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PLANNING IMPLICATIONS OF HIGHWAY CORRIDORS ON SETTLEMENT PATTERNS ALONG BHUBANESWAR–PURI SECTION OF NH 316

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ABSTRACT

The Government of India is sanctioning heavy funds the creation, maintenance and upgradation Highways in the attempt to influence its adjoining hinterlands and allowing higher rates of development in terms of economic and social. This paper explores the relationship between highway infrastructure, regional development and impact of these on the settlement pattern by conducting an assessment of the NH 316 corridor with the help of GIS tool. It aims to identify the growth drivers along the National Highway corridors and relate it to the levels of regional development. NH 316 corridor is taken into consideration for this study to investigate the corridor model as a strategy for urban development through socio-economic development and channelising the growth direction of the settlements along the corridor.

Keywords: NH 316, Corridor Settlement, Demography, Socio-Economic, Infrastructure, Development Index, TOD.

I. INTRODUCTION

Both Urban & rural areas are an integral part of Settlement Hierarchy, to connect them transport system expanded so that places are well connected to its surroundings. These laid the groundwork for a series of settlements along transport corridors.

Transport corridors are defined as **linear agglomeration of economic activities & people** along the physical backbone of transport infrastructure. Transport infrastructure is a basic necessity for development of a region and regional development is primarily driven by economical forces. Hence, creation of transport corridors & infrastructure will bring about economical, social and human development along the routes.

An efficient transportation system can lead to greater economic and social benefits by improving market accessibility, increasing production efficiency, providing balanced growth of regional economies, providing employment and enabling labour force mobility. Increasing population mobility including tourist flows, medical tourism, and students and teaching staff mobility.

Huge investments are being made and facilitated by the GOI for development of highways which centrally assumes that presence of a transport network will influence its immediate hinterland and the adjoining corridor is expected to have a higher development and would bring economic, social and human development along these corridors.

Bhubaneswar to Puri Section of NH 316 is an important transport corridor as it connects the two major growth centres and tourist spot of Odisha. Major economic node along the corridor are Uttara, Pipili, Dandamukundapur, Sakhigopal, Chandanpur, etc. More than 8,000 people travel from Bhubaneswar to Puri on daily basis for work, vacation and miscellaneous activities. Creation and upgradation of NH 316 ensured smooth traffic flow, less travel time and safe passenger movement. Hence, to understand the impact of the transport corridor on development of its adjoining areas and the settlement structure along the highway, the impact assessment study is need to be done. In this study, only the impacts on settlements are considered with its parameters.

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II. LITERATURE STUDY

Rapid urbanisation has been a factor affecting cities negatively & irreversibly leading to depleting natural resources with unbalanced & uneven urbanism. To handle the population influx into core urban regions and to promote holistic & sustainable development government is looking upon urban corridor-oriented development solutions.

Improved visualisation and understanding of effects of development on the urban ecosystem is the need of the hour to guide the planning of corridors in existing policies. Corridor pattern of settlement distribution is beneficial and can be used as a strategy to steer & shape the adjacent settlement developments in a holistic manner.

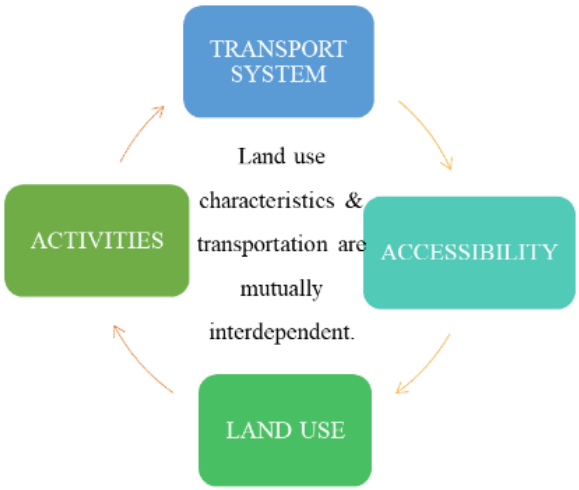

Figure 1: Mutual Inter-dependency of Land use and Transportation

Geddes (1915) proposed the concept of as "urbanscape" when he coined the term 'conurbation'. This concept gave rise to what we now refer to as 'urban corridors.

Urban corridors are a pattern of urban systems that gradually developed along the transport routes which provided linkages between major urban hubs and resulted in growth of the urban peripheral areas.

Land is an appropriate measure of space and land use provides a spatial framework for urban development and activities. The location of activities & their need for interaction creates demand for transportation, while the provision of transport facilities influence location itself. Land uses, by virtue of their occupancy, are these needs are directed to specific targets.

