Analysing travel time variability using Wi-Fi detections

Vikram Singh, Ninad Gore, Shriniwas Arkatkar
SVNIT Surat

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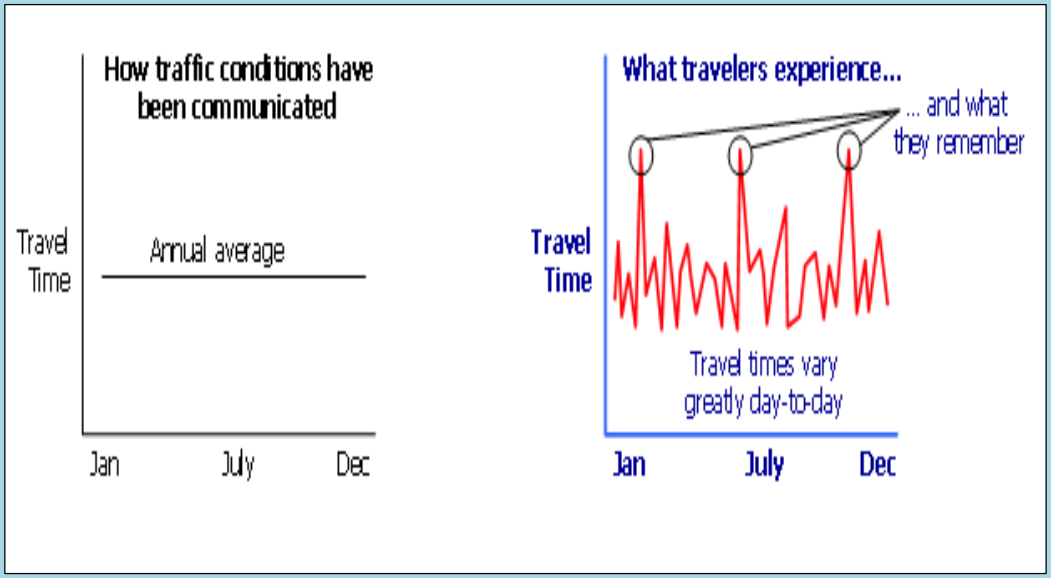
Travel Time Variation

Causes of Travel Time Variation

- Recurrent Disturbances
- Non-Recurrent Disturbances

- Improving transportation agency operations,
- Providing advance trip related information to travelers,
- Analyzing choice of route,
- Calibration and validation of simulation models
- Computation of travel time reliability metrics



Source : FHWA

To capture these variations, Spatial and Temporal Travel Time Data is required.

How to get this large amount of data?

Introduction: ITS Services

Aim: “Optimize efficiency of the existing transport infrastructure, without having to resort to expensive infrastructure upgradation”

Video Imaging

- Need for **extensive network** of cameras
- **High-end computing** requirements

