

Integrated Ring Road Design for Coimbatore Using GIS Based Traffic Flow Analysis and Smart Infrastructure Planning

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Abstract-Coimbatore, one of the fastest-growing urban and industrial centres in Tamil Nadu, has been experiencing rapid expansion in population, economic activities, and vehicle ownership. This rapid growth has significantly increased travel demand and placed heavy pressure on the city's road infrastructure. As congestion continues to rise, the need for a well-planned and integrated ring road system has become essential to support smooth traffic movement and sustainable urban development. Currently, Coimbatore faces severe traffic congestion due to rapid urbanization and industrial growth. The absence of a continuous and functional ring road forces regional and freight traffic to pass through the city core, leading to overcrowded roads and inefficient circulation. This results in longer travel times, increased fuel consumption, higher pollution levels, and greater accident risks. In addition, existing road development strategies are often uncoordinated and lack integration of spatial traffic data and land-use patterns. The present infrastructure has not kept pace with urban expansion, making it inadequate to handle growing mobility demands. To address these challenges, this study proposes an integrated ring road design using GIS-based traffic flow analysis and smart infrastructure planning. The methodology incorporates multiple spatial and analytical components. Land Use Land Cover (LULC) analysis is carried out using satellite imagery to understand the distribution of built-up areas, vegetation, water bodies, and barren land, which helps in identifying suitable and restricted zones for road alignment. Traffic volume data is collected and analysed to identify congestion hotspots and major traffic corridors, ensuring that the proposed ring road effectively diverts heavy and through traffic.

In addition, thematic layers such as slope and elevation are generated using Digital Elevation Models (DEM) to assess terrain suitability and minimize construction challenges and costs. Drainage analysis is also performed to understand natural flow patterns and avoid waterlogging or disruption of existing drainage networks. These layers are integrated in a GIS environment using overlay and network analysis techniques to determine the most efficient and sustainable alignment for the ring road. The approach ensures that environmental, topographical, and traffic-related factors are all considered together. The results indicate that the proposed ring road alignment can significantly reduce traffic congestion within the city by diverting non-local traffic away from the core areas. It improves connectivity between major highways, industrial zones, and residential areas while minimizing environmental impact. The integration of LULC, traffic volume, terrain, and drainage data ensures a balanced and practical design. Overall, the study demonstrates that GIS-based planning combined with smart infrastructure strategies can provide an effective and sustainable solution for urban transportation challenges in Coimbatore.

Key words:

Keywords: GIS, Ring Road Planning, Traffic Flow Analysis, Urban Transportation Planning, Coimbatore.

1. Introduction

Urban transportation systems are under increasing pressure as cities expand rapidly. Coimbatore, one of the fastest-growing industrial and commercial centers in South India, has experienced a sharp rise in population, vehicle ownership, and freight movement over the past decade. This growth has significantly increased traffic volume on major arterial roads, leading to frequent congestion, longer travel times, and higher fuel consumption. A major challenge is that regional and through traffic—including heavy vehicles—are forced to pass through the city core, placing additional stress on already saturated road networks.

To address such challenges, the development of a well-planned ring road becomes essential. A ring road functions as a bypass corridor that diverts non-destination traffic away from the city center, thereby reducing congestion, improving travel efficiency, and enhancing road safety. It also supports balanced urban growth by encouraging development along the periphery and reducing pressure on central urban areas. For a rapidly expanding city like Coimbatore, the absence of a fully functional and integrated ring road system has become a critical infrastructure gap that needs immediate attention.

Several Indian cities have successfully implemented ring road systems to manage traffic and guide urban expansion. For example, Bengaluru developed the Outer Ring Road to reduce congestion in the central business district and improve connectivity between IT corridors. Similarly, New Delhi has an extensive ring road and outer ring road network that plays a crucial role in managing high traffic volumes and facilitating inter-city movement. In Pune, the proposed ring road project aims to decongest urban roads and support planned suburban development. These examples highlight how ring roads can significantly improve urban mobility and regional connectivity when planned effectively.

In this context, Geographic Information Systems (GIS) and remote sensing technologies play a vital role in modern infrastructure planning. GIS enables the integration and analysis of multiple spatial datasets such as land use/land cover (LULC), traffic density, elevation, slope, and drainage patterns. Remote sensing provides up-to-date satellite imagery that helps in understanding urban expansion and environmental constraints. Together, these tools support data-driven decision-making, allowing planners to identify the most suitable alignment for a ring road while minimizing environmental impact and construction costs.

Objectives of the Study

1. To analyse traffic flow patterns and spatial characteristics of the Coimbatore region using GIS and remote sensing techniques for identifying the need and alignment of a ring road.
2. To design an integrated and efficient ring road corridor incorporating smart infrastructure planning for improved traffic management, connectivity, and sustainable urban development.

2. Study Area

Coimbatore is located in the western part of Tamil Nadu, India, and is one of the major industrial and commercial centers in South India [2]. The city lies near the foothills of the Western Ghats and is situated along important transportation corridors that connect Tamil Nadu with neighbouring states such as Kerala and Karnataka [6]. Coimbatore has experienced rapid urban growth over the past two decades due to the expansion of textile industries, manufacturing units, educational institutions, and information technology sectors. This growth has led to a significant increase in population, vehicle ownership, and daily commuting activities, resulting in heavy pressure on the existing road infrastructure [30][38]. The city is strategically connected by several major highways, including Avinashi Road, Mettupalayam Road, Sathyamangalam Road, Pollachi Road, Palakkad Road, and Trichy Road. These roads not only carry local traffic but also serve as important regional corridors [13] for passenger and freight movement. As a result, a large volume of

through traffic passes through the urban core, causing congestion, longer travel times, and increased environmental pollution.

