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# Examining Traffic Patterns and Intersection Performance at Aam Chottor Intersection in Rajshahi City: Findings from a Traffic Volume Survey

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### ABSTRACT

Rapid urbanization exerts a substantial influence on crucial traffic variables, including the escalating number of automobiles, the capacity of urban highways, and the level of service rendered, impacting several transportation sectors. An effective traffic management system is crucial for facilitating the swift and safe transportation of people, goods, and vehicles. The current road infrastructure is insufficient to handle the anticipated traffic demands of any metropolis without effective planning and traffic management. Therefore, obtaining a deep understanding of the extent of the traffic is a vital component of the traffic control system. This study intends to assess the traffic patterns and variety of transport modes, as well as identify the Level of Service (LOS) at the Aam Chottor intersection of Rajshahi City Corporation, whose purpose is to gain an understanding of the traffic patterns in this area. The volume of different types of traffic has been resolved by converting different vehicles into equivalent passenger cars and calculating the volume in terms of passenger car units (PCUs) per hour of both motorized and non-motorized vehicles. The methods that are used to find the Level of Service (LOS) are based on finding the Passenger Car Units (PCUs) each hour which counts the V/C Ratio and Peak Hour Factor (PHF) which shows LOS-C for Monday (Weekday) and LOS-B for Friday (Weekend). The study finds that auto rickshaws and motorcycles are dominant vehicles during peak and off-peak hours, while cycle rickshaws and carts are found in low numbers. Therefore, the research has the potential to enhance the efficiency and efficacy of roads and offer valuable insights for the development of future infrastructure.

**KEYWORDS:** Traffic Volume Survey, PCU, V/C ratio, Modal Variation, LOS

### 1. INTRODUCTION

Traffic congestion is an increasing challenge in metropolitan areas globally, severely influencing travel times, fuel consumption, and air quality. (T. Litman, 2020) Rajshahi City, Bangladesh, which is the focus of this paper, is also growing, and the number of cars only increases, along with it traffic jams occur regularly, particularly at some crucial crossroads, such as Aam Chottor Intersection. Rajshahi, a vital city in Bangladesh, faces increased traffic congestion due to the growing number of slow-moving vehicles like auto-rickshaws and easy bikes. (Nahar et al., 2018)

This study will centre on the Aam Chottor junction in Rajshahi City. Its goal is to investigate traffic flow within it, as well as modal diversity and the level of service using primary traffic volume data. This material will

provide an overview of the occupation of the intersection during the day: the traffic is busy in the morning, at night, what types of vehicles are the most numerous, what jams, and when its intensity decreases. Additionally, using the collected data, it will be possible to conduct a LOS analysis. This metric will present an index of traffic flow workability and allow identifying probable congestions and assessing the current state.

The assessment of traffic patterns encompasses a thorough study of vehicle movements throughout the day, examining changes in volume, directionality, and composition of traffic streams. Furthermore, examining the diversity of transportation modes reveals information on the use trends of different modes such as automobiles, buses, motorcycles, bicycles, and pedestrians. Such data are vital for understanding the modal choices of commuters and suggesting options for increasing sustainable transportation solutions.

Again, The TVS data supplies inputs that aid in traffic management and infrastructure design, ultimately optimizing transport networks, reducing congestion, and enhancing road safety. Continuous urbanization and rising vehicle usage necessitate an understanding of traffic patterns to facilitate the construction of more efficient road networks and the deployment of effective traffic management measures. Traffic volume data are essential for environmental policies aimed at reducing emissions and promoting sustainable transportation. The current study will provide essential information on future urban planning and transportation policy to solve existing and future mobility challenges.

In addition to analyzing traffic patterns and mode diversity, determining the Level of Service (LOS) at the Aam chottor Intersection is crucial for evaluating its operational efficiency and effectiveness in fostering smooth traffic flow. Choke points experience significant traffic congestion, leading to delays, frustration, and even safety hazards. (Hoque & Mahmud, 2015). By addressing these purposes, the study aims to evaluate the traffic patterns and diversity of transportation modes throughout the day and to determine the Level of Service at the Aam Chottor intersection.

## 2. LITERATURE REVIEW

The study findings highlight a concerning trend where a significant portion, specifically 40%, of time wasted during green signals is concentrated at a single intersection, therefore creates interest in delays at junctions and the role that mixed traffic geometries play in aggravating congestion. Their work deals with these isolated junctions and talks about measures like expansion of the road and restriction of certain vehicle movements at peak hours. Although a more specific and subtle approach- for instance, using Rajshahi's Aam Chottor intersection as our subject study highlights very useful information on how to improve flow at junctions. The present study gives actionable insights for managing intersections in the typical urban setting of cities; our study provides specific data such as PCUs, temporal traffic changes, and modal diversity, unlike their general advice (Savithramma et al., 2022).

The research evaluated the traffic volume and LOS of Rajshahi and showed critical congestion problems due to the fluctuating traffic pattern and inadequate transportation infrastructure. Consistent with their results, the alternatives include increasing road capacity and restricting truck traffic. Our study adds to the literature by including both time and modal variations in traffic flows, noting the dominance of motorbikes and autorickshaws during peak hours, regardless of the study's focus on more general infrastructure issues. Your discussion becomes much more specific because it is couched in a particular geographic and commercial configuration of the Aam Chottor crossing (Kafy et al., 2018).

It is observed that the need to learn various traffic aspects in mixed-use areas, especially by analyzing pedestrian behavior at intersections. Also, it has pointed out the interaction between pedestrian and driver behaviors as critical factors for congestion. Our study work extends to include vehicle flow characteristics and LOS analysis but also deals with the mixed traffic dynamics at Aam Chottor. Pedestrian flow data can also be accommodated in your analysis for a clearer view of intersection performance (Kamani & Bhatt, 2017). To analyses the dynamics of vehicular movement at unsignalized intersections and concludes with some recommendations to enhance the traffic flow in the research. Our study includes ways to diminish traffic during peak demand periods and lateral friction and also, an unsignalised, priority-controlled intersection is just nearby Aam Chottor. Our study, however, goes a step further by using the PHF and V/C ratios to provide quantitative analysis and hence a better assessment of operating efficiency. Your suggestions could become stronger if our proposal for reducing side friction were brought in (Isradi et al., 2022).

The simulation to model the dynamics of motorized vehicles at signalized intersections for traffic pattern and noise level predictions are highlighted in the study. Our study deals with the specific challenges of Rajshahi's unsignalized configurations, whereas Aly et al. cover signalized crossings. However, their technique may give a framework for further developments of your work in developing traffic flow prediction models at Aam Chottor by utilizing the PCU and LOS data accumulated (Aly et al., 2022).

Yadav's paper comments on a model of traffic noise pollution based on the density and proximity of vehicles to intersections in Indian urban cities. It demonstrates how congestion amplifies noise pollution levels in the environment. While it is not an explicit concern, noise pollution can potentially become one of the most significant impacts of traffic around Aam Chottor. Integrating these findings from Yadav into the current research being conducted for the congestion management initiatives employed by Rajshahi adds and supplements the larger goal of environmental sustainability (Yadav et al., 2023).

The implications of on-street parking and its effects on the increase in V/C ratio and a decrease in effective carriageway width in Rajshahi is studied in the research. The research findings of Nahar et al. are similar to the congestion factors—like insufficient road width and mixed traffic dynamics—that identified in our studies. By including LOS analysis and specific recommendations for solutions to peak-hour traffic, such as lane management and enforcement of roadside parking, our report carries these matters further (Nahar et al. (2018)). This work presents models for the estimation of delay and platooning effects through an examination of the headway distribution on two-lane highways in India having heterogeneous vehicular traffic. Similar headway patterns may have been contributing factors to delays at Aam Chottor. Rajshahi's roadways also face mixed traffic conditions. Headway distribution analysis can help to understand how traffic moves better and ensure LOS assessments are more accurate in our study (Roy & Saha (2018)).

### 3. STUDY AREA PROFILE

Rajshahi is a metropolitan city and a major urban, administrative, commercial and educational centre of Bangladesh. Rajshahi is the fourth largest city in Bangladesh. As a metropolitan city, there are some major intersections of roads. One of the major intersections is Aam Chottor. Am Chattar is widely known to every inhabitant of Rajshahi and it is symbolized as the city of Mango. Our study area focuses on the region of Aam chottor, Rajshahi. This location is defined by the geographic coordinates 24.3666666667 and 88.6. The distance to the main CBD of Rajshahi is around 6 kilometres. This Aam Chottor intersection offers access in four distinct directions. The directions are- Railgate, Chapai Nawabganj. Noagaon and Dhaka. Chapainawabgonj is connected to Dhaka via the Rajshahi-Dhaka bypass at this intersection. Aam Chottor is predominantly a commercial zone. Numerous banks and administrative institutions are present.