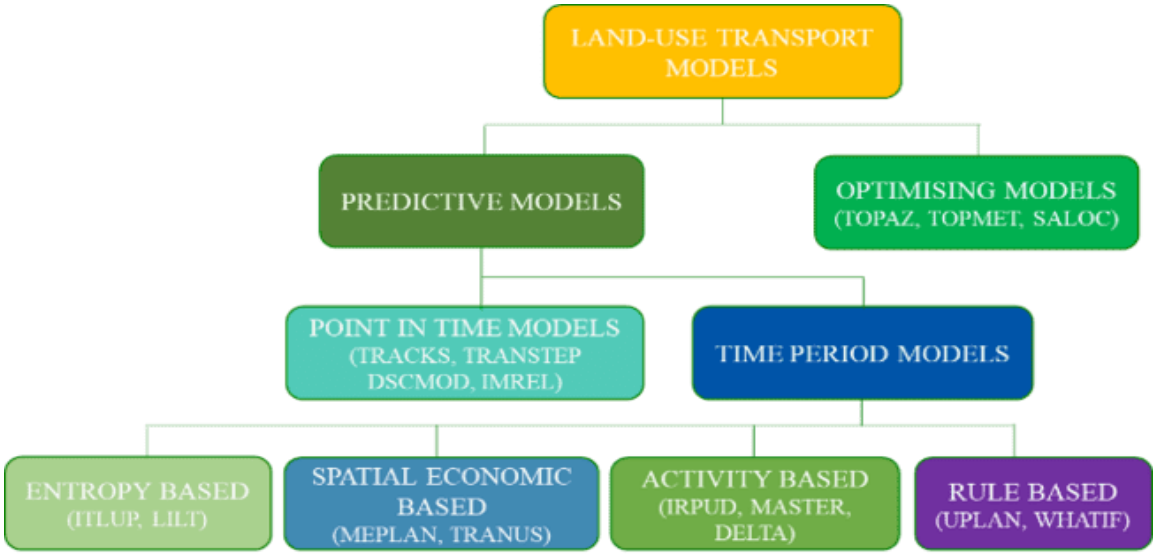

Figure 2: Classification of Land use Transport Model

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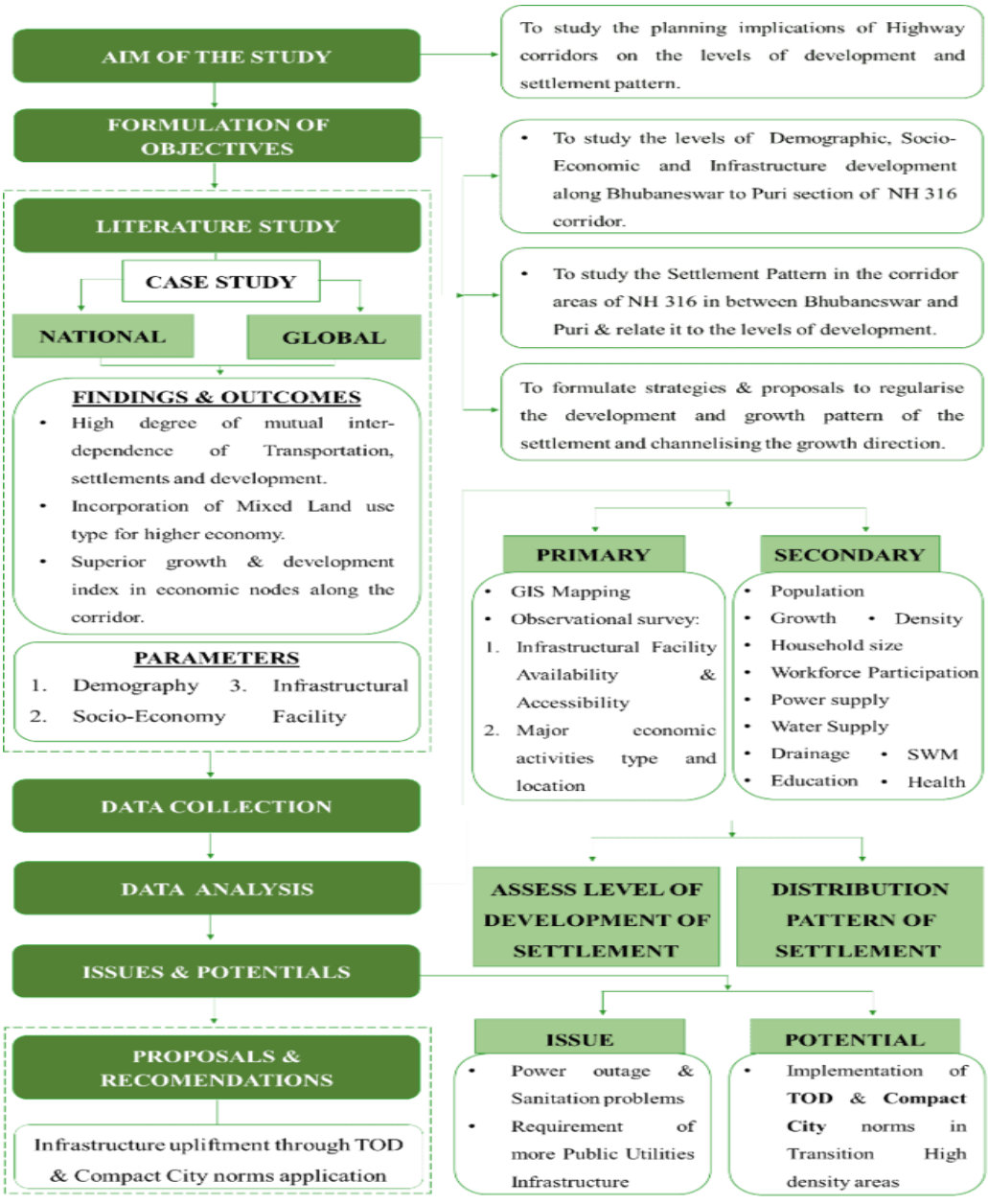
The interaction between the indicators of Land use Transport is classified into Land use Transport Model. The purpose of LUTM is to assess the policy impacts in terms of the implications of the future growth patterns on both land use & travel. U-Plan Growth Model (Johnston, 2000) is a GIS based system for land use modelling. It's a rule-based model, aiming to identify the effects of travel on land use & major concept is to forecast the future land consumption & channelise growth direction. Land consumption is predicted based on demographic data and density factors. GIS analysis is based on raster data for Integrated Land use & Travel Demand. Model application starts with identifying the attractive areas in terms of land development & areas or physical features with low potential of future development. Then the projected land consumption / future development is allocated starting from the highest valued areas.

Balanced planned settlement and transport corridors must ensure sustainable mobility:

1. Better accessibility with infrastructure
2. Higher social equity & economic efficiency
3. Efficient environmental protection
4. Higher quality of life

