9th Urban Mobility India Conference & Expo 2016
Planning Mobility for City's Sustainability

EFFECTIVENESS OF QUEUE JUMPER LANE AND TSP FOR BUS PERFORMANCE IMPROVEMENT

Smart Traffic Solution for Smart Cities

Sahil Chawla and Shalini Sinha

PRESENTATION STRUCTURE

- INTRODUCTION
- AIM / OBJECTIVES
- STUDY APPROACH
- LITERATURE REVIEW
- MODEL DEVELOPMENT
- RESULTS EVALUATION
- CONCLUSIONS

- **INTRODUCTION**
- LITERATURE REVIEW
- MODEL DEVELOPMENT
- RESULTS EVALUATION AND CONCLUSIONS

- *Definition*
- *Need for Research*
- *Aim / objectives*
- *Study approach*

Queue jumpers and TSP

Bus priority "Systems" as Smart Solution for Smart cities

King George Boulevard at 96 Avenue

Source: http://www.surrey.ca/city-services/7585.aspx

QUEUE JUMPER LANES

Source :www.cmt4austin.org/QJ_Parmer_Lamar.html

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NEED FOR RESEARCH

- Poor policy and institutional framework
- Limited finances and resources
- Deteriorating environmental quality
- Fuel consumption

- Multi-faceted problems as a result of rapid urbanization. . . . . **rapid motorization**
- Limited road area
- Rapidly increasing vehicle density

The 'Bottom Up" approach i.e. significant improvement in Bus services and operations can serve as smart transport mode in upcoming smart cities.

NEED FOR RESEARCH

Indian city profiles. . . .

Year	Census population	Total registered vehicles	Registered buses	Buses to million population	Share of buses to total vehicles
1981	683	5391	162	237.2	3
1991	846	21374	331	391.3	2
2001	1027	54991	634	617.3	1.1
2011	1210	141866	1604	1325	1.1

Source: Motor Transport Statistics of India, 2001-02, Road Transport Yearbook 2010 – 2011

	population	Average trip length	Per capita trip rate (PCTR)	No of cities
Category 1	< 5 lakhs	2.4	0.8	-
Category 2	5-10 lakhs	3.5	1	47
Category 3	10-20 lakhs	4.7	1.2	30
Category 4	20-40 lakhs	5.7	1.3	7
Category 5	40-60 lakhs	7.2	1.5	4
Category 6	> 80 lakhs	10.4	1.6	2

Source: W. Smith Associations, ministry of urban development, GOI, New Delhi, census 2011

AIM

The study aims at assessment of effectiveness

Queue Jumper and Transit Signal Priority on Bus Performance

RESEARCH OBJECTIVES

- Performance assessment of QJ and TSP
- Using micro simulation tool for Bus performance assessment.

RESEARCH APPROACH

Review of literature and regulatory regime

- Trends of urbanization, traffic and public transport, Policies and programmes for UT sector
- Indicators (evaluation parameters)

Primary and secondary data collection

- Primary surveys for base model development
- Secondary data (bus services, traffic inputs etc.)

Base model development

- Model development using different inputs as per primary and secondary survey
- Validation and calibration

Scenario generation and evaluation

- Development of alternate scenarios (using different priority measures)
- Result evaluation

Conclusions and recommendations

- Comparison (indicators) and efficacy analysis
- Recommendations (design based)

LITERATURE REVIEW

Impacts

- **Rutherford S.(2010).** . . . . . .
  "dedicated lane systems were always better than typical local busses running in mixed traffic"
  - **Improved level of service**
  - **Travel time saving**

- **Skabardonis A. (2010)** . . . . . .
  "describes the formulation of both passive and active signal priority techniques for major roads"
  "examined the transit improvement strategies and identifies the major factors affecting transit priority"
  - **transit network improvements**

