CONGESTION MODELLING AND LEVEL OF SERVICE ASSESMENT OF URBAN ROADS IN DEVELOPING COUNTRIES

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ABSTRACT

Traffic congestion is a concern in the urban areas all over the world. Inadequate public transport, stagnant road infrastructure development and increased usage of private transport by the people of satisfy the travel demand has led to increase in congestion. Heterogeneous traffic on poor roadway and control condition has made the problem more complex in developing countries like India. Traffic congestion has resulted in travel delay and increased vehicular emissions.Studies have been carried out in developed countries to quantify congestion to evaluate the present situation and forecast the feature scenarios the methods have been successfully used to plan for additional infrastructure facilities and measures required to mitigate congestion. The existing methods used in Indian conditions are not sufficient to explain the congestion due to mixed traffic conditions. The popularly used V/C ratio and LOS to assess the quality of travel in urban areas have certain limitations due to fixed PCU adopted for the vehicles and the capacity norms proposed for urban roads. The present study is formulated with the objectives to build a mathematical model to quantify traffic congestion for heterogeneous traffic and also assign LOS to the study road stretches video graphic technic is used for data collection several stretches on Panthechowk, Dal Gate stretch have been marked for study the characteristics of the traffic have been analyze by extracting the relevant data from the digital video file.The flow on the urban roads is not continuous, the capacity of the urban roads depends on the capacity of intersections ahead the flow on the urban roads has both constrained and free flowing vehicles the flow rate is computed based on the actual time taken by the vehicle to cross based on the speed flow relationship established accounting the mix of traffic congestion index for heterogenous traffic flow is proposed based on the free flow time taken by a vehicle to cross the stream and the actual travel time, thereby improving LOS of the stretch which in term means less difference in free flow and actual travel time

KEY WORDS

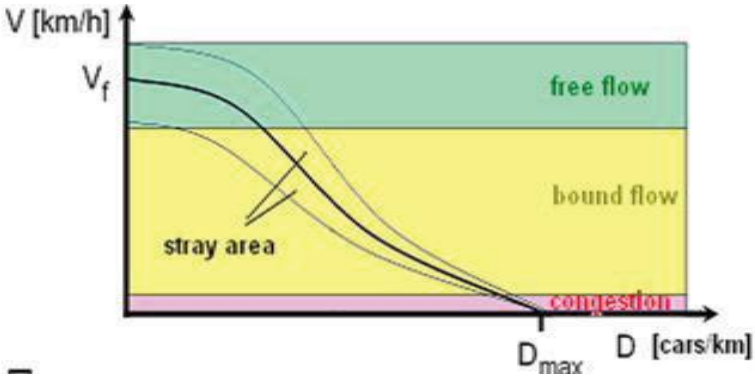
Congestion, urbanization, congestion index (CI), free flow speed, heterogeneous traffic, level of service, quantifying congestion, passenger car equivalents, free flow, travel time, capacity, speed flow relationship

1. INTRODUCTION

Traffic on the Indian city roads has increased tremendously due to the increasing rate of urbanization. Globalization of the Indian economy and the improvement in economic status of the people has also induced greater impact on the transportation system. Increasing inadequacy of public transport, rising rate of vehicle ownership and migration of people to urban fringes have led to extensive use of private modes, clogging the road network. The traffic movements in city roads have been compounded by frequent interruptions, resulting in drastic reduction in speed, leading to congestion. With an increase in ease of vehicle ownerships across the globe, particularly in developing countries, traffic on the roads has grown significantly. At the same time the pace at which the existing road facilities are upgraded and new facilities introduced is much slower than the pace at which traffic is growing on the roads. On the other hand, the public transportation system is quite inefficient at some places and unreliable at others. The modern life style where people are somewhat compelled to make most out of their lives by saving all the time they can has also forced an increase in personal vehicle ownership. All these factors have resulted in a significant increase in traffic on roads, often exceeding the capacity and making it difficult for the traffic to ply smoothly and hence the traffic congestion.

Speed-Density

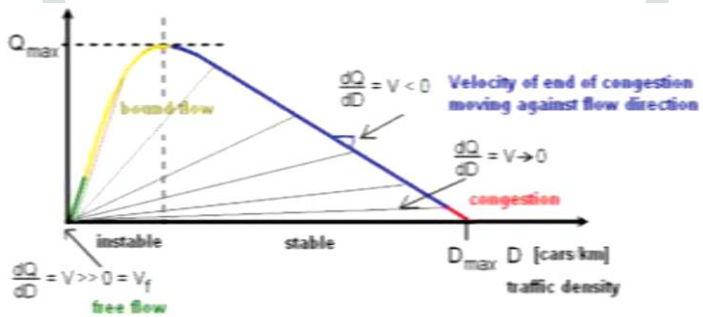
The speed-density relationship is linear with a negative slope which explains as the density of traffic increases the speed on the roadway decreases. The line crosses the speed axis, y, at the free flow speed, and the line crosses the density axis, x, at the jam density. Here the speed approaches free flow speed as the density approaches zero and speed approaches zero when the density equals the jam density.