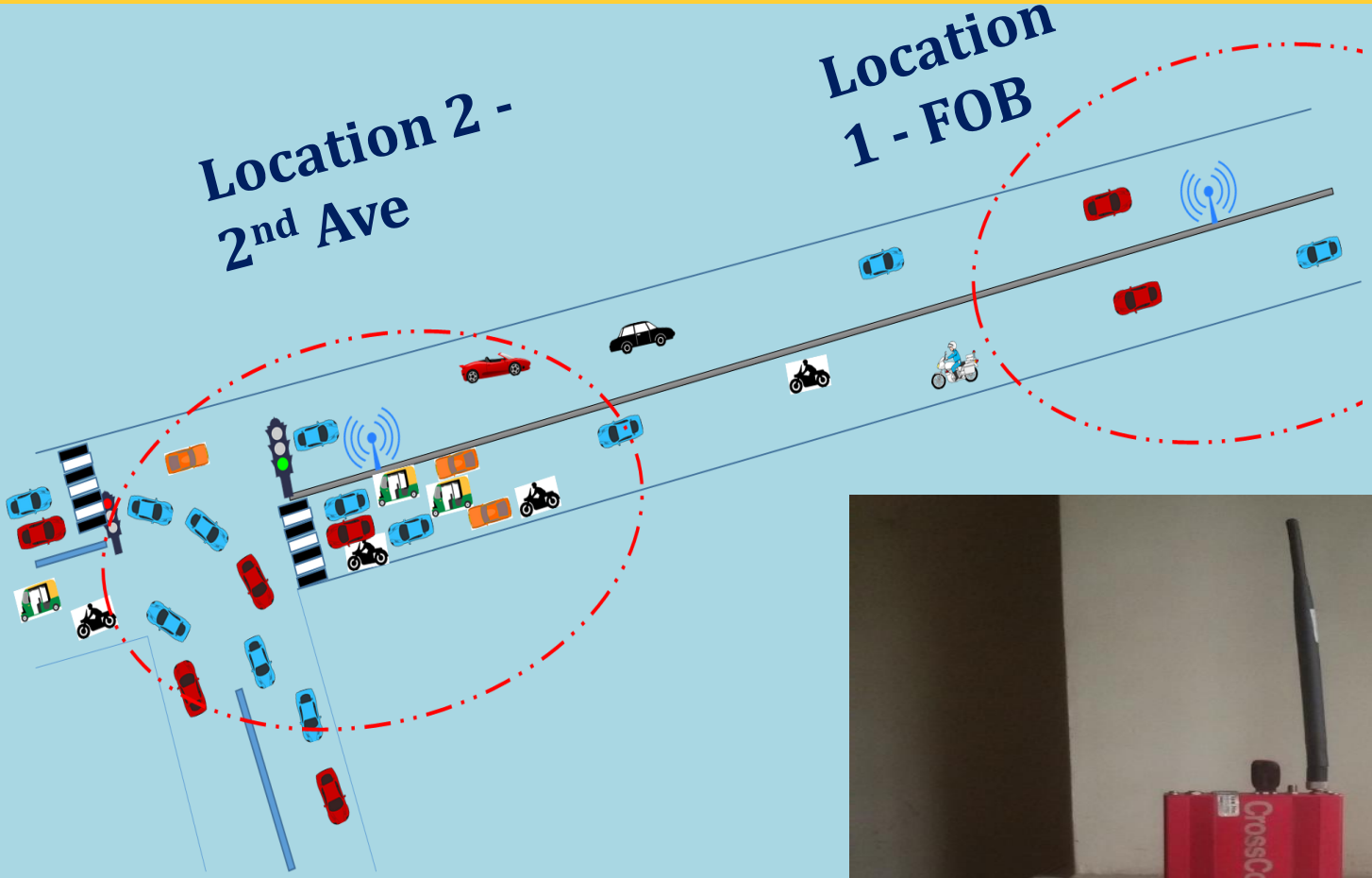
Mobile Sensors (GPS)

- Privacy concerns
- Only public transport vehicles are commonly used as probes
- Very small sample of the vehicle population

Fixed Sensors

- Loop detectors
- Bluetooth / Wi-Fi Sensors

Bluetooth/Wi-Fi Sensors



Literature review

Domain	Authors	Findings
Notable Studies in India on Bluetooth/Wi-Fi Sensors	Mathew et al. (2016)	• Carried out travel time reliability study of two routes in the city of Chennai using Bluetooth sensor approach. • A penetration rate of 4-6% was observed. Bluetooth technology has enormous potential to provide fairly accurate travel time estimations across urban arterials in India.
	Chintan et. al. (2019)	• Study outlines the methodology for formation of O-D matrix by matching the MAC ids for the devices along with their analogous time stamps. • Burr and GEV distribution were found to be best fitted. • A model was developed to predict the through traffic from the matching detection among links.

Literature on Travel Time Distribution

Authors	Distributions	Type of facility
Eman and Al-Deek (2006)	Log-normal, Weibull, Exponential	Freeways
Nie et al. (2012)	Gamma	Arterial roads, local rods
Lie et at. (2014)	Generalized extreme value (GEV), Generalized Pareto (GP), Weibull, Burr, Normal, Gamma, Log-normal	Urban Expressways
Kieu et al. (2015)	Burr, Gamma, Log-normal, Normal, Weibull	Public Transportation Systems
Talor and Susilawati (2012)	Burr	Urban roads
Chen et al. (2018)	Normal, Gamma, Weibull, Log-normal	Expressways, Major roads, local streets
Aron et al. (2014)	Log-normal, Gamma, Burr, Weibull, Normal, Mixture distribution	French motorways

