

ASSESSMENT OF INTERSECTION PERFORMANCE USING TRAFFIC VOLUME AND LAND USE-TRANSPORTATION RELATIONSHIP: EVIDENCE FROM RAJSHAHI, BANGLADESH

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ABSTRACT

Talaimari intersection is a critical but unmarked misaligned (or unaligned) crossing of the Dhaka-Rajshahi Highway (N6), which links the intersection with four arterial streets, serving two major universities and suffering chronic overloading during the peak hours. This paper evaluates the traffic volume, modal variation, intersection performance through the Level of Service (LOS), and land use-transportation relationship in order to make informed decisions in urban planning. A manual counting system was utilized on both a weekday and an off-day. The data were recorded every 15 minutes during morning peak (8:00–10:00), noon off-peak (12:00–14:00), and evening peak (16:30–18:30) periods and in eight directional lanes in four stations. Calculations are performed in Microsoft Excel by converting the traffic volumes to Passenger Car Unit (PCU). The analysis of the data by time showed the highest hourly flows, with the outflow the highest on Monday at 2,953 PCU/h (Kazla to Talaimari evening) and the inflow the highest on Friday at 3,509.75 PCU/h (same station, evening). The volumes on Fridays were 10-15 percent greater, due to weekend travel, in spite of the light rain. Three-wheeled vehicles (autos and auto-rickshaws) were predominant (67% motorized traffic), followed by motorcycles (12-26%), cars (7-35%), and minimal trucks (<1%); the rest of the non-motorized modes, such as bicycles and carts, were predominant. The consistency of LOS measurements was the following: PHF scored B (Monday, avg. 0.65) and A (Friday, avg. 0.60); V/C average scores A (0.50 Monday, 0.49 Friday), but in some cases, it was E; in terms of speed (16.4427.48 km/h). The traffic volume survey and Gravity modeling created an Origin-Destination that identified important socio-economic adjustment factors (K_{ij}) with a high value of labor supply chain between Saheb Bazar and Fultola ($K_{ij} = 5.31$) and low value of socio-spatial isolation between institutional zones and low-income peripheries. These findings underscore the necessity for dedicated non-motorized lanes, intersection signalization, and real-time traffic tracking to improve safety and support Rajshahi's sustainable urban and economic development.

Keywords: *Traffic volume survey, Modal Variation, Peak Hour Factor (PHF), Volume-to-Capacity ratio, Gravity Model, Socio-Economic Factor (K_{ij})*

1 INTRODUCTION

The purpose of a traffic volume survey is to ascertain the quantity, flow, and kind of vehicles on the road at any one moment. The purpose of the survey activities is to help the appropriate authorities plan and build traffic facilities, estimate road usage and traffic patterns, and measure existing demand to determine priorities for road development and improvement. Precise traffic volume estimation is essential for effective transportation planning (Kadim et al., 2020). Since the growth of a country's road network has a direct impact on its economy, it is imperative to ensure that all of the country's regions are connected by roads and that the transportation infrastructure is in excellent physical shape. Being a rapidly expanding metropolitan region, Rajshahi faces increasing traffic demands at important intersections like Talaimari Intersection. Unsignalized intersections, mixed vehicle types, lane restrictions, small and damaged roads, unscheduled pauses, and speed disparities are the main causes of this problem (Jisan et al., 2023). Since it is a significant interchange that connects the Dhaka-Rajshahi Highway (N6), traffic flow via the intersection should be tracked and evaluated to allow for efficient planning and control. The objectives of this study are to view the modal variance and traffic flow pattern at different times of the day and determine the Level of Intersection (LOS) of Talaimari Intersection, and also to determine the relationship between land use and. A systematic traffic volume study can help identify the pattern of vehicular flows, the application of residential structures, peak hour traffic, and modal share, which will form the core of upgrading intersections and strategies to overcome congestion as a whole.

2 LITERATURE REVIEW

Traffic volume surveys are an essential component of transportation planning. It promotes efficient and sustainable transportation planning and urban development (Salisu & Oyesiku, 2020). It provides real time traffic data to contribute to comprehensive decision-making regarding road design, network capacity, and traffic management strategies (Satterthwaite, 1981). A traffic volume survey systematically counts and categorizes cars passing through a specified point or section over a set period, providing crucial data to engineers and planners. Manual counts during peak periods in Chanakyapuri Bridge in India were employed to examine the types of vehicles, volumes and the highest hourly traffic and directional traffic. This data was instrumental in the planning and design of the sub-arterial road segment by defining the road patterns of usage (Rahman, 2018). Likewise at the Moylapota Intersection in Khulna, Bangladesh, human traffic measurements determined the flow rates, vehicle types and variability in the peak-hours. Intersection design changes and traffic control procedures based on the resulting data were to improve the safety efficiency and efficiency of operation (Das, 2013). Traffic volume surveys were used to measure peak-hour factor, average annual daily traffic, modal share, and directional distribution at Bijoy Sharani and Shatrasta junctions in Dhaka using manual method. This information helped to design the appropriate structure of the roadway and plan the efficient traffic management system (Sabbir, 2022). Rajshahi, Bangladesh, used a case study to assess the level of service (LOS) on the basis of peak-hour factor, volume-to-capacity ratio, and temporal variation to investigate the level of service at three crossways. Among the recommendations that resulted were reduction of truck movement to enhance traffic flow (Janković et al., 2021). Estimation of the origin-destination (O-D) matrix is a critical component of transportation modeling, which is commonly modeled by the use of gravity models, which apportion trips by zonal productions, attractions, and travel impedance (Ortúzar and Willumsen, 2011). The gravity model includes a socio-economic adjustment variable, K_{ij} , to eliminate the un-modeled factors, like population or economic differences between zones (Cleofas & Sundo, 2016). K_{ij} is usually set to 1.0 and optimized with iterative steps (e.g. error minimization algorithms or proportional fitting) to the point where predicted trips are consistent with observed data (Pani & Sahu, 2019). These model calibrations improve the accuracy of the models and also allow the researcher to obtain insights into both time and space socio-economic changes of trip patterns. As there is increasing pressure on urban transport system in Rajshahi, traffic volume surveys are important for informed transportation planning and infrastructure design. This study in the Talaimari intersection, Rajshahi, aims to provide insights about real-time traffic conditions in the intersection to contribute to taking proper strategies for better traffic flow and management systems.

