Evaluating Los at Urban Midblock Section & Signalized Intersection

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***Abstract*—This study assesses the service quality of signalized junction areas and urban midblock sections. PCU units of various vehicle kinds, traffic volume, road capacity, passing vehicle speed, and the volume to capacity ratio are all used to gather data. then used the v/c ratio to establish the service level. Safety and Congestion Management: LOS analysis aids in enhancing road safety and reducing congestion in transportation systems.**

***Key words*—Traffic, Free Flow Speed, Volume, LOS**

I. INTRODUCTION

In traffic engineering, Level of Service (LOS) is a qualitative indicator used to assess how well roads and bridges operate. It displays the efficiency, comfort, and convenience that drivers experience based on factors including vehicle speed, trip length, traffic flow, delay, and congestion. The six LOS levels range from LOS A (excellent conditions with unimpeded traffic flow) to LOS F (very congested conditions with stop-and-go traffic). These levels are used by engineers to evaluate the state of traffic, identify problems, and create improvement strategies. LOS is defined and standardized in the Highway Capacity Manual (HCM) as a crucial tool for transportation planning, route design, and traffic management [1].

The Level of Service (LOS) is a qualitative indicator used to assess the operational status of transportation infrastructure as well as the comfort and convenience of users. In urban midblock regions (the parts of roadways between junctions), many modes of transportation, such as automobiles, bicycles, and pedestrians, often interact, making LOS particularly crucial. These midblock spaces often contain parking access points, pedestrian crossings, driveways, and public transit stops, all of which affect traffic flow, safety, and overall performance. Traffic engineers and urban planners in these areas employ LOS evaluation to help them discover congestion issues, optimize road design, and improve user safety and mobility [1].

Level of Service (LOS) is a critical performance metric used to evaluate the efficiency and caliber of traffic operations at signalized intersections. The delay experienced by cars is a reflection of the intersection's overall performance under various traffic loads and signal control techniques. In urban road networks, signalized intersections are essential sites where conflicting traffic volumes must be managed by predetermined signal phases. The LOS of these facilities is often defined in terms of average vehicle delay, with two categories: LOS A (free-flow conditions) and LOS F (very crowded, substantial delays). LOS evaluation at signalized crossings is essential for traffic management, junction design, and improving mobility and safety in urban environments [1].

II. LITERATURE REVIEW

Vision-based investigation of road traffic and violations at urban roundabout in India using UAV video: A case study Yagnik M Bhavsar a, Mazad S Zaveri a, Mehul S Raval. This paper presents a case study (and the methodology) for drone/ UAV video-based investigation of road traffic and violations at a multi-lane urban roundabout in India. The computer vision techniques used in our work are YOLOv7 for vehicle detection and SORT-based tracking of vehicles. Our methodology divides the road scene (roundabout) into specific zones. We then formulated the dictionary. We have investigated a multi-lane urban roundabout (in Ahmedabad city). Around 23.26% of vehicles committed violations (including over- speeding within the roundabout). We detected traffic violations related to lane indiscipline, driving against the authorized flow of the traffic, parking violations, and over-speeding within roundabout. The central island diameter is