The absence of a well-developed ring road system has further intensified these issues, making it difficult to efficiently manage traffic flow around the city. [30]The study area includes the urban and peri-urban regions of Coimbatore where rapid land use changes and infrastructure expansion are taking place[20]. The terrain of the region consists of relatively flat areas with gentle slopes, which are suitable for transportation infrastructure development. However, careful analysis is required to avoid environmentally sensitive areas and densely built-up zones[4]. In this context, Geographic Information System (GIS) and Remote Sensing techniques play a crucial role in analysing spatial parameters such as land use and land cover, elevation, slope, road network distribution, and traffic congestion patterns. These datasets help in identifying suitable corridors for ring road development and support data-driven planning for improving urban mobility and regional connectivity in Coimbatore.

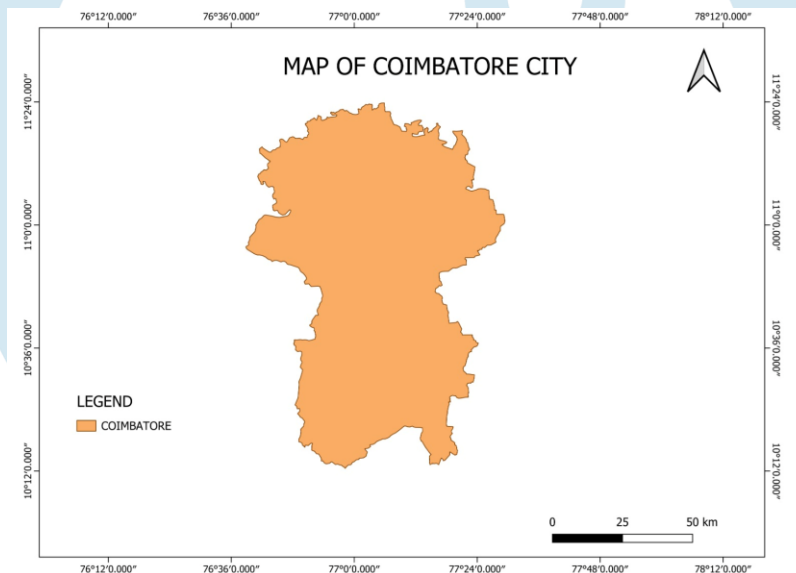


Fig 1. Map of Coimbatore city

3. Data Sources

Table:1 List of Data sources used

Data	Source	Purpose
SRTM DEM	USGS	Elevation and slope analysis
Satellite imagery	Sentinel-2	Land Use/Land Cover classification
Road network	OpenStreetMap /government sources	Corridor mapping
Traffic survey data	Field videographic survey	Vehicle count and demand analysis
Congestion points	Field observation	Traffic congestion mapping

4. Methodology

4.1. Land Use Land Cover (LULC) Analysis

Land Use Land Cover analysis was conducted to examine the spatial distribution of different land cover categories within the Coimbatore region and to evaluate the suitability of different land areas for the development of a ring road corridor [4]. Satellite remote sensing data provides an effective way to analyse land cover patterns over large geographic areas. For this study, Sentinel-2 satellite imagery was obtained from the Copernicus Open Access Hub [1].

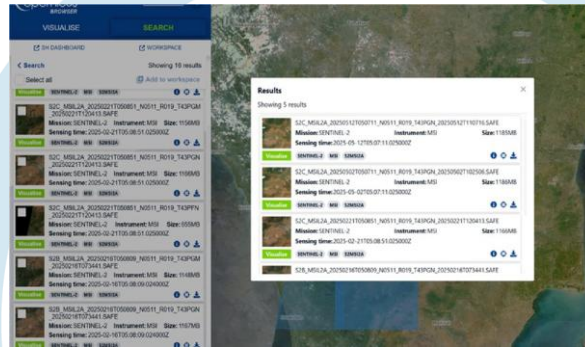


Fig 2. Sentinel-2 satellite image of Coimbatore city

The preprocessing stage involved several steps to prepare the satellite imagery for classification. First, the relevant spectral bands from the Sentinel-2 imagery [5] were selected and combined through a band stacking process. The stacked imagery was then clipped to the boundary of the study area to ensure that only the required geographic extent was analysed. To enhance the visual differentiation of various land cover types, a False Colour Composite image was generated, which allows vegetation, water bodies, and built-up areas to be distinguished more clearly based on their spectral signatures. Supervised classification was then carried out using the Maximum Likelihood Classification algorithm. In this approach, representative training samples were selected for each land cover category [5] based on their spectral characteristics within the satellite imagery. The classifier uses statistical probability to assign each pixel to the most likely land cover class. Based on spectral behaviour and visual interpretation, the study area was classified into four major land cover categories: built-up areas, vegetation, barren land, and water bodies [4][20].

