15th Urban Mobility India Conference & Expo 2022

Azadi Ka Amrit Mahotsav

A Seminar on

Shapley Additive Explanation Method for Assessing Motorized Two-Wheeler Level of Service at Signalized Intersection

Authors:

Manisha Biswal

Prof. Prasanta Kumar Bhuyan

Presented by :

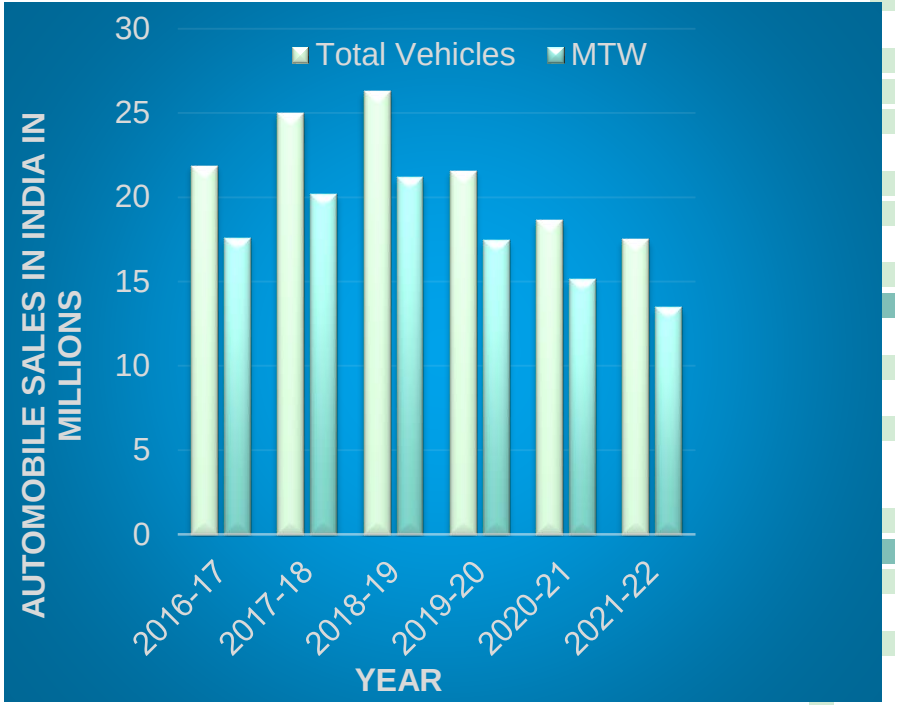
Manisha Biswal

Doctoral Research Scholar

NIT Rourkela

Why Motorized Two Wheelers ?

- Motorcycles, scooters, mopeds represents Motorized Two Wheeler (MTW) in India.
- More than 70% of automobiles sold in India are MTW(SIAM India).



Unique MTW Characteristic's

- Small Size
- High Flexibility
- High Power to Weight Ratio
- Small turning Radius
- High angle of view
- Easy Accessibility
- Low Price

Related Work

Sl No	Authors	Findings
1	Kittelsons and Roess (2001)	LOS should be based on drivers perception, travel efficiency, sense of safety, and aesthetics.
2	Jou et al. (2013)	Service score evaluations of MTW riders and car riders are different from each other's.
3	Othayoth and Rao (2017)	Perform statistical analysis on user perception and found that road surface condition, visibility of traffic signals from queue, road marking, and presence of signs positively influence the level of service. However, vehicle waiting time in queue, queue length, presence of a pedestrian, presence of heavy vehicle, and obstructions negatively influence the perceived level of service.
4	Jena et al. (2018), Novikov et al (2018)	Traffic volume, effective road width, travel speed, pavement condition, on-street parking, land use, hindrance due to public transits and movements of non-motorized vehicles, affects the level of service of automobile users.

Research Gap and Motivation

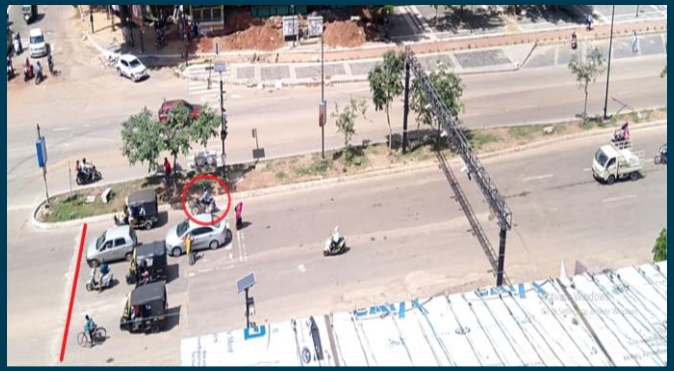
- Most of the studies conducted to analyse the level of service has taken the standard car as subject vehicle. There are no research attempts to measure the service performance at signalized intersections considering MTWs riders point of view.

