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Transitional Impact Of Influencing Factors Leading To Traffic Congestions

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Traffic congestion is an ever-increasing issue across urban road networks in developing countries. One potential mitigation strategy is to improve our understanding of how the geographical patterns of urban land use influence congestion. Unfortunately, there is no much attention paid towards this influencing factor. To potentially identify the actual influencing factors leading to traffic congestions and to quantify them, a detailed analytic approach and traffic surveys to study the impact and relationships between different influencing factors were used in the present study. It was found that the abundance and spatial configuration of urban land uses in terms of business activities were correlated with traffic congestion. Specifically, high degrees of polycentricism for both high-intensity and low-intensity urban land uses were associated with more congestion, while contiguous residential development was correlated with less congestion. The approach of the present study is tested on a critical part of an urban road network existing in one of the central business district in Hyderabad city. The study area is delineated and captured using Google Earth and Qgis using digitization technique. Subsequently the road Network is studied in detail with respect to the different influencing factors – Roadway Width, Pavement Surface Conditions and Violation of Right of Way in terms of functionality. Also traffic surveys are conducted to assess the impact and relationship between the influencing factors. Findings from the study can potentially direct the future to think about the actual influencing factors apart from the traditional factors. The study also suggests the mitigation measure for the curtailment of congestions in urban road network.

Keywords: Urban Traffic Congestion, Land use, Roadway Width, Pavement Surface Conditions, Violation of Right of Way.

1.0 Introduction

Transportation is very essential for the economic development of any region since every commodity which is produced and every service that is rendered produces warrants for transport at production & distribution stages, the inadequacy of which retails the socio-economic development of the country. Thus transportation occupies a high place in modern life. Road Transport plays a vital role in the social and economic development of any country. Cities provide the necessary infrastructure for trade, commerce and industry. Urbanization attracts the surplus labour force from the rural areas and utilizes it in the running the various service which are vital to the existence of town. In advanced countries and at abroad, the level or urbanization is rather high. Settlements of land by different activities are promoting complex interactions, which are non-uniform in a time frame over a specified space occupation. The road users and dwellings along the road side are facing the problems of overcrowding which is the result of high intensity of the residential land uses which is reflected in the density of houses, households, populations etc. In most of the Indian cities people try to live as close to the city centre which is modified by other factor such as accessibility and different social economic status and so forth. With the development of cities and increase in traffic in the recent decades, there has been a continuous and rising problem of congestion taking place in urban road network. The same forces that draw inhabitants to congregate in large urban areas also lead to sometimes intolerable levels of traffic congestion on urban streets and thoroughfares. Effective urban governance requires a careful balancing between the benefits of agglomeration and the dis-benefits of excessive congestion. Road traffic congestion poses a challenge for all large and growing urban areas.

Factors Contributing to Traffic Congestion

Traffic congestion is a result of a combination of factors, which evolve over time and interact in complex ways. The key factors can be classified into the following categories:

Urbanization and Population Growth

Urbanization brings an influx of people into cities, straining existing transportation infrastructure. In areas rapid population growth has led to an increased number of vehicles on the roads. As more people migrate to cities, the demand for transportation rises, and without corresponding infrastructure upgrades, the roads become congested.

Infrastructure and Road Network Design

The design and capacity of road networks are crucial determinants of traffic flow. Poorly designed road networks, including narrow lanes, lack of signal synchronization, and inadequate intersections, contribute significantly to congestion.

Public Transport System

An efficient public transport system can alleviate congestion by reducing the number of private vehicles on the road. However, when the public transport system is underdeveloped or unreliable, as is often the case in many Indian cities, people are more likely to use personal vehicles.

Social Behavior and Driving Culture

Social behavior, including aggressive driving, poor adherence to traffic rules, and lack of lane discipline, plays a significant role in traffic congestion. In many urban areas, drivers frequently disregard traffic regulations, leading to accidents, blockages, and slower traffic flow. Addressing these behavioral issues requires both stricter law enforcement and driver education.