To evaluate the reliability of the classification results, an accuracy assessment was conducted using reference data obtained from high-resolution satellite imagery. A confusion matrix was generated using the Semi-Automatic Classification Plugin in QGIS software [5]. The confusion matrix compares classified pixels with reference data and calculates several statistical measures including overall accuracy, user's accuracy, producer's accuracy, and the Kappa coefficient. These metrics provide a quantitative assessment of the classification performance and indicate how accurately the satellite imagery has been classified into the defined land cover categories.

4.2. Videographic Survey

A videographic survey was conducted to collect primary traffic data and identify high-demand transportation corridors within Coimbatore [12][37]. Survey locations were selected based on public survey responses and preliminary traffic demand analysis. Major arterial roads including Sathy Road, Avinashi Road, Mettupalayam Road, Trichy Road, and Pollachi Road were identified as key corridors for traffic assessment.

Video recordings were captured at selected locations during peak traffic hours to document traffic movement and vehicle composition [13]. The recorded footage was subsequently analysed through manual counting methods to determine traffic volume and vehicle classification.

Vehicles were categorized into three groups:

- Heavy vehicles
- Medium vehicles
- Small vehicles

The traffic counts obtained from the videographic survey were tabulated and analysed to determine the total traffic volume for each corridor [12]. The results were visualized using bar charts to compare traffic intensity across different roads. Corridors with higher traffic volumes were identified as high-demand corridors, and congestion points were geo-referenced and mapped within the GIS environment. The videographic survey data was integrated with other thematic layers such as elevation, slope, and LULC to create a comprehensive spatial database. This integrated dataset supports multi-criteria spatial analysis for identifying an optimal ring road alignment that can effectively divert through-traffic and reduce congestion in the urban core. [5][24]

4.3 Elevation Analysis

Elevation analysis was conducted to understand the terrain characteristics of the study area and to evaluate the feasibility of potential ring road alignments. Digital Elevation Model (DEM)[7] data derived from the Shuttle Radar Topography Mission (SRTM) was obtained from the United States Geological Survey (USGS). The DEM dataset [1] was imported into the GIS environment and reprojected into the appropriate projected coordinate reference system to maintain spatial consistency across all datasets [28].

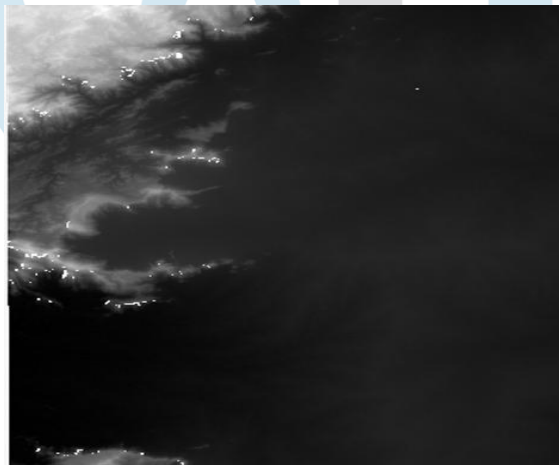


Fig 3. DEM with no data pixels

During the preprocessing stage, the DEM was examined for missing values, and approximately 790 No Data pixels were identified within the study area. These missing values were filled using the Inverse Distance Weighting (IDW) interpolation technique [28] with a power parameter of 2, which assigns greater influence on nearby elevation values within the interpolation radius.

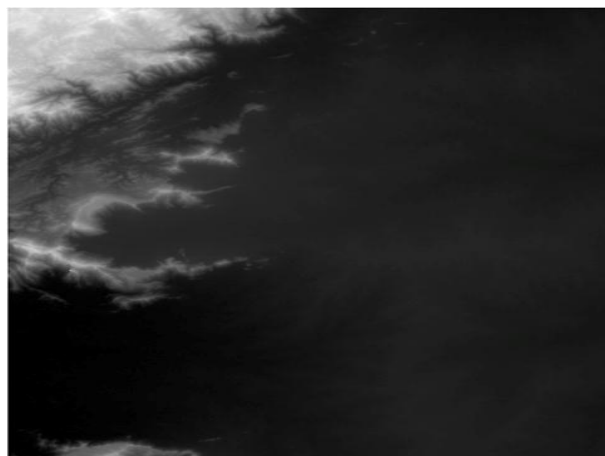


Fig 4. DEM Data with filled pixels.

To further improve the quality of the terrain surface, iterative low-pass smoothing was applied to remove minor interpolation artifacts and irregularities. The resulting DEM provided a continuous and consistent elevation surface that accurately represents the terrain of Coimbatore. This elevation dataset was subsequently used for terrain assessment, slope derivation, and route feasibility analysis for the proposed integrated ring road alignment.

4.4 Slope Analysis

Slope analysis was performed to evaluate the gradient variations within the study area and to identify terrain conditions suitable for road construction [7][16]. The slope layer was generated from the corrected DEM using terrain analysis tools [1] available in Geographic Information System (GIS) software. The slope values represent the rate of elevation change across the terrain and were calculated in degrees. Areas with lower slope values are considered more suitable for road construction due to reduced earthwork requirements, improved safety, and lower construction costs. In contrast, areas with steep slopes may require extensive cutting, filling, or additional engineering structures, making them less suitable for road alignment. The derived slope map was further reclassified into suitability classes representing different levels of terrain feasibility. Gentle slopes were categorized as highly suitable, while moderate and steep slopes were classified as moderately suitable or unsuitable for infrastructure [3][7] development. The slope layer was then standardized with other thematic datasets such as LULC and elevation to facilitate spatial overlay analysis for route optimization.

