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# Assessment and Formulation of Model for Predicting Operational Delay on Urban Sub-Arterial Road Link due to Metrorail Work zone Condition

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**Abstract-**Due to rapid urbanization and development of city, many construction work zones are created. Construction work zones leads many issues like delay, reduction of capacity of road, increasing density of road, decreasing Level of Service (LOS), related safety issues of road users and pollution at surrounding environment. The existing vehicular traffic pattern is increasing day by day in the Ahmedabad city. It increase the costs of delay and safety of users, even for low flows requires to take adequate management actions. The purpose of present study is to estimate operational delay at arterial road due to work zone. The various factors, which affects the operational delay are like transition area length, length of work zone area, available lane width and composition of heavy vehicles. Using multiple regression technique, the relationship is established between operational delay, transition area length, length of work zone area and available lane width.

**Index Terms**- Operational delay, Work zone, Activity area length.

## 1. INTRODUCTION

In a developing country, many construction works are in progress at various location of the cities and villages. Construction of the multistoried buildings, construction of new roads, and maintenance of existing roads and changing lanes of roads create a long and short term work zones. The presence work zones could reduce road capacity and travelling speed. The reduction of road capacity and low travelling speed could increase traffic delay. Work zone configuration factors like the activity area length and transition area length are found to significantly affect traffic delay at work zones.

The activity area length of a work zone influence vehicles travel speed and travel time through driver human factors. According to Land Transport Authority of Singapore (LTA,2007), a longer transition area length is not necessarily better than a shorter length, particularly in urban areas, because the extended transition area length tends to encourage sluggish driving and delay lane changes. In addition to the work zone configuration factors, traffic flow and heavy vehicles percentage are another two factors influencing traffic delay at work zones. In general, it will result in larger traffic delay if the higher traffic flow approaches the work zone.

Although the four factors mentioned above, affects traffic delay and comprehensively evaluate their marginal impacts on traffic delay at work zones. Therefore, it is necessary and interesting to evaluate the effects of activity area length, transition area length Traffic flow and heavy vehicle percentage on traffic delay at work zones.

## 2. LITERATURE REVIEW

**(Quiang MENG, 2013) (1)** evaluated the effect work zone configuration, traffic flow and heavy vehicle percentage on traffic delay at work zones by using a heterogeneous cellular automata (HCA) model. Qiang MENG, considered activity area length, transition area length, composition of vehicles to affect operational delay. It was found that transition area length has a larger impact than the activity area length, especially in light traffic condition.**(Vittorio Astarita, 2014) (2)** studied impact of work zone on existing traffic patterns are significant. The costs of delay and safety suffered by users even for low flows requires to take adequate management actions. The objects of this study was to allow the evaluation of the delay that is suffered by the users of two-lane freeways when only one lane is available. The delays for different flow levels and different length of reconstruction area were evaluated with the use of a tailored new developed microscopic traffic simulation model. The various factors considered in the study are,

1. The total length of road
2. The length of free road section
3. The traffic flow
4. The work zones layout
5 .The percentage of heavy vehicles
6. The distribution of the speed of heavy vehicles

**(Madhav Chitturi, 2010**) **(3)** carried out study on development of reliable strategies to overcome

adverse mobility impacts of highway work zones requires accurate computation of delay and queues in work zones. This paper presents a methodology for quantifying the mobility impacts that considers the effects of roadway and traffic on speeds (and delays) of cars and heavy vehicles separately. The delay caused due to the differences in speeds of different vehicles can be significant when there is limited opportunity for passing or there are significant slow-moving vehicles. The moving delay was computed using delay-based passenger car equivalent (PCE) values for work zones.**(Steven I-Jy Chien, 2002) (4)** carried out study on work zone related traffic delay is an important cost component on freeways with maintenance activities. This study demonstrates that delays may be underestimated by using the deterministic queuing theory. Computer simulation was valuable approach of estimating delay under a variety of existing and future conditions. A method was developed in this paper to approximate delays by integrating limited simulation data, obtained from CORSIM and the concept of deterministic queuing theory, while various geometric conditions and time-varying traffic distribution are considered. The survey for a study was carried out at segment of Interstate 1-80 in New Jersey. Author concluded that the proposed method is efficient to quickly produce accurate total delay, including the queuing and moving delays. **(S.Llgin Guler, 2016)(5)** established methodology to systematically evaluate the expected delay. They carried out survey at five locations in Zurich, Switzerland. The result showed that methodology can predict the delay of different vehicles steams to within 4 s/veh**. (Chenhao Wang, 2017)(6)** estimated arterial link travel times and traffic delays using vehicular positioning data, such as automatic vehicle location (AVL). They considered three factors for estimating link delay, free flow travel time, congestion time, and stopping time at signalized intersections and bus stops.**(Sergio Martin, 2016)(7)** calculated a delay for estimating LOS. In this study researchers used Fuzzy model for determination of delay. They considered factors for estimating delay such as human factors, and subjective perceptions regarding the road, the car, the driver, environmental condition.**(Melike Baykal, 2006) (8)** calculated the delay of vehicles, which is occurs due to various incident on roads. They estimated delay by queuing approach model and validate the model the result with Simulation method. They concluded that the computational result from the Queuing approach model was very close to the Simulation model.

