International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 10 | October 2025 www.irjet.net p-ISSN: 2395-0072

Analysis of Traffic Survey Data in Raipur City based on different methods and variety of approaches.

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Abstract - A successful transportation system can only be achieved by smartly monitoring real-time data and analyzing it according to different traffic factors.

It is essential to collect comprehensive traffic survey data to comprehend the actual circumstances, emphasizing management strategies, capacity, operations, and management. As a result, these research initiatives help to create efficient strategies that reduce traffic congestion.

As a result, these research initiatives help to create efficient strategies that reduce traffic congestion. According to the gathered data, the service level has been assessed based on lane width and the intended service volume. Furthermore, the traffic patterns for each road segment are analyzed through a hypothetical analysis study using statistical t-tables approach and traffic conversions, which uncovers the differences within particular sections and assists in determining the AADT value, that is, Average Annual Daily Traffic in relation to PCU (Passenger Car Unit). Along with this, it also helps in deciding the usage of patterns for different classified vehicles, which further helps in highlighting the variation of mean group data with respect to each other at the busiest intersection of road city of Raipur, Chhattisgarh. The findings from the research indicate that improving traffic management and control, offering more efficient public transportation alternatives, boosting investment in transport infrastructure, utilizing advanced technologies, and implementing coordinated policies for transport and land use are essential elements for reducing congestion. This study is based on real-time data taken manually from site site-based videography system.

Key Words: Data Collection, Traffic Survey data, Passenger Car Unit (PCU), Annual Average Daily Traffic (AADT), Peak Hour.

1. INTRODUCTION

Data collection through traffic surveys is essential for thorough traffic and transportation planning. Gaining insight into the existing traffic conditions and travel behaviors is crucial for improving traffic and transportation strategies aimed at alleviating congestion issues. This study facilitates a proper analysis of data collection to determine road usage patterns through hypothetical analysis and statistical techniques. The gathered data can be evaluated through various methods. The main objective of traffic surveys is to perform a study on traffic volume. This includes examining the variety of vehicles present on the road during a defined timeframe. Traffic volume may be quantified by the overall count of vehicles passing through a specific road over time or in relation to passenger car units (PCU) and time. The trend of road utilization reflects a theoretical examination of the Passenger Car Units (PCUs) produced on a particular segment of roadway, considering different times like morning and evening peak hours. This research analyzes the patterns of road usage derived from survey sessions. Given the limited availability of data, the approach taken by the researcher makes the hypothetical statistical t-test especially appropriate for analyzing these types of data and thus increases its efficiency. Additionally, this paper describes the method for calculating the average annual daily traffic (AADT) through the analysis of the maximum traffic volume observed on a specific day. Focus has also been given to measuring traffic volume and assessing the level of service. The significance of this research study and analysis will back smart mobility initiatives rooted in real-time traffic information, enabling the improvement of traffic signal schedules, routing, and public transportation systems, thereby encouraging more effective and sustainable urban transit and thus increasing mobility. Charging fees for driving in busy areas during high-traffic periods encourages people to travel during less crowded times and to use alternative routes, which directly affects congestion levels. Combining transportation planning with land-use strategies, including mixed-use developments and transit-oriented design, lessens the need for extended trips and encourages more sustainable, walkable urban environments. By integrating technological policies, infrastructure, and urban design, city planners, along with relevant research and agencies, seek to develop sustainable mobility solutions that significantly alleviate traffic congestion.

2. LITERATURE REVIEW

UDIT BATRA and MANDAR V. SARODE (RATMIG, 2013, IJAIEM) emphasize the significance of traffic surveys in conducting a detailed analysis of traffic and transportation. Various approaches are employed for traffic surveying, depending on the limited time available for the survey location. Different categories of traffic surveys can be conducted to assess current traffic conditions and travel demand patterns, which aid in developing plans for improvements in transportation infrastructure, such as road inventory surveys, classified traffic volume counting surveys, origin and destination surveys, household interview surveys, speed and delay studies, parking surveys, pedestrian surveys, surveys of intermediate public transport operations, and user surveys for intermediate public transport. A Traffic Count Survey using video analysis incorporates cameras with clear visibility and wide-angle lenses that cover extensive areas for research, allowing for precise counting and classification of vehicles, pedestrians, and cyclists. This approach presents several advantages, including efficient data collection that minimizes errors, the ability to observe specific sites such as cycle paths or intersections, and the provision of multimodal traffic counts that include both pedestrians and cyclists. Additionally, it ensures data accuracy and boasts a vehicle classification and detection reliability rate exceeding 99%. This research document presents findings regarding the level of service derived from data collected at five intersection points. The analysis of road usage trends was conducted utilizing a statistical t-table hypothetical evaluation, which reveals variations between the mean and the average, assisting in identifying the actual usage patterns of the roadway. This contributes to improving our capacity to change lanes, reduce traffic bottlenecks, and decrease accidents and other related issues. Ultimately, the thorough analysis helps in identifying crucial elements that are necessary for establishing an effective and sustainable transportation system catering to various types of road users.

