Assessment of Travel Time & Delay Modelling on an urban arterial Road of Rajkot city

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Abstract – Over the last two decades the rapid growth in the urbanization has increased in India. Due to the urbanization the demand in transportation facilities which are the basic need of the country's population increases tremendously. The aim of study is to analyze travel time and congestion under heterogeneous traffic condition in urban area Rajkot and propose remedial measure in existing traffic condition. The vehicular population in Rajkot city is around 13,90,640 (2011) so it is very essential to manage its movements and ill effects like as air and noise pollution, traffic congestion, time loss, and so on. most important link, is passes through the Traffic area. For addressing the traffic congestion, classified volume count survey (by Video Graphic method), travel time and delay survey (by Moving Observer Method), Origin – Destination Survey (by License plate matching method) and for speed-flow-density relationship, Spot speed study at intersection will be performed and analyzed. From the calculated data, graph of flow vs. density, speed vs. density and speed vs. flow relationship has been developed with the R2 value of each relationship. From all analyzed data, alternate remedial measures are explored. Based on those alternative remedial measures best alternative will be chosen and validated in the simulation Model or statistical model validation.

(Key Words –Travel time, Delay, Congestion, Delay, Heterogeneous Traffic, Model.)

INTRODUCTION

Traffic congestion is caused by commuters travelling to work. One of the main reasons for traffic jam is that the majority of people prefer using their own cars instead of public transportation means that they tend to travel alone. Because, public transportation is not reliable and efficient for them and with an increasing world population, the cars on the roads are also increased. Another factor is that most people live in the suburbs outside the city centre and they tend to travel at the same time of day. Moreover, cars and road space are not used efficiently. As a result, this causes traffic jams during the rush hour.

In race of the rapid growth, it increased the industrialization of some region, to full fill the requirement of demand, it requires the rapid transportation. As the urbanization increases the per capita income is also increased that leads them to use their own vehicle for easy movement of origin to destination. In fact, the Growth rate of the country's economic development raises too fast and perhaps much faster than infrastructure development causing limited road space to deal with the ever-increasing demands in automobile travel.

Motorized transport availability due to increase in the household income and increase in commercial and industrial activities that would have further added to transport demand. There are many cases where demand has overcome the road capacity. Increased congestion and delays in the many cities of India indicate the ill-effects of traffic related issues. It has been concluded that traffic accidents are among the primary cause of accidental deaths in Indian cities. The main reason of these problems is the case of imbalance in modal split and insufficient transportation infrastructure.

II. OBJECTIVES OF STUDY

- To Estimate Delay at Major Intersection & on the route of study area.
- To develop the delay model considering different parameters for urban arterial road network.
- To compare the developed model with other model and validate it.

III. LITERATURE REVIEW

Preethi P., Varghese A. (2016), "Modelling delay at signalized intersections under heterogeneous Traffic Condition"
Modification to Webster's delay model was proposed in this study to determine delay at signalized intersections having varying control conditions under heterogeneous traffic conditions. Instead of the semi empirical adjustment term in the Webster's model a field delay adjustment term (fdadj) that accounts for the delay variability under heterogeneous traffic condition was introduced. fdadj was modelled using ANN approach and the variation in fdadj with respect to various input parameters was also studied. It was found that the proposed adjustment term varies with respect to the control conditions at signalised intersections. As degree of saturation increases by 10% the adjustment factor increases by 9% for the control condition through movement only. But at intersections with control condition through and right turn movement permitted in single phase.

MohsinSahzad 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, a n 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 th at 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 t he 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%.

Solanki Mrugesh J., Umrigar F. S. (2016), "Travel Time and Congestion analysis under heterogeneous traffic condition of C.B.D area case study of Surat City"

In this paper The vehicular population in Surat is around 24, 21,043 (2015) so it is very essential to manage its movements and ill effects like as air and noise pollution, traffic congestion, time loss, and so on. Rajmarg an oldest and most important link, is passes through the C.B.D. area. For addressing the traffic congestion, classified volume counts survey of 3 days, travel time and delay survey (by Moving Observer Method), Origin – Destination Survey (by License plate matching method) for 3 days and for speed-flow-density relationship Spot speed study at Chowk Bazar, Bhagal and Delhi Gate has been performed and analysed. From the calculated data, graph of flow vs density, speed vs. density and speed vs. flow relationship has been developed with the R2 value of each relationship.In this study prepared the simulation model in VISSIM Software, Vehicle Category and Volume feed as an input data. After completion of simulation model, model is run and data is obtaining in form of excel sheet and graph were prepared in VISSIM Software from obtained data. After data collection and analysis remedial measure are proposed by using VISSIM (Visual Simulation) Software proposal of constructing elevated over bridge from Chowk Bazar to Delhi Gate can be possible.