III. METHODOLOGY



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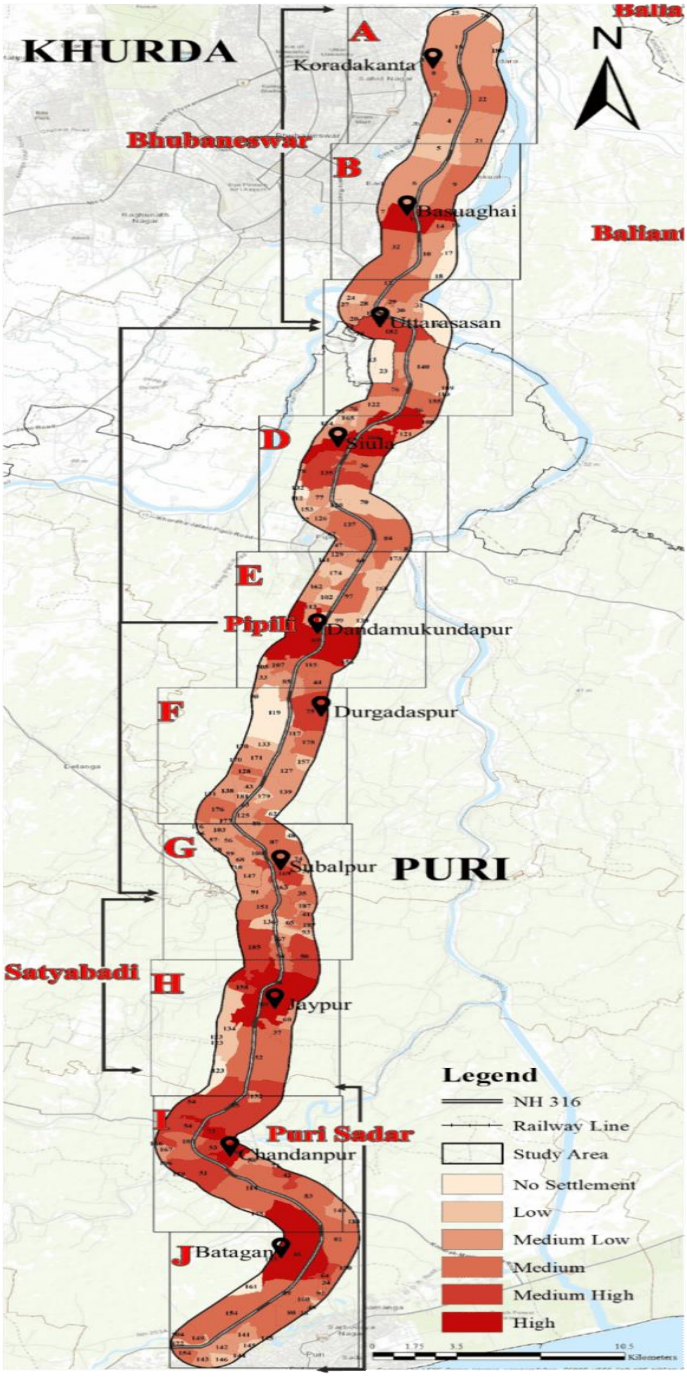
The first phase of this research involves identifying the existing growth drivers (i.e., Demography, Socio-Economic and Infrastructure) and estimating the levels of the growth drivers in the corridor area through primary and secondary survey.

The second phase involves in developing a visual model to understand the structure of the settlement pattern in the corridor area with the help of GIS and U-PLAN modelling software. And further integrating the pattern of development with the level of growth drivers to generate a development index for the corridor. By compatring the index most favourable or potential transition settlements in the corridor area are selected for further development.

The final phase involves in formulating strategies and proposals to regularize the development and channelizing the growth of the settlement in the corridor. And also, to promote homogeneous development in form of clustered cities at a certain distance with proper infrastructure facilities and basic amenities to ensure standard quality of life.



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IV. DATA COLLECTION AND ANALYSIS

Demography Levels:

The stretch along **NH 316** of Bhubaneswar to Puri section is **61.8km** long which contains **187 settlements** from which **25 are urban settlements** and **162 are rural settlements**. Total **Population** along NH 316 in between Bhubaneswar to Puri section is **85,631**. **Dandamukundapur** has the **Highest Population** followed by **Chandanpur** in the stretch. Total corridor area of NH 316 is 126.471 sqkm. 1 km from the side of the NH is considered as the corridor area. The road is segregated into grids at 5.5 km

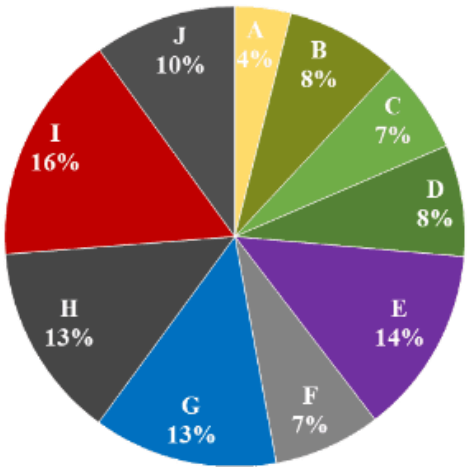

Figure 3: Population Density

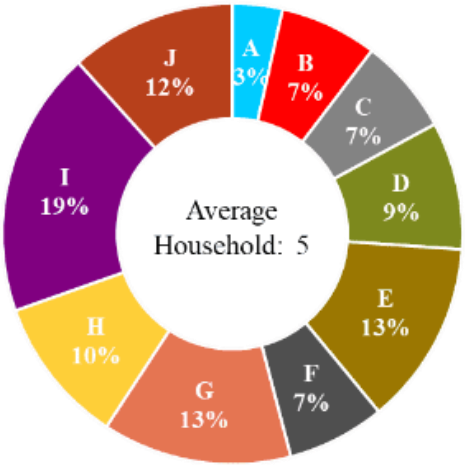

Figure 4: Number of Household

The total stretch is divided into Grids for proper compilation and representation of data which would enable to identify a grid for further proposal.

Grid I has the **Highest Population density** and **Households followed** by **Grid E** in the stretch.