3. MATERIAL AND METHODS

DATA COLLECTION

Traffic survey information has been collected at five distinct road intersection sites. To ensure precision, the volume of Passenger Car Units (PCUs) during peak hours has been recorded for both morning and evening periods. Manual counts, complemented by video footage from cameras, were utilized to compute the PCUs per hour for each roadway segment. Furthermore, the Level of Service has been evaluated based on the standards and guidelines presented in IRC: 106. The hypothetical assessment using the statistical t-table has been conducted, providing insight into the traffic patterns for each segment of the road. The traffic counts have been converted and illustrated with specific peak-hour data to show the analysis in line with Botswana guidelines, along with further calculations for the Annual Average Daily Traffic (AADT).

DATA ANALYSIS

The collected data presents the Level of Service, reflecting how a roadway segment supports mobility and its effectiveness based on lane width and the design service volume for urban arterial roads, in accordance with the standard DSV set by IRC: 106. Additionally, the investigation of Road Use Patterns emphasizes usage trends derived from a hypothetical statistical t-table analysis that uncovers deviations from the group mean. Traffic Count Conversion assists in identifying the PCU during peak hours, as well as the average and maximum daily traffic, ultimately leading to the determination of the Annual Average Daily Traffic (AADT).

4. DATA COLLECTION

LEVEL OF SERVICE

Traffic surveys have compiled data indicating the PCU (Passenger Car Unit) per hour during both the morning and evening peak periods. Assessing the PCU per hour for each segment of the road intersection enables the evaluation of the Level of Service (LOS) by calculating the ratio of PCU per hour to the Design Service Volume (DSV) according to IRC: 106; this information is summarized in the table that details the Level of Service for all roadways.

5. DATA ANALYSIS

The Road Use Pattern pertains to the theoretical examination of the Passenger Car Unit (PCU) generated at diverse sections of road intersections, utilizing statistical data analyzed against the t-table to identify the road usage trend. This trend shows minimal variation or deviation in the group mean of the usage pattern, whereas distinct types of patterns exhibit considerable differences in road usage. The techniques for translating traffic count calculations aid in determining the Peak Hour Factor in relation to Average Daily Traffic, converting average daily traffic data into Maximum Daily Traffic, and ultimately leading to the calculation of Average Annual Daily Traffic (AADT).

ROAD USE PATTERN

The Road Use Pattern relates to the theoretical examination of the PCU generated at different sections of road intersections, based on statistical data analyzed against the t-table to identify the road use pattern. This pattern shows minimal variation or deviation in the group mean of the usage pattern, while various types of patterns indicate substantial differences in road usage. The techniques for transforming traffic count calculations aid in determining the Peak Hour Factor in relation to Average Daily Traffic, converting average daily traffic figures to Maximum Daily Traffic, and ultimately facilitating the calculation of Average Annual Daily Traffic (AADT).

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{\Sigma\left(X_{1i} - \overline{X}_1\right)^2 + \Sigma\left(X_{2i} - \overline{X}_2\right)^2}{n_1 + n_2 - 2} \times \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}}$$

with d.f. $= (n_1 + n_2 - 2)$

In this context,'t' refers to the t-value, while 'X bar' represents the mean of the dataset. To begin, we need to determine the degrees of freedom (d.f.). To calculate this 'd.f.', the sample size ('n') is required, which will lead us to the d.f. Value. Next, we will identify the 't'-value, which corresponds to the t-critical value. At a significance level of 5%, the expected t-critical value is 1.9146. By substituting the values into the formula, we can find the t-statistic. If the t-statistic exceeds the t-critical value, this indicates a difference in road usage patterns between the two sessions; otherwise, it suggests the road usage patterns are similar across both sessions. We have a total of 8 samples, which results in the degrees of freedom (d.f.) being calculated as (8 + 8 - 2) = 14. For a d.f. of 14 at a 5% significance level, the critical t value is 1.9146.

Table -1: Level of service for all sections of road intersection.