2.Literature review

Feng et al. **[1]** focused on a typical situation of LBS (Location Based Search) which is to provide services for users in cars that move in a road network. To provide such kind of services, an integration method for representing transportation information with a road map is proposed. Terzi and Kaya **[2]** attempted to measure urban sprawl using a sprawl index and analyses urban form through fractal analysis for characterizing urban sprawl in Istanbul which has not been measured or characterized yet. The study suggests that the fractal dimension of urban form is positively correlated with the urban sprawl index score when urban growth pattern is more likely "concentrated". However, a negative relationship was observed between fractal dimension and sprawl index score when the urban growth pattern changes from the concentrated to the semi-linear form. Attikos and Doumpos**[3]** Stated that fractal dimension is widely adopted in spatial databases and data mining, among others as a measure of dataset skewness. State-of-the-art algorithms for estimating the fractal dimension exhibit linear runtime complexity whether based on box-counting or approximation schemes. Also presented a correlation fractal dimension estimation algorithm that redundantly rescans the dataset and, extending that work, proposed another linear, yet faster and accurate method. Chen and Jiang**[4]** proposes a method to analyze the spatial structure of urban systems using ideas from fractals. Regarding a system of cities as a set of "particles" distributed randomly on a triangular lattice, a spatial correlation function of cities is constructed. Suppose that the spatial correlation follows the power law. It can be proved that the correlation exponent is the second order generalized dimension. Chen**[5]** Presented that the process of urban evolution falls into two effects: one is the Pareto effect indicating city number increase (external complexity), and the other the Zipf effect indicating city size growth (internal complexity). Because of struggle of the two effects, the scaling exponent varies from 0.5 to 2; but if the two effects reach equilibrium with each other, the scaling exponent approaches 1. Thomas and Frankhauser**[6]** compared the fractal dimension measured on built-up spaces with the fractal dimension measured on the street network in an urban environment. The differences are demonstrated theoretically and empirically. Fractal dimensions, curves of scaling behavior, and concordance analyses are computed for the city region of Antwerp.It was concluded that, if cities in a given region follow Zipf's law, the frequency and size correlations will follow the scaling law. Vilayath and Lakshmana Rao**[7]** visualised the fractal view of different urban areas and suggested to analyse the road network on different parameters – Accessibility, Mobility, Connectivity, Self –Similarity (Visualizing the fractal view) to improve the existing infrastructures. Behaviour and characteristics of links were studied and subsequently Transverse Corridors and Longitudinal Corridors with the feeder roads to increase the functionality of the sub-arterial roads were proposed. Lagarias**[8]** Analysed the

built-up patterns and compares the urban form of several Mediterranean cities using fractal dimensions. A methodology that accounts for the densities of built up areas is proposed and fractal dimensions are estimated using data from the Urban Atlas and the Imperviousness-Soil Sealing Degree Databases. Boeing**[9]** Presented a study in which complexity's relevance was unpacked to urban design. Then it reviews temporal, visual, spatial, scaling, and connectivity measures of complexity from various disciplines, exploring their relevance to urban form character and urban design outcomes. Finally, it collates these measures into a typology to formalize and assess design claims, project results, and the urban form. **Salingaros [10]** Developed an edge in a geographical sense, and applied geometrical analysis to the general morphology of coastal cities. The coast was considered as a fractal line, with very special mathematical properties and presented a method of analysis which can be applied to design new urban growth and to repair existing urban fabric that has been damaged by any interventions. **Chen [11]** presented that urban area is a scale-dependence measure, which indicates the scale-free distribution of urban patterns. Accordingly a study was made in which the urban description based on characteristic lengths were replaced by urban characterization based on scaling. It was concluded that the urban form can be explored as fractals within certain ranges of scales and fractal geometry can be applied to the spatial analysis of the scale-free aspects of urban morphology

3. Methodology

In the present study the study area is captured through digitization technique from Google Earth and using Qgis the study area is demonstrated with larger accuracy. A central business district Nampally in the Hyderabad City and its adjoining area is taken as the study area for the present research. The area comprises of multi level business activities, road side business, education centers, retail markets and other rich heritage monuments which have become the leads of the transportation system. The study area so formed is studied in details with respect to different influencing factors – Traffic Composition, Roadway Width, Violation of Right of Way, and Pavement Surface Condition. Traffic Surveys are also conducted to assess the capacities and functionality of the network. The study has shown that much of the attention was given to traditional factors in the past but the current scenario of the congestion in urban networks has changed due to its influencing factors.