Speed (v) vs density (k).

Flow-Density

The flow-density diagram is used to determine the traffic state on a roadway. The triangular shaped curve consists of two vectors. The first vector is the free flow side of the curve by placing the free flow velocity vector of a roadway at the origin with rising slope up to apex of curve. The second vector is the congested branch, which is created by placing the vector of the shock wave speed at zero flow and jam density. The congested branch has a negative slope, which implies that the higher the density on the congested branch the lower the flow. The intersection of free flow and congested vectors is the apex of the curve and is considered the capacity (Qmax) of the roadway, which is the traffic condition at which the maximum number of vehicles can pass by a point in a given time period. The flow and capacity at which this point occurs is the optimum flow and optimum density, respectively.



flow (Q) vs. density (K).

1.1. Objectives of study

Based on the above statement of the problem, the objectives of the study are as

- To identify the most congested road and period of congestion at the study intersection.
- To quantify congestion and to develop a congestion-prediction model.
- To identify the level of service of each link in the study stretch.
- To provide recommendations to reduced congestion and improve level of service of stretch.

1.2. . Scope of the study

Congestion is also due to the incidents related to road accidents, maintenance works, etc. (non - recurrent congestion) and due to the traffic characteristics (recurrent congestion). Recurrent Congestion is observed at the same time and location on working days or during holidays. Congestion can occur at intersections and on mid blocks. Here in this study only recurrent congestion observed on stretches other than intersections is considered, and the primary focus is on quantifying congestion due to traffic heterogeneity and pavement encroachment. The study also encompasses the level of fuel consumption, pollution in the form of particulate matter and delays arising out of congestion.

2. STUDY METHODOLOGY

In order to appreciate the cause for traffic interruption and consequent congestion, the type of traffic flow needs to be understood. The flow is classified as free flow and constrained flow based up on the time headway of the vehicles. Vehicles cleared from the up-stream intersection travel in groups and dispersed vehicles based on the type of vehicle, driver and traffic characteristics. The speed of the vehicle depends on the clearance available to it in the front i.e headway available to the vehicle. The headway at which vehicles travel freely without any speed restriction is called free headway and the corresponding flow is free flow. The headway when there is speed restriction due to presence of other vehicles is called constrained headway and the corresponding flow is constrained flow.The flow that occurs in peak hour is not enterally constrained flow. Vehicles with sufficient headway travel at free speed and once the headway is minimum the flowing vehicle travels at the same speed or speed less then the leading vehicle as speed is the criteria for measuring congestion, the headway blow which the vehicles are encountering speed restriction is taken as the guideline for defining the platoon.

2.1. DATA COLLECTION

Traffic flow parameters consist of a set of complicated factors interacting with one another therefor ordinary menial methods of data collection cannot fully cope with the demands of compaction study, embracing different parameters such as time headway, volume, density, delay, speed etc. Accurate measurement of vehicle speeds and headway on road networks are essential requirements for congestion muddling. Parameters relevant to the vehicular flow are to be collected with appropriate method which yields the maximum accuracy. The information required are traffic flow lane wise, vehicle speed, time headway of the vehicles and vehicular composition. Manual techniques are successful at low volumes of traffic flow, at higher traffic flow the task becomes tedious and the results are erroneous. Mechanical devices do not yield satisfactory results due to the complex behavior of mixed traffic in Indian cities. Radar speed meter is suitable for measuring the speed of vehicle's accurately at low volumes. At times of heavy flow radar speed measurements are not dependable as confusion regarding the identity of vehicle whose speed is measure is existing. There are certain limitations regarding the usage of the radar speed meter for measuring the speed of two wheelers. Time lapse photography was first used by Greenshields (1935) to study traffic flow behavior. Thirumurthy (1979) has studies the contribution of traffic congestion by autorickshaws using time lapse photography. Equipment having detectors are in use in USA for traffic surveillance and control photographic techniques are appropriate in mixed mode environment. The method is expensive and data retrieval is time consuming recent advances in image processing, electronic cameras, special purpose computer architecture and micro processer technology have made the machine vision alternative for vehicle detection attractive, economical and promising.Among the many methods of data collection for the conduct of experiments mixed traffic flow, videography is having the greatest potential as the equipment and recurring cost are low and man power requirement is considerably less the traffic flow data collected by videography from the field can be studied and analyzing in the laboratory. The above method is found to be quick easy accurate, and also cost effective for investigating the traffic movements. Use of video recording has a number of advantage and the measure one is production of a permanent and complete record of the traffic characteristics which can be reanalyzed at any stage and it provides an account of each traffic event observed.Video recording, digital map processing techniques with multimedia software and data extraction using data base software in windows environment have been used in the study

3.2. STUDY STRETCH SELECTION

Chose of study stretch and appropriate method of data collection plays an important role in the collection of reliable information the site for data collection of this study was selected on panthachowk to dalgate road. The following criteria were considered in the selection sites for collecting the required data.

