual Average Road User Cost per vehicle-km (INR)	Annual Average VOC per vehicle-km (INR)	Annual Average VOT per vehicle-km (INR)	Annual Average Road User Cost per vehicle-km (INR)
State Roads (SH, MDR, ODR, VRs)						
Motorized 2-Wheelers	3.02	1.35	4.37	2.73	0.42	3.15
Auto-rickshaw	3.59	3.31	6.90	3.26	1.02	4.28
Bus	16.48	63.45	79.93	14.90	19.37	34.28
Car	8.18	5.09	13.27	7.42	1.54	8.96
LCV	12.68	1.07	13.74	11.51	0.32	11.84
Mini Bus	13.72	23.79	37.52	12.47	7.25	19.72

Vehicle Type	Do Nothing (No Improvement)			With Improvement		
	Annual Average VOC per vehicle-km (INR)	Annual Average VOT per vehicle-km (INR)	Annual Average Road User Cost per vehicle-km (INR)	Annual Average VOC per vehicle-km (INR)	Annual Average VOT per vehicle-km (INR)	Annual Average Road User Cost per vehicle-km (INR)
Truck 2-Axle	18.05	2.45	20.50	16.66	0.74	17.40
Truck 3-Axle	31.50	2.41	33.91	28.74	0.73	29.47
Truck more than 3-Axle	33.31	3.11	36.42	30.64	0.95	31.59
National Highways						
Motorized 2-Wheelers	2.75	1.22	3.96	1.67	0.40	2.06
Auto-rickshaw	3.28	2.98	6.25	2.03	0.97	3.00
Bus	15.85	59.51	75.36	9.80	19.48	29.28
Car	7.93	4.78	12.71	4.95	1.54	6.50
LCV	12.29	1.00	13.29	7.76	0.32	8.09
Mini Bus	13.28	22.32	35.60	8.41	7.29	15.70
Truck 2-Axle	17.61	2.30	19.91	12.46	0.75	13.20
Truck 3-Axle	31.00	2.30	33.30	20.54	0.74	21.27
Truck more than 3-Axle	34.77	3.13	37.90	24.98	1.01	25.99

9.6 Other Benefits

New Employments– Construction being the second largest economic activity in India, any change in the level of construction activity has an effect on the GDP, general employment and income of the people. It provides gainful employment to a large number of workers. Recent mechanization of construction sub-sector has resulted in opportunities both for skilled, semi-skilled and unskilled workers. It is, therefore, almost certain that, this kind of investment for the proposed road improvement for the Odisha road network will generate a significant employment for skilled as well as semi-skilled and unskilled category of workers.

Reduction in Carbon Footprints – Land transportation remains one of the main contributors of GHG emissions. This is in addition to traffic congestion and accidents which result in the loss of productivity. The recommended improvements proposed in the RNMP, will certainly improve the performance measures and measure of effectiveness resulting in decrease in congestions and bottlenecks resulting in reduced carbon footprints.

Social Benefits – Improved road conditions or enhanced accessibility to rural habitations generate both economic and social benefits. This is also worth noting that social benefit is one of the key reasons of economic evolution, which has been proved for centuries together. Social benefit, therefore, considered as an important qualitative benefits, which should seriously be considered as a result of additional and enhanced new road accessibility/connectivity. The qualitative benefit should be quantified in economic terms so as to incorporate them as benefits together with the economic benefits.

9.6.1 Economic Internal Rate of Return

The economic analysis of the justifiability of the investments was done using the HDM-4. The entire cost-benefit analysis of the project (118 Homogeneous Sections/Groups) indicates that the project's economic benefits are satisfactory. The overall NPV of the upgrading of Odisha State roads, including the expenditure components pertaining to the maintenance program is positive. The 'Capital Costs' of the proposed improvements will be in the neighbourhood of INR 204,660 million during the short term horizon, approximately INR 14,298 million during the medium term horizon and approximately INR 46,383 million during Long term horizon. **Table 9-7** summarizes the results of the economic analysis in terms of NPV and EIRR, including the cost and benefit parameters of all recommended improvement in all three horizons. The detailed table of the EIRR, NPV and other benefits for each Homogeneous Section, as part of the recommended improvements under different horizons, is presented in **Appendix 9.4**.

Table 9-7: Economic Analysis Summary for Proposed Improvements

Sl. No.	Economic Components	Description (Currency: INR Million)	SH, MDR, ODR and VR Combined	National Highways
Short term Horizon (2015-2020)				
1	**Cost**	Capital	2,04,659.56	69,743.33
2		Recurrent	8,397.56	2,831.31
3	**Benefits**	VOC Saving	2,59,546.92	1,41,979.22
4		Travel Time Savings (MT)	2,12,262.39	1,13,349.67
5		VOC & VOT Savings for NMT	2,174.99	272.17
6	**NPV**	Net Present Value	2,60,927.50	1,83,026.50
7	**EIRR**	Economic Rate of Returns (%)	28.80%	43.10%
Midterm Horizon (2020-2025)				
1	**Cost**	Capital	34,777.33	15,417.03
2		Recurrent	1,466.80	655.62
3	**Benefits**	VOC Saving	49,263.63	11,484.67
4		Travel Time Saving(MT)	41,882.85	12,163.45
5		VOC & VOT Savings for NMT	501.83	65.93
6	**NPV**	Net Present Value	55,437.19	7,641.40
7	**EIRR**	Economic Rate of Returns	29.2%	18.4%
Long Term Horizon (2025-2035)				
1	**Cost**	Capital	93,277.54	37849.79
2		Recurrent	3,676.10	1300.36
3	**Benefits**	VOC Saving	96,120.32	42406.14
4		Travel Time Saving (MT)	66,158.03	30940.34
5		VOC & VOT Savings (NMT)	1,551.27	493.32
6	**NPV**	Net Present Value	66,875.96	34689.65
7	**EIRR**	Economic Rate of Returns %	22.1%	24.1%

9.7 Findings

It becomes apparent that based on EIRR value cut-off criteria (i.e. 12%) the results of the economic analysis reflect that some of the road improvements proposed under the Short Term and Long Term horizons do not qualify for implementation. It is worth noting that various economic benefits accruing from the road improvements are not confined to the road users only. The social desirability of road improvements is much more prominent than the economic benefits only. Enhanced accessibility and mobility result in various social developments that include increased adult literacy, improved health consciousness, increased family income for the low-income group households etc., which benefit both users as well as non-users.

A road improvement scheme could trigger an overall development in rural areas, even to those areas other than where the provision of road access is made. It is nearly impossible to completely isolate the benefits accruing from the road alone, e.g. a road does not directly affect agriculture; however getting the fertilizers to the farms, a road is needed. Based on the above observations it could be concluded that the implementation of recommended road network improvement as part of the phased implementation of RNMP, should not be seen only through user benefit criteria. The existing 15 westerly districts of the State are economically backward, and some of the recommended improvements might not be economically viable due to low demand for travel on those roads. However, not providing necessary infrastructure to these backward areas will leave these areas avoided forever, which will eventually lower the progress of the State of Odisha as a whole. There has to be some other criteria for project implementation, which can do justice to the rural and tribal areas, where there is very scanty road availability, along with very low traffic.

The criterion of ensuring project viability based on results from economic analysis only, has therefore, been discouraged and a multi-criteria analysis is proposed for finalization of the prioritization of highway improvement projects in a reasonable manner.

10 Prioritization of Road Network in RNMP

10.1 Background

Further to the findings from the economic analysis of the Odisha State road network, an enhanced approach was undertaken to establish the priority of the recommended road improvements. To develop the priority list, the proposed approach targeted to include all the following attributes as potential input to a Multiple Account Evaluation (MAE).

- V/C ratio – Congested corridors;
- Road –route serving inter-state traffic;
- Backward area linkage;
- High commercial traffic;
- Strategic/Industrial linkage;
- Road condition
- Traffic growth rate;
- Road connectivity;
- Alternate route;
- Environmental aspects, tribal areas etc.

In addition to the above parameters various socio economic parameters and other relevant data, as discussed in the following sections in this chapter, were also used to successfully complete the planned MAE.

10.1.1 Objective of Prioritization

The primary objective of the prioritization process[19] was to ensure that:

- The decisions are not based only on the basis of perceived user benefits and Internal Rate of Return (IRR) criteria.
- A multiple criteria decision making process is utilized to increase the efficiency of highway/ road investment.

The primary needs for prioritization through MAE was multifold as listed below:

i. If the project is constrained by budget or schedule, the MAE will help to decide change in weightage of input parameters that best suites the requirements;
ii. Prioritizing road sections or road links, and identifying benefits, costs and dependencies will help create system architecture;
iii. Prioritization improves user satisfaction by increasing the likelihood that the most important requirements are implemented and delivered first;
iv. The highest priority requirements are ensured to be served utilizing the best resources.

[19] This prioritization covers the entire OSTM road network identified for improvement as part of RNMP and includes the additional length of road that are required to be upgraded from lower class roads to upper class in the road hierarchy.

10.1.2 Approach & Methodology

The MAE was framed through establishing a ***Multi-Criteria Decision Making Analysis*** (MCDMA) method. The method consists of a linear additive approach, where the overall performance of a proposed road projects is measured by the sum of its weighted performance on a set of parameters.

10.2 Parameter Selection

The multi-criteria decision making towards developing the road improvement priority list was based on three broad parameters, as listed below, which were also assigned respective weightages for necessary input to the MAE.

A. Traffic & Network parameters: (40 Points)
B. Socio-Economic parameters: (40 Points)
C. Road User Benefit parameter (EIRR): (20 Points)

The degree of compensation between the parameters is determined by the respective weightages. **Table 10-1** summarizes the broad parameters and their individual attributes.

Table 10-1: Parameters Adopted for Prioritization of Road Links

Sl. No.	A: Traffic & Network	B: Socio-Economic	C: Road User
1	Volume- Capacity Ratio	Human Development Index (HDI)	Value of EIRR
2	Network Function	Tribal Area Connectivity	
3	Commercial Traffic	Employment: Work Participation Rate	
4	Rural Connectivity	Registration Rate of Motorized 2-Wheelers	

The homogeneous sections (or groups of road links with similar characteristics) for prioritization of the entire network (identified for planned development under RNMP), as discussed in the previous chapter were divided into two categories as NHs and State Roads (SH, MDR, ODR) and the prioritization was done separately for the two categories. The prioritized sections (or groups of road links) developed for both these categories are provided at the end of this chapter.

10.2.1 Traffic & Network Parameters (40 Points)

The capacity analysis of the entire Odisha main road network using the OSTM assignments reflects performance measures for individual network link under the short term, midterm and long term horizons. The results from the performance measure or measurement of effectiveness include V/C ratios, link delay, congested speed, and travel time.

The outcome of the capacity analyses could also be utilized to identify congested network links serving interstate movements, and connecting ports, tourist places, and other strategic areas of significant economic interests. The performance measures obtained as results from the OSTM network analysis were organized and aggregated to serve as inputs to other policy-related analyses.

Based on the high importance of vehicular mobility in the State of Odisha, this broad parameter has been given a weightage of 40 points within the prioritization criteria. The main attributes and/or parameters to be used as components are discussed below.

Volume – Capacity Ratio (15 Points) – Capacity constrained corridors within the State of Odisha have been resulting in slower travelling speeds, causing faster deteriorating pavement conditions along with other derogatory outcomes of road transportation. This has resulted in increased VOC, higher driver frustration that leads to defective driving and unacceptable drivers' behaviour.

Higher priority was given to links identified for development under RNMP that possess higher V/C ratios. The range of traffic volume/capacity ratio has been divided in to 4 class intervals and **Table 10-2** summarizes the classes including the weightages provided to each class.

Table 10-2: Weightage According to Level-of-Service

Level of Service (volume-capacity ratio)	Weightage
LOS-E (> 0.85)	15
LOS-D (0.7-0.85)	10
LOS-C (0.5-0.7)	5
LOS-B (0.3-0.5) & LOS-A (<0.3)	0

Network Function (10 Points) – The road links, identified for improvement based on strategic network improvement criteria, were primary candidates to be considered in the priority list, and hence the road links were weighted based on five sub-criteria as below.

1. ***Port and Industry Connectivity***- this sub- criterion covers the road links connecting the five upcoming ports and important industries, which has been given highest priority because these provide impetus to the industrial growth and regional growth, that brings an all-round prosperity to the State of Odisha.
2. ***Tourist Place Connectivity***- With a 400 kilometer long coastline, towering mountains, ancient temples and monuments, serene lakes and frolicking rivers, Odisha has been a hotspot of tourist interest, where pilgrimage have been given a special attention according to State Policy. Tourism therefore, has been given second highest weightage in this category, and connecting road link to individual tourist places was considered in the weightage allocation.
3. ***Interstate Movements and Intrastate Connectivity***- It is imperative to have a good connectivity among the neighbouring States and an acceptable riding quality of such linkages to facilitate direct connections between points of interests including providing proper mobility and ease of travel. Under this sub-criterion weights were assigned to each of the 30 interstate routes, and two corridors connecting Bhubaneswar with Koraput; and Keonjhar with Kirtania and Dhamra ports.
4. ***District and Block Head Quarter Connectivity***- The roads connecting the District and Block Headquarters have been given due importance in accordance to Road Development Plan 2021 and weightages were assigned to them accordingly.
5. ***Town/City Connectivity***- Under this sub-criterion, weights were assigned to each road link being recommended for improvement under the requirement of connecting each Town/City having population more than 5,000 by SH as planned in Road development Plan – Vision 2021.

Each sub criteria with the respective weightage assigned to each is summarized in the **Table 10-3**.

Table 10-3: Weightage for Network Function

Network Function	Weightage
Port/Industry Connectivity	10
Tourist Place Connectivity	8
Interstate/Intrastate Connectivity	6
District and Block Head Quarter Connectivity	4
Town/City Connectivity	2

Commercial Traffic (10 Points) – Odisha contains a fifth of India's coal deposit, a quarter of national iron ore deposits, a third of the country's bauxite reserves and most of the chromite. Rourkela Steel Plant was the first integrated steel plant in the State and home to several major public sector enterprises like Hindustan Aluminum Limited (HAL), Sunabeda (Koraput), National Aluminum Limited (NAL – Anugul in Angul District, Damanjodi in Koraput). Odisha is a major investment destination for steel, aluminum, power, refineries and ports. The road links that are high in commercial traffic volumes are assigned with weightage based on the proportion of commercial traffic within total traffic, such that the road link with higher proportion of commercial traffic gets higher weightage. **Table 10-4** summarizes the weightage according to the percentage of commercial traffic.

Table 10-4: Weightage for Commercial Traffic

Commercial Traffic	Weightage
> 75%	10
60% - 75%	8
40% - 60%	6
20% - 40%	4
10% - 20%	2

Rural Connectivity (5 Points) – In order to give a high priority to the connectivity of villages with the main road network, appropriate weightage was assigned to the districts with least number of villages connected with main road network. Five class intervals have been selected based on the existing road connection to the villages in a district in such a way that the district with higher proportion of unconnected villages receives more weightage. **Table 10-5** summarizes the weightages provided to the districts in regards to existing level of village connectivity.

Table 10-5: Weightage for Rural Connectivity

% of villages connected by either Track Road or No Road in a District	Weightage
>10%	5
7% - 10%	4
5% - 7%	3
3% - 5%	2
1% - 3%	1

The complete list of the proportion of villages without road connectivity for each district is presented in Table-1 in the **Appendix 10.1**.

10.2.2 Socio-Economic Parameters (40 Point)

The State of Odisha is home for a substantial size of backward population (nearly 40 per cent SC and ST population). A backward subsistence-oriented agricultural economy has failed to bridge the development disparities among the districts that have long existed between the people and space at the inter-district level.

In recent years, three of the old and undivided backward districts namely, Kalahandi, Bolangir and Koraput (KBK District) in the southwestern part of Odisha have become vulnerable to recurring droughts and famine, which lead to distress migration of the poor during non-agricultural season. They are also considered very backward districts in the country and are popularly known as KBK districts. The economic development of the State is difficult without special attention to this region. This regional socio-economic disparity and reduction in poverty is one of the important goals of Odisha, and therefore, the MAE process emphasizes on it and the enhanced connectivity of this KBK Districts and assigned weightages accordingly. The main attributes of socio-economic parameter are discussed below.

Human Development Index (15 Points) – The HDI is a summary composite index that measures a country/state's average achievements in three basic aspects of human development: longevity, knowledge, and a decent standard of living. Longevity is measured by life expectancy at birth; knowledge is measured by a combination of the adult literacy rate and the gross enrolment ratio in combined primary, secondary, and tertiary level education; and standard of living by GDP per capita (PPP US$).

One of the main purposes of computing HDI is to move beyond the income-based measurement of development. Thus, it becomes important to consider the correspondence (or rather lack of it) between per capita district domestic product (DDP) and the HDI value. For weightage purpose 5 class intervals were selected, and the districts which were having least HDI value were given higher weightages. The class intervals along with the corresponding weightage have been summarized in the **Table 10-6**.

Table 10-6: Weightage for HDI Value

Human Development Index	Marks
< 0.4	15
0.4 - 0.5	12
0.5 - 0.55	9
0.55 - 0.6	6
0.6 - 0.7	3

The complete list of HDI for each district is presented in Table-2 in **Appendix 10.1**.

Tribal Area Connectivity (10 Points) – In the absence of rural road connectivity or minimal connectivity, the subsistence of the population in the tribal areas and especially KBK region heavily depends upon uncertain agriculture and vagaries of weather and the population of such areas are significantly exposed to extremities.

Therefore, tribal area connectivity was emphasized in the MAE process and assigned very high priority. In the prioritization criteria, the districts with more than 50% of the population being Scheduled Tribe were assigned highest weightage. **Table 10-7** summarizes the weightage according to tribal population in any district.

Table 10-7: Weightage for Proportion of ST Population

Tribal Area Connectivity: Proportion of ST Population	Weightage
> 50%	10
30% - 40%	8
15% - 30%	6
10% - 15%	4
5% - 10%	2

The complete list of the proportion of ST population for each district is presented in Table-3 of **Appendix 10.1**.

Employment: Work Participation Rate (10 Points) –Equitable access to fairly paid employment with reasonable and safe working conditions is an essential element of any poverty reduction strategy. Therefore, employment, (Work Participation Rate) was given a special attention while judging the socio-economic status of the districts/links. The districts having lowest employment levels or work participation rates have been given highest weightage according to this criterion. **Table 10-8** summarizes the level of weightage based on work participation rate.

Table 10-8: Weightage for Work Participation Rate

Employment: Work Participation Rate	Weightage
< 35%	10
35% - 40%	8
40% - 45%	6
45% - 50%	4

The complete list of work participation rate for each district is presented in Table-4 of **Appendix 10.1**.

Number of Registered Vehicles: 2 Wheelers (5 Points) – Number of registered vehicles (2 wheelers) in a district was considered as an index for socio-economic status of the people of that district. The districts with lowest no. of motorized two-wheelers have been given highest weightage. **Table 10-9** summarizes the weightage pattern according to the number of registered 2 Wheelers in a district.

Table 10-9: Weightage for Number of Registered Motorized 2-Wheelers

No. of Motorized 2-Wheelers Registered in the District	Weightage
< 10,000	5
10,000 – 50,000	4
50,000 – 75,000	3
75,000 – 1,00,000	2
1,00,000 – 1,50,000	1

The complete list of the number of registered motorized 2-wheelers for each district is presented in Table-5 of **Appendix 10.1**.

10.2.3 Value of EIRR based on Road User Benefits (20 Points)

Higher the value of EIRR, higher is the desirability of the project. In the MAE process the value of EIRR has been given a weightage of 20, and all the homogeneous sections (groups of road links) based on their EIRR value have been put under different categories of respective weightage, as presented in **Table 10-10**.

Table 10-10: Weightage for EIRR Value

EIRR Value	Weightage
> 40%	20
30 - 40%	15
15 - 30%	10
5 - 15%	5
< 5%	1

10.3 Prioritization of Network Links

The MAE process produces respective scores for all the considered broad evaluation parameters, while the addition of the individual scores from all the parameters produces a total score that decides the ranking of any candidate link improvement under the RNMP. While the summary of prioritized road improvements for short term, medium term, and long term are summarized in **Table 10-11**, the prioritized list with score of each link (homogeneous section) is presented in **Table 10-12** to **Table 10-14**. This structured process would be of great benefit to develop transparent decisions with explicit trade-offs between social and traffic/network factors.

Table 10-11: Summary of Prioritized Road Improvements (2015-2035)

Short term (2015-2020)			
National Highways		**SH, MDR, ODR and VR**	
Group (year of implementation)	**Length (km)**	**Group (year of implementation)**	**Length (km)**
A1 (1st Year)	337	A2 (1st Year)	1,385
B1 (2nd Year)	139	B2 (2nd Year)	1,437
C1 (3rd Year)	372	C2 (3rd Year)	1,449
D1 (4th Year)	509	D2 (4th Year)	1,349
E1 (5th Year)	426	E2 (5th Year)	1,357
Total Length	**1,782**	**Total Length**	**6,977**
Medium term (2020-2025)			
A1 (6th Year)	64	A2 (6th Year)	218
B1 (7th Year)	56	B2 (7th Year)	202
C1 (8th Year)	81	C2 (8th Year)	177
D1 (9th Year)	43	D2 (9th Year)	137
E1 (10th Year)	37	E2 (10th Year)	139

Short term (2015-2020)			
National Highways		**SH, MDR, ODR and VR**	
Group (year of implementation)	**Length (km)**	**Group (year of implementation)**	**Length (km)**
Total Length	**281**	**Total Length**	**873**
Long term (2025-2035)			
A1 (11th Year)	144	A2 (11th Year)	158
B1 (12th Year)	87	B2 (12th Year)	122
C1 (13th Year)	104	C2 (13th Year)	193
D1 (14th Year)	115	D2 (14th Year)	181
E1 (15th Year)	63	E2 (15th Year)	196
F1 (16th Year)	126	F2 (16th Year)	227
G1 (17th Year)	114	G2 (17th Year)	207
H1 (18th Year)	64	H2 (18th Year)	158
I1 (19th Year)	28	I2 (19th Year)	165
J1 (20th Year)	20	J2 (20th Year)	179
Total Length	**865**	**Total Length**	**1,786**

Table 10-12: Prioritization of Road Links Identified for Short term Improvements (2015-2020)