## 3. STUDY AREA

The study location should be in such a way that the long term work zones are available. The travel time of vehicles is more and delay occurs due to work zone.

**Site selection is based on the following factors:**

- There is large impact on the traffic flow due to the lane closure.
- Lane width variation due to work zone is more.
- Other stretch of metro corridor have not more traffic than East-west corridor.
- North-South corridor of metro project is placed upon old railway track so impact on traffic is very less.
- Available lane width is very less.
- The density of traffic is very high.

**Based on above criteria the following locations is selected:**

- The selected stretch is located in Ahmedabad city.
- Selected stretch is Thaltej to Stadium cross road at which the East-West corridor of metro rail project.
- It is located in Ahmedabad city in Gujarat state.

**Features of Stretch**

- Metro rail will be established between Ahmedabad and Gandhinagar city as it is rapidly developed.
- There are two corridors of metro rail one is north-south corridor and another is east-west corridor. North-south corridor covers stretch from Thaltej to Stadium cross road.
- Thaltej to stadium cross road is urban arterial road and the selected stretch carries heavy traffic because of residential, commercial and industrial area on the stretch.
- Traffic is more at morning and evening peak hours.
- Due to construction of metro rail project work zones are created on this stretch. The lane of road are covers due to work zones.
- Congestion due to work zones are occurs mainly at morning and evening peak hour and delay should be occurred.

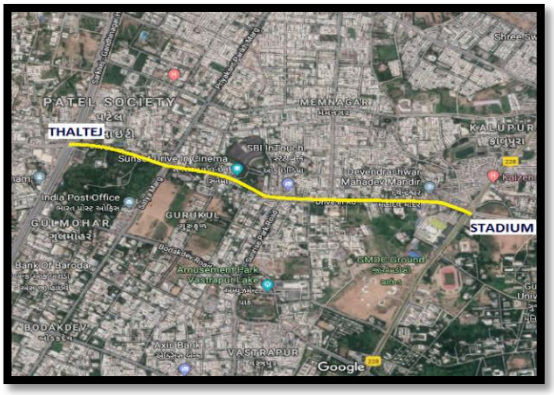


Fig. 1. Map of Stretch

## 4. DATA COLLECTION AND ANALYSIS

The difference between travel time over a route during an extremely low and during very high traffic indicates the amount of operation delay.

### *4.1Road Inventory Data*

Table: 1 Road Inventory Data

| Thaltej To Sal hospital | | | |
|---|---|---|---|
| Stretch | Length of stretch (Activity Area length) | Available lane width | Transition Area length |
| 1 | 455m | 5m | 5m |
| **Gurukul to Topa Circle** | | | |
| 1 | 175m | 3.3m | 4.5m |
| 2 | 390m | 5.5m | 3.5m |
| **Topa circle to Saurabh char rasta** | | | |
| 1 | 208m | 5.7m | 3.6m |
| 2 | 220m | 5.0m | 3.3m |

### *4.2 Classified Volume Count*

Data collection should be done on various stretch having varies activity area length, available lane width and transition area length. Data is collected by videography. Two persons are standing at entry and exit location of stretch. Data is collected at morning peak hour at 9:30AM to 11:30AM, off peak hour at 1:00PM to 2:30PM and evening peak hour at 5:00PM to 7:00PM.Classified volume count survey is done by calculating the category wise vehicle at the entry point of stretch at morning, off, and evening peak hour.