4.5 Drainage Network Analysis

Drainage network analysis was carried out to understand the hydrological characteristics of the study area and to identify natural flow pathways that influence the planning of the proposed Outer Ring Road. The analysis was performed in QGIS using the SAGA GIS toolbox with Digital Elevation Model (DEM) data as the primary input. Initially, the DEM was pre-processed to ensure hydrological accuracy by removing surface depressions that could interrupt continuous flow. This was achieved using the Fill Sinks tool based on the Wang & Liu method available in the SAGA toolbox. This method effectively eliminates spurious sinks while preserving the natural terrain structure, thereby enabling reliable flow direction and flow accumulation modelling. Following the sink-filling process, terrain-based hydrological analysis was performed to derive flow paths and extract the drainage network.

The resulting drainage channels were then classified using the Strahler stream ordering method, which assigns hierarchical order to streams based on their branching pattern. First-order streams represent the smallest tributaries, while higher-order streams represent larger and more significant drainage channels formed through the confluence of smaller streams. To improve the clarity and relevance of the drainage network for infrastructure planning, stream orders were filtered and only hydrologically significant channels were retained. Lower-order streams were selectively removed to reduce noise and over-density in the network representation, while higher-order streams were preserved as primary drainage pathways. This refinement ensured that the final drainage map clearly represents the dominant hydrological structure of the study area. The extracted and classified drainage network was then visualized in QGIS and used as a constraint layer in the suitability analysis and alignment planning of the proposed Outer Ring Road.

4.6 Suitability Analysis

Suitability analysis was carried out to identify spatially favorable zones for the proposed Outer Ring Road in Coimbatore using a multi-criteria evaluation approach within a Geographic Information System environment. The analysis was performed in QGIS using raster-based weighted overlay techniques. The thematic layers considered for the analysis included slope, Land Use Land Cover (LULC), and elevation, which represent the primary physical and land-use constraints affecting transportation corridor development. All input datasets were converted into raster format and standardized to a common coordinate system, spatial resolution, and geographic extent to ensure consistency in analysis.

Each thematic layer was reclassified into suitability classes based on its influence on road alignment feasibility. Gentle slopes, open and barren lands, and moderately elevated terrain were assigned higher suitability values, whereas steep slopes, dense built-up areas, and unfavorable terrain conditions were assigned lower suitability values. A weighted overlay analysis was performed by assigning relative importance to each factor. The weights were derived through normalization of initial factor values, ensuring proportional contribution of each parameter. The normalized weights used in the analysis were:

$$\text{Slope} = 0.623$$

$$\text{LULC} = 0.262$$

$$\text{Elevation} = 0.115$$

These values indicate that slope is the dominant factor influencing suitability, followed by land-use characteristics and elevation. The final suitability index was computed using the Raster Calculator in QGIS based on the following weighted linear combination:

$$S = (0.623 \times \text{reclassifiedSlope}) + (0.262 \times \text{reclassifiedLULC}) + (0.115 \times \text{reclassifiedElevation})$$

The resulting raster output was classified into three categories: Suitable, Moderately Suitable, and Not Suitable, and visualized to generate the final suitability map for the study area.

4.6 Outer Ring Road Alignment Analysis

The Outer Ring Road alignment was developed and analyzed to evaluate spatial connectivity and integration with the existing road network around Coimbatore. The analysis was carried out using QGIS with the support of satellite imagery and base road network layers. Based on the results of the suitability analysis and drainage network assessment, a feasible corridor was identified for the proposed alignment. A new vector layer was created in QGIS, and the alignment was manually digitized using the line tool by tracing the most suitable path around the urban periphery. During digitization, care was taken to ensure that the alignment passes through highly suitable zones while avoiding areas classified as not suitable and major drainage channels. The alignment was also designed to maintain continuity and smooth geometry for efficient transportation movement. The existing L&T Bypass was incorporated into the analysis as a reference layer to evaluate connectivity between the proposed Outer Ring Road and the existing transportation infrastructure. This integration helps in assessing how the proposed corridor complements the current road network.

4.7 Outer Ring Road Alignment and Infrastructure Analysis

The analysis of the proposed Outer Ring Road alignment was carried out to evaluate its spatial configuration and its interaction with existing infrastructure elements such as road networks, railway lines, and drainage crossings. The study was conducted using QGIS by integrating multiple geospatial layers including road networks, railway lines, and field-verified infrastructure points. The alignment of the proposed Outer Ring Road was digitized based on planning inputs and satellite imagery. The existing L&T Bypass Road was also included to understand connectivity with the proposed corridor. Infrastructure features were mapped as point layers. Road intersections were identified where the alignment crosses existing roads. Railway intersections were mapped at locations where the alignment crosses railway lines. Culverts were identified where the alignment intersects minor drainage channels. All features were digitized and quantified using attribute tables in QGIS. The final map was prepared to clearly represent the spatial distribution of these infrastructure elements.