Homogeneous Section Properties							Criteria A: Traffic and Network Characteristics (Marks)					Criteria B: Socio-economic Characteristics (Marks)					Criteria C: Economic Analysis (Marks)		Total Marks (A+B+C)	Rank				Group (Year of Implementation)
Name of Homogeneous Section	Length (Km)	Road Type	2018 Traffic (PCU)	Volume-Capacity Ratio (2018)	Existing Carriageway	Proposed Carriageway	Volume Capacity Ratio	Network Function	High Commercial Traffic	Rural Connectivity	Traffic & Network Criteria (total)	HDI	Tribal Area Connectivity	Employment	Reg. Motor Vehicles	Socio-Economic Criteria (total)	EIRR	Economic Analysis		A: Traffic & Network Characteristics	B: Socio-Economic Characteristics	C: Economic Analysis	Final Rank	
HS5.3	93.7	NH	14081	1.17	IL	DLPS	15.0	0.0	4.0	0.0	**19.0**	8.6	4.6	4.8	3.8	**21.8**	66.5%	**20**	**60.8**	**5**	**5**	**2**	**1**	**A1**
HS9.4	80.2	NH	10777	0.90	IL	DLPS	13.2	1.0	3.9	0.0	**18.2**	6.0	8.0	4.0	4.0	**22.0**	58.0%	**20**	**60.2**	**8**	**4**	**3**	**2**	**A1**
HS5.2	162.7	NH	10032	0.84	IL	DLPS	10.9	2.1	3.8	0.0	**16.7**	7.5	3.0	6.0	4.5	**21.0**	54.8%	**20**	**57.7**	**9**	**7**	**6**	**3**	**A1**
HS7.7	38.1	NH	17453	1.45	IL	4L	15.0	0.0	4.0	0.0	**19.0**	0.0	8.0	6.0	4.0	**18.0**	44.9%	**20**	**57.0**	**5**	**10**	**9**	**4**	**B1**
HS7.9	51.3	NH	11456	0.95	IL	4L	15.0	6.0	2.0	0.0	**23.0**	0.0	8.0	6.0	4.0	**18.0**	33.3%	**15**	**56.0**	**3**	**10**	**15**	**5**	**B1**
HS11.4	8.8	NH	48993	1.63	DL	4L	15.0	0.0	6.0	0.0	**21.0**	3.0	4.0	6.0	1.0	**14.0**	73.7%	**20**	**55.0**	**4**	**17**	**1**	**6**	**B1**
HS5.1	40.6	NH	28194	2.35	IL	4L	15.0	6.0	3.7	0.0	**24.7**	0.0	2.0	8.0	0.0	**10.0**	48.9%	**20**	**54.7**	**2**	**21**	**7**	**7**	**B1**
HS2	372.2	NH	20233	0.69	DL	4L	7.5	0.7	4.1	0.0	**12.3**	7.6	7.3	4.1	2.6	**21.6**	44.9%	**20**	**53.9**	**13**	**6**	**9**	**8**	**C1**
HS7.6	43.6	NH	13240	1.10	IL	4L	15.0	0.0	4.0	0.0	**19.0**	6.0	8.0	4.0	1.0	**19.0**	34.7%	**15**	**53.0**	**5**	**8**	**13**	**9**	**D1**
HS7.8	26.9	NH	37313	3.48	IL	4L	15.0	6.0	4.0	0.0	**25.0**	0.0	8.0	6.0	4.0	**18.0**	29.7%	**10**	**53.0**	**1**	**10**	**16**	**9**	**D1**
HS10.1	75.1	NH	22375	0.75	DL	4L	8.7	0.0	4.1	0.0	**12.8**	4.7	4.0	7.2	1.6	**17.5**	41.2%	**20**	**50.3**	**11**	**13**	**11**	**11**	**D1**
HS9.2	242.9	NH	6395	0.53	IL	DLPS	3.7	0.0	1.7	0.0	**5.3**	11.4	8.3	4.5	3.4	**27.6**	34.4%	**15**	**47.9**	**17**	**2**	**14**	**12**	**D1**
HS6.4	14.1	NH	6109	0.20	DL	DLPS	0.0	6.0	1.9	0.0	**7.9**	9.0	8.0	6.0	1.0	**24.0**	35.2%	**15**	**46.9**	**15**	**3**	**12**	**13**	**D1**
HS7.3	29.4	NH	9689	0.78	IL	DLPS	9.4	0.0	2.0	0.0	**11.4**	3.0	4.0	6.0	1.0	**14.0**	56.8%	**20**	**45.4**	**14**	**17**	**5**	**14**	**D1**
HS9.1	76.7	NH	10317	0.82	IL	DLPS	11.3	0.4	1.1	0.0	**12.8**	6.0	0.0	6.0	0.0	**12.0**	57.3%	**20**	**44.8**	**12**	**20**	**4**	**15**	**D1**
HS1	114.9	NH	8033	0.27	DL	DLPS	0.0	3.8	2.1	0.0	**5.9**	12.0	10.0	4.0	2.0	**28.0**	29.0%	**10**	**43.9**	**16**	**1**	**17**	**16**	**E1**
HS7.5	28.1	NH	9009	0.75	IL	DLPS	10.0	0.0	4.0	0.0	**14.0**	3.0	8.0	0.0	5.0	**16.0**	21.4%	**10**	**40.0**	**10**	**15**	**19**	**17**	**E1**
HS3	87.5	NH	9675	0.32	DL	DLPS	0.2	0.0	0.0	0.0	**0.2**	3.0	0.0	8.0	2.0	**13.0**	47.7%	**20**	**33.2**	**20**	**19**	**8**	**18**	**E1**
HS8	80.9	NH	12819	0.43	DL	DLPS	0.0	0.0	3.7	0.0	**3.7**	3.4	9.2	4.3	1.7	**18.6**	17.0%	**10**	**32.3**	**18**	**9**	**21**	**19**	**E1**
HS7.4	85.2	NH	3736	0.31	IL	DLPS	0.0	0.8	0.8	0.0	**1.6**	3.0	8.0	0.0	5.0	**16.0**	19.7%	**10**	**27.6**	**19**	**15**	**20**	**20**	**E1**
HS9.3	29.5	NH	3420	0.28	IL	DLPS	0.0	0.0	0.0	0.0	**0.0**	3.0	6.0	4.0	3.0	**16.0**	23.4%	**10**	**26.0**	**21**	**14**	**18**	**21**	**E1**
HS101	168.2	SH	7719	1.47	SL	DLPS	12.7	6.0	4.8	0.0	**23.5**	11.1	8.4	2.8	3.8	**26.0**	46.9%	**20**	**69.5**	**4**	**18**	**19**	**1**	**A2**
HS100.1	78.3	SH	10204	1.73	IL	DLPS	11.4	6.0	4.0	0.0	**21.4**	12.0	10.0	4.0	2.0	**28.0**	55.9%	**20**	**69.4**	**6**	**11**	**9**	**2**	**A2**
HS100	201.8	SH	4345	0.82	SL	DLPS	10.4	6.0	3.0	0.0	**19.4**	14.3	10.0	0.9	4.3	**29.5**	46.2%	**20**	**68.9**	**11**	**5**	**21**	**3**	**A2**
HS206	29.2	MDR	14518	1.14	IL	DLPS	13.1	5.2	4.5	2.8	**25.7**	6.0	7.4	4.1	1.3	**18.9**	70.3%	**20**	**64.6**	**2**	**51**	**1**	**4**	**A2**
HS123	13.3	SH	22634	0.71	DL	4L	8.0	6.0	4.0	0.0	**18.0**	9.0	8.0	6.0	1.0	**24.0**	57.6%	**20**	**62.0**	**14**	**19**	**6**	**5**	**A2**
HS100.2	40.3	SH	12893	1.39	DL	DLPS	7.1	5.3	5.3	0.0	**17.7**	10.6	8.9	3.5	3.5	**26.5**	31.0%	**15**	**59.2**	**17**	**17**	**45**	**6**	**A2**
HS219	13.7	MDR	6184	1.55	SL	DLPS	15.0	0.0	2.0	3.0	**20.0**	6.0	8.0	4.0	1.0	**19.0**	45.9%	**20**	**59.0**	**9**	**38**	**22**	**7**	**A2**
HS308	4.9	ODR	7265	1.49	SL	DLPS	11.3	0.0	3.5	2.0	**16.8**	9.0	2.0	10.0	1.0	**22.0**	54.6%	**20**	**58.8**	**23**	**26**	**10**	**8**	**A2**
HS101.1	54.7	SH	4876	1.10	SL	DLPS	9.5	2.0	2.3	0.0	**13.8**	12.0	10.0	4.0	2.9	**28.9**	32.6%	**15**	**57.7**	**44**	**7**	**40**	**9**	**A2**
HS211	27.7	MDR	6912	1.31	SL	DLPS	12.2	0.3	1.0	2.0	**15.5**	9.0	2.0	10.0	1.0	**22.0**	56.4%	**20**	**57.5**	**33**	**28**	**8**	**10**	**A2**
HS216	2.2	MDR	24866	0.83	DL	4L	10.0	0.0	6.0	2.0	**18.0**	9.0	8.0	6.0	1.0	**24.0**	32.1%	**15**	**57.0**	**15**	**19**	**42**	**11**	**A2**
HS142	120.1	SH	3660	0.89	SL	DLPS	9.8	4.3	3.3	0.0	**17.4**	14.1	10.0	1.2	4.1	**29.4**	26.6%	**10**	**56.8**	**19**	**6**	**54**	**12**	**A2**
HS106	41.2	SH	41790	1.53	DL	4L	14.8	7.0	4.2	0.0	**26.0**	0.0	1.6	8.0	0.0	**9.6**	53.5%	**20**	**55.5**	**1**	**92**	**11**	**13**	**A2**
HS102.7	109.4	SH	14859	2.69	SL	DLPS	10.3	10.0	3.4	0.0	**23.7**	3.9	1.2	8.8	2.1	**16.0**	37.1%	**15**	**54.7**	**3**	**69**	**29**	**14**	**A2**
HS214	55.6	MDR	5470	1.25	SL	DLPS	13.4	5.9	0.5	1.4	**21.3**	3.6	8.8	4.4	1.6	**18.4**	32.6%	**15**	**54.7**	**7**	**52**	**40**	**15**	**A2**
HS109	50.1	SH	10717	1.19	IL	DLPS	11.7	5.7	2.6	0.0	**20.0**	1.9	0.0	9.2	3.1	**14.2**	57.6%	**20**	**54.3**	**8**	**78**	**6**	**16**	**A2**

Homogeneous Section Properties							Criteria A: Traffic and Network Characteristics (Marks)					Criteria B: Socio-economic Characteristics (Marks)					Criteria C: Economic Analysis (Marks)		Total Marks (A+B+C)	Rank				Group (Year of Implementation)
Name of Homogeneous Section	Length (Km)	Road Type	2018 Traffic (PCU)	Volume-Capacity Ratio (2018)	Existing Carriageway	Proposed Carriageway	Volume Capacity Ratio	Network Function	High Commercial Traffic	Rural Connectivity	Traffic & Network Criteria (total)	HDI	Tribal Area Connectivity	Employment	Reg. Motor Vehicles	Socio-Economic Criteria (total)	EIRR	Economic Analysis		A: Traffic & Network Characteristics	B: Socio-Economic Characteristics	C: Economic Analysis	Final Rank	
HS301	75.4	ODR	3162	0.79	SL	DLPS	8.9	0.0	1.5	4.4	**14.9**	13.1	10.0	2.5	3.1	**28.8**	26.9%	**10**	**53.6**	**40**	**9**	**53**	**17**	**A2**
HS302	68.5	MDR	4303	0.98	SL	DLPS	13.5	0.0	0.1	2.2	**15.8**	7.8	6.8	5.2	2.8	**22.6**	30.9%	**15**	**53.3**	**30**	**25**	**46**	**18**	**A2**
HS107.2	90.6	SH	10605	1.01	IL	DLPS	11.7	7.9	2.4	0.0	**21.9**	1.1	1.0	8.0	0.7	**10.8**	61.5%	**20**	**52.7**	**5**	**89**	**3**	**19**	**A2**
HS102.3	44.4	SH	8214	1.46	SL	DLPS	13.6	0.0	2.0	0.0	**15.6**	5.1	5.7	5.4	0.6	**16.7**	49.4%	**20**	**52.3**	**31**	**66**	**16**	**20**	**A2**
HS115	45.9	SH	7587	0.84	IL	DLPS	8.6	2.0	1.1	0.0	**11.7**	7.7	1.6	9.8	1.3	**20.4**	47.9%	**20**	**52.2**	**59**	**30**	**18**	**21**	**A2**
HS212	42.5	ODR	13854	0.70	DL	DLPS	5.6	0.0	4.5	1.8	**11.8**	8.2	1.8	9.1	0.9	**20.1**	45.1%	**20**	**52.0**	**57**	**31**	**23**	**22**	**A2**
HS128.1	7.2	SH	3973	0.99	SL	DLPS	15.0	2.0	0.0	0.0	**17.0**	3.0	10.0	6.0	0.0	**19.0**	35.3%	**15**	**51.0**	**21**	**38**	**31**	**23**	**A2**
HS311	2.8	ODR	20634	1.16	DL	4L	10.5	0.0	5.5	1.0	**17.0**	3.0	4.0	6.0	1.0	**14.0**	50.3%	**20**	**51.0**	**22**	**79**	**14**	**24**	**B2**
HS307	58.1	ODR	4702	1.12	SL	DLPS	14.0	0.0	0.4	1.0	**15.4**	6.0	4.0	8.0	2.0	**20.0**	36.5%	**15**	**50.4**	**34**	**32**	**30**	**25**	**B2**
HS215	26.4	ODR	5019	1.25	SL	DLPS	14.9	0.0	0.5	1.0	**16.4**	3.0	10.0	4.0	2.0	**19.0**	38.2%	**15**	**50.4**	**25**	**38**	**28**	**26**	**B2**
HS102	42.5	SH	22300	1.79	DL	4L	11.4	0.0	4.8	0.0	**16.2**	5.4	3.2	8.4	2.2	**19.2**	31.5%	**15**	**50.3**	**27**	**35**	**44**	**27**	**B2**
HS205	90.7	MDR	7127	1.45	SL	DLPS	12.1	0.0	3.0	1.0	**16.1**	4.9	5.3	2.2	1.6	**14.0**	48.4%	**20**	**50.1**	**28**	**81**	**17**	**28**	**B2**
HS202	130.8	MDR	5271	0.95	SL	DLPS	8.9	0.0	0.7	4.0	**13.6**	3.3	6.2	4.0	3.1	**16.5**	43.4%	**20**	**50.1**	**48**	**67**	**25**	**29**	**B2**
HS107	50.0	SH	15351	1.14	IL	4L	13.1	1.1	3.4	0.0	**17.6**	2.5	0.3	8.0	1.7	**12.5**	44.8%	**20**	**50.1**	**18**	**84**	**24**	**30**	**B2**
HS100.4	56.6	SH	2790	0.64	SL	DLPS	7.8	6.0	2.7	0.0	**16.5**	12.0	10.0	4.0	2.0	**28.0**	6.0%	**5**	**49.5**	**24**	**12**	**80**	**31**	**B2**
HS207	90.9	MDR	6363	1.13	IL	DLPS	9.5	0.0	3.0	1.0	**13.5**	3.9	3.0	7.6	1.3	**15.7**	40.5%	**20**	**49.3**	**49**	**74**	**26**	**32**	**B2**
HS201	111.9	MDR	2461	0.50	SL	DLPS	4.4	1.6	1.6	2.8	**10.3**	12.0	10.0	4.0	2.8	**28.8**	17.9%	**10**	**49.1**	**67**	**8**	**66**	**33**	**B2**
HS119	278.4	SH	3718	0.67	SL	DLPS	7.2	0.3	1.0	0.0	**8.5**	13.4	8.4	4.1	4.1	**29.9**	20.6%	**10**	**48.4**	**77**	**2**	**62**	**34**	**B2**
HS127	37.6	SH	10571	0.39	DL	DLPS	0.7	5.6	3.1	0.0	**9.4**	3.0	10.0	6.0	0.0	**19.0**	46.5%	**20**	**48.4**	**72**	**38**	**20**	**35**	**B2**
HS209	23.3	MDR	8487	0.71	IL	DLPS	10.0	0.0	2.0	3.0	**15.0**	3.0	0.0	8.0	2.0	**13.0**	50.1%	**20**	**48.0**	**38**	**83**	**15**	**36**	**B2**
HS312	5.4	VR	22230	5.56	SL	4L	15.0	0.0	4.0	1.0	**20.0**	0.0	8.0	6.0	4.0	**18.0**	19.6%	**10**	**48.0**	**9**	**55**	**63**	**36**	**B2**
HS102.2	29.5	SH	4906	1.15	SL	DLPS	13.8	0.0	0.0	0.0	**13.8**	3.0	10.0	4.0	2.0	**19.0**	33.2%	**15**	**47.8**	**46**	**38**	**37**	**38**	**B2**
HS114	60.8	SH	5897	0.98	IL	DLPS	8.1	8.0	1.9	0.0	**18.0**	4.3	1.0	9.0	0.5	**14.7**	34.3%	**15**	**47.8**	**13**	**76**	**35**	**39**	**B2**
HS208	33.4	MDR	10262	0.86	IL	DLPS	11.7	0.0	0.8	2.7	**15.2**	2.1	0.6	8.0	1.4	**12.1**	59.5%	**20**	**47.4**	**35**	**86**	**4**	**40**	**B2**
HS213	117.6	MDR	4757	1.14	SL	DLPS	13.1	0.2	0.4	2.4	**16.2**	5.2	2.9	7.1	0.8	**16.0**	34.4%	**15**	**47.2**	**26**	**71**	**34**	**41**	**B2**
HS137.2	122.5	SH	4964	0.53	IL	DLPS	3.6	5.5	0.5	0.0	**9.5**	11.0	9.2	3.7	3.7	**27.6**	27.4%	**10**	**47.1**	**70**	**15**	**52**	**42**	**B2**
HS104	67.6	SH	15090	1.52	IL	DLPS	13.1	1.8	3.8	0.0	**18.7**	0.0	0.5	8.0	0.0	**8.5**	65.9%	**20**	**47.1**	**12**	**93**	**2**	**43**	**B2**
HS129	56.4	SH	6256	1.24	IL	DLPS	12.0	0.0	0.8	0.0	**12.8**	5.5	8.3	4.3	0.8	**19.0**	31.8%	**15**	**46.8**	**53**	**38**	**43**	**44**	**C2**
HS125	17.9	EH	13427	0.63	DL	DLPS	3.9	4.8	3.6	0.0	**12.3**	9.0	8.0	6.0	1.0	**24.0**	23.5%	**10**	**46.3**	**56**	**19**	**58**	**45**	**C2**
HS304	8.0	ODR	8330	1.94	SL	DLPS	13.8	0.0	0.0	2.0	**15.8**	0.0	2.0	8.0	0.0	**10.0**	59.0%	**20**	**45.8**	**29**	**91**	**5**	**46**	**C2**
HS111	33.3	SH	19725	1.58	IL	4L	13.8	0.0	4.0	0.0	**17.8**	0.0	0.0	8.0	0.0	**8.0**	51.9%	**20**	**45.8**	**16**	**94**	**13**	**47**	**C2**
HS309	78.0	ODR	6013	0.62	IL	DLPS	5.5	5.8	4.3	1.8	**17.3**	7.5	8.5	5.5	1.2	**22.8**	11.3%	**5**	**45.1**	**20**	**24**	**74**	**48**	**C2**
HS116	113.1	SH	6410	0.80	IL	DLPS	8.1	5.1	1.8	0.0	**14.9**	6.0	0.7	6.6	1.3	**14.6**	33.1%	**15**	**44.5**	**39**	**77**	**38**	**49**	**C2**
HS210	31.6	MDR	6710	1.06	IL	DLPS	10.3	0.0	0.0	1.0	**11.3**	6.0	0.0	8.0	4.0	**18.0**	33.1%	**15**	**44.3**	**63**	**55**	**38**	**50**	**C2**
HS204	147.4	MDR	2862	0.49	IL	DLPS	5.5	2.6	1.9	4.6	**14.5**	12.2	9.2	2.7	4.4	**28.6**	3.8%	**1**	**44.1**	**42**	**10**	**86**	**51**	**C2**
HS310	60.2	ODR	4927	0.88	SL	DLPS	6.8	0.3	2.0	1.7	**10.9**	4.1	7.8	4.7	1.3	**17.9**	35.3%	**15**	**43.8**	**66**	**61**	**31**	**52**	**C2**
HS220	45.7	MDR	3546	0.88	SL	DLPS	11.2	1.2	1.8	1.3	**15.5**	0.6	8.3	5.9	3.4	**18.2**	24.2%	**10**	**43.7**	**32**	**53**	**57**	**53**	**C2**
HS218	104.6	MDR	6480	1.15	IL	DLPS	11.0	0.0	0.6	3.0	**14.6**	3.0	10.0	6.0	0.0	**19.0**	24.7%	**10**	**43.6**	**41**	**38**	**56**	**54**	**C2**
HS136	126.0	SH	3261	0.70	IL	DLPS	7.4	0.0	1.6	0.0	**9.1**	8.1	8.3	4.0	3.5	**23.9**	22.5%	**10**	**43.0**	**73**	**23**	**59**	**55**	**C2**

Homogeneous Section Properties							Criteria A: Traffic and Network Characteristics (Marks)					Criteria B: Socio-economic Characteristics (Marks)					Criteria C: Economic Analysis (Marks)		Total Marks (A+B+C)	Rank				Group (Year of Implementation)
Name of Homogeneous Section	Length (Km)	Road Type	2018 Traffic (PCU)	Volume-Capacity Ratio (2018)	Existing Carriageway	Proposed Carriageway	Volume Capacity Ratio	Network Function	High Commercial Traffic	Rural Connectivity	Traffic & Network Criteria (total)	HDI	Tribal Area Connectivity	Employment	Reg. Motor Vehicles	Socio-Economic Criteria (total)	EIRR	Economic Analysis		A: Traffic & Network Characteristics	B: Socio-Economic Characteristics	C: Economic Analysis	Final Rank	
HS121	65.2	SH	5230	0.61	IL	DLPS	5.7	6.0	2.1	0.0	**13.8**	3.0	10.0	6.0	0.0	**19.0**	21.6%	**10**	**42.8**	**45**	**50**	**60**	**56**	**C2**
HS139	89.2	SH	3336	0.62	IL	DLPS	5.7	5.0	2.2	0.0	**12.8**	12.0	10.0	1.3	4.7	**28.0**	4.0%	**1**	**41.8**	**52**	**14**	**85**	**57**	**C2**
HS141	64.8	SH	2845	0.61	SL	DLPS	6.6	6.0	0.0	0.0	**12.6**	12.0	10.0	4.0	2.0	**28.0**	4.7%	**1**	**41.6**	**54**	**12**	**84**	**58**	**C2**
HS131.1	54.0	SH	7407	1.54	IL	DLPS	10.5	1.3	3.3	0.0	**15.1**	4.4	4.0	5.5	1.9	**15.8**	29.6%	**10**	**41.0**	**36**	**73**	**48**	**59**	**C2**
HS140	134.2	SH	3280	0.66	IL	DLPS	7.5	0.0	1.3	0.0	**8.8**	12.0	10.0	0.0	5.0	**27.0**	5.9%	**5**	**40.8**	**74**	**16**	**81**	**60**	**C2**
HS117.3	24.7	SH	10289	0.68	IL	DLPS	9.7	0.0	4.0	0.0	**13.7**	6.0	0.0	6.0	0.0	**12.0**	39.6%	**15**	**40.7**	**47**	**87**	**27**	**61**	**C2**
HS305	19.8	ODR	3855	0.81	SL	DLPS	11.3	0.0	0.1	1.0	**12.4**	3.0	0.0	10.0	5.0	**18.0**	18.9%	**10**	**40.4**	**55**	**58**	**65**	**62**	**C2**
HS113	114.0	SH	9640	0.57	DL	DLPS	5.0	0.0	2.2	0.0	**7.2**	6.0	0.0	8.0	4.0	**18.0**	30.8%	**15**	**40.2**	**80**	**59**	**47**	**63**	**C2**
HS104.1	60.9	SH	8392	1.01	IL	DLPS	9.1	0.0	0.4	0.0	**9.5**	1.1	0.7	8.0	0.4	**10.1**	53.1%	**20**	**39.6**	**71**	**90**	**12**	**64**	**C2**
HS303	53.4	ODR	5394	0.85	IL	DLPS	7.7	0.2	1.3	1.7	**11.0**	2.7	2.5	6.9	1.2	**13.2**	35.3%	**15**	**39.2**	**65**	**82**	**31**	**65**	**D2**
HS122	27.3	SH	3973	0.73	SL	DLPS	9.1	6.0	0.0	0.0	**15.1**	3.0	10.0	6.0	0.0	**19.0**	10.5%	**5**	**39.1**	**37**	**38**	**76**	**66**	**D2**
HS102.1	273.2	SH	4940	0.76	IL	DLPS	7.9	5.1	0.4	0.0	**13.5**	4.2	9.3	4.4	1.7	**19.6**	13.4%	**5**	**38.0**	**50**	**33**	**69**	**67**	**D2**
HS100.3	25.2	SH	2553	0.20	IL	DLPS	0.0	5.9	0.0	0.0	**5.9**	11.9	9.9	4.0	4.0	**29.6**	0.1%	**1**	**36.6**	**84**	**4**	**91**	**68**	**D2**
HS138	192.8	SH	2831	0.42	IL	DLPS	1.7	0.0	4.0	0.0	**5.7**	11.9	9.9	4.0	4.0	**29.8**	3.4%	**1**	**36.6**	**85**	**3**	**87**	**69**	**D2**
HS203	88.2	VR	3294	0.53	SL	DLPS	4.1	2.3	0.5	1.7	**8.6**	6.2	6.0	2.9	2.2	**17.3**	19.3%	**10**	**35.9**	**76**	**65**	**64**	**70**	**D2**
HS135	110.2	SH	4473	1.01	SL	DLPS	9.3	1.3	1.3	0.0	**11.8**	5.6	6.0	4.9	2.6	**19.0**	13.5%	**5**	**35.8**	**58**	**37**	**68**	**71**	**D2**
HS137.1	22.8	SH	4590	0.84	IL	DLPS	8.2	6.0	0.0	0.0	**14.2**	3.0	6.0	4.0	3.0	**16.0**	11.0%	**5**	**35.2**	**43**	**70**	**75**	**72**	**D2**
HS102.5	47.2	SH	6170	0.45	IL	DLPS	2.5	5.1	1.1	0.0	**8.7**	5.9	4.0	5.9	0.0	**15.9**	28.0%	**10**	**34.6**	**75**	**72**	**50**	**73**	**D2**
HS108	37.4	SH	7199	0.90	IL	DLPS	6.4	2.0	3.0	0.0	**11.4**	4.5	2.0	8.0	3.0	**17.5**	13.3%	**5**	**33.9**	**62**	**63**	**70**	**74**	**D2**
HS118	152.8	SH	5335	0.35	DL	DLPS	2.2	5.9	1.6	0.0	**9.7**	9.0	3.5	5.2	1.4	**19.1**	11.4%	**5**	**33.8**	**69**	**36**	**73**	**75**	**D2**
HS114.1	18.1	SH	13888	0.73	DL	DLPS	5.7	2.0	4.0	0.0	**11.7**	9.0	2.0	10.0	1.0	**22.0**	-6.8%	**0**	**33.7**	**60**	**26**	**96**	**76**	**D2**
HS133	261.7	SH	5044	0.49	IL	DLPS	2.9	0.0	1.1	0.0	**4.0**	7.4	6.2	3.4	2.2	**19.2**	21.2%	**10**	**33.2**	**89**	**34**	**61**	**77**	**D2**
HS137.3	39.2	SH	1509	0.34	SL	DLPS	0.7	2.0	0.4	0.0	**3.1**	12.0	10.0	4.0	4.0	**30.0**	-1.1%	**0**	**33.1**	**92**	**1**	**93**	**78**	**D2**
HS130	69.3	SH	4682	0.30	IL	DLPS	0.0	0.0	0.0	0.0	**0.0**	6.0	4.9	4.0	3.0	**18.0**	33.3%	**15**	**33.0**	**97**	**60**	**36**	**79**	**E2**
HS112	42.6	SH	3337	0.56	IL	DLPS	5.2	8.0	0.2	0.0	**13.4**	3.0	0.0	10.0	5.0	**18.0**	3.4%	**1**	**32.4**	**51**	**55**	**87**	**80**	**E2**
HS103.1	48.1	SH	10640	0.41	DL	DLPS	0.4	3.7	4.0	0.0	**8.1**	6.0	8.0	4.0	1.0	**19.0**	8.4%	**5**	**32.1**	**78**	**38**	**79**	**81**	**E2**
HS110	117.3	SH	6665	0.56	IL	DLPS	2.8	1.9	0.4	0.0	**5.2**	3.0	0.0	10.0	3.5	**16.5**	29.2%	**10**	**31.7**	**87**	**68**	**49**	**82**	**E2**
HS103	152.4	SH	4700	0.67	IL	DLPS	5.9	4.5	0.8	0.0	**11.2**	3.3	6.2	2.6	2.7	**14.8**	12.3%	**5**	**31.0**	**64**	**75**	**71**	**83**	**E2**
HS306	19.1	VR	3550	0.89	SL	DLPS	9.5	0.0	0.9	1.0	**11.4**	0.0	0.0	8.0	0.0	**8.0**	27.8%	**10**	**29.4**	**61**	**94**	**51**	**84**	**E2**
HS114.2	39.4	EH	4948	0.36	IL	DLPS	2.0	0.0	0.0	0.0	**2.0**	7.8	7.0	5.2	0.9	**20.9**	5.5%	**5**	**27.9**	**95**	**29**	**82**	**85**	**E2**
HS131	236.7	SH	3244	0.43	IL	DLPS	2.9	2.0	0.2	0.0	**5.0**	5.7	2.8	5.2	3.8	**17.4**	11.9%	**5**	**27.4**	**88**	**64**	**72**	**86**	**E2**
HS126.1	8.8	SH	4428	0.36	IL	DLPS	1.1	2.0	0.3	0.0	**3.4**	3.0	10.0	6.0	0.0	**19.0**	9.0%	**5**	**27.4**	**91**	**38**	**78**	**87**	**E2**
HS217	45.3	MDR	1625	0.37	SL	DLPS	1.3	4.0	0.7	1.0	**7.1**	3.0	10.0	4.0	2.0	**19.0**	0.4%	**1**	**27.1**	**81**	**38**	**90**	**88**	**E2**
HS124	14.8	SH	1107	0.15	IL	DLPS	0.0	2.0	0.0	0.0	**2.0**	9.0	8.0	6.0	1.0	**24.0**	-12.5%	**0**	**26.0**	**94**	**19**	**97**	**89**	**E2**
HS105	37.9	SH	8330	0.28	DL	DLPS	0.0	6.0	2.0	0.0	**8.0**	0.0	0.0	8.0	0.0	**8.0**	16.6%	**10**	**26.0**	**79**	**94**	**67**	**90**	**E2**
HS117	299.2	SH	5266	0.46	IL	DLPS	2.3	0.6	0.7	0.0	**3.6**	6.0	0.1	6.1	0.2	**12.3**	25.6%	**10**	**26.0**	**90**	**85**	**55**	**91**	**E2**
HS128	28.8	SH	2216	0.14	DL	DLPS	0.0	6.0	0.0	0.0	**6.0**	3.0	10.0	6.0	0.0	**19.0**	-2.2%	**0**	**25.0**	**83**	**38**	**95**	**92**	**E2**
HS102.4	67.8	SH	4118	0.23	DL	DLPS	0.0	1.8	0.0	0.0	**1.9**	2.8	9.5	3.8	1.9	**18.0**	5.5%	**5**	**24.9**	**96**	**54**	**82**	**93**	**E2**
HS117.1	30.2	SH	2881	0.47	SL	DLPS	2.7	2.6	0.2	0.0	**5.5**	6.0	0.0	6.0	0.0	**12.0**	10.2%	**5**	**22.5**	**86**	**88**	**77**	**94**	**E2**