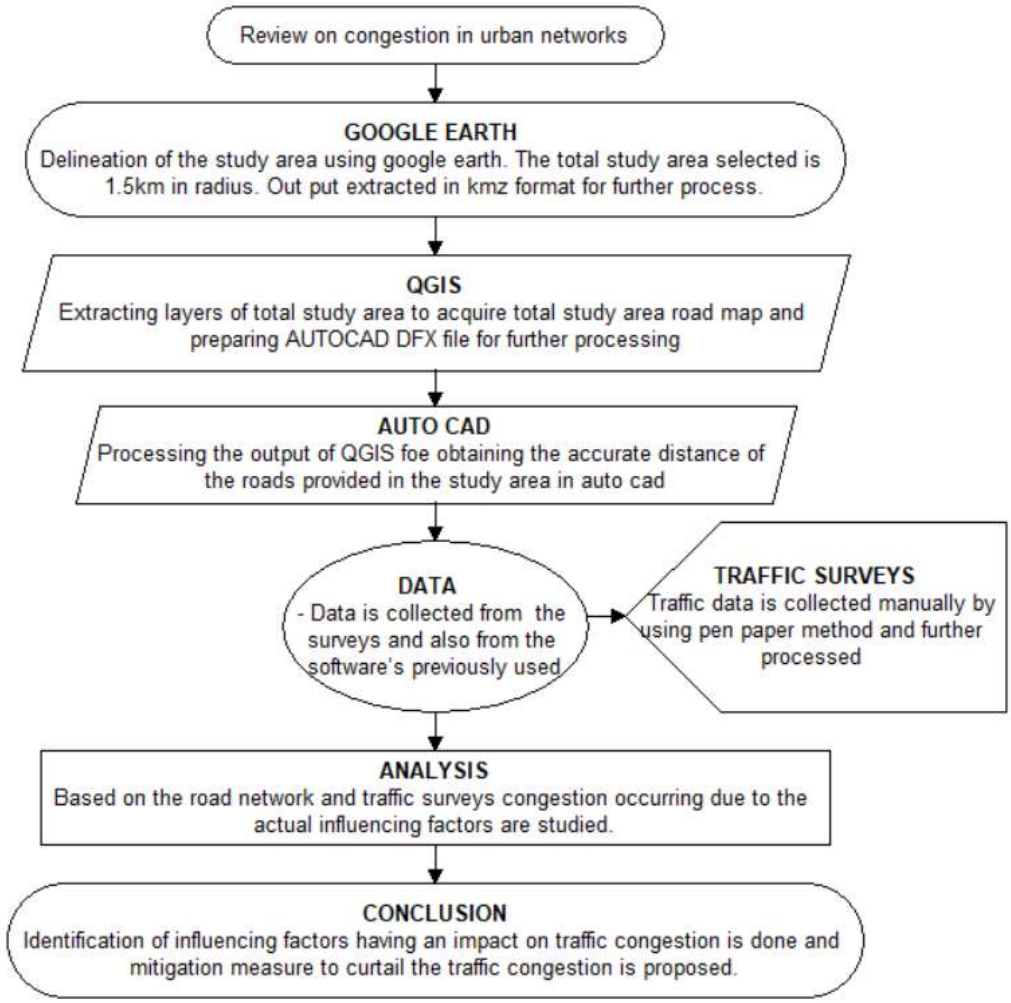

Figure 1: Proposed flow chart extraction of study area

3.0 Data Collection and Data Processing

Hyderabad is the capital and largest city of the southern Indian state of Telangana located at 17.3667° N, 78.4667° E. It occupies 650 square kilometers (250 sq mi) on the banks of the Musi River. Its population is 6.8 million, and its metropolitan area increases that number to 7.75 million people, making it India's fourth most populous city and sixth most populous urban agglomeration. Three National Highways pass through the city:NH-7, NH-9 and NH-202. Five state highways, SH-1, SH-2, SH-4, SH-5 and SH-6, either begin at or pass through Hyderabad.