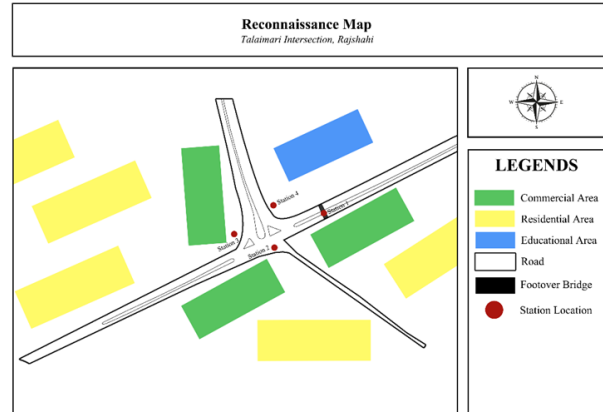
3 METHODOLOGY

3.1 Study Area Description

The study is carried out in the Talaimari intersection in the Rajshahi City Corporation area. The geographic coordinate of the intersection is between 24.36 and 88.63. It is a “Misaligned Intersection”. It has great importance as it serves the Dhaka-Rajshahi Highway (N6) and adjacent to two universities. This intersection significantly experiences both peak-hour congestion and continuous traffic flow throughout the day. The intersection is connected to 4 distinct directions: Vodra, Saheb Bazar, Kazla, and Fultola. The entire study area was divided into 4 stations with 8 different routes with 8 different directions. The station locations are shown in Table 1.

Table 1: Station & Route of Lanes

Station	Route of the Lanes	Directions
ST-1	Talaimari to Vodra	Outflow
	Vodra to Talaimari	Inflow
ST-2	Talaimari to Kazla	Outflow
	Kazla to Talaimari	Inflow
ST-3	Talaimari to Fultola	Outflow
	Fultola to Talaimari	Inflow
ST-4	Talaimari to Saheb Bazar	Outflow
	Saheb Bazar to Talaimari	Inflow



The cross-sectional element of each route to Talaimari intersection and its dimensions are illustrated in Figure 1.

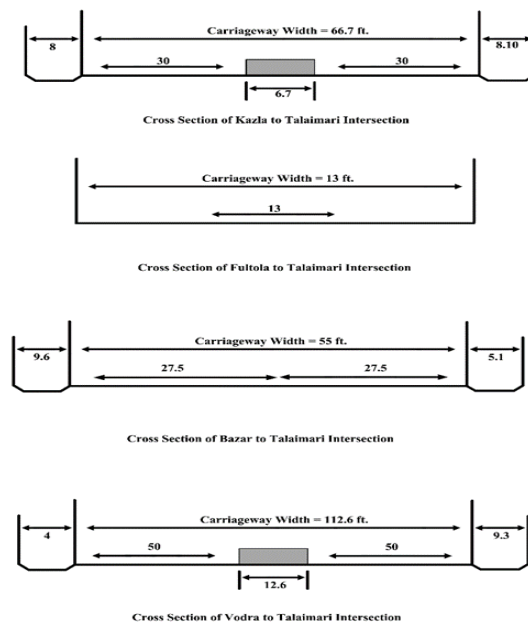


Figure 1: Cross-sectional elements with their dimensions of each route of Talaimari intersection

The Manual Counting Method has been used in this research, which counts each vehicle that travels by a specific location on a road for a predefined period of time. Although the count might go on for any length of time, it usually lasts 16–24 hours per day for three or four days in a row. According to their type (trucks, cars, buses, rickshaws, etc.) and direction of travel, vehicles are grouped by the count. For

better accuracy, videos have also been recorded from foot over bridge. Survey was conducted on Monday (28-07-2025), which was a weekday, and another one on Friday (01-08-2025), which was an off day. The data were collected at 15-minute intervals over three different time periods. The time schedules were on morning peak hour (8:00 am- 10:00 am), noon off-peak hour (12:00 pm-2:00 pm), and evening peak hour (4:30 pm-6:30 pm).

