Delay Estimation & Development of Model for urban Arterial Road

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Abstract— Measuring delay is important in computing the level of service provided to road users at signalized intersection. Intersection delays may include queue delay and control delay. The techniques developed for delay estimation in the most traffic signal design guidelines are based on the assumption that queue discharge rate at signalized intersections becomes stable after a few vehicles passes through the stop line, which is termed as saturation flow rate. This assumption has been challenged in recent times as a number of field observation in different parts of the world reported an increasing queue discharge rate observed along the back of queue. Estimation of delay is required to enhance the facility related to traffic condition, roadway facilities, signal design etc. Based on the delay estimation, model will develop by compiling data related to average control delay at intersection, delay on route, classified volume count and space mean speed. Regression based model is developed for estimation of stop control delay at intersection and average travel time time delay along the route. Then model is validated on basis of different statistical test and give some limitation of particular model.

Key words: Traffic composition, Idling delay, Statistical test

I. INTRODUCTION

Traffic congestion and Delay is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. The most common example is the physical use of roads by vehicles. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream, this results in some congestion. These negative aspects of traffic congestion have been receiving a lot of attention.

Road traffic conditions in India get shock every day. Spending hours in traffic jam have become part and Routine of the metropolitan lifestyle, leading to health and environmental hazards. The accelerated increase in vehicle ownership in India in particular has increased the traffic Density, Increase Travel Time that has created various Hazardous problems such as congestion and formation of long queues ultimately causing heavy delays and increase in the number of accidents at various locations on roadways. Different ITS techniques aim to provide information like current road congestion level, predicting travel time, predicting traffic congestion, Estimating the Delay Etc. Commuters can make use of this information to plan their travel better- by choosing a less congested road if there is a choice, by adjusting traveling time to avoid peak-traffic hours. It will be necessary to review the traffic signal timing. For a particular intersection, cycle time is an important parameter to minimize delays that ultimately cause formation of long queues and accidents. An important component required for the reduce the Delay at Intersection and Overall Delay over the urban arterial road network to pass with acceptable increase in travel time.

II. OBJECTIVES OF STUDY

- To estimate average control delay and travel time delay considering various traffic parameter
- To developed the regression based model to formulate the delay including both stop & travel time delay.

III. LITERATURE REVIEW

A. Ch.Ravi Sekhar, Pranoy Raj (2013), "Estimation Of Delay And Fuel Loss During Idling Of Vehicles At Signalized Intersection In Ahmedabad"

The signalized intersection capacity and LOS estimation procedures are built around the concept of average control delay per vehicle. In India mainly two methods were using to estimate control delay those are field measurement and theoretical/analytical measurement. Field measurement of control delay includes the use of test-car observations, path tracing of individual vehicles, and the recording of arrival and departure volumes at Intersection but this expensive for long period. This model is follow the car following theory and micro simulation based model is best suited for individual delay estimation. For delay estimation, taking a case study of Ahmedabad city of thaltej intersection to vijay char rasta intersection. In this study, provision of fly over was considered on every intersection along the direction drive in road. The travel time and travel speed behaviour under this scenarios is further used to measure the fuel estimation before and after scenario.

B. Mohsin Sahzad Chaudhry, Prakash Ranjitkar (2013), "Delay Estimation At Signalized Intersection With Variable Queue Discharge Rate"

Delay model was developed on the basis of queue discharge rate at intersection and compared it with existing delay model. Based on field observation, an empirical model is proposed to accommodate expected increasing queue discharge rate behaviour at signalized intersection. From the early days when delay models for signalized intersections are proposed, it was observed that the delay predicted by the model is about 5 to 15% exceeding from the actual delay. Webster (1958) realized it first and introduced a correction term. The variations at departure flow rate can impact the delay calculations. A decrease in delay estimation reduces the need for a correction term that was recommended by Webster (1958) due to over estimation of delay. The reduction in delay in first term indicates that the queue is dissipated earlier during long green cycles and the saving of the green time gained from this early dissipation can be utilized to other phases. This investigation confirms the findings of the previous researchers that Webster model overestimates the delay. The incorporation of variable discharge flow rate in the uniform component of the delay

formulation lowered the delay estimation by 5 to 6%. This decrease in delay compensate for a significant proportion of delay overestimation by Webster formulation which is approximately 10%.