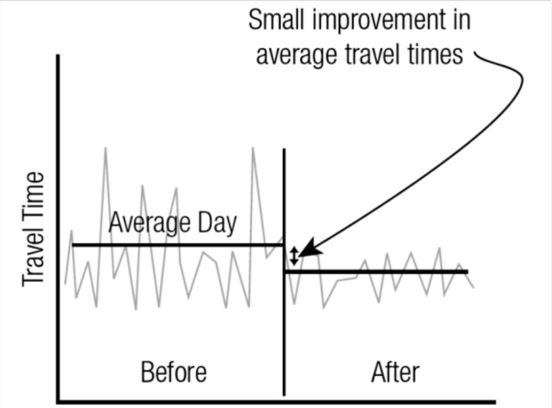
- **Zlatkovic et al (2013)** . . . . . .
  "examined the independent and collective effects of queue jump lanes and signal priority system on performance of a Bus Rapid Transit system through Simulation"
  - **Bus TT improvement**
  - **Bus speed improvement**

Scale of projects

- STRATEGIC
- MESOSCOPIC
- MICROSCOPIC

Evaluation parameters

Variability indexing



Punctuality Index $P_1 = \frac{S_1^2}{h_t^2}$

Variables $S_1^2 = \frac{1}{I}\sum_{i=1}^{I}(t_i - \tau_i)^2$

(Kho et al, 2005)

Travel time
Delay
Headway Variability
incidence

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LITERATURE REVIEW

- **Zhou and Gan, (2011)**. .. . . "Assessed how various design parameters influences the performance Queue Jumpers. The assessment was done for different signal priority strategies, fleet size and volume, detector locations, dwell times and bus stop location."

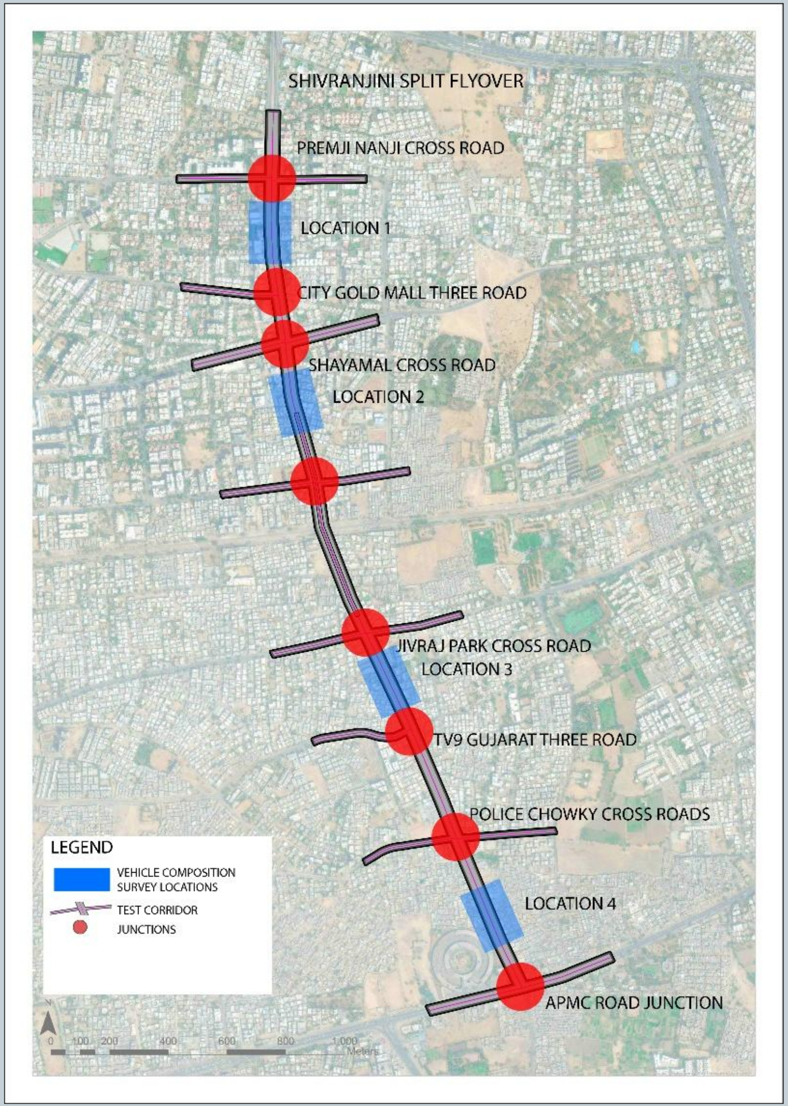
- **Zlatkovic et al. (2013)..** . . "simulation of 13 intersections transit travel time 13-22 % reduction and 22 percent increase in bus speed"