extremely small, and splitter islands are absent, which could be the reason for the violations: Driving in the wrong way, driving in anti- clockwise direction at the roundabout, and wrong U-turn. Zebra crossings (road markings) are absent and the location of a grocery store (at the northeast corner) could be the reason for pedestrians walking dangerously within the roundabout.[2] Modelling of road traffic fatalities in India Rahul Goel. In this study an ecological regression model was developed at the state level to understand the relationship between road deaths and commute distance travelled by different modes in India. The relationship controlled for diesel consumed, length of national highways, percent population urban, and population density [3]. A game-theoretic approach for modelling pedestrian– vehicle conflict resolutions in uncontrolled traffic environments. Roja Ezzati Aminia, Mohamed Abouelelaa, Ashish Dhamaniyab, Bernhard Friedrichc, Constantinos Antoniou. Pedestrians with a high level of movement freedom on the road can perform unexpected behavior, leading to more complex traffic interactions. Traffic participants intend to dominate the road space during the interaction process while their safety is assured. Such com petitions over the road space are more complicated in uncontrolled mixed environments where users have to negotiate the right of way. Furthermore, the pedestrian interactions with other road users may become more challenging with the integration of ADS as a new road user into the traffic and when the road infrastructure is not fully ready for merging such vehicles. In this case, the ADS require a suitable interaction method to predict the intentions/decisions of interacting users and consequently avoid conflict and improve traffic efficiency [4]. An Insight into Real Time Vehicle Detection and Classification Methods using ML/DL based Approach, as technology evolves from a manual to an automated system, the traffic surveillance system must evolve into a fully automated system to eliminate human error. In this paper, we studied various machine learning and deep learning algorithms for vehicle detection and classification. Among these papers, we found that they used limited datasets and had limitations in identifying and classifying specific types of vehicles. Few algorithms are facing problems in detecting vehicles in overlapping and nighttime situations. [6]. Transportation Planning Aspects of a Smart City- Case Study of GIFT City, Gujarat, D Srinivasa Reddy a, Dr. K V Ganesh Babu b, Dr. D L N Murthy, GIFT City is based on Transit Oriented Development approach where metro stations are strategically located at the center of high-density commercial development with progressively lower-density development spreading outward from the center. GIFT City transport plan envisages a modal split of 10:90 between private and public transport. Proposed smart transportation applications in GIFT City improve transport outcomes such as transport safety, transport productivity, travel reliability, informed travel choices, environmental performance and network operation resilience GIFT City transport master plan addresses the needs of all users of GIFT City [7]. Comparison of SUMO and SiMTraM for Indian Traffic Scenario Representation, Viral Patel, Manish Chaturvedi, Sanjay Srivastava, this paper publicizes the open-source availability of the upgraded SiMTraM which has been developed by adapting SUMO0.17 on Fedora 17 platform [8]. Characteristics of urban freight traffic in a medium size Indian city – a case study of Udaipur, R, Sanjay Gupta, Kushagra Sinha, at present, the Urban Control Area of Udaipur gets a flow of about 89,549 tons of freight volume daily, that is, about 13 kilograms of freight generation per capita per day [9]. Evaluating LOS at Urban Midblock Section under the Influence of Crossing Pedestrians in Mixed Traffic Conditions, Haresh Kumar Dahya Bhai Golakiya, Ashish Dhamaniya, the paper has achieved the objectives of evaluation of the delay incurred by different categories of vehicles due to pedestrian interference at the undesignated midblock crosswalk on the urban street segment [10]. Examining Traffic Operations at Multi-Legged Intersection Operating under Heterogeneous Traffic: A Case Study in India, Jay Mistry, Purvang Chaudhari, Shrinivas Arkatkarc, Constantinos Antoniou, In the present study, a microsimulation-based approach is adopted to assess the effectiveness of different traffic management measures to reduce delay and improve traffic efficiency. To this end, the Kamrej intersection, located in Surat, one of the busiest intersections located along the NH-48, was selected [11]. Level of Service at Signalized Intersection, T. Sutaria, J. J. Haynes, the hypothesis that LF is a better predictor of level of service than AID was tested and was rejected. 2. The entire LF range of 0 to 1 failed to encompass all levels of service A through F (5-1) and indicated that LF values less than zero were required for ratings 5 and 4 (levels of service A and B). In other words, LF is insensitive to low service volumes [12]. Determination of Pedestrian Level of Service at Signalized Midblock Locations for Mixed Traffic Conditions, Teja Tallam, K. M. Lakshmana Rao, LOS scores are developed using K-mean clustering analysis for the obtained speeds and are compared with the Indo HCM 2017 methodology [13]. Impact of Transit Signal

Priority on Level of Service at Signalized Intersections, Alexander Skabardonis, Eleni Christofa, A method for estimating the impacts of transit signal priority (TSP) at signalized intersections using the HCM procedures is proposed. The method uses information commonly available on traffic conditions (v/s), signal settings (g/C), frequency of the buses and the TSP strategy characteristics [14].

III. OBJECTIVES

Evaluation of the urban midblock area and the signalized area of various vehicle categories owing to pedestrian crossing activity are the main goals of the current effort. Using the volume-capacity ratio to determine the degree of service is another goal of this research.

IV. METHODOLOGY

(1) Study Area and Data Collection :-

The primary objective of the research is to evaluate the Level of Service (LOS) of a specific midblock section in Rajkot city. The midblock length was chosen because it is reflective of typical urban arterial features, has no significant crossings, and is relevant to contemporary traffic patterns. To document variations in traffic conditions during peak and off-peak hours, data was collected using field surveys [1].

The traffic volume (vehicles per hour) and free-flow speed (km/h) were the two main metrics that were measured.

* Roadway geometry (number of lanes, lane width, on street parking, medians)
* Bicycle and pedestrian volumes (if any)

The data was obtained using a variety of methods, including human counts, geometric measurements using tape and laser rangefinders, spot speed studies using radar guns, and automatic traffic recorders (ATR) [1]. The Rajkot city region, where the selected study portion is located, is a significant urban artery that links the central business district with the surrounding residential and industrial sectors. The road is a vital route for traffic moving through and within the city.