Homogeneous Section Properties							Criteria A: Traffic and Network Characteristics (Marks)					Criteria B: Socio-economic Characteristics (Marks)					Criteria C: Economic Analysis (Marks)		Total Marks (A+B+C)	Rank				Group (Year of Implementation)
Name of Homogeneous Section	Length (Km)	Road Type	2018 Traffic (PCU)	Volume-Capacity Ratio (2018)	Existing Carriageway	Proposed Carriageway	Volume Capacity Ratio	Network Function	High Commercial Traffic	Rural Connectivity	Traffic & Network Criteria (total)	HDI	Tribal Area Connectivity	Employment	Reg. Motor Vehicles	Socio-Economic Criteria (total)	EIRR	Economic Analysis		A: Traffic & Network Characteristics	B: Socio-Economic Characteristics	C: Economic Analysis	Final Rank	
HS132	31.4	SH	2485	0.27	IL	DLPS	0.7	6.0	0.0	0.0	**6.7**	6.0	6.0	0.0	2.0	**14.0**	3.4%	**1**	**21.7**	**82**	**79**	**87**	**95**	**E2**
HS126	48.5	SH	3262	0.13	DL	DLPS	0.2	0.0	2.8	0.0	**3.0**	3.0	9.2	3.6	2.0	**17.8**	-0.6%	**0**	**20.8**	**93**	**62**	**92**	**96**	**E2**
HS207.1	19.6	MDR	1179	0.05	SL	DLPS	0.0	4.0	4.9	1.0	**9.9**	0.0	0.0	8.0	0.0	**8.0**	-1.1%	**0**	**17.9**	**68**	**94**	**93**	**97**	**E2**

Table 10-13: Prioritization of Road Links Identified for Medium term Improvements (2020-2025)

Homogeneous Section Properties							Criteria A: Traffic and Network Characteristics (Marks)					Criteria B: Socio-economic Characteristics (Marks)					Criteria C: Economic Analysis (Marks)		Total Marks (A+B+C)	Rank				Group (Year of Implementation)
Name of Homogeneous Section	Length (Km)	Road Type	2023 Traffic (PCU)	Volume-Capacity Ratio (2023)	Existing Carriageway	Proposed Carriageway	Volume Capacity Ratio	Network Function	High Commercial Traffic	Rural Connectivity	Traffic & Network Criteria (total)	HDI	Tribal Area Connectivity	Employment	Reg. Motor Vehicles	Socio-Economic Criteria (total)	EIRR	Economic Analysis		A: Traffic & Network Characteristics	B: Socio-Economic Characteristics	C: Economic Analysis	Final Rank	
HS55	64.5	NH	26092	0.72	DLPS	4L	9.9	0.0	8.0	0.0	**17.9**	6.0	4.0	8.0	2.0	**19.9**	0.229	10	**47.8**	**1**	**2**	**1**	**1**	**A1**
HS58	55.7	NH	18529	0.51	DLPS	4L	4.9	0.0	4.0	0.0	**8.9**	8.4	3.6	4.0	5.0	**21.0**	0.154	10	**39.9**	**3**	**1**	**4**	**2**	**B1**
HS57	81.0	NH	17941	0.50	DLPS	4L	2.6	0.0	4.1	0.0	**6.7**	3.4	9.1	4.3	1.7	**18.5**	0.166	10	**35.3**	**4**	**4**	**3**	**3**	**C1**
HS54	43.2	NH	18863	0.57	DLPS	4L	3.0	2.7	3.5	0.0	**9.2**	6.0	0.9	6.9	1.8	**15.5**	0.224	10	**34.7**	**2**	**5**	**2**	**4**	**D1**
HS56	36.9	NH	18159	0.50	DLPS	4L	1.6	0.0	4.6	0.0	**6.2**	6.0	8.0	4.0	1.0	**19.0**	0.132	5	**30.2**	**5**	**3**	**5**	**5**	**E1**
HS354	27.6	ODR	40652	1.13	DLPS	4L	15.0	6.0	8.0	2.0	**31.0**	9.0	8.0	6.0	1.0	**24.0**	0.17	10	**65.0**	**1**	**3**	**18**	**1**	**A2**
HS255	28.3	MDR	6599	1.59	SL	DLPS	14.5	0.0	0.0	4.0	**18.5**	6.0	8.0	4.0	4.0	**22.0**	0.471	20	**60.5**	**7**	**5**	**1**	**2**	**A2**
HS251	9.7	ODR	37393	1.04	DLPS	4L	15.0	0.0	8.0	2.0	**25.0**	9.0	2.0	10.0	1.0	**22.0**	0.227	10	**57.0**	**2**	**5**	**10**	**3**	**A2**
HS153	18.1	SH	37393	1.04	DLPS	4L	15.0	2.0	6.0	0.0	**23.0**	9.0	2.0	10.0	1.0	**22.0**	0.209	10	**55.0**	**3**	**5**	**15**	**4**	**A2**
HS253	17.9	SH	41200	1.14	DLPS	4L	15.0	0.0	5.6	0.0	**20.6**	9.0	8.0	6.0	1.0	**24.0**	0.242	10	**54.6**	**4**	**3**	**9**	**5**	**A2**
HS252	116.7	MDR	9046	0.76	IL	DLPS	7.9	0.0	2.8	2.5	**13.2**	5.1	8.8	5.8	0.5	**20.2**	0.463	20	**53.4**	**10**	**8**	**2**	**6**	**A2**
HS155	49.8	SH	21050	0.58	DLPS	4L	5.0	2.4	5.2	0.0	**12.5**	12.0	10.0	4.0	3.2	**29.2**	0.224	10	**51.7**	**12**	**2**	**11**	**7**	**B2**
HS156	9.5	SH	19242	0.53	DLPS	4L	3.9	1.4	5.5	0.0	**10.8**	12.0	10.0	4.0	4.0	**30.0**	0.218	10	**50.8**	**15**	**1**	**12**	**8**	**B2**
HS254	28.2	MDR	25640	0.71	DLPS	4L	9.3	0.0	6.3	2.8	**18.3**	6.0	7.4	4.1	1.3	**18.9**	0.214	10	**47.2**	**8**	**12**	**14**	**9**	**B2**
HS256	115.0	MDR	4995	0.79	IL	DLPS	8.5	0.0	0.1	4.2	**12.8**	4.9	6.9	4.0	3.2	**19.0**	0.354	15	**46.8**	**11**	**11**	**3**	**10**	**B2**
HS352	176.9	VR/ODR	3784	0.77	SL	DLPS	9.5	0.0	1.2	1.3	**12.0**	5.7	5.9	4.8	2.4	**18.8**	0.3	15	**45.9**	**13**	**13**	**5**	**11**	**C2**
HS154	33.8	SH	19636	0.55	DLPS	4L	5.0	9.9	4.0	0.0	**18.9**	6.0	4.0	6.0	0.0	**16.0**	0.217	10	**44.9**	**5**	**15**	**13**	**12**	**D2**

HS152	47.1	SH	24068	0.66	DLPS	4L	4.9	9.8	3.9	0.0	**18.6**	2.9	0.0	9.8	2.9	**15.7**	0.261	10	**44.3**	**6**	**16**	**8**	**13**	**D2**
HS351	55.9	ODR	4351	0.50	IL	DLPS	3.7	0.0	1.1	1.7	**6.6**	4.8	4.2	8.0	2.6	**19.7**	0.33	15	**41.3**	**17**	**9**	**4**	**14**	**D2**
HS157	13.5	SH	21749	0.60	DLPS	4L	5.0	0.0	6.0	0.0	**11.0**	3.0	10.0	6.0	0.0	**19.0**	0.179	10	**40.0**	**14**	**10**	**16**	**15**	**E2**
HS151	58.2	SH	24957	0.69	DLPS	4L	6.7	6.0	4.0	0.0	**16.6**	0.0	0.4	8.0	0.0	**8.4**	0.28	10	**35.1**	**9**	**18**	**6**	**16**	**E2**
HS151.1	61.7	SH	21777	0.60	DLPS	4L	5.6	1.0	2.9	0.0	**9.6**	1.9	0.6	8.7	2.3	**13.4**	0.272	10	**33.0**	**16**	**17**	**7**	**17**	**E2**
HS353	5.2	ODR	4603	0.15	DL	DLPS	0.0	0.0	0.0	3.0	**3.0**	6.0	2.0	4.0	5.0	**17.0**	0.173	10	**30.0**	**18**	**14**	**17**	**18**	**E2**

Table 10-14: Prioritization of Road Links Identified for Long term Improvements (2025-2035)

Homogeneous Section Properties							Criteria A: Traffic and Network Characteristics (Marks)					Criteria B: Socio-economic Characteristics (Marks)					Criteria C: Economic Analysis (Marks)		Total Marks (A+B+C)	Rank				Group (Year of Implementation)
Name of Homogeneous Section	Length (Km)	Road Type	2033 Traffic (PCU)	Volume-Capacity Ratio (2033 Do Nothing Scenario)	Existing Carriageway	Proposed Carriageway	Volume Capacity Ratio	Network Function	High Commercial Traffic	Rural Connectivity	Traffic & Network Criteria (total)	HDI	Tribal Area Connectivity	Employment	Reg. Motor Vehicles	Socio-Economic Criteria (total)	EIRR	Economic Analysis		A: Traffic & Network Characteristics	B: Socio-Economic Characteristics	C: Economic Analysis	Final Rank	
HS80	144.2	NH	69716	0.87	4L	6L	11.3	0.8	6.0	0.0	**18.1**	9.0	6.9	6.7	1.0	**23.6**	32.0%	**15**	**56.7**	**5**	**2**	**1**	**1**	**A1**
HS79	7.1	NH	94896	1.19	SL	DLPS	14.9	6.0	6.0	0.0	**26.8**	3.0	10.0	6.0	0.0	**19.0**	9.5%	**5**	**50.8**	**1**	**6**	**9**	**2**	**B1**
HS72	80.2	NH	24128	0.67	4L	6L	5.7	6.0	4.0	0.0	**15.7**	6.0	8.0	4.0	4.0	**22.0**	24.1%	**10**	**47.7**	**6**	**4**	**4**	**3**	**B1**
HS75	103.7	NH	21364	0.59	4L	6L	5.0	6.0	4.0	0.0	**15.0**	8.3	3.5	4.9	4.8	**21.5**	18.1%	**10**	**46.5**	**7**	**5**	**6**	**4**	**C1**
HS71	114.8	NH	17302	0.48	DLPS	4L	1.4	6.0	3.2	0.0	**10.6**	12.0	10.0	4.0	2.0	**28.0**	14.7%	**5**	**43.6**	**9**	**1**	**7**	**5**	**D1**
HS73	38.0	NH	21002	0.58	SL	DLPS	5.0	0.0	4.0	0.0	**9.0**	9.0	6.0	6.0	2.0	**23.0**	28.4%	**10**	**42.0**	**10**	**3**	**3**	**6**	**E1**
HS83	24.6	NH	67724	0.85	DLPS	4L	12.7	6.0	3.5	0.0	**22.1**	0.0	2.0	8.0	0.0	**10.0**	12.4%	**5**	**37.1**	**2**	**13**	**8**	**7**	**E1**
HS76	125.8	NH	101398	1.27	DLPS	4L	14.9	0.0	5.6	0.0	**20.5**	3.5	2.8	7.6	1.2	**15.0**	0.0%	**1**	**36.5**	**3**	**9**	**11**	**8**	**F1**
HS74	113.8	NH	85711	1.07	DL	4L	11.5	0.9	6.3	0.0	**18.7**	5.1	6.7	1.7	2.1	**15.6**	0.0%	**1**	**35.3**	**4**	**8**	**11**	**9**	**G1**
HS81	34.9	NH	23963	0.67	4L	6L	5.0	0.0	0.0	0.0	**5.0**	3.0	0.0	8.0	2.0	**13.0**	31.6%	**15**	**33.0**	**13**	**11**	**2**	**10**	**H1**
HS77	29.4	NH	19615	0.54	DLPS	4L	5.0	0.0	2.0	0.0	**7.0**	3.0	4.0	6.0	1.0	**14.0**	21.7%	**10**	**31.0**	**12**	**10**	**5**	**11**	**H1**
HS78	28.1	NH	20567	0.57	IL	DLPS	5.0	0.0	6.0	0.0	**11.0**	3.0	8.0	0.0	5.0	**16.0**	0.0%	**1**	**28.0**	**8**	**7**	**11**	**12**	**I1**
HS82	20.3	NH	20210	0.56	SL	DLPS	5.0	0.0	4.0	0.0	**9.0**	6.0	0.0	6.0	0.0	**12.0**	9.5%	**5**	**26.0**	**10**	**12**	**9**	**13**	**J1**
HS174	157.6	SH	98053	1.23	4L	6L	15.0	0.0	6.8	0.0	**21.8**	2.8	9.3	5.7	1.0	**18.8**	41.7%	**20**	**60.6**	**5**	**15**	**1**	**1**	**A2**
HS371	64.9	VR	3030	0.76	SL	DLPS	10.8	0.0	1.2	5.0	**17.0**	15.0	10.0	0.0	5.0	**30.0**	20.7%	**10**	**57.0**	**12**	**1**	**17**	**2**	**B2**
HS177	45.5	SH	59645	0.75	4L	6L	9.6	3.6	7.1	1.2	**21.5**	9.0	8.0	6.0	1.0	**24.0**	24.8%	**10**	**55.5**	**6**	**3**	**6**	**3**	**B2**
HS275	11.2	MDR	68914	0.86	4L	6L	15.0	0.0	6.0	1.8	**22.8**	9.0	2.0	10.0	1.0	**22.0**	28.2%	**10**	**54.8**	**3**	**6**	**3**	**4**	**B2**
HS172	193.3	SH	25367	0.70	DLPS	4L	7.8	5.2	4.9	0.0	**17.9**	10.3	7.2	3.2	3.2	**24.0**	16.7%	**10**	**51.9**	**8**	**4**	**24**	**5**	**C2**
HS271	22.6	MDR	7168	1.75	SL	DLPS	14.7	0.0	0.0	4.0	**18.7**	6.0	8.0	4.0	4.0	**22.0**	24.1%	**10**	**50.7**	**7**	**6**	**7**	**6**	**D2**
HS171	118.6	SH	23460	0.65	DLPS	4L	6.6	4.2	4.0	0.0	**14.8**	12.0	10.0	4.0	2.0	**28.0**	11.8%	**5**	**47.8**	**15**	**2**	**29**	**7**	**D2**
HS273	39.3	MDR	25196	0.70	DLPS	4L	8.2	0.0	6.6	3.0	**17.8**	3.0	10.0	6.0	0.0	**19.0**	20.8%	**10**	**46.8**	**9**	**11**	**16**	**8**	**D2**
HS274	60.4	MDR	38011	2.36	DL	4L	15.0	0.0	6.0	1.4	**22.4**	3.5	8.9	4.4	1.6	**18.5**	7.5%	**5**	**45.8**	**4**	**16**	**33**	**9**	**E2**
HS173	11.0	SH	56030	0.70	4L	6L	11.3	7.5	4.5	0.0	**23.3**	6.0	0.0	6.0	0.0	**12.0**	24.0%	**10**	**45.3**	**2**	**30**	**8**	**10**	**E2**
HS276	30.8	ODR	29956	0.84	DLPS	4L	11.9	0.0	5.2	0.6	**17.8**	4.1	4.0	6.8	1.4	**16.3**	17.5%	**10**	**44.1**	**10**	**22**	**23**	**11**	**E2**
HS381	8.2	ODR	5432	0.98	IL	DLPS	9.5	0.0	0.0	1.0	**10.5**	9.0	6.0	6.0	2.0	**23.0**	23.7%	**10**	**43.5**	**25**	**5**	**9**	**12**	**E2**
HS277	38.4	MDR	3664	0.75	SL	DLPS	9.1	0.0	0.0	2.0	**11.1**	9.0	4.0	4.0	5.0	**22.0**	20.1%	**10**	**43.1**	**23**	**6**	**18**	**13**	**E2**

Homogeneous Section Properties							Criteria A: Traffic and Network Characteristics (Marks)					Criteria B: Socio-economic Characteristics (Marks)					Criteria C: Economic Analysis (Marks)		Total Marks (A+B+C)	Rank				Group (Year of Implementation)
Name of Homogeneous Section	Length (Km)	Road Type	2033 Traffic (PCU)	Volume-Capacity Ratio (2033 Do Nothing Scenario)	Existing Carriageway	Proposed Carriageway	Volume Capacity Ratio	Network Function	High Commercial Traffic	Rural Connectivity	Traffic & Network Criteria (total)	HDI	Tribal Area Connectivity	Employment	Reg. Motor Vehicles	Socio-Economic Criteria (total)	EIRR	Economic Analysis		A: Traffic & Network Characteristics	B: Socio-Economic Characteristics	C: Economic Analysis	Final Rank	
HS375	4.9	ODR	16342	0.54	DL	4L	4.4	0.0	3.5	2.0	**9.9**	9.0	2.0	10.0	1.0	**22.0**	18.8%	**10**	**41.9**	**28**	**6**	**21**	**14**	**E2**
HS372	42.0	ODR	4430	1.11	SL	DLPS	15.0	0.0	1.7	1.0	**17.7**	6.0	6.0	0.0	2.0	**14.0**	27.7%	**10**	**41.7**	**11**	**25**	**5**	**15**	**E2**
HS179	36.2	SH	20051	0.56	DLPS	4L	5.0	4.3	2.8	0.0	**12.0**	5.3	0.8	10.0	2.2	**18.3**	22.7%	**10**	**40.4**	**21**	**17**	**12**	**16**	**F2**
HS178	9.4	SH	26891	0.75	DLPS	4L	9.2	0.0	4.0	0.0	**13.2**	6.0	4.0	6.0	0.0	**16.0**	23.7%	**10**	**39.2**	**20**	**23**	**9**	**17**	**F2**
HS182	39.2	SH	156926	1.96	4L	6L	15.0	8.0	4.4	0.0	**27.4**	0.0	1.6	8.0	0.0	**9.6**	0.0%	**1**	**38.0**	**1**	**33**	**35**	**18**	**F2**
HS380	43.6	ODR	5612	0.59	IL	DLPS	4.0	0.0	0.5	3.8	**8.3**	5.8	1.5	5.8	1.5	**14.6**	32.3%	**15**	**37.8**	**32**	**24**	**2**	**19**	**F2**
HS176	99.1	SH	21365	0.59	DLPS	4L	4.3	2.9	3.7	0.0	**10.9**	4.5	6.1	4.8	1.1	**16.5**	20.9%	**10**	**37.4**	**24**	**21**	**15**	**20**	**F2**
HS184	102.0	SH	22395	0.62	DLPS	4L	6.6	4.9	3.5	0.0	**15.0**	6.0	1.3	7.3	2.6	**17.2**	11.4%	**5**	**37.2**	**14**	**19**	**30**	**21**	**G2**
HS181	105.0	SH	19028	0.53	DLPS	4L	4.4	0.0	3.3	0.0	**7.8**	6.0	0.0	8.0	4.0	**18.0**	19.6%	**10**	**35.8**	**34**	**18**	**20**	**22**	**G2**
HS376	130.7	ODR	8882	0.95	IL	DLPS	9.7	0.0	1.6	2.2	**13.5**	1.8	1.2	7.9	1.2	**12.1**	22.3%	**10**	**35.6**	**19**	**29**	**13**	**23**	**H2**
HS374	27.7	ODR	19941	0.55	DLPS	4L	5.0	2.0	4.2	2.6	**13.8**	5.4	5.2	5.6	0.4	**16.6**	7.9%	**5**	**35.5**	**18**	**20**	**32**	**24**	**H2**
HS280	8.9	MDR	17763	0.49	DLPS	4L	0.1	0.0	1.9	1.9	**4.0**	8.6	1.9	9.5	1.0	**21.0**	19.9%	**10**	**34.9**	**35**	**10**	**19**	**25**	**I2**
HS272	13.4	MDR	21996	0.61	DLPS	4L	5.0	0.0	4.0	1.0	**10.0**	6.0	6.0	0.0	2.0	**14.0**	21.4%	**10**	**34.0**	**26**	**25**	**14**	**26**	**I2**
HS279	47.2	MDR	6821	0.70	DL	DLPS	5.0	0.0	2.1	2.7	**9.9**	5.1	8.0	4.3	1.4	**18.9**	14.6%	**5**	**33.7**	**27**	**14**	**25**	**27**	**I2**
HS373	28.9	ODR	4550	0.74	IL	DLPS	7.2	0.0	1.5	1.0	**9.7**	3.0	10.0	4.0	2.0	**19.0**	14.4%	**5**	**33.7**	**29**	**11**	**26**	**28**	**I2**
HS175	13.8	SH	18884	0.52	DLPS	4L	5.0	0.0	4.0	0.0	**9.0**	4.2	9.2	5.2	0.4	**19.0**	11.3%	**5**	**33.0**	**31**	**13**	**31**	**29**	**I2**
HS379	6.6	ODR	17442	0.55	DL	4L	5.0	1.6	3.3	2.0	**11.9**	0.0	2.0	8.0	0.0	**10.0**	28.0%	**10**	**31.9**	**22**	**32**	**4**	**30**	**I2**
HS377	13.1	ODR	20900	0.58	DLPS	4L	5.0	2.0	4.0	2.9	**13.9**	2.8	0.1	8.0	1.9	**12.8**	13.9%	**5**	**31.7**	**17**	**27**	**27**	**31**	**I2**
HS278	33.4	MDR	21522	0.60	DLPS	4L	5.3	0.0	1.5	2.7	**9.5**	2.1	0.6	8.0	1.4	**12.1**	23.5%	**10**	**31.7**	**30**	**28**	**11**	**32**	**I2**
HS183	64.0	SH	25452	0.70	DLPS	4L	8.9	1.7	3.6	0.0	**14.3**	1.9	0.7	7.9	1.3	**11.8**	12.3%	**5**	**31.1**	**16**	**31**	**28**	**33**	**J2**
HS378	9.5	ODR	7558	1.68	SL	DLPS	13.4	0.0	2.0	1.0	**16.4**	0.0	0.0	8.0	0.0	**8.0**	5.5%	**5**	**29.4**	**13**	**35**	**34**	**34**	**J2**
HS180	105.5	SH	17731	0.49	DLPS	4L	3.1	2.3	2.7	0.0	**8.1**	0.3	0.0	8.2	0.5	**9.0**	18.1%	**10**	**27.2**	**33**	**34**	**22**	**35**	**J2**

10.4 Details of Network Links Recommended for Improvement

Prioritized list of road network links recommended for improvement under short term, medium term, and long term are presented in the form of tables and maps in **Appendix 10.2 to 10.4.** A Homogeneous Section comprises of number of road links of similar characteristics, and hence identification of road links for project implementation based on Homogeneous Section Number (group of links) may be difficult. Hence, Reference Number has been assigned to each road link for easy identification during project implementation. If more than one road link forms one prioritized homogeneous section (group of links), then each link of prioritized group of links will get a Reference No. for its distinct identification. The tables presented in **Appendix 10.2 to 10.4** mentioned above, contain detailed information for each of the road links recommended for improvement, such as,

1. Reference number
2. Homogenous Section number
3. Reclassified and original road category
4. Name of road, if any
5. Recommended carriageway width
6. Length of the road
7. Name of districts through which the road link is passing
8. Information of start and end points (from and to) of road link
    a. Name of place, intersection or nearest village/town
    b. Name of Block
    c. GPS coordinates in terms of latitude and longitude (of start and end points)

The maps showing prioritized road links for improvement are labeled with 'Reference Number' so that the road links in the map can be easily referenced with details given in the tables. The sequence of 'Reference Number' assigned to the road links (prioritized for each horizon), and corresponding Appendix numbers are given in **Table 10.15**. Each Appendix contains separate maps and corresponding tables for each year.