Study Location: IT Expressway, Chennai

Study Period : 17-05-2018 to 06-07-2018

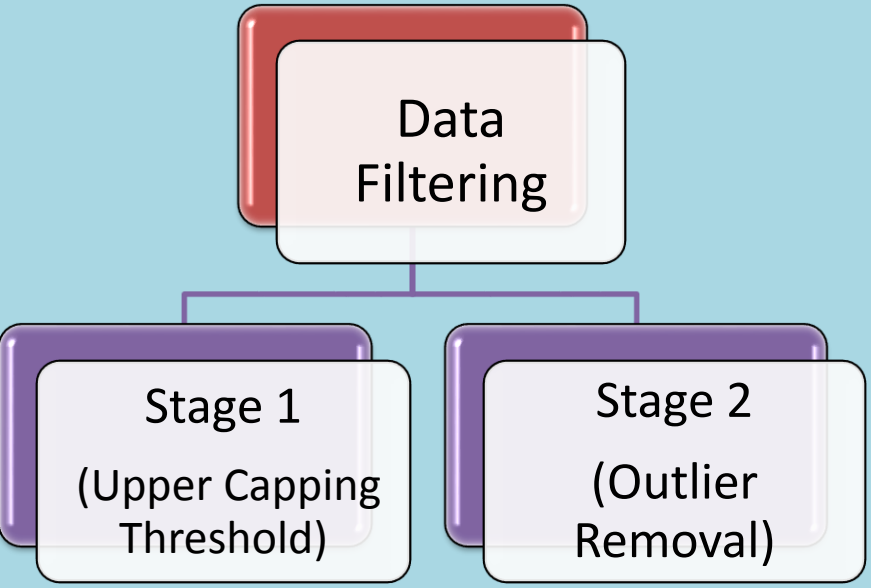
Sr. No.	Location	Designation	Description
1	Foot over bridge 1 (near Madya Kailash)	FOB	Mid-block section 6-lane divided carriageway Service lane on either side
2	2nd Avenue (near Indira Nagar Railway Station)	2nd Avenue	Signalized T-intersection 6-lane divided carriageway Service lane on either side
3	Tidel Intersection (near Tidel park)	TIDEL	Four-Legged Signalized Intersection 6-lane divided carriageway Service lane on either side

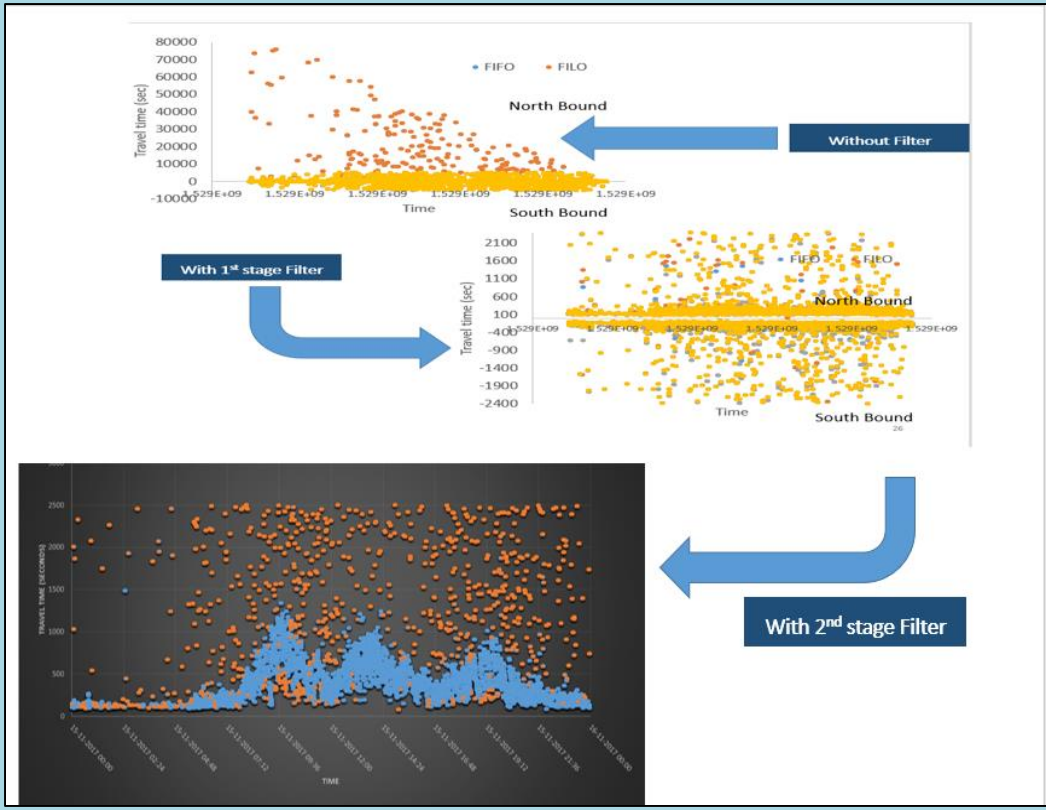
Length of Links:

FOB1 to 2nd Avenue (NI)= 1.0 km

2nd Avenue (NI) to Tidel =0.7 km

Data Filtering





MAD is Median Absolute Deviation

$\tilde{x}$ is Median

$$M_i = \frac{0.6745(x_i - \bar{x})}{MAD}$$

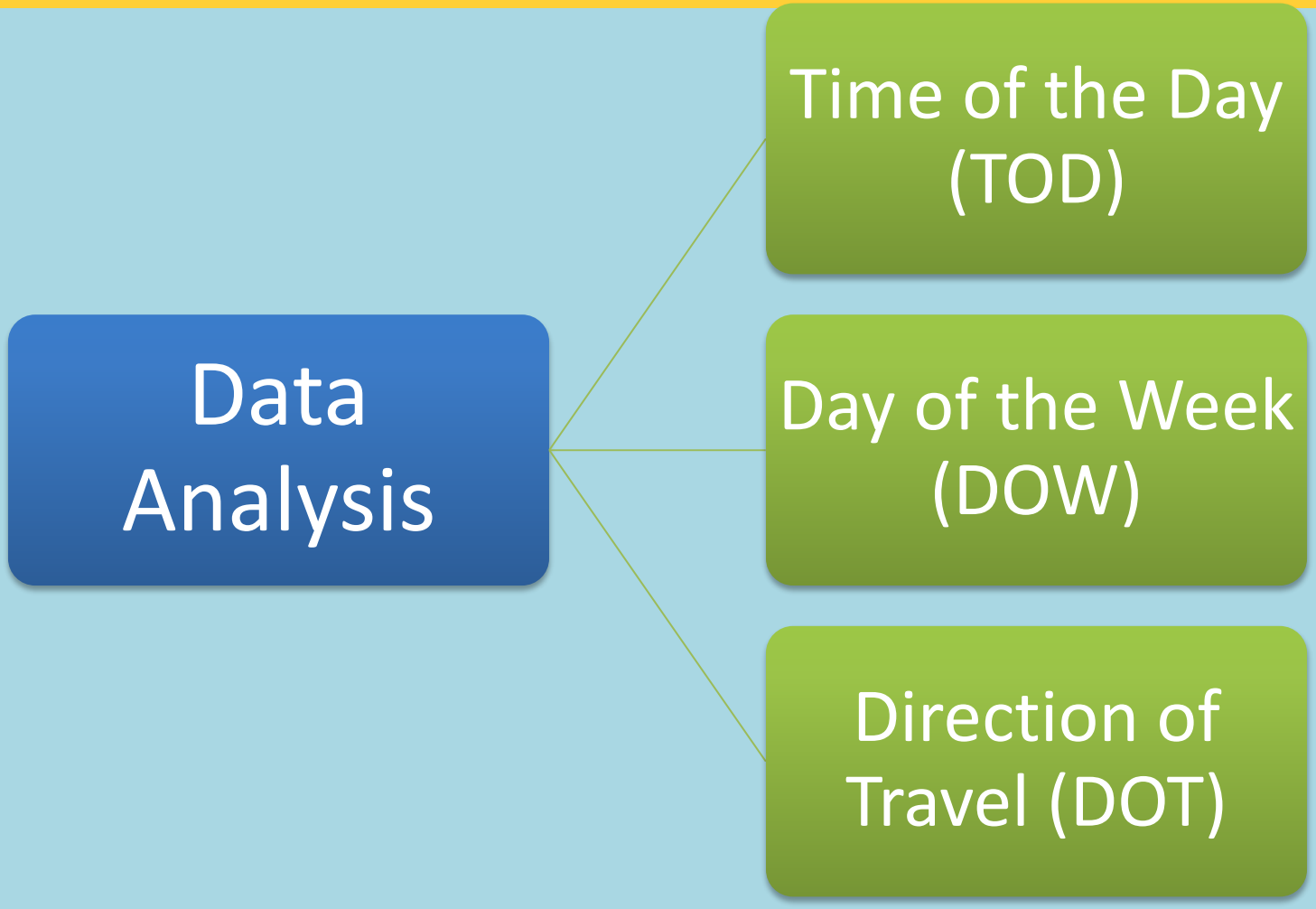
P-Statistic Value

Weights										
Day	**Normal**	**GEV**	**Burr**	**Log normal**	**Log normal (3P)**	**Wakeby**	**Gamma**	**Log logistic**	**Log logistic (3P)**	**Weibul**
Monday	0.310	0.041	0.043	0.057	0.060	0.033	0.156	0.063	0.061	0.176
Tuesday	0.301	0.040	0.053	0.038	0.043	0.030	0.218	0.057	0.055	0.166
Wednesday	0.300	0.046	0.049	0.037	0.062	0.022	0.183	0.058	0.065	0.177
Thursday	0.309	0.048	0.046	0.041	0.063	0.026	0.181	0.057	0.067	0.164
Friday	0.304	0.042	0.054	0.032	0.044	0.040	0.165	0.075	0.059	0.185
Saturday	0.286	0.038	0.056	0.073	0.033	0.030	0.161	0.071	0.037	0.214
Sunday	0.158	0.070	0.076	0.124	0.098	0.040	0.070	0.149	0.097	0.117
Weighted	0.244	0.011	0.013	0.021	0.016	0.005	0.088	0.027	0.017	0.091
Rank	10	2	3	6	4	1	8	7	5	9
P Statistic Value										
Simple Average	0.122	0.020	0.023	0.024	0.024	0.013	0.071	0.032	0.027	0.075
Rank	10	2	3	5	4	1	8	7	6	9
Percentile	0.1331	0.0202	0.0222	0.0192	0.0223	0.0151	0.0781	0.0290	0.0277	0.0711
Rank	10	3	4	2	5	1	9	7	6	8