3.2 Data Analysis

3.2.1 Volume-to-Capacity (V/C) Ratio Method

The capacity (C) is calculated as in Equation (1) :

Where, Highest Design Capacity is based on road type (Table 2). The V/C ratio, which determines

$$C = \frac{\text{Highest Design Capacity} \times \text{Effective Width}}{12} \quad (1)$$

LOS, is derived from Equation (2):

$$LOS = \frac{V}{C} \quad (2)$$

where V = total hourly PCU volume. LOS thresholds are provided in Table 1.

3.2.2 Peak Hour Factor (PHF) Method

The PHF for each peak hour was derived from 15-minute interval counts [Equation (3)]:

$$PHF = \frac{\text{Average PCU of 1 Hour}}{(15 \text{ Minute Highest PCU}) \times (\text{Number of Readings})} \quad (3)$$

Here, 4 readings have been taken in every session. Thereafter, LOS was assigned according to Table 1

3.2.3 Speed-Based Method

Average travel speed over 1-km segments was measured using the floating test-car technique. Later, it was calculated using Equation (4). LOS was classified per Table 1

$$\text{Speed (km/h)} = \frac{\text{Distance (km)}}{\text{Travel Time (h)}} \quad (4)$$

Later, the data analysis was completed in Microsoft Excel. Various methods, like Temporal Variation, Modal Variation, PHF, LOS, and V/C Ratio were used for calculating the survey data.

Table 2: Highest Design Capacity of Roads

Table 1: LOS Thresholds Based on V/C Ratio, PHF and Speed

Road Types	Capacity (PCU/Hour)	Level of Service (LOS)	Volume Capacity (V/C) Ratio	Peak Hour Factor (PHF)	Speed (km/h)
Freeway	2000	A	≤ 0.6	≤ 0.7	≥ 40
Major Arterial	1200	B	0.6–0.7	0.7–0.8	30–40
		C	0.7–0.8	0.8–0.85	25–30
Minor Arterial	900	D	0.8–0.9	0.85–0.9	20–25
Collector	600	E	0.9–1.0	0.9–0.95	15–20
		F	≥ 1.0	≥ 1.0	≤ 15

3.2.4 Gravity-Based Trip Distribution Framework

The trip distribution at Talaimari intersection was modelled based on a traditional doubly-constrained gravity formulation, with a socio-economic adjustment parameter K_{ij} to be used just to interpret the land use-transportation relationship, but not to re-estimate or re-calibrate any other O-D matrix:

$$T_{ij} = \frac{A_j F_{ij} K_{ij}}{\sum_j A_j F_{ij} K_{ij}} \quad (5)$$

where

T_{ij} = trips from origin zone i to destination zone j ;

P_i = total trip productions at zone i ;

A_j = total trip attractions at zone j ;

F_{ij} = friction factor (inverse function of travel time/impedance);

K_{ij} = socio-economic adjustment factor for the i - j interchange.

3.2.5 Construction of The Base O-D Matrix from Traffic Counts

The initial O-D matrix was developed with the help of classified traffic volume surveys at the intersection of Talaimari. The number of vehicles was counted on the assumption that all the vehicles will have the same origin-destination pair without the use of intermediate stops, change of direction, or the creation of mid-path trips. Approach volumes and turning-movement counts were transformed into origin destination flows between the approach legs and the adjacent zones by standard traffic assignment and proportional allocation techniques, based on a previous practice in O-D estimation on the basis of link counts. The observed OD matrix T_{ij}^{obs} can be used in the analysis; there was no other developed gravity-calibrated O-D matrix (ModelIT, 1996; Al-Mosawi, 2025).

3.2.6 Derivation of travel time and impedance from speed survey

In order to measure inter zonal impedance, the speed based field survey was carried out in all links between the intersection of Talaimari and the adjacent zones. Average travel speed \bar{v}_{ij} were calculated between each ij pair and travel time was computed using the following:

$$t_{ij}(\text{minutes}) = \frac{d_{ij}(\text{km})}{\bar{v}_{ij}(\frac{\text{km}}{\text{h}})} \times 60 \quad (6)$$

The resulting travel time matrix $T=[t_{ij}]$ forms the basis for calculating friction factors (TRB, 1969).

3.2.7 Friction factor specification and calibration

A deterrence or friction factor F_{ij} , was formulated as a monotonic decreasing characteristic of the travel time T , representing the decreasing propensity to travel as there is an increased time interval between

zones. In keeping with a common trend about urban and intra-urban mobility, a distance-decay form was adopted:

$$F_{ij} = e^{-\beta t_{ij}} \quad (7)$$

where β is a decay parameter that is sensitive to trips regarding time of travel. Such exponential forms are suitable in empirical studies of short-distance, local-scale urban flows and intersection-level studies. According to these results and trial calibration with experimentally observed trip length distribution the value of β was fixed to 0.08 min^{-1} a value that is indicative of the scale impedance to travel at an intersection in such contexts (Ortúzar & Willumsen, 2011).