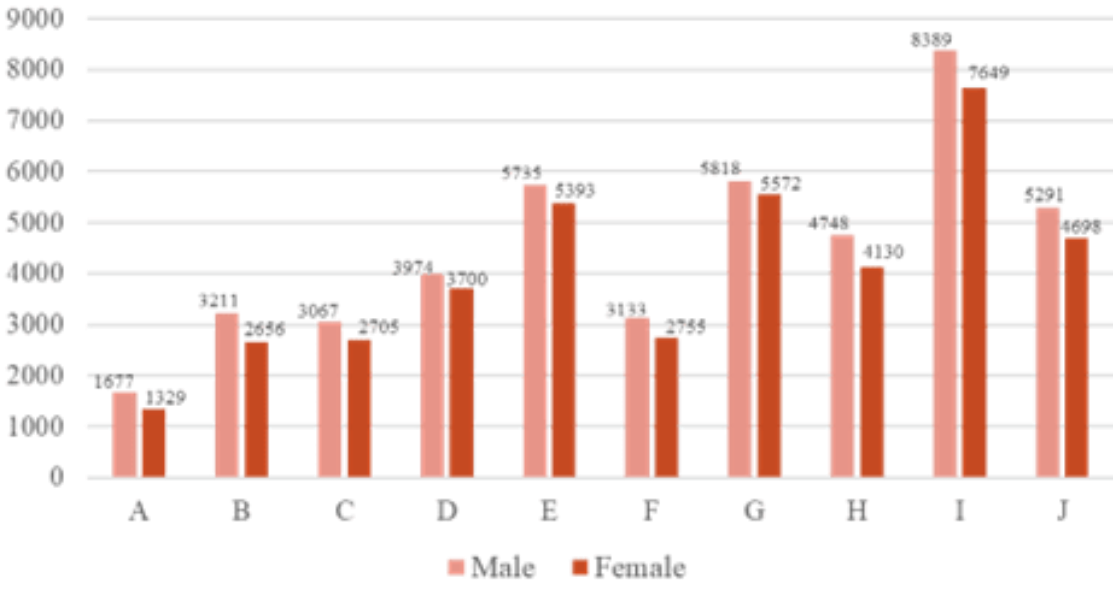

Figure 5: Male and Female Population

Figure 6 represents the population of the stretch and the location of the corridor village. Grid I has the Highest Population of Male and Female in the stretch.

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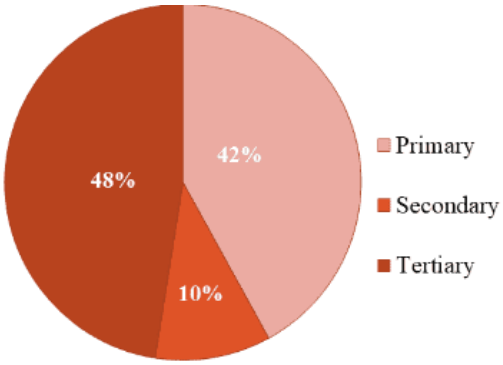

Figure 6: Population Map

Socio-Economic Levels:

Grid I has the **Highest Working Population** in the stretch.

More people are engaged in **Tertiary** activities followed by **Primary** activities.

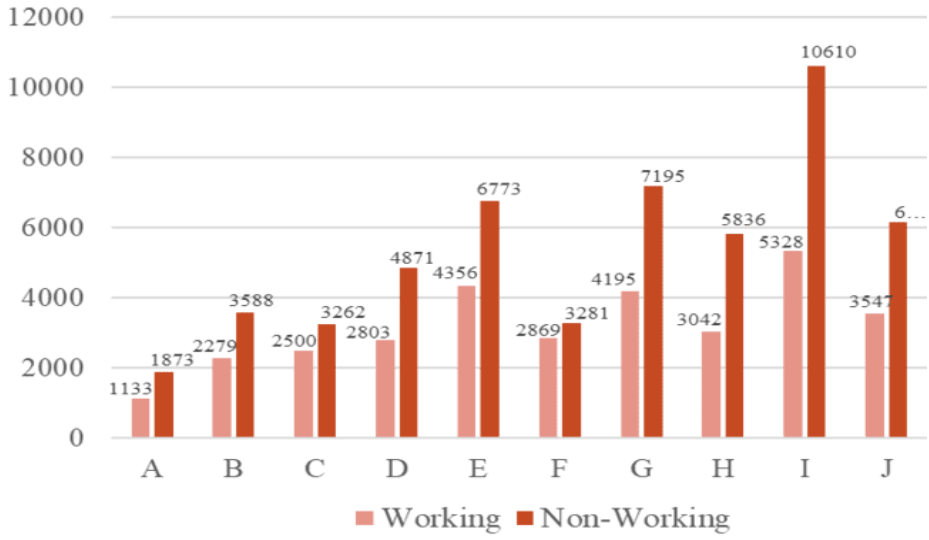

Figure 7: Working and Non-working population

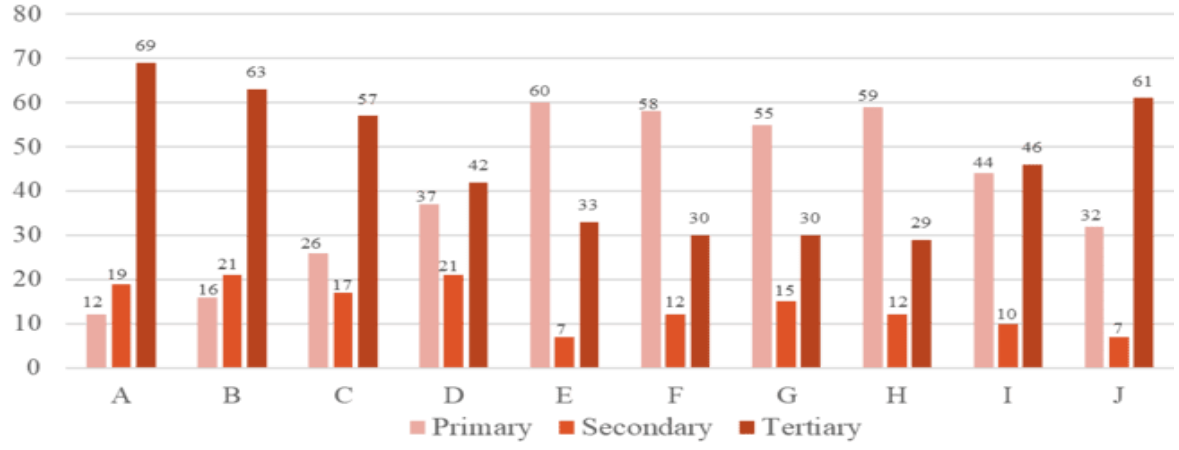

Figure 8: Work force participation rate

Grid A has the **Highest Tertiary activity** Population.

