PERFORMANCE ANALYSIS OF SIGNALIZED INTERSECTIONS FROM TRUCK DRIVERS PERSPECTIVE

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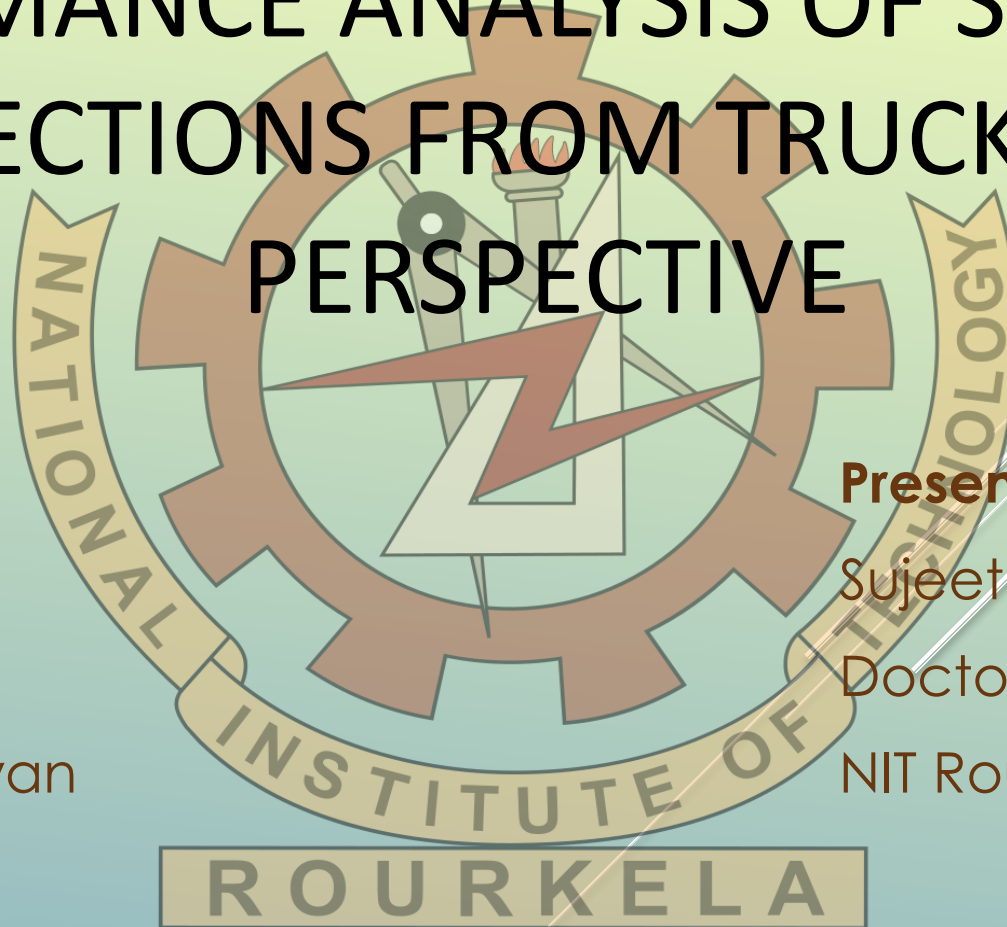Chaganti Sudha

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INTRODUCTION

➢ Indian traffic is recognized by its heterogeneity and non-lane based driving system.

➢ A signalization at intersections are provided to enhance the crossing opportunity.

➢ Performance analysis of signalized intersection are traditionally based on LOS derived by delay or Volume to Capacity ratio.

➢ Performance analysis in accordance to users' perception reveals that more parameters affect the satisfactory level of users'.

➢ Trucks having varying static and dynamic characteristics experiences different service level than other modes of transportation.

➢ Trucks being an important component of Indian traffic.