3.2.8 Iterative estimation of socio-economic adjustment factor K_{ij}

The socio-economic adjustment factor K_{ij} was calculated through the process of calibration iteratively to include land-use and socio-economic effects of trip interchange that were not accounted by productions, attractions and travel time alone. The process was done in five steps:

- (1) Initialize all $K_{ij} = 1.0$
- (2) compute modelled flows T_{ij}^{mod} using Equation (5) with observed P_i, A_j , calibrated F_{ij} , and current K_{ij} ;
- (3) calculate error ratios using Equation (8) and identify the maximum discrepancy;

$$r_{ij} = \frac{T_{ij}^{obs}}{T_{ij}^{mod}} \quad (8)$$

- (4) update the critical pair's socio-economic factor using Equation (9)

$$K_{ij}^{new} = K_{ij}^{old} \times r_{ij} \quad (9)$$

- (5) Repeat until the maximum relative error across all non-zero O–D pairs fell below 0.5% (< 0.00005 in proportional terms), consistent with standard convergence tolerances in gravity model calibration (Ortúzar & Willumsen, 2011; Cleofas & Sundo, 2016; ModelIT, 1996.)

4 RESULT AND DISCUSSION

4.1 Analysis of Temporal Variation

The evening outflow of station 1 recorded the highest traffic flow of Kazla to Talaimari Intersection at 2953 PCU/hour. In contrast, the morning inflow of station 2 recorded the lowest off-peak value of 27.5 PCU/hour in Fultola to Talaimari Intersection. At station 3, the evening off-peak of inflow recorded the highest amongst all the entries in station 3. The highest value is 2262.75 PCU/hour of Vodra to Talaimari Intersection at evening. The traffic volume of station 4 falls in between all other stations. The traffic volume is average in station 4 (Vodra to Talaimari Intersection) in both Inflow and Outflow (Figure 2).

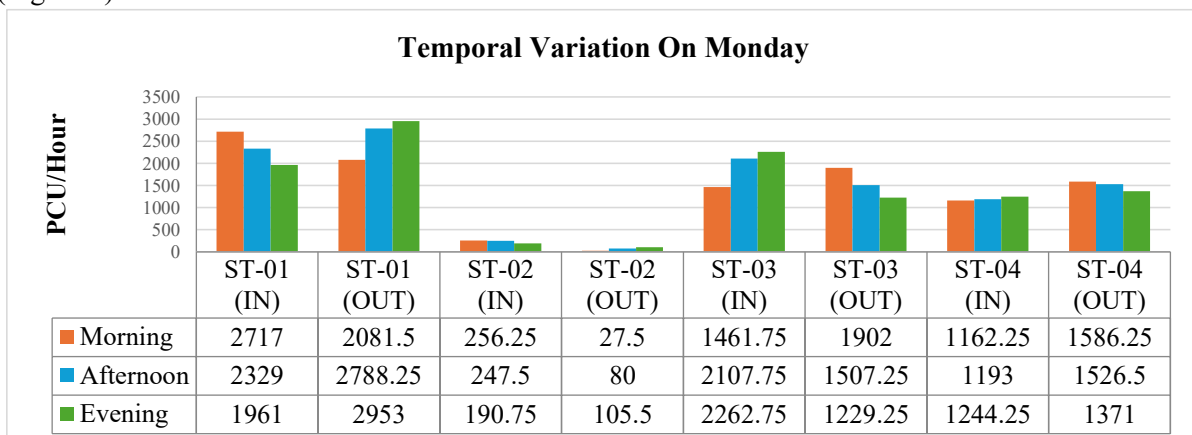


Figure 2: Temporal Variation on Monday

On Friday, the traffic is higher compared to weekday. During the morning off-peak, the highest value is recorded at Station 1 Inflow at 2335 PCU/hour of Kazla to Talaimari Intersection. Similarly, the highest evening off-peak traffic is also recorded at the Station 1. The lowest PCU/hour is recorded at the Station 2 (Fultola to Talaimari Intersection) at the morning off-peak at 39 PCU/hour. Both the Station 3 and Station 4 are recorded average values in all of the entries (Figure 3).