Grid B has the **Highest Secondary activity** Population

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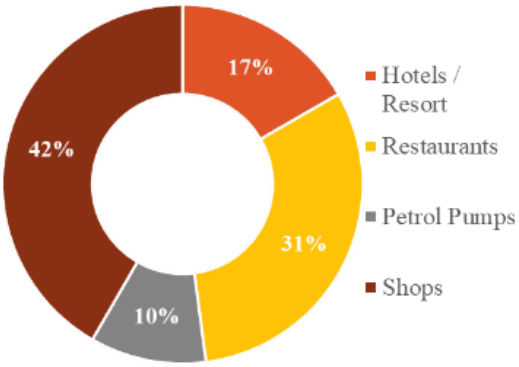

Figure 9: Workforce participation population

Grid E has the **Highest Primary activity** Population.

Maximum **Road-side shops** are found along the corridor which are open till **8pm** at night as the owners are staying near the shop.

Road-side shops include small food stalls, Dhaba, packaged food and drink shops, car and bike repair shop, small stationary shop, small grocery shop, fast food shops, etc.

Infrastructure Levels:

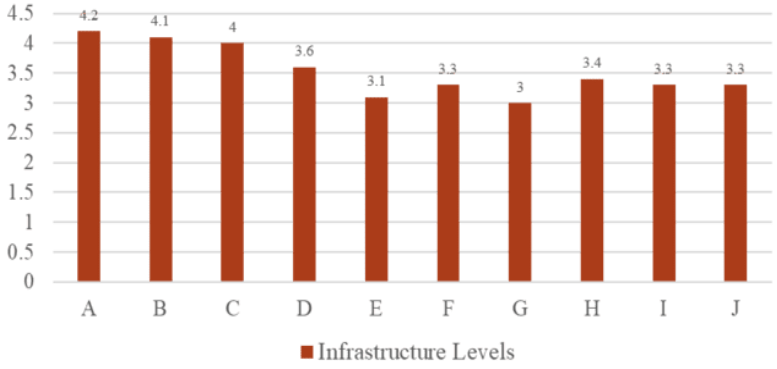

Figure 10: Infrastructure Levels

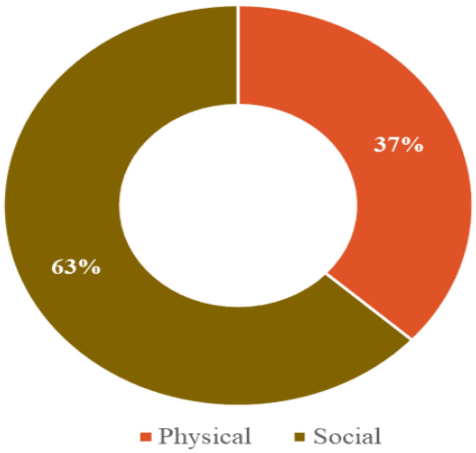

Figure 11: Physical and Social Infrastructure

Grid G has the **Lowest Levels of Infrastructure** in the stretch.

Grid A has the **Highest Levels of Infrastructure** in the stretch.

Social Infrastructure is more evident in comparison to Physical Infrastructures in the stretch.

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Sanitation facilities like drainage, sewage and Solid waste management system are required more. Power outage issues are found in the settlements along the corridor. Grid Station is located in Mangalapur (Grid F).

Maximum number of Primary schools are present along the corridor.

Maximum number of Private and government Hospitals are present along the corridor.

Maximum number of Post offices are present along the corridor.

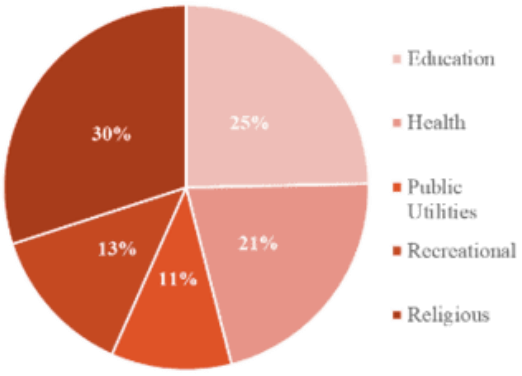

Figure 12: Social Infrastructure

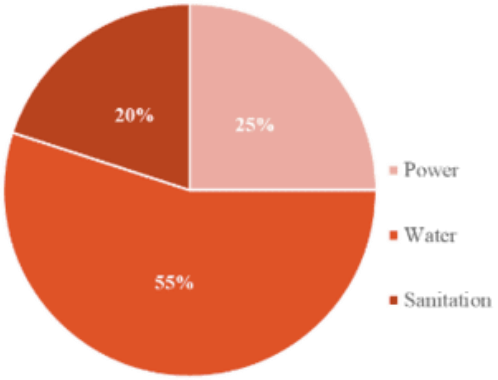

Figure 13: Physical Infrastructure

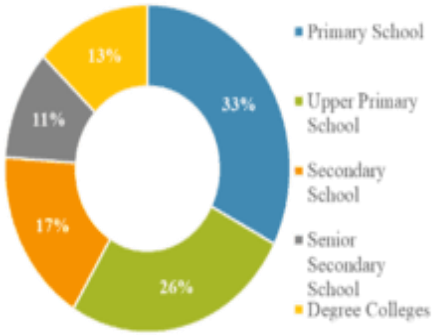

Figure 14: Educational Activities

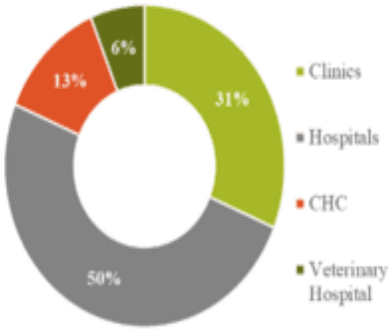

Figure 15: Health Activities

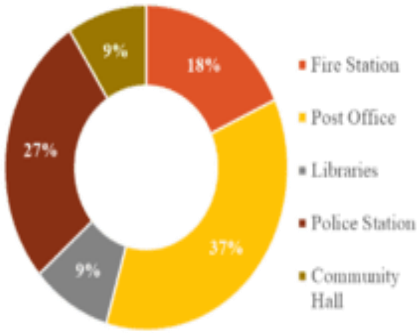

Figure 16: Public Utilities

Figure 18 represents the Land use of the corridor which has been digitized and generated through Arc GIS software. The land use helps to identify the characteristics of the corridor and further helps to recommend specific compatible land use activities to be integrated together or to segregate in order to achieve the best utilization of land.