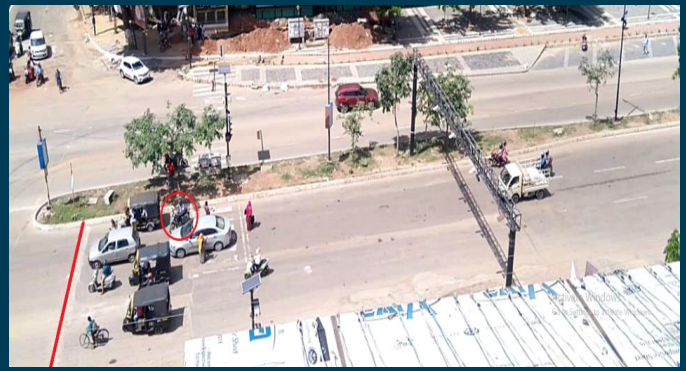
- This research attempts to fill that gap by performing LOS analysis in perspective of MTW riders. To ease the complexity of the prediction model, machine learning techniques was used. This research also tries to explain the black box present in machine learning techniques through SHAP analysis.

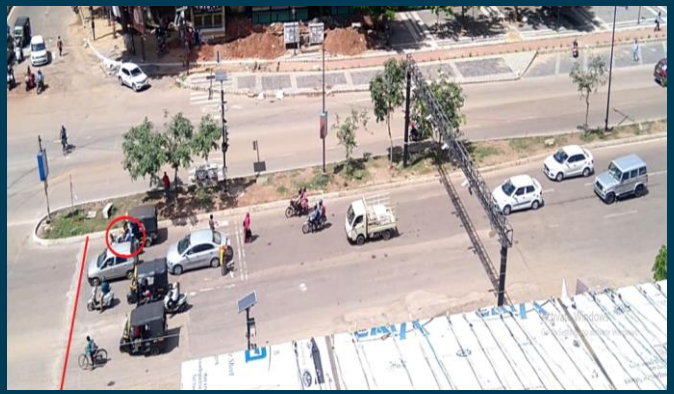
Data Collection and Extraction

- Data was collected from 38 approaches of 11 signalized intersections of Bhubaneswar city.
- Vehicle delay was calculated from field with reference to free flow speed.
- Five-point scale with 1 representing the worst and 5 representing excellent, the Pavement Condition Index (PCI) was measured.
- Approach width was varied from field to field due the different obstructions such as roadside parking, presence of bus bays, etc.
- Obstruction of visibility was calculated by eye observation on the field due presence of board, trees, heavy vehicles, or other obstructions.

MTW Behaviour at Signalized Intersection







Location : Unit 9 Chowk BBSR

Data Extraction Methods

Sl No	Attributes	Abbreviation	Calculating Method
1	Average Control Delay	D	Calculated from video data
2	Pavement Condition Index	PCI	Field observation
3	Commercial Density	CD	Both from video and field data
4	Peak Hour Volume	PHV	Calculated from video data
5	Percentage of Heavy Vehicle	HV	Calculated from video data
6	Presence of Median	-	Field observation
7	Obstruction due to visibility	Ov	Field observation
8	Approach Width	W	Collected from field
9	Pedestrian Volume	Pv	Video-data analysis

Spearman correlation of input variables with MLOS score at signalized intersection

- Spearman's rank correlation measures the strength and direction of association between two ranked variables.
- It basically gives the measure of monotonicity of the relation between two variables i.e. how well the relationship between two variables could be represented using a monotonic function.

Variables	Spearman Rank Coefficient	p-value
PHV	-0.643	0.000
D	-0.614	0.000
W	-0.264	0.003
HV	-0.018	0.009
Pv	-0.628	0.000
Ov	-0.625	0.000
PCI	0.476	0.007
CD	-0.534	0.002
Median	0.322	0.000