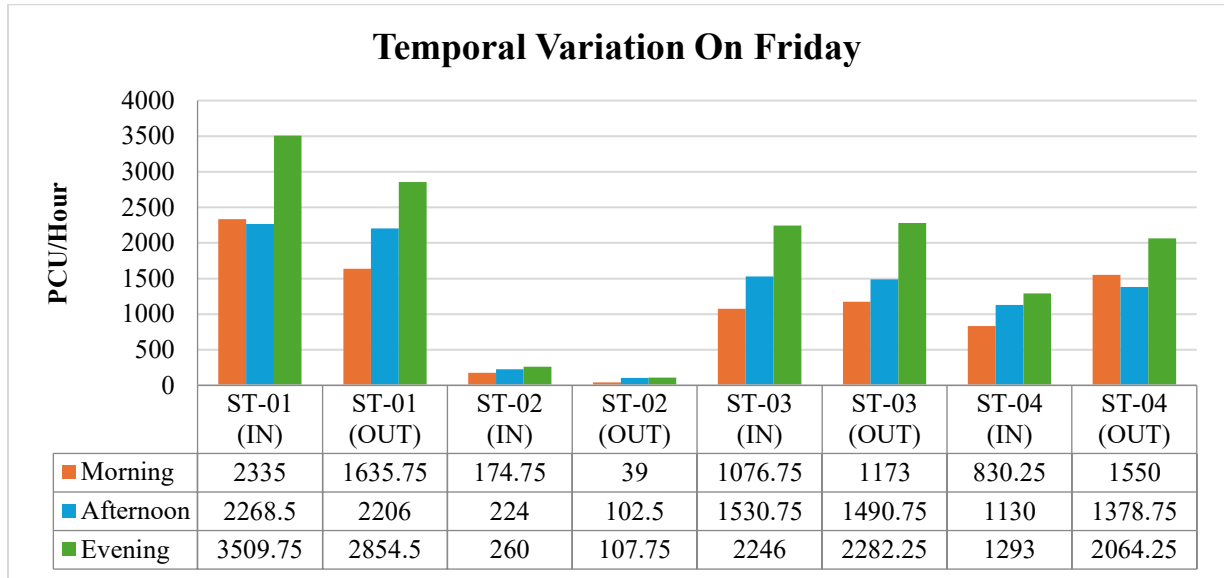


Figure 3: Temporal Variation on Friday

4.2 Analysis of Modal Variation

The modal variation across the locations of various survey stations around approaches to Talaimari Intersection showed a steady percentage of Auto and Auto-Rickshaw, but also, there were temporal and spatial variations between Monday and Friday. Auto (29.6–31.8) and Auto-Rickshaw (27.032.4) were at the top at Station-01 (Kazla), with more share on Friday (20.4) and peaks in the evening (Figure 7, 8). There was high Auto dominance (37.439.5%), high car use on Monday (34.8%), and high evening use on Friday in Station-02 (Fultola) (Figure 9, 10). The maximum volumes were observed at Station-03 (Saheb Bazar) (3,1113,423 vehicles), balanced Auto/Auto-Rickshaw/Motorcycle (2528%), increased bicycle usage on Monday (11.5%), and evening hegemony (Figure 11, 12). Station-04 (Vodra) saw 1,9342,260 vehicles, with Auto (30.431.2) and Auto-Rickshaw (22.823.1) the top, and higher car presence (18.0) and motorcycle presence (14.5) on Friday, and obvious evening peaks (Figure 13,14). In general, auto modes were dominating and Friday was characterized by more balanced distributions and greater evening activity.

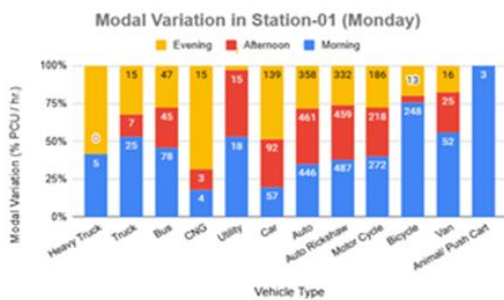


Figure 5: Modal Variation in Station-01 (Monday)

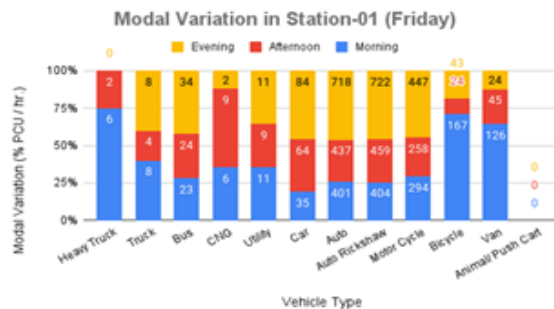


Figure 6: Modal Variation in Station-01 (Friday)

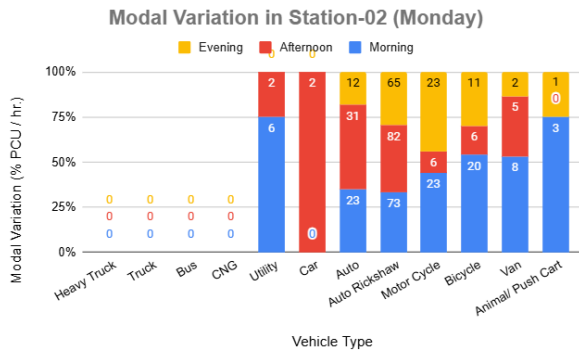


Figure 7: Modal Variation in Station-02 (Monday)

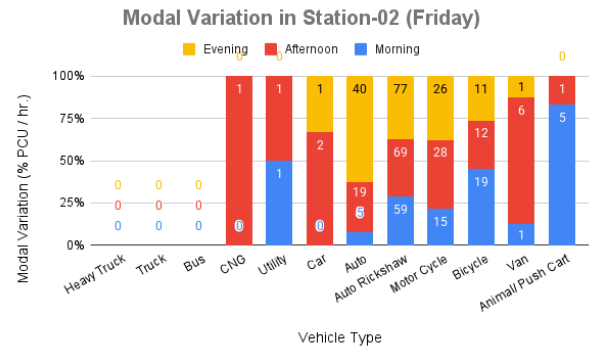


Figure 8: Modal Variation in Station-02 (Friday)

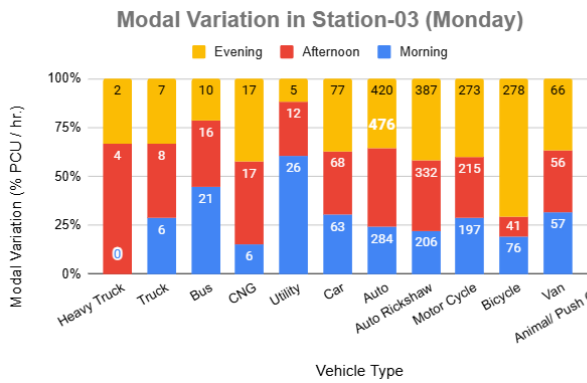


Figure 9: Modal Variation in Station-03 (Monday)