- **Lahon (2013)** . .. . . "modelling six signalized junctions in VISSIM, reduction in delay at junction was reduced by 30% along the corridor"

- INTRODUCTION
- LITERATURE REVIEW
- **MODEL DEVELOPMENT**
- RESULTS EVALUATION AND CONCLUSIONS

- *Test corridor and rationale*
- *Model development*
- *Calibration and validation*
- *Scenario development and sim-runs*

DESCRIPTION OF TEST CORRIDOR AND RATIONALE



- **Premji Nanji Cross Roads to APMC junction (132' ring road)**
- **Number of lanes: 4 on each side**
- **Predominant Land use: Mix use**
- **'Proposed Prioritized Bus plan'**
- **Feeder to 'proposed Metro'**

Total Junctions: 8

Signalized Junctions: 4

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VISSIM MODEL DEVELOPMENT

Understanding of project scale

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Data Collection (Traffic surveys)

- Road Inventory
- Classified volume count
- Volume on links and turns
- Speed and Delay analysis
- Queue length at junctions
- Parking accumulation
- Signal phasing

Pre-Modelling work

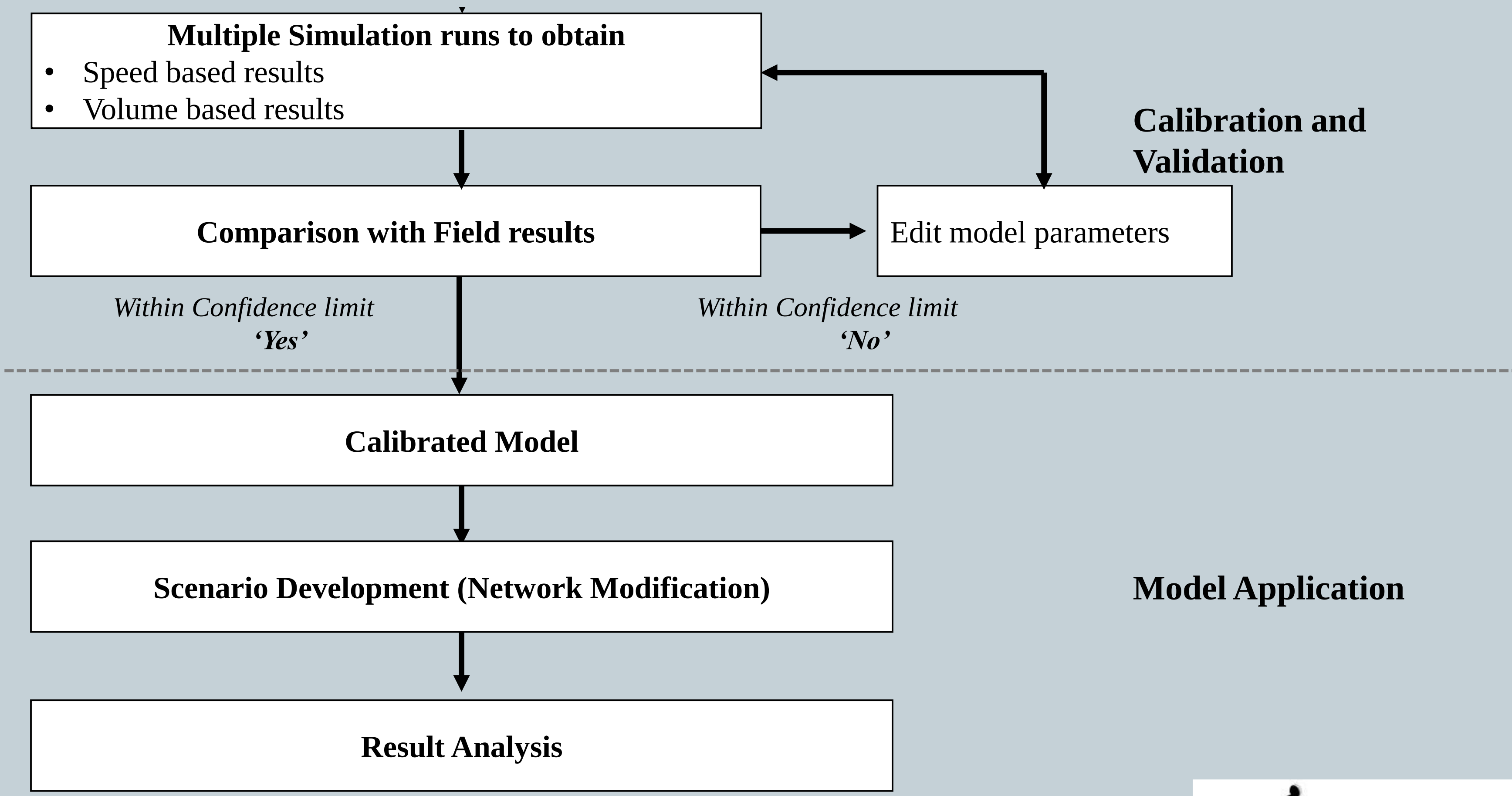
↓

Model Building

- Network elements (Links and Nodes)
- Origin and turning volumes
- Traffic composition and defining vehicle types