The study area for the present study comprises of circular area of 1.5 Km radius from Darussalam. The extents of study area are from Bazar Ghat at one end to Begum Bazaar in one direction and Sultan Bazaar at one end to Jhirra at other end in other direction. The major

business / Commercial centers are Redhills, Abids, New Mallepally, Nampally, Asif Nagar, Jhirra, Mangalhat, Begum Bazaar, Chudi Bazaar and Jam Bagh.

Table 1: Details of Arterial and sub ArterialRoad Areas

S.No	Starting Point	Ending Point
1	Asif Nagar	Goshamahal
2	Goshamahal	Asif Nagar
3	Nampally Haj House	Afzal Gunj
4	Afzal Gunj	Nampally Haj House
Sub - Arterial Roads		
1	A Battery Lane	Ek minar near Board of Intermediate
2	Ek minar near Board of Intermediate	A Battery Lane
3	Goshamahal Petrol Pump	Nayapul
4	Mozamjahi Market	Begum Bazar Road
5	Voulga Hotel Darussalam	Ek Minar near Board of Intermediate
6	Ek Minar near Board of Intermediate	Voulga Hotel Darussalam

3.1 Use of Google Earth in digitization of study area

Figure 2 – GUI of Google Earth Application

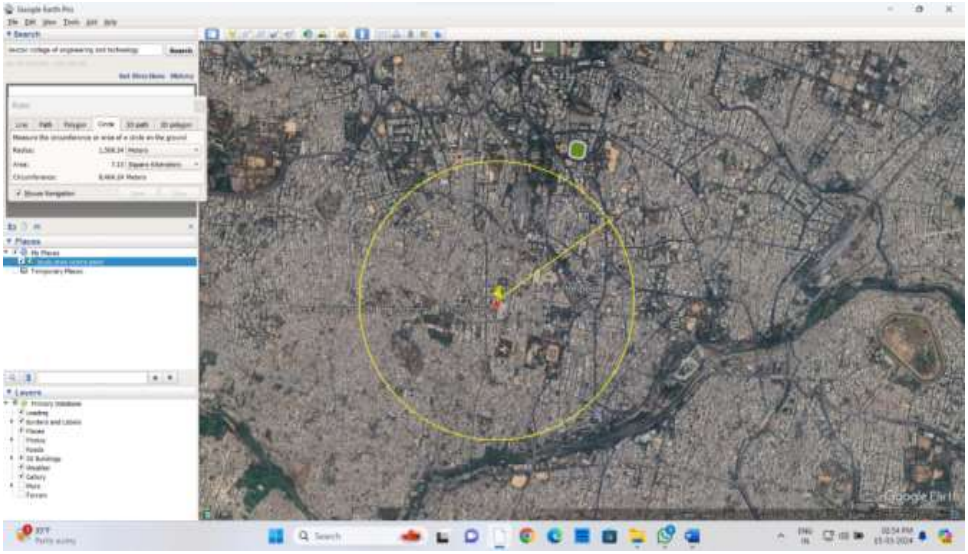

Figure 3 – Earmarking of the extents of study area using tools menu in Google Earth

The figure successfully shows the earmarked extents of Nampally Darussalam with a 1.50 KM radius using Google Earth tools. The circular boundary clearly defines the study area within the urban landscape.