Sr. No.	Location at intersection	Time Period	PCU /hr. (Passenger Car Unit)	Width of road per lane (m)	No. of Lanes	Design Service Volume (DSV)	Volume/Capacity ratio	LOS (Level of service)
1.	Durg Road AH46	Morning Peak Hour	1362	3.75	1	1800	0.76	B
	(Mumbai – Kolkata Highway)	Evening Peak Hour	1374	3.75	1	1800	0.76	B
2.	Ring Road No. 01	Morning Peak Hour	1477	3.75	1	2400	0.62	B
	(Surat – Kolkata Highway)	Evening Peak Hour	1440	3.75	1	2400	0.60	B
3.	Tatibandh	Morning Peak Hour	1557	3.75	1	2400	0.65	B
	Great Eastern Road	Evening Peak Hour	1443	3.75	1	2400	0.60	B
4.	Ring Road No. 02	Morning Peak Hour	1546	3.5	1	1800	0.86	B
		Evening Peak Hour	1414	3.5	1	1800	0.79	B
5.	Raipur – Bilaspur Highway	Morning Peak Hour	1592	3.5	1	1800	0.88	B
		Evening Peak Hour	1488	3.5	1	1800	0.83	B

Table 2. Road Use Pattern Analysis by t-table.

Serial No.	Road Sections at Intersection	t-Critical	t-Stat	Type of Pattern
1.	Durg Road AH 46 (Mumbai – Kolkata Highway)	1.9146	-0.0075	Same
2.	Ring Road No. 01 (Surat – Kolkata Highway)	1.9146	0.0354	Same
3.	Tatibandh (Great Eastern Road)	1.9146	0.0820	Same
4.	Ring Road No. 02	1.9146	0.0944	Same
5.	Raipur – Bilaspur Highway	1.9146	0.0454	Same

TRAFFIC COUNT CONVERSION

The primary input factors for developing an improved road network involve analyzing traffic volumes. To create a road network intended to last 20 years, the Annual Average Daily Traffic (AADT) measurement is utilized. This figure represents the total number of vehicles that pass a specific point in both directions each day, while considering seasonal variations in traffic patterns and the total axle counts associated with that vehicle volume. To calculate the AADT from the Average Peak Flow gathered from a 2-hour traffic survey, several steps must be followed to determine the average daily maximum flow. After recording the peak traffic counts over 24 hours, one can convert this data to the standard 24-hour flow to compute the Average Daily Traffic, which will then allow for the determination of the Annual Average Daily Traffic.

The traffic volume during peak hours, used for design calculations, reflects the number of vehicles that pass a certain point during the most congested hour(s) of the observation period. To transform peak-hour traffic data into Average Daily Traffic (ADT), the first step is to calculate the Peak Hour Factor (PHF), which is the ratio of the highest volume in a single hour to four times the maximum volume recorded during 15 minutes within that peak hour.

Now, calculating Peak Hour Factor, $PHF = \frac{V}{4 \times V15}$.

Where: 1-hour peak flow (Obtained from traffic survey)

V15=15-minute peak flow of the 1-hour peak flow (combining both morning and evening peak hours).

1. Conduct two traffic observation sessions for every segment of the roadway.

2. Determine the four highest traffic volumes from each observation session for a particular section of the road (15-minute interval).

3. Compute the average of the four volumes from each session.

4. Calculate the overall average of the averages obtained from each session.

5. This will yield the peak hour volume for that specific segment of the road.

6. Repeat this entire process for all five segments of the roadway.

7. Compute the average across all five segments of the road.

8. Consider the highest traffic volume for one hour based on the average value obtained.

9. Evaluate the highest volume over a 15-minute timeframe using the calculated 1-hour average peak volume. After determining the Peak Hour Factor, calculate the maximum flow rate for the peak hour period. MRF represents the peak volume recorded during 1 hour divided by the PHF. The maximum daily traffic (MDT) is calculated by multiplying the maximum flow rate (MFR) by 24 hours. To determine the Average Daily Traffic, multiply the MDT by a traffic conversion factor. This factor represents the ratio of the second-highest peak traffic flow to the highest recorded flow value during a specific peak time, under the same circumstances and within a designated counting period.

2. Conversion of Average Daily Traffic (ADT) to Annual Average Daily Traffic (AADT)

The Annual Average Daily Traffic (AADT) reflects the anticipated number of vehicles that will utilize a specific road throughout a year (365 days). To calculate the Annual Average Daily Traffic from Average Daily Traffic, the formula used is AADT = T-ADT / 365. In this equation, AADT denotes Annual Average Daily Traffic, while T-ADT signifies Total Average Daily Traffic. To find the Total Average Daily Traffic, a peak traffic survey is performed for one week each month, and the total monthly traffic counts are summed to derive the overall average daily traffic.