- Defining parking areas and duration
- Signal phasing Programming
- Inputs to driving behavior parameters

Model Preparation

VISSIM MODEL DEVELOPMENT



CALIBRATION

Parameters	Trial 1	Trial 2-6	Trial 7
Following			
Look ahead distance (Min)	0	5-20	20
Look back distance (Min)	0	5-20	20
Car following model	Wiedemann 99 (Default)	Wiedemann 99 (Modified)	Wiedemann 99 (Modified)
CC0 (Standstill distance)	1.5	0.2 - 0.9	0.20
CC1 (Headway Time)	0.9	0.4 - 0.9	0.90
CC2 (Following Variation)	4	2.0 - 4.0	2.00
Lane Change			
General Behavior	Show lane rule	Multiple	Free lane selection
Lateral			
Desired position at free flow	Middle of lane	Middle/Any	Any
keep lateral distance to vehicles on next lane(s)	Untick	Untick/Tick	Tick
Diamond shaped queuing	Untick	Untick/Tick	Tick
Minimum lateral distance (at 0 kmph)	1.0	0.2 - 1.0	0.2
Minimum lateral distance (at 50 kmph)	1.0	0.6 - 1.0	0.6
Desired Speed Distribution			
Two wheeler	Default values	Varying the desired speed iteratively (Maximum being the free flow speed at low volumes)	60 (LB) -80 (UB)
Three wheeler	Same as Car		35 (LB) -55 (UB)
Four wheeler	-do-		45 (LB) -70 (UB)
Bus	-do-		35 (LB) -65 (UB)
Goods vehicle	-do-		50 (LB) -70 (UB)