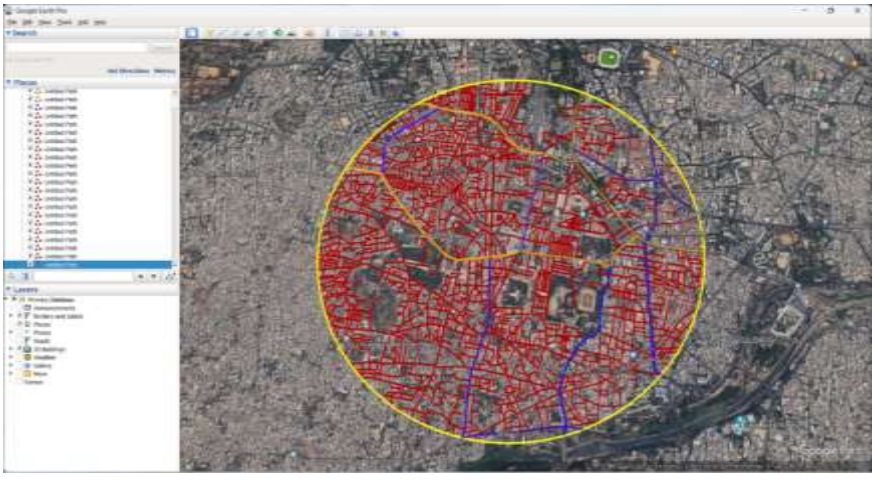

Figure 4 – Developing the Arterial Roads, Sub-Arterial Roads and Local Streets Using Path Commandin the Nampally Darussalam Area

It shows a satellite view of the urban area with a circular overlay highlighting a specific region. This overlay appears to be focused on the Nampally Darussalam area area with color-coded road classifications: red for Arterial Roads, blue for Sub-Arterial Roads, and unmarked

Local Streets. The task involves developing these road networks using path commands in GIS software.

3.2 Use of Qgis in Improving the map of study area:-

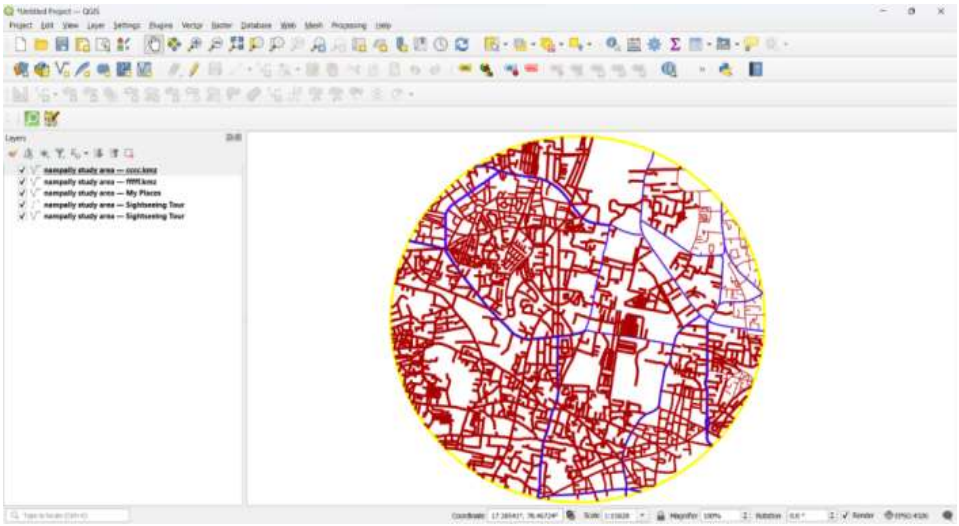

Figure 5 – Improved View of the Nampally Darussalam study area

The figure shows a detailed road network map within a circular boundary, likely representing an urban area. The map appears to be displayed in a GIS (Geographic Information System) software interface, possibly QGIS, as indicated by the toolbar and layers panel on the left side of the figure a detailed view of the road network in the Nampally area, likely in Hyderabad, India. The map shows a dense, complex urban structure with various road types and intersections.