**Stretch 1: Thaltej to Sal**

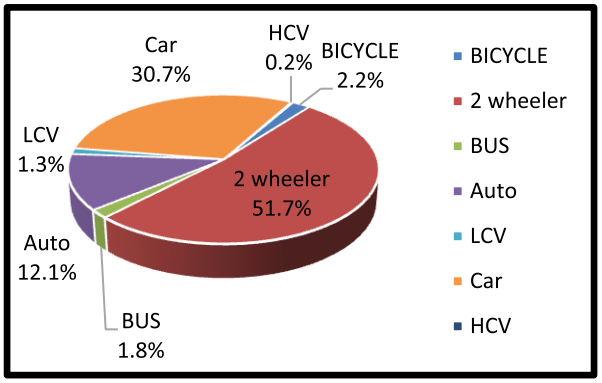


Fig.2. Morning Peak Hour

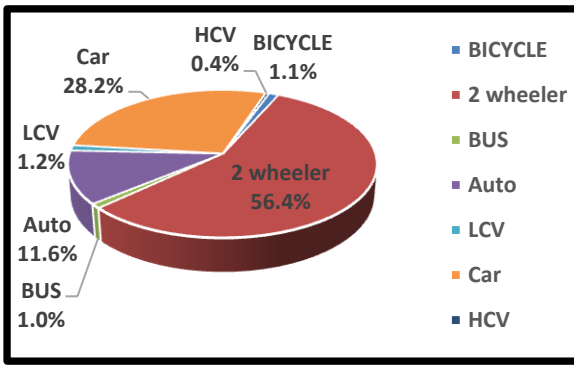


Fig.3. Off Peak Hour

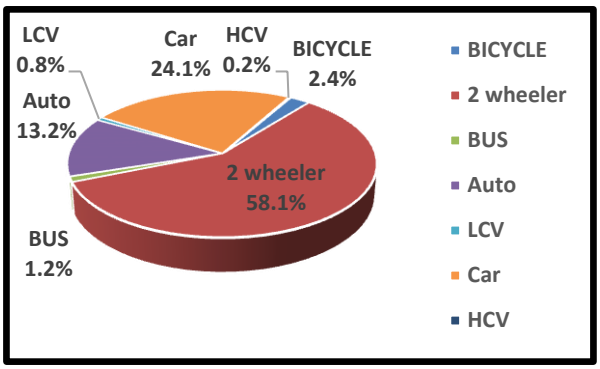


Fig.4. Evening Peak Hour

From the Classified Volume Count survey, it is observed that, the share of 2wheelers, Cars (4w) and Auto (3w) is higher than other category of vehicles.

### *4.3 Operational Delay Analysis*

**License Plate matching method**: license plate matching relies on video signal processing algorithms to extract the license number of vehicles passing at entry point. Travel time between locations is then obtained by simply calculating the time difference between entry location and exit location. Travel time measures morning peak, off peak and evening peak by above method. The travel time measure at free flow condition at night and in the morning. The difference of travel time gives the operational delay of the stretch.

**Observed Operational Delay (category wise)**

Table: 2 Operational Delay for 2 wheeler

| Travel Time (s) | Time in Free Flow(s) | Operational Delay (s) |
|---|---|---|
| 68 | 40 | 28 |
| 70 | 40 | 30 |
| 28 | 18 | 10 |
| 27 | 18 | 9 |
| 65 | 43 | 22 |
| 64 | 43 | 21 |
| 37 | 19 | 18 |
| 35 | 19 | 16 |
| 32 | 17 | 15 |
| 34 | 17 | 17 |

Table: 3 Operational Delay for Auto (3 wheeler)

| Travel Time (s) | Time in Free Flow(s) | Operational Delay (s) |
|---|---|---|
| 79 | 55 | 24 |
| 78 | 55 | 23 |
| 33 | 20 | 13 |
| 35 | 20 | 15 |
| 68 | 40 | 28 |
| 69 | 40 | 29 |
| 43 | 26 | 17 |
| 41 | 26 | 15 |
| 35 | 22 | 13 |
| 36 | 22 | 14 |

Table: 4 Operational Delay for Car (4wheeler)

| Travel Time (s) | Time in Free Flow(s) | Operational Delay (s) |
|---|---|---|
| 80 | 36 | 44 |
| 79 | 36 | 43 |
| 29 | 15 | 14 |
| 28 | 15 | 13 |
| 56 | 31 | 25 |
| 58 | 31 | 27 |
| 39 | 19 | 20 |
| 37 | 19 | 18 |
| 31 | 17 | 14 |
| 30 | 17 | 13 |

Table: 5 Operational Delay for Bus

| Travel Time (s) | Time in Free Flow(s) | Operational Delay (s) |
|---|---|---|
| 91 | 47 | 44 |
| 85 | 47 | 38 |
| 28 | 21 | 7 |
| 26 | 21 | 5 |
| 66 | 40 | 26 |
| 61 | 40 | 21 |
| 45 | 26 | 19 |
| 49 | 26 | 23 |
| 35 | 21 | 14 |
| 38 | 21 | 17 |

