COMPLEX TRAFFIC FLOW BEHAVIOR ANALYSIS AND CAPACITY MODELING AT MULTI-LANE URBAN USING RAFF'S METHOD

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Abstract: India's traffic has several features not found in developed countries. Percentage of various vehicle kinds is a major issue. Indian traffic is dominated by two-wheelers. Depending on categorization volume, two-wheeled traffic at the intersection is 65 to 70%. To gather statistics on India's traffic, a clear mechanism was needed. These approaches examine Indian traffic and driver decision-making. Data analysis assumes the driver is consistent and homogenous. The proportion of forced gaps is higher than authorized. Raff's Method was utilized to determine each vehicle's essential gap for studying classification gap acceptance behavior. Two-wheelers have a 1.25-second gap. Three-wheelers average 1.78 seconds. Cars must have a spacing of 1.425 seconds. Size and acceleration may explain certain vehicle differences. The intersection data was analyzed using Harder's, Raff's, and Ashworth's methods. Based on approved and rejected delays, the lowest essential gap is 1.29 seconds. With a population of nearly 1.21 billion, India is the world's second most populous nation. Indians now make up 17.5% of the global population, and that number is expected to rise to 20% by 2025. Increased demand for transportation means more vehicles on the road and a rise in traffic volume, as a consequence. In India, junctions are especially crucial because of the wide range of traffic types. At peak times, all metropolitan cities have congested urban streets, and the intersections on these streets are the most dangerous places for traffic to become stuck. Intersection capacity is further diminished by the presence of various roadside business and social activities. This problem can only be solved by putting in place a correct system at the junction to alleviate traffic jams and improve safety. Depending on the volume of traffic, this might be a signal system, flyover, or roundabout. When traffic flow is high in both directions, the use of flyovers or grade-separated crossings may also be beneficial, although restricting the ability to change directions must be addressed. To avoid the traffic signal's delays, cars may move at any time without having to wait for it to change, making roundabouts significantly more efficient than a signalized junction. As a result of these benefits, many idle automobiles are less likely to pollute the air.

Keywords: Raff's Method, traffic flow behavior, capacity modeling, Three-wheelers

I. INTRODUCTION

Field studies are carried out so as to assess the present condition of traffic and its behavior so that one can take traffic management decisions to study, analyse and improve the traffic performance. The proposed work being of development of model, hence large amount of data is required from the field so as to ensure the quality work. The data collection includes the following works.

SELECTION of ROUNDABOUT

The following are the considerations that went into selecting the junction for the study:

- The crossroads need to have four legs with a suitable volume of traffic flow.
- The percentage of non-motorized vehicles shall not exceed a certain threshold.
- The approach lane ought to be straight, and hence, none of the approaching arms ought to have any bends.
- The road surface should be level and consistent so that drivers who are approaching the junction are not compelled to slow down because of the poor surface condition of the road. This will guarantee that the flow of traffic is not disrupted.
- The gradient should have no influence on any of the sides of the approach at all.

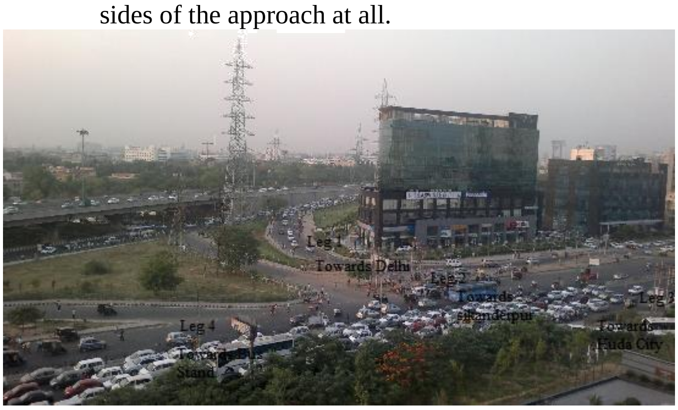


Figure 1: View of IFFCO chowk through video recording

Traffic Volume Survey

Vehicles passing a certain piece of road in a given time period are counted as traffic volume. Vehicles per day and vehicles per hour are the most often used measures for measuring traffic volume as a quantity of flow. Roundabout traffic volume studies are undertaken to determine how traffic changes over time at each of the roundabout's approaches.