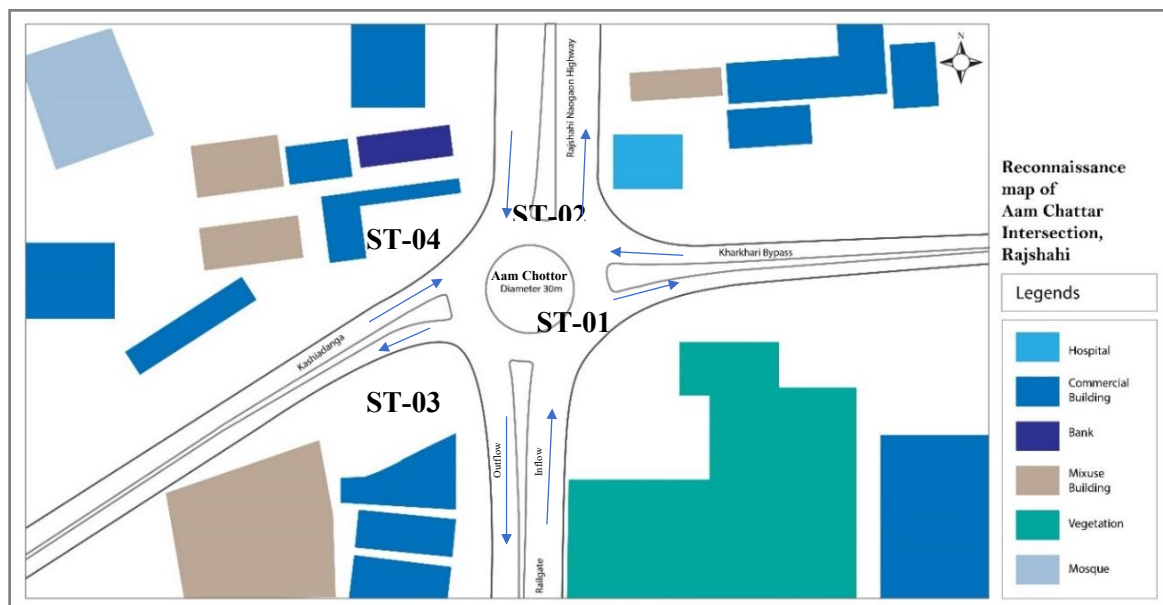


Figure 3.1: Study Area Map with Station Locations (Prepared By Authors)

For conducting the Traffic Volume Survey, the entire study area was divided into 4 stations with 8 different routes with 8 directions of traffic flow. Station 1 denotes the route from Noagoan highway to Aam Chottor and Aam Chottor to Noagoan highway route whereas stations 2 count the inflow and outflow of the route Aam Chottor to Kashiyadanga. Stations 3 count the inflow and outflow of the route Aam Chottor to Kharkhari bypass. Lastly, Stations 4 denote the inflow and outflow of the route Aam Chottor to Rail gate.

Table 3.1: Station &amp; Routes of Lanes

| Station      | Route of the Lanes              | Direction                            |
|--------------|---------------------------------|--------------------------------------|
| <b>ST-01</b> | Aam Chottor to Noagoan Highway  | Away from the Intersection (Outflow) |
|              | Noagoan Highway to Aam Chottor  | Towards the Intersection (Inflow)    |
| <b>ST-02</b> | Aam Chottor to Kashiyadanga     | Away from the Intersection (Outflow) |
|              | Kashiyadanga to Aam Chottor     | Towards the Intersection (Inflow)    |
| <b>ST-03</b> | Aam Chottor to Kharkhari bypass | Away from the Intersection (Outflow) |
|              | Kharkhari bypass to Aam Chottor | Towards the Intersection (Inflow)    |
| <b>ST-04</b> | Aam Chottor to Rail gate        | Away from the Intersection (Outflow) |
|              | Rail gate to Aam Chottor        | Towards the Intersection (Inflow)    |

Table 3.1 above delineates the stations from which data was collected during the TVS. Four distinct stations have been selected, and each station is counted. Two lanes designated for both inflow and outflow. For example, Station 1 features two routes: “Aam Chottor to Noagoan Highway,” which signifies outflow from the intersection, and “Noagoan Highway to Aam Chottor,” which indicates inflow into the intersection.

#### Road Geometry:

Table 3.2: Dimension of Roads and Roundabout

| Routes of Aam Chottor Intersection                           | Lane Width | Median  | Shoulder |
|--------------------------------------------------------------|------------|---------|----------|
| Aam Chottor to Noagaon Highway                               | 24 ft.     | 6.5 ft. | 7 ft.    |
| Aam Chottor to Kashiyadanga (Chapainawabganj highway)        | 20 ft.     | 4.5 ft. | 2 ft.    |
| Aam Chottor to Kharkhari bypass (Chandrima Residential Area) | 22 ft.     | 4.5 ft. | 3 ft.    |
| Aam Chottor to Rail gate                                     | 24 ft.     | 6.5 ft. | 2.5 ft.  |
| Inscribed Circle Diameter (ICD) of Roundabout                | 120 ft.    |         |          |

Source: Prepared By Authors

Table 3.2 illustrates the comprehensive road geometry of the intersection. The width of the lane, median, and shoulder for each route has been measured and its detailed illustration has been shown in Figure 3.2.

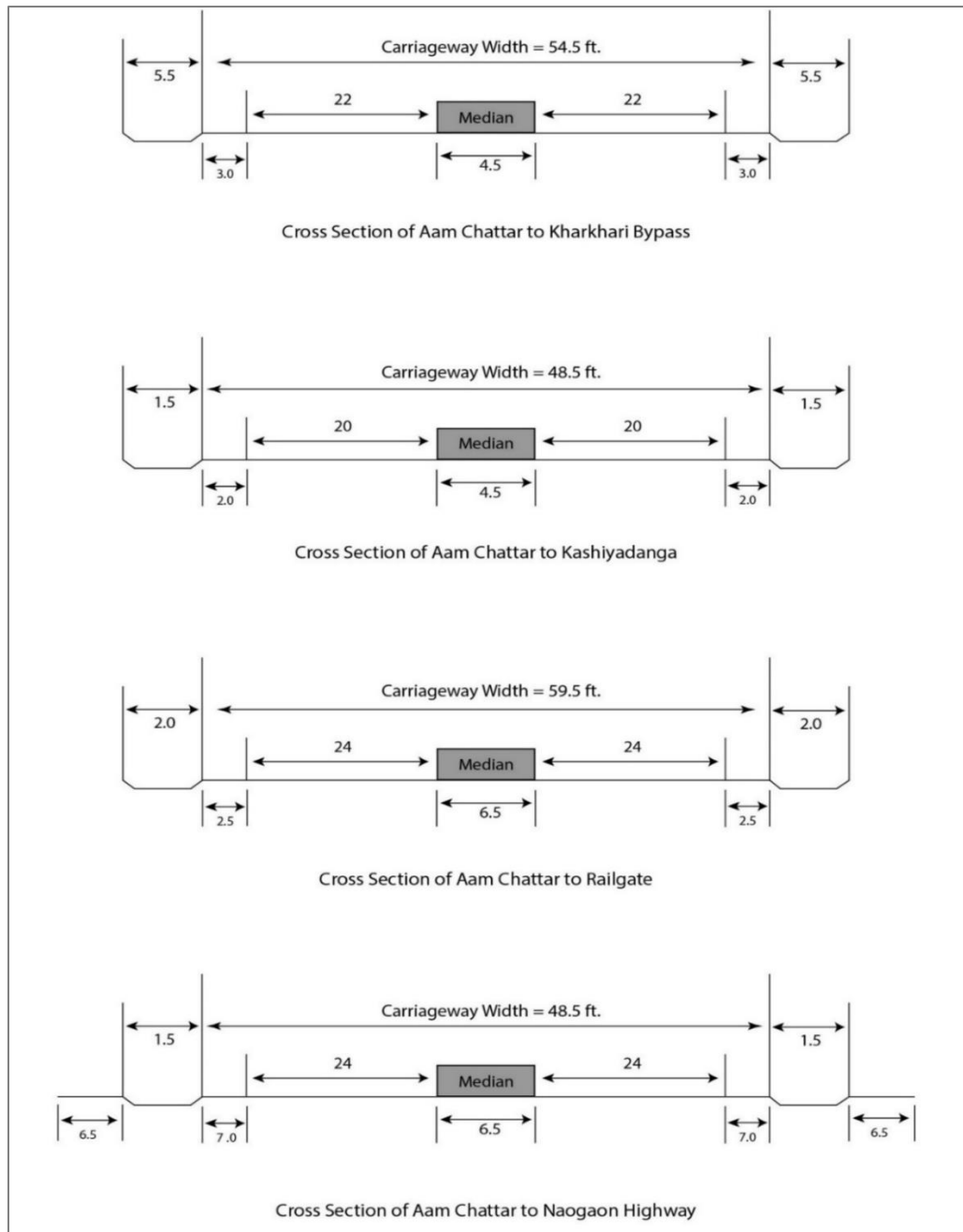


Figure 3.2: Road measurements (Prepared by Authors)

#### 4. METHODOLOGICAL FRAMEWORK

**4.1 Selection of Study Area:** Aam Chottor intersection is the center of four major roads. This intersection is one of the most consequential intersections of Rajshahi City. It is the entryway leading from the northeastern areas near Rajshahi. Every moment of the day, a lot of traffic passes by the intersection. Here are a variety of means of transportation.

**4.2 Manual Classified Count (MCC):** MCC involves keeping track of each vehicle that passes a specific location on a route for a defined period of time. The count can go on for as long as you want, although it usually takes three or four days, with sixteen to twenty-four hours a day. Vehicles are categorized by the count based on their type (trucks, cars, bus, rickshaw etc.) and the direction in which they are travelling. This is where the term "classified count" originates.

**4.3 Data Collection:** Data was gathered for a variety of vehicles, including cars, auto rickshaws, cycle rickshaws, vans, minibuses, big and small trucks, utility vehicles, and bicycles etc. Data were collected at 15 min intervals and 15 min survey for two hours in three shifts in a day. Three shifts were 8:00AM-10:00AM, 12:00PM-2PM and 4:30PM-6:30PM. The number of distinct traffic categories was recorded on both weekdays and weekends in order to track changes in the volume of traffic. After being gathered in a survey form, the data was moved to an Excel file for upcoming computation and analysis.

