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Review Article

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A Study on Traffic Flow Characteristics and Volume Analysis for Future Solution – A Case Study at Sony Square to Mirpur 10

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ABSTRACT
Traffic congestion is a growing concern in rapidly urbanizing cities, particularly in Dhaka, where mixed traffic conditions and poor infrastructure exacerbate delays and reduce mobility. This study aims to evaluate traffic flow characteristics and volume along the corridor from Sony Square to Mirpur 10 and identify the key contributors to congestion. The research follows a systematic methodology involving manual traffic volume counts using tally counters and video recordings at strategic locations across four daily time slots over ten consecutive days. The collected data were categorized by vehicle type and analyzed through conversion to Passenger Car Units (PCU) to standardize heterogeneous traffic. Microsoft Excel was employed for data tabulation, graphical analysis, and service flow rate calculations. The Highway Capacity Manual (HCM) framework was used to evaluate the Level of Service (LOS) at different times of day.

The findings reveal that evening peak hours exhibit the most critical congestion levels (LOS F), while morning peaks also approach capacity (LOS E). Midday and afternoon periods show relatively smoother flow (LOS B and LOS C/D, respectively). Contributing factors to congestion include excessive vehicular traffic, the absence of dedicated lanes, inefficient signal timings, unauthorized street parking, and a lack of traffic discipline among both pedestrians and drivers. Based on these insights, the study proposes practical recommendations, including the implementation of dedicated lanes, optimized signal coordination, strict enforcement of parking regulations, and enhanced public transportation operations. These strategies aim to alleviate congestion and support efficient traffic management in urban corridors, such as Mirpur 10.

Keywords: Manual Traffic Survey, Mixed Traffic Flow, Passenger Car Unit (PCU), Peak Hour Congestion, Traffic Flow Analysis, Urban Mobility, Volume-to-Capacity Ratio

Introduction

Urbanization in developing nations has accelerated rapidly over the past few decades, bringing with it unprecedented pressure on urban infrastructure, particularly in the transport sector. In major metropolitan areas, traffic congestion has emerged as one of the most critical challenges, negatively affecting economic productivity, environmental sustainability, and the quality of urban life [1]. Dhaka, the capital city of Bangladesh and among the most densely populated cities globally, exemplifies this problem acutely. With a population exceeding 21 million and a road network covering merely 7% of its total area, Dhaka's transport system is unable to meet the growing demands of its residents and vehicular population [2].

Every day, over 1,000 new vehicles are added to Dhaka's streets, exacerbating congestion on an already strained road network [1]. The resulting gridlock leads to increased travel time, elevated levels of air and noise pollution, and significant economic losses. A study by the Bangladesh University of Engineering and Technology found that the average speed of vehicles during peak hours in central Dhaka was just 6.4 km/h, a stark contrast to the ideal range of 15–20 km/h for efficient traffic movement [3]. Key urban corridors, such as the stretch between Sony Square and Mirpur 10, experience some of the city's worst congestion due to

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a combination of high population density, diverse vehicle types, inadequate infrastructure, and inefficient traffic management practices.

This corridor serves as a vital artery for commuters and commercial transport in the northern part of the city. The traffic composition is highly heterogeneous, involving private cars, buses, motorcycles, rickshaws, and CNG auto-rickshaws—each with varying operational characteristics. Such mixed traffic conditions make traditional vehicle-per-hour analysis ineffective, necessitating the use of Passenger Car Unit (PCU)-based models to standardize different vehicle types for comparative analysis [4].

Several studies have identified recurring issues that worsen Dhaka's traffic situation, including poor traffic signal coordination, the lack of dedicated lanes for different modes of transport, frequent illegal parking, informal stopping practices by buses, and weak enforcement of traffic laws [5,6]. Moreover, the behavior of road users—including unpredictable pedestrian crossings and interactions between motorized and non-motorized vehicles (NMVs)—further complicates the traffic scenario. In commercial hubs like Mirpur 10, the absence of footbridges or marked pedestrian crossings means that foot traffic frequently disrupts vehicular movement [7].

Despite these known challenges, many government interventions, such as the construction of flyovers and the introduction of Bus Rapid Transit (BRT) systems, often fail to produce the desired impact due to a lack of localized and real-time traffic data. As noted by Satyanarayana, traffic flow characteristics are location-specific, and without context-sensitive data, effective policy formulation becomes highly constrained [8].

Therefore, localized traffic flow studies that take into account time-of-day variations, vehicle mix, and user behavior are essential for designing effective interventions. This research seeks to address this critical gap by conducting a detailed field-based analysis of the traffic conditions in the Sony Square to Mirpur 10 corridor using PCU-based conversion and Level of Service (LOS) assessment as defined in the Highway Capacity Manual (HCM) (Transportation Research Board). By identifying congestion factors through empirical observation and volume studies across multiple time slots, the study aims to propose realistic and implementable solutions for one of Dhaka's most congested road segments [9].