Table 10-15: Reference Numbers for Road Links for Short, Medium and Long term Improvements and Appendix Numbers

Horizon	Year of Implemen-tation	Reference Numbers		Appendix No.
		State Roads	National Highways	
Short term horizon (2015-2020)	Year-1	101 to 150	151 to 200	Appendix 10.2A: Tables Appendix 10.2B: Maps
	Year-2	201 to 250	251 to 300	
	Year-3	301 to 350	351 to 400	
	Year-4	401 to 450	451 to 500	
	Year-5	501 to 550	551 to 600	
Medium term horizon (2020-2025)	Year-1	1001 to 1050	1051 to 1100	Appendix 10.3A: Tables Appendix 10.3B: Maps
	Year-2	1101 to 1150	1151 to 1200	
	Year-3	1201 to 1250	1251 to 1300	
	Year-4	1301 to 1350	1351 to 1400	

Horizon	Year of Implemen-tation	Reference Numbers		Appendix No.
		State Roads	National Highways	
	Year-5	1401 to 1450	1451 to 1500	
Long term horizon (2025-2035)	Year-1	2001 to 2050	2051 to 2100	Appendix 10.4A: Tables Appendix 10.4B: Maps
	Year-2	2101 to 2150	2151 to 2200	
	Year-3	2201 to 2250	2251 to 2300	
	Year-4	2301 to 2350	2351 to 2400	
	Year-5	2401 to 2450	2451 to 2500	
	Year-6	2501 to 2550	2551 to 2600	
	Year-7	2601 to 2650	2651 to 2700	
	Year-8	2701 to 2750	2751 to 2800	
	Year-9	2801 to 2850	2851 to 2900	
	Year-10	2901 to 2950	2951 to 3000	

This is worth noting that the detailed list of the identified road network improvements in the RNMP should be used for locating links for implementation of the improvements in respective horizon periods of the Master Plan in next 20 years. Necessary budget provisions per km of road improvements, as indicated in the previous chapter should be considered for capital works of road improvements to be undertaken, during financial planning for different five year plans. Budgetary provisions for individual schemes should include costs for detail feasibility study, which will be followed by appropriate cost estimation with a Detail Project Report.

10.5 Road Improvement Cost and Funding Options

Using the estimate per km of cost for road improvement, given in Chapter 9, the total cost of road improvements in each year was estimated. The estimated costs for National Highways and State Roads according to their priority of improvement (under three horizons) are presented in the **Table 10-16** below.

Table 10-16: Estimated Cost of Road Improvements under three Horizons

Year of implementation	National Highways		SH, MDR, ODR and VR	
	Length (km)	Cost of Road Improvement (INR in Crores)	Length (km)	Cost of Road Improvement (INR in Crores)
Short term (2015-2020)				
1st Year	337	1,152	1,385	5,005
2nd Year	139	965	1,437	5,574
3rd Year	372	2,512	1,449	4,928
4th Year	509	2,146	1,349	4,342
5th Year	426	1,288	1,357	4,157
Total of Short term	**1,782**	**8,062**	**6,977**	**24,008**
Medium term (2020-2025)				
6th Year	64	421	218	1,019

Year of implementation	National Highways		SH, MDR, ODR and VR	
	Length (km)	Cost of Road Improvement (INR in Crores)	Length (km)	Cost of Road Improvement (INR in Crores)
7th Year	56	365	202	950
8th Year	81	505	177	568
9th Year	43	286	137	692
10th Year	37	231	139	871
Total of Medium term	**281**	**1,809**	**873**	**4,098**
Long term (2025-2035)				
11th Year	144	1,236	158	1,351
12th Year	87	587	122	716
13th Year	104	680	193	1,268
14th Year	115	718	181	1,116
15th Year	63	440	196	1,096
16th Year	126	1,078	227	1,378
17th Year	114	976	207	1,325
18th Year	64	391	158	588
19th Year	28	185	165	808
20th Year	20	127	179	1,107
Total of Long term	**865**	**6,418**	**1,786**	**10,754**

The above estimation of costs for road improvement is significant in comparison to the budgetary allocations of OWD in past years. However, to relieve the growing congestion and support the road network development for sustaining the socio-economic growth of the State, this investment is necessary. The short term improvements recommended will take care of the capacity enhancement of the network, and therefore, a significant investment of Rupees 24,000 crores will be required with amenable yearly allocations. This will take care of next ten years in a substantial way, except that investment of a modest Rupees 4,000 crores will be required during the medium term (2020-2025) with less than Rupees 1,000 crore yearly allocations. However, in the longer term as the economy further stabilizes in its growth path, Rupees 10,000 crores investment will be required to keep the road network competitive in terms of handling the freight traffic supporting other economic developments of the State.

10.5.1 Budgetary Allocation for Capital Works

The allocation for capital works has been on an increasing trend and with focus of GOO on infrastructure development, as well as with the current financial position of GOO, this trend is likely to continue. Considering the recent trend of past three years with 19% CAGR, the budgetary allocation for capital works for the future years is projected in Table below. The budgetary allocation for capitals works under three horizons i.e. short term, medium term and long term is presented in the **Table 10-17** below.

Table 10-17: Projected budgetary allocation for capital works for three horizons

Year	Budget Allocation for Capital Works (Rs./ Crore)	Year	Budget Allocation for Capital Works (Rs./ Crore)

Short term horizon (2015-2020)		Long term horizon (2025-2035)	
2015-16	2,187	2025-26	12,980
2016-17	2,614	2026-27	15,510
2017-18	3,123	2027-28	18,533
2018-19	3,732	2028-29	22,145
2019-20	4,459	2029-30	26,462
Medium term horizon (2020-2025)		2030-31	31,619
2020-21	5,329	2031-32	37,782
2021-22	6,367	2032-33	45,146
2022-23	7,608	2033-34	53,946
2023-24	9,091	2034-35	64,460
2024-25	10,863		

10.5.2 Estimate of Capital Works Requirement

The estimate for capital investment over the next 5 years is Rs. 24, 006 crore as detailed in the road Master Plan prepared under the current study. The cost estimate for capital works in short term includes State Highways, Major District Roads, Other District Roads and Village Roads for five year, that is 2015-16 to 2019-20. The capital works proposed in the road master plan will spread over the years and it is likely that fund estimated for the capital work commencing in a particular year is assumed to be expended in the ratio of 25%, 50% and 25% over the three year implementation period. In addition to the proposition contained in the master plan prepared under the current study, it is reasonable to expect that capital improvement for the other programs going on in the road sector in Odisha will continue. Accordingly, a 10% additional amount is considered in the capital improvement cost to account for these programs. The estimated requirement of capital works based on the proposition in the road master plan and assumptions stated above is given under three horizons i.e. short term, medium term and long term in **Table 10-18** below.

Table 10-18: Estimated Fund Requirement for Capital Works for three Horizons (for State Roads only)

Year	Estimated Requirement (Rs./ Crore)	Year	Estimated Requirement (Rs./ Crore)
Short term horizon (2015-2020)		**Long term horizon (2025-2035)**	
2015-16	1376	2025-26	1041
2016-17	4286	2026-27	1179
2017-18	5797	2027-28	1114
2018-19	5437	2028-29	1201
2019-20	4886	2029-30	1264
Medium term horizon (2020-2025)		2030-31	1289
2020-21	3761	2031-32	1424
2021-22	1965	2032-33	1269
2022-23	959	2033-34	910
2023-24	764	2034-35	911
2024-25	776		

10.5.3 Funding Gap

By comparing the figures of budgetary allocation and capital works requirements, it is evident that there is a gap in fund allocation and requirement only in the short-term horizon, whereas in the medium term and long term the budgetary allocation is in surplus (refer **Table 10-19**).

Table 10-19: Gap/Surplus for three Horizons (for State Roads only)

Year	Budget Allocation for Capital Works (Rs./ Crore)	Estimated Requirement (Rs./ Crore)	Total Gap/Surplus
Col-1	**Col-2**	**Col-3**	**Col-4 = Col2-Col3**
Short term horizon (2015-2020)			
2015-16	2,187	1,376	**811**
2016-17	2,614	4,286	**-1,672**
2017-18	3,123	5,797	**-2,674**
2018-19	3,732	5,437	**-1,705**
2019-20	4,459	4,886	**-427**
Medium term horizon (2020-2025)			
2020-21	5,329	3,761	**1,568**
2021-22	6,367	1,965	**4,402**
2022-23	7,608	959	**6,649**
2023-24	9,091	764	**8,327**
2024-25	10,863	776	**10,087**
Long term horizon (2025-2035)			
2025-26	12,980	1,041	**11,939**
2026-27	15,510	1,179	**14,331**
2027-28	18,533	1,114	**17,419**
2028-29	22,145	1,201	**20,944**
2029-30	26,462	1,264	**25,198**
2030-31	31,619	1,289	**30,330**
2031-32	37,782	1,424	**36,358**
2032-33	45,146	1,269	**43,877**
2033-34	53,946	910	**53,036**
2034-35	64,460	911	**63,549**

The funding of road network development is being taken care of in the various funding options of road sector considered under a separate task, which will elaborate on the strategies to be adopted for funding the RNMP recommendations. However, a snap shot of that is provided here. The possible sources of fund for recommended road improvements are,

- Budget allocation,
- Public Private Partnership (PPP),
- External Borrowing, and
- Central Government Scheme.

The sections of roads, which are likely to qualify for taking up under PPP mode of implementation were identified based on the traffic volume of Sambalpur-Rourkela Road Project being implemented under this mode in Odisha. The Sambalpur – Rourkela Road (SH-10) is 161km long with three toll plazas and the tollable traffic is 13,500 PCU per day (Total traffic being approximately 15,000 PCUs). This has been adopted as threshold traffic to identify projects likely to be viable on PPP mode among the road improvements recommended by RNMP study. **Table 10-20** gives length and cost of such road sections under the three horizons: short, medium and long term.

Table 10-20: Length and Cost of Road Improvements that Qualify PPP Mode of Implementation

Year of implementation	National Highways (with PPP mode)		SH, MDR, and ODR (with PPP mode)	
	Length (km)	Cost of Road Improvement (INR in Crores)	Length (km)	Cost of Road Improvement (INR in Crores)
Short term (2015-2020)				
1st Year	-	-	56	396
2nd Year	49	333	42	279
3rd Year	330	2,229	33	221
4th Year	94	644	-	-
5th Year	-	-	-	-
Total of Short term	**473**	**3,207**	**131**	**896**
Medium term (2020-2025)				
6th Year	64	421	64	453
7th Year	56	365	78	512
8th Year	81	505	-	-
9th Year	43	286	81	514
10th Year	37	231	58	382
Total of Medium term	**281**	**1,809**	**281**	**1,860**
Long term (2025-2035)				
11th Year	144	1,236	158	1,351
12th Year	80	526	46	390
13th Year	104	680	193	1,268
14th Year	115	718	119	778
15th Year	38	237	91	661
16th Year	126	1,078	138	955
17th Year	114	976	207	1,325
18th Year	35	208	-	-
19th Year	-	-	33	209
20th Year	-	-	64	415
Total of Long term	**756**	**5,659**	**1,049**	**7,354**

Details of road sections likely to be viable for PPP mode are presented in tabular and map form in **Appendix 10.5A and 10.5B** respectively.

It can be seen in the above table that in the short term only 131 km of State roads qualify for implementation under PPP mode, whereas as the traffic grows in the network during medium and long term, more roads qualify for implementation under PPP with 281 and 1,049 kms respectively. Higher traffic volumes and more projects of 4-laning and 6-laning under medium and long term horizons make PPP an attractive option in the long run. Considering the cost of projects likely to be viable under PPP mode, the gap in the budgetery allocations and capital cost required for the short term horizon has been revised as given in **Table 10-21** below. It is to be noted that only the State Highways under PPP mode have been considered here as the MDRs and ODRs despite having tollable traffic more than 13,500PCU may not attract private investment due to various reasons, such as more proportion of local traffic, short distance trips, etc.

Table 10-21: Gap/Surplus for Short term Horizon considering Investment in PPP Mode (Rs in crores)

Year	Total Gap/Surplus	Cost of SHs Viable under PPP mode	Revised Gap/Surplus
2015-16	811	478	**1,289**
2016-17	-1,672	349	**-1,323**
2017-18	-2,674	276	**-2,398**
2018-19	-1,705	-	**-1,705**
2019-20	-427	-	**-427**

Note: Assumed grant component as 0%

10.5.4 Sources of Fund

Currently, there are no well-defined State policy initiatives in Odisha that cater to the specific needs of road sector and the funding of the road sector is primarily dependent on State budgetary allocation.

It is envisaged that finances can be raised through the following sources:

1. **Existing Sources:** Earmarking of certain percentage of exiting Road User Charges such as VAT on fuel, toll fees collected by the Government and which currently forms part of General Budgetary Sources Allocation from VAT on fuel, which has a strong link with the road use and is quasi user charge for road infrastructure, and earmarking part of VAT on fuel for allocation for major road network maintenance, has a merit. The present revenue from VAT on fuel @ 19.18% will be around Rs. 14485 Crores for next 5 years and this can be used for funding gap of major road network maintenance amounting to Rs. 4322 crores and balance can be utilized for funding gap of Capital Works to the extent of Rs. 10163 Crores and balance gap of Rs. 1304 Crores can be mitigated from other sources.

2. **Other Sources**
   - **Toll Rates:** Amount Collected by Odisha Bridge Construction Corporation Limited being a road user charge is directly linked with proper upkeep of tolled roads and the amount should be spent for road maintenance purpose.

- **Utility Licence Fees:** Motels, garages, parking plazas and other wayside facilities are indirect beneficiary from development of the roads. Once the roads are operational, traffic starts commuting and such facilities starts growing providing revenue to these service providers. Hence, Government can consider imposition of licence fees on these utility services.
- **Levy on Land Registration Fee:** This charge is based on the assumption that lands adjacent to roads haves higher market value than the other places. The reason for higher prices is due to development of roads near the land. Government makes investment for the development of the road sector; hence all beneficiaries from the development of road sector should contribute certain percentage of their gains for the development of the road sector. So, to generate fund for the proposed Road Fund government can put extra levy on registration fee on land transactions near the roads that have been constructed or upgraded or widened. It may be mentioned that the Karnataka Highways Act, 1964 provides levy for betterment charges.
- **Levy on transport of minerals and agri-based:** industrial produce in the state- Odisha is rich in mineral resources and mining is one of the main economic activities being performed in the state. However, there is limited scope to increase tax on these commodities. Additional revenue generation through increasing vehicle registration fee for heavy vehicles is an option.
- **Pre-constructed ducts under or along new roads:** This could be taken up for all up-gradation projects – especially those which are predominantly cement concrete roads. The usage of these ducts could be rented out to telecom companies and other users – and the revenues could flow for use for the road sector.
- **One Time Vehicle Registration fees** on new vehicle registrations
- **Charges on Vehicle Insurance Premium**

3. **Leveraging the Road Fund as mechanism to generate additional revenue**

   In the long term, if a Road Fund is considered for setting up, the Road Fund can leverage its capital to raise cheaper fund from market and can also raise capital through issuance of bonds etc. Given the complexities in the financing mechanisms for funding the Road Fund and their relative advantages and disadvantages, it would be advisable that the allocation should be made through the budgetary sources which would take care of such complexities. However, this should be followed by a specific provision to institutionalize the funding for Road Fund from budgetary sources, if the Road Fund is considered to be setup. At this stage to further provide a credible financing mechanism, the option of making Road Fund Board as a 'collection arm' can also be built into its financing arrangement.

While the details of available fund under each possible source is detailed in the other task report, an assessment of fund required for the road section, which are likely to be viable under PPP, is carried out here by identifying the links which qualify for PPP. In this connection, it may be mentioned that for a typical Road Project costing Rs. 1500 crores, if a project is implemented on PPP basis, then the project can be constructed and maintained by private investors through contribution form their own Equity (30% say Rs. 450 Crores) and Debt from Banks/ Financial Institutions (70% say Rs. 1050 Crores). This kind of arrangement will supplement the Government funding. However in case the project is not viable, then there is a provision of Viability Gap Funding, which is maximum of 40% of the Total Project Cost. For this 40% gap, it is required to be contributed by the State Government.

11 Reclassification

11.1 Reclassification Objective

The classification of road network in Odisha, like all other States in India, follows the national classification to five categories of roads, viz. NH, SH, MDR, ODR and VR. For the VRs, there are several organizations, which are made responsible for the vast network of village or RRs. These are generally PMGSY roads constructed and attended by Rural Development Department under a central assistance scheme, while the same Department takes care of another set of RRs funded and managed by the State Government.

In addition, there is Gram Panchayat roads, Panchayat Samiti roads, which are looked after by the Panchayati Raj Department of the State Government, some of which are in the form of cart tracks or foot paths. Beyond these, the State has another set of roads looked after by other departments for their specific purposes, viz. Forest roads, Irrigation road, Mining roads, etc. While the basic classification of roads is not required to be changed, the traffic and development functions require the roads to be reclassified to higher category to meet the overall development objectives. An example of this is the upgradation of a State road to NHs from time to time, based on regional balance and other legitimate reasons. In the same way, based on traffic and development criteria, the State road network also needs reclassification from time to time. Thus, the primary aim and objective of this State road reclassification is to ensure enhancement of functionality of the existing roads in support of improving mobility and accessibility. The enhanced functionality was targeted to be accomplished through upgrading connectivity between the existing core road network with links of different levels of hierarchy to the links of higher level of hierarchy by improving the capacity and network level accessibility for the administrative headquarters, business centres, major industries, intermodal locations, tourist locations including interstate connectivity, etc. in the region.

11.2 Road Classification Criteria for Odisha

The road re-classification process was primarily guided by the **Road Development Plan - Vision 2021** recommendations and **other** relevant **State Policies** for the road sector**.** Connectivity among major State level headquarters has been prioritized based on futuristic network level accessibilities recommended in the vision document in a hierarchical system of road classification. These priorities have been adopted as follows:

- Between State Head Quarter (SHQ) and District Head Quarter (DHQ) through SH;
- Between DHQ to Block Head Quarter (BHQ) through MDR; and
- Between BHQ to Gram Panchayat Head Quarter (GPHQ) through ODR.

Primary emphasis of road reclassification was on upgrading road categories to ensure best possible mobility between major administrative headquarters. In case of any existing connections between the SHQ and the DHQs are lower than SH classification, those links are recommended to be upgraded to SH category. Similarly all road links connecting to existing or future ports, interstate links, major town connectors, links to tourist destinations of National importance, are recommended to be upgraded to SH category.

It is worth noting that if the existing connectors are already SH or NH, they will remain the same. A road reclassification guideline was developed and adhered to undertake the reclassification of the existing State roads. The entire reclassification was subdivided into three hierarchical levels, and these are called Type A, Type B and Type C. **Table 11-1** summarizes the adopted reclassification guidelines with network level hierarchy. The District wise existing and re-classified road network, as well as GPHQ connectivity is shown in maps given in **Appendix 11.1A.**

Table 11-1: Reclassification Guidelines

Connectivity	Minimum Road Class Recommended			Reclassification Type
	SH*	MDR	ODR	
SHQ-DHQ	Δ	-	-	A
Major Ports/Airports	Δ	-	-	
Interstate	Δ	-	-	
Tourist Places of National Importance	Δ	-	-	
Major Towns with 5000 (+) Population	Δ	-	-	
DHQ-Sub divisional HQ/BHQ	-	Δ	-	B
Tourist Places of State Importance	-	Δ	-	
Market Centres (Agricultural)	-	Δ	-	
Sub divisional HQ-BHQ[20]	-	Δ	-	C
BHQ-GPHQ	-	-	Δ	

It is worth noting all the roads reclassified to SH will be improved to 2-lane road and included in OSTM.

11.3 Road Reclassification – Type A

11.3.1 State HQ to DHQ

According to the Road Development Plan – Vision 2021, all District Headquarters should be connected with State HQ by a SH. All the existing ODR and MDR road links between the State HQ and DHQs were, therefore, identified and recommended for upgradation to SH from their existing classifications. **Table 11-2** summarizes the required length for upgradation of existing road class to SH classification.

Table 11-2: Connectivity for State HQ to DHQ

Sl. No.	Road Section	Existing	Proposed	Upgraded Length (KM)	Link		Total Length KM
					From	To	
1	Malkangiri DHQ - to NH (Koraput)	SH+MDR+ ODR	SH	42.56 (MDR) 1.62 (ODR)	SH 25	NH 26	44.18
2	Koraput DHQ- Rayagada DHQ	MDR	SH	78.31 (MDR)	NH 26	SH 4	78.31

11.3.2 Ports

Odisha has planned to operate six significant maritime ports by 2020. Paradeep Port out of total six ports has been in operation at its full capacity whereas remaining five ports i.e. Dhamra, Gopalpur, Astaranga, Kirtania/Subarnarekha, and Chudamani, are expected to be fully operational by the year

[20] Minimum carriageway width should be single lane plus paved shoulder

2020. Road links connecting the individual ports to the nearest core road network are recommended to be upgraded to SH. **Table 11-3** summarizes the details of reclassification of port connectivity.

Table 11-3: Ports Connecting Roads

Sl. No.	Port Name	Existing	Proposed	Length (Km)	Link		Total Length (Km)
					From	To	
1	Gopalpur	MDR	SH	11.04	MDR 65	NH 16	11.04
2	Astaranga	SH	SH	Nil	SH 43	SH 43	Nil
3	Paradeep	NH	NH	Nil	NH 53	NH 53	Nil
4	Dhamra	MDR	SH	76.44	MDR 85	NH 16	76.44
5	Chudamani	MDR+ODR	SH	15.97 + 10.89	MDR 85	NH 16	26.86
6	Kirtania	MDR+VR	SH	22.75 + 18.29	MDR	NH 16	41.04

11.3.3 Interstate Routes

The existing interstate routes were closely reviewed to identify potential routes that serve major towns/cities or connect two major roads across the State border. A total of 29 interstate links meeting the criteria were recommended to be upgraded to SH classification. Any higher or equivalent category among these links will continue to be the same. **Table 11-4** summarizes the details of road upgradation and reclassification for interstate connectivity.

Table 11-4: Interstate Connector Reclassification

Sl. No.	District	Road Name	Connect	Existing	Road Name	Length (Km)	Proposed
1	Koraput	Jeypore-Kotta-Malkangiri-Motu Road	AP Border and NH 43 at Jeypore	MDR	-	44.2	SH
2	Malkangiri	Jeypore-Kotta-Malkangiri-Motu Road		SH	SH 25	157.6	SH
3	Malkangiri	Govindapalli-Balimela-Chitrakonda-Sileru road (Govindapalli-Rajakonda Colony)	AP border SH 25	SH	SH 47	82.8	SH
4	Koraput	Baragarh Barapali Balangir-Bhawanipatna Boriguna-Koraput-Sunki-Salur-Vijayanagar	AP border Intersection of SH and NH 43	NH	NH 43	50.1	NH
5	Koraput	Semiliguda-Handiput Road and Vizag-Jeypore Road [Kumbhiguda (AP	AP border NH 43 at Semiliguda	MDR	-	64.8	SH

Sl. No.	District	Road Name	Connect	Existing	Road Name	Length (Km)	Proposed
		Border) Gunju] (From 125.800 to 198.492 Km)					
6	Koraput	Parvatipur-Laxmipur Road (From 12.600 to 69.237)	AP border Intersection with MDR at Lakshmipur	SH	SH 51	56.6	SH
7	Koraput	Jagdalpur-Kotapad-Boriguma	CG border Intersection with NH 201 at Boriguma	NH	NH 43	41.9	NH
8	Nabrangpur	Papadahandi-Umerkote-Yerla Road	CG border Intersection with NH 201 at Paprahandi	SH	SH 39	66.8	SH
9	Nabrangpur	Umerkote-Raighar-Kundei-Likma Road (Khiloli-Umerkote)	CG border Intersection with SH 39 at Umarkote	MDR	-	55.8	SH
10	Kalahandi	Baldimal Dhamragarh Road (Baldimal to Tel Bridge)	CG border Intersection with NH 201 near Junagarh	SH	SH 2	22.8	SH
11	Nuapada	Mahasamund-Nuapara-Khariar Road	CG border Intersection with SH 3	NH	NH 217	13.7	NH
12	Baragarh	Padampur Jagadalpur Road (Padampur-Chhatisgarh Border)	CG border Intersection with SH 3 at Padmapur	MDR	-	26.6	SH
13	Baragarh	Sohela Grinjal Road	CG border Intersection with NH 6 at Sohela	ODR	-	4.8	SH
14	Jharsuguda	Raigarh-Kanaktora-Jharsuguda-Kuchinda-Pravasuni-Deogarh-Barakote-Pallhara-Keonjh	CG border Intersection with SH 10 at Jharsuguda	NH	NH 200	71.3	NH
15	Sundargarh	Duduka-Gopalpur-Taparia Road	CG border Intersection with MDR (Ref-14)	ODR	-	28.8	SH
16	Sundargarh	Surguda-Balichuan-	Intersection with	MDR	-	34.9	SH

Sl. No.	District	Road Name	Connect	Existing	Road Name	Length (Km)	Proposed
		Balinga - Benjharia - Hemgir -Kanika-Belpahar Road, and Sundargarh-Lephripara Road	ODR (Ref-13) Intersection with SH 10 at Sundargarh				
17	Sundargarh	Karamdihi - Talsara - Lulkidihi Road	CG border Intersection with SH 10 at Karamdihi	SH	SH 31	52.5	SH
18	Sundargarh	Talsara-Luhakera Road	CG border Intersection with SH 31 at Talsara	MDR	-	12.8	SH
19	Sundargarh	Kukurbhukha-Laxmiposh-Jharkhand Border Road, Hatibari - Birmitrapur-Raiboga-Salangabahal Road (Birmitrapur - Raiboga), and Hatibari - Birmitrapur-Raiboga-Salangabahal Road (Salangabahal-Bihar border Road)	JH border Intersection with SH 10 near Kutra	MDR	-	27.3	SH
20	Sundargarh	Biramitrapur-panposh-rajamunda-Barakote (Biramitrapur-NH 143)	JH border Intersection with SH 10 at Rourkela	NH	NH 23	21.6	NH
21	Keonjhar	Banei Border Barbil-Nalda Road (Bhadrasahi-Nalda)(From Km 299.00 to 312.10)	JH border Intersection with NH 215 at Barbil	SH	SH 10B	13.1	SH
22	Keonjhar	Champua-Rimuli - Keonjhar-Panikoili Road	JH border Intersection with NH 215 near Rimuli/Parsora	NH	NH 75	14.1	NH
23	Mayurbhanj	Baripada	JH border	SH	SH 50	36.2	SH

Sl. No.	District	Road Name	Connect	Existing	Road Name	Length (Km)	Proposed
		Bamanghati Road (From Boisoi to Tiring Border)	Intersection with SH 40 at Rairangpur				
24	Mayurbhanj	Seragarh Nilagiri Kaptipada Udala Baripada Medinapur border Road (From Udala to Chaks)	WB border Intersection with NH 5 at Baripada	SH	SH 19	20.8	SH
25	Balasore	Jaleswar-Batagram-Chandaneswar Road, and Chandaneswar-Digha Road	WB border Intersection with NH 60 near Jaleswar town	MDR	-	36.7	SH
26	Ganjam	Chikiti-Digapahandi-Aska Road (From Km 4.200 to 62.955)	AP border Intersection with SH 17 at Digapahandi	SH	SH 29	36.6	SH
27	Rayagada, and Gajapati	Kakiriguma Laxmipur Rupokona Rayagada K. Petavangi Junction to Gunupur, and Mandasa-Meliaputti- Pkd.-Kasinagar- Gunupur Road	AP border Intersection with SH near Ramanguda	SH	-	74.4	SH
28	Gajapati	Parlakhemundi-Narasenapeta Road	AP border Intersection with SH near Parlakhemundi	ODR	-	1.5	SH
29	Rayagada	Rayagada Kerada Road	AP border Intersection with SH at Rayagada	MDR	-	25.2	SH

11.3.4 Major Towns with 5,000+ Population

Based on Census 2011 it was identified that 182 towns out of 191 towns in the State are having a population over 5,000. The existing links connecting these 182 towns with neighbouring core road network were recommended to be upgraded and reclassified as SH. **Table 11-5** summarizes the reclassification requirement of 40 of these links connecting these towns, which are to be taken up, and others are already connected by SH or higher category roads.