#### 4.4 Data Analysis Process

**4.4.1 Calculation of Traffic volume:** Each traffic modal data was converted to its designated PCU factor once the traffic data was collected in order to turn the number into a unit number. Next, the average for each shift was chosen as PCU/shift, and the total was evaluated as PCU/day.

**4.4.2 Calculation of LOS (Level of service):** The stages of road services and amenities that determine the road's adequacy and user comfort are known as the level of service. Sequentially, A, B, C, D, E, and F are the six service levels. There are three techniques that have been utilized to clarify the LOS. Such the speed-based, peak hourly factor, volume/capacity ratio, etc.

- I. **Volume Capacity Ratio:** The volume/capacity ratio is compared to predetermined LOS standards using the V/C Ratio Method, which is used to evaluate the Level of Service (LOS). By dividing the total hourly Passenger Car Units (PCUs) for a single hour by the capacity, the V/C ratio is calculated. This ratio is computed by dividing the entire volume of the survey by the width and Capacity of the road,

$$\text{Capacity, } C = (\text{Highest design capacity} * \text{effective width}) / 12$$

Since the roads surrounding Aam Chottor are arterial and Sub-arterial routes, 1200 & 900 (PCU/Hr.) is the maximum design capacity. The roads are Am Chottor to Noagoan 68.5 feet wide, Aam Chottor to Kashiyadanga 48.5 feet, Aam Chottor to Kharakhari Bypass 54.5 and Aam Chottor to Rail gate 59.5 feet in actual width including Median and shoulder. The LOS of the intersection can be ascertained by comparing the computed V/C ratio with accepted norms, which offers important information about the efficacy. The standard PCU for Bus and truck are 3, whereas it is 2 for CNG and Auto Rickshaw, 1 for Private car and Utility Vehicles, 4 for an animal drawn Cart, 0.5 for Bicycle and 0.75 fir motorcycle. (Source: RHD, 2000 & TRB, 2000)

- II. **Peak Hourly Factor:** The Peak Hour Factor (PHF) Method is an alternate technique for figuring out the Level of Service (LOS) at a crossing. It makes use of peak hour volume and additional pertinent factors to evaluate the intersection's capacity. Because the flow rate reflects the volume of traffic during peak hours, it is important to capture data during these vital times.

$$\text{Peak hour factor} = (\text{Average PCU of 1 hour}) / (15 \text{ minutes highest PCU} * \text{Number of reading})$$

- III. **Speed-Based Method:** This method is an additional technique for figuring out the LOS. The process is choosing two stations that are close to each lane, usually at the closest crossroads. The duration of the journey is then determined by measuring the distance travelled with an auto rickshaw and dividing the result by the recorded time. The following formula is used to determine the speed of each lane:

$$\text{Speed} = \text{Distance} / \text{Time}$$

Table 4.4.2.1: Traffic performance standards measurement by V/C ratio, PHF and Speed Based Method

| LOS | V/C ratio | Speed | PHF | Characteristics |
|-----|-----------|-------|-----|-----------------|
|-----|-----------|-------|-----|-----------------|

|          |            |           |            |                                                                                                       |
|----------|------------|-----------|------------|-------------------------------------------------------------------------------------------------------|
| <b>A</b> | $\leq 0.6$ | $\geq 40$ | $\leq 0.7$ | Free flow, with low volumes and high speeds. Drivers can maintain their desired speeds with no delay  |
| <b>B</b> | 0.6-0.7    | 30-40     | 0.7-0.8    | Stable flow, operating speeds to be restricted somewhat. Drivers have reasonable freedom for speeds   |
| <b>C</b> | 0.7-0.8    | 25-30     | 0.8-0.85   | Stable flow but speeds are controlled by higher volumes. Drivers' freedom for speeds are restricted   |
| <b>D</b> | 0.8-0.9    | 15-25     | 0.85-0.9   | Approaches unstable flow, with tolerable operating speeds. Drivers have little freedom to maneuver    |
| <b>E</b> | 0.9-1.0    | $\leq 15$ | 0.9-0.95   | Operating speed is lower than in LOS-D. Flow is unstable and may have stoppages of momentary duration |
| <b>F</b> | $\geq 1.0$ | ----      | $\geq 1.0$ | Forced flow operations at low speeds. Stoppages may occur for short or long periods                   |

Source: Level of Service Standard and Measurements (2016) pp. 391-394.

LOS delineates the operational states of traffic flow, ranging from ideal (LOS A) to severely congested (LOS F) as described in Table 4.4.2.1. In LOS A, traffic functions under free-flow conditions characterized by low volumes, elevated speeds, and the absence of delays, allowing drivers to sustain their preferred speed. As traffic volume escalates, circumstances progressively worsen: LOS B offers stable flow with few constraints, whereas LOS C indicates diminished speeds and restricted driver options due to increased volumes. LOS D signifies conditions nearing instability, characterized by acceptable speeds and little maneuvering space. LOS E denotes unstable flow characterized by frequent delays and intermittent stoppages, while LOS F signifies forced flow with extended stoppages and exceedingly low speeds, typically due to overcapacity. The principal metrics utilized in capacity categorization comprise the volume-to-capacity (V/C) ratio, speed, and peak hour factor (PHF).

## 5. RESULT AND DISCUSSION

### 5.1 ANALYSIS OF TEMPORAL VARIATION

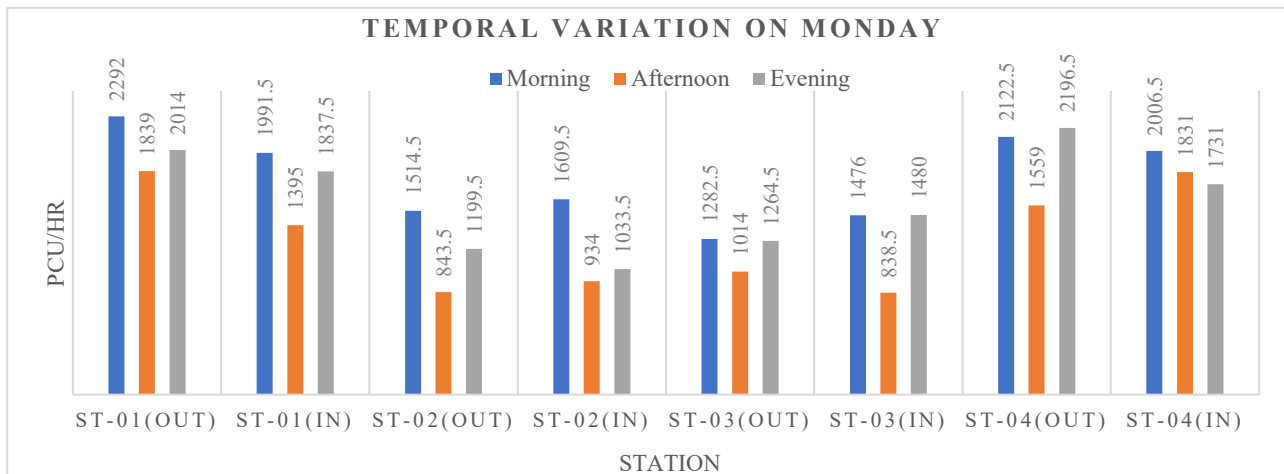


Figure 5.1.1: Temporal Variation on Monday (Prepared by Authors)

From (Figure 5.1.1), During the morning off-peak on Monday, Station-1-OUT (Aam Chottor to Noagoan) recorded the highest traffic flow at 2292 PCU/hour. In contrast, Station-03-OUT (Aam Chottor to Kharkhari Bypass) showed the lowest flow at 1282.5 PCU/hour. In the afternoon off-peak, Station-1-OUT (Aam chottor to Noagoan) again had the highest flow with 1839 PCU/hour, while Station-02-OUT (Aam Chottor to Kashiyaadanga) recorded the lowest at 843.5 PCU/hour. By the evening off-peak, Station-4-OUT (Aam Chottor to Railgate) had the highest flow at 1837.5 PCU/hour, whereas Station-02-IN (Kashiyaadanga to Aam Chottor) showed the lowest at 1033.5 PCU/hour.

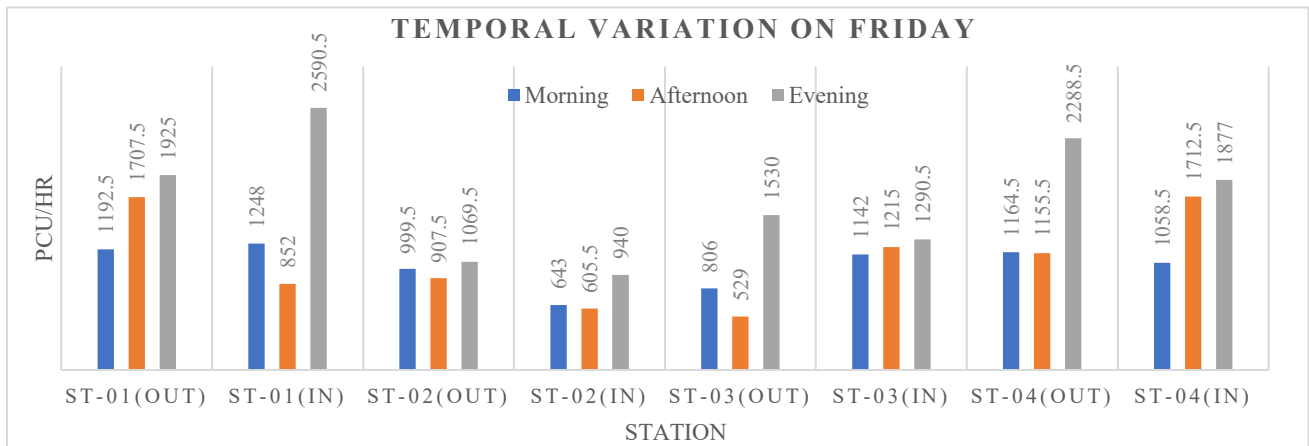


Figure 5.1.2: Temporal Variation on Friday (Prepared by Authors)

On Friday, the overall PCU/hour was lower than Monday. During the morning off-peak, Station-01-IN (Noagoan to Aam Chottor) recorded the highest flow at 1248 PCU/hour, while Station-02-IN (Kashiyadanga to Aam Chottor) had the lowest at 643 PCU/hour. In the afternoon off-peak, Station-1-OUT (Aam Chottor to Noagoan) reached 1707.5 PCU/hour, the highest among all lanes. Meanwhile, Station-03-OUT (Aam Chottor to Kharkhari Bypass) recorded the lowest at 529 PCU/hour. In the evening off-peak, Station-1-IN (Noagoan to Aam Chottor) had the highest flow at 2590 PCU/hour, and Station-02-IN showed the lowest at 940 PCU/hour.