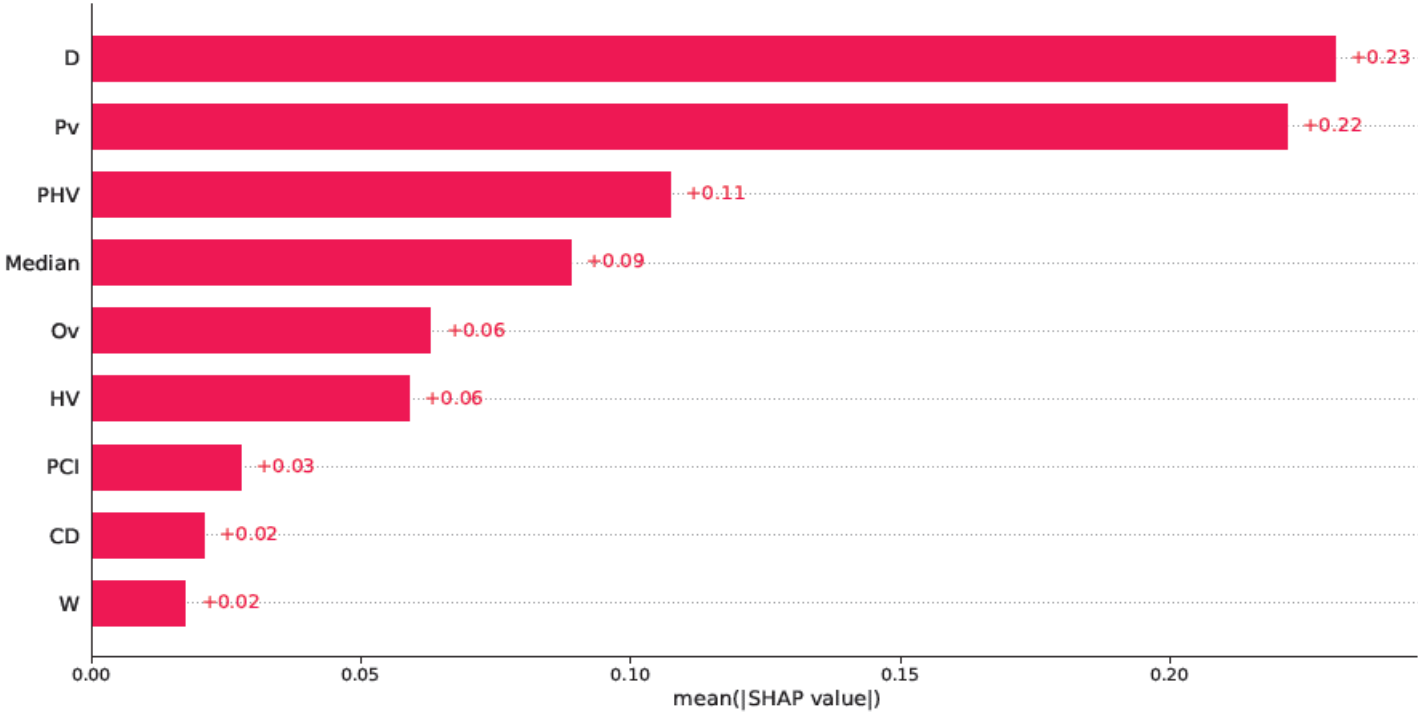
Random Forest Model

- Random Forest (RF) is a learning method for classification, regression by constructing a multitude of decision trees at training time.
- The linear random forest is a bagging ensemble of randomized linear decision trees, which is inspired by the random forest algorithm. The formal definition of the random forest was first made by Breiman in 2001, which is a bagging of uncorrelated CART trees learned with randomized node optimization.
- The model performance is analyzed through different prediction parameters such as goodness of fit measure (R^2), Mean Average Error (MAE), Root Mean Square Error (RMSE). Random forest model shows good prediction results with accuracy of $R^2 = 0.869$ and error MAE = 0.248, MSE = 0.103, RMSE = 0.321.

SHAP Analysis

- Shapley Additive Explanation (SHAP) method was used to identify the influential parameters for different machine learning models.
- SHAP uses combinatorial calculus to determine the impact of each feature on the target variable.
- A feature's significance can be determined by calculating the average absolute value of its impact on a given target variable.
- The SHAP method is used in various interpretations of the outcomes anticipated by the random forest model.

Sensitivity Analysis by SHAP



Summery And Conclusion

- As per Highway Capacity Manual (HCM 2010), the delay is a major parameter to measure the LOS experienced by automobile users, SHAP analysis concluded that, in case of MTW riders also, delay affects the user perception even after MTW performs seepage operation.
- PHV, D, W, HV, Pv, Ov and CD negatively influence the MTW service score, whereas PCI and the presence of median positively influence the MTW service score.
- The Random forest model can predict the MTW service score accurately with the accuracy of 0.869

References

1. Breiman, L. (2001). Random forests. Machine learning, 45(1), 5-32.
2. Kittelson, W. K., & Roess, R. P. (2001). Highway capacity analysis after highway capacity manual 2000. Transportation research record, 1776(1), 10-16.
3. Jou, R. C., Kou, C. C., & Chen, Y. W. (2013). Drivers' perception of LOSs at signalised intersections. Transportation research part A: policy and practice, 54, 141-154.
4. Othayoth, D., Krishna Rao, K.: Factors influencing level of service for motorized vehicles at signalized intersection under mixed traffic condition. Transportation in developing economies 3(2), 1–10 (2017).
5. Othayoth, D., Rao, K.: Statistical analysis of user perceived level of service at signalized intersection. Technical report (2017).
6. Novikov, A., Novikov, I., & Shevtsova, A. (2018). Study of the impact of type and condition of the road surface on parameters of signalized intersection. Transportation research procedia, 36, 548-555.

THANKS!

Any questions?