Table 11-5: Town/City Road Connectivity

Sl. No.	District	Town Name	Population	Existing	Proposed	Nearest Link	Length (Km)
1	Anugul	Dera Colliery Township	15787	NH 53	NH	-	-
2	Anugul	Talcher Thermal Power Station Township	3613	NH 53	NH	-	-
3	Anugul	Talcher	40841	NH 53	NH	-	-
4	Anugul	Gotamara	7420	NH 149	NH	-	-
5	Anugul	Athmallik	12298	MDR	SH	NH 55	35.86
6	Anugul	Nuahata	5920	NH 55	NH	-	-
7	Anugul	Kulad	4256	NH 55	NH	-	-
8	Anugul	Anugul	43795	NH 55	NH	-	-
9	Anugul	Budhapanka	6129	NH 149	NH	-	-
10	Anugul	Nalco	19644	NH 149	NH	-	-
11	Balasore	Jaleswar	25747	NH 16	NH	-	-
12	Balasore	Remuna	33378	NH 16	NH	-	-
13	Balasore	Nilagiri	17264	SH 19	SH	-	-
14	Balasore	Soro	32531	NH 16	NH	-	-
15	Balasore	Baleshwar	144373	NH 16	NH	-	-
16	Baragarh	Padmapur	17625	SH 3	SH	-	-
17	Baragarh	Sohela	6917	NH 53	NH	-	-
18	Baragarh	Khaliapali	6865	NH 53	NH	-	-
19	Baragarh	Bargarh	80625	NH 53	NH	-	-
20	Baragarh	Bijepur	6922	ODR	SH	NH 26	21.01
21	Baragarh	Barapali	20850	NH 26	NH	-	-
22	Baudh	Ghantapada	15169	SH 41	SH	-	-
23	Baudh	Baudhgarh	20424	NH 57	NH	-	-
24	Bhadrak	Dhamanagar	22920	MDR 8A	SH	NH 16	8.3
25	Bhadrak	Bhadrak	121338	NH 16	NH	-	-
26	Bhadrak	Erei	7890	NH 16	NH	-	-
27	Bhadrak	Basudebpur	33690	MDR 85	SH	NH 16	14.01
28	Bolangir	Titlagarh	34067	NH 59	NH	-	-
29	Bolangir	Balangir	98238	NH 57	NH	-	-
30	Bolangir	Bangomunda	5759	NH 59	NH	-	-
31	Bolangir	Kantabanji	21819	SH 42	SH	-	-
32	Bolangir	Badmal	5431	MDR 40	SH	LINK NH 59 &26	24.66
33	Bolangir	Patnagarh	21024	SH 42	SH	-	-
34	Bolangir	Loisinga	6220	NH 26	NH	-	-
35	Bolangir	Tarbha	8334	NH 57	NH	-	-
36	Cuttack	Nuapatna	8057	SH 65	SH	-	-
37	Cuttack	Banki	17521	MDR 77	SH	LINK NH	63.83

Sl. No.	District	Town Name	Population	Existing	Proposed	Nearest Link	Length (Km)
						57 & 16	
38	Cuttack	Athagad	17304	SH 65	SH		
39	Cuttack	Dadhapatna	5005	MDR 107	SH	NH 16	17.63
40	Cuttack	Belagachhia	5516	NH 16	NH	-	-
41	Cuttack	Choudwar	57015	NH 55	NH	-	-
42	Cuttack	Cuttack	610189	NH 16	NH	-	-
43	Cuttack	Badamba	6284	SH 65	NH	-	-
44	Deogarh	Debagarh	22390	NH 49	NH	-	-
45	Dhenkanal	Kamakshyanagar	16810	NH 53	NH	-	-
46	Dhenkanal	Bhuban	22200	NH 53	NH	-	-
47	Dhenkanal	Dhenkanal	67414	NH 55	NH	-	-
48	Gajapati	Paralakhemundi	46272	SH 4	SH	-	-
49	Gajapati	Kashinagar	9684	SH 4	SH	-	-
50	Gajapati	R.Udayagiri	4851	SH 34	SH	-	-
51	Gajapati	Mohana	5197	SH 17	SH	-	-
52	Ganjam	Kabisurjyanagar	17430	SH 30	SH	-	-
53	Ganjam	Kodala	13965	SH 30	SH	-	-
54	Ganjam	Rambha	12111	NH 16	NH	-	-
55	Ganjam	Polasara	23119	MDR 72	SH	LINK SH 30 & 33	25.82
56	Ganjam	Badakodanda	5137	SH 7	SH	-	-
57	Ganjam	Mundamarai	4253	NH 59	NH	-	-
58	Ganjam	Bellaguntha	11297	SH 21	SH	-	-
59	Ganjam	Surada	14867	NH 59	NH	-	-
60	Ganjam	Asika	21428	SH 7	SH	-	-
61	Ganjam	Badagada	6982	SH 17	SH	-	-
62	Ganjam	Lalsingi	7078	SH 7	SH	-	-
63	Ganjam	Bhanjanagar	20482	SH 7	SH	-	-
64	Ganjam	Buguda	15176	SH 33	SH	-	-
65	Ganjam	Ganjam	11747	NH 16	NH	-	-
66	Ganjam	Purusottampur	15366	SH 31	SH	-	-
67	Ganjam	Kukudakhandi	7361	NH 59	NH	-	-
68	Ganjam	Hinjilicut	24671	SH 36	SH	-	-
69	Ganjam	Sheragada	6653	SH 17	SH	-	-
70	Ganjam	Chhatrapur	22027	NH 16	NH	-	-
71	Ganjam	Palurgada	5019	NH 16	NH	-	-
72	Ganjam	Suvani	7993	NH 16	NH	-	-
73	Ganjam	Lochapada	16377	NH 59	NH	-	-
74	Ganjam	Gopalpur	7221	MDR	SH	NH 16	11.04
75	Ganjam	Khalikote	13022	SH 30	SH	-	-
76	Ganjam	Brahmapur	356598	NH 59	NH	-	-
77	Ganjam	Patrapur	6059	MDR + ODR	SH	SH 17	11.3
78	Ganjam	Chikiti	11645	SH 17	SH	-	-

Sl. No.	District	Town Name	Population	Existing	Proposed	Nearest Link	Length (Km)
79	Ganjam	Digapahandi	13190	SH 17	SH	-	-
80	Jagatsinghpur	Chandapur	5565	SH 12	SH	-	-
81	Jagatsinghpur	Paradip	68585	NH 53	NH	-	-
82	Jagatsinghpur	Paradipgarh	4790	SH 12	SH	-	-
83	Jagatsinghpur	Krushnanandapur	8974	VR	SH	SH 12	18.87
84	Jagatsinghpur	Jagatsinghapur	33631	SH 43	SH	-	-
85	Jajpur	Jajapur	37458	MDR	SH	NH 16	16.12
86	Jajpur	Kalarangiata	5505	ODR	SH	NH 53	18.4
87	Jajpur	Brahmabarada	10721	ODR	SH	NH 16	13.52
88	Jajpur	Kabatabandha	4080	NH 53	NH	-	-
89	Jajpur	Anjira	6561	NH 53	NH	-	-
90	Jajpur	Sayadpur	8798	ODR + MDR	SH	NH 16	17.37
91	Jharsuguda	Belpahar	38993	NH 49	NH	-	-
92	Jharsuguda	Bandhbahal	9735	VR	SH	NH 49	7.54
93	Jharsuguda	Brajarajnagar	80403	NH 49	NH	-	-
94	Jharsuguda	Jharsuguda	97730	NH 49	NH	-	-
95	Kalahandi	Junagarh	19656	NH 26	NH	-	-
96	Kalahandi	Kesinga	19239	NH 26	NH	-	-
97	Kalahandi	Madanpur Rampur	7892	ODR	SH	NH 59	12.94
98	Kalahandi	Bhawanipatna	69045	NH 26	NH	-	-
99	Kandhamal	Daringbadi	6995	NH 59	NH	-	-
100	Kandhamal	Baliguda	16611	NH 59	NH	-	-
101	Kandhamal	G.Udayagiri	11302	SH 7A	SH	-	-
102	Kandhamal	Phulabani	37371	SH 1	SH	-	-
103	Kendrapada	Pattamundai	36528	MDR	SH	NH 53	21.45
104	Kendrapada	Saranga	6426	ODR+VR	SH	NH 53	11.7
105	Kendrapada	Kendrapara	47006	NH 53	NH	-	-
106	Keonjhar	Kandasar	6668	MDR (12A)	SH	NH 20	7.5
107	Keonjhar	Barbil	66540	SH 10	SH		
108	Keonjhar	Balagoda(Bolani)	11708	ODR	SH	SH 10	9.11
109	Keonjhar	Joda	46631	EXP II	EXP	-	-
110	Keonjhar	Jajanga	7482	EXP II	EXP	-	-
111	Keonjhar	Champua	10394	NH 20	NH	-	-
112	Keonjhar	Jhumpura	6064	NH 20	NH	-	-
113	Keonjhar	Kendujhar	60590	NH 49	NH	-	-
114	Keonjhar	Anandapur	39585	SH 53	SH	-	-
115	Keonjhar	Kaliapani	5028	MDR 12B	SH	NH 49	13.71
116	Keonjhar	Surala	8258	SH 53	SH	-	-
117	Khordha	Dungamal	6271	NH 16	NH	-	-
118	Khordha	Pathar	6072	NH 16	NH	-	-
119	Khordha	Banapur	17278	NH 16	NH	-	-
120	Khordha	Balipatapur	6898	ODR	SH	NH 16	9.3
121	Khordha	Majhihara	5598	VR+ODR	SH	NH 316	15.72

Sl. No.	District	Town Name	Population	Existing	Proposed	Nearest Link	Length (Km)
122	Khordha	Bhakarsahi	7110	VR+ODR	SH	NH 316	16.72
123	Khordha	Khordha	46205	NH 57	NH	-	-
124	Khordha	Pratapsasan	12830	NH 316	NH	-	-
125	Khordha	Arjyapalli	8001	MDR 107	SH	NH 16	11.8
126	Khordha	Bhubaneswar	885363	NH 16	NH	-	-
127	Khordha	Jatani	63697	SH 13	SH	-	-
128	Koraput	Jeypur	84830	NH 26	NH	-	-
129	Koraput	Damanjodi	8862	MDR	SH	SH 51	39.42
130	Koraput	Sunabeda	50394	NH 26	NH	-	-
131	Koraput	Koraput	47468	NH 26	NH	-	-
132	Koraput	Boriguma	9785	NH 26	NH	-	-
133	Koraput	Kotpad	16326	NH 63	NH	-	-
134	Malkangiri	Chitrakonda	6725	SH 47	SH	-	-
135	Malkangiri	Balimela	11796	SH 47	SH	-	-
136	Malkangiri	Malkangiri	31007	SH 25	SH	-	-
137	Mayurbhanj	Rairangpur	34929	SH 49	SH	-	-
138	Mayurbhanj	Jashipur	5101	NH 49	NH	-	-
139	Mayurbhanj	Karanjia	22865	SH 49	SH	-	-
140	Mayurbhanj	Udala	13152	SH 19	SH	-	-
141	Mayurbhanj	Baripada	116849	NH 18	NH	-	-
142	Nabarangapur	Papadahandi	9390	NH 26	NH	-	-
143	Nabarangapur	Khatiguda	6361	ODR	SH	NH 26	38.65
144	Nabarangapur	Umarkote	28993	SH 39	SH	-	-
145	Nabarangapur	Raighar	5936	MDR	SH	SH 39	28.03
146	Nabarangapur	Nabarangapur	36945	NH 26	NH	-	-
147	Nayagarh	Balugaon	17645	MDR	SH	NH 57	6
148	Nayagarh	Bhapur	6438	MDR	SH	NH 57	23.87
149	Nayagarh	Rajasunakhala	6299	NH 57	NH	-	-
150	Nayagarh	Ranapurgada	10001	MDR	SH	LINK NH 16 & 57	29.23
151	Nayagarh	Itamati	10317	NH 57	NH	-	-
152	Nayagarh	Kunjabangarh	6906	NH 57	NH	-	-
153	Nayagarh	Odagaon	5401	MDR	SH	LINK SH 33 & NH 57	38.2
154	Nayagarh	Kantilo	9181	MDR	SH	NH 57	40.59
155	Nayagarh	Khandapada	9038	MDR	SH	NH 57	18.7
156	Nayagarh	Nayagarh	17030	NH 57	NH	-	-
157	Nuapada	Khariar	15087	NH 353	NH	-	-
158	Nuapada	Khariar Road	18967	NH 353	NH	-	-
159	Puri	Birapratappur	4708	NH 316	NH	-	-
160	Puri	Godiputamatiapara	5967	SH 13	SH	-	-
161	Puri	Konark	16779	NH 316	NH	-	-
162	Puri	Pipili	17623	NH 316	NH	-	-

Sl. No.	District	Town Name	Population	Existing	Proposed	Nearest Link	Length (Km)
163	Puri	Nimapada	19289	MDR	SH	NH 316	20.2
164	Puri	Puri	200564	NH 316	NH	-	-
165	Rayagada	Rayagada	71208	SH 4	SH	-	-
166	Rayagada	Gudari	6931	VR+MDR	SH	SH 17	18.6
167	Rayagada	Gunupur	28870	SH 4	SH	-	-
168	Rayagada	Chandili	18552	SH 45	SH	-	-
169	Rayagada	Kalyanasingpur	4660	SH 45	SH	-	-
170	Rayagada	Bishama katak	8399	SH 5	SH	-	-
171	Sambalpur	Kochinda	15576	NH 49	NH	-	-
172	Sambalpur	Rengali Dam Project Township	10867	SH 10	SH	-	-
173	Sambalpur	Hirakud	30207	NH 53	NH	-	-
174	Sambalpur	Burla	46698	NH 53	NH	-	-
175	Sambalpur	Redhakhol	15379	NH 55	NH	-	-
176	Sambalpur	Sambalpur	189366	NH 53	NH	-	-
177	Sonapur	Sonapur	20770	NH 57	NH	-	-
178	Sonapur	Subalaya	5072	ODR	SH	SH 15	27
179	Sonapur	Binika	15765	MDR	SH	NH 57	22.06
180	Sundargarh	Banaigarh	7080	MDR + ODR	SH	NH 143	5.33
181	Sundargarh	Raurkela	320040	NH 143	NH	-	-
182	Sundargarh	Raurkela Industrial Township	216410	NH 143	NH	-	-
183	Sundargarh	Sundargarh	45036	SH 10	SH	-	-
184	Sundargarh	Rajagangapur	51362	SH 10	SH	-	-
185	Sundargarh	OCL Industrial Township	2397	SH 10	SH	-	-
186	Sundargarh	Panposh	9923	NH 143	NH	-	-
187	Sundargarh	Biramitrapur	33442	NH 143	NH	-	-
188	Sundargarh	Kuanrmunda	9043	NH 143	NH	-	-
189	Sundargarh	Jalda	15789	NH 143	NH	-	-
190	Sundargarh	Hatibandha	8938	NH 143	NH	-	-
191	Sundargarh	Lathikata	7405	SH 10	SH	-	-

11.3.5 Tourist Places of National Importance

Tourism industry is one of the important elements in the State's economy. Based on discussions with the State Tourism Department, 14 tourist places of National importance and 29 tourist locations of State importance were identified. The road links connecting to the tourist places of National importance were reclassified and upgraded to SH, whereas the tourist places of State level importance have been considered for upgradation by reclassification to MDR. **Tables 11-6** summarize the reclassification of the connecting links to tourist location of National Importance and Table **11-7** summarizes the reclassification for connecting links to the tourist places of State level importance.

Table 11-6: Connectivity for Tourist Places of National Importance

Sl. No.	Location (Tourist Place Type)	Existing	Proposed	Upgraded Length (Km)	Link		Total Length in Km
					From	To	
1	Dhauli (Monument)	ODR	SH	3.17	ODR	NH 316	3.17
2	Konark (Monument)	NH 316	NH	-	NH 316	-	-
3	Lalitgiri (Monument)	ODR	SH	2.84	ODR	NH 53	2.84
4	Khandagiri-Udayagiri (Monument)	MDR	SH	0.69	MDR	NH 16	0.69
5	Daringbarhi (Scenic Spot)	NH 59	NH	-	NH 59	-	-
6	Vedavyasa (Scenic Spot)	NH 143	NIL	-	NH 143	-	-
7	Puri (Sea Beach)	NH 316	NH	-	NH 316	-	-
8	Chandipur (Sea Beach)	VR	SH	12.32	VR	Old NH 5 (MDR)	12.32
9	Bhubaneshwar (Temple)	NH 316	NH	-	NH 316	-	-
10	Puri (Temple)	NH 316	NH	-	NH 316	-	-
11	Bihitarakanika (Water Front)	MDR+ ODR	SH	36.7+ 27.36	MDR + ODR	NH 53	64.06
12	Similipal WLS (Wild Life Sanctury)	VR	MDR	80.48	VR	Link NH 49 & SH 19	80.48
13	Nandankanan (Wild Life)	MDR	SH	17.63	MDR	NH 16	17.63
14	Chandaka (Wild Life)	MDR 77	SH	39.1	MDR 77	Link NH 16	39.1

Table 11-7: Connectivity for Tourist Places of State Importance

Sl. No.	Location (Tourist Place Type)	Existing	Re-classify	Up-gradation Length in km	Link		Total Length in Km
					From	To	
1	Gopalapur (Sea Beach)	MDR	MDR	-	MDR	-	-
2	Huma (Temple)	SH 15	SH	-	SH 15	-	-
3	Khiching (Temple)	VR	MDR	6.16	VR	ODR (Update MDR)	6.16
4	Talesari (Sea Beach)	ODR	MDR	11.46	ODR	-	11.46
5	Aradi (Temple)	SH 35	SH	-	SH 35	-	-
6	Kapilas (Temple)	VR	MDR	6.68	VR	Link between	6.68

Sl. No.	Location (Tourist Place Type)	Existing	Re-classify	Up-gradation Length in km	Link		Total Length in Km
					From	To	
						MDR 17 & ODR	
7	Ghatagaon (Temple)	NH 20	NH	-	NH 20	-	-
8	Lakhari (Wild Life)	VR	MDR	6.07	VR	SH 34	6.07
9	Badrama (Wild Life)	VR	MDR	8.8	VR	NH 53	8.8
10	Khalasuni (Wild Life)	VR	MDR	16.3	VR	NH 53	16.3
11	Baisipalli (Wild Life)	VR	MDR	27.63	VR	NH 57	27.63
12	Satkoshia (Wild Life)	MDR	MDR	-	MDR	-	-
13	Barkul (Water Front)	NH 16	NH	-	NH 16	-	-
14	Satpada (Water Front)	NH 316	NH	-	NH 316	-	-
15	Barehipani (Water Fall)	VR	MDR	5.7	VR	NH 49	5.7
16	Joranda (Water Fall)	VR	MDR	17.9	VR	SH 19	17.9
17	Deokund (Water Fall)	VR	MDR	80.48	VR	NH 49 & SH 19	80.48
18	Sana Ghagara (Water Fall)	VR	MDR	15.06	VR	NH 20	15.06
19	Khandadhar (Water Fall)	VR+ODR	MDR	7.8+4.8	VR+ODR	NH 520	12.6
20	Pradhanpar (Water Fall)	VR	MDR	14.77	VR	NH 53	14.77
21	Nrusinghanath (Water Fall)	SH 3	SH	-	SH-3	-	-
22	Harishankar (Water Fall)	VR+ODR	MDR	3.3+11.4	VR+ODR	MDR 37	14.7
23	Duduma (Water Fall)	VR	MDR	10	VR	MDR 100	10
24	Taptapani (Scenic Spot)	VR	MDR	3.32	VR	SH 17	3.32
25	Kantilo (Scenic Spot)	MDR	MDR	-	MDR	-	-
26	Gonasika (Scenic Spot)	MDR 12B	MDR	-	MDR 12B	-	-
27	Paradeep (Sea Beach)	NH 53	NH	-	NH 53	-	-
28	Atri (Scenic Spot)	NH 57	NH	-	NH 57	-	-
29	Sarala (Temple)	VR	MDR	7.64	VR	SH 43	7.64

11.3.6 BHQ

The connecting links to BHQ were reclassified for upgradation to MDR. **Table 11-8** summarizes the links for BHQ connectivity in the State. It may be noted that a majority of them are already

connected by MDR or higher level network links. It is imperative that with this strategy, the Sub-Divisional HQs will also be connected by MDR automatically.