3.3 Analysisof different influencing factors in Arterial & Sub Arterial Roads

Arterial Road = Asif Nagar To Goshamahal Road

Influencing Factor 1 – Roadway Width	
Segment [m]	**Roadway width [ft]**
0-500	30
500-1000	25
1000-1500	30
1500-2000	20
2000-2500	50
2500-2836	40

Table 2 – Average Roadway Width in Asif Nagar to Goshamahal road

Influencing Factor 2 – Violation of Right of Way		
Segment	**Illegal Parking**	**Usage of Footpath**
0-500	Yes	Shops and parking
500-1000	Yes	Shops and parking
1000-1500	Yes	No Footpath
1500-2000	Yes	No Footpath
2000-2500	Yes	No Footpath
2500-2836	Yes	No Footpath

Table 3 – Details of the violation of Right of Way in Asif Nagar to Goshamahal road

Influencing Factor 3 – Pavement Surface Condition		
Segment	**Pavement Surface**	**Remarks**
0-500	Good	Potholes
500-1000	Bad	Uneven Surface
1000-1500	Bad	Potholes
1500-2000	Good	Clear
2000-2500	Bad	Uneven Surface
2500-2836	Bad	Potholes

Table 4 – Details of Pavement Surface at different stretches in Asif Nagar to Goshamahal road

Figure 6 – Deteriorated Pavement Surface Condition in Asif Nagar to Goshamahal road

Influencing Factor 4 – Traffic Composition

Following is the table showing the classified volume counts of traffic in road Asif Nagar to Goshamahal

Time in Hours		Fast Moving Vehicles								
		1	2	3	4	5	6	7		
From	To	Cars, Vans & Jeeps	Busses & Trucks	3- Seater Autos	7- Seater Autos	2-Wheelers	LCV's	Others/Slow moving vehicles	Total No. of Vehicles	Total PCU's
PCU Factor		**1.00**	**3.70**	**2.00**	**1.50**	**0.75**	**2.00**	**0.00**		
02:15:00	**02:30:00**	14	0	49	0	241	11	**0**	315.00	481.75
02:30:00	**02:45:00**	19	1	70	0	268	16	**0**	374.00	7552
02:45:00	**03:00:00**	24	0	64	0	316	18	**7**	429.00	9760
03:00:00	**03:15:00**	25	0	82	0	194	10	**4**	315.00	9036
03:15:00	**03:30:00**	11	0	39	0	286	9	**0**	345.00	5219
03:30:00	**03:45:00**	17	1	50	0	349	7	**0**	424.00	4139
03:45:00	**04:00:00**	20	0	68	0	407	25	**3**	523.00	12465
04:00:00	**04:15:00**	34	1	74	0	381	27	**0**	517.00	16701
SUM		**164**	**3**	**496**	**0**	**2442**	**123**	**14**	**3242**	**36187.75**