Table: 6 Operational Delay for LCV

| Travel Time (s) | Time in Free Flow(s) | Operational Delay (s) |
|---|---|---|
| 71 | 51 | 20 |
| 68 | 51 | 17 |
| 29 | 21 | 8 |
| 26 | 21 | 5 |
| 58 | 47 | 11 |
| 56 | 47 | 9 |
| 44 | 25 | 19 |
| 48 | 25 | 23 |
| 38 | 23 | 15 |
| 36 | 23 | 13 |

Table: 7 Operational Delay for HCV

| Travel Time (s) | Time in Free Flow(s) | Operational Delay (s) |
|---|---|---|
| 85 | 55 | 30 |
| 82 | 55 | 27 |
| 46 | 22 | 24 |
| 50 | 22 | 28 |
| 77 | 47 | 33 |
| 72 | 47 | 25 |
| 45 | 27 | 18 |
| 43 | 27 | 16 |
| 39 | 25 | 14 |
| 36 | 25 | 11 |

Table: 8 Average Operational Delay

| Sr.No. | Vehicle Category | Average Operational Delay per vehicle (s) |
|---|---|---|
| 1 | 2 wheeler | 13 |
| 2 | Auto | 12 |
| 3 | Car | 17 |
| 4 | Bus | 17 |
| 5 | LCV | 12 |
| 6 | HCV | 16 |

It is observed from analysis that on the given stretch, observed operational delay is 15 sec/vehicle due to metro rail work zone condition.

### *4.4 Development of Model*

Prediction Model for operational delay considering all Category of vehicles is shown as below.

$$\mathbf{Y = 0.02X_1 + 0.21X_2 + 1.72X_3}$$
$$\mathbf{R^2 = 0.82}$$

Y= Operational delay in second per vehicle
$X_1$= Activity area length in meter
$X_2$= Transition area length in meter
$X_3$= Available lane width in meter due to work zone

## 5. CONCLUSION

Due to construction work zone, the available lane width is less. Therefore increase a travel time and also operational delay occurred. Followings are the major conclusion.

1. It is observed from the study that car and bus having high operational delay of 17 sec.
2. Operational delay is mostly affected by the available lane width.
3. The proportion of two wheeler and auto is higher than the other category of vehicles.
4. The effect of activity area length and transition area length is not significantly affecting to the operational delay.

## REFERENCES

[1]. Chenhao Wang, L. P. (2017). Link Travel Time and Delay Estimation Using Transit AVL Data. 4th Interanational Conference on Transportation Information and Saftey (pp. 67-72). Banff, Canada: ICTIS.

[2]. Madhav Chitturi, R. F. (2010). Work Zone Queue Length and Delay Methodology. The International Journal of Transportation Research , 273-283.

[3]. Melike Baykal, Z. D. (2006). Delay Estimation for Traffic Flow Interrupted by Incidents. 86th

Annual Transportation Research Conference (pp. 1-18). Washington: TRC.

[4]. Quiang MENG, J. W. (2013). Impact Analysis of Work Zone Configuration, Traffic Flow and Heavy Vehicle Percentage on Traffic Delay at Work Zone. Asian Transportation Studies , 239-252.

[5]. S.Llgin Guler, M. M. (2016). Methodology for Estimating Capacity and Vehicle Delay at Unsignalized Multimodal Intersection. 6. S.Llgin Guler,Monica Menendez "Methodology for Estimating Ca International Journal of Transportation Science and Technology , 257-267.

[6]. Sergio Martin, M. G. (2016). Fuzzy Model of Vehicle Delay to Determine Level of Service of Two Lane Roads. Expert System With Application , 48-60.

[7]. Steven I-Jy Chien, D. G. (2002). Simulation-Based Estimates of Delay at Freeway Work Zones. Journal of Advanced Transportation , 131-156.

[8]. Vittorio Astarita, G. G. (2014). Traffic Delays Estimation in Two-Lane Highway Reconstruction. Procedia Computer Science , 331-338.

[9]. Shmuel Yahalom, Shoaib M. Chowdhury "Simulation Based Estimates of Delays at Freeway Work Zone" Journal of Advance Transportation, Vol. 36 No. 2, pp. 131-156(2017)

[10]. Kadiyali L.R " Traffic Engineering and Transport Planning" Khanna Publishers (2000)

[11]. Saxena S.C "Highway and Traffic Engineering" CBS Publishers (2014)

[12]. Dr. Tom V. Mathew, IIT Bombay pdf for "Transportation System Engineering"(2014)

[13]. IRC:SP:55-2014 "Guidelines on Traffic Management in Work Zones" Indian Road Congress (2014)