A: Mid-blocks on divided urban roads having uniform width

B: The road stretch away from the intersections and interfering traffic.

C; the stretch having clearly marked lanes.

D: Availability of suitable locations for mounting the video camera for recording the events.

E: The study stretches located on plain terrain.

3. METHODS FOR CONDUCTING VEHICULAR COUNTS & RESULTS

1. Manual Method: A team of observers can record not only traffic volume but also the types of vehicles, turning movements, directions of movements, laden weights of trucks and other such details that can not be captured by using automatic methods.

However it is not practicable to conduct to manual counts for all the 24 hr of the day and on all days of the year but it is the most reliable method to obtain traffic volume by classified kinds of traffic and directional volume for short counts needed for intersection design.

Mechanical counts are usually used for periods of 24 hr are longer

Manual counts, including turning movements and vehicle classification and possible pedestrians are made for the following periods.

A. 12 hrs :- 7:AM TO 7:PM

B. 8 hrs :- 7:AM TO 11:AM, 2:PM TO 6:PM

C. 4hrs:- 7:AM TO 9:AM, 4:PM TO 6:PM]\

2. Automatic Counters: Automatics counters uses less number of observers and have the advantage of collecting a continuous record of traffic movement

3. Moving observe Method: in this method, an observer in a car moves along with the traffic and against the traffic to count the numbers of vehicles met, number over taken and the time of interval.

$Y = 0.18364 + 0.16027 X_1 + 0.11922 X_2$

Y = 15 MINUTE TRAFFIC VOLUME

X_1 = NO OF LARGE STEERING REVERSALS

X_2 = NO OF BREAK APPLICATIONS

This equation was developed to predict the traffic volume

Presentation of traffic volume study data :- the data obtained from traffic volume studies are presented and different forms for arriving at appropriate conclusions depending on the purpose of studies .

A. Hourly, daily, weekly, seasonal and annual variations of traffic in the form of charts or graphs. This will help in evaluating the existing facilities and for traffic regulation and control.

B. Design hourly volume of a traffic may be determined from a plot between hourly traffic volume and the number of hours in a year when the particular traffic volume is exceeded

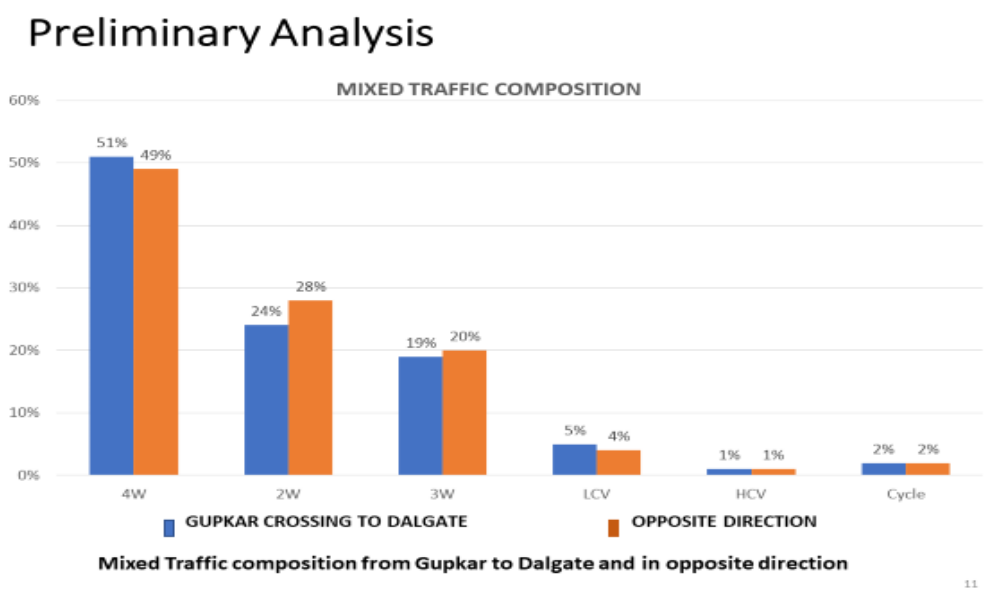
MORNIG AND EVENING DATA SURVAY: Traffic shows great and reasonably predicatable fluctuation by time period. There is usually no pronounced early morning peak in rural areas, but in urban areas there is a pronounced peak which occurs in the 7: AM to 9:AM interval for both rural and urban locations, the greatest peak through out the day occurs in the 4 to 6:PM interval.