C. R. Prasanna Kumar, G. Dhinakaran (2012), "Estimation Of Delay At Signalized For Mixed Traffic Condition Of A Developing Country"

Site specific PCU values were developed considering the static and dynamic characteristics of vehicles. This study was carried out in TamilNadu. Even after taking several measures, good correlation between observed and predicted delay could not be obtained. Therefore, in the present scenario field measured control delay was taken into account to define LOS. Traffic surveys were carried out at all the study intersections. As part of this, turning movement survey was conducted manually on typical week days after posting sufficient number of traffic enumerators to get the classified vehicle count of left turning, straight going and right turning movements and to arrive at the morning and evening peak hours. The change in size and acceleration capability of car will have a major influence on PCU, saturation flow and as a result in delay also. It is a fact that the PCU for a vehicle depends on several factors affecting the traffic stream characteristics. Even after taking the measures mentioned above a good correlation between measured delay and delay estimated from HCM 2000 delay model could not be obtained at all the approaches of study intersections. Therefore in the present scenario it was found that field measured delay can only be taken as criteria for defining the operating LOS of study intersections under the prevailing roadway, traffic and signalization conditions.

IV. DATA COLLECTION

For the data collection to measure delay there are different methods for traffic survey, ranging from manual to complex automatic techniques. All these methods have some own goodness. Any method, which should be selected for any study depends on many factors like the type of study, availability of manpower, ease of analysis, cost and should provide a permanent record of data for further analysis at any time. Methodology for study is mostly depends on many Parameter like vehicle speed, Saturation flow, Signal Timing, Width of Road, Gradient, Traffic Composition etc. this all data collected by considering three of survey include, Classified Volume Count, Spot Speed Survey and Delay survey at Intersection and on Road Network.

V. DATA ANALYSIS

A. Road Inventory Survey

Intersection	Major Road Width of CW		Minor Road Width of CW		BRTS lane width	Intersecti-on Type
	Leg-A	Leg-B	Leg-C	Leg-D		
Mavdi Chowk	9	10.2	7.75	7.75	9.7	Controlled
KKV Chowk	9.2	9.2	7.9	7.4	8.6	Controlled
Raiya Chowk	9.5	10.3	7.5	7.5	9.7	Controlled

(all dimensions are in mm)

Table 1: Road Inventory Features

B. Delay at Intersection

Delay survey is carried out manually at intersection and based on the Average Delay it gives the relationship between Average Control Delay of all four leg and volume of particular leg as under,