In our traffic study conducted over one day at a single location, we gathered seven sets of traffic survey data across seven days. Consequently, the T-ADT is computed as ADT multiplied by 31 and then by 12.

Note:

1. All traffic volumes should be represented in Passenger Car Units (PCU).

2. To convert peak-hour (2 hr.) traffic data into Average Daily Traffic, if a road section shows a stable usage pattern throughout both sessions, the average of the peak hours from each session should be taken. Conversely, if the road section displays varying patterns during the two sessions, the highest peak hour from either session should be chosen.

COMPUTATION OF TRAFFIC SURVEY DATA:

Table 3. PCU (Traffic Volume) for AADT Computation

Time (15 min)	1st	2nd	3rd	4th	5th	6th	7th	8th
PCU (Passenger Car Unit)	550	472.2	384.9	351.2	423.5	388.5	351.4	340.7

Peak Hour Traffic Volume for:

2-hour (considering both morning and evening peak hours) = 3262.4 PCU

1-hour (considering both morning and evening peak hours) = 1834.2 PCU V15 = 550

PHF = 1834.2/4X550 = 0.83373

PHF denotes Peak Hour Traffic

Rate of flow (Max.-1 hour) = 1834.2/0.83373 = 2200

Maximum Daily Traffic (MDT) = 24 X 2200 = 52800

Average Daily Traffic (ADT) = 52800 X 0.946

= 49948.8 PCU

(Using data: 0.946 = Traffic conversion factor by Botswana Guideline 9)

(T-ADT) = (ADT X 31 X 12).....(31 days in a month & 12 months

= (49948.8 X 31 X 12) = 18580953.6 PCU

Average Annual Daily traffic (AADT)

= (T-ADT)/365

= 18580953.6/365

= 50906.722 PCU (Final Answer)

6. RESULT

The various techniques for analyzing traffic survey data provide insights into the methods utilized for assessment. Evaluations of traffic volume studies reveal the quantity of traffic on a road segment during peak times, which are defined as two hours in the morning and two hours in the evening, and are measured by the total number of vehicles on the road as well as in passenger car units. The fluctuations in traffic volume over time are depicted in Fig. 1, while Fig. 2 illustrates the percentage distribution of different types of vehicles utilizing that roadway during the same timeframe. The assessment of the level of service offers a quantitative measure of traffic flow efficiency throughout the city. Results show that major roads receive a level of service rating of "B," indicating a stable flow that allows drivers to maintain a reasonable degree of speed choice and maneuverability within the traffic. Average travel speeds generally reach around 70 percent of the free-flow speed for arterial roads. Traffic usage patterns have been analyzed in connection with specific traffic trends during peak morning and evening hours. Roads exhibiting similar usage patterns display identical characteristics in terms of traffic flow and various parameters during both peak periods. Conversely, roads with differing usage patterns reveal distinct traffic flow characteristics during morning and evening peak hours. The analysis of road usage patterns has employed a research method involving t-tests. Establishing a consistent road usage pattern implies that the level of service for that particular road during both morning and evening peak periods should also be the same. The assessment of traffic count conversion yields the annual average traffic count derived from surveys conducted during peak times. The analysis period has been specified as 31 days within a month, as traffic planning should focus on managing the peak traffic volume. Therefore, utilizing this method, the annual average traffic count has been calculated in terms of Passenger Car Units (PCU).

7. SUMMARY AND CONCLUSIONS

Understanding data is essential for devising transportation and traffic initiatives, which is the main focus of this paper. Research on traffic volume has been conducted during peak periods to evaluate the necessity for road development or planning that corresponds with anticipated traffic volumes. Road usage patterns have been examined utilizing a method that illustrates how different roads are used at various times, along with their corresponding traffic volumes. The approach for converting traffic counts has been utilized to calculate the Average Annual Daily Traffic (AADT) from the Average Daily Traffic (ADT), which aids in forecasting future AADT and analyzing service levels to assess traffic adaptability. As a transportation engineer, ensuring a safe and dependable experience for public transportation is a top priority. Thus, this research assists future scholars in the area by thoroughly analyzing traffic surveys to mitigate traffic-related issues. Ultimately, it paves the way for further examination of traffic survey data through the ITMS system, which delivers real-time traffic information gathered by an intelligent system and provides algorithms for smart traffic detection. Additionally, it contributes to achieving high-efficiency mobility on roads, alleviating congestion and related challenges.

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