VALIDATION

Criterion 1 :Volume and Queue Lengths at Junctions

	Approached from	Field Results	Model Outputs	% Error
Premji Nanji cross road	Shivranjini split flyover	100.67	91.70	-9.78
	Punit nagar road	49.67	47.00	-5.67
	City Gold mall three road	87.33	79.00	-10.55
	Jodhpur Gam road	30.50	39.50	22.78
Shayamal cross road	City Gold mall three road	114.00	103.90	-9.72
	MA Anandmayi marg	74.67	81.50	8.38
	Jivraj park cross road	123.67	136.50	9.40
	100 feet road	53.33	46.80	-13.96
Jivraj park cross road	Shayamal cross road	105.33	95.50	-10.30
	Dr. Jivraj Mehta Marg	100.00	104.80	4.58
	TV9 Gujarat cross road	60.67	64.80	6.38
	Vejalpur road	50.67	46.40	-9.20
APMC road junction	Police chowky cross road	60.00	55.60	-7.91
	Vasna road (Gupta nagar)	45.00	49.70	9.46
	Vasna road (Sanklit nagar)	30.33	18.80	-61.35

VALIDATION

Criterion 2: Validation results of travel time and Delay- link wise (E.g. Two wheelers)

Link	Field results (Travel in secs)	Model results (Travel time in seconds)	Residual
Split flyover to Premji-Nnaji Intersection	52.0	55.7	3.7
Premji-Nanji Intersection to City Gold mall three road	36.0	37.1	1.1
City Gold mall three road to Shayamal cross road	28.0	40.5	12.5
Shayamal cross road to Jivraj park cross road	130.0	132.6	2.6
Jivraj park cross road to TV9 three road	30.0	23.3	-6.7
TV9 three road to Police chowky cross road	22.0	28.3	6.3
Police chowky cross road to APMC Junction	44.0	32.1	-11.9
Total	342.0	349.6	7.6

SCENARIOS DEVELOPMENT

	Network properties	Signal priority
BASE SCENARIO (Business as usual)	• Base network representing site • Curb side bus stations	N/A
Queue jumper with active signal priority	• Queue jumper at junctions • Curb side bus stations (curb extensions)	Active signal priority (VAP)

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- **RESULTS EVALUATION AND CONCLUSIONS**

- *Results comparison for various indicators*
- *Conclusions*

BUS PERFORMANCE

Bus travel time

BAU

Base - 0

QJ +VAP

-15.5 %

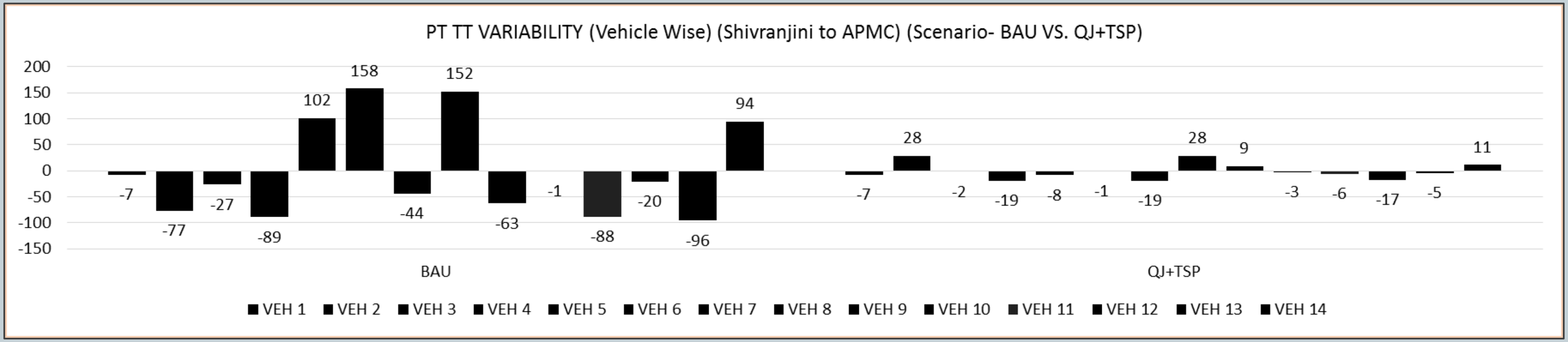
Maximum improvement

Bus Delay

Reduction by **27 %**

- VAP resulted in max. delay reduction
- Vehicle maneuvering from one lane to other resulted in delay (less amount)