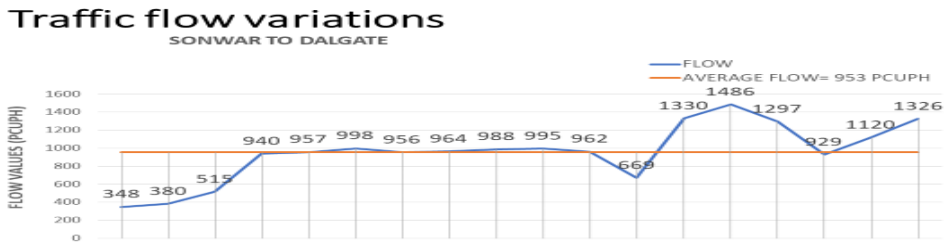
In urban areas there is high directional peak in bound in the morning on express ways and radial atreals leading into the CBD and out bound in the evening.

Duration of peak flows is very important in planning traffic controls such as peak priod parking and stopping restrictions, restrictions on turning movements and signal timing. The duration of peak flows is indicate the appropriate times of the days such controls should be in effect

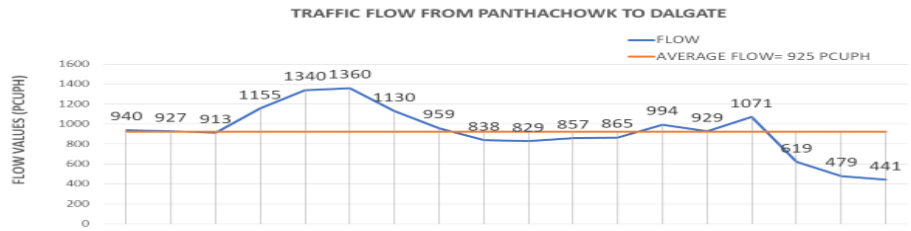
Variables	Stretch A	Stretch B	Stretch C	Stretch D	Stretch E	Stretch F	Stretch G
Flow(PCU/HR)	1830	1751	1982	1882	1680	1560	1732
Width(M)	7.5	8.0	8.3	8.0	7.8	7.3	6.5
Length(KM)	1.2	1.1	0.9	2.3	1.4	1.1	1.4
Illegally parked vehicles	63	48	73	52	41	28	36
Street vendors	19	17	15	24	18	17	11

Securty check points	3	9	2	1	1	1	1
Intresections	4	7	6	5	4	5	6
Ancroachments	11	9	19	15	9	7	8
Obstructions within the carriage way	7	8	12	19	9	9	7
Moving bottle necks	1	2	1	1	1	1	1
Surface distress	1	2	3	2	2	1	1
Pedestrain crossing behavior	2	3	3	1	2	2	2
Density(PCU/KM)	130	111	143	67	60	75	71
Effect of no motrable traffic	3	2	3	2	2	2	2
Speed (KMPH)	14	15.8	13.5	28.4	28	22	36

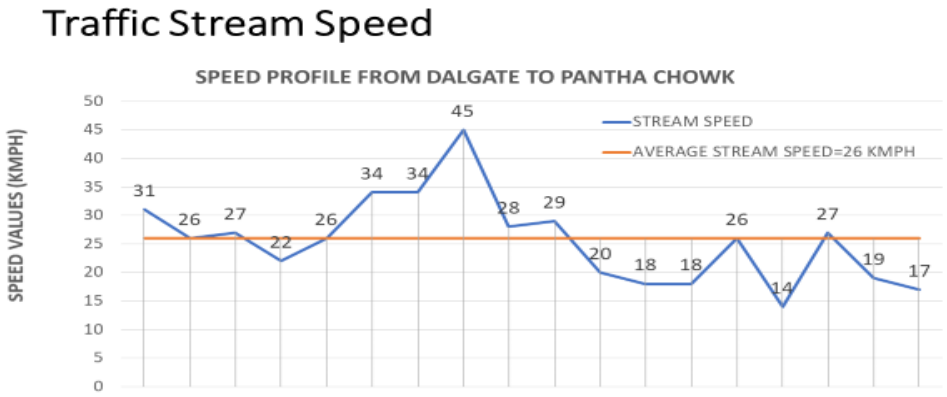



Traffic flow variations
SONWAR TO DALGATE
FLOW
AVERAGE FLOW= 953 PCUPH
FLOW VALUES (PCUPH)
1600
1400
1200
1000
800
600
400
200
0
348 380 515 940 957 998 956 964 988 995 962 669 1330 1486 1297 929 1120 1326