Classified Volume Count

There are a wide range of vehicles in India's vehicular traffic, from modest pedal cycles to huge commercial trucks. Each kind has its own unique impact, therefore a basic volume count, without dividing the cars into separate categories, is of minimal use. Counting the volume of cars is consequently a common procedure that divides them into separate categories. The data extraction for each leg's categorised volume count was done by monitoring the cars through the produced frames. Vehicles were categorised as two-wheeler, three-wheeler (Auto rickshaw and pick up), automobile, light commercial vehicle, minibus, and slow moving (cycle and hand carts) based on their use of the junction.

Turning Movement Count

In order to asses intersections turning movement counters (TMC's) are used to quantify the movement of vehicles through the area. It is also used for a variety of intersection analysis, including traffic operations analysis, intersection design, and transportation planning applications. Accordingly, there is a need to forecast turning movements at the intersection.

Accepted Gap

Minor stream vehicle (Vehicle approaching junction) and two major stream vehicles (Circulating Vehicle) accepted the spacing between them. During a certain moment in time when a minor stream vehicle entered between two large stream vehicles, all of the war zone's vehicles were monitored. Later, a point of contention was identified for those particular cars. All three cars (2 from the Major and 1 from the Minor streams) must pass through the conflict location on the route.

Figure 2: Accepted Gap Estimation

II. ANALYSIS

The study's data analysis is now underway. IFFCO chowk's video data is being used for this purpose, as well. The following are some of the observations I've made about the traffic at the intersections:

- Lane based Gap noted
- Vehicles are considered only when in area.
- Gaps are either rejected or forced however, the proportion of forced gap is higher.
- The flow from and through leg 1(Delhi) is highest and is followed by Leg 4 (towards bus stand/ Manesar).
- Lane discipline is not observed by majority of the drivers.
- Majority of the Forced gap occurs during the high volume periods.
- Proportion of vehicles for U-turn is less than 1 % for all the approach directions.
- Majority of the vehicles opting for a U-Turn are adopting wrong direction avoiding the circulation through the roundabout.
- The proportion of trucks and busses using the intersection is less than 0.5% and hence is considered in categories of other vehicles.
- Permanent parking is done within the circulating lane converting it from 3 Lane to 2 Lane.
- Forced gap is likely to take place if speed of major vehicle is comparatively less.
- Forced gap depends on the type of vehicles involved.

Turning Movement Count

Turning movement counts (TMC's) are used to measure the movement of cars in and out of junctions in order to evaluate their safety. Counting the number of turns was done manually by watching the tape and replaying it over and over again for varied lengths of time. Using the PCU values set by the IRC for urban junctions, the numbers in the turning movement count are based on the total number of vehicle movements.

Table 1.PCU values for Rural Intersection (IRC SP41:1994)

No.	Type of Vehicle	PCU value
1	Passenger Car	1.0
2	Auto rickshaw	1.0
3	Motor Cycle, Bicycle	0.5
4	Lorry, Bus, tractor	3.0
5	Light Commercial Vehicle	1.0

There are graphs below showing the percentage of cars accessing the junction in terms of PCU from various approaches.

Speed profile using Performance box

Speed, Position, Acceleration, and Heading are all measured 10 times every second by the Performance Box. It has a memory card reader for MMC and SD cards. Time, distance, speed, position, and split times may all be recorded at a rate of 10Hz using this. You may use the PC programmed offered to evaluate the MMC flash card data in great detail. Memory card data may then be downloaded via Performance Box' USB connection on a PC compatible computer when a survey has been completed. One may measure the vehicle's acceleration, braking, and cornering ability using the Performance box. Calibration isn't required since it is powered by the quickest GPS engine in its class, which updates every 10 samples per second. Using Google Earth, you can overlay your car's trip on the satellite map of the area where your Performance Box is located. This data may be used to examine the vehicle's performance in the testing region and the stretch's speed-reducing position.

At the crossroads, the performance box was put to good use. It was common practice to utilize a car as a study vehicle since most traffic consisted of automobiles. At intervals of ten meters, the intersection's speed profile was examined at each of the intersection's four conflict sites. As seen in the graph, the speed profile for conflict point A is as follows.

III. DETERMINATION OF CRITICAL GAP

The acceptable and rejected gap values affect the critical gap, which is defined in several ways. As a result, figuring out where the big hole is is a big deal. Researchers from across the globe have recently proposed a variety of approaches and concepts to determine the crucial gap. However, due to the fact that Indian traffic is diverse, the conditions under which these algorithms were developed and employed before are different from those in India now. Only a few of these techniques have been used in the research domain, with the following findings.