Table 11-8: BHQ Connector Reclassification

Sl. No.	District	Block Name	Existing	Proposed	Length (Km)	Link to Nearest Road
1	Malkangiri	Podia	ODR	MDR	27.18	SH 25
2	Malkangiri	Kalimela	SH	SH	-	-
3	Malkangiri	Korkunda	ODR	MDR	29.19	SH 47 & SH 25
4	Malkangiri	Malkangiri	SH	SH	-	-
5	Malkangiri	Kudumulguma	SH	SH	-	-
6	Malkangiri	Mathili	SH	SH	-	-
7	Malkangiri	Khairput	SH	SH	-	
8	Koraput	Boipariguda	MDR	SH	18.89	SH 25
9	Koraput	Lamptaput	MDR	MDR	-	-
10	Koraput	Nandapur	MDR	MDR	-	-
11	Koraput	Pottangi	NH	NH	-	-
12	Koraput	Similiguda	NH	NH	-	-
13	Koraput	Koraput	NH	NH	-	-
14	Koraput	Jeypore	NH	NH	-	-
15	Koraput	Kundra	ODR	MDR	50.46	MDR
16	Koraput	Kotpad	NH	NH	-	-
17	Koraput	Borigumma	NH	NH	-	-
18	Koraput	Dasamantapur	ODR	MDR	18.1	MDR
19	Koraput	Lakshmipur	SH	SH	-	-
20	Koraput	Narayanpatna	SH	SH	-	-
21	Koraput	Bandhugaon	SH	SH	-	-
22	Nabarangapur	Nandahandi	ODR	SH	11.86	NH 26
23	Nabarangapur	Tentulikhunti	ODR	MDR	15.58	NH 26
24	Nabarangapur	Nawarangpur	NH	NH	-	-
25	Nabarangapur	Kosagumuda	ODR	MDR	20.37	NH 26
26	Nabarangapur	Paparahandi	NH	NH	-	-
27	Nabarangapur	Dabugan	SH	SH	-	-
28	Nabarangapur	Jharigan	VR	MDR	18.78	SH 39
29	Nabarangapur	Chandahandi	VR	MDR	24.9	SH 39
30	Nabarangapur	Umarkote	SH	SH	-	-
31	Nabarangapur	Raighar	MDR	MDR	-	-
32	Rayagada	Kashipur	SH	SH	-	-
33	Rayagada	Kalyanasingpur	SH	SH	-	-
34	Rayagada	Rayagada	SH	SH	-	-
35	Rayagada	Kolnara	SH	SH	-	-
36	Rayagada	Ramanguda	SH	SH	-	-
37	Rayagada	Gunupur	SH	SH	-	-
38	Rayagada	Padmapur	MDR	MDR	-	-
39	Rayagada	Gudari	VR	SH	9.26	Existing MDR 58

Sl. No.	District	Block Name	Existing	Proposed	Length (Km)	Link to Nearest Road
						(Update to SH)
40	Rayagada	Bissam Cuttack	SH	SH	-	-
41	Rayagada	Muniguda	SH	SH	-	-
42	Rayagada	Chandrapur	VR	MDR	39.36	SH 5
43	Kalahandi	Thuamul-Rampur	MDR	MDR	-	-
44	Kalahandi	Kalampur	MDR	MDR	-	-
45	Kalahandi	Jayapatna	MDR	MDR	-	-
46	Kalahandi	Kokasara	NH	NH	-	-
47	Kalahandi	Dharamgarh	SH	SH	-	-
48	Kalahandi	Junagarh	NH	NH	-	-
49	Kalahandi	Golamunda	MDR	MDR	-	-
50	Kalahandi	Bhawanipatna	NH	NH	-	-
51	Kalahandi	Lanjigarh	ODR	MDR	20.27	MDR
52	Kalahandi	Narla	SH	SH	-	
53	Kalahandi	Kesinga	NH	NH	-	-
54	Kalahandi	Madanpur-Rampur	NH	NH	-	-
55	Kalahandi	Karlamunda	VR	MDR	4.51	MDR
56	Nuapada	Sinapalli	MDR	MDR	-	-
57	Nuapada	Khariar	SH	SH	-	-
58	Nuapada	Boden	MDR	MDR	-	-
59	Nuapada	Komna	NH	NH	-	-
60	Nuapada	Nuapada	NH	NH	-	-
61	Baragarh	Jharbandh	VR	MDR	14.11	SH 3
62	Baragarh	Paikmal	SH	SH	-	-
63	Baragarh	Rajborasambar	SH	SH	-	-
64	Baragarh	Gaisilet	ODR	MDR	19.42	SH 3
65	Baragarh	Sohella	NH	NH		
66	Baragarh	Bijepur	ODR	SH	21.01	NH 26
67	Baragarh	Barpali	NH	NH		
68	Baragarh	Bheden	ODR	MDR	16.36	MDR
69	Baragarh	Bargarh	NH	NH	-	-
70	Baragarh	Attabira	NH	NH	-	-
71	Baragarh	Bhatli	MDR	MDR	-	-
72	Baragarh	Ambabhona	MDR	MDR	-	-
73	Bolangir	Khaprakhol	MDR	MDR	-	-
74	Bolangir	Turekela	ODR	MDR	15.33	SH 42
75	Bolangir	Belpara	SH	SH	-	-
76	Bolangir	Patnagarh	SH	SH	-	-
77	Bolangir	Agalpur	ODR	MDR	25.02	NH 26
78	Bolangir	Loisinga	NH	NH	-	-
79	Bolangir	Puintala	NH	NH	-	-
80	Bolangir	Balangir	NH	NH	-	-

Sl. No.	District	Block Name	Existing	Proposed	Length (Km)	Link to Nearest Road
81	Bolangir	Deogaon	NH	NH	-	-
82	Bolangir	Tentulikhunti	ODR	MDR	19.56	MDR
83	Bolangir	Saintala	NH	NH	-	-
84	Bolangir	Titilagarh	NH	NH	-	-
85	Bolangir	Muribahal	ODR	MDR	11.57	NH 59
86	Bolangir	Bangomunda	NH	NH	-	-
87	Sonapur	Dunguripali	NH	NH	-	-
88	Sonapur	Binika	MDR	MDR	-	-
89	Sonapur	Ulunda	SH	SH	-	-
90	Sonapur	Biramaharajpur	ODR	SH	13.9	SH 15
91	Sonapur	Sonepur	NH	NH	-	-
92	Sonapur	Tarbha	ODR	MDR	0.939	NH 57
93	Baudh	Kantamal	SH	SH	-	-
94	Baudh	Boudh	NH	NH	-	-
95	Baudh	Harbhanga	ODR	MDR	6.02	MDR
96	Kandhamal	Khajuripada	SH	SH	-	-
97	Kandhamal	Chakapad	VR	MDR	16.6	SH 7
98	Kandhamal	Phulbani	SH	SH	-	-
99	Kandhamal	Tikabali	VR	MDR	3.37	SH 7
100	Kandhamal	Phiringia	ODR	MDR	0.558	SH 1
101	Kandhamal	Baliguda	NH	NH	-	-
102	Kandhamal	K.Nuagaon	SH	SH	-	-
103	Kandhamal	Raikia	SH	SH	-	-
104	Kandhamal	G. Udayagiri	SH	SH	-	-
105	Kandhamal	Daringbadi	NH	NH	-	-
106	Kandhamal	Kotagarh	SH	SH	-	-
107	Kandhamal	Tumudibandha	SH	SH	-	-
108	Gajapati	Nuagada	ODR	MDR	6.39	MDR
109	Gajapati	Gumma	MDR	MDR	-	-
110	Gajapati	Kasinagar	SH	SH	-	-
111	Gajapati	Paralakhemundi	VR	SH	4.87	SH 4
112	Gajapati	Rayagada	SH	SH	-	-
113	Gajapati	R. Udaygiri	SH	SH	-	-
114	Gajapati	Mohana	SH	SH	-	-
115	Ganjam	Patrapur	ODR	SH	3.73	Existing MDR (Update to SH)
116	Ganjam	Chikiti	SH	SH	-	
117	Ganjam	Rangeilunda	ODR	MDR	4.77	MDR 65 & NH 16
118	Ganjam	Kukudakhandi	NH	NH	-	-
119	Ganjam	Digapahandi	SH	SH	-	-
120	Ganjam	Sanakhemundi	ODR	MDR	1.51	SH 17
121	Ganjam	Dharakote	ODR	MDR	4.66	NH 59
122	Ganjam	Seragad	SH	SH	-	-

Sl. No.	District	Block Name	Existing	Proposed	Length (Km)	Link to Nearest Road
123	Ganjam	Aska	NH	NH	-	-
124	Ganjam	Sorada	ODR	MDR	0.91	NH 59
125	Ganjam	Bhanjanagar	SH	SH	-	-
126	Ganjam	Jagannathprasad	SH	SH	-	-
127	Ganjam	Bellaguntha	SH	SH	-	-
128	Ganjam	Buguda	SH	SH	-	-
129	Ganjam	Polasara	MDR	MDR	-	-
130	Ganjam	Kabisuryanagar	SH	SH	-	-
131	Ganjam	Beguniapada	ODR	MDR	1.51	SH 30
132	Ganjam	Purusottampur	SH	SH	-	-
133	Ganjam	Hinjilicut	NH	NH	-	-
134	Ganjam	Chhatrapur	SH	SH	-	-
135	Ganjam	Ganjam	NH	NH	-	-
136	Ganjam	Khallikote	SH	SH	-	-
137	Puri	Krushnaprasad	ODR	MDR	33.99	NH 16
138	Puri	Bramhagiri	NH	NH	-	-
139	Puri	Kanas	ODR	MDR	13.41	MDR 108
140	Puri	Puri	NH	NH	-	-
141	Puri	Satyabadi	NH	NH	-	-
142	Puri	Delanga	MDR	MDR	-	-
143	Puri	Pipili	NH	NH	-	-
144	Puri	Nimapada	MDR	MDR	-	-
145	Puri	Gop	MDR	MDR	-	-
146	Puri	Kakatpur	MDR	MDR	-	-
147	Puri	Astaranga	MDR	MDR	-	-
148	Khordha	Banapur	ODR	SH	5.61	NH 16
149	Khordha	Chilika	NH	NH	-	-
150	Khordha	Tangi	VR	MDR	1.6	NH 16
151	Khordha	Bolagad	NH	NH	-	-
152	Khordha	Begunia	NH	NH	-	-
153	Khordha	Khordha	NH	NH	-	-
154	Khordha	Jatani	SH	SH	-	-
155	Khordha	Bhubaneswar	NH	NH	-	-
156	Khordha	Balianta	ODR	MDR	2.5	NH 16
157	Khordha	Balipatna	ODR	SH	11.83	NH 316
158	Nayagarh	Ranapur	MDR	MDR	-	-
159	Nayagarh	Odagaon	MDR	MDR	-	-
160	Nayagarh	Nayagarh	NH	NH	-	-
161	Nayagarh	Nuagaon	NH	NH	-	-
162	Nayagarh	Dasapalla	MDR	MDR	-	-
163	Nayagarh	Gania	ODR	MDR	0.24	Existing MDR (Update to SH)
164	Nayagarh	Khandapada	MDR	MDR	-	-

Sl. No.	District	Block Name	Existing	Proposed	Length (Km)	Link to Nearest Road
165	Nayagarh	Bhapur	ODR	MDR	0.668	Existing MDR (Update to SH)
166	Cuttack	Narasinghpur	SH	SH	-	-
167	Cuttack	Badamba	SH	SH	-	-
168	Cuttack	Banki	VR	MDR	6.19	MDR
169	Cuttack	Banki-Dampara	MDR	MDR	-	-
170	Cuttack	Tigiria	SH	SH	-	-
171	Cuttack	Athagad	SH	SH	-	-
172	Cuttack	Tangi-Choudwar	NH	NH	-	-
173	Cuttack	Mahanga	ODR	MDR	12.43	SH 9A
174	Cuttack	Nischintakoili	SH	SH	-	-
175	Cuttack	Salepur	SH	SH	-	-
176	Cuttack	Cuttack Sadar	ODR	MDR	5.77	SH 12
177	Cuttack	Barang	VR	MDR	3.54	MDR
178	Cuttack	Kantapada	MDR	MDR	-	-
179	Cuttack	Niali	VR	MDR	1.5	MDR
180	Dhenkanal	Hindol	SH	SH	-	-
181	Dhenkanal	Odapada	NH	NH	-	-
182	Dhenkanal	Dhenkanal	MDR	MDR	-	-
183	Dhenkanal	Gandia	ODR	MDR	9.89	MDR 17
184	Dhenkanal	Bhuban	NH	NH	-	-
185	Dhenkanal	Kamakhyanagar	NH	NH	-	-
186	Dhenkanal	Parajang	NH	NH	-	-
187	Dhenkanal	Kankadahad	ODR	MDR	17.77	NH 53
188	Anugul	Athmallik	MDR	MDR	-	-
189	Anugul	Angul	NH	NH	-	-
190	Anugul	Banarpal	NH	NH	-	-
191	Anugul	Talcher	NH	NH	-	-
192	Anugul	Chhendipada	SH	SH	-	-
193	Anugul	Kishorenagar	ODR	MDR	6.2	NH 55
194	Anugul	Kaniha	NH	NH	-	-
195	Anugul	Palalahada	NH	NH	-	-
196	Deogarh	Reamal	NH	NH	-	-
197	Deogarh	Barkot	NH	NH	-	-
198	Deogarh	Tileibani	NH	NH	-	-
199	Sambalpur	Naktideul	SH	SH	-	-
200	Sambalpur	Rairakhol	NH	NH	-	-
201	Sambalpur	Maneswar	NH	NH	-	-
202	Sambalpur	Jujomura	NH	NH	-	-
203	Sambalpur	Jamankira	NH	NH	-	-
204	Sambalpur	Dhankauda	NH	NH	-	-
205	Sambalpur	Rengali	SH	SH	-	-
206	Sambalpur	Kuchinda	NH	NH	-	-

Sl. No.	District	Block Name	Existing	Proposed	Length (Km)	Link to Nearest Road
207	Sambalpur	Bamra	MDR	MDR	-	-
208	Jharsuguda	Laikera	ODR	MDR	10.25	NH 49
209	Jharsuguda	Kolabira	NH	NH	-	-
210	Jharsuguda	Kirimira	VR	MDR	4.5	Existing ODR (Updated to MDR)
211	Jharsuguda	Jharsuguda	NH	NH	-	-
212	Jharsuguda	Lakhanpur	NH	NH	-	-
213	Sundargarh	Hemgiri	MDR	MDR	-	-
214	Sundargarh	Lephripara	MDR	MDR	-	-
215	Sundargarh	Tangarapali	MDR	MDR	-	-
216	Sundargarh	Balisankara	MDR	MDR	-	-
217	Sundargarh	Subdega	SH	SH	-	-
218	Sundargarh	Sundargarh	SH	SH	-	-
219	Sundargarh	Baragaon	SH	SH	-	-
220	Sundargarh	Kutra	SH	SH	-	-
221	Sundargarh	Kuanrmunda	NH	NH	-	-
222	Sundargarh	Nuagaon	ODR	MDR	11.06	MDR 28
223	Sundargarh	Bisra	MDR	MDR	-	-
224	Sundargarh	Lathikata	NH	NH	-	-
225	Sundargarh	Rajagangapur	VR	MDR	2.05	SH 10
226	Sundargarh	Gurundia	MDR	MDR	-	-
227	Sundargarh	Baneigarh	ODR	SH	3.18	Existing MDR (Updated to SH)
228	Sundargarh	Lahunipara	NH	NH	-	-
229	Sundargarh	Koida	NH	NH	-	-
230	Keonjhar	Joda	EXP	EXP	-	-
231	Keonjhar	Champua	NH	NH	-	-
232	Keonjhar	Jhumpura	NH	NH	-	-
233	Keonjhar	Banspal	ODR	MDR	3.78	MDR 12C
234	Keonjhar	Kendujhar	ODR	MDR	4.16	NH 20
235	Keonjhar	Patana	SH	SH	-	-
236	Keonjhar	Saharapada	SH	SH	-	-
237	Keonjhar	Telkoi	MDR	MDR	-	-
238	Keonjhar	Harichandanpur	ODR	MDR	18.63	MDR 12A
239	Keonjhar	Ghatgaon	NH	NH	-	-
240	Keonjhar	Ghasipura	VR	MDR	10.68	Expressway
241	Keonjhar	Anandapur	SH	SH	-	-
242	Keonjhar	Hatadihi	SH	SH	-	-
243	Mayurbhanj	Raruan	ODR+VR	MDR	5.1	ODR
244	Mayurbhanj	Sukruli	ODR	MDR	21.5	NH 49
245	Mayurbhanj	Kusumi	VR	MDR	6.93	SH 49
246	Mayurbhanj	Jamda	VR	MDR	13.13	SH 50
247	Mayurbhanj	Tiring	SH	SH	-	-

Sl. No.	District	Block Name	Existing	Proposed	Length (Km)	Link to Nearest Road
248	Mayurbhanj	Bahalda	SH	SH	-	-
249	Mayurbhanj	Rairangpur	SH	SH	-	-
250	Mayurbhanj	Bijatola	ODR	MDR	9.23	SH 50
251	Mayurbhanj	Saraskana	ODR+VR	MDR	11.7	Existing ODR (Update to MDR)
252	Mayurbhanj	Bangiriposhi	MDR	MDR	-	-
253	Mayurbhanj	Bisoi	NH	NH	-	-
254	Mayurbhanj	Jashipur	NH	NH	-	-
255	Mayurbhanj	Karanjia	SH	SH	-	-
256	Mayurbhanj	Thakurmunda	MDR	MDR	-	-
257	Mayurbhanj	Kaptipada	SH	SH	-	-
258	Mayurbhanj	Udala	SH	SH	-	-
259	Mayurbhanj	Gopabandhunagar	SH	SH	-	-
260	Mayurbhanj	Khunta	SH	SH	-	-
261	Mayurbhanj	Shamakhunta	SH	SH	-	-
262	Mayurbhanj	Kuliana	NH	NH	-	-
263	Mayurbhanj	Suliapada	ODR	MDR	13.47	SH 19
264	Mayurbhanj	Baripada	MDR	MDR	-	-
265	Mayurbhanj	Barsahi	ODR	MDR	5.36	Existing ODR (Update to MDR)
266	Mayurbhanj	Betanati	ODR	MDR	0.483	NH 18
267	Mayurbhanj	Muruda	ODR	MDR	5.35	MDR 4
268	Mayurbhanj	Rasagovindpur	MDR	MDR	-	-
269	Balasore	Jaleswar	MDR	MDR	-	-
270	Balasore	Bhograi	ODR	MDR	7.01	MDR
271	Balasore	Baliapal	MDR	MDR	-	-
272	Balasore	Basta	MDR	MDR	-	-
273	Balasore	Baleswar	MDR	MDR	-	-
274	Balasore	Remuna	ODR	SH	2.76	NH 16
275	Balasore	Nilagiri	SH	SH	-	-
276	Balasore	Bahanaga	NH	NH	-	-
277	Balasore	Soro	NH	NH	-	-
278	Balasore	Oupada	VR	MDR	6.44	MDR
279	Balasore	Khaira	MDR	MDR	-	-
280	Balasore	Simulia	NH	NH	-	-
281	Bhadrak	Basudebpur	MDR	MDR	-	-
282	Bhadrak	Chandabali	SH	SH	-	-
283	Bhadrak	Tihidi	SH	SH	-	-
284	Bhadrak	Bhadrak	NH	NH	-	-
285	Bhadrak	Bant	VR	MDR	1.88	SH 53
286	Bhadrak	Bhandaripokhari	NH	NH		
287	Bhadrak	Dhamanagar	MDR	MDR	-	-
288	Jajpur	Sukinda	NH	NH	-	-

Sl. No.	District	Block Name	Existing	Proposed	Length (Km)	Link to Nearest Road
289	Jajpur	Danagadi	MDR	MDR	-	-
290	Jajpur	Korei	ODR	MDR	4.25	NH 20
291	Jajpur	Rasulpur	NH	NH	-	-
292	Jajpur	Jajapur	ODR	MDR	0.58	Existing MDR (Updated to SH)
293	Jajpur	Dasarathpur	MDR	MDR	-	-
294	Jajpur	Binjharpur	MDR	MDR	-	-
295	Jajpur	Bari	VR	MDR	1.3	MDR 14
296	Jajpur	Dhamrasala	NH	NH	-	-
297	Jajpur	Badachana	ODR	MDR	1.37	NH 16
298	Kendrapada	Rajkanika	ODR	MDR	1.53	MDR
299	Kendrapada	Rajnagar	ODR	MDR	3.57	MDR
300	Kendrapada	Aul	MDR	MDR	-	-
301	Kendrapada	Pattamundai	MDR	MDR	-	-
302	Kendrapada	Derabisi	ODR	MDR	1.06	MDR
303	Kendrapada	Garadpur	ODR	MDR	11.17	NH 53
304	Kendrapada	Kendrapara	ODR	MDR	1.06	NH 53
305	Kendrapada	Marsaghai	ODR	MDR	4.81	NH 53
306	Kendrapada	Mahakalapada	ODR	MDR	11.28	NH 53
307	Jagatsinghpur	Kujang	SH	SH	-	-
308	Jagatsinghpur	Ersama	ODR	MDR	17.61	SH 13
309	Jagatsinghpur	Tirtol	SH	SH	-	-
310	Jagatsinghpur	Raghunathpur	ODR	MDR	0.965	SH 12
311	Jagatsinghpur	Biridi	ODR	MDR	1.26	SH 43
312	Jagatsinghpur	Jagatsinghapur (P)	SH	SH	-	-
313	Jagatsinghpur	Naugaon	MDR	MDR	-	-
314	Jagatsinghpur	Balikuda	SH	SH	-	-

11.3.7 Market Centres (Agricultural) Connectivity

Major Agriculture Produce Market Centres (APMCs) are all found to be connected by a MDR to the neighbouring core road network, and therefore, there was no additional candidate links that required any upgradation or reclassification. **Table 11-9** summarizes the links for Market Centre connectivity in the Odisha State.

Table 11-9: Market Centre Road Connectivity in Odisha State

Sl. No.	District Name	Block Name	RMC Place	Existing Road	Proposed Road
1	ANUGUL	Athmallik	Athamallik	MDR	MDR
2	ANUGUL	Angul	Anugul	NH	NH
3	ANUGUL	Palalahada	Pallahara	NH	NH
4	ANUGUL	Talcher	Talcher	NH	NH
5	BALANGIR	Balangir	Bolangir	NH	NH
6	BALANGIR	Patnagarh	Patnagarh	SH	SH

Sl. No.	District Name	Block Name	RMC Place	Existing Road	Proposed Road
7	BALANGIR	Turekela	Kantabanji	SH	SH
8	BALASORE	Jaleswar	Jaleswar	NH	NH
9	BALASORE	Remuna	Balasore	NH	NH
10	BALASORE	Nilagiri	Nilagiri	SH	SH
11	BARGARH	Bargarh	Bargarh	NH	NH
12	BARGARH	Rajborasambar	Padmapur	SH	SH
13	BHADRAK	Bhadrak	Bhadrak	NH	NH
14	BHADRAK	Chandabali	Chandabali	SH	SH
15	BOUDH	Boudh	Boudh	NH	NH
16	CUTTACK	Narasinghpur	Narsinghpur	SH	SH
17	CUTTACK	Banki-Dampara	Banki	MDR	MDR
18	CUTTACK	Nischintakoili	Kendupatna	SH	SH
19	DEOGARH	Tileibani	Deogarh	NH	NH
20	DHENKANAL	Hindol	Hindol	SH	SH
21	DHENKANAL	Dhenkanal	Dhenkanal	NH	NH
22	DHENKANAL	Kamakhyanagar	Kamakhyanagar	NH	NH
23	GAJAPATI	Paralakhemundi	Paralakhemundi	SH	SH
24	GANJAM	Bhanjanagar	Bhanjanagar	SH	SH
25	GANJAM	Digapahandi	Digapahandi	SH	SH
26	GANJAM	Hinjilicut	Hinjilicut	NH	NH
27	JAGATSINGHPUR	Jagatsinghapur (P)	Jagatsinghpur	SH	SH
28	JAJPUR	Jajapur	Jajpur	MDR	MDR
29	JHARSUGUDA	Jharsuguda	Jharsuguda	SH	SH
30	KALAHANDI	Bhawanipatna	Bhawanipatna	NH	NH
31	KALAHANDI	Junagarh	Junagarh	NH	NH
32	KALAHANDI	Kesinga	Kesinga	NH	NH
33	KANDHAMAL	Tikabali	Tikabali	SH	SH
34	KANDHAMAL	Phulbani	Phulbani (Kandhamal)	SH	SH
35	KENDRAPADA	Kendrapara	Kendrapara	NH	NH
36	KEONJHAR	Anandapur	Anandapur	NH	NH
37	KEONJHAR	Kendujhar	Keonjhar	NH	NH
38	KEONJHAR	Champua	Champua	NH	NH
39	KHURDA	Jatani	Jatni	SH	SH
40	KHURDA	Chilika	Chilka/Balugaon	NH	NH
41	KORAPUT	Koraput	Koraput	NH	NH
42	KORAPUT	Jeypore	Jeypore	NH	NH
43	MALKANGIRI	Malkangiri	Malkangiri	SH	SH
44	MAYURBHANJ	Udala	Udala	SH	SH
45	MAYURBHANJ	Betanati	Betnoti	NH	NH
46	MAYURBHANJ	Baripada	Baripada	NH	NH
47	MAYURBHANJ	Karanjia	Karanjia/Panchpir	SH	SH
48	NAWRANGPUR	Nawarangpur	Nawrangpur	NH	NH
49	NAYAGARH	Odagaon	Bahadajhola	MDR	MDR

Sl. No.	District Name	Block Name	RMC Place	Existing Road	Proposed Road
50	NUAPADA	Nuapada	Khariar Road	NH	NH
51	PURI	Nimapada	Nimapara	MDR	MDR
52	PURI	Satyabadi	Sakhigopal	NH	NH
53	RAYAGADA	RAY-Rayagada	Rayagada	SH	SH
54	RAYAGADA	Gunupur	Gunupur	SH	SH
55	SAMBALPUR	Rairakhol	Rairakhol	NH	NH
56	SAMBALPUR	Maneswar	Sambalpur	NH	NH
57	SAMBALPUR	Kuchinda	Kuchinda	NH	NH
58	SONEPUR	Biramaharajpur	Biramaharajpur	ODR	SH
59	SONEPUR	Dunguripali	Dungripalli	NH	NH
60	SUNDERGARH	Sundargarh	Sundergarh	SH	SH
61	SUNDERGARH	Baneigarh	Bonai	MDR	MDR
62	SUNDERGARH	Kuanrmunda	Panposh	NH	NH

11.3.8 Gram Panchayat Head Quarter (GPHQ) Connectivity

All GPHQs were recommended to be connected with an ODR or a road link of higher level of hierarchy. Out of 6234[21] Gram Panchayat HQs in Odisha, 6131 were identified based on available data[22]. Rest of GPHQs could not be identified because their names were not matching with any of the villages which constitute the GP. A list of missing GPHQ is given in **Appendix 11.3**, which is only 74, and therefore, out of 6234 GPHQ only 6205 are found with their names.

A large number of GPHQs are having connectivity only with all-weather VR or kutcha VR. Thus, the existing connectors that were primarily in the VR category were recommended to be reclassified and upgraded to ODR. **Table 11-10** Summarize the District wise Existing Connectivity status of GPHQ. The details of existing connectivity of GPHQ with nearest major category road (i.e. ODR and above), and population of each GP (combined for all constituent villages) are given in **Appendix 11.1B.** It may be noted that, the name of GP village against each constituent village is not available in Census 2011 data, and thus GP population could not be obtained directly from Census 2011 data. The Census 2001 data contains this information, and hence GP population (of all constituent villages) was obtained using both the Census 2001 and Census 2011 data by following the below mentioned steps,

1. Determine decadal growth in population of all districts, from Census 2001 and Census 2011 data
2. Apply this growth factor on all villages identified in Census 2001 data to arrive at the projected population of all villages for year 2011
3. Using the GPHQ and village information (names) from ORSAC data, and the estimated village population data for 2011 (as in 2 above), the GP population (of constituent villages) was estimated.

[21] Source: http://odishapanchayat.gov.in/english/demographic.asp

[22] Source: 'Orissa Space Application Centre' (ORSAC) Digital Data (supplied by the Client) and 'General Elections to Panchayats-2007 Report'

Table 11-10: District wise Existing Road Connectivity Status of GPHQ Villages

Sl. No.	District Name	Total No. of GPHQ	Connected By ODR and above Roads	Connected By Village Roads
1	Angul	208	105	103
2	Baleswar	281	125	156
3	Bargarh	247	73	174
4	Bhadrak	190	78	112
5	Bolangir	284	136	148
6	Boudh	63	27	36
7	Cuttack	336	145	191
8	Deogarh	59	27	32
9	Dhenkanal	197	77	120
10	Gajapathi	125	57	68
11	Ganjam	460	257	203
12	Jagathsinghpur	192	82	110
13	Jajpur	277	139	138
14	Jharsuguda	76	27	49
15	Kalahandi	269	99	170
16	Kandamal	152	71	81
17	Kendrapara	229	89	140
18	Keonjhar	285	110	175
19	Khurda	165	76	89
20	Koraput	215	97	118
21	Malkangir	107	34	73
22	Mayurbanj	376	148	228
23	Nawarangapur	164	42	122
24	Nayagarh	177	83	94
25	Nuapada	106	58	48
26	Puri	225	95	130
27	Rayagada	162	62	100
28	Sambalpur	147	60	87
29	Sonepur	96	24	72
30	Sundergarh	261	122	139
Total GPHQ Villages		**6131**	**2625**	**3506**

The connectivity of 3,506 GPHQ villages connected by VR is recommended to be upgraded to ODR, which will result in upgrading 19,487km of VR to ODR. The district wise length of VR to be upgraded/reclassified to ODR is given in **Table 11-11.**

11.4 Summary

The proposed reclassification of State road network will result upgradation of lower category roads to higher categories for meeting the traffic demands and the development objectives of the State. This would entail primarily a significant increase in the lengths of SH and ODR networks. By the reclassification strategy, SH length is going to be increased approximately by 1,730 Km, whereas ODR length will be increased by approximately 18,493 Km. The district-wise change in road classification is summarized in the **Table 11-11,** while status of re-classified road network is given in **Table 11-12**. **Figure 11.1A** and **Figure 11.1B** illustrate the existing network with road classes, and the proposed

future network with road classification that could be implemented within the short term horizon of 2020. The reclassified road network map of Odisha state has been presented in **Figure 11.2,** and same has been given in larger size in **Appendix 11.2**.

