EXAMINATION OF THE EFFECT OF ILLEGAL PARKING ON CAPACITY REDUCTION OF URBAN ROADS

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Abstract- The city of Karachi has more than 20 million residents which face severe traffic congestion due to infrastructure problems and inefficient traffic management. One of the reasons for the congestion is the habit of illegal parking which results in the formation of bottlenecks. This study investigates the impact of illegal parking on traffic congestion, which is a major cause for air pollution and increased emission levels. On-site surveys were conducted to measure vehicle flow, illegal parking extent, and operational lanes during peak hours. Data was collected manually at Allama Shabbir Ahmed Usmani Road, in Gulshan-e-Iqbal Town. It was found that an average of 2.05 lanes are operational which cater a traffic volume of 2575 PC/hr in front of Blue Ribbon Bakery and 1.88 lanes are operational with a traffic volume of 3144 PC/hr in front of Manpasand Foods. The calculated road capacity was found to be 2075.6 PC/hr/lane. This slightly higher peak hour volume, indicates a near saturation condition and that congestion is inevitable. This congestion leads to increased fuel consumption and emissions, adversely affecting commuters' health. The study underscores the need for improved traffic management to mitigate these issues.

Keywords- sustainability, illegal parking, congestion, emissions.

1 Introduction

Karachi being a mega city is home to more than 20 million people spread over 3530 square kilometers [1]. This vast population commutes daily through the city for work, education and other purposes. Similar to other metropolitan cities, including developed countries, Karachi also suffers from traffic congestion and subsequently the emissions that occur due to it. These issues become severe due to its problematic infrastructure and highly inefficient traffic management and public transport system. These issues range from illegal parking, badly optimized traffic signals, unreliable public transport system, worn-out roads and deteriorating pavements.

In Karachi, the average total delay of vehicles throughout the city due to congestion is estimated to be 600,000 minutes/day which is nearly 410 days/day [2]. Faiq et al. (2012) found that the primary reasons for these traffic jams in Karachi are encroachments on roads and footpaths, an excess of cars, and insufficient parking facilities [3]. These key factors contribute significantly to severe traffic congestion leading to increased travel time, additional fuel costs, delays, and consequently, higher emissions[3]. Now, these delays not only results in reduced mobility but it has a direct impact on the energy consumption which is mostly fossil fuel for vehicles. The more time a vehicle spend on roads in idling crawling or undergoing acceleration and deceleration, the more fuel it is likely to consume resulting in higher emissions and longer exposure times for commuters in these polluted environments.

These emissions include a variety of air pollutants including Black carbon (BC), Carbon Dioxide (CO_2), carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_X), nitrogen dioxide (NO_2), PM2.5 and PM10 particulate matter, and particles with a diameter < 0.1 µm also known as ultra fine particles (UFP) [4][5]. Delays in commuting time increase the daily exposure to these pollutants, which in turn raises the risk of skin, eye, and lung-related health issues, as well as physical and mental health problems due to traffic congestion[6][7]. Traffic-related air pollution constitutes a significant public health crisis. Its impact is substantial and continues to grow as advancements in knowledge and quantification methods emerge [8].

This study focuses on causes and effects of illegal parking on congestion which eventually results in traffic related air pollution and emissions. The first section of study covers the study area, the second details capacity and peak hour volume calculations, the third presents results and discussions, and the final section offers recommendations.

2 Study Area

The study solely focuses on the impact of illegal parking on traffic congestion. To investigate this issue, a survey was conducted on a 100 meter section of Allama Shabbir Ahmed Usmani Road, extending from Maskan Chowrangi, in front of Blue Ribbon Bakery and Manpasand Sweets.