5.Results and Discussion

5.1. Land Use Land Cover (LULC) Analysis Results

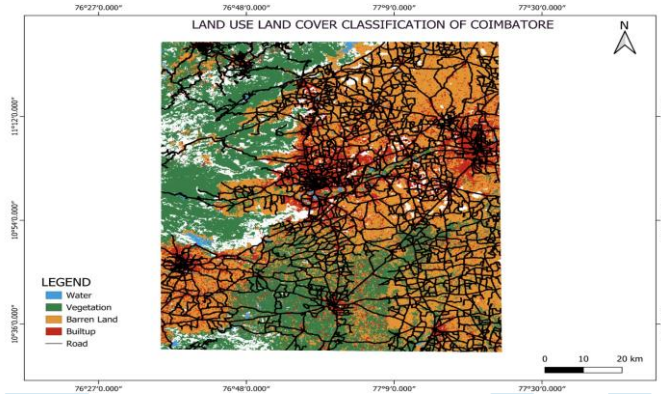


Fig 5. Land Use Land Cover (LULC) Analysis Results.

The supervised classification of Sentinel-2 imagery produced a Land Use Land Cover map of the Coimbatore study area with an overall classification accuracy of 86.74%, indicating reliable representation of land cover categories.

Table 2: Error Matrix

Class Classified \ Reference	Producer's Accuracy(%)		User's Accuracy(%)		Kappa Coefficient	
	Water	Vegetation	Barren Land	Built-up	Total	
Water	77.1		99.73	0.9969		
Vegetation	28815	79	0	0	28894	
Barren Land	91.02		45.93	0.6013		
Built-up	193	8941	1	2	9137	
Water	83.88		95.62	0.8952		
Vegetation	100	49	4974	33	5156	
Barren Land	97.9	43	66.27	0.7809		
Built-up	12	43	235	3090	3380	
Total	29120	9112	5210	3125	46597	

Table 3: Accuracy Matrix

The classified map revealed four primary land cover classes within the study region:

- Built-up areas
- Vegetation
- Barren land
- Water bodies

Table 4: Data derived from the LULC stud based on LULC analysis

Raster Value	Area (km ²)	Percentage (%)
Water	36.516	0.89
Vegetation	783.8794	19.22
Barren land	2083.3529	51.07
Built-up	1175.5128	28.82
Total	4079.262	100

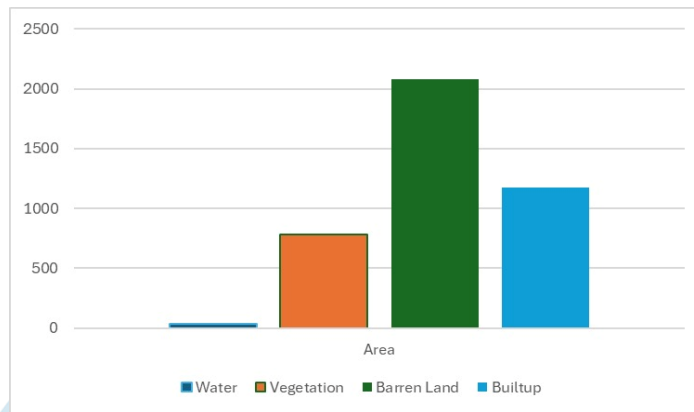


Fig 6. Land cover composition of the study region

Built-up areas were predominantly concentrated within the central urban region of Coimbatore, reflecting high levels of urbanization and infrastructure development. These areas are characterized by dense residential, commercial, and industrial land uses, making them less suitable for major new road corridors due to potential land acquisition challenges.

Vegetation-covered areas were mainly observed in the peripheral zones, particularly in agricultural regions surrounding the city. These regions represent moderate suitability for road development, provided that ecological impacts are carefully considered. Barren land areas were distributed sporadically around the outskirts of the city and were identified as Highly suitable zones for road alignment due to minimal land-use conflicts. Water bodies were limited in spatial extent but were clearly identified and excluded from potential road corridors to prevent environmental disruption. The LULC analysis was therefore instrumental in guiding the proposed ring road alignment by avoiding densely built-up regions while utilizing open or less-developed areas wherever possible.

5.2 Videographic Survey Results

The videographic survey provided valuable primary traffic data for major arterial roads in Coimbatore. Video recordings captured during peak traffic hours were analysed to determine traffic volume and vehicle composition. The results showed that several key corridors experience high traffic intensity, particularly:

- Sathy Road
- Avinashi Road
- Mettupalayam Road
- Trichy Road
- Pollachi Road

Table 5: Traffic volume composition

ROAD	Heavy vehicles	Medium vehicles	Small vehicles
SATHY ROAD	190	2456	3742
AVINASHI ROAD	403	3560	3868
METTUPALAYAM ROAD	153	2048	3549
TRICHY ROAD	221	2167	3329
POLLACHI ROAD	151	1589	1859