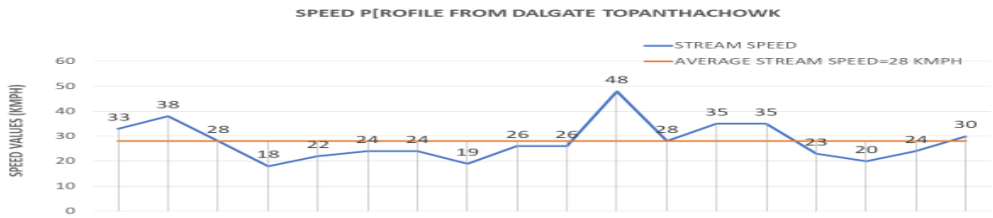
12

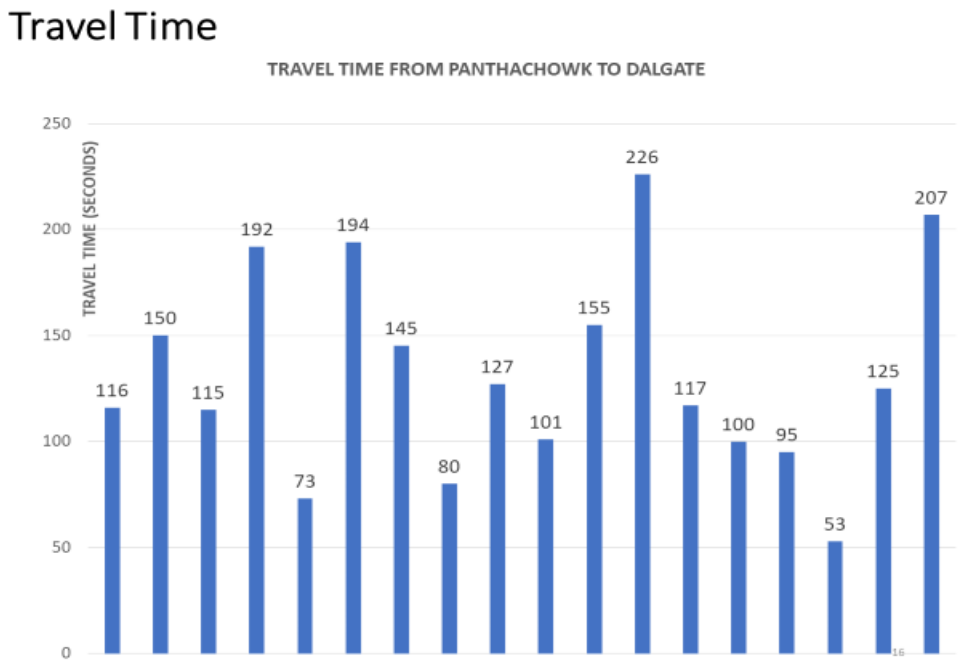

TRAFFIC FLOW FROM PANTHACHOWK TO DALGATE
FLOW
AVERAGE FLOW= 925 PCUPH
FLOW VALUES (PCUPH)
1600
1400
1200
1000
800
600
400
200
0
940 927 913 1155 1340 1360 1130 959 838 829 857 865 994 929 1071 619 479 441

13

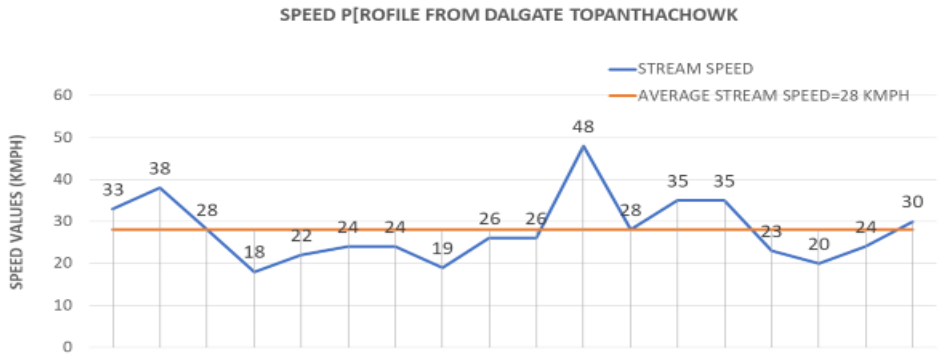

Traffic Stream Speed
SPEED PROFILE FROM DALGATE TO PANTHA CHOWK
STREAM SPEED
AVERAGE STREAM SPEED=26 KMPH
SPEED VALUES (KMPH)
50
45
40
35
30
25
20
15
10
5
0
31 26 27 22 26 34 34 45 28 29 20 18 18 26 14 27 19 17