Methodology

Overview

This study adopts a field-based empirical methodology to assess traffic congestion and flow characteristics along the corridor between Sony Square and Mirpur 10 in Dhaka, Bangladesh. The methodology includes site selection, reconnaissance survey, manual traffic volume data collection, vehicle classification, Passenger Car Unit (PCU) conversion, and Level of Service (LOS) evaluation, following guidelines from the Highway Capacity Manual (HCM) and the Bangladesh Road Transport Authority (BRTA).

Study Area and Site Selection

The selected corridor, extending from Sony Square to Mirpur 10, is a key arterial segment of northern Dhaka. The area was chosen due to its high traffic volume, modal diversity, and frequent congestion. Observation points were strategically selected to capture directional traffic flow and vehicle mix in both inbound and outbound directions.

Data Collection Period and Schedule

Traffic volume data were collected over ten consecutive days, from 31 January to 9 February 2025, during four critical time slots representing different parts of the day:

- Morning Peak: 8:00 AM – 8:30 AM
- Midday: 12:00 PM – 12:30 PM
- Afternoon: 2:00 PM – 2:30 PM
- Evening Peak: 6:30 PM – 7:30 PM

These time windows were selected based on preliminary field observation and align with known peak traffic periods in the area.

Reconnaissance Survey

A reconnaissance survey was conducted before formal data collection to:

- Identify suitable observation points with unobstructed views
- Understand directional flow and vehicular turning behavior
- Plan optimal surveyor positioning and data recording strategy

This preliminary assessment ensured the accuracy and reliability of subsequent manual counts.

Data Collection Method

Due to the heterogeneous nature of traffic and resource constraints, the Direct Manual Counting Method was adopted. Enumerators recorded the number and type of vehicles passing a fixed point during each time slot. To enhance accuracy, two trained surveyors were deployed at each location to count in opposite directions. Supplementary video recordings were taken for post-verification.

Vehicle Classification

Vehicles were classified into the following categories based on function and mode:

- **Public Transport:** Buses, CNG auto-rickshaws
- **Private Transport:** Cars, Motorcycles
- **Freight Vehicles:** Trucks, Pickups
- **Non-Motorized Vehicles (NMVs):** Rickshaws, Bicycles

This classification allowed detailed analysis of modal share and congestion contribution by type.

Passenger Car Unit (PCU) Conversion

To account for the mixed-traffic environment, raw vehicle counts were converted into Passenger Car Units (PCUs) using standard conversion factors recommended by BRTA and IRC:106-1990. Table 1 presents the PCU values applied [10,11].

Table 1: Standard PCU Values Used

Vehicle Type	PCU Value
Bus	3.00
Car	1.00
Pickup	1.50
CNG Auto-rickshaw	0.75
Motorcycle	0.75
Rickshaw (NMV)	0.50

These values normalize the impact of different vehicle types for accurate capacity analysis under heterogeneous conditions [12].

PCU-Based Service Flow Rate Calculation

To quantify traffic intensity and understand congestion levels, vehicle counts were converted into PCU per hour using the formula:

Service Flow Rate (PCU/hr) = (PCU in 30 minutes) × 2

This approach facilitates comparisons across vehicle types and enables congestion assessment using Level of Service (LOS) standards.

Table 2: Service Flow Rate (Time Slot: 8:00 AM – 8:30 AM)

Type of Vehicle	PCU Factor	Flow (30 min)	PCU (30 min)	Service Flow Rate (PCU/hr)
Bus	3.00	167.1	501.3	1002.6
Car	1.00	265	265	530.0
Pickup	1.50	62.2	93.3	186.6
CNG	0.75	56.8	42.6	85.2
Motor Bike	0.75	344.4	258.3	516.6
Rickshaw	0.50	430.2	215.1	430.2
Total				1375.6

Table 3: Service Flow Rate (Time Slot: 12:00 PM – 12:30 PM)

Type of Vehicle	PCU Factor	Flow (30 min)	PCU (30 min)	Service Flow Rate (PCU/hr)
Bus	3.00	96.2	288.6	577.2
Car	1.00	103.8	103.8	207.6
Pickup	1.50	37.7	56.55	113.1
CNG	0.75	52.8	39.6	79.2
Motor Bike	0.75	102.6	76.95	153.9
Rickshaw	0.50	243.6	121.8	243.6
Total				687.3

Table 4: Service Flow Rate (Time Slot: 2:00 PM – 2:30 PM)