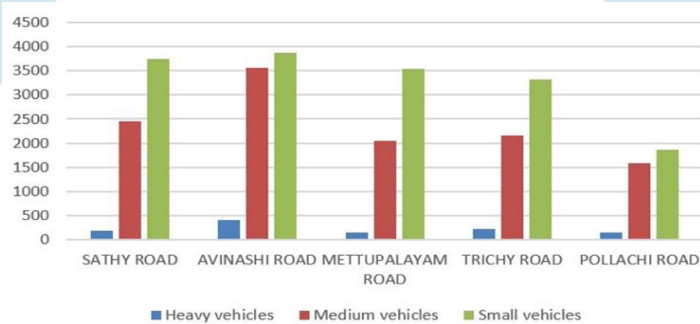


Fig7. Comparative traffic volume analysis of major corridors in Coimbatore

Among these corridors, Avinashi Road and Sathy Road exhibited the highest traffic volumes, with a large proportion of small and medium vehicles, along with a significant presence of heavy vehicles. The traffic composition analysis revealed that small vehicles formed the majority of traffic flow, followed by medium vehicles and a smaller proportion of heavy vehicles. The presence of heavy vehicles in urban corridors contributes significantly to congestion and travel delays. The traffic volume comparison across the surveyed roads indicated that several corridors currently operate under high congestion levels during peak hours. These congestion points were spatially mapped and integrated into the GIS database.

The results highlight the need for an alternative route capable of diverting through-traffic and heavy vehicles away from the urban core. The proposed ring road is expected to address this issue by redistributing traffic flows and reducing congestion on existing arterial roads.

5.3. Elevation Analysis Results

Elevation analysis was carried out to understand the terrain characteristics of the Coimbatore region and to evaluate the feasibility of different corridors for the proposed integrated ring road. Digital Elevation Model (DEM) data derived from the Shuttle Radar Topography Mission (SRTM) was obtained from the United States Geological Survey (USGS). The DEM dataset provides elevation information in raster format and serves as a fundamental dataset for terrain-based spatial analysis. The acquired DEM data was first imported into the Geographic Information System (GIS) environment and reprojected into an appropriate projected coordinate reference system to maintain spatial consistency with other datasets used in the study.

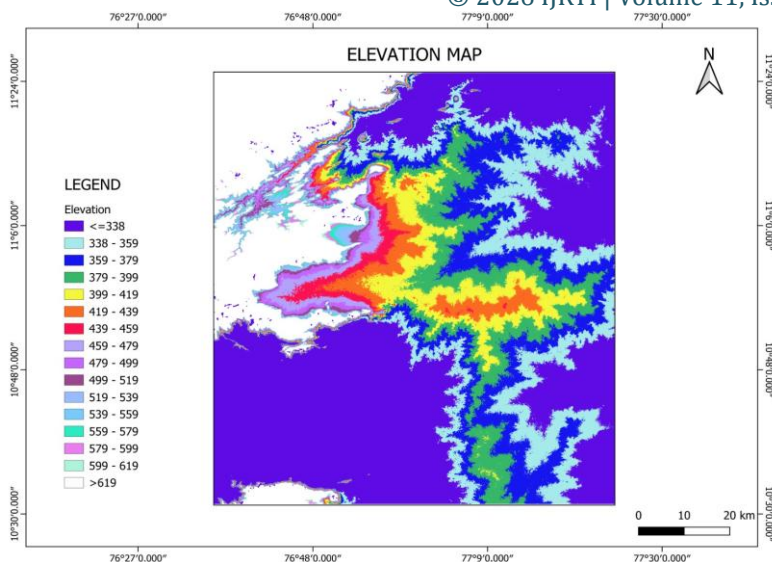


Fig 8. Elevation Map

During the preprocessing stage, the DEM was examined to identify missing elevation values represented as NoData pixels. These missing values can affect terrain calculations and therefore needed to be corrected before further analysis. The No Data cells were filled using the Inverse Distance Weighting (IDW) interpolation technique. This interpolation method estimates unknown elevation values by considering nearby elevation points and assigning greater weight to values located closer to the unknown pixel. A power parameter was applied in the interpolation process to ensure that closer elevation values had stronger influence on the estimated values.

Following interpolation, the DEM surface was further refined using smoothing techniques to eliminate minor irregularities and artifacts introduced during the interpolation process. Iterative filtering was applied to improve the continuity of the elevation surface and produce a more realistic terrain representation. The final processed DEM provided a continuous elevation surface of the study area and served as the base dataset for slope derivation and terrain suitability analysis required for transportation planning.

5.4. Slope Analysis Results

The slope map derived from the DEM provided insight into terrain gradients across the study area. The slope values were classified into different categories representing varying levels of suitability for road infrastructure development. The analysis revealed that a large proportion of the study area consists of gentle slopes, which are highly suitable for road construction due to minimal grading requirements and improved road safety conditions. These areas provide favourable terrain for designing long transportation corridors such as ring roads.

Moderate slopes were observed in certain peripheral regions of the city. While these areas remain technically feasible for infrastructure development, they may require limited earthwork or slope stabilization measures. Steep slope regions were comparatively limited and mostly located toward the outer boundary of the study area. These areas were identified as less suitable for road alignment due to increased construction complexity and potential environmental disturbances. The slope analysis therefore played a critical role in eliminating unsuitable terrain and identifying corridors with Optimal gradient conditions for ring road development.