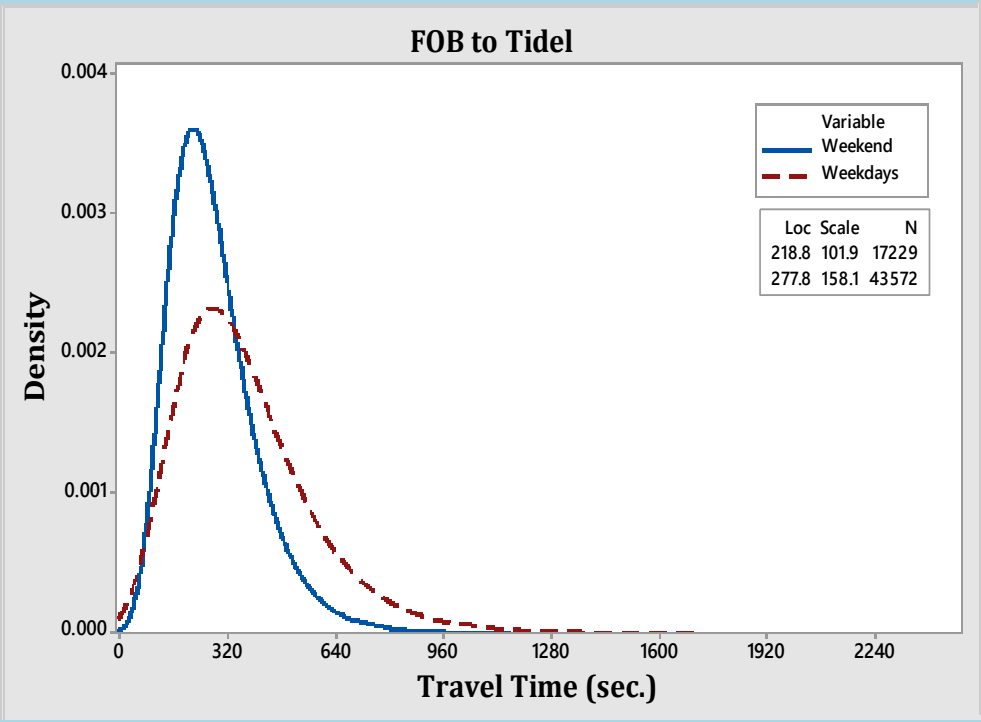
Summary of Shape Factor

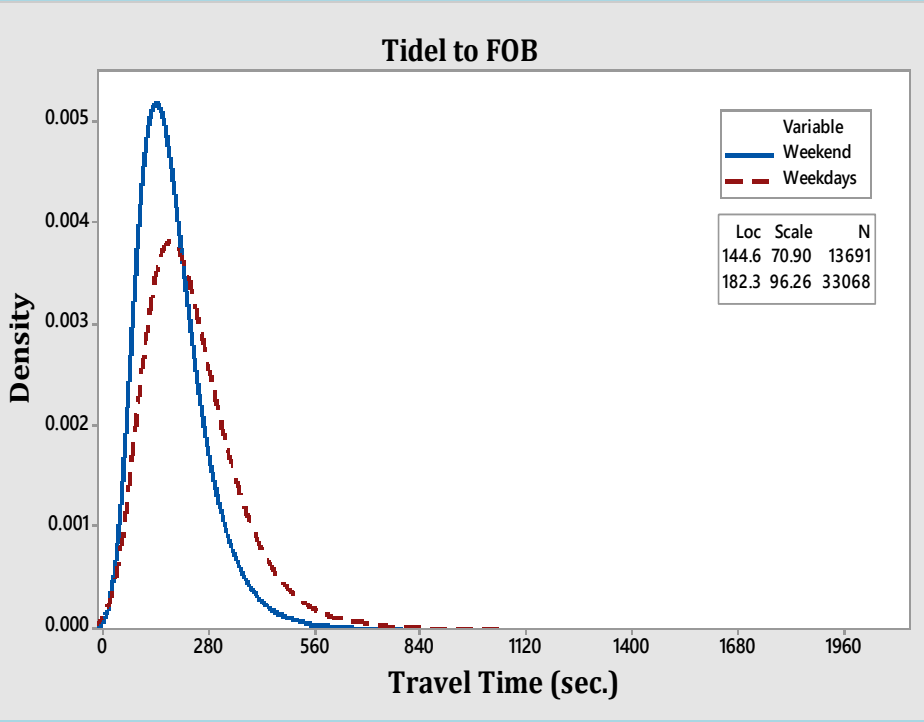
Day	FOB to Tidel	Tidel to FOB
Monday	0.2481	0.14391
Tuesday	0.02734	0.38437
Wednesday	0.2583	0.18502
Thursday	-0.03357	0.28236
Friday	0.21679	0.38198
Saturday	0.02133	0.17494
Sunday	-0.01731	0.18293
Weekdays	0.14694	0.01599
Weekends	-0.0063	0.0023
Timewise		
Off Peak	0.01615	0.29047
Peak	0.1418	0.30389