Type of Vehicle	PCU Factor	Flow (30 min)	PCU (30 min)	Service Flow Rate (PCU/hr)
Bus	3.00	163.3	489.9	979.8
Car	1.00	157.7	157.7	315.4
Pickup	1.50	31.0	46.5	93.0
CNG	0.75	53.4	40.05	80.1
Motor Bike	0.75	145.5	109.125	218.25
Rickshaw	0.50	187.7	93.85	187.7
Total				937.1

Table 5: Service Flow Rate (Time Slot: 6:30 PM – 7:00 PM)

Type of Vehicle	PCU Factor	Flow (30 min)	PCU (30 min)	Service Flow Rate (PCU/hr)
Bus	3.00	269.2	807.6	1615.2
Car	1.00	318.3	318.3	636.6
Pickup	1.50	50.9	76.35	152.7
CNG	0.75	77.3	57.975	115.95
Motor Bike	0.75	307.9	230.925	461.85
Rickshaw	0.50	460.8	230.4	460.8
Total				1721.6

Level of Service (LOS) Reference

To assess traffic performance, the computed service flow rates were compared with standard LOS thresholds.

Table 6: Level of Service and Corresponding PCU/hr

LOS Grade	Service Flow Rate (PCU/hr)
A	≤ 600
B	601–700
C	701–900
D	901–1200
E	1201–1400
F	> 1400

Results and Discussion

3PCU-Based Traffic Volume Analysis

In this study, the observed heterogeneous traffic volumes were converted into Passenger Car Units (PCU) using standard PCU factors to standardize vehicle impact on road capacity [13,14]. The service flow rates were calculated for four key periods: morning peak (8:00–8:30 AM), midday (12:00– 12:30 PM), afternoon (2:00–2:30 PM), and evening peak (6:30–7:00 PM). The summary of PCUbased traffic volumes and corresponding service flow rates is presented in Table 7.

Table 7: Summary of Service Flow Rates and LOS Classification

Time Interval	Service Flow Rate (PCU/hr)	Level of Service (LOS)
8:00 – 8:30 AM	1375.6	E
12:00 – 12:30 PM	687.3	B
2:00 – 2:30 PM	937.1	C/D
6:30 – 7:00 PM	1721.6	F

Interpretation of Service Flow Rates

- **Morning Peak (8:00–8:30 AM):** The service flow rate reached 1375.6 PCU/hr, placing it under LOS E, which reflects high congestion and limited maneuverability. Buses and motorcycles were the dominant contributors.
- **Midday (12:00–12:30 PM):** Traffic volumes dropped considerably to 687.3 PCU/hr, indicating LOS B is a condition of stable flow and minimal delays.

- **Afternoon (2:00–2:30 PM):** Traffic intensity increased to 937.1 PCU/hr, corresponding to LOS C/D, with moderate congestion attributed to increased private car and bus movement.
- **Evening Peak (6:30–7:00 PM):** The highest traffic volume was recorded at 1721.6 PCU/hr, indicating LOS F, or oversaturated conditions. Buses alone contributed 47% of the total PCU during this interval.

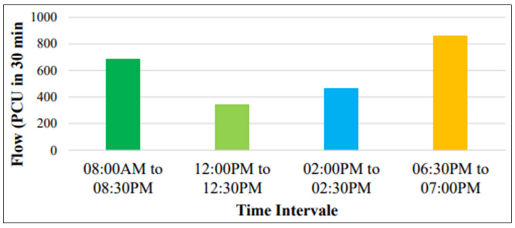

Figure 1: Comparison of Flow (PCU) at Different Time Intervals

Figure 1 illustrates traffic fluctuations across different time intervals. The morning and evening peaks exhibit the highest traffic volumes, with the latter reaching a critical congestion level. The midday period experiences the lowest traffic volume, aligning with LOS B classification.

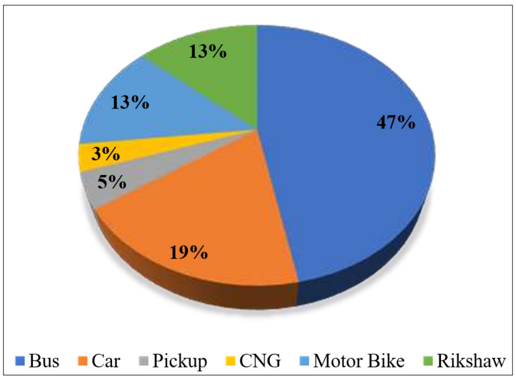

Figure 2: Evening Peak Hour Traffic Composition

Figure 2 presents a detailed breakdown of vehicle category contributions during the evening peak period. The distribution is as follows:

- **Buses (47%)** constitute the largest proportion of traffic, highlighting the dependency on public transport.
- **Cars (19%)** contribute significantly to congestion, emphasizing the need for carpooling initiatives.
- **Motorbikes (13%)** and rickshaws (13%) add to the overall traffic density while providing flexible maneuverability.
- **Pickups (5%)** and **CNGs (3%)** have a relatively lower share, yet their movement patterns contribute to localized congestion.