## 5.2 LANE WISE VEHICLE FLOW (PCU/HR.)

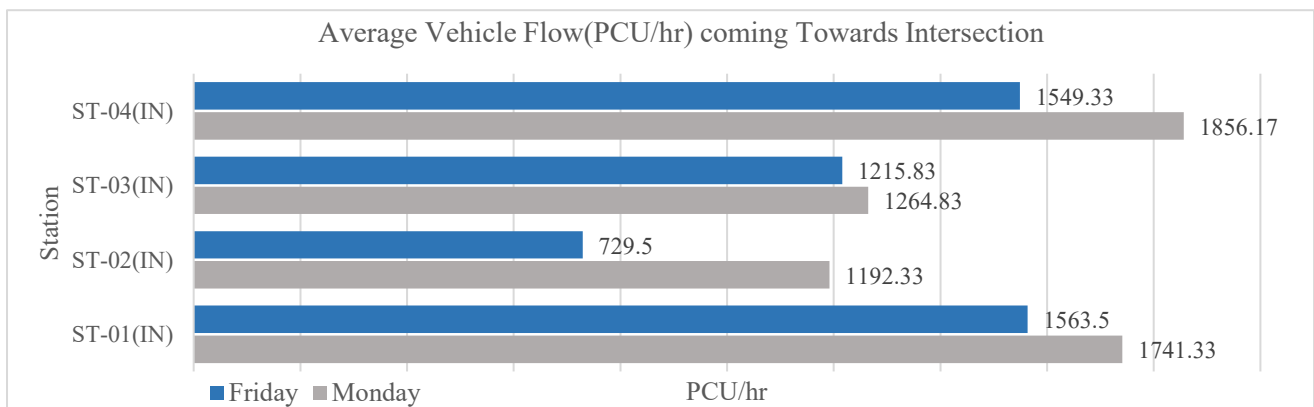


Figure 5.2.1: Average Vehicle Flow (PCU/hr.)- Coming towards Intersection (Prepared by Authors)

On Monday, in (figure 5.2.1) Station-04(IN) (Rail Gate to Aam Chottor) recorded the highest average flow at 1856.17 PCU/hour, followed by Station-01(IN) (Noagoan Highway to Aam Chottor) with 1741.33 PCU/hour. The lowest flow was observed at Station-02(IN) (Kashiyadanga to Aam Chottor) with 1192.33 PCU/hour. On Friday, Station-01(IN) recorded the highest flow at 1563.5 PCU/hour, while Station-02(IN) showed the lowest at 792.5 PCU/hour. Overall, Friday's vehicle flow was lower than Monday's.



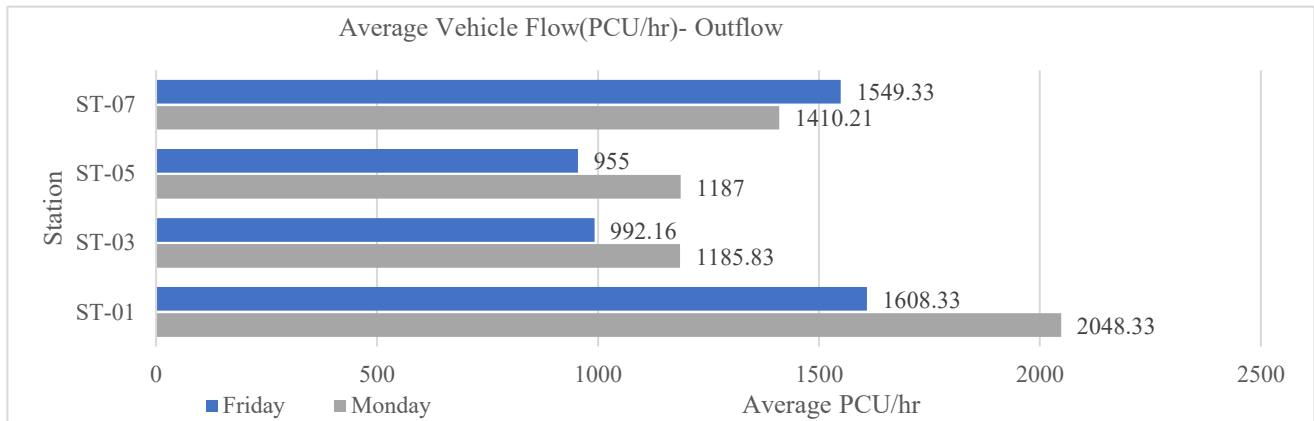


Figure 5.2.2: Average Vehicle Flow (PCU/hr) Coming away from intersection (Prepared by Authors)

On Monday, Station-01(OUT) (Aam Chottor to Noagoan Highway) had the highest flow at 2048.33 PCU/hour, followed by Station-04(OUT) (Aam Chottor to Rail Gate) with 1410.21 PCU/hour. Station-03(OUT) (Aam Chottor to Kharkhari Bypass) recorded the lowest flow at 955 PCU/hour. On Friday, the highest flow was at Station-04(OUT) with 1549.33 PCU/hour, while Station-03(OUT) again recorded the lowest at 955 PCU/hour. Notably, Station-04(OUT) had a higher flow on Friday than Monday.

### 5.3 ANALYSIS OF MODAL VARIATION

#### 5.3.1 Modal Variation on Weekday (Monday)

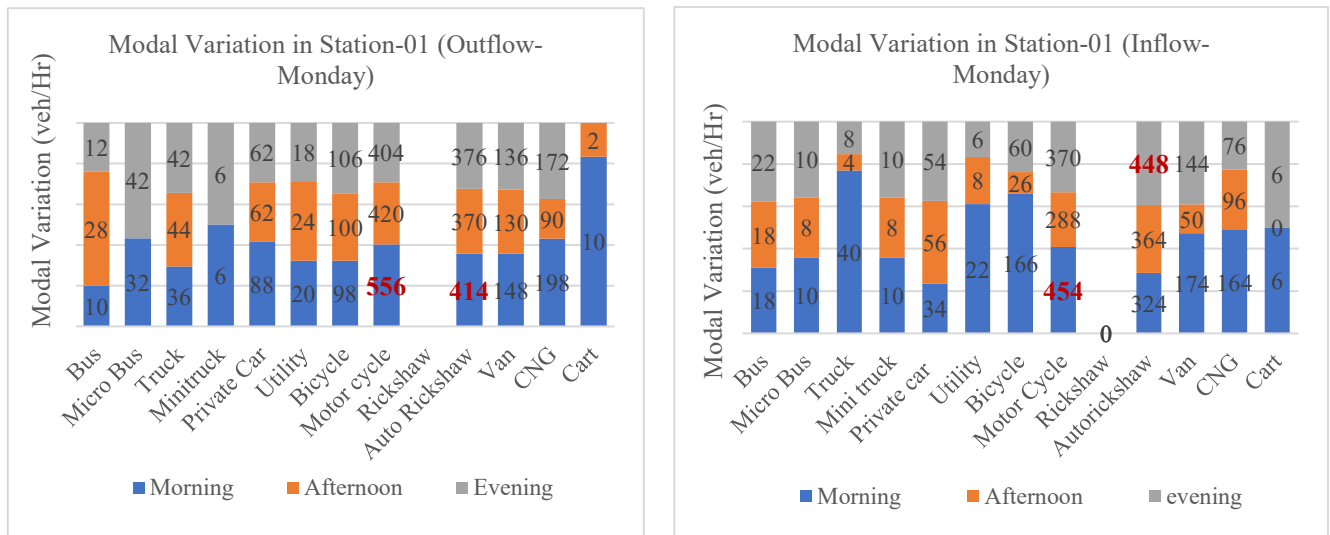


Figure 5.3.1.1: Modal Variation in Station-01 (Monday) (Prepared by Authors)

Bikes are the most popular form of public transportation, with an average of 556 bikes per hour during the morning peak, as shown in Figure 5.3.1.1 (Outflow). Following at 414 and 148 vehicles per hour, respectively, are auto rickshaws and vans. The greatest number of vehicles occurs during morning peaks, with buses, trucks, and utility vehicles continuing to be less common. Bicycles, CNG vehicles, and private automobiles have a modest level of dominance, with changes during peak hours.

Motorcycles also predominate, with an average speed of 454 per hour at the morning peak, according to the inflow data in Figure 5.3.1.1. With a peak of 448 vehicles per hour in the afternoon and 174 in the evening, auto rickshaws and vans rank second in terms of frequency. Utility vehicles, carts, and minibuses are less common modes.