Table 5 – Classified Volume Counts in road Asif Nagar to Goshamahal

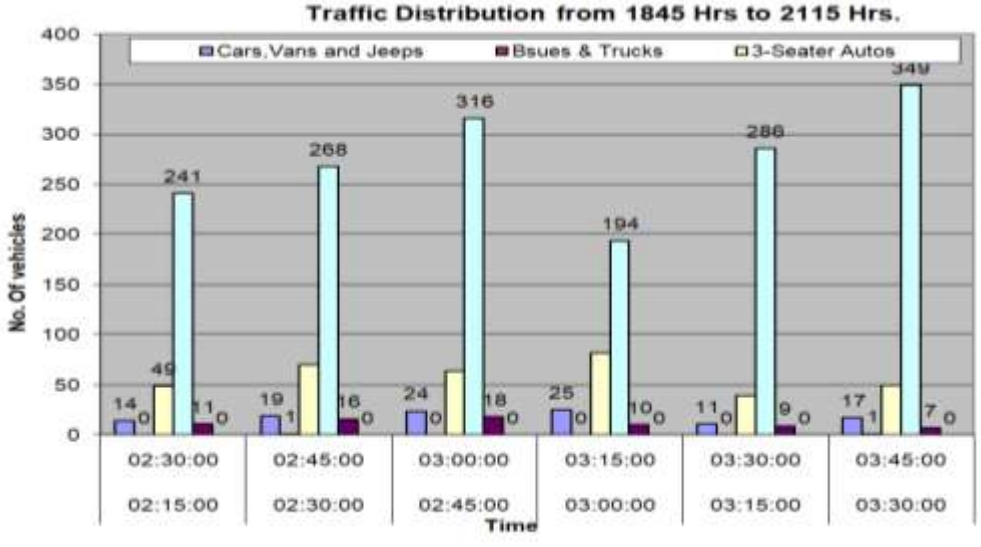

Figure 7: Traffic Composition and Distribution in road Asif Nagar to Goshamahal

Arterial Road = Nampally Haj House to Afzal Gunj

Influencing Factor 1 – Roadway Width	
Segment [m]	**Roadway width [ft]**
0-500	60
500-1000	100
1000-1500	100
1500-2000	70
2000-2624	80

Table 6 – Details of Roadway Width at different stretches in Nampally Haj House to Afzal Gunj road

Influencing Factor 2 – Violation of Right of Way		
Segment	**Illegal Parking**	**Usage of Footpath**
0-500	Yes	Shops
500-1000	Yes	Pedestrians & Parking
1000-1500	Yes	Pedestrians & Shops
1500-2000	Yes	Pedestrians & Shops
2000-2624	Yes	Parking & Shops

Table 7 – Right of Way Violation in different stretches in Nampally Haj House to Afzal Gunj road

Influencing Factor 3 – Pavement Surface Condition		
Segment	**Pavement Surface**	**Remarks**
0-500	Bad	Potholes
500-1000	Good	Even Surface
1000-1500	Good	Even Surface
1500-2000	Good	Even Surface
2000-2624	Good	Even Surface

Table 8 – Pavement Surface Condition stretches in Nampally Haj House to Afzal Gunj road

Figure 8: Riding Surface Condition in Nampally Haj House to Afzal Gunj road

Influencing Factor 4 – Traffic Composition

Following is the table showing the classified volume counts of traffic in Nampally Haj Hous

Time in Hours		Fast Moving Vehicles								
Gunj road		1	2	3	4	5	6	7		
From	To	Cars,Vans & Jeeps	Busses & Trucks	3- Seater Autos	7- Seater Autos	2-Wheelers	LCV's	Others/Slow moving vehicles	Total No. of Vehicles	Total PCU's
PCU Factor		1.00	3.70	2.00	1.50	0.75	2.00	0.00		
02:15:00	02:30:00	330	15	332	0	421	42	10	1150.00	1712.5
02:30:00	02:45:00	289	20	299	0	443	35	14	1100.00	209813
02:45:00	03:00:00	410	24	311	0	312	38	12	1107.00	228961
03:00:00	03:15:00	276	19	267	0	346	20	11	939.00	203025
03:15:00	03:30:00	346	22	114	0	357	33	15	887.00	137935
03:30:00	03:45:00	381	13	265	0	422	34	9	1124.00	174595
03:45:00	04:00:00	337	28	337	0	461	28	8	1199.00	229954
04:00:00	04:15:00	462	26	418	0	457	29	13	1405.00	310761