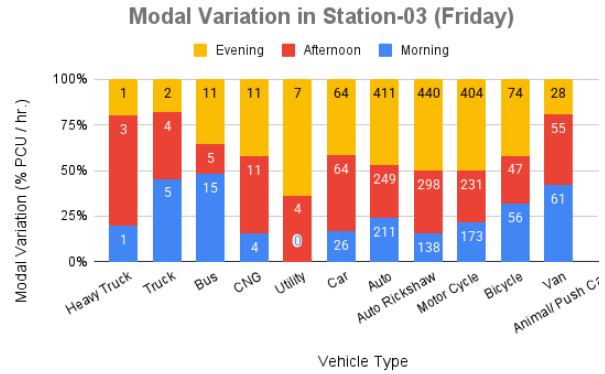


Figure 10: Modal Variation in Station-03 (Friday)

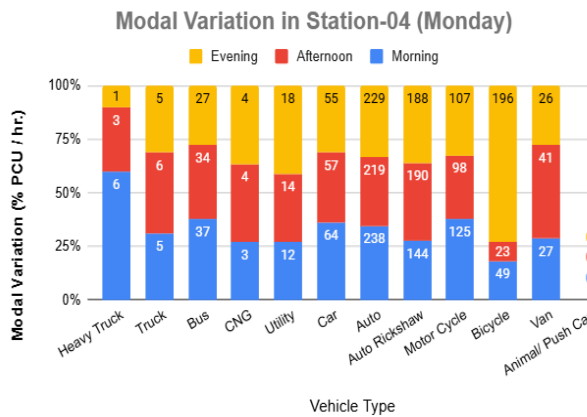


Figure 11: Modal Variation in Station-04 (Monday)

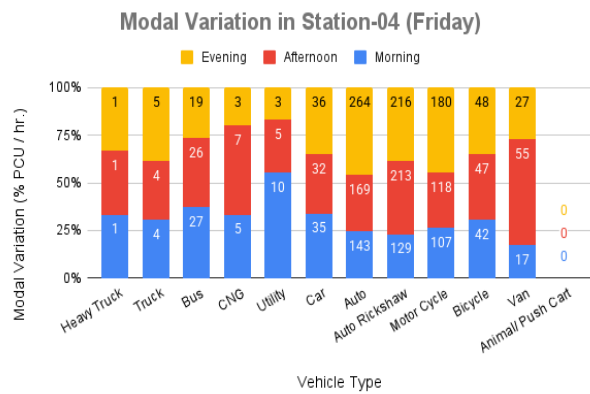


Figure 12: Modal Variation in Station-04 (Friday)

4.3 Level of Service (LOS) Analysis

4.3.1 Level of Service (LOS) of the Lanes and in the Intersection based on Peak Hour Factor (PHF)

Table 3: LOS Calculation of Intersection based on the PHF method

Name of the Lane	Day	Average Volume (PCU/hr.)	15 Minute Highest PCU	PHF	LOS of Lane	LOS of Intersection	
Kazla to Talaimari	Monday	2335.67	776.75	0.75	B	Monday	Friday
	Friday	2704.41	1009	0.67	A		
Talaimari to Kazla	Monday	2607.58	826.75	0.78	B		
	Friday	2232.08	820	0.68	A		
Fultola to Talaimari	Monday	68.83	109	0.16	A		
	Friday	79.33	83	0.24	A		
Talaimari to Fultola	Monday	71	33.5	0.53	A	Average PHF (0.65)	Average PHF (0.60)
	Friday	83.08	45	0.46	A		
Bazar to Talaimari	Monday	1662	653	0.64	A	A	A
	Friday	1321.17	495.5	0.66	A		
Talaimari to Bazar	Monday	1546.17	568.25	0.68	A		
	Friday	1648.67	610	0.67	A		
Vodra to Talaimari	Monday	1199.83	387.25	0.77	B		
	Friday	1084.42	371.25	0.73	B		
Talaimari to Vodra	Monday	1494.58	424.5	0.88	D		
	Friday	1664.33	596.5	0.7	B		

Table 3 shows the analysis of LOS of different road sections. For the segment of Kazla to Talaimari Intersection, the LOS is stable on both Monday and Friday. It indicates the free flow of vehicles on this segment with average volume is 2469.935 PCU/hour. Fultola to Talaimari intersection recorded the lowest traffic volume of all other road segments. Here the average LOS is A. It indicates the excellent traffic flow of the lane. Bazar to Talaimari Intersection notices free flow of traffic on both Monday and Friday with the average LOS is B. Finally, the Vodra to Talaimari Intersection recorded a busier traffic volume on Monday in compared to Friday, which seems normal as Monday is the last working day of week. The average PHF for intersections is 0.65 on Monday, with an LOS of B, and 0.60 on Friday, with an LOS of B. This data highlights variations in traffic volume and LOS across different days and lane segments.