There was some small rutting and patchwork visible, but overall the road user surface condition was rated as acceptable to good. Mixed traffic flow is experienced by the road stretch, which is typical of Indian city streets [1].

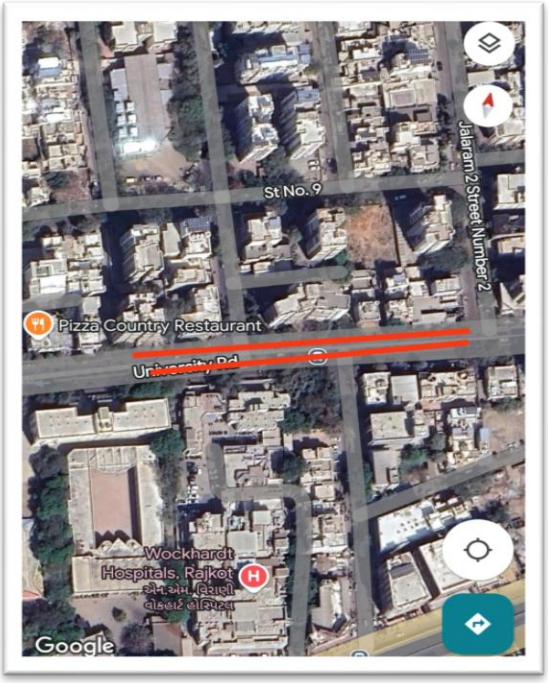


Figure-1 Google earth image of the study area (Midblock Area)

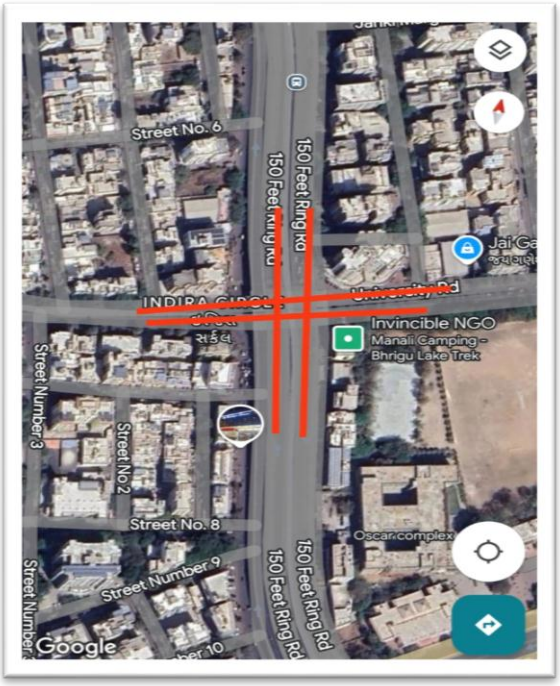


Figure-2 Google earth image of the study area (Intersection Area)

(2) Framework for the LOS Evaluation:

The LOS evaluation was carried out using the procedures specified in the *Highway Capacity Manual (HCM) (most recent edition) for urban street midblock segments. The LOS was calculated using the two primary performance parameters that impact

midblock activities: density (pc/km/lane) and average speed [1].

The actions listed below were taken:

1. Traffic Flow Analysis:

Density, speed, and flow rate (vehicles per hour) were assessed in order to ascertain operating conditions on the midblock section [1].

The traffic's composition

Peak and off-peak categorized traffic volume counts were conducted over a period of three days and twelve hours (7 AM to 7 PM). Table 1 [1] provides a summary of the modal split, or percentage share of each vehicle category.

Vehicle Type	Percentage Share (%)
Two-wheelers	48-52
Auto-rikshaws	14-18
Cars/Jeep/Vans	16-20
Commercial Vehicle	04-07
Buses/Trucks	06-09
Cycles/Carts	02-05

Large cars and non-motorized means are prominently displayed, while cars, autorickshaws, and two-wheelers dominate the composition, which portrays a typical Indian urban traffic stream [1].

2. Speed: -

Utilizing the predetermined study period and the vehicle's course completion time (as recorded on the stopwatch data form), calculate the vehicle's speed using the following formula.

$$V = D/1.47\ T \text{ [1]}$$

where V = spot speed (mph),
D = length (feet), and
T = elapsed time (seconds).

The constant in the equation that changes feet per second into miles per hour is 1.47. For example, if the driver's elapsed time is 2.5 seconds and the spot speed study length is 100 feet, the driver is moving at

100 feet / 1.47 (2.5 seconds) = 27 mph.