The high bus dependency indicates the necessity for improved public transportation systems, while better lane allocation and optimized intersection management can mitigate the congestion impact.

Figure 3 illustrates the distribution of vehicle types during the morning peak period. The key observations include:

- **Buses (36%)** remain the dominant mode of transport, reinforcing their critical role in daily commutes.
- **Cars (19%)** contribute substantially to congestion, similar to the evening peak period.
- **Motorbikes (19%)** and **rickshaws (16%)** represent a significant portion of traffic, indicating their essential role in last-mile connectivity.
- **Pickups (7%)** and **CNGs (3%)** contribute modestly to the overall traffic flow.

The morning peak exhibits high congestion levels due to the simultaneous demand for work, school, and business-related travel. Strategic measures such as staggered work hours, improved public transit efficiency, and designated lanes for buses and non-motorized transport can help reduce congestion in this period.

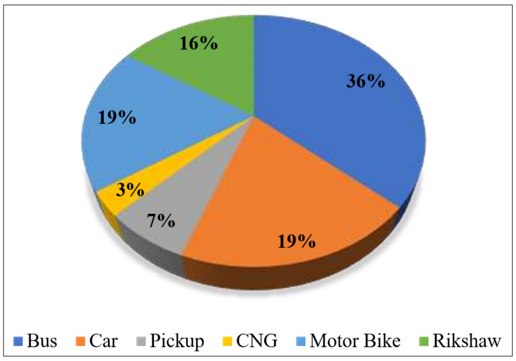

Figure 3: Morning Peak Hour Traffic Composition

Congestion Contributing Factors

The findings indicate that traffic congestion in the Sony Square–Mirpur 10 corridor is primarily driven by:

- Excessive vehicle volume exceeding road capacity;
- Absence of dedicated lanes for different vehicle types;
- Poor traffic signal coordination and frequent stops;
- Illegal roadside encroachments and unregulated pedestrian crossings;
- Lack of road maintenance and alternative routes.

These structural and operational deficiencies collectively contribute to reduced travel speeds, longer delays, and increased user frustration, especially during peak hours.

Conclusion and Recommendations

- This study thoroughly assessed the traffic flow characteristics and volume along the Sony Square to Mirpur 10 corridor—an arterial segment in Dhaka known for chronic congestion and heterogeneous traffic.
- Peak-hour analyses revealed critical service flow rates, with Level of Service (LOS) F in the evening and LOS E in the morning, highlighting an oversaturated traffic condition during these times.
- Buses emerged as the highest contributors to overall traffic load, particularly during peak hours, followed by private cars, motorcycles, and rickshaws, signifying both modal imbalance and capacity constraints.
- Key congestion factors identified include:

o Absence of lane discipline and dedicated road space for different modes. o Inefficient traffic signal coordination leading to unnecessary delays.

- o Unauthorized parking, roadside encroachments, and uncontrolled pedestrian crossings.
- o Poor enforcement of traffic laws and lack of structured traffic management systems.
- The research confirms that localized, PCU-based volume analysis, integrated with Level of Service (LOS) evaluation, provides actionable insights for urban traffic planning in developing cities.

Based on the findings, the following strategic recommendations are proposed to alleviate congestion and enhance traffic efficiency:

- Develop dedicated lanes for buses, NMVs (rickshaws, bicycles), and private vehicles to reduce conflict and improve overall road performance.
- Implement adaptive traffic signal systems using real-time data to optimize green time and minimize intersection delays.
- Strictly regulate roadside parking and encroachments through digital enforcement tools and increased patrol visibility.
- Enhance public transportation services, focusing on punctuality, coverage, and passenger comfort to encourage modal shift from private cars.
- Construct pedestrian-friendly infrastructure, including footbridges, signalized crossings, and barriers to control jaywalking.
- Promote staggered institutional and business hours to flatten peak demand and distribute traffic loads more evenly.
- Deploy Intelligent Traffic Management Systems (ITMS) to monitor flow, predict congestion patterns, and adjust controls dynamically.
- Launch public awareness campaigns focused on traffic discipline, proper road use behavior, and the benefits of shared mobility.

These measures, if planned and executed holistically, can significantly improve traffic performance, enhance commuter experience, and support sustainable urban mobility in Dhaka and similar urban contexts.

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