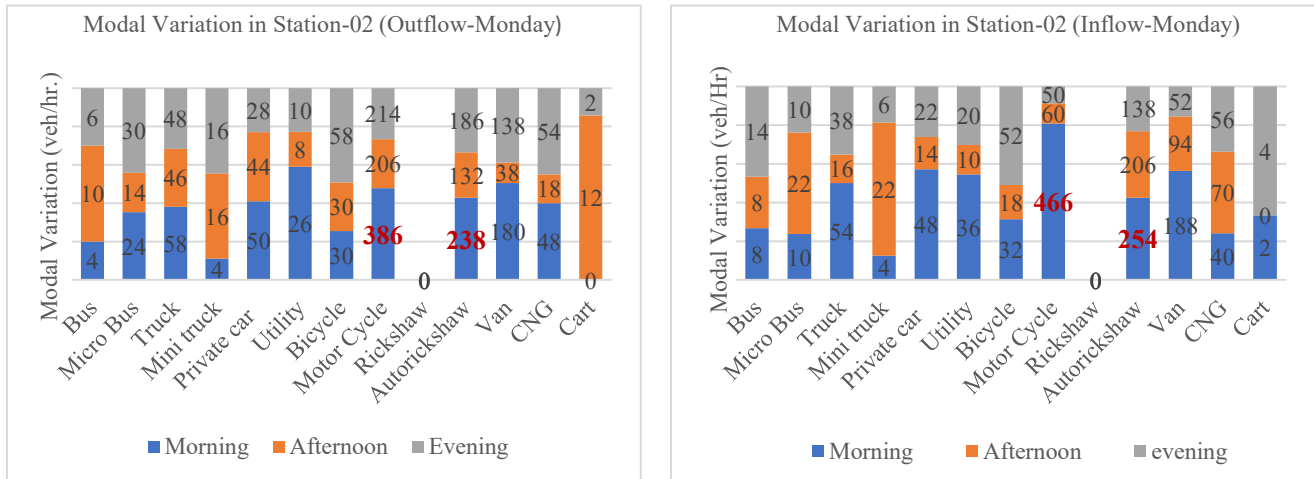


Figure 5.3.1.2: Modal Variation in Station-02(Monday) (Prepared by Authors)

Motorcycles are the most popular form of public transportation, with an average speed of 386 per hour during the morning peak (Figure 5.3.1.2, Outflow). With peaks of 238 and 180 vehicles per hour, respectively, auto rickshaws and vans come next. Utility vehicles, buses, and mini trucks are less common types of vehicles. During moments of strong traffic, the peak values of the moderately dominant modes—private automobiles, CNG vehicles, and bicycles—show fluctuations.

Motorcycles, on the other hand, are once again in the lead, averaging 466 per hour during the morning peak (Figure 5.3.1.2, Inflow). Second-place vehicles are auto rickshaws and vans, with 254 and 188 vehicles per hour, respectively. While private automobiles, CNG vehicles, and bicycles show modest dominance, with different peak usage during morning, afternoon, or evening hours, buses, carts, and small trucks are subordinate modes.

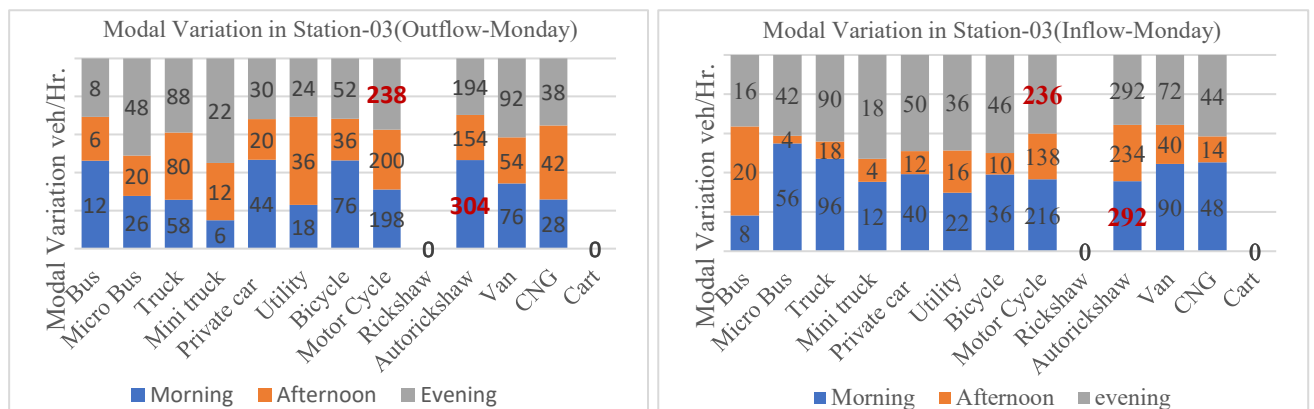


Figure 5.3.1.3: Modal Variation in Station-03(Monday) (Prepared by Authors)

Despite not having a defined lane, auto rickshaws are the most popular form of public transportation, averaging 304 vehicles per hour during the morning peak (Figure 5.3.1.3 (Outflow)). Trucks, vans, and motorcycles are also common modes; average 238 vehicles per hour, in the evening. Buses, mini trucks, and utility vehicles are less common types of vehicles. During times of high demand, intermediate modes like trucks and bicycles exhibit variable peak values.

Auto rickshaws also predominate, with an average of 292 vehicles during peak hours and no assigned lane, according to Figure 5.3.1.3 (Inflow). Vans and motorcycles come next as dominating modes. In contrast to private cars, CNGs, and trucks, which show intermediate dominance depending on peak-hour traffic, buses, micro trucks, and utility vehicles are subordinate vehicles.

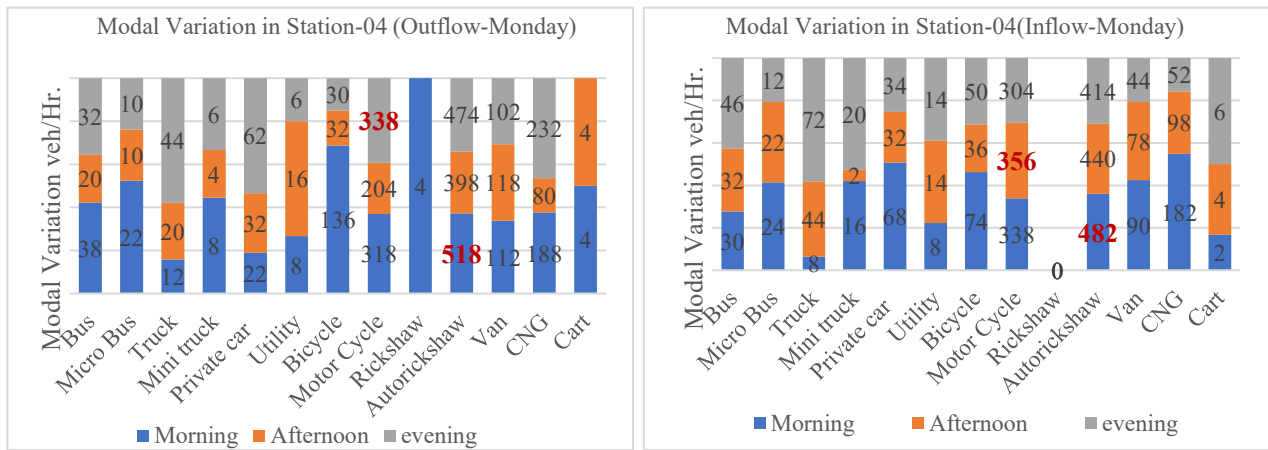


Figure 5.3.1.4: Modal Variation in Station-04(Monday) (Prepared by Authors)

Figure 5.3.1.4 (Outflow) shows that auto rickshaws are the most common public transit mode, averaging 518 vehicles per hour during the morning peak. Despite their prevalence, no specific lanes are designated for these vehicles. Motorbikes and CNG vehicles are the second most popular, with motorbikes peaking at 338 per hour during the evening rush. Subordinate vehicles include micro trucks and utility vehicles. Private cars, vans, bicycles, and trucks exhibit moderate prevalence, with peak values fluctuating during high-demand periods in the morning, afternoon, or evening.

Similarly, Figure 5.3.1.4 (Inflow) highlights auto rickshaws as the leading transit option, averaging 482 per hour in the morning peak. Motorbikes and CNG vehicles follow, with motorcycles peaking at 356 per hour during the afternoon off-peak and CNGs at 182 during the morning peak. Lesser-used vehicles include small trucks and utility vehicles, while private cars, vans, bicycles, and trucks show moderate dominance, varying across peak periods.