4.3.2 Level of Service (LOS) of the Lanes and in the Intersection based on Volume Capacity (V/C) Ratio

Table 4: LOS Calculation of Intersection based on the V/C Ratio

Name of the Lane	Day	Average Volume (PCU/hr.)	Capacity (C)	V/C Ratio	LOS of Lane	LOS of Intersection	
Kazla to Talaimari	Monday	2335.67	3000	0.78	C	Monday	Friday
	Friday	2704.41	3000	0.90	E		
Talaimari to Kazla	Monday	2607.58	3000	0.87	D		
	Friday	2232.08	3000	0.74	C		
Fultola to Talaimari	Monday	68.83	650	0.11	A	Average V/C Ratio (0.5)	Average V/C Ratio (0.49)
	Friday	79.33	650	0.12	A		
Talaimari to Fultola	Monday	71	650	0.11	A	A	A
	Friday	83.08	650	0.13	A		
	Monday	1662	2062.5	0.81	D		

Bazar to Talaimari	Friday	1321.17	2062.5	0.64	B
Talaimari to Bazar	Monday	1546.17	2062.5	0.75	C
	Friday	1648.67	2062.5	0.80	D
Vodra to Talaimari	Monday	1199.83	5000	0.24	A
	Friday	1084.42	5000	0.22	A
Talaimari to Vodra	Monday	1494.58	5000	0.30	A
	Friday	1664.33	5000	0.33	A

From Table 4, it has been found that the traffic volume from Kazla to Talaimari on both Monday and Friday remains within LOS C & E respectively indicating stable flow to unstable flow, with tolerable to low operating speeds. E indicates unstable flow, where operations are near capacity and maneuverability is extremely limited. The flow from Talaimari to Kazla on both days is close to capacity, resulting in LOS D & C respectively indicating stable flow but speeds are controlled by higher volumes. Drivers' freedom for speed is restricted. The traffic flow from Fultola to Talaimari shows another condition, LOS A & A. Again, having a glance at the Talaimari to Fultola it can be found that LOS ranging from A to A, indicating free flow, with low volumes and high speeds where drivers can continue their journey with speedy movement with no delay. Again, LOS D is found from the Bazar to Talaimari route on Monday and LOS B on Friday. Here, the flow from Talaimari to Bazar also experiences LOS C on Monday, and D on Friday which is close to the capacity. But while considering the route from Vodra to Talaimari it is found to get LOS A on Monday and LOS A on Friday. Using the V/C ratio method, the LOS of Talaimari intersection is A, six times from six different routes whereas LOS C, D & LOS B are also found in the intersection as well. So, considering the frequency of Monday, LOS A is acceptable whereas considering the situation of Friday, LOS A is the depicted scenario to be found. Overall, the data suggests that on Monday, free traffic can have a stable flow but speeds are controlled by higher volumes. Driver's freedom for speed is restricted. Again, in the context of Friday, stable flow, and operating speeds were restricted somewhat. Drivers have reasonable freedom for speeds.

4.4 Speed-Based Survey

Table 5: LOS Calculation of Intersection Based on Speed-Based Survey

Road Lane	Distance	Travel Time (min)	Average Speed (km/h)	LOS
Kazla to Talaimari	1 KM	2 min 45 sec	21.82 km/h	D
Talaimari to Kazla	1 KM	2 min 55 Sec	20.57 km/h	D
Fultola to Talaimari	1 KM	0	0 km/h	---
Talaimari to Fultola	1 KM	0	0 km/h	---
Bazar to Talaimari	1 KM	3 min 39 Sec	16.44 km/h	D
Talaimari to Bazar	1 KM	3 min 25 sec	17.56 km/h	D
Vodra to Talaimari	1 KM	2 min 11 sec	27.48 km/h	C

Talaimari to Bazar	1 KM	2 min 35 sec	23.23 km/h	D
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4.5 Relationship between Land Use and Trip Generation

Table 7 : O-D Matrix derived from Traffic Count

Origin \ Destination	To Kazla	To Fultola	To Saheb Bazar	To Vodra
From Kazla	0	0	4462	4659
From Fultola	43	0	542	222
From Saheb Bazar	5670	311	0	863
From Vodra	3343	0	911	0

Table 8: Socio-economic Factor derived from O-D Matrix

Origin \ Destination	To Kazla	To Fultola	To Saheb Bazar	To Vodra
From Kazla	0	0	4.183	2.737
From Fultola	0.102	0	3.422	1.119
From Saheb Bazar	3.246	5.305	0	0.734
From Vodra	2.319	0	1.341	0

The calibration of the gravity model of the Rajshahi City demonstrated some important factors of socioeconomic adjustment that were significant and underscoring the heterogeneity of urban movement other than the distance decay. The derived matrix analysis indicates that there is a functional interdependence between the commercial core and peripheral low-income settlements, which is more prominent in the interaction between Saheb Bazar and Fultola (Table 7). The extremely large K_{ij} -factors (5.31) of this relationship, Saheb Bazar to Fultola and 3.42 the reverse are strong indicators of a viable labor supply chain in which the friction of distance has been overcome by economic need; people in the Fultola slum areas have no other choice but to travel to the Central Business District (CBD) to seek informal employment, and trip volumes are highly enhanced resulting in very large K_{ij} -factors. On the other hand, the matrix reveals a socio-spatial isolation of the educational island of Kazla and the degraded nature of the periphery of Fultola. Although the two are geographically close, there is virtually no interaction between them because of the strict social barrier in terms of which the university student population has no functional use in visiting the low-income residential areas of Fultola, and the reverse is also true. More so, the high level of connectivity recorded between Kazla and Saheb Bazar as the value of $K_{ij}=4.18$ represents a lifestyle tie, in which, the student population cuts across intermediate opportunities to receive the specialized services within the CBD. At the same time, the high factor between Kazla and Vodra, $K_{ij}=2.74$, recognizes Vodra not so much as a residential area but as an important multimodal transit point, where the short-term student population can travel in and out of the district (Table 8). Eventually, these factors of adjustment prove that mobility in Rajshahi is controlled not so much by the Euclidean distance, but by a strict grid of socioeconomic classes, institutional membership, and economic survival tactics.