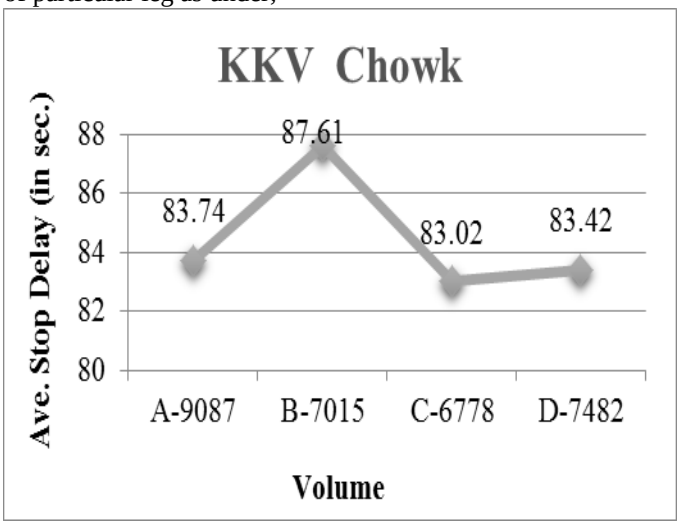

Fig. 1: Leg Wise Relation bet. Stop Delay & Vol. of KKV

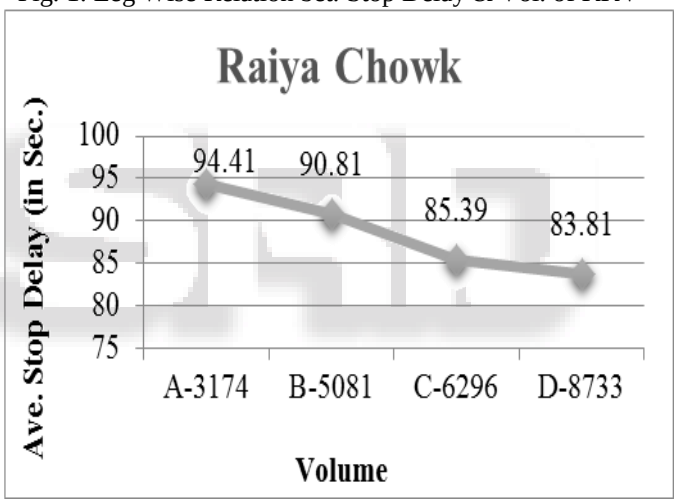

Fig. 2: Leg Wise Relation bet. Stop Delay & Vol. of Raiya

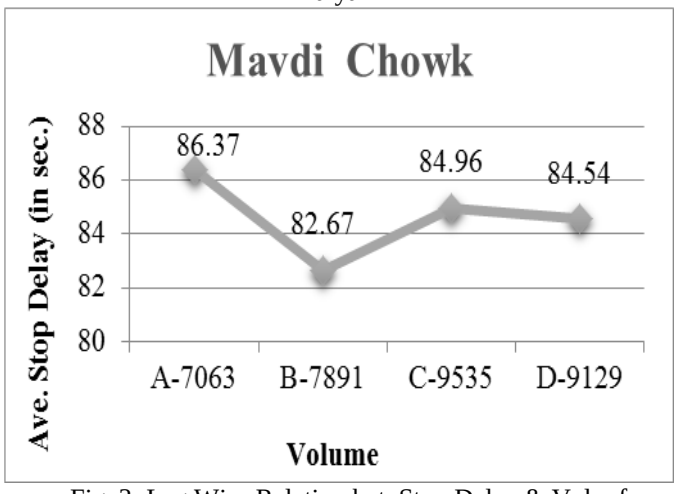

Fig. 3: Leg Wise Relation bet. Stop Delay & Vol. of Mavdi

C. Space Mean Speed Survey

Intersecti-on	Direction	Vehicle Type			
		2W (kmph)		4W (kmph)	
		Max.	Min.	Max.	Min.
Mavdi Circle	To Gondal	44.31	32.86	53.44	36.84
	To Madhapar	44.19	20.38	63.12	42.51
KKV Circle	To Gondal	48.32	30.61	60.32	41.94
	To Madhapar	47.32	36.42	53.47	40.21
Raiya Circle	To Gondal	44.38	30.21	56.10	40.57
	To Madhapar	52.36	38.25	61.47	43.36

Table 2: Min. & Max. Speed of 2W & 4W

D. Comparison between Average Travel Time Delay & Average Stop Delay

Intersection	Leg. No.	Stop Time Delay / leg	Ave. Stop Time Delay (min.)	Ave. Travel Time Delay	
				2W (min.)	4W (min.)
Mavdi	C	1.42	1.415	4.6	6.2
	D	1.41			
Raiya	C	1.42	1.405	5	5.5
	D	1.39			

Table 3: Comparison of TT Delay & ST Delay

VI. DEVELOPMENT OF MODEL

The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits your data, and then returns an array that describes the line. You can also combine LINEST with other functions to calculate the statistics for other types of models that are linear in the unknown parameters, including polynomial, logarithmic, exponential, and power series. Because this function returns an array of values, it must be entered as an array formula.

A. Model – 1 (Linear)

In this model dependant variable is taken as a summation of avg. Stop control delay at three intersections. Then independent variables are composition of vehicle, space mean speed of 2W & 4W & Travel time delay. Following is the model for Delay,

Y = 4.454 **X1** + 4.297 **X2** + 3.395 **X3** + 5.502 **X4** + 11.971 **X5** + 7.171 **X6** + 0.0019 **X7** + 0.0016 **X8** – 0.172 **X9** – 0.017 **X10** – 170.65

R^2 Value:- 0.30 (Fairly Accepted)

Because range is lies between 0.5 to 0.90

Where,

Y = Delay per Vehicle
X1 = 2W Composition in %
X2 = 4W Composition in %
X3 = 3W Composition in %
X4 = LCV Composition in %
X5 = HCV Composition in %
X6 = BUS Composition in %
X7 = Avg. Travel Time Delay of 2W
X8 = Avg. Travel Time Delay of 4W
X9 = Space mean speed of 2W
X10 = Space mean speed of 4W

B. Statistical Test for Model Validation

1) Chi² Test

Critical Value:- 1.145
Observed Model Value:- 1.63 (higher then critical)
Accepted

2) F Test

Critical Value:- 1.772
Observed Model Value:- 3.268 (higher then critical)
Accepted

3) T Test

Critical Value:- 0.487
Observed Model Value:- 0.043 (lower then critical)
Not Accepted

C. Assumption for Model

- Vehicle composition is considered in percentage (%).
- This model is applicable only if having three intersection in between study stretch.
- Delay time is considered in seconds.
- Total summation of X1,X2,X3,X4,X5,X6 is must be 100.

D. Summary of Model Validation

Developed model is suited for current location & give the acceptable model output & difference between observed delay & model output delay is quite low and acceptable.

VII. CONCLUSION

The study presented in the paper has been conducted to formulated the delay mode of the selected stretch.

- The estimation of stop delay at three intersection of Rajkot city along with the estimation of route delay on study stretch.
- Developed model is give amount of delay considering avg. Stop delay with the avg. Travel time delay so effect of route congestion is also expressed in model.
- Regression based mathematical model is having ten independent variables.
- Model is developed using Microsoft excel & model is validated using statistical test.
- For developed of model various parameter like vehicle composition , avg. Travel time delay , avg. Stop delay , space mean speed .
- Space mean speed is taken only of 2W & 4W because in our India especially in saurashtra region 2W & 4W is most dominating vehicle.
- T test is failed to give the satisfactory result of model but chi & F test is validate the model in a better way. R^2 of model low below 0.50 but model output is not justify lacking in value of R^2.

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