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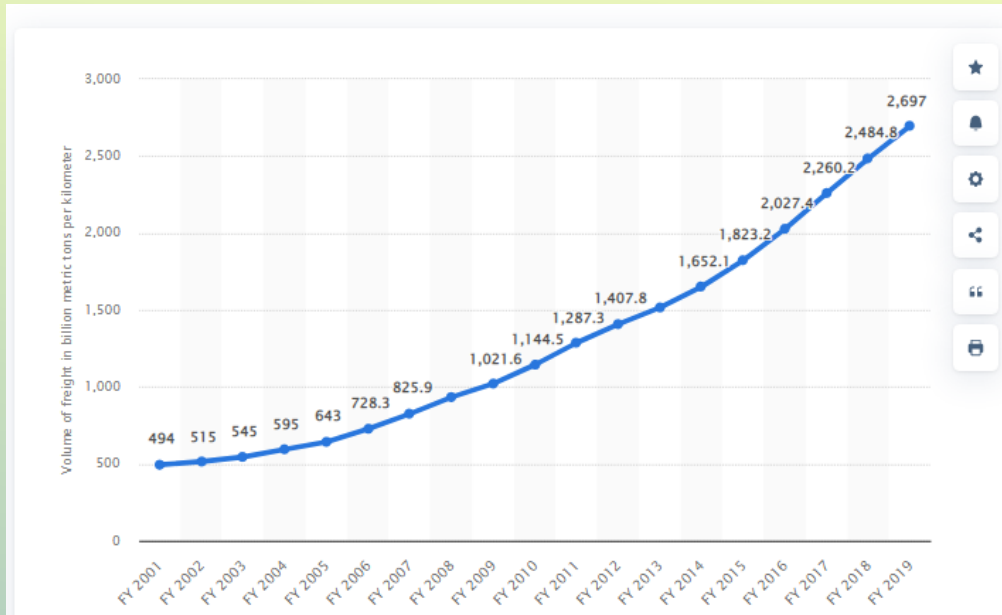29-11-2022

GROWTH IN TRUCK TRAFFIC

Fig 1:Freight transport growth
(source: www.statistica.com)

➢ Freight transport in India shows an exponential growth pattern.

➢ Logistics account for about 14% of India's GDP, and road transport alone comprises 70% share.

➢ The annual e-commerce sales reported were USD 84 billion in 2021. This has been a key operator in the road freight industry.

➢ With an increase in online retail in 2020 because of COVID-19, the demand for logistics has manifold in tier 2 and tier 3 cities.
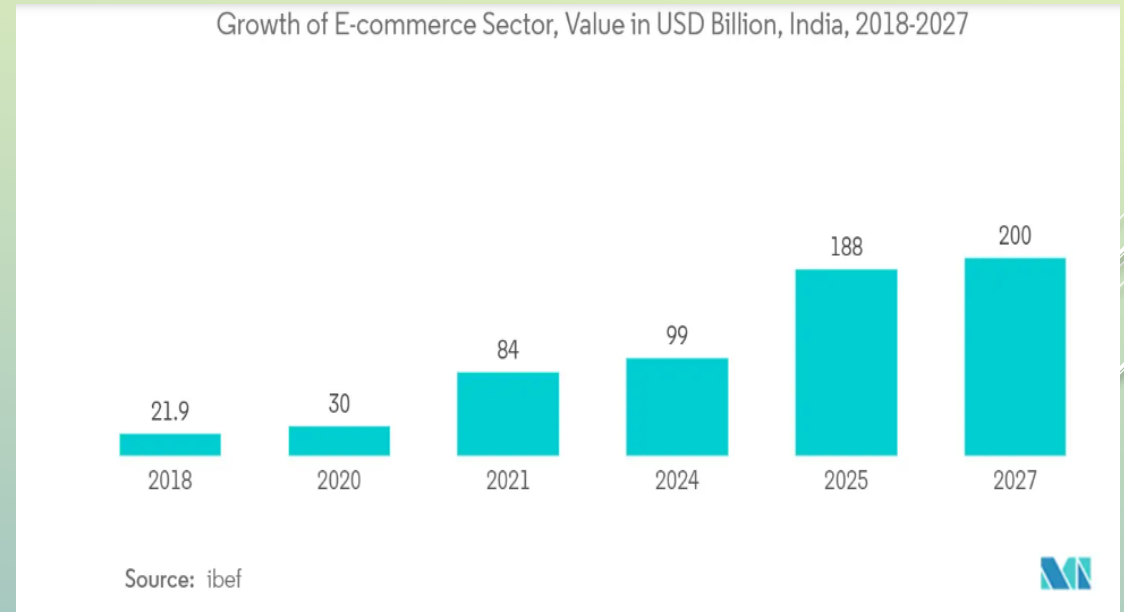

Fig 2: E-commerce growth and forecasting
(source: www.ibef.com)

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BACKGROUND LITERATURE

Title	Authors and year	Key findings
Automobile Drivers' Perceptions of Service Quality on Urban Streets.	Pécheux et. al. (2004)	Users' survey about performance level of urban street and influential factors.
Identification of Preferred Performance Measures for the Assessment of Truck Level of Service	Ko et. al. (2007)	Written surveys and postage-paid surveys regarding truck trip satisfaction.
Unsignalized Intersection Level of Service: A Bicyclist's Perspective.	Beura et. al. (2021)	Modelled user perceived bicyle-LOS using MGGP.
Perceived level of service at signalized intersections under heterogeneous traffic conditions.	Othayoth et al. (2020)	Automobile users' perceived Los modelled at signalized intersection

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STUDY REQUIREMENT--TRUCK MODE

➢ In 2020, the gross value added (GVA) by the transport sector was INR 6.54 trillion. The GVA added only by the road transport sector majorly trucks is INR 4.32 trillion, an increase of 3.59% from 2019.