TRAVEL TIME VARIABILITY

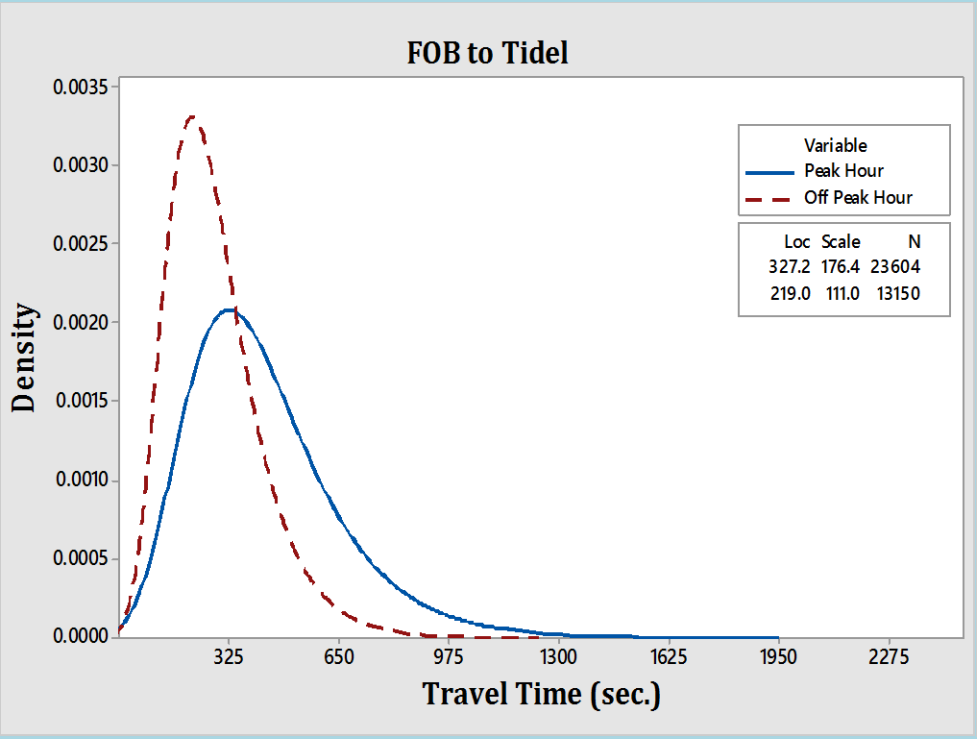


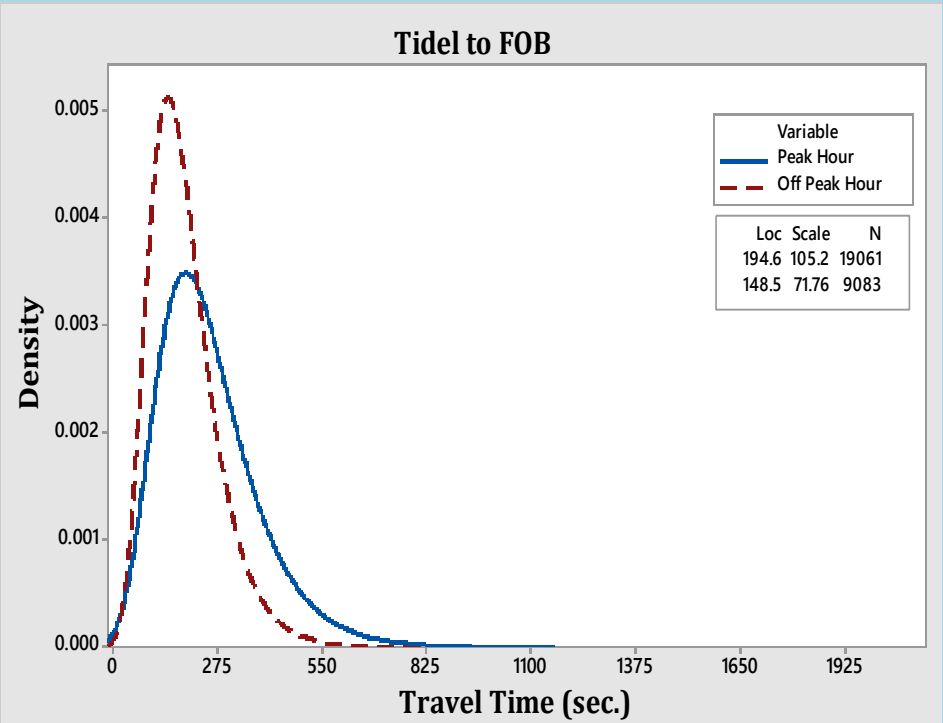
Day of Week (DOW)