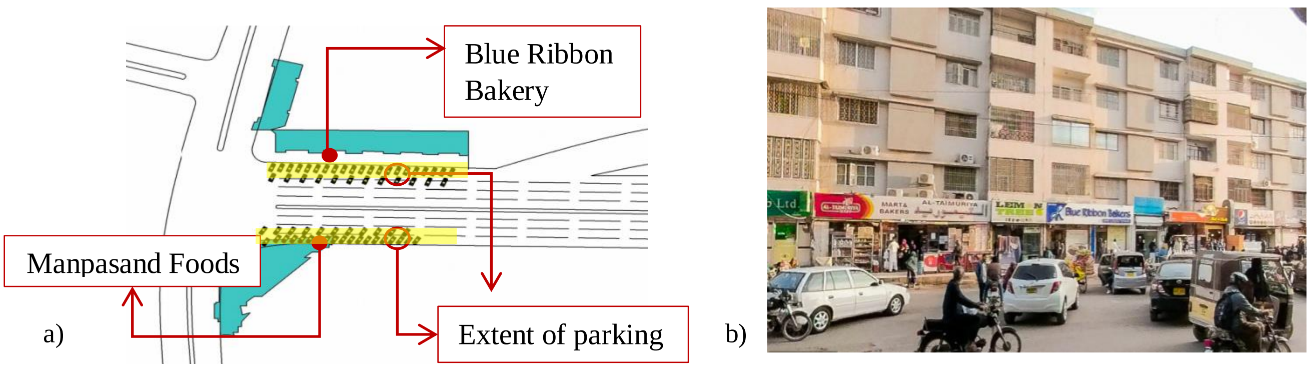

Figure 1: Study Area, a. Geometry of study area, b. Condition of illegal parking in front of Blue Ribbon as of 30 May,2023 at 6:00 pm.

Figure 1 depicts the geometry and current conditions of the study area on Allama Shabbir Ahmed Usmani Road, with the 100-meter section under observation highlighted in yellow (Figure 1a). Figure 1b captures the reality of vehicles illegally parked along this specific section of the road.

2.1 Locations

The location selected for this particular study is the starting point of Allama Shabbir Ahmed Usmani Road, in front of the Manpasand Foods (coordinates: 24.935039N, 67.104908E) and Blue Ribbon Bakery (coordinates: 24.934667N, 67.105108E) (Figure 2).

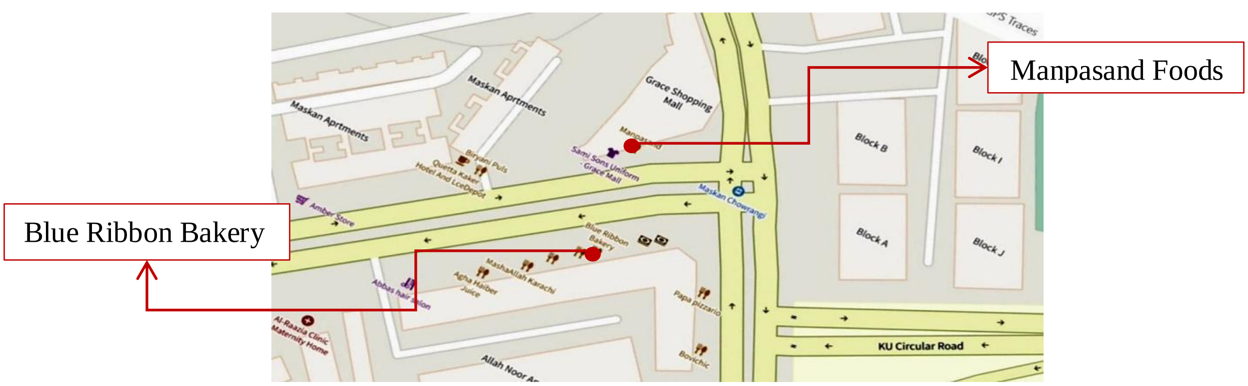

Figure 2: Location of the study area (Source: openstreetmap.org)

2.2 Data Collection

The survey was performed on 30 May, 2023 from 6 pm till 10 pm at the specified location. The data was collected manually in a group of two by stationing at the site to obtain required information. The survey focused on the number of operational lanes on each side of the road during peak hours and the traffic volume. The finding indicate an average of 2 operational lanes in front of Blue Ribbon and 1.88 in front of Manpasand Foods with traffic volumes are 2575 PC/hr and 3144 PC/hr respectively.