BUS TRAVEL TIME VARIABILITY



Business as usual	QJ + VAP
± 30 % variation	**-5% to +10 % variation**
-115 SECS to 124 SECS	**-19 SECS TO 28 SECS**

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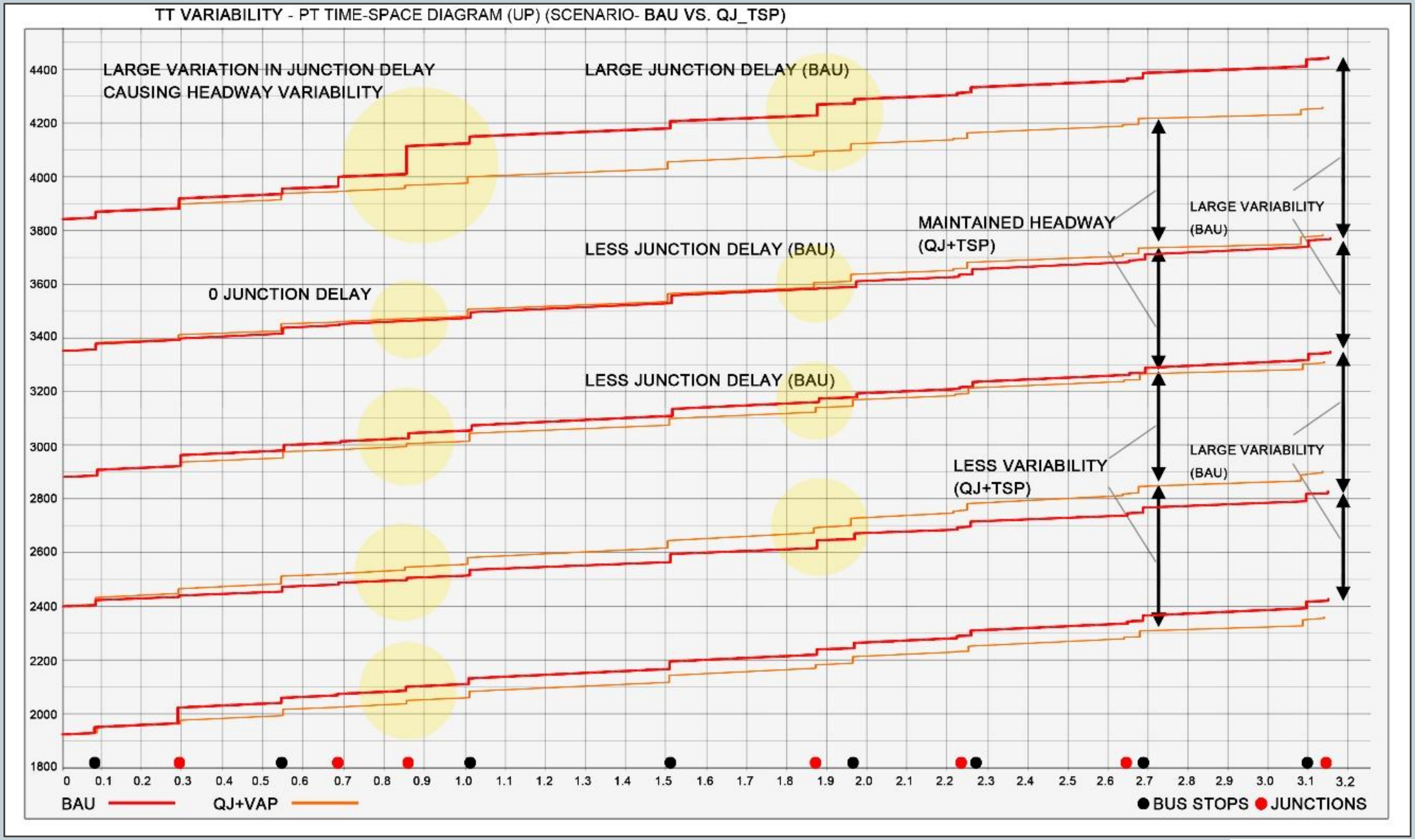
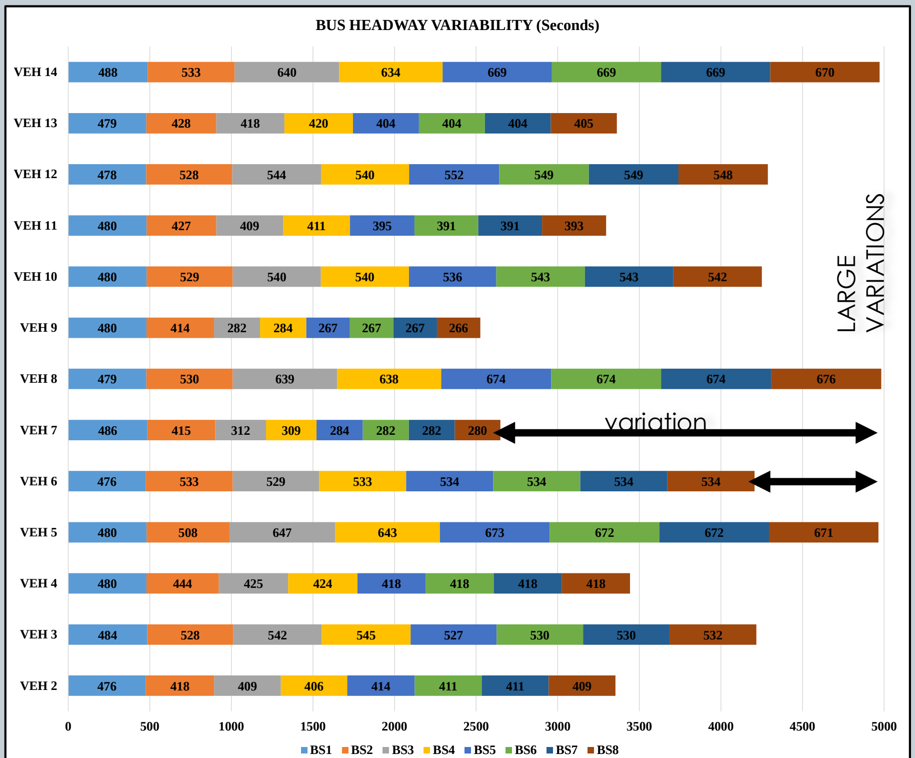
ARRIVAL TIME VARIABILITY