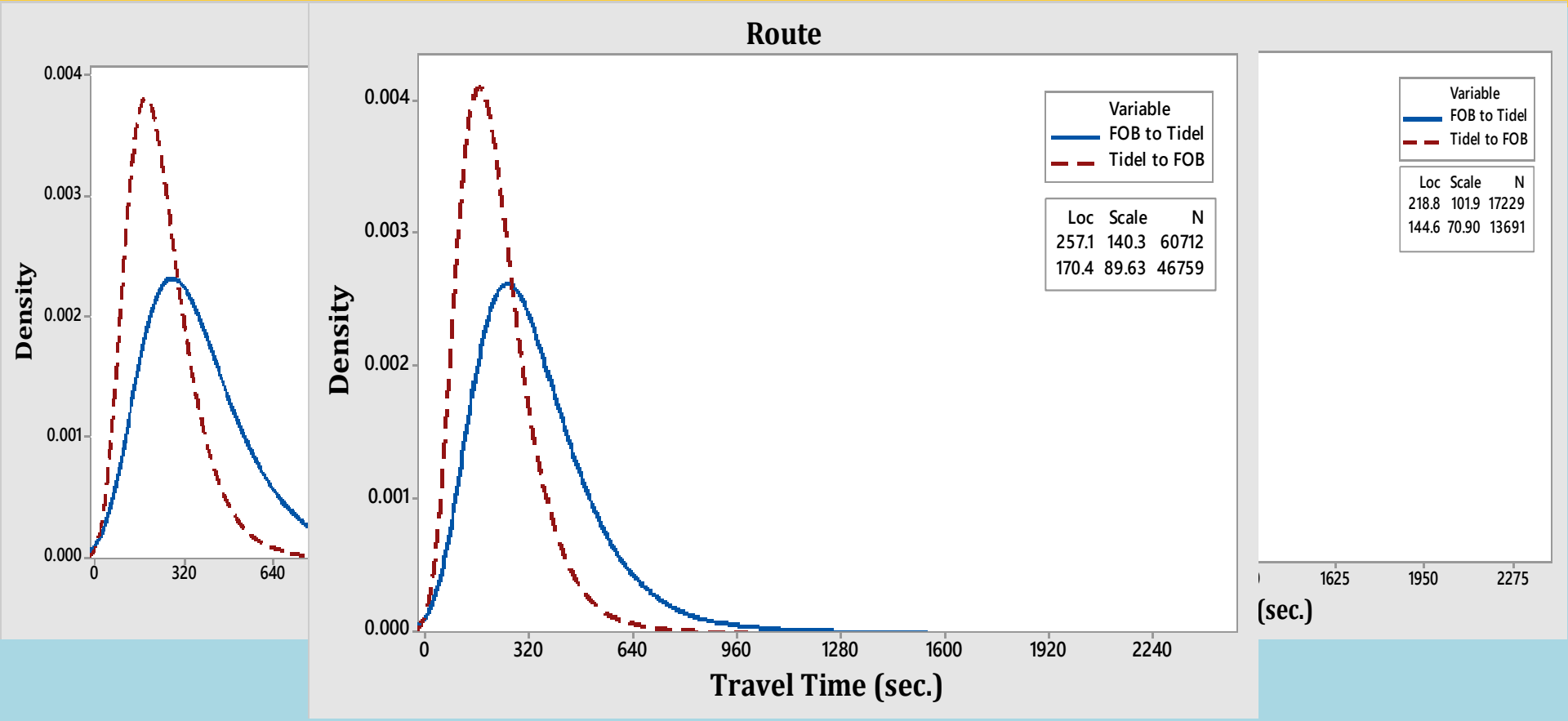


Time of Day (TOD)





Direction of Travel (DOT)



Conclusions

- Generalized extreme value distribution as the best-fitted distribution for explaining variations in travel time

- Travel time was observed to be positively skewed for all the survey days.

- The variation in travel time is significantly influenced by the time of day, the day of week and the direction of travel.

- Higher travel time values were observed for peak hours and weekdays compared to off-peak hours and weekends. Higher average travel time values were noted for FOB-Tidel compared to Tidel-FOB.

- The normal distribution can better explain variation in travel time for off-peak hours and weekend. Therefore, the skewness of the curve gradually decreases (approaches zero) as the traffic flow condition varies from extreme peak condition to free-flow conditions.

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Thank You