Figure 19 represents Settlement pattern and structure of the corridor which has been generated through kernel point density estimation (KDE) using GIS tool. KDE is an application of the kernel smoothing for probability density estimation or calculation, which derives to be a non-parametric method to estimate the probability density function of a random variable based on kernels as weights. It is a fundamental data smoothing problem where the inferences about the population are made, based on a finite data sample which is integrated through the satellite imagery.

Figure 19 highlights that **Grid E** and **I** has **high number of settlements** along the stretch.

Figure 20 represents the land cover changes which is derived through LANDSAT 8 satellite imagery in GIS. This would help to identify the areas that has grown significantly in since years and the significant change in land use type.

Figure 20 highlights the Major increase in Built-up and reduction of vegetation from 2011 to 2021 along NH 316 in between Bhubaneswar to Puri.

Built-up includes residential, commercial, industrial, public and semi-public; institutes, offices, etc. Due to the availability NH 316, the growth population along the corridor has triggered. People commute for work which is either at Puri or Bhubaneswar. Thus, the rise in built-up.

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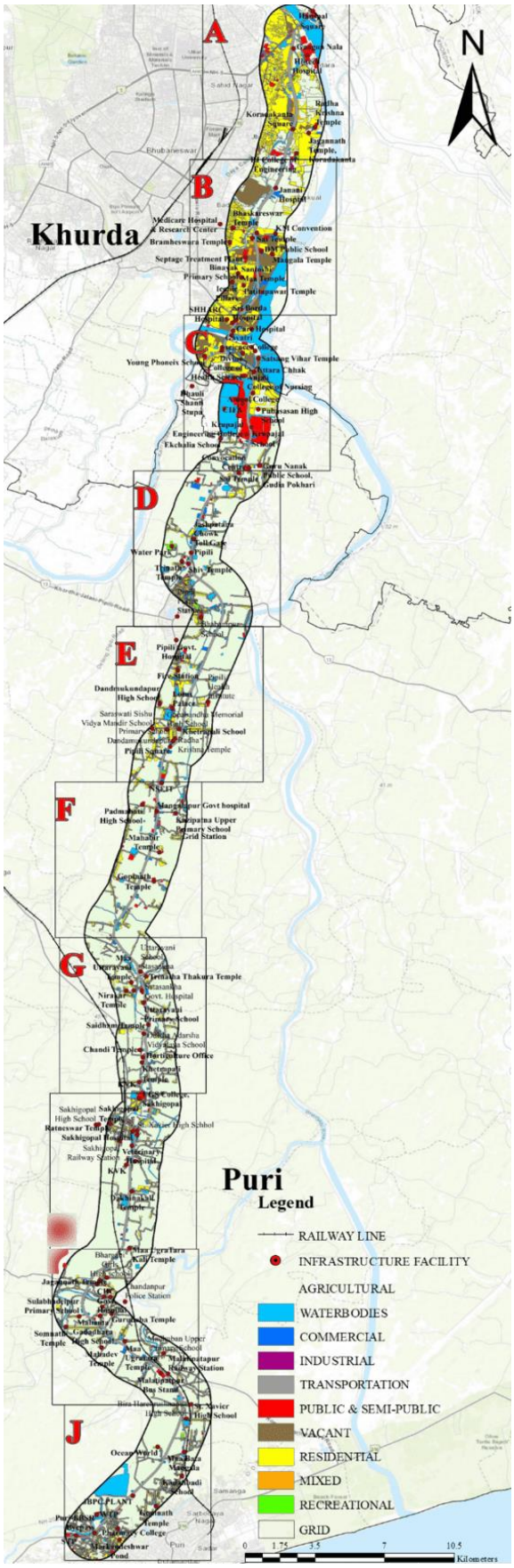