- The total length of existing NH, SH, MDR and ODR within the State of Odisha is approximately 17,957 Km.
- The existing length of SH is approximately 3,665 Km. Based on the proposed reclassification the future length of SH will become 5,395 Km, which will be an increase of approximately 1,730 Km. The additional 1,730 Km of SH will include upgradation of the i) VR to SH: 96 Km; ODR to SH: 395 Km; and MDR to SH: 1,238 Km. The lower category of road chosen for reclassification are part of a corridor in an urban/suburban area, where the road is already with geometry of higher category. This will be worth noting that all these additional lengths of SH was recommended to be a minimum 2-lane cross-section with paved shoulder on either side.
- Based on the proposed reclassification the existing length of MDR will be reduced by 203 Km. Upgradation to MDR included VR to MDR: 436 Km; ODR to MDR: 599 Km, i.e. a total upgraded length to MDR of approximately 1,035 Km, whereas a total length of 1,238 Km was upgraded from MDR to SH.
- Due to the proposed reclassification the length of existing ODR will decrease by approximately 994 Km. 599 Km of existing ODR is proposed to be upgraded to MDR and 395 Km ODR is proposed to be upgraded to SH. Additional length of newly upgraded ODR from VR will be 19,487 Km.

Table 11-11: District Level Existing and Re- Classified Road Length

Sl. No.	District Name	Existing Road Length in KM						Re-Classified Road Length in KM					
		NH	SH	EXP	MDR	ODR	Total Length	NH	SH	MDR	ODR	VR to ODR	Total Length
1	Angul	226.12	51.11	0	182.93	384.24	844.4	226.12	108.43	153.52	359.76	709.26	1557.09
2	Baleswar	119.44	31.03	0	189.46	302.87	642.8	119.44	136.09	139.95	284.38	757.34	1437.2
3	Baragarh	97.66	101.58	0	152.39	127.25	478.88	97.66	163.65	162.82	68.87	1131.30	1624.3
4	Bhadrak	39.55	115	0	123.33	99.73	377.61	39.55	189.59	61.52	88.83	456.1	835.59
5	Bolangir	162.01	132.25	0	127.11	502.58	923.95	162.01	175.97	192.37	396.93	724.20	1651.48
6	Boudh	111.28	64.87	0	32.58	46.08	254.81	111.28	78.96	38.61	40.05	195.65	464.55
7	Cuttack	66.23	147.75	0	192.68	339.13	745.79	66.23	283.03	113.03	295.04	850.05	1607.38
8	Deogarh	190.89	101.56	0	37.83	6.73	337.01	190.89	102.54	52.61	5.75	169.94	521.73
9	Dhenkanal	158.23	8.74	0	107.07	242.63	516.67	158.23	8.74	141.4	214.97	687.32	1210.66
10	Gajapathi	0	256.62	0	68.29	54.09	379	0	262.48	80.31	45.92	437.73	826.44
11	Ganjam	213.97	494.48	0	214.29	552.17	1474.91	213.97	550.25	197.09	516.89	860.93	2339.13
12	Jagathsinghpur	10.38	103.97	0	40.71	182.56	337.62	10.38	110.54	68.26	162.66	386.39	738.23
13	Jajpur	150.15	1.59	20.26	131.74	359.95	663.69	170.41	88.82	100.72	305.04	685.67	1350.66
14	Jharsuguda	105.57	26.91	0	3.81	30.58	166.87	105.57	34.45	18.57	20.32	353.36	532.27
15	Kalahandi	184.3	116.36	0	288.93	82.63	672.22	184.3	141.48	313.72	37.22	959.02	1635.74
16	Kandamal	114.41	283.75	0	105.75	199.59	703.5	114.41	283.75	126.29	199.03	589.49	1312.97
17	Kendrapada	45.06	0.625	0	116.18	292.34	454.205	45.06	104.22	70.89	234.03	537.112	991.312
18	Keonjhar	289.25	80.24	52.39	68.61	351.96	842.45	241.64	89.26	120.94	316.38	1074.05	1942.27
19	Khurda	159.84	15.89	0	239.5	371.41	786.64	159.84	127.35	173.2	337.77	344.30	1142.46
20	Koraput	172.8	102.82	0	321.88	248.96	846.46	172.8	317.74	203.86	178.76	821.63	1694.79
21	Malkangir	0	230.42	0	48.01	56.29	334.72	0	230.42	104.31	0	542.43	877.16
22	Mayurbhanj	192.87	266.74	0	188.57	424.93	1073.11	192.87	317.39	343.7	361.4	1332.95	2548.31
23	Nawarangapur	43.07	66.48	0	55.64	123.65	288.84	43.07	160.7	65.62	63.14	688.53	1021.06
24	Nayagarh	101.32	13.45	0	153.72	230.27	498.76	101.32	171.28	35.95	217.84	354.98	881.37
25	Nuapada	91.66	30.52	0	64.95	218.55	405.68	91.66	30.52	64.95	218.55	310.14	715.82
26	Puri	130.35	10.03	0	119.65	294.69	554.72	130.35	63.33	103.33	257.72	523.48	1078.21
27	Rayagada	0	390.48	0	123.6	62.85	576.93	0	437.99	124.72	62.85	585.35	1210.91
28	Sambalpur	206.29	175.92	0	101.42	126.09	609.72	206.29	180.77	126.54	121.24	762.15	1396.99
29	Sonepur	42.85	40.09	0	67.74	63.34	214.02	42.85	126.54	23.87	20.75	341.91	555.92
30	Sundergarh	168.59	203.66	0	304.45	274.36	951.06	168.59	318.68	247.3	226.42	1313.79	2274.78

Table 11-12: Overall existing and Re-classified Road Length (km)

Existing and Reclassified Road Network Length (km) Summary			
Road Type	**Re-Classified Road**	**Existing Road**	**Difference**
NH	3,666	3,594	72
SH	5,394	3,664	1,730
EXP	0	72	-72
MDR	3,770	3,973	-203
ODR	5,659	6,653	-994
New ODR	19,487	0	19,487
Total Length in KM	**37,976**	**17,956**	**20,020**

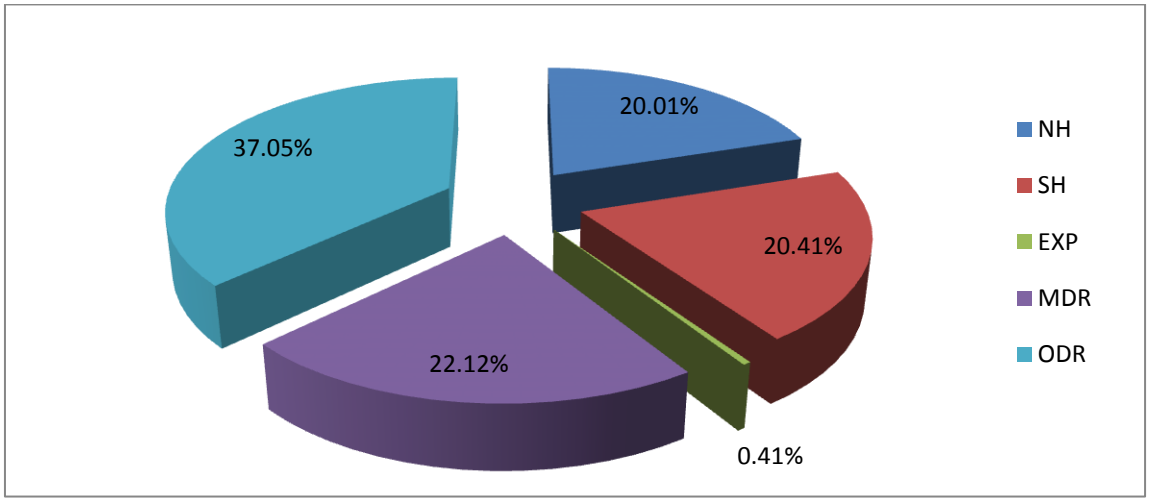


Figure 11.1A: Existing Road Network of Odisha

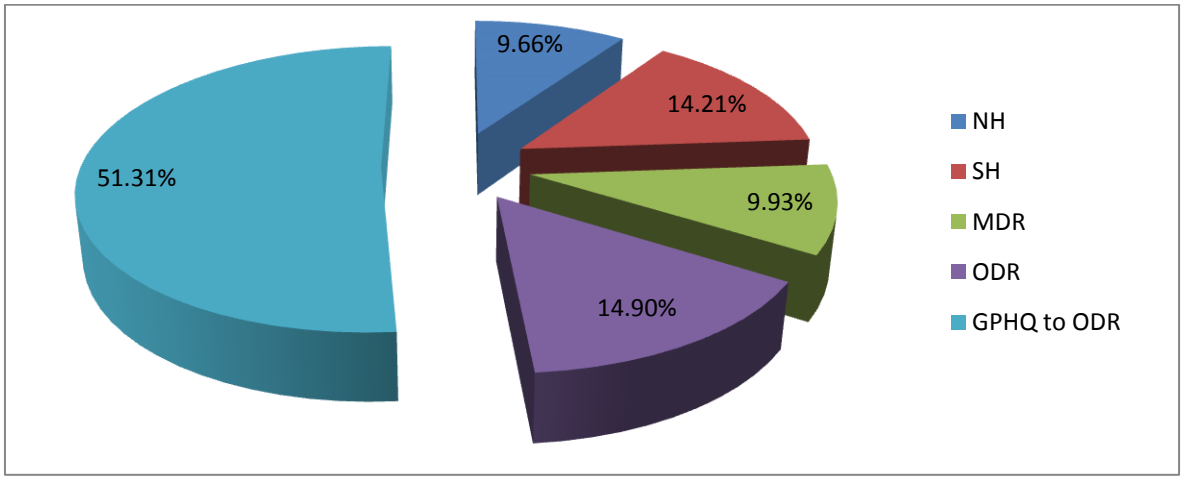


Figure 11.1B: Re-classified Road Network of Odisha

As a result of the proposed reclassification the total length of the NH, SH, MDR, and ODR will become 37,976 Km, The additional length will be inducted as a result of upgradation of existing 19,487 Km of VR to ODR. This upgradation of VR will be triggered as the existing linkage to GPHQs connecting the Block HQs are recommended to be upgraded to ODR.

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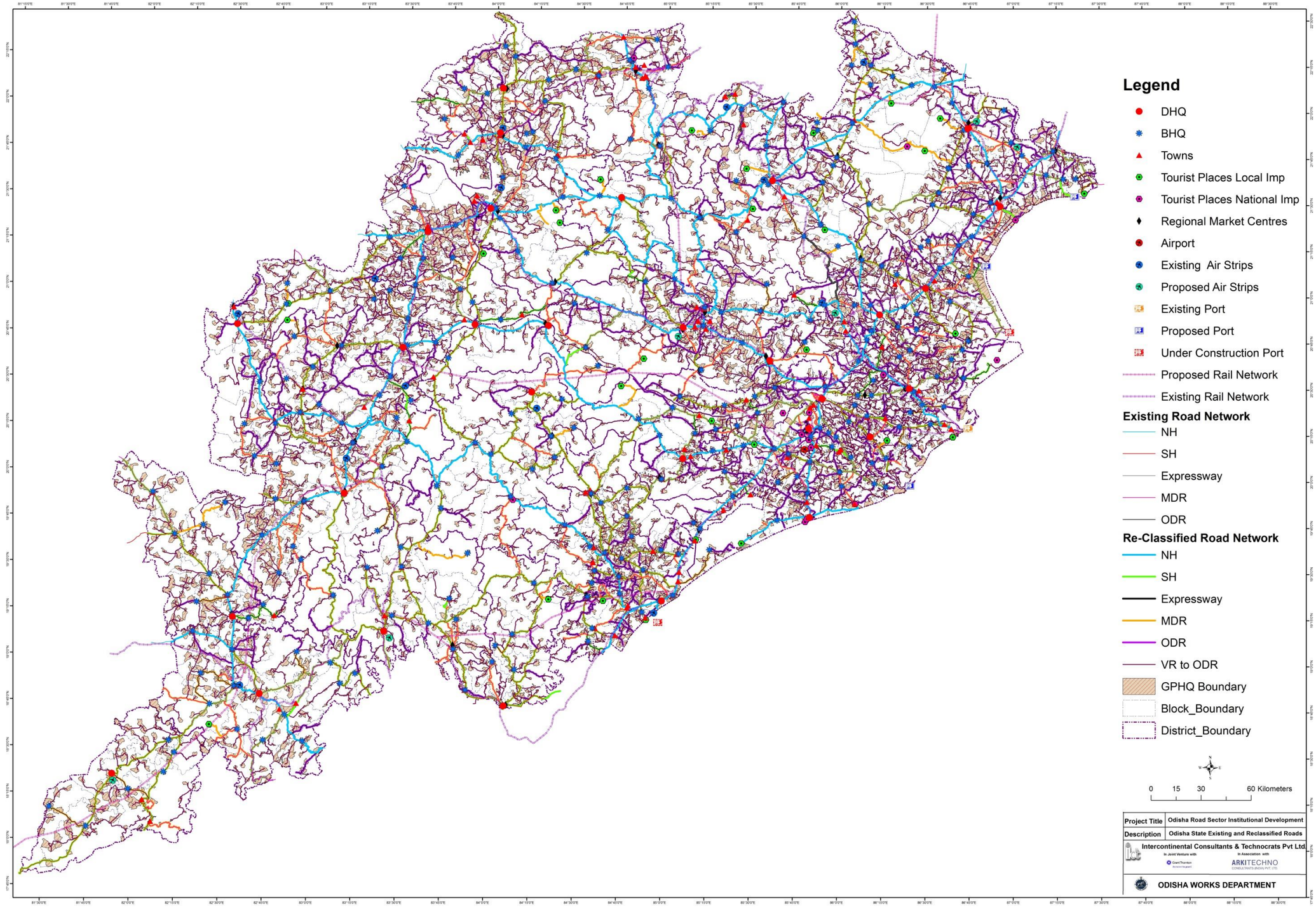

Figure 11.2: Reclassified Road Network of Odisha State

12 Institutional Development and Capacity Building

The consultants have developed a Road Network Master Plan using OSTM as a tool. However, to utilize the available potential of OSTM, OWD/GOO should continuously upgrade the OSTM by incorporating any upcoming/on-going road improvements that are to be implemented, and necessary traffic assignment run should be undertaken to identify any impact on network traffic. It should be even updated by incorporating the proposed developments and any other relevant information pertaining to the road network development under plans. Appropriate integration of these in the "planning process" shall establish the phasing of future project preparation and development of DPR. Needful models (like sub-area models) can be utilized to estimate traffic assignments on all roads up to the level of VR, and any traffic flow related mitigation measures can be developed, as necessary. However, this requires institutionalization of OSTM within GOO system. It is proposed to undertake this in the manner as described in the following sections.

12.1 Establishment of Road Planning Unit

The State Road Policy has mandated integration of the transportation planning process for any road or land-use improvement in the State. As per recommendations of RNMP, Front End Engineering and Design (FEED) study should be made a 'must' for the implementation of the Master Plan recommendations. It is further recommended to establish an independent 'Road Planning Unit' focusing on planning and coordinating required for FEED studies. This Unit should be equipped with necessary competencies and facilities to work on Master Planning and related works, and to update the Master Plan from time to time.

Considering the strengths and limitations of various road sector entities, it is proposed to estabslish such a unit within OWD. The existing "Planning and Asset Management Unit" of OWD can be strengthened to undertake these responsibilities. It is realized that formalization of establishment of such a well-equipped unit could take considerable time in OWD. It is therefore receommended to strengthen the existing Planning and Asset Management Unit. It s presently headed by an Executive Engineer, which upon new formation should be headed by a Superintending Engineer (Planning) under the overall control of CE (Policy and Planning). It is further elaborated that Superintending Engineer (Planning) shall also be responsible for supervising Asset Management and a GIS Unit, both headed by a professional equivalent to Executive Engineer (EE). This arrangement shall result in development of value added cost effective development schemes by EE (Planning). The Planning Unit shall work closely with Directorate of Design of OWD, which shall undertake all FEED (Front End Engineering and Design) studies for carrying forward the master plan.

12.1.1 Human Resource Requirements

The proposed organizational structure of OWD has considered a "Road Planning and Asset Management" Division or Cell, headed by a Superintending Engineer (SE). This Division or Cell has been proposed with different units for road planning, asset management and GIS, all headed by an officer of EE or equivalent level. However, for optimum utilization of OSTM, the planning unit need to be staffed with fresh, energetic and young professionals with interest in undertaking such tasks. This Planning Unit should have following positions besides the EE (Planning) and AE (Planning):

- Senior Transportation Planner (1),
- Senior (1) and Intermediate Level (1) Traffic Engineer,
- Junior (2)/Intermediate (1) and Senior level (1) Traffic Modellers, and
- IT Support Personnels

However, as these professionals cannot be hired on deputation, this would require overcoming specific constraints (typical of GOO/OWD) in hiring such services/ professionals to formulate this new multi-disciplinary Unit. However, OWD/GOO needs to take a decision on this.

12.1.2 Responsibilities and Tasks of Planning Unit

The primary task of this 'Planning Unit" shall be to update Master Plan and coordinate the development of the interim Concept Design package, prior to moving towards preparation of DPR for a project. This Planning Unit should also facilitate development of an effective Concept Design (CD) of the potential development schemes, which should be carried forward to preparation of Preliminary Design, Detail Design and the DPR package. Immediate integration (through coordination) of such Planning and Design activities in the proposed OWD structure shall result in development of value added cost effective development schemes, and could save significant throw-away costs due to upfront planning of utilities. The major tasks or responsibilities of the 'Road Planning Unit" shall be:

- Carry out 'Traffic Impact Assessment' for any capital improvement or major land-use development using the OSTM base model
- Update OSTM incorporating the proposed developments and any other relevant information pertaining to the road network or any planning data
- Carryout traffic assignment analysis including capacity analysis using the OSTM to identify any traffic operation/capacity issues
- Develop and utilize sub-area models to estimate traffic assignments on all project area roads up to the level of VR, and develop any traffic flow related mitigation measures, if necessary.
- Integrate OSTM in the proper planning process to enhance individual future detail project preparation and development of DPR
- To request and coordinate FEED studies (to be undertaken by Directorate of Design) for any capital improvement works to identify the detailed impacts of such capital improvements on the existing infrastructure
- To provide inputs in undertaking concept design study at the interim stage, prior to preparation of DPR, where design issues e.g. road cross-sections, lane configurations, at grade junctions and surface area drainage including utility corridor identification/ relocation etc. must be addressed towards best utilization of public funds minimizing throwaway costs.

12.1.3 Infratstructural Requirements

The 'Road Planning Unit' shall be equipped with (or should have **access to**) following software and hardware:

- Transportation Planning and Modelling: CUBE, TransCAD, VISSUM, etc.
- Economic Analysis Software: HDM4
- Drafting: AutoCAD

- Mapping and GIS: ArcGIS (alternatively open source software like QGIS, PostGIS, GRASS, etc.) –This has been proposed as a seprate unit under same Superintending Engineer
- Road Design: MXROAD

The office of the Unit should also be equipped with following facilities to support the activities:

- Desktop computers and laptops,
- Database server,
- Highspeed internet connection, and
- Power backup system.

12.2 OSTM/RNMP Handover

During last three years, RSID and Assset Management Consultants have developed an extensive database for the entire road network of the State. Along with its inventory, they have also collected extensive data on asset/road condition, traffic volumes, axle load etc., which is available for further use. One of the major tasks for institutionalization of road planning in the State shall be to handover all these database and the associated tools used for carrying out the Master Planning task to the Odisha Works Department, as the primary Client. It is suggested that this may be handed over to "Road Planning Unit" or a dedicated team of OWD oficials, who may be designated to work with the proposed "Road Planning Unit" of OWD. The handing over shall include details of each database and its contents in both soft and hard copies along with a detailed explanation in a training mode.

12.3 Capacity Building Needs

12.3.1 Initial Hand Holding of OWD Planning Division/Cell

The handing over of databse and tools is proposed to be followed by a short term training of the assigned officials of OWD (Road Planning Unit), for explaining them about the utility of database as well as about the tools used in analysing and producing the outputs for the Master Plan. It is to be realized that in absence of requisite hardware and software, the officials of the Road Planning Unit will not be able to use these for any improvements, updation or modifications of RNMP outputs.

Extensive **training** of designated staff from OWD, including the newly recruited staff of 'Road Planning Unit" shall be desired so as to ensure proper competency development of staff to manage OSTM. Apart from formal training sessions, on the job training shall be required on a continuous basis to develop the organizational competency levels and understanding of proper utilization of OSTM, GIS Database as well as to support with undertaking of required road designs. The level of training should be such that it enables the OWD/GOO staff to update the OSTM and GIS database at individual Block level (sub- area level) for local area planning and using necessary technical steps. The following types of training should be organized by utilizing the in-house capacity or external training agencies,

- Basic and advance training of the Transportation Modeling software
- Conceptual training on subject matter, such as Transportation Planning and Modelling, Traffic Engineering, Road Design, etc.
- Basic and advanced training for use of GIS
- Basic and advanced training on database management

12.3.2 Sustainable Capacity Development of OWD

Since this planning activity uses advanced techniques of modelling as well as GIS, and these are not the current expertise of the Planning Unit, the capacity development should not be a one time activity, but it should require considerable amount of time so as to master these techniques. A long-term training in a hand-holding mode seems to be the most appropriate option, where a expert agency in Transportaion Modeling and GIS based Planning works with and for OWD over a few years (say 2-3 years) in a rouine manner for all day-to-day work using OSTM/RNMP to develop their capabilities to the desired level.

12.3.3 Capacity Building Options versus Outsourcing

Although, internal capacity building has been the conventional strength of various government departments like OWD, but with increasing availability of expertise in the market, outsourcing has been gaining more and more acceptance. With reference to Master Planning, there is dearth of internal expertise in the areas of GIS, Transportaion Planning, Transportaion Modelling and even traffic engineering. What it meant here is that these resources would have to be hired from the market, as possibility of hiring them on deputation from other government departments, or recruiting staff with such specialisations is also very very low. Secondly, the challenges associated wth hiring of individuals (or their services) from market by the government departments are well known. Thirdly, all the required surveys to support modelling and planning is most likely to be outsourced, as no such internal resources are available. Fourthly, expertise available in market generally is much more updated than departmental pool of exeprts. Finally, the costs involved (human resources, hardware and software, training) in long run needs to be vetted on a longer horizon. Therefore, OWD/GOO needs to review the options available and make a systematic analysis amongst available choices: whether to develop internal competenece or rely on outsourcing. The possible options may include the following.

Option I: On-site Engagement of Consultant

One of the options could be to outsource all the required activities pertaining to Master Planning, which is a very similar option to what has been pursued under RSID consultancy. The Terms of Reference can be modified a bit to have selective as well as extensive surveys for traffic volumes and its periodc updation. However, the system does not provide regular updation of Master Plan and the in-house competencies required for assiting the implementation of RNMP recommendations may not be developed. This would thus be leaving OWD with high dependency on outside agencies.

Option II: Outsourcing - Regular Trainings and Working Together

The RNMP report has recommended for engagement of a “external consultant” on a long term basis to assit OWD in setting and building up the ‘Road Planning Unit’ and to start integration of the planning process with OWD’s traditional project preparation system. It recommends that a number of OWD staff should be deployed to work simultaneously with the PMC to gain hands-on experience in undertaking transport modelling work and handling GIS database. This process could assist in developing sustainable competencies in the staff of the Planning Unit.

Option III: Outsourcing the Road Planning Activities

The third option could be possible off-site out-sourcing of OSTM operation only. This can be done by hiring a professional agency, and required inputs are prvided by OWD to prepare/update the Master Plan. For this,OWD may hire some survey agencies and a limited number of staff only. Of course, such arrangement also would require huge effort of coordination and scrutiny of data and outputs.

12.4 Benefits to Road Sector Stakeholders

The proposed Road Planning Unit in OWD shall aso be a valuable resource for several stakeholders of the road network of Odisha. These stakeholders may include:

(a) Rural Development Department
(b) Panchayati Raj Department
(c) Irrigation Department
(d) Urban Development Department
(e) Forest Department

The above GOO Departments are engaged in road sector activities and the comprehensive database developed under RNMP shall be a highly useful resource for all these Departments, as it is on a GIS platform. A Coordination Body of all the stakeholders can be set up to not only share the resources of Road Planning Unit but also to integrate available data/information/resources with various stakeholders. The developed resource/facilities can be then used by all concerned. The staleholders shall be benefitted by sharing of ongoing plans/developments undertaken by OWD as well as details of varius traffic suveys etc., which would assist them in improved planning and better use (thru integration/convergence) of their resources for an improved road network at all levels of hierarchy. However, to make it work, OWD will have to take leadership and arrange periodc meetings with various stakeholders for sharing and integrating the data/information.