SUM	**2831**	**167**	**2343**	**0**	**3219**	**259**	**92**	**8911**	**956041.5**

Table 9– Classified Volume Counts in Nampally Haj House to Afzal Gunj road

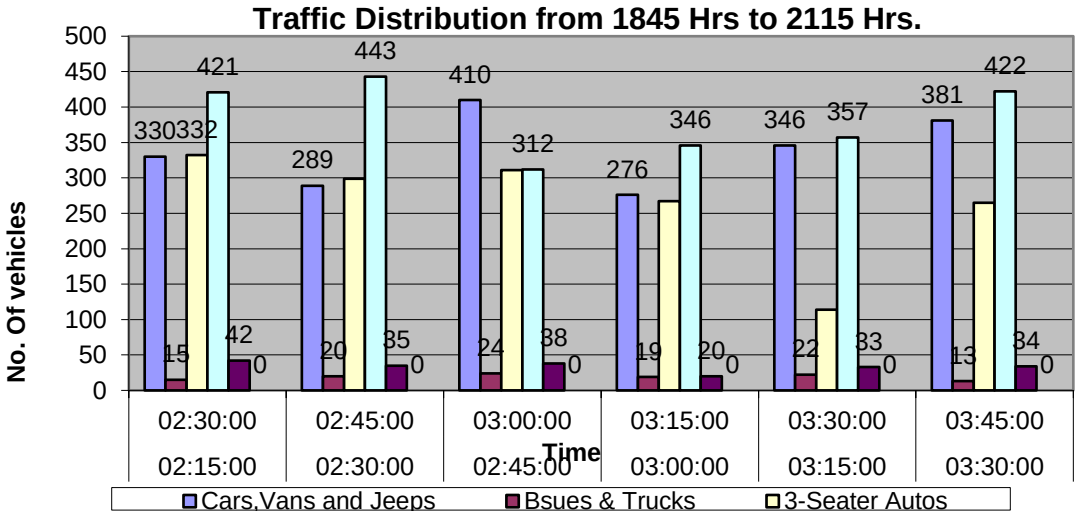

Figure 9: Traffic Composition and Distribution in Nampally Haj House to Afzal Gunj road

5.0 Conclusion

1. Google earth can be used in the formulation ofthe study area. Path command and area marking command in google earth can be used to digitize arterial roads, sub arterial roads, collector streets and land use, in the study area.
2. Integration of the google earth and Qgis software can be used to obtain path length, locating nodes , determining link length , mid block length
3. The different influencing factors causing traffic congestion in the study area which is a central business district are {typical vehicle composition, traffic density, reduced carriage way, absence of right of way, on street parking, poor road geometrics,} frequent stoppage of LCV / HCV , and business along the road side.
4. In many links of study area it is observed that frequent loading and unloading of LCV/HCV making traffic congestions to the tune of jamming density. Long ques are being formed due to business along the road side and frequent stoppage of LCV and HCV, absence of shoulder, absence of right of way ,and pedestrian movement.
5. Traffic surveys shows that volumes are going beyond the capacity at peak hours and Road surface condition is leading to the long formation of ques and having impact on the smooth traffic flow.

6. Based on hierarchical connectivity of roads, traffic surveys conducted, land use in the vicinity of the study area mitigation measures for confining the congestion can vary of two types, one is a management measure the other is a policy measure.
7. Management measure can be done through installing cameras at salient locations or employing traffic police. Policy measure can be done by enforcing some laws like restricting the time of LCV/HCV entering into the study area.
8. Role of Traffic Composition, Right of way violation and Poor Supportive infrastructure is having transitional effect which can be modeled mathematically for addressing the problem in a more rational form.

References

1. Attikos, Christos, and Michael Doumpos. 2009. "Faster Estimation of the Correlation Fractal Dimension Using Box-Counting." 2009 4th Balkan Conference in Informatics, BCI 2009 93–95. doi: 10.1109/BCI.2009.6.
2. Chen, Yanguang, and Shiguo Jiang. 2010. "Modeling Fractal Structure of Systems of Cities Using Spatial
3. Chen, Yanguang. 2011. "Modeling Fractal Structure of City-Size Distributions Using Correlation Functions." PLoS ONE 6(9). doi: 10.1371/journal.pone.0024791.
4. Thomas, Isabelle, and Pierre Frankhauser. 2013. "Fractal Dimensions of the Built-up Footprint: Buildings versus Roads. Fractal Evidence from Antwerp (Belgium)." Environment and Planning B: Planning and Design 40(2):310–29. doi: 10.1068/b38218.
5. Vilayath, Mirza, and K. M. Lakshmana Rao. 2016. "Road Network Characteristics and Orientation – Design Leads in Urban Areas." International Journal of Innovative Research in Science and Engineering No 2(2):78–86.
6. Boeing, Geoff. 2018. "Measuring the Complexity of Urban Form and Design." Urban Design International 23(4):281–92. doi: 10.1057/s41289-018-0072-1.
7. Chen, Yanguang. 2020. "Fractal Modeling and Fractal Dimension Description of Urban Morphology." Entropy 22(9). doi: 10.3390/e22090961.