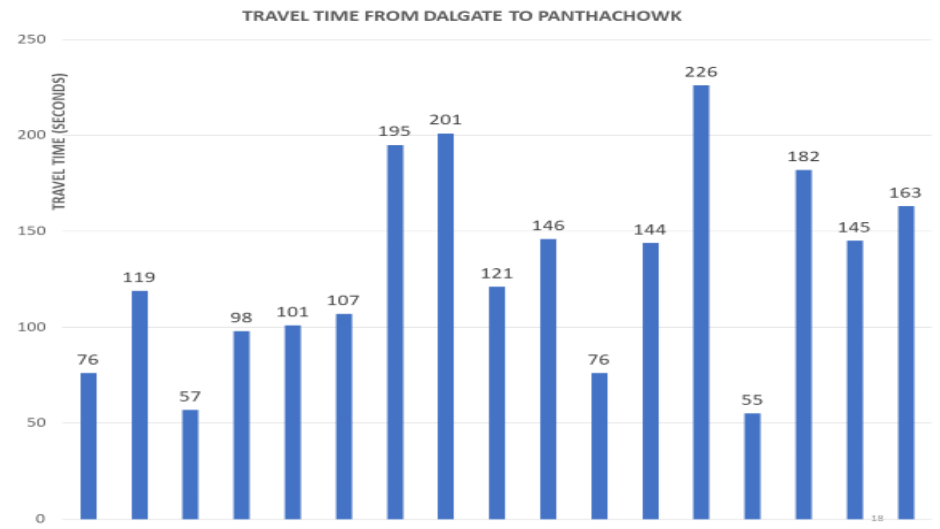
14

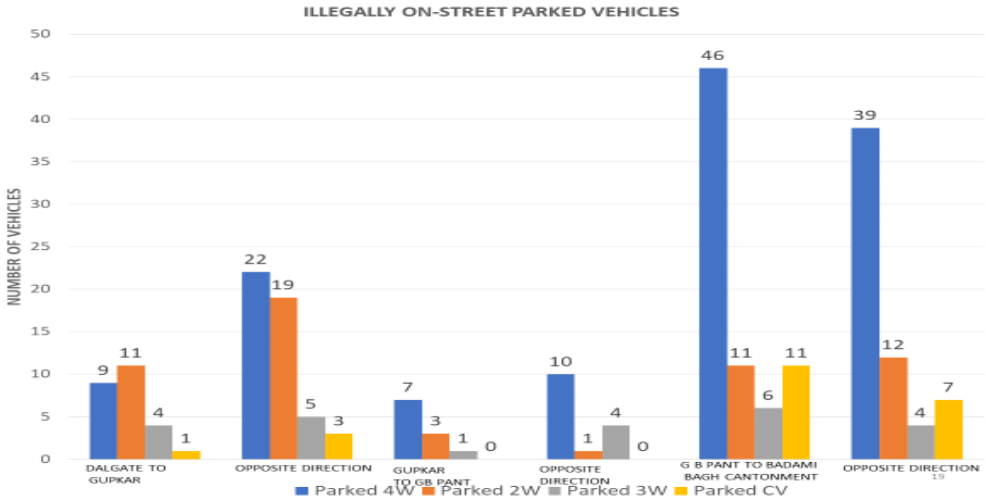




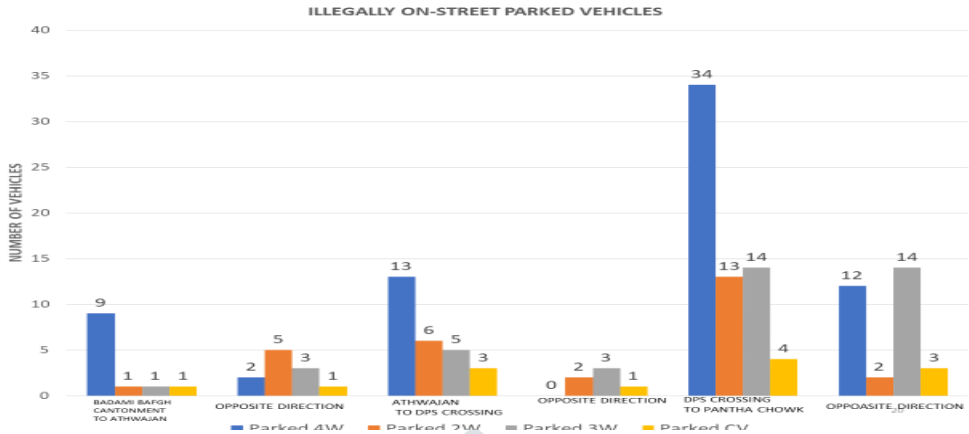
It is generally recognized that the travel time along a road is not fixed value but will depend on the level flow. The nature of dependence should be bound up with the maximum flow possible on the road in this case the saturation flow rate should be defined as the flow that occurs on when the travel time is finite