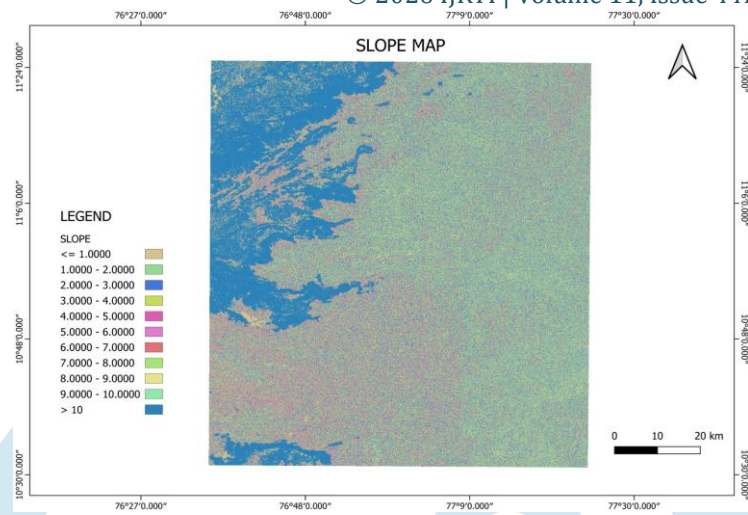


Fig 9. Slope Map

5.5. Drainage Network Analysis

The extracted drainage network map reveals a well-developed and spatially distributed system of natural flow channels across the study area. The drainage pattern consists of numerous interconnected stream segments, with a clear hierarchy defined by the Strahler stream ordering method. The analysis indicates that lower-order streams are widely distributed throughout the study area, forming a dense network of minor tributaries. In contrast, higher-order streams are fewer in number but represent major drainage pathways that carry significant surface runoff. These higher-order channels are critical hydrological features and act as primary constraints in infrastructure planning. The application of stream order filtering resulted in a refined drainage network that emphasizes the most hydrologically significant channels. This approach improved the interpretability of the map by reducing excessive detail from minor tributaries while retaining major flow paths relevant for planning purposes. The spatial distribution of the drainage network suggests variations in terrain and slope conditions across the study area. Regions with higher drainage density indicate areas of increased surface runoff and potential susceptibility to water accumulation, erosion, and localized flooding.

Such areas are less suitable for linear infrastructure development and require careful consideration during route alignment. The integration of the drainage network with the suitability analysis ensured that the proposed Outer Ring Road alignment avoids major drainage pathways to the maximum extent possible. This reduces the need for large hydraulic structures such as bridges and minimizes the risk of disrupting natural flow regimes. At locations where the alignment intersects drainage channels, the map highlights potential points requiring engineering interventions such as culverts or cross-drainage structures. The identification of these locations at the planning stage provides a basis for more accurate cost estimation and design considerations in future stages of the project. Overall, the drainage network analysis provides a comprehensive understanding of the hydrological framework of the study area. The use of the Wang & Liu sink-filling method and Strahler stream ordering ensures a scientifically robust representation of drainage patterns. The refined drainage network serves as a critical input for sustainable corridor planning by minimizing hydrological impacts and improving the long-term performance of the proposed Outer Ring Road.

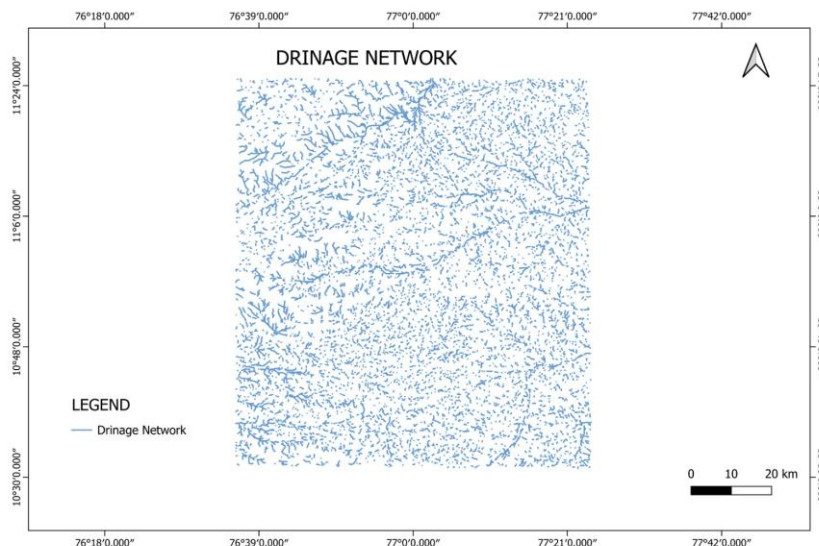


Fig 10. Drainage Map

5.6 Suitability Analysis

The final suitability map generated for Coimbatore reveals a clear spatial distribution of land suitability for the proposed Outer Ring Road alignment. The classification into Suitable, Moderately Suitable, and Not Suitable zones highlights the combined influence of terrain characteristics and land-use patterns across the study area. The map indicates that highly suitable zones are predominantly distributed in the central and eastern portions of the study area. These regions are characterized by relatively gentle slopes, favourable land-use conditions, and moderate elevation ranges, making them more appropriate for road construction with minimal engineering constraints. In contrast, the western and north-western parts of the study area are largely categorized as not suitable, as evident from the dominance of red-coloured regions in the map. These areas correspond to terrain with steeper slopes and complex topography, likely influenced by the presence of elevated landforms associated with the Western Ghats. Such conditions significantly increase construction difficulty, cost, and environmental impact, making them unsuitable for corridor development.