### 5.3.2 Modal Variation on Weekend (Friday)

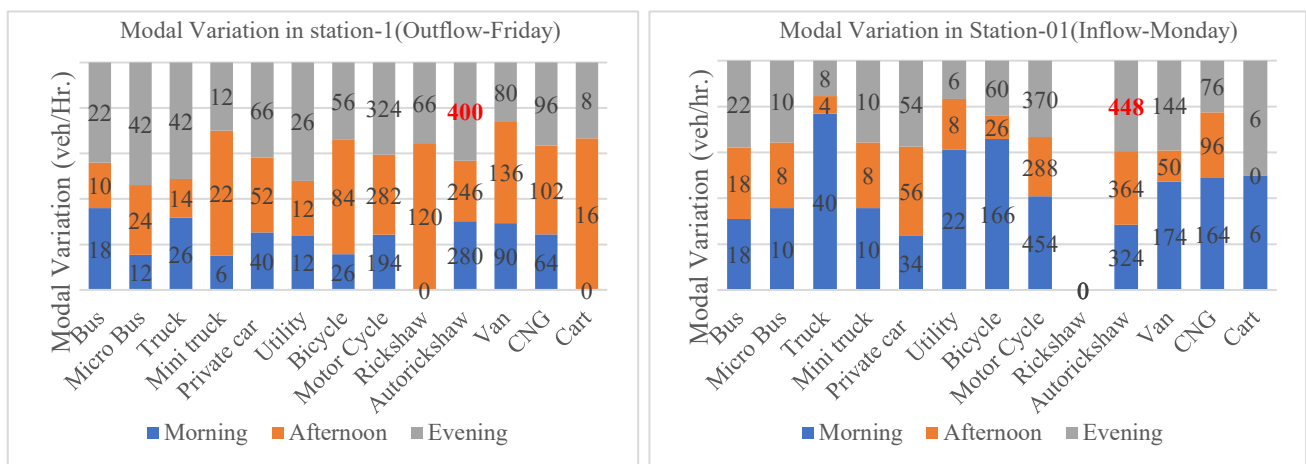


Figure 5.3.2.1: Modal Variation in Station-01(Friday) (Prepared by Authors)

Despite not having a designated lane, auto rickshaws are the most common form of public transportation, moving at 400 per hour during the evening peak (Figure 5.3.2.1, Outflow). The second most popular vehicles are motorcycles and CNG cars; afternoon CNG traffic peaks at 102 per hour, while motorcycle traffic peaks at 324 per hour. Less frequently seen are buses, carts, and utility vehicles. Bicycles, CNGs, and private vehicles exhibit a modest level of dominance, with peak hours differing by daypart.

Auto rickshaws continue to be the most common, with 570 motorcyclists per hour at the evening peak, according to Figure 5.3.2.1 (Inflow). In the morning, cars predominate over buses, mini trucks, and carts, and traffic peaks vary with time.

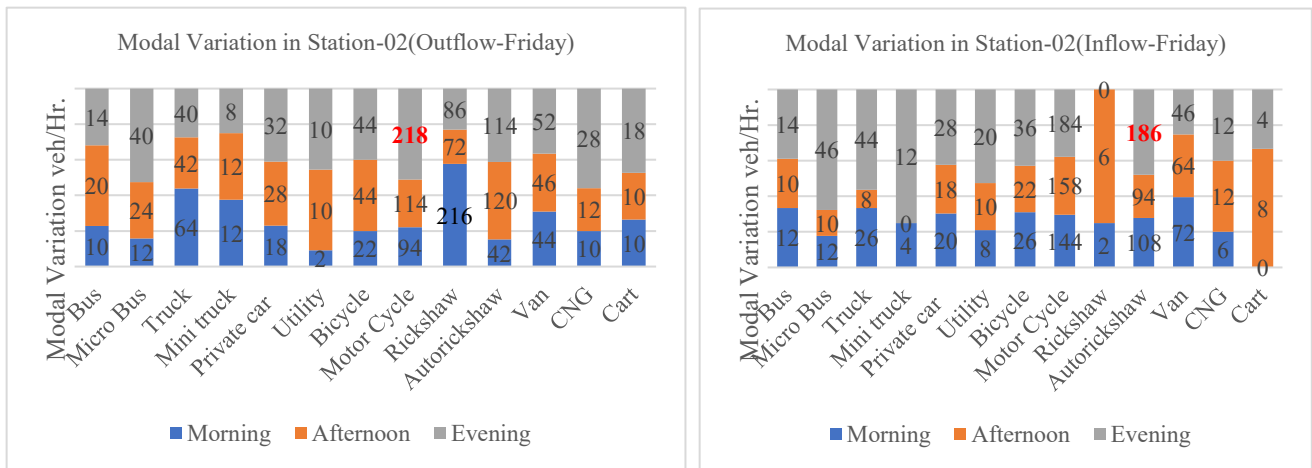


Figure 5.3.2.2: Modal Variation in Station-02(Friday) (Prepared by Authors)

As shown in Figure 5.3.2.2 (Outflow), motorbikes are the predominant means of public transportation, with an average of 258 vehicles per hour during the evening peak. Auto rickshaws, with no designated lanes, rank second, peaking at 218 vehicles per hour. Buses, micro trucks, and utility vehicles are less common. Private vehicles and bicycles show moderate use, with peak values varying across rush hours.

From the inflow data in the figure, auto rickshaws dominate public transport, averaging 186 vehicles per hour during the evening peak. Without designated lanes, motorcycles rank second, with motorcycles peaking at 184 vehicles per hour. Buses, minibuses, and utility vehicles remain less prevalent, with peak values varying by time.

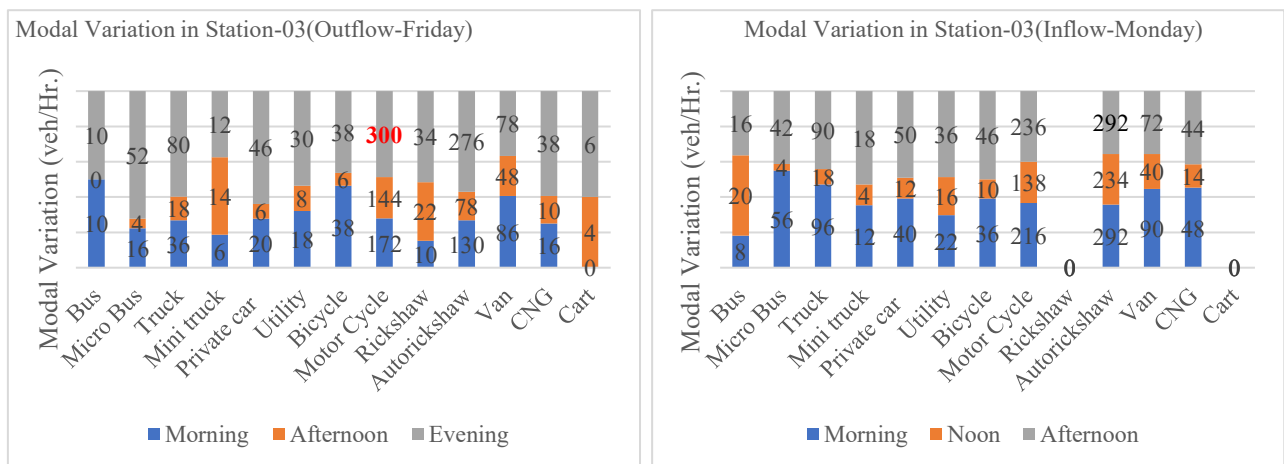


Figure 5.3.2.3: Modal Variation in Station-03(Friday) (Prepared by Authors)

Motorcycles are the most common form of transportation, with 310 vehicles per hour during the morning peak, as seen in Figure 5.3.2.3 (Outflow). With no designated lanes, auto rickshaws come in second, with an evening peak of 300 vehicles per hour. Vans follow, with the morning peak seeing 86 vehicles every hour. In the morning, private automobiles predominate, but buses, carts, and utility vehicles are less frequent. Cars, trucks, and bicycles exhibit moderate utilization.

With an average of 276 vehicles per hour during afternoon off-peak hours, auto rickshaws dominate public transportation, according to the inflow chart. The second most common modes of transportation are motorcycles, vans, and rickshaws; motorcycle traffic peaks at 214 per hour in the evening.

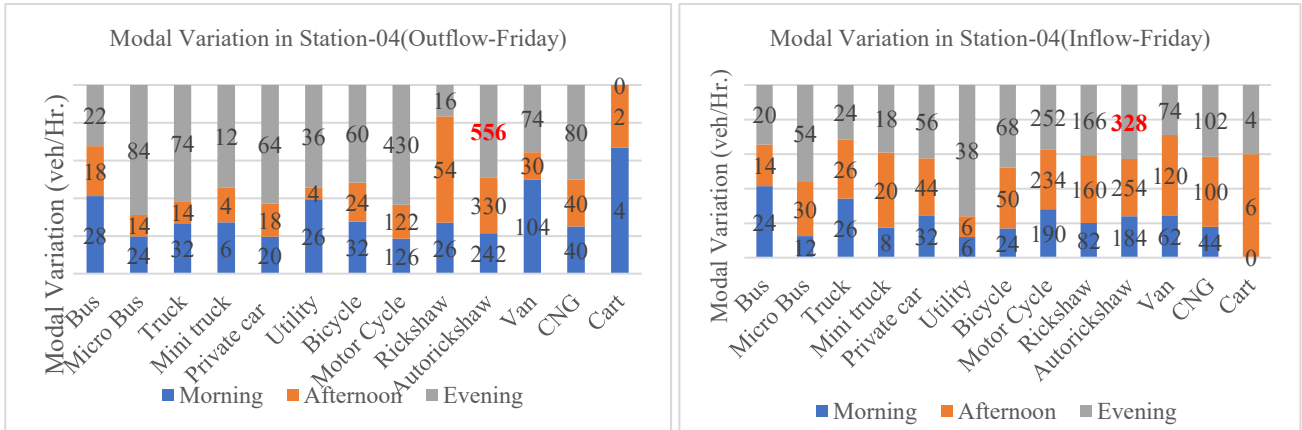


Figure 5.3.2.4: Modal Variation in Station-4(Friday) (Prepared by Authors)

Despite the lack of designated lanes, auto rickshaws are the most common form of public transportation, with an average of 556 vehicles per hour during peak hours (Figure 5.3.2.4 (Outflow)). With a peak of 430 motorcycles per hour in the evening, motorbikes come in second. While buses, micro trucks, and carts are less frequent and exhibit variable peak values throughout the morning, afternoon, and evening.

With 328 vehicles per hour during the evening peak, auto rickshaws continue to be the most popular mode, according to the inflow data. Vans, rickshaws, and motorcycles come next; in the evening, motorbike traffic peaks at 252 vehicles per hour. Throughout the day, the peak values of minor vehicles, such as buses, micro trucks, and utilities, fluctuate.