3 Capacity Analysis

For capacity analysis we consider a segment of road on level terrain with a length of 180 m and a base free flow speed of 60 kmph. The peak hour volume recorded is 3144 veh/hr. The road features a width of 13 meters with individual lane widths of 3.6 m and lateral clearance of 2.5 meters. Based on these parameters, we proceed with the capacity and Level of Service (LOS) calculations.

3.1 Current capacity and LOS

The current capacity was calculated considering the adverse conditions, with operational traffic lanes of 1.88 and a volume of 3144 PC/hr, as indicated by the survey. Hence,

$FFS = BFFS - F_{LW} - f_{LC} - f_M - f_A$ [9]

$\text{FFS} = 40 - 0 - 1.44 - 0 - 1 = 37.56\ \text{km/hr}$

$\text{FHV} = \frac{1}{1+\text{Pt}(\text{Et}-1)+\text{Pr}(\text{Er}-1)} = 0.989$ [9]

When N=1.88,

$\text{VP} = \frac{\text{V}}{\text{PHF}\times\text{N}\times\text{FHV}\times\text{FP}} = \frac{3144}{0.9\times1.88\times0.989\times1}$ **=1878.82 PC/hr/ln** [9]

LOS for Vp=1878.82 PC/hr/ln is: **LOS F**

For practical capacity,

$\text{Capacity} = 2200 + 10 * (\text{V} - 50)$ [9]

When V = 37.56 km/hr

Capacity = 2075.6 PC/hr/ln

Capacity = **3902.128 PC/hr/roadway** (*when, no of operational lanes = 1.88*)

3.2 Proposed capacity and LOS

Proposed capacity will be when all 3 of the lanes will become functional, so the peak hour volume per lane will reduce while the practical capacity per lane will remain same. Hence,

When N=3,

$\text{Vp} = \frac{\text{V}}{\text{PHF}\times\text{N}\times\text{FHV}\times\text{FP}} = \frac{3144}{0.9\times3\times0.989\times1}$ **=1177.39 PC/hr/ln** [9]

LOS for Vp=1177.39 PC/hr/ln is: **LOS D**

For practical capacity,

Capacity = **6226.8 PC/hr/roadway** (*when, no of operational lanes = 3*)

3.3 Comparison between proposed and current

A comparative analysis of the LOS at the study location is presented in Table 1. It can be observe that the current and proposed capacity and LOS changes with the change in available number of functional lanes. A noteworthy increase of

37% in the capacity of the road in a particular direction can be achieved if the numbers of functional lanes increase from 1.8 to 3.

Table 1 Comparison table between current and proposed conditions

	Capacity (PC/hr/roadway)	LOS
Current	3902	F
Proposed	6226	D

4 Discussions

The maximum per lane capacity of road is coming out to be 2075.6 PC/hr/lane. This capacity is calculated at a base free flow speed of 40 kph. The value of this capacity is more than the peak hour volume, which is 1878.8 PC/hr/lane. Since, the capacity of the road is greater than the peak hour volume this means that the condition is not saturated and there will not be any further queuing of vehicles and the outflow will be equal to the inflow. But in practical and as per our observation, since the value of Vp is very close to the capacity of the road, the road can become oversaturated when parking maneuvers occurs, therefore congestion will be imminent. This will create delay eventually causing more fuel to burn resulting in emissions and more exposure time to the commuters. Furthermore, the investigation indicates that if all three lanes will remain operational the peak hour volume per lane will reduce improving the level of service (LOS) from F to D. This indicates that restoring the full capacity of the road by eliminating illegal parking could significantly reduce congestion, reduce fuel consumption, and lower emissions.

5 Recommendations

In order to effectively mitigate the issue of illegal parking it is crucial to enforce traffic regulations. Research shows that rigorous enforcement significantly reduces traffic violations by imposing substantial penalties, encouraging compliance and keeping lanes clear. For the successful execution of an optimal enforcement strategy, it is crucial to consider its selection as a fundamental part of the comprehensive transport plan, rather than treating it as an afterthought to be added later [10].

Other effective strategies include congestion pricing, successfully used in Singapore and London to reduce traffic volumes. Incentives like free entry for electric vehicles and public transport into congestion zones have proven even more successful [11]. Implementing similar strategies in Pakistan could lower traffic volumes, carbon emissions, air pollution, and queuing times.

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