Figure 17: Land use Map

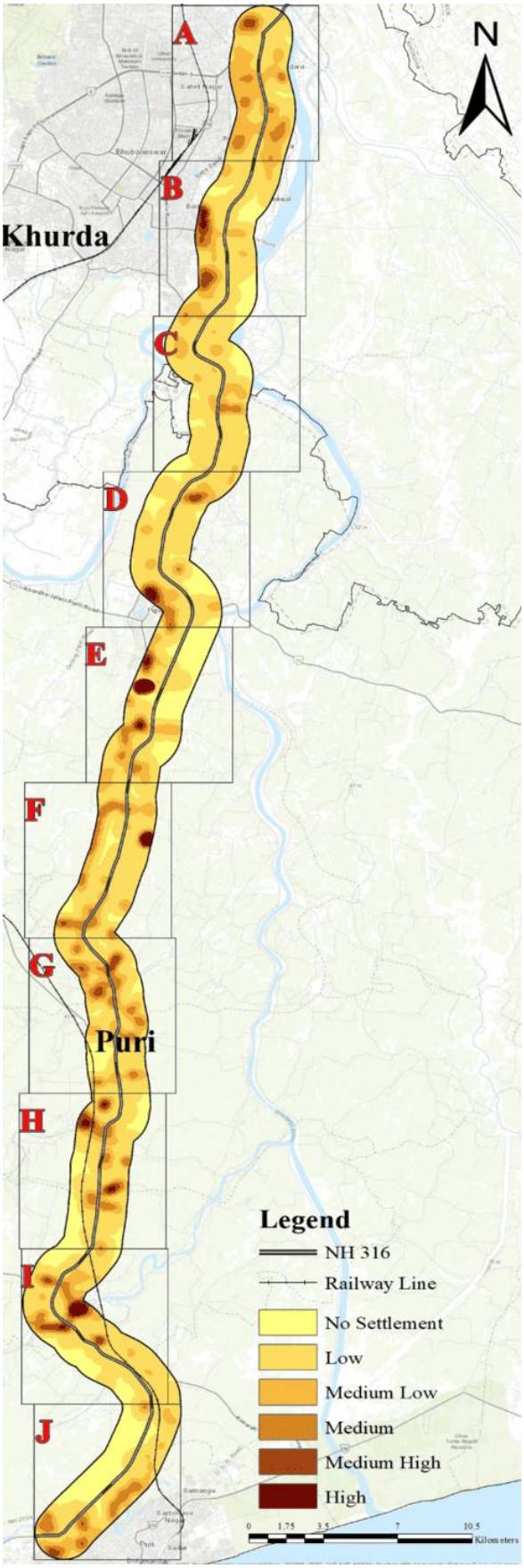

Figure 18: Settlement structure through kernel Density

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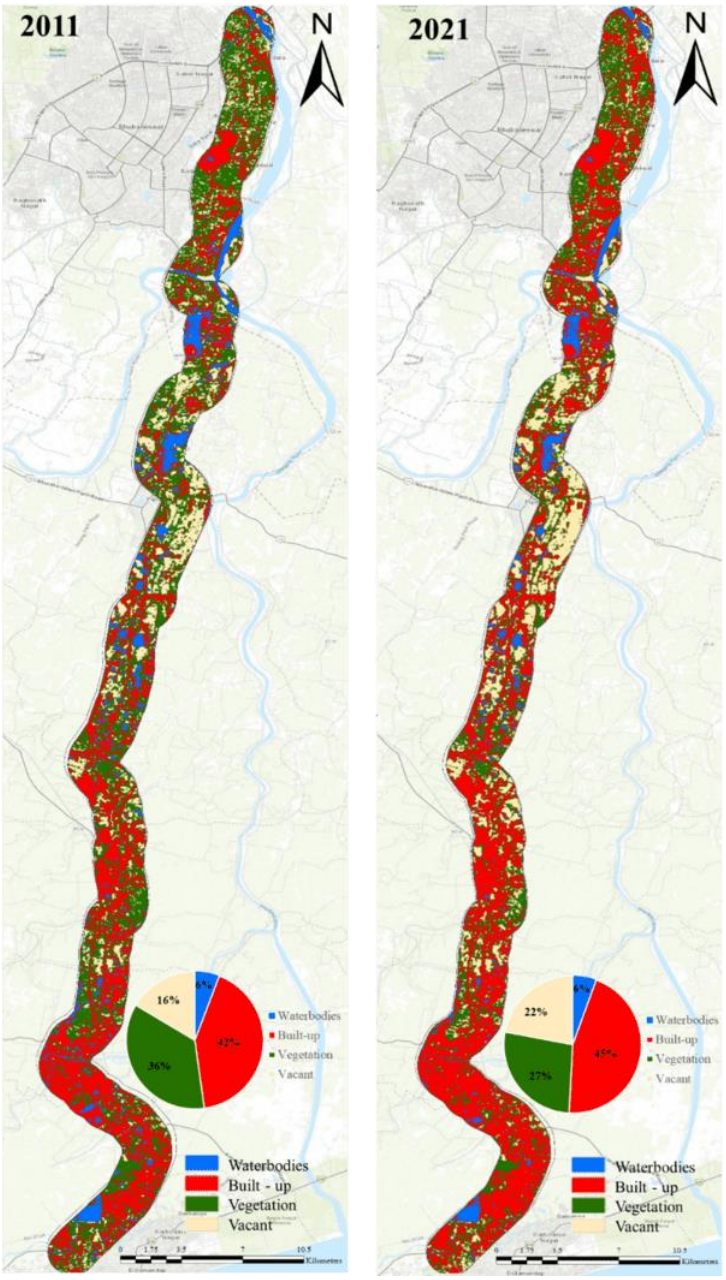

Figure 19: Land cover Change

V. RESULTS

After analyzing the levels of demography, socio-economic and infrastructure a level of development an index is generated which is shown in Table 1.

Development Index can be defined as the average mean of Demography, socio-economic and infrastructure services available in the corridor.

Grid F illustrates Lowest Levels of Development in the stretch.

Grid A and B has the Highest Levels of Development as they are a part of BMC.

Grid I and E are the transition zones where development in terms of infrastructure is required.

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Table 1: Levels of Development Index

GRID	Demography	Socio-Economic	Infrastructure	Levels of Development
A	2.3	2.1	4.2	4.3
B	3.2	2.7	4.1	4.3
C	2.8	2.9	4	3.8
D	3.5	3.3	3.6	3.6
E	4.4	4.2	3.1	3.8
F	2.6	3.1	3.3	3.2
G	4.1	4.3	3.1	3.6
H	4	3.9	3.4	3.6
I	4.9	4.8	3.2	4
J	3.8	4	3.3	3.9

VI. RECOMMENDATIONS

Both Grid I and E are to be developed through integration of Transit Oriented Development (TOD). TOD is an effective way to integrate land use and transport in pursuit to develop planned sustainable urban growth centers with high density mixed land-use with the goal of sustainable development. The main aim is infrastructure upliftment and developing an eco-tourism corridor ensuring socio economic growth.

Vision of Transit Oriented Development Integration:

1. **Enable Transformation**: To assist in transformation of transition areas with public transport oriented development.
2. **Compact Walkable Communities**: To create liveable and affordable communities, which are compact, walkable and accessible to the NH.
3. **Accessible Public Transport**: To promote the usage of public transport by making it accessible, to near by settlements and encourage green mobility.
4. **Mixed Land use:** To provide basic needs of work / job, shopping, public amenities, entertainment, recreational, open spaces required for a good quality of life in the corridor area with mixed land use
5. **Infrastructure upliftment**: To develop social and technical infrastructure & mitigating the infrastructural demand of the corridor area which would help in improving the quality of life of residents.