## 5.4 TOTAL NUMBER OF VEHICLES (MOTORIZED & NON-MOTORIZED) & DOMINANT VEHICLE CALCULATION

### 5.4.1 Vehicle calculation on Monday

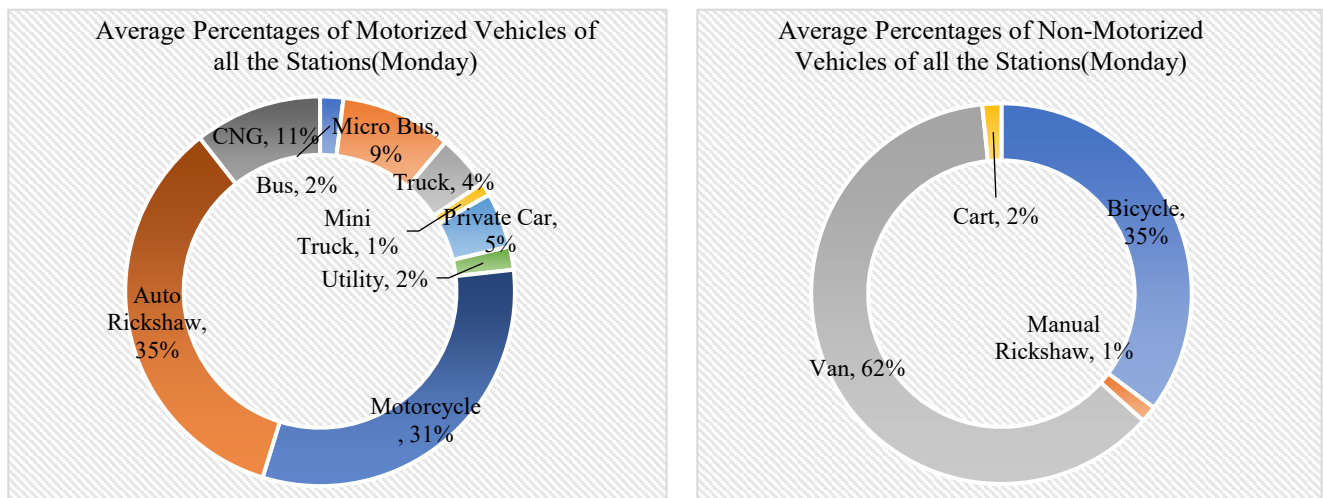


Figure 5.4.1.1: Total Average Number of Vehicles (Motorized & Non-Motorized) in all Stations on Monday (Prepared by Authors)

From the above pie chart (Figure-5.4.1.1), On Monday, auto-rickshaws (35%) and motorcycles (31%) dominated motorized vehicles, with 956 and 870 units, respectively. Utility and mini trucks were the least common, at 2% and 1%. Among non-motorized vehicles, vans were dominant with 305 units, while rickshaws were minimal with only 7 units.

### 5.4.2 Vehicle calculation on Friday

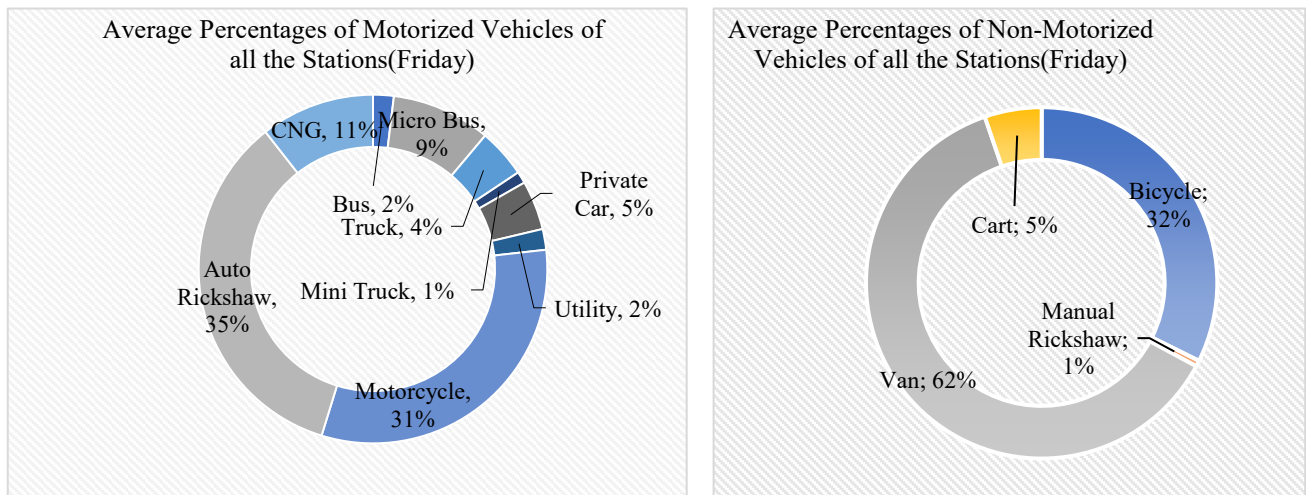


Figure 5.4.2.11: Total Average Number of Vehicle (Motorized & Non-Motorized) in all Stations on Friday  
(Prepared by Authors)

On Friday, the pie chart (Figure 5.4.2.1) shows mini trucks and private cars were the least common motorized vehicles, each comprising 2% with 30 and 45 units, respectively. Auto-rickshaws (35%) and motorcycles (31%) were the most dominant, with 704 and 609 units. Among non-motorized vehicles, vans accounted for 62% with 224 units, while manual rickshaws made up only 1%.

## 5.5 LOS ANALYSIS

### 5.5.1 LOS of the Lanes and in Intersection based on PHF:

Table 5.5.1.1: LOS Calculation of Intersection on PHF method

| S/N | Name of the Lane                | Day    | Average Volume (PCU/hr.) | 15 Minutes Highest PCU | PHF  | LOS Of Lane | LOS Of intersection     |               |
|-----|---------------------------------|--------|--------------------------|------------------------|------|-------------|-------------------------|---------------|
| 1   | Aam Chottor to Noagoan Highway  | Monday | 2048.33                  | 580.5                  | 0.88 | C           | Average PHF (0.81)<br>C | Monday Friday |
|     |                                 | Friday | 1608.33                  | 492                    | 0.81 | C           |                         |               |
| 2   | Noagoan Highway to Aam Chottor  | Monday | 1741.33                  | 464.25                 | 0.83 | C           |                         |               |
|     |                                 | Friday | 1563.5                   | 516.25                 | 0.75 | B           |                         |               |
| 3   | Aam Chottor to Kashiyadanga     | Monday | 1185.83                  | 344.25                 | 0.86 | C           |                         |               |
|     |                                 | Friday | 992.17                   | 534.75                 | 0.46 | A           |                         |               |
| 4   | Kashiyadanga to Aam Chottor     | Monday | 1192.33                  | 387.75                 | 0.71 | B           |                         |               |
|     |                                 | Friday | 729.5                    | 246.75                 | 0.73 | B           |                         |               |
| 5   | Aam Chottor to Kharkhari bypass | Monday | 1187                     | 346.5                  | 0.85 | C           |                         |               |
|     |                                 | Friday | 955                      | 502.5                  | 0.47 | A           |                         |               |
| 6   | Kharkhari bypass to Aam Chottor | Monday | 1264.83                  | 410                    | 0.89 | D           |                         |               |
|     |                                 | Friday | 1215.83                  | 368.5                  | 0.82 | C           |                         |               |
| 7   | Aam Chottor to Rail gate        | Monday | 1410.21                  | 571.75                 | 0.61 | B           |                         |               |
|     |                                 | Friday | 1536.17                  | 582.25                 | 0.66 | A           |                         |               |
| 8   | Rail gate to Aam Chottor        | Monday | 1856.17                  | 505.25                 | 0.81 | C           |                         |               |
|     |                                 | Friday | 1549.33                  | 529.25                 | 0.73 | B           |                         |               |

Source: Prepared By Authors

The table (5.5.1.1) presents an analysis of the Level of Service (LOS), which is a qualitative measure describing operational conditions within a traffic stream and the perception of these conditions by motorists and passengers,



for various lanes and intersections based on the Peak Hour Factor (PHF). For the segment from Aam Chottor to Noagoan Highway, the LOS is C (stable flow with some restrictions) on both Monday and Friday, with average volumes of 2048.33 PCU/hr and 1608.33 PCU/hr respectively. The return segment from Noagoan Highway to Aam Chottor shows an LOS of C on Monday and B (stable flow with reasonable freedom to maneuver) on Friday, with corresponding average volumes of 1741.33 PCU/hr and 1563.5 PCU/hr. The lane from Aam Chottor to Kashiadanga has an LOS of C on Monday and A (free flow) on Friday, while the return from Kashiadanga to Aam Chottor has an LOS of B on both days. For the segment from Aam Chottor to Kharkhari Bypass, the LOS is C on Monday and A on Friday, whereas the reverse segment from Kharkhari Bypass to Aam Chottor shows an LOS of D (high-density flow but stable) on Monday and C on Friday. The lane from Aam Chottor to Rail Gate has an LOS of B on Monday and A on Friday, and from Rail Gate to Aam Chottor, the LOS is B on both days. The average PHF for intersections is 0.81 on Monday, with an LOS of C, and 0.67 on Friday, with an LOS of A. This data highlights variations in traffic volume and LOS across different days and lane segments.