5. CONCLUSION

The study of Traffic Volume Survey on the Talaimari Intersection gave an overview on the traffic condition on one of the major routes connecting to Rajshahi. According to the survey of traffic flow at the Talaimari intersection, Monday at Station-01 (Katakhalhi to Shaheb Bazar) experiences the most evening peak-hour congestion, while Friday at Station-02 (Fultola to Vodra) experiences the least. Motorcycles, rickshaws, and autorickshaws are the most common kind of vehicles on the routes, with moderate cycles and vans, and very few cars. On Monday, there was heavy rain, and on Friday, there was slight rain along with a political meeting. Doing a traffic volume survey manually is undoubtedly a difficult undertaking. When designing, planning, and building roads, bridges, highways, and other infrastructure, traffic volume is a fundamental requirement. The study of traffic volume is crucial to enhancing safety at both signalized and unsignalized junctions in both urban and rural settings. The

study emphasizes how important it is to assess traffic patterns and implement suitable solutions in order to raise the Level of Service at Talaimari intersection. Everyone can work toward creating a functional transportation system that promotes sustainable urban growth, economic development, and an improved standard of living for Rajshahi's citizens by putting the suggested tactics into practice and encouraging a culture of safe driving

DECLARATION OF USE OF AI

In the writing of this research paper, artificial intelligence (AI) products were only used in formatting the paper, in help writing the paper, and in searching the literature about the topic. AI was not used in data collection, analysis, and results interpretation, as well as the original research findings. The authors did all the core scientific contribution of the research such as methodology, data processing and conclusions without the intervention of AI.

REFERENCE

- Al-Mosawi, A. (2025). *Review different methods for estimating the origin-destination matrix. Iraqi Journal of Applied Sciences*. <https://iasj.rdd.edu.iq/journals>
- Banerjee, A., & Maurya, A. K. (2020). A comparative study of pedestrian movement behavior over foot over bridges under similar land-use type. *Transportation research procedia*, 48, 3342-3354.
- Cleofas, J., & Sundo, M. B. (2016). Calibration of the gravity model for estimation of UPLB employee trips. Transportation Science Society of the Philippines. <https://ncts.upd.edu.ph/tssp/wp-content/uploads/2016/08/Cleofas-Sundo.pdf>
- Das, H. (2013). A Report on traffic Volume Survey on Moylapota Intersection of Khulna.
- Janković, S., Uzelac, A., Zdravković, S., Mladenović, D., Mladenović, S., & Andrijić, I. (2021). TRAFFIC VOLUMES PREDICTION USING BIG DATA ANALYTICS METHODS. *International Journal for Traffic & Transport Engineering*, 11(2).
- Jisan, A., Daniel, S., & Rahman, M. (2023). Present Scenario of Existing Intersection of Rajshahi City Corporation Area, Rajshahi, Bangladesh. *Architecture and Civil Engineering*.
- Kadim, Z., Johari, K. M., Samaon, D. F., Li, Y. S., & Hon, H. W. (2020). Real-time deep-learning based traffic volume count for high-traffic urban arterial roads. 2020 IEEE 10th Symposium on Computer Applications & Industrial Electronics (ISCAIE)
- Manual, H. C. (2000). Highway capacity manual. *Washington, DC*, 2(1), 1.
- ModelIT. (1996). *Improved algorithms for calibrating gravity opportunity models*. <https://www.modelit.nl/modelit/pdf/euro96.pdf>
- Ortúzar, J. de D., & Willumsen, L. G. (2011). *Modelling transport* (4th ed.). John Wiley & Sons.
- Pani, A., & Sahu, P. K. (2019). Comparative evaluation of trip distribution methods in urban areas: A case study of India. *Transportation Research Procedia*, 41, 699–711. <https://doi.org/10.1016/j.trpro.2019.09.121>
- Rahman, N. (2018). Estimating traffic volume to identify the level of service in Major Intersections of Rajshahi, Bangladesh. *Trends in Civil Engineering and Its Architecture*.
- Sabbir, S. (2022). Traffic volume in Dhaka city at selected priority junctions. *Journal of Transportation Engineering and Traffic Management*, 3(1), 1-10.
- Salisu, U. O., & Oyesiku, O. O. (2020). Traffic survey analysis: implications for road transport planning in Nigeria. *LOGI: Scientific Journal on Transport and Logistics*, 11(2), 12-22.
- Satterthwaite, S. (1981). A survey of research into relationships between traffic accidents and traffic volumes. *Publication of: Transport and Road Research Laboratory*(SR 692 Monograph).
- TRB. (1969). *The mathematical form of travel time factors*. Highway Research Record, 283, 37-50. <https://onlinepubs.trb.org/Onlinepubs/hrr/1969/283/283-004.pdf>