Business as usual vs QJ Scenario



HEADWAY VARIABILITY

Business as usual



QJ + VAP

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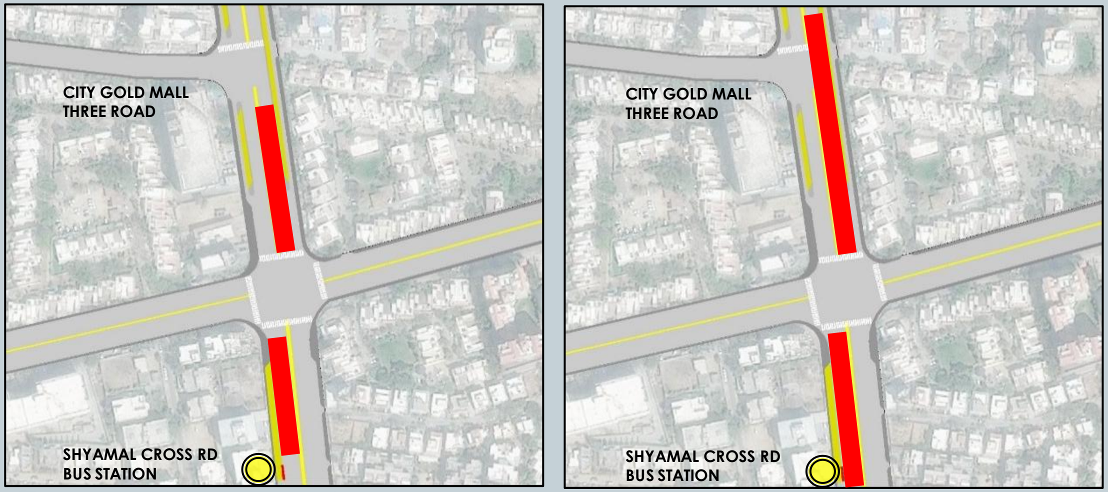
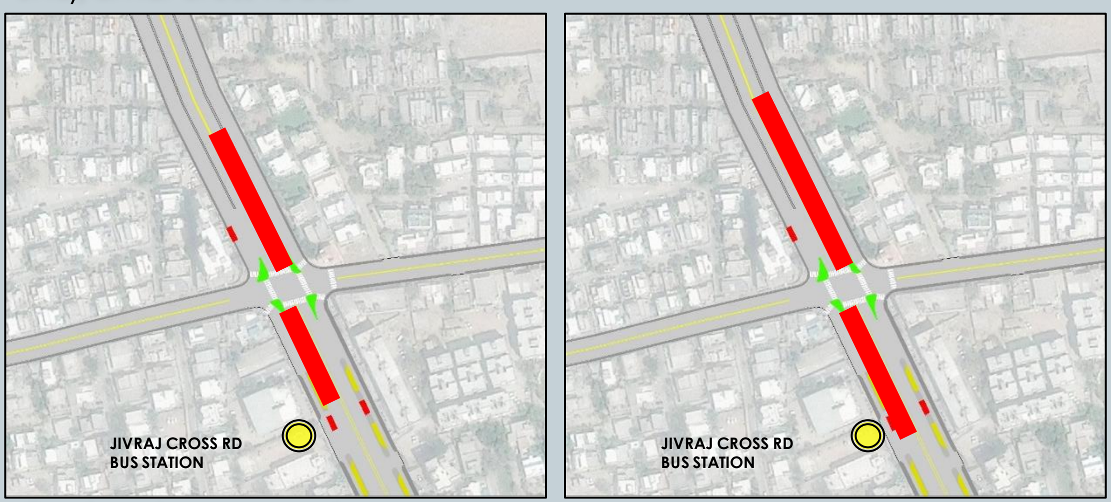
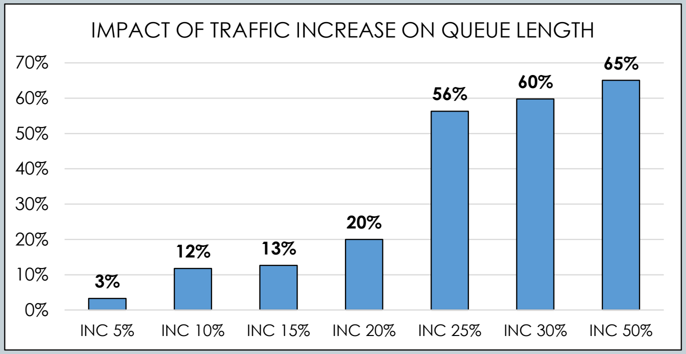
IMPACT OF INCREASE IN TRAFFIC



Shayamal cross roads



Jivraj park cross roads



- Queue length comprehends over previous junction
- Queue length obstruct the bus station and movement
- Length of QJ lane > Maximum queue length, which make QJ ineffective as traffic increases

CONCLUSIONS

Short term

- Results comparable to buses running in segregated lanes

Queue jumper lanes —*active signal priority*—

Long term

- Delay, TT increases Exponentially
- Worse impacts on private vehicles
- Poor network performance

- *Priority at junction maximizes the bus performance whether design based or signal priority based*
- *Fixed time signal priority doesn't affect the private vehicular performance, where as active signal priority does, and performance decreased exponentially.*
- *Buses running in mixed traffic limits the bus service improvement, even though prioritized the service declines and reduce overall network efficiency when traffic increases.*

Thank you