12.5 Way Forward

The RNMP task under RSID Project delivers a comprehensive report covering transportation issues, recommendations towards mitigation of the issues, a detailed economic analysis and an exhaustive priority list of schemes that need to be implemented over next twenty years. The RNMP task includes a value added deliverable i.e. the OSTM, which should be a living tool for best use by the OWD/GOO towards developing/enhancing their planning process. The best utilization of the RNMP and the OSTM will require:

- Establishment of an independent ‘Road Planning’ Unit (or assigning dedicated professional) with following functions
    - To update OSTM at a specified interval (say two years) until the end of the short term horizon. This may involve traffic data collection, analysis etc.
    - Cordinate/undertake feasibility studies to meet traffic needs, as one of the primary task of this ‘Road Planning’ unit, shall be development of the interim Concept Design package, prior to moving towards preparation of DPR.
- Initial training of staff from OWD Road Planning Unit must be facilitated to ensure proper qualification of staff to handle and work with the OSTM. For the purpose, a short course of 3-4 days shall be organized by RSID Consultant and this should help OWD in “real” setting up

of an "active planning unit" and start integration of the planning process with OWD's traditional project preparation system. Considering the needs, the above training of OWD staff on handing over and acquainiting with the entire database and modeling system is proposed to be conducted during second half of October 2014, subject to assigning dedicated officials to work with the proposed planning unit and confirmation of dates by the client.

- Basic documentation and guidelines to work on OSTM: RSID consultants shall provide basic guidelines to work on OSTM besides explaining CUBE software.
- Selection of Option by OWD for sustainable capacity buiding: The option for selection needs to consider and analyze issues in hiring/recruiting of trasnportation planners, trafiic engineers etc. besides required hardware/software on one side and hiring of professional services (consultants) on the other side and its cost benefit analysis over a period.
- Procurement of hardware and software (as suggested): RSID Consultant may provide detailed specifications and advise on selection of "right" hardware/software and help in choosing the same.
- Implementaion of selected option by OWD in a reasonable time frame.

13 Conclusions and Recommendations

The Road Network Master Plan (RNMP) primarily focussed on identifying traffic operation issues under short term, medium term and long term traffic conditions and ensuring provision of road connectivity to all villages including backward and tribal areas. The RNMP study identified necessary road improvements in the State to augment capacity under different time frame with a horizon of 20 years for better accommodation of future traffic demand and also to provide enhanced road network connectivity to disconnected hamlets, tribal and backward areas. The RNMP study emphasized ensuring effective freight transportation connecting the potential high commercial trip generators to the existing and potential future intermodal facilities and to support better interstate road connectivity. The study also addresses socio-economic developments of the State by attending to the industrial, tourism and mining developments, by identifying high commercial traffic corridors, and therefore, provides due importance to future road infrastructure improvements (recommended under RNMP) with priorities. This study also identifies areas that need to be addressed in Road Sector Policy and recommends appropriate actions to integrate the OSTM within the existing infrastructure planning practices within GOO, especially in Works Department including organizational strengthening.

The RNMP also identified enhanced connectivity required between major business areas across the State borders to enhance interstate mobility. A detailed reclassification of the State roads based on Road Development Plan - Vision 2021 was established to enhance connectivity among various levels of administrative headquarters in the State including improved connections to intermodal facilities, major cities/towns within the State, tourist places, and major market centres resulted in expansion of existing OWD main road network from 17,550 Km to approximately 38,000 km. This significant expansion was resulted from upgradation of significant length of VRs to ODR, and also upgradation of SHs, MDRs and ODRs based on the Road Development Plan - Vision 2021 for regional road networks.

13.1 Conclusions

The existing road network in the State comprises of approximately 250,328 Km, and could be summarized as per **Table 13-1** below:

Table 13-1: Length of Road Network in Odisha

Sl. No.	Road Classification	Length (Km)	Sl. No.	Road Classification	Length (Km)
1.	National Highways	3,594	7.	Rural Roads	28,159
2.	State Highways	3,664	8.	Panchayat Samiti Roads	25,703
3.	Expressways	72	9.	Gram Panchayat Roads	145,368
4.	Major District Roads	3,973	10.	Forest Roads	7,518
5.	Other District Roads	6,653	11.	Irrigation Roads	6,277
6.	Urban Roads	18,591	12.	GRIDCO Roads	88

Source: Economic Survey 2012-13, Odisha & ORSAC Data

A detail GIS based road network was developed based on GIS maps prepared by ORSAC. The GIS maps were enhanced integrating additional and relevant information available from other reliable

sources. An integrated strategic transportation model covering the entire State of Odisha (OSTM: Odisha Strategic Transportation Model) was developed using CUBE software. The traffic analysis work, undertaken utilizing OSTM for the successful completion of the RNMP, primarily focused on the major road network that is susceptible to traffic flow, whereas most of the State road network was scanned thoroughly to identify village connectivity and ensuring potential restoration of village connectivity by all-weather road. The OSTM constituted of 314 internal TAZs and 12 external TAZs, and was calibrated to represent the existing traffic flow whereas the enhanced GIS based map was utilized to identify road connectivity issues with existing villages, backward areas and tribal areas.

The OSTM road network for the base year included all roads down to ODR classification, and some VRs were also included in the model, and a network of a total length of approximately 21,028 Km road was included in the OSTM. The **Table 13-2** below summarizes the total road network included in the OSTM.

Table 13-2: Length of Road Network in Km adopted in OSTM

Road Classification	Lane Configuration							
	8-lane	6-lane	4-lane	2-lane + paved shoulder	2-lane	Intermediate lane	Single lane	Total
National Highway	-	62	541	6	1,769	1,229	-	**3,607**
State Highway	-	-	8	73	893	1,112	1,565	**3,651**
Major District Road	4	21	19	36	433	1,478	1,869	**3,860**
Other District Road	-	0	17	29	295	1,423	4,602	**6,367**
Village Road	-	-	-	-	-	-	2,966	**2,966**
Expressway	-	-	2	8	35	13	5	**63**
Total	**4**	**84**	**588**	**151**	**3,425**	**5,255**	**11,008**	**20,514**

The 'IRC: 64-1990 Guidelines for Capacity of Roads in Rural Areas', was utilized to determine the Design Service Volume (DSV) and capacity of the road links in Odisha. The guideline presumes rural highways as all-purpose roads with no control of access, and with heterogeneous mix of fast and slow moving vehicles, which are the features generally observed in all categories of roads in Odisha. The guideline suggests DSV of roads at LOS-B (i.e. DSV is half of capacity with V/C ratio of 0.5), which means the road links with volume-capacity ratio more than 0.5 are congested. The 2013 traffic conditions are summarized below in **Table 13-3**.

Table 13-3: Road Links (Length) with V/C > 0.5 in km

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane
NH	0	568	446	0	21	9	-
SH	539	218	130	34	-	-	-
MDR	349	187	18	-	-	-	-

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane
ODR	261	32	-	-	-	-	-
VR	128	-	-	-	-	-	-
Expressway	-	-	-	-	-	-	-
Total	**1,278**	**1,005**	**594**	**34**	**21**	**9**	**0**

Vehicular traffic growth in the network was estimated based on historical vehicle registration data. Additional development traffic was estimated based on the planned and proposed socio-economic development information collected from various sources (development of industries, ports, mining, etc.). Future traffic volumes under short term, medium term and long term were estimated incorporating normal vehicular traffic growth and development traffic volumes based on their year of full built-out. **Table 13-4** summarizes the ***length of various categories of roads that become capacity constrained (i.e. V/C > 0.5)*** progressively under short term, medium term and long term horizons with "Do Nothing" scenario of the road network, i.e. business as usual. This shows that in the long run approximately 13,000 km of the main road network will be seriously capacity constrained if no improvement is planned.

Table 13-4: Road Length in Km with V/C > 0.5 - Short, Medium, and Long term

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
Short Term Horizon (2020)								
NH	5	969	1,476	8	325	59	0	**2,843**
SH	865	563	148	45	0	0	0	**1,622**
MDR	583	403	75	0	0	0	0	**1,061**
ODR	604	87	13	1	0	0	0	**704**
VR	459	0	0	0	0	0	0	**459**
Total	**2,516**	**2,023**	**1,711**	**54**	**325**	**59**	**0**	**6,687**
Medium Term Horizon (2025)								
NH	0	1,035	1,732	6	466	61	0	**3,301**
SH	1,246	802	216	52	1	0	0	**2,318**
MDR	850	559	148	0	9	0	0	**1,567**
ODR	994	245	13	1	0	0	0	**1,253**
VR	751	0	0	0	0	0	0	**751**
Total	**3,842**	**2,641**	**2,110**	**59**	**477**	**61**	**0**	**9,190**
Long Term Horizon (2035)								
NH	0	1,082	1,768	6	528	62	0	**3,446**
SH	1,412	1,070	463	51	0	0	0	**3,037**
MDR	1,326	1,122	228	1	9	0	0	**2,687**

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane	Six Lane	Eight Lane	Total
ODR	1,979	521	91	3	0	0	0	**2,593**
VR	1,216	0	0	0	0	0	0	**1,216**
Total	**5,933**	**3,796**	**2,582**	**63**	**539**	**62**	**0**	**12,978**

The detailed economic analysis of the proposed road improvements has been carried out by Highway Development and Management (HDM-4) model. **Table 13-5** summarizes the findings from the economic analysis:

Table 13-5: Summary of Economic Analysis

Short Term Horizon (2015-2020)			
		State Roads (SH, MDR, ODR etc.)	National Highways (NH)
NPV	Net Present Value (million INR)	260,927.50	1,83,026.50
EIRR	Economic Rate of Returns (%)	28.80%	43.10%
Medium Term Horizon (2020-2025)			
NPV	Net Present Value (million INR)	55,437.19	7,641.40
EIRR	Economic Rate of Returns (%)	29.2%	18.4%
Long Term Horizon (2025-2035)			
NPV	Net Present Value (million INR)	66,875.96	34689.65
EIRR	Economic Rate of Returns (%)	22.1%	24.1%

The NPV and EIRR values were very promising for most of the road sections; however the values were less than cut-off criteria (i.e. 12%) for some of the sections. The primary reasons for such declination could be for multiple reasons, such as low volume of traffic, and the benefit estimation did not include multiple attributes. This is worth noting that although results from economic analysis reflect the economic viability, investment decisions should include other parameters such as socio-economic impact and other relevant parameters as well. The existing 15 westerly districts of the state are economically backward, and some of the recommended improvements might not be showing very high economic viability due to low demand levels in the network. However, not providing necessary basic and upgraded infrastructure to these backward areas will leave these areas avoided forever, which will eventually lower the progress of the entire State of Odisha. Investment on road network has been shown many times as to be having multiplier effect on the overall economy, as well as social developments.

Theestimated capital costs for implementation of the recommended road improvements for the State Roads under short term, medium term and long term horizon are around INR 24,000 crore, INR 4,000 crore, and INR 10,000 crore respectively. Whereas, these figures for National Highways are INR 8,000 crores, INR 1,800 crores, and INR 6,400 crores respective for the three horizons.

The village connectivity analysis using the GIS based road network yielded the results as shown in **Table 13-6**.

Table 13-6: Status of Village Connectivity in Odisha

State of Odisha	Village Connectivity Status (Number of Villages)				
	No Road	Track Road	Kutcha Road	Pucca Road	Total
	1,965	986	11,202	37,703	51,856

The total length of all-weather roads need to be constructed to effect connection to number of villages not connected with all-weather roads is summarized in **Table 13-7**.

Table 13-7: Required Village Connectivity

State of Odisha	Existing Road	Total Villages	Length to be Upgraded (Km)
	Track Road+ No Roads	2,951	2,926

13.2 Recommendations

The RNMP study found there are multiple issues connected to the road network development, which require applicable mitigation measures for necessary resolution. Recommendations developed to address all such issues and these covered the following:

- Mitigation of traffic operation issues;
- Enhanced road connections to Ports, Industries, Tourist areas and important Towns/Cities;
- Best utilization of RNMP in Capital Budgeting for next 20 years in a planned manner and sourcing of funds for planned developments;
- State Road reclassification;
- Mitigation of village/backward area/tribal area connectivity issues;
- Integration of RNMP with State Policy; and
- Institutional Strengthening for best utilization of the RNMP and associated tools like OSTM and GIS mapping.

Traffic Operation: It is worth noting that NHAI have been planning implementation of some corridor improvements that include NH widening, building of some strategic link etc. towards capacity augmentation. The RNMP, prior to considering any specific capacity augmentation, all recommended implementation of some Strategic Improvements in line with the recommendations provided in Road Development Plan - Vision 2021 document, have been considered. The ***strategic improvements*** included:

- Widening of SH to a TL[23] cross-section all through the State of Odisha;
- Widening of the NH to a TL[3] cross-section throughout Odisha;
- Improvement of some of the Inter-State Connectivity links for better mobility and accessibility;
- Enhanced connectivity to Ports through upgrading existing Port connecting link/service roads to ensure efficient transportation of goods and trades;
- Upgradation of existing road classes that connect existing Towns and Cities with faster access to major road network;

[23] All 2-lane sections are considered as 2-lane plus paved shoulder to ensure better operation and safety.

- Upgradation of existing road classes that connect major Tourist Places of National and State importance.

In addition to above, ***three strategic corridors*** within the State have been recommended. Two corridors were recommended primarily based on the identified desired pattern of travel within the State of Odisha, and one corridor, which is a federal plan to connect to major towns located in Chhattisgarh and Andhra Pradesh. These corridors are recommended as TL^3 cross-section to enhance direct connectivity and improve efficient freight transport. The strategic corridors are:

- **Vijaywada-Ranchi Corridor:** This is a Nationally Planned North-South corridor that will pass through the State of Odisha. The RNMP recommends that the subject corridor possesses at least a 2-lane[3] to facilitate proper passage of freight and passenger transportation;
- **Cuttack/Bhubaneswar to Koraput/Jeypore Corridor:** This is an alternative corridor identified based on the desired line diagram, developed during OSTM development. This strategic corridor will facilitate adopting shortest route of travel between the east to west coast of the State avoiding major and widely travelled corridors; and
- **Keonjhar to Kirtania/Dhamra Port Corridor:** This is another alternative freight corridor that will provide the shortest path between major mining locations/industrial areas to the existing major ports. This corridor will facilitate freight movements by avoiding major NHs.

In addition to the above, road improvements recommended in the RNMP also include installation of bypasses to some of the major towns to ease traffic movement demand through the cities/towns. 13 bypasses were recommended around cities, and three bridges were proposed to connect the missing links, one bridge is across Mahananda River near Banki in Cuttack connecting Banki to Nuapatna, the second one across Mahananda River near Athmalik in Angul connecting Athmalik to Puranakatak (on NH-224), and the third bridge near Chendipada in Angul on the Vijaywada-Ranchi Corridor joining a missing link between Naktideuli-Angabira-Aunil Road and Chendipada-Bagedia Road.

With all these, the performance measure of the OSTM network will improve under the short term horizon; however, still a considerable length of road network will remain as capacity constrained, which will require further capacity augmentation to mitigate the capacity constraint, as summarized in **Table 13-8**.

Table 13-8: Congested Corridors After all Strategic Improvements (2020)

Road Classification	Single Lane	Intermediate Lane	Two-Lane	Two-Lane + Paved Shoulder	Four Lane*	Six Lane*	Eight Lane*	Total
NH	0	0	4	447	545	59	0	**1,054**
SH	0	0	0	148	77	0	0	**225**
MDR	0	15	56	0	0	0	0	**71**
ODR	147	35	1	1	0	0	0	**184**
VR	177	0	0	0	0	0	0	**177**
Total	**324**	**50**	**60**	**596**	**622**	**59**	**0**	**1,711**

**Multilane roadways do not warrant any capacity augmentation until the V/C exceeds 0.75*[24].

The overall recommendations for improvements including the strategic improvements and capacity augmentations are summarized in **Table 13-9.**

Table 13-9: Overall Road Improvements under Short term Horizon (2020)

Road Category	Short Term Horizon (2015-2020) Road length recommended for widening to (Km)	
	2-Lane Cross-section with paved shoulder either side (carriageway width = 10m)	Four-lane plus with paved shoulder either side. (carriageway width = 17m)
NH	1,126	657
SH	5,065	180
MDR	1,188	2
ODR	427	3
VR	107	5
Total Length	**7,913**	**847**

Further road improvements, beyond implementation of the road improvements under short term horizon, were recommended to be implemented under medium term horizon, and are summarized in **Table 13-10.**

Table 13-10: Road Improvements Considered for Medium term Horizon (2025)

Road Category	Medium Term Horizon (2020-2025) Road length (in Km) recommended for widening to,	
	Two-lane with paved shoulders (carriageway width = 10m)	Four-lane (carriageway width = 17m)
NH	-	281
SH	-	310
MDR	260	28
ODR	61	37
VR	177	-
Total Length	**498**	**656**

Note: The length of planned/ongoing road improvements is not included in the above table.

It is worth noting that due to expected stabilization of growth rate over time, the necessity of road improvement rate will diminish as we move to future periods. It may be noted that, the short term development has also included the backlog of the network development missed over last one or two decades. Further road improvements will still be necessary under the long term horizon, and **Table 13-11** summarizes the requisite road improvements.

Table 13-11: Road Improvements Considered for Long term Horizon (2035)

Road Category	Long Term Horizon (2025-2035) Road length (in Km) recommended for widening to,		
	Two-lane with paved shoulders (carriageway width = 10m)	Four-lane (carriageway width = 17m)	Six-lane (carriageway width = 23m)

[24] IRC: SP 84 - 2009

NH	-	449	416
SH	-	847	253
MDR	108	155	11
ODR	263	83	0
VR	65	-	-
Total Length	**436**	**1534**	**680**

Prioritization of Improvements: A MAE was adopted through establishing a Multi Criteria Decision Making Analysis (MCDMA) to evaluate the priority of the proposed improvements. The parameters considered for the MAE and the attributes to the evaluation parameters are summarized in **Table 13-12** below.

Table 13-12: Parameters Adopted for Prioritization of Road Links

Sl. No.	A: Traffic & Network Parameters	B: Socio-Economic Parameters	C: Road User/ Economic Parameters
1	Volume- Capacity Ratio	Human Development Index (HDI)	Value of EIRR
2	Network Function	Tribal Area Connectivity	
3	Commercial Traffic	Employment: Work Participation Rate	
4	Rural Connectivity	Registration rate of Motorized 2-Wheelers	

The recommended priority of the proposed road improvements under short term, medium term and long term horizons are summarized below in **Table 13-13**.

Table 13-13: Summary of Prioritized Road Improvements (2015-2035)

National Highways		SH, MDR, ODR and VR	
Group (year of implementation)	**Length (km)**	**Group (year of implementation)**	**Length (km)**
Short term (2015-2020)			
A1 (1st Year)	337	A2 (1st Year)	1,385
B1 (2nd Year)	139	B2 (2nd Year)	1,437
C1 (3rd Year)	372	C2 (3rd Year)	1,449
D1 (4th Year)	509	D2 (4th Year)	1,349
E1 (5th Year)	426	E2 (5th Year)	1,357
Total Length	**1,782**	**Total Length**	**6,977**
Medium term (2020-2025)			
A1 (6th Year)	64	A2 (6th Year)	218
B1 (7th Year)	56	B2 (7th Year)	202
C1 (8th Year)	81	C2 (8th Year)	177
D1 (9th Year)	43	D2 (9th Year)	137
E1 (10th Year)	37	E2 (10th Year)	139
Total Length	**281**	**Total Length**	**873**
Long term (2025-2035)			

National Highways		SH, MDR, ODR and VR	
Group (year of implementation)	**Length (km)**	**Group (year of implementation)**	**Length (km)**
A1 (11th Year)	144	A2 (11th Year)	158
B1 (12th Year)	87	B2 (12th Year)	122
C1 (13th Year)	104	C2 (13th Year)	193
D1 (14th Year)	115	D2 (14th Year)	181
E1 (15th Year)	63	E2 (15th Year)	196
F1 (16th Year)	126	F2 (16th Year)	227
G1 (17th Year)	114	G2 (17th Year)	207
H1 (18th Year)	64	H2 (18th Year)	158
I1 (19th Year)	28	I2 (19th Year)	165
J1 (20th Year)	20	J2 (20th Year)	179
Total Length	**865**	**Total Length**	**1,786**

Enhanced Connectivity to Multimodal Hubs and Industries: The RNMP identifies the importance of enhanced road connections to intermodal hubs, where all the existing and future port connections were emphasized. Connections to existing and future industries are also recommended to be provided with higher class roads, primarily by SHs. The OSTM includes all such road upgradation and the RNMP considers all this under the recommended reclassification scenario.

Village Connectivity: All the villages were recommended to be connected by all-weather road in the State. The road reclassification recommended upgrading of all GPHQs with connectivity by ODR, facilitating direct connection between the GPHQ and OWD Main Road Network.

Reclassification: RNMP developed recommendations for various reclassification of State roads based on the objective of enhanced connectivity. The enhanced connectivity was recommended through upgrading existing road links to State level main road network to connect various administrative headquarters at different levels of hierarchy, transport hubs like ports, airports, major rail heads, etc., major industries and tourist places of National and State level importance. Recommendation towards reclassification and upgradation of other road classes were based on their functionality in short, medium and long term development objectives of the State. As a result, approximately 2,000 Km of various roads were upgraded to SH, approximately 20,000 Km of VR was upgraded to ODR. **Table 13-14** summarizes the recommendations.

Table 13-14: Road Reclassification Criteria

Connectivity	Minimum Road Class Recommended			Reclassification Type
	SH*	MDR	ODR	
State HQ-DHQ	Δ	-	-	A
Major Ports/Airports	Δ	-	-	
Interstate	Δ	-	-	
Tourist Places of National Importance	Δ	-	-	
Major Towns with 5000 (+) Population	Δ	-	-	
DHQ-Subdivisional HQ/BHQ	-	Δ	-	B

Tourist Places of State Importance	-	Δ	-	
Market Centres (Agricultural)	-	Δ	-	
Subdivisional HQ-BHQ	-	Δ	-	C
BHQ-GPHQ	-	-	Δ	

13.3 RNMP Integration with State Policy

The State Road Policy has mandated integration of the transportation planning process for any road or land-use improvement in the State. Front end engineering and design (FEED) study should be made a 'must' in the implementation of this, as suggested in Road Policy. The FEED should properly be undertaken for any capital improvement work and should identify the detail impact of such capital improvements on the existing infrastructure. All major land-use developments should also undertake such FEED study prior to seeking any approval. Transportation planning process should be inherently integrated with all major developments to identify their inherent and true impacts.

Road Policy should mandate 'Traffic Impact Assessment', which should be carried out for any capital improvement or major land-use development using the OSTM base model. The OSTM should be updated incorporating the proposed developments and any other relevant information pertaining to the road network or any planning data. Traffic assignment analysis including capacity analysis should be undertaken using the OSTM and any traffic operation/capacity issues should be identified. The integration of OSTM in the proper planning process shall enhance individual future detail project preparation and development of DPR. The sub-area models should be utilized to estimate traffic assignments on all project area roads up to the level of VR, and any traffic flow related mitigation measures shall be developed, if necessary. A concept design study stage shall be introduced at the interim stage, prior to preparation of DPR, where design issues e.g. road cross-sections, lane configurations, at grade junctions and surface area drainage including utility corridor identification/ relocation etc. must be addressed towards best utilization of public funds minimizing throwaway costs.

13.4 Institutional Development Perspective

OWD/GOO should make all emphasis to integrate the RNMP and its associated tools i.e. the OSTM and the transport network mapping on GIS platform, to develop cost effective transportation solutions. OWD must consider establishing an independent "Planning & Asset Management Division/Cell", the planning component of which will only focus on carrying out FEED studies as well as support the asset management component. The planning group should also be made responsible to updating OSTM at an interval of every two years until the end of the short term horizon. Rigorous training of staff from this Division/Cell must be facilitated to ensure proper handling and working with the OSTM. Apart from formal short term training sessions, on-job training should also be considered on a continuous basis to develop the organizational skill level and understanding of proper utilization of OSTM. The level of training should be such that it enables the OWD/GOO staff to update the OSTM at individual Block level through necessary technical steps. Proper staffing of this 'Planning' unit is to be considered during recommending restructuring the OWD/GOO organizational structure. Best utilization of the OSTM will require induction of fresh, energetic and young staff, who will pay their highest attention and interest in learning the required skills and help in implementing the planning steps properly and with pride. The primary task of this 'Planning' component of the division/cell shall be development of the interim Concept Design package, prior to

moving towards preparation of DPR for a project. This planning unit shall host Transportation Planners, Traffic Modellers, and GIS specialists. Design Engineers consisting of Highway Design Engineers, Storm Water Management Specialists, Municipal Services Specialists, Electrical and Mechanical Engineers required for an effective Concept Design (CD) of the potential development schemes, shall be available from Design Directorate. Such a 'Planning' unit in the existing/proposed OWD/GOO organization shall result in development of value added cost effective development schemes, and must save significantly by avoidable costs due to upfront planning of the details.

13.5 Way Forward

The RNMP task under RSID Project has delivered a comprehensive report covering transportation issues, recommendations towards mitigation of the issues, a detailed economic analysis and an exhaustive priority list of schemes that need to be implemented over next twenty years. The RNMP task includes a value added deliverable i.e. the OSTM, which should be a living tool for best use by the OWD/GOO towards developing/enhancing their planning process. The best utilization of the RNMP and the OSTM will require:

1. Immediate formal training of OWD staff on working with the OSTM model for making it sustainable. To avail the best results a 3rd Party Agency (Project Management Consultant (PMC)) might be engaged to help OWD in setting up an active planning unit and start integration of the planning process with OWD's traditional project preparation system;
2. A number of OWD staff should be deployed (including fresh recruits) to work simultaneously with the PMC to gain hands-on experience in undertaking transport modelling work and working with GIS database for road network;
3. Closer screen-lines afresh should be established based on obvious locations in individual Block level, and conduct all necessary surveys, and also the road network database should be completed by including ownerships and available right of way information;
4. Rigorous calibration of OSTM should be done with respect to the closer screen-lines, and the entire OSTM should be updated at individual Block level integrating all the ODRs that are recommended for upgrading from VR;
5. OSTM should continuously be upgraded incorporating any upcoming/on-going road improvements and major land use developments that are to be implemented and necessary traffic assignment run should be undertaken to identify any impact on the network;
6. Detail feasibility studies to develop concept design should be established prior to undertaking DPR. Any road improvements including what are recommended in the RNMP should be reviewed through development of sub-area modelling. Any recommended road improvement/required road improvement should be studied closely. Necessary ROW width for implementation of any road improvements should be identified, and any land acquisition necessary should be identified even before the DPR, and necessary negotiation should be undertaken with the affected parties; and
7. Road Policy should be updated to mandate use of OSTM for developing any road improvement or any major land-use development involving capital budget.