3. Free Flow Speed: -

The free-flow speed (FFS) is a crucial indicator for assessing road performance and determining capacity and level of service (LOS). The Highway Capacity Manual (HCM) defines free flow speed as "the mean speed of passenger cars measured under low traffic volumes and minimal impediments, representing ideal driving conditions" [1].

The equation of Free-Flow Speed:

$$FFS=75.4 – F_{LW} – F_{LC} – 3.22\ TRD^{0.84} \text{ [1]}$$

Where, FFS= Free-Flow Speed
F_{LW}= Lane Width
F_{LC}= Right side lateral clearance
TRD= Total ramp density

4. Free Volume: -

In traffic flow theory, the word "free volume" refers to the observed traffic flow rate (vehicles/hour or PCU/hour) under particular conditions. when vehicles approach or pass their FFS with minimal other vehicle interference or impediment. Free volume, a crucial operational stage, characterizes the flow circumstances prior to observable congestion or capacity constraints [1].

Free Volume (q_0) can be defined as:

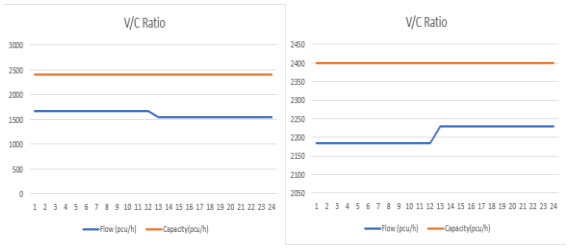
"The amount of traffic that can pass through a section of road while preserving free-flow conditions, that is, when drivers set their own speeds independent of other cars or traffic control measures" [1].

VEHICLE TYPE	PCU VALUE
CYCLE	0.2
TWO-WHEELER	0.4
RIKSHAW	1
CAR	1
TRUCK	1
HEAVY VEHICLE	1.5
BUS	2
CONTAINERS	2.3

It is not a fixed number; rather, it depends on the state of the road, the amount of traffic, and the behaviour of drivers. Heterogeneity and diverse driver interactions are common in urban mixed traffic, where free volume typically corresponds to low to moderate flow rates (\~10-30% of highway capacity) [1].

5. Capacity Estimation

Roadway capacity was assessed using HCM correction factors, accounting for parameters such as lane width, lateral clearance, and traffic composition (the proportion of heavy trucks). We made the assumption that the capacity was 2400 pcu/h in this work [1].



4. LOS Determination

The HCM threshold values (A to F scale) were used to compute average trip speed and density in order to determine LOS. Additional qualitative observations of driver behaviour, delays, and user impressions were added to the quantitative data to validate them [1].

"LOS is a quality statistic that describes operational circumstances inside a traffic stream," according to service parameters like speed and travel time.

freedom to maneuver, traffic interruptions, and comfort and convenience" [1].

LOS CLASS	TRAFFIC STATE AND CONDITION	V/C RATIO
A	Free Flow	0-0.60
B	Stable flow with unaffected speed	0.61-0.70
C	Stable flow but speed is affected	0.71-0.80
D	High-density but the stable flow	0.81-0.90
E	Traffic volume near or at capacity level with low speed	0.91-1.00
F	Breakdown flow	>1.00

Result of LOS Evaluation:

Time Period	Travel Speed	FFS	Volume (pcu/h)	Capacity (pcu/h)	V/C	LOS
Morning	18.34	69.4	1663	2400	0.69	B
Evening	20.52	69.4	1951	2400	0.81	D
Morning	13.24	69.4	1738	2400	0.72	C
Evening	15.25	69.4	1198	2400	0.50	A

V. CONCLUSION

The Level of Service (LOS) of a specific midblock section of an urban two-lane undivided road in Rajkot was evaluated in this study when a variety of mixed traffic was present. The study method involved field-based data collection of traffic volume, vehicle speeds, and transportation geometry in compliance with the Highway Capacity Manual (HCM) framework, which was adjusted for Indian conditions. The research region had varying service conditions throughout the day, according the LOS evaluation, which made use of the V/C ratio and the percentage of FFS: LOS A at lunchtime and early morning, when traffic is unhindered and accidents are rare. At the morning peak, LOS C displayed a steady but relatively restricted flow. LOS D during evening peak, a sign of approaching unstable flow conditions and a sharp drop in travel speed. The primary factors influencing LOS worsening were found to be high traffic volume, a varied vehicle composition, roadside frictions (on-street parking), and non-lane-based driving behaviour typical of Indian urban roadways.

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