IV.DATA COLLECTION

Data Collection and Analysis process is most important part of the thesis to accomplice the objectives with proper effectiveness. For development of delay model required more parameter to get the accurate outcome. Data collection of various surveys is done with representing each of relation with other. 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

- Road Inventory Survey

Table 1 : Road Inventory Features

Intersection	Width of C.W. on Major Road		BRTS Lane Width
	To Gondal	To Morbi	
Madhapar Chowk	8.0 m	7.0 m	9.7 m
K.K.V Chowk	7.2 m	7.5 m	7.7 m

- 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,
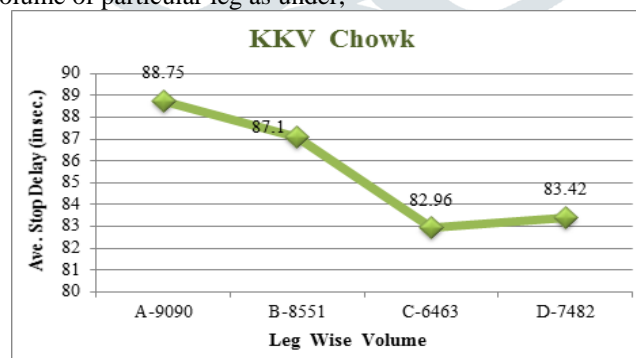

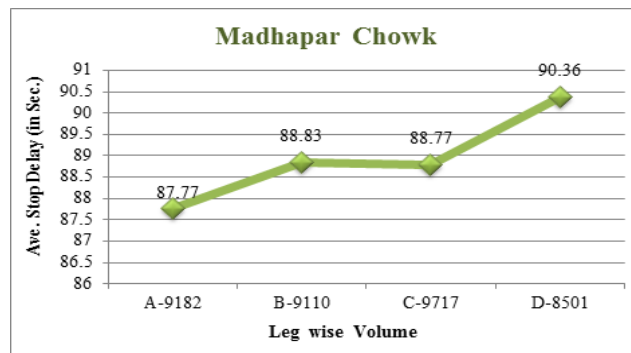Figure: 1: Leg Wise Relation between Stop Delay & Vol. of KKV Chowk

Figure: 2: Leg Wise Relation between Stop Delay & Vol. of Madhapar chowk

- Space mean speed survey

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

Intersections	Directions	Vehicle Type			
		2W(kmph)		4W(kmph)	
		Max.	Min.	Max.	Min.
KKV Circle	To Gondal	48	30	40	35
	To Madhapar	41	32	49	41
Madhapar	To Gondal	39	25	55	42
	To Madhapar	42	34	59	39

- Comparison between Average Travel Time Delay & Average Stop Time Delay

Table 3: Comparison of TT Delay & ST Delay

Intersection	Leg. No.	Stop T ime Delay / leg	Ave. Stop Time Delay (min)	Ave. Travel Time Delay	
				2W (mi n.)	4W (min.)
KKV	C	1.39	1..38	3.64	3.2
	D	1.38			
Madhapar	C	1.48	1.49	3.77	4.15
	D	1.50			

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 t he 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.

1)   MODEL

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

$$Y = 0.019086\ X_{tw} + 0.42057 X_c + 0.003029 X_a + 0.156601 X_L + 0.13163\ X_h + 0.075088\ X_b + 0.057833\ X_{t1} + 0.0129704\ X_{t2} - 0.11438\ X_{s1} - 0.00475\ X_{s2} + 81.71674$$

R^2 Value :- 0.54 (Accepted) Because range is lies bet ween 0.5 to 0.90

Where,
Y = Delay per Vehicle
X_t = 2W Composition in %
X_c = 4W Composition in %
X_a = 3W Composition in %
X_L = LCV Composition in %
X_h = HCV Composition in %

Xb = BUS Composition in %
Xt1 = Avg. Travel Time D elay of 2W
Xt2 = Avg. Travel Time D elay of 4W
Xs1 = Space mean speed of 2W
Xs2 = Space mean speed of 4W

VALIDATION OF MODEL

Validation of model using F-test, T-test and Chi-Square test is described below.

Table no.2 Validation of Model

	R	F observed	F critical	T observed	T critical	Chi observed	Chi critical	Comment
Model-1	0.54	1.8349	1.3231	0.52338	0.33845	10.37	1.145	Accepted

- Assumption for model:

➢ Vehicle composition is considered in percentage (%).
➢ This model is applicable only if having two intersection in between study stretch.
➢ Delay time is considered in seconds

- Summary of model validation:

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

VIII.   CONCLUSION
The Study carried out in this paper to formulate the delay model of stretch of two intersection.

- The estimation of stop delay at two intersection of Rajkot city along with the estimation of route delay on study stretch.
- Developed model is 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 , F test and chi square give the satisfactory result of model and validate the model in a better way. R^2 of model is 0.54.

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