### 5.5.2 LOS of the Lanes and in Intersection based on V/C ratio:

Table 5.5.2.1: LOS Calculation of intersection by V/C ratio

| S/N | Name of the Lane                | Day    | Average Volume (PCU/hr.) | Capacity (C) | V/C Ratio | LOS Of Lane | LOS Of intersection             |                                 |
|-----|---------------------------------|--------|--------------------------|--------------|-----------|-------------|---------------------------------|---------------------------------|
| 1   | Aam Chottor to Noagoan Highway  | Monday | 2048.33                  | 2400         | 0.85      | D           | <b>Monday</b>                   | <b>Friday</b>                   |
|     |                                 | Friday | 1608.33                  | 2400         | 0.67      | B           |                                 |                                 |
| 2   | Noagoan Highway to Aam Chottor  | Monday | 1741.33                  | 2400         | 0.72      | C           | <b>Average V/C Ratio (0.75)</b> | <b>Average V/C Ratio (0.63)</b> |
|     |                                 | Friday | 1563.5                   | 2400         | 0.65      | B           |                                 |                                 |
| 3   | Aam Chottor to Kashiyadanga     | Monday | 1185.83                  | 1500         | 0.79      | C           | <b>C</b>                        | <b>B</b>                        |
|     |                                 | Friday | 992.17                   | 1500         | 0.66      | B           |                                 |                                 |
| 4   | Kashiyadanga to Aam Chottor     | Monday | 1192.33                  | 1500         | 0.79      | C           | <b>C</b>                        | <b>B</b>                        |
|     |                                 | Friday | 729.5                    | 1500         | 0.48      | A           |                                 |                                 |
| 5   | Aam Chottor to Kharkhari bypass | Monday | 1187                     | 1650         | 0.71      | C           | <b>C</b>                        | <b>B</b>                        |
|     |                                 | Friday | 955                      | 1650         | 0.57      | A           |                                 |                                 |
| 6   | Kharkhari bypass to Aam Chottor | Monday | 1264.83                  | 1650         | 0.76      | C           | <b>C</b>                        | <b>B</b>                        |
|     |                                 | Friday | 1215.83                  | 1650         | 0.73      | C           |                                 |                                 |
| 7   | Aam Chottor to Rail gate        | Monday | 1410.21                  | 2400         | 0.58      | A           | <b>C</b>                        | <b>B</b>                        |
|     |                                 | Friday | 1536.17                  | 2400         | 0.64      | B           |                                 |                                 |
| 8   | Rail gate to Aam Chottor        | Monday | 1856.17                  | 2400         | 0.77      | C           | <b>C</b>                        | <b>B</b>                        |
|     |                                 | Friday | 1549.33                  | 2400         | 0.64      | B           |                                 |                                 |

Source: Prepared By Authors

From the table (5.5.2.1), it has been found that the traffic volume from Aam Chottor to Noagoan on both Monday and Friday remains within LOS D & B respectively indicating unstable flow, with tolerable operating speeds. Drivers have little freedom to maneuver. B indicates Stable flow and operating speeds were restricted somewhat. Drivers have reasonable freedom for speeds. The flow from Aam Chottor to Kashiyadanga on both days is close to capacity, resulting in LOS C & B respectively indicating Stable flow but speeds are controlled by higher volumes. Drivers' freedom for speed is restricted. The traffic flow from Kashiyadanga to Aam Chottor shows another condition, LOS C & A. Again, having a glance at the Aam Chottor to Kharkhari bypass it can be found that LOS ranging from C to A, indicating Stable flow but operating speeds were restricted & Free flow, with low volumes and high speeds where drivers can continue their journey with speedy movement with no delay. Again, LOS C is found from the Kharkhari bypass to the Aam Chottor route on both days. Here, the flow from Aam Chottor to Rail gate also experiences LOS A on Monday, and B on Friday which is less than the capacity. But while considering the route from Rail gate to Aam Chottor it is found to get LOS C on Monday but LOS B on Friday. Using the V/C ratio method, the LOS of Aam Chottor intersection is C, six times from six different routes whereas LOS A, D & LOS B are also found in the intersection as well. So, considering the frequency of

Monday LOS C is acceptable whereas considering the situation of Friday LOS B 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. Since the intersectional roads are newly constructed it can maintain better service with sufficient capacity.

## **5.6 Discussion:**

### **5.6.1 Causes of Congestion in Intersection:**

Am Chottor intersection is predominantly a commercial zone offering access in four distinct directions with numerous banks and administrative institutions and private hospitals. This is the main reason of rising different types of vehicles volume in Am-chottor intersection. Traffic flow in afternoon off-peak is higher than other two peak hours. This is connected to railgate intersection and three other districts Chapai Nawabganj, Natore and Naogaon. The factors for greater traffic flow from railgate to intersection is the land use containing important establishments like bus stand, Schools, Airport, Mills, Commercial bank etc. As the effective carriageway width is only 12 feet, the LOS of these two lanes is LOS-C for Monday and LOS-B for Friday. One of the main factors contributing to the majority and increasing popularity of Autorickshaws is their low cost of living and ability to reach their destinations swiftly (Rabeya Basri, June,2016). This paper examined into some likely explications for riders and operators who find riding their motorbikes to be saving time.

### **5.6.2 Effect of Congestion in Intersection:**

Uncontrolled or non-signalized junctions are a big drawback. The term "priority-controlled intersection" also is related to this. When the vehicle approaches an intersection to enter, it does not indicate that there is concern for the driver (Yuan, 12 July,2017). Low priority movement, maintenance and less restrictions on roads cause delay that influence the performance of such type intersection very strongly. This leads to vehicle conflict, which is the cause of accidents and traffic jams. LOS of four intersections was C on Monday means stable flow but speeds are controlled by higher volumes and drivers' freedom for speeds are restricted. LOS of four intersections was B on Friday means Stable flow, operating speeds to be restricted somewhat and drivers have reasonable freedom for speeds. Commercial activities around Am chottor intersection attract people so why LOS of Aam chottor is very medium. Normally, traffic moves through this intersection quite slowly. More recently, there has been an extended traffic obstructions at this intersection. Very few lanes have a flow rate that exceeds what is necessary. If traffic volume equal or fall short of capacity There will be accidents involving vehicles, slow average speeds, and numerous unplanned stops.

### **5.6.2 Accidents Data Analysis in Rajshahi City due to congestion in intersection:**

Non-signalized intersections cause several serious accidents in Rajshahi city. In Godagari upazila, a truck helper was killed when a truck ran him over at Dayingpara intersection on Chapainawabganj-Rajshahi road (TheDailyStar., 2017). In Rajshahi city, a woman was killed and five others injured as a bus rammed a battery-run three-wheeler and two motorcycles in Railway Station area, Four people including a policeman were killed and six others injured in four separate road accidents in Rajshahi. In Mohonpur upazila, a police constable of Special Branch in Rajshahi was killed and his co-rider injured as a bus rammed the motorcycle, they were riding on (TheDailyStar).

Based on the above analyses and discussions it is evident that this study puts implication and contribution in 3 cases namely theoretical, practical, and future implications. In consideration of theoretical implications, it can help in advancing the traffic flow theory based on peak hours, and holidays. Again, it can help in network optimization and capacity analysis that creates a new framework for traffic distribution.

In case of practical implication, this study can help in infrastructure planning and management, Road safety issues that provide insights into accident-prone areas correlating with traffic density.

From the perspective of future implications, it can play a vital role in the introduction of autonomous and connected vehicles (CAVs) as well as it can serve as the crucial input for the formation of ITS (Intelligent Transport system) which is the basis of sustainable transport for the future smart cities which is a broad way to explore for the future researcher.



## 6. RECOMMENDATION AND CONCLUSION

The analysis of traffic flow at the Aam Chottor intersection in Rajshahi reveals that the highest peak hour congestion is recorded on Monday at Station-01 (Aamchottor to Noagoan), while the lowest peak hour congestion is observed on Friday at Station-02(Aamchottor to Kharkhari bypass). The most dominant vehicles on the routes are auto rickshaws and motorcycles, while cycle rickshaws and carts are found at a very low amount. Besides, The level of service at the intersection is LOS-C for Monday and LOS-B for Friday indicating the existing capacity of the roads can fulfill the capacity demand for vehicle movement, providing a stable flow but controlling speeds by higher volumes but the scenario may be different in the near future.

So, Traffic management strategies for peak hour congestion including analysis of lane management, signalization optimization, increasing footpath width, enforcing regulations to discourage roadside parking, adding or improving bicycle lanes, and implementing access management techniques must have to be taken under consideration. Public transport integration and encouragement can be achieved through route planning, public awareness campaigns, and reduced traffic during off-peak times as well. Strategies should be developed for reduced traffic include reviewing signage and markings, implementing demand management strategies, adopting Intelligent Transportation Systems (ITS), and creating a sustainable urban mobility plan. Besides Continuous monitoring and adjustments to maintain an acceptable LOS are also recommended by.

In addition, the study highlights the importance of planning transportation and building infrastructure together to make places that can last. As cities grow quickly and traffic becomes heavier, it is crucial to look at and improve the capability of transportation systems. Stakeholders can work towards making Rajshahi's transportation system better, more efficient, and longer-lasting by following these suggestions. It is important to recognize that solving transportation problems requires a group effort from many people, including the public, urban planners, transportation engineers, and government officials. By making others more aware of and respectful of traffic laws and rules, individuals can help reduce traffic jams and improve traffic conditions.

In conclusion, the study emphasizes the importance of analyzing traffic patterns and taking the right steps to enhance the Level of Service at the Aam Chottor crossing in Rajshahi. By implementing these strategies and encouraging responsible road behavior, we can work towards a well-functioning transportation system that supports healthy urban growth, economic development, and better quality of life for the people of Rajshahi.

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