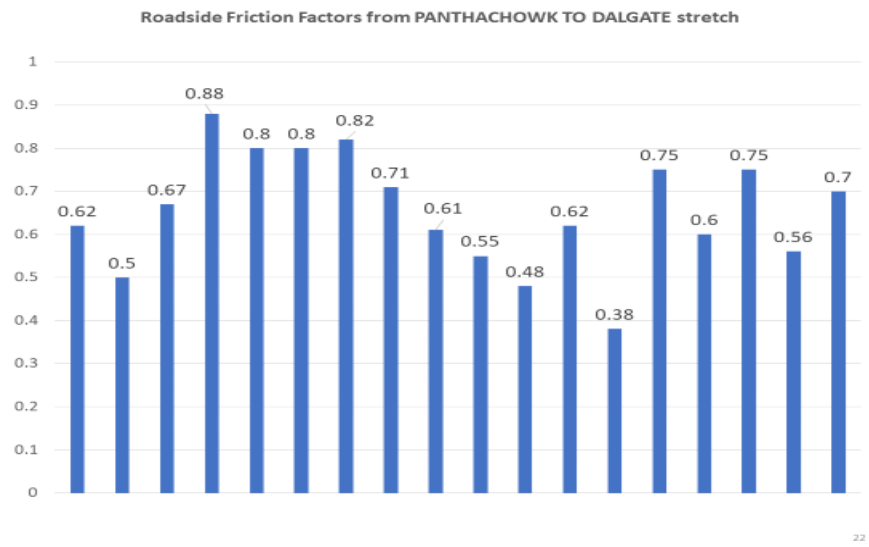

SPEED P[ROFILE FROM DALGATE TOPANTHACHOWK
STREAM SPEED
AVERAGE STREAM SPEED=28 KMPH
SPEED VALUES (KMPH)
60
50
40
30
20
10
0
33
38
28
18
22
24
24
19
26
26
48
28
35
35
23
20
24
30


TRAVEL TIME FROM DALGATE TO PANTHACHOWK
TRAVEL TIME (SECONDS)
250
200
150
100
50
0
76
119
57
98
101
107
195
201
121
146
76
144
226
55
182
145
163


ILLEGALLY ON-STREET PARKED VEHICLES
NUMBER OF VEHICLES
50
45
40
35
30
25
20
15
10
5
0
9
11
4
1
22
19
5
3
7
3
1
0
10
1
4
0
46
11
6
11
39
12
4
7
DALGATE TO GUPKAR
OPPOSITE DIRECTION
GUPKAR TO GB PANT
OPPOSITE DIRECTION
G B PANT TO BADAMI BAGH CANTONMENT
OPPOSITE DIRECTION
Parked 4W
Parked 2W
Parked 3W
Parked CV

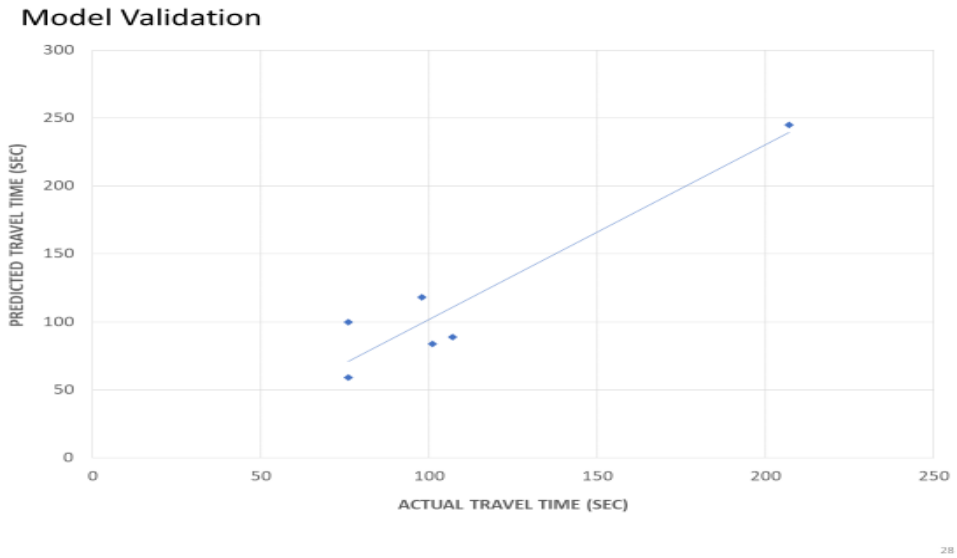
In the above graph we have concluded that the no of vehicles illegally parked in zone 5 i.e from GB pant to badami bagh cantonment and no of 4w is high in opposite direction