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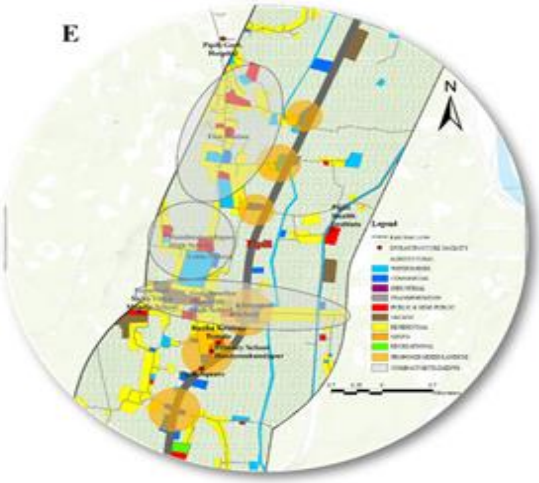

Figure 20: Grid E proposed Land use Map

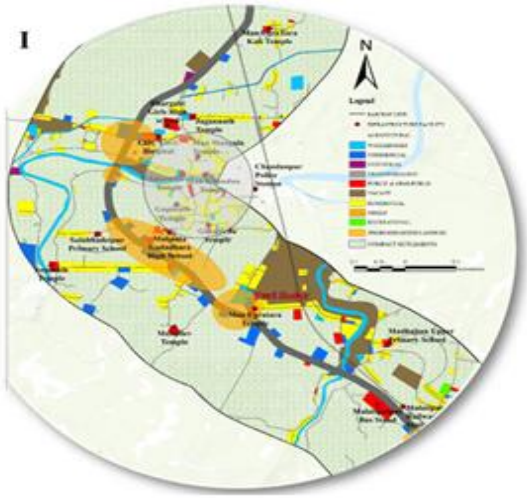

Figure 21: Grid I proposed Land use Map

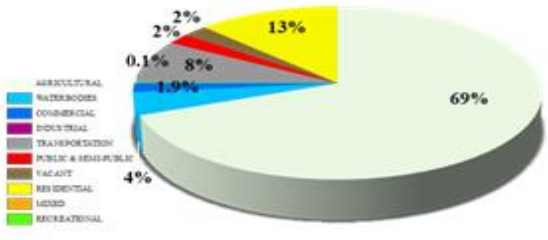

Figure 22: Land use percentage of Grid E

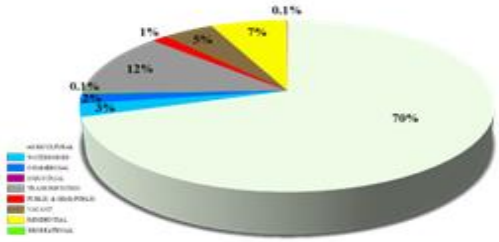

Figure 23: Land use percentage Grid I

Mixed land use is proposed in the intersections or junctions of the roads (NH with Arterial, Sub- Arterial and inner local roads) and transit stations are to be located in the compact settlement locations. Redevelopment of the inner local road is the first priority. The existing road condition of the local roads is the major reason of for the past Malatipatapur TOD failure. The development and maintenance of the local roads would enable smooth transit of the inhabitants in the corridor which would lead to more economic generation activities and hence successful TOD integration in the transition areas.

Table 2: TOD criteria with applicability in Grid I and E

SL No.	CRITERIA	APPLICABILITY	
		GRID I	GRID E
1	 Population Density	• Population Density of 1081.48/sqkm. • Highest populated village is Chandanpur.	• Population Density of 880.36/sqkm. • Highest populated village is Dandamukundapur.
2	Mixed Land use 	• Propose Diverse functions of land along NH & near major settlements to ensure accessibility. • Increase in employment opportunities.	• Propose Mixed Landuse pattern in the road junctions & in major settlements. • Would lead to reduction in Transport Cost (Time & Operation Cost).

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3	Walk / Cycle 	• Widening and maintenance of the roads connecting the settlements to the NH so as to promote walk / cycle.	• To develop inclusive habitat so that people dependent on public transport can walk / cycle to transit stops of NH.
4	Economic Development 	• Major work force is engaged in Tertiary activities. • Attract external audience for transit and boost the Cultural economies. • Greater participation of women and senior citizens in workforce.	• Major work force is engaged in Primary activities. • Localization of business would ensure lower Local price and wider choice. • Would lead to creation of jobs in non-agricultural sectors of the economy.
5	Mass Transit System 	• Malatipatapur Bus Stand with Bus transit stops and Malatipatapur Railway Station are the major transit stations of the section.	• Bus transit stops along the NH are the major transit stations. • High density zones would increase the share of transit of public transport.
6	 User-Friendly	• To meet the daily needs use of Public transport or by cycling / walking result in reduction in pollution & congestion.	• To ensure development with special attention to safety of women, children, senior citizen and differently abled by creation of basic infrastructures.
7	Accessibility 	• Existing local roads within the corridor needs to be redeveloped & maintained. • To establish a dense road network ensuring safe & easy movement along with connectivity of NMTs.	• To promote liveable and affordable communities, which are compact, walkable and accessible. • To ensure development with special attention accessibility for senior citizen and differently abled.

Implementing Strategies and Recommendations:

Strengthening cooperation of municipalities in corridor scale by creating shared goals & benefits based on common vision & identity as the stretch lies in between two districts.

Development of tourism & tertiary activities along the stretch to view the corridor with cultural & heritage importance.

Development of economy by incorporating mixed land use functions near dense commercial influence zones which would lead to create in additional job opportunities and reduction of transit costs.

Development in corridor areas should be in clusters of mini cities and must be planned at appropriate distances to create a semi-contiguous chain of settlements.

Creation of more Healthcare centers along the Highway to mitigate the accidents.

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Encouraging participation of women in workforce as integration of TOD would reduce the need for travel and would help in bringing economical benefits.

Prevention of urban sprawl in the buffer region by accommodating the growing population in a compact area with access to the transit corridor, which would also consolidate investments and bring down the infrastructure cost for development.

VII. CONCLUSION

This research has derived the outcome that integration of TOD would help in more economic generation and high standard of living the transition areas. It demonstrates that there is a degree of correlation between the land use and transportation. The study therefore provides the detail assessment of the growth drivers to delineate the index of the existing facilities with the pattern of settlements. Inclusion of TOD along with the redevelopment of the local roads would lead to be a success.

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