Harder's Method

Based on the values of Gap, this is a straightforward technique. The procedure is simplified by assuming that the drivers are consistent. Drivers are expected to behave and respond the same way in all scenarios if they are considered consistent. A video camera was used to capture a study area and measure all of the research area's Gaps. Gaps have been accepted or rejected and the time scale is separated into 1 second pieces. Every second, the number of Gaps that have been seen and accepted is counted. For a given segment, the estimated value of ai is equal to the ratio of the observed to acceptable gap.

Pa, Gap= Fc(t)

And if ti is the time at the center of interval i, then

Fc (ti) = ai

This is an approximation of the cumulative distribution function of critical gaps. The mean critical gap is then given as

$$tc=\sum^{W} ti.Fc(ti)-Fc(ti-1)$$

Where W is the number of intervals of 1 second.

According to this graph, the crucial gap is determined by the total number of gaps that have been seen and rejected.

Table 2. Calculation of Critical Gap Using Harder's Method

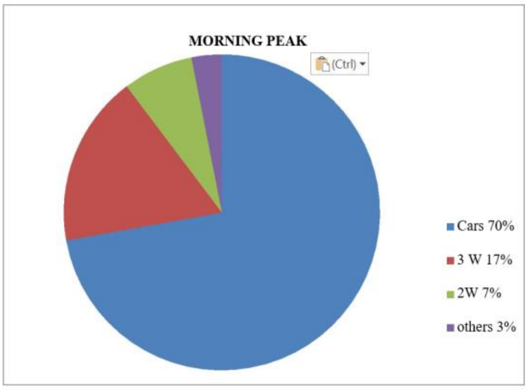
Time (Sec)	Accepted Gaps	Rejected Gaps	Observed Gaps	a_i	$F_c(t_i)-F_c(t_{i-1})$
0-1	23	61	84	3.65	---
1-2	103	35	138	1.33	2.32
2-3	86	5	91	1.06	0.27
3-4	55	0	55	1	0.06
4-5	13	0	13	1	0

To guarantee that the technique is successful, it is necessary to provide a sample size that is sufficiently big at each interval I. This calls for a longer duration of observation. Aside from that, it simply accounts for the circumstance in which there is not a waiting list. As a consequence of this, the essential values may be able to be differentiated from the gaps in a consistent manner. The Lag technique is no longer used in clinical settings for these and other related reasons.

IV. RESULT AND CONCLUTION

Traffic Volume Analysis

Three-wheelers, a common means of public transportation in Gurgaon, follow closely behind the city's high share of cars. The graphic below shows the traffic patterns in the morning and evening peak hours for the intersection investigated, which links the city with Manesar



EVENING PEAK

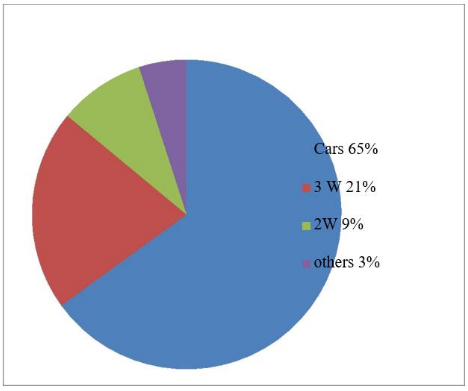


Figure 3. Chart showing the proportion of each vehicle type using the intersection

Leg 1 provides the best view of the morning peak flow. However, during evening rush hour, the volume of traffic accessing the crossing decreases. During peak hours in the morning and evening, the chart depicting the percentage of cars leaving the junction shows the exact opposite pattern of behavior.

Speed Profile

When approaching the combat zone, cars' speeds are seen to slow down. When a performance box is put on a research vehicle, it may be used to plot a speed profile.

Follow up time

The time it takes for the cars entering the junction to follow up is listed below. There is an average of 0.48 seconds of follow-up time for each leg. Leg 2 has the greatest value, which may be explained by the fact that the flow from that leg is the lowest.

Table 3.Follow up time details

Follow up time	Leg 1	Leg 2	Leg 3	Leg 4	Combined
Average	0.52	0.39	0.38	0.45	0.42
Standard Deviation	0.25	0.22	0.19	0.24	0.23
Min.	0.18	0.16	0.08	0.17	0.18
Max.	1.28	1.04	0.92	1.16	1.28

Leg 4 is the busiest, and this leg's minimum time was 0.08 seconds. The follow-up time varies by 0.19 to 0.26 seconds, with a standard variation of 0.23 seconds for all of the leg's data combined.

Headway

Each leg's headway was calculated using a minute-by-minute volume count. In the following table, the results are presented in a concise form.