S. No	VARIABLES	SYMBOLS	UNIT
1	Travel Time	TT	SECONDS
2	Segment Length	L	KM
3	Number of Lanes	NOL	
4	Number of Major Intersections	NOI	
5	Flow	Q	PCUPH
6	Speed	V	KMPH
7	Density	K	PCUKM
8	Number of illegally parked 4W	P4W	
9	Number of illegally parked 2W	P2W	
10	Number of illegally parked 3W	P3W	
11	Number of illegally parked CV	PCV	
12	Presence of Speed Barrier	POB	
13	Rating of Roadside Friction Points	RSF_R	
14	Number of Friction Points	RSF_N	
15	Pavement Condition Factor	PCF	

Symbols and units for variables used



4. Conclusion and recommendations

From the above data it's concluded that traffic congestion is a major problem in urban areas during Peak Hours I.e in the morning as well as in the evening so the above modal is established as per the data from various techniques

From the traffic composition data of the selected stretch it's clearly evident that the majority of vehicles are 4w

The highest value of RSF = 0.88 in segment from GB pant to Badami bagh cantonment bridge

Illegal parking on streets of 4W highest from GB pant to Gupkar crossing = 46 V/H

Condition of the pavement worst in the segment from DPS to GB pant with value 0.95

Congestion index value highest in the segment sonwar to Dal Gate =4.58 indicating severally congested during peak period

The development of control system deal with the traffic congestion in urban areas is a critical research issue various traditional method have been applied to reduce the problem of traffic congestion. Some of these include road pricing, supporting the green traffic, parking enforcement, fuel levies, expansion of existing road networks, elimination of roundabout and so many others. During this time, technology has been integrated to develop some intelligent control systems to deal with the traffic congestion issue, specifically in urban areas many intelligent approaches have been intergraded to model and simulate or implement the real time traffic control system like activity theory, neural network, petri nets and there hybrid approaches. In this thesis the work carried out is to model and simulate the real traffic control system in the urban city, Srinagar (panthachowk to dalgate). The proposed work consists of modelling at one traffic intersection and handling traffic congestion with minor lane bypass in a road network. The work has been done in two phases, first phase include the conceptual modelling of the proposed system by activity theory and in a second phase the conceptually modeled system simulating through the MATLAB 7.0 and it is proved the results are found competitive and satisfactory as well In future the authors are interested to extend the proposed work by expanding its capabilities to manage the traffic on highway through satellite global positioning systems (GPS) The extension of the work will include modelling of the road networks at district and state level connected through the GPS and satellite imaging techniques to predict the traffic flow and routing in traffic road network

RECOMMENDATIONS

The share of buses, trucks, cars and autorickshaws need reduction if the congestion index requires to be maintained at the same level. But from the pollution and passenger carrying capacity considerations, the share of buses needs to be increased, while the share of other vehicles has to be curtailed. Therefore, the only alternative available is to reduce the share of autorickshaws and introduce exclusive bus lanes to promote public transport. Though buses have more contribution in the rise of congestion index it's the most preferred mode in terms of person carrying capacity. A vehicular mix of 16 % buses can be used to satisfy a travel demand of 20,000 persons/Hour/lane (for a reduction factor of 1) along with 40 % cars, 36 % two wheelers and 8 % autorickshaws. The above mix has the congestion index of 0.71 and the corresponding flow level is 1878 vehicles/hour/lane. The per person emission load for traffic mix is low if higher proportion of buses and cars travel with minimum shear autorickshaws. Travel by bus has to be encouraged to ensure batter air quality in urban areas.To achieve economy in terms of fuel consumption maximum proportion of buses and two wheelers

with minimum proportions of cars and autorickshaws has to be allowed in the traffic mix at flow levels. Thus, bus transport is the most preferred in terms of economy, environmental pollution and in satisfying the public travel demand.The flow in the mid blocks of urban roads can be classified as free flow and constrained flow using the time headway of vehicles. Platoons can be defined as the group of vehicles with time headway less than the average free headway of the vehicles. The flow and stream speed of the platoon of vehicles can be computed from the observations and a good relationship is found to exist between speed and flow for heterogenous traffic condition.It was observed that speed-flow relationship for 100 % car stream is good with an r^2 value of 0.5456 and the maximum observed flow is 1749 cars per hour lane. The flow can be taken as the capacity of urban roads per hour per lane with suitable reduction based on time during which the traffic is permitted into the road.The speed-flow relationship for heterogenous traffic stream is established with an r^2 value of 0.682. the maximum observed flow is 3300 vehicles per hour per lane for a reduction factor of 1.The relationship can be used to compute the average speed of vehicles at different compositions. The capacity flow for different compositions can also be computed.

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