The moderately suitable zones are scattered between the highly suitable and unsuitable regions, forming transitional areas where one or more constraints exist but do not completely restrict development. These areas may require limited engineering interventions, such as minor earthwork adjustments or localized land-use management. The spatial pattern observed in the suitability map strongly reflects the influence of slope, which has the highest weight (0.623) in the analysis. The gradual transition from unsuitable to suitable zones from west to east clearly demonstrates how terrain steepness governs infrastructure feasibility in the region. The contribution of LULC (0.262) is also evident in avoiding dense built-up zones and prioritizing open land areas, while elevation (0.115) plays a secondary but supportive role in refining the suitability distribution. Overall, the generated suitability map provides a scientifically derived spatial framework for identifying optimal zones for Outer Ring Road development around Coimbatore. The analysis ensures that the proposed alignment prioritizes areas with lower construction complexity, reduced environmental impact, and better land-use compatibility. This suitability assessment forms a critical decision-support base for subsequent alignment planning, infrastructure design, and feasibility evaluation.

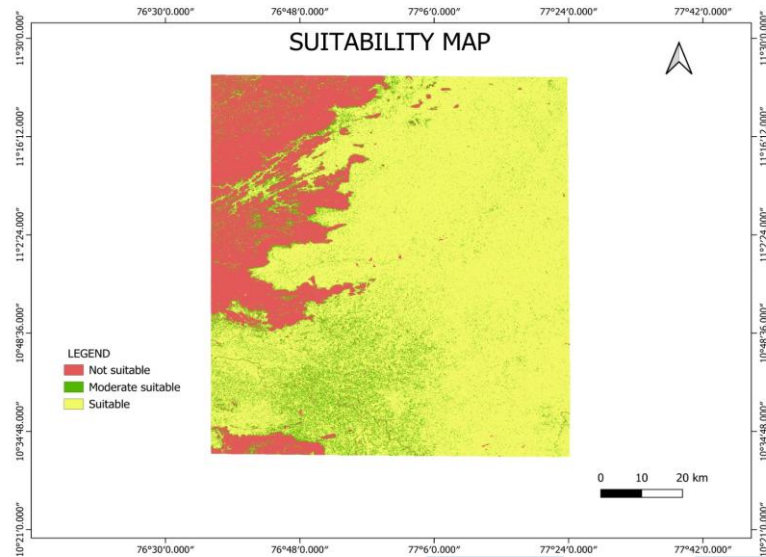


Fig 11. Suitability Map

5.7 Outer Ring Road Alignment Results

The final Outer Ring Road alignment forms a continuous corridor along the northern, northeastern, and southeastern periphery of Coimbatore, effectively connecting major developing regions and existing road infrastructure. The alignment originates in the northwestern region near Thudiyalur and Kanuvai, where it connects semi-urban areas and local road networks. It then extends eastward towards Saravanampatti, which is a rapidly developing zone characterized by residential growth and emerging industrial activities.

Further along the northeastern section, the alignment connects areas near Kalapatti and Neelambur. This segment provides important connectivity to Avinashi Road, one of the major arterial roads in the region, enhancing regional accessibility and traffic distribution.

The alignment then curves southward and connects with the existing L&T Bypass near Irugur. This junction forms a key integration point between the proposed Outer Ring Road and an established high-capacity roadway, enabling efficient long-distance traffic movement and bypassing the city core. The overall alignment demonstrates a clear relationship with the suitability map, as it predominantly passes through zones classified as suitable and moderately suitable while avoiding highly constrained regions. It also minimizes intersections with major drainage channels identified in the drainage analysis, thereby reducing the need for extensive cross-drainage structures. By connecting important radial corridors such as Mettupalayam Road, Sathyamangalam Road, and Avinashi Road, the proposed Outer Ring Road improves traffic circulation across the outskirts of Coimbatore. This reduces congestion within the city center and supports future urban expansion in peripheral regions. The integration of suitability analysis, drainage constraints, and existing road infrastructure in defining the alignment ensures that the proposed corridor is both technically feasible and functionally efficient. The resulting alignment provides a sustainable and strategically planned transportation route for long-term regional development.



Fig 12. Outer Ring Road

5.8 Outer Ring Road Alignment and Infrastructure Analysis Results

The mapped Outer Ring Road alignment forms a peripheral corridor around the urban area, helping to reduce congestion within the city core while improving regional connectivity. A total of 8 road intersections were identified along the alignment. These intersections improve connectivity with the existing road network and support traffic distribution. However, proper design measures such as signal control or grade separation may be required to ensure smooth traffic flow. The analysis identified 2 railway intersections along the proposed alignment. These locations are critical and require special structures such as overpasses or underpasses to maintain safety and uninterrupted movement. A total of 4 culvert locations were mapped along the alignment. These are necessary to maintain natural drainage flow and prevent waterlogging. Their presence indicates that the alignment considers local hydrological conditions. The integration of the proposed alignment with the existing L&T Bypass improves overall network efficiency by providing alternative routes and reducing traffic pressure on inner roads. Overall, the analysis shows that the proposed Outer Ring Road is well aligned with existing infrastructure and natural features. The identification and quantification of intersections and culverts provide useful input for future design, cost estimation, and sustainable planning.



Fig 13. Outer Ring road Alignment and Infrastructure features

6. References

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