Table 4.Headway Time Details

Headway	Leg 1	Leg 2	Leg 3	Leg 4	Combined
Average	2.73	2.14	2.06	4.56	2.87
Standard Deviation	0.97	0.80	0.57	1.57	1.45
Min.	1.43	1.22	0.90	2.14	0.90
Max.	5.45	6.00	5.45	10.00	10.00

Leg 4 is the leg that has the most headway in terms of both minimum and maximal. The values on the other three legs are quite close to one another. The distribution of headway values is examined. There is a wide range of values in the range of 0.22 to 0.49 that best suit the distribution as an exponential (negative). All the legs' combined data sets provide 0.35 for lambda, which is the average of the individual values.

Lag Time

The lag number seems to be consistent across all legs. The overall standard deviation ranges from 0.19 seconds to 0.26 seconds for all legs.

Table 5. Lag time details

Lag	Leg 1	Leg 2	Leg 3	Leg 4	Combined
Average	0.59	0.73	0.85	0.678	0.718
Standard Deviation	0.19	0.25	0.26	0.21	0.25
Min.	0.24	0.4	0.48	0.24	0.24
Max.	1.12	1.52	1.84	1.4	1.84

Leg 3's maximum and minimum lag values have the greatest and lowest lag values, respectively. Front lag is not included in these lag figures.

V. CONCLUSION

There are a few distinctive aspects to India's traffic that aren't seen in industrialized nations. The percentage of different types of vehicles is a significant consideration when considering numerous factors. More over half of the vehicles in Indian traffic are two-wheelers. The share of two-wheeled traffic in total traffic at the junction varies from 65 to 70 percent based on the classification volume count.

It was necessary to have a method that was clearly specified in order to collect data from the varied traffic circumstances in India. These methods take into consideration normal Indian traffic conditions and the driver's decision-making. However, the driver is presumed to be consistent and homogeneous for the sake of data analysis. As a result, the percentage of forced gaps is determined to be larger than the approved percentage.

In order to study the classification gap acceptance behavior of each kind of vehicle, Raff's Method was used to estimate the crucial gap for each vehicle. Only for two-wheelers, the essential gap is as little as 1.25 seconds. For three-wheeled vehicles, the average time is 1.78 seconds. As a result of this, the crucial gap value for automobiles is 1.425 seconds. Car factors like size and acceleration rate, for example, might explain some of the discrepancy across vehicles.

The data acquired from the intersection was subjected to the fundamental three ways of determining critical gap: Harder's method, Raff's method, and Ashworth's approach. The lowest crucial gap value is 1.29 seconds, based on the accepted and rejected lags. Based on statistical distribution functions of accepted and rejected gaps and their intercept, Raff's technique calculates a critical gap value of 1.4 second. Critical gap is 1.53 seconds according to Ashworth's technique, which takes into consideration the mean and standard deviation of allowed gaps.

At every 10 metre interval, the percentage decrease in speed for incoming vehicles is greater than the % gain in speed for departing vehicles. In both pre- and post-conflict situations, the average decline in speed is found to be roughly 17 percent. According to a speed profile of a vehicle's journey, drivers prefer to accelerate up as soon as they leave conflict zones, while slowing down far in advance of the conflict zone.

Each leg's headway was calculated using a minute-by-minute volume count. There is a correlation between traffic volume and headway values; the plot best fits as an exponential (negative) with a value ranging from 0.22 to 0.49, according to the data. All the legs' combined data sets provide 0.35 for lambda, which is the average of the individual values.

In the past, comparisons between Surat and other cities were made using the same three approaches. This analysis is distinct from the one that came before it in just the slightest of ways.

FUTURE SCOPE

A four-legged dual-lane roundabout was used in the research. Various portions of the crossroads have been left undisturbed for future construction because of the intersection's varying size, shape, and number of lanes.

• Researchers have come up with a variety of methods for determining the worth of key gaps in the recent past. The Lag approach, Raff's method, and Ashworth's method were all used in this investigation. Other approaches that may be used are also out there.

The Harder's Approach, the Logit-Probit method, and the highest likelihood method. Researchers utilized these approaches using data obtained under homogeneous traffic conditions, which differ from those seen in India. As a result, they may be employed in India.

• When it comes to unsignalized junction capacities, War drop's Model is employed in India. It takes into account the shape and movement of vehicles. Researchers throughout the globe have revealed that the capacity might be found to be more dependent on the vehicle's willingness to tolerate the gap in the road. A new approach for estimating capacity at unsignalized intersections may be developed since War drop's method does not take into account gap acceptance behavior.

• In our investigation, we focused on a four-legged junction with two circulation lanes. The number of approach lanes and circulation lanes in the junction might be examined in future research.

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