➢ Because of COVID-19, the e-commerce industry grew about 8% in India, making the logistics industry a profitable sector in 2020 and 2021.

➢ For long hauls freight logistic even if other modes proves to be economical the last mile ride is always based on trucks.

➢ Trucks having different static and dynamic characteristics from other modes faces different service level than other modes of transportation.

➢ Trucks playing a key role in transportation and facing different service level than other modes motivates a dedicated Truck-level of service study.

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STUDY AREA

➢ Study area is focussed on signalized intersection present on out-skirt city where truck, traffic is significant.

➢ The sites for study are selected with a focus to have wide variance among the independent parameters, those are traffic and operational element, geometric element, and conglomerative elements.

➢ Cities selected for the study are large and mid-sized cities.

➢ The selected sites are composed of both 3 legged and four legged intersections.

➢ The cities selected for the current research are-

   ➢ Hyderabad

   ➢ Bhubaneswar

   ➢ Kolkata

   ➢ Ernakulam.

DATA COLLECTION AND EXTRACTIONS

➢ The data from the selected sited were extracted using videographic survey, use of google earth pro, field investigation and measurement, and visual observations.

➢ Extracted parameters are categorized into three categories traffic and operational, geometric, and conglomerative elements.

➢ Geometric parameters are consist of Number of legs, Number of lanes, presence of adequate shoulder width, presence of median, presence of raised kerbs, presence of grade separated foot path, presence of street light, presence of road side reflectors and effective width.

➢ Traffic parameters are platoon ratio, percentage of non-motorized vehicle, percentage of two wheeler and percentage of four wheeler, cycle characteristics, Volume to Capacity ratio and control delay.

➢ Conglomerative elements are presence of road side commercial activity, Land use pattern, pedestrian crossing inflicting green time, frequent transit stops, on-street parking volume.

METHODOLOGY

➤ Perceived satisfactory scores are collected from truck driver's by showing them the videos collected from sites and asking them to rate the intersection in a Likert types scales of 1-7.

➤ Responded perceives the Likert type scale as a linear scale is used to categorise the perceived scores into six orderly categories.

➤ Partial spearman correlation test is used to identify the factors those have statistically significant relation.

➤ Ordered logit model is a probabilistic model

$$Z_i = \sum_{j=1}^{J} \beta_j X_{ji} + \varepsilon_n = E(Y^*)$$

$$\phi(t) = \frac{1}{1 - e^{-(\mu_t - \alpha x_n)}}$$

$$P(y = t) = \phi(u_t - \alpha x_n) - \phi(u_{t-1} - \alpha x_n)$$

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SPEARMAN CORRELATION ANALYSIS

Parameter	p-value	Rho
Turning Radius	0.888	-0.017
No of legs	0.081	-0.207
No of lanes	0.947	0.008
Pavement condition index*	<0.000	0.570
Presence of adequate shoulder width	0.302	-0.123
Effective road width*	0.003	0.345
Presence of Median	0.699	0.046
Raised Kerb	0.853	-0.022
Grade separated Footpath	0.319	-0.119
Platoon ratio	0.986	0.002
Percentage of non-motorised traffic	0.898	0.015
Effective green time	0.349	0.112
Red time	0.963	0.005
Amber time	0.747	-0.039
Cycle time	0.497	0.081
Hourly traffic	0.295	-0.125
v/c ratio*	<0.000	-0.591

Parameter	p-value	Rho
Percentage of two-wheeler traffic	0.895	-0.016
Percentage of four-wheeler traffic	0.120	-0.293
On-street pedestrian through volume	0.267	-0.133
Pedestrian crossing volume	0.353	0.111
Capacity	0.349	-0.112
Queue length	0.267	0.132
Control delay*	0.007	-0.312
Road side commercial activity	0.137	-0.177
Land use pattern	0.157	-0.168
On-street parking*	0.004	-0.330
Presence of street lights	0.344	-0.113
Road side reflectors	0.594	-0.064
Frequent transit stops	0.525	0.076
Pedestrian crossing inflicting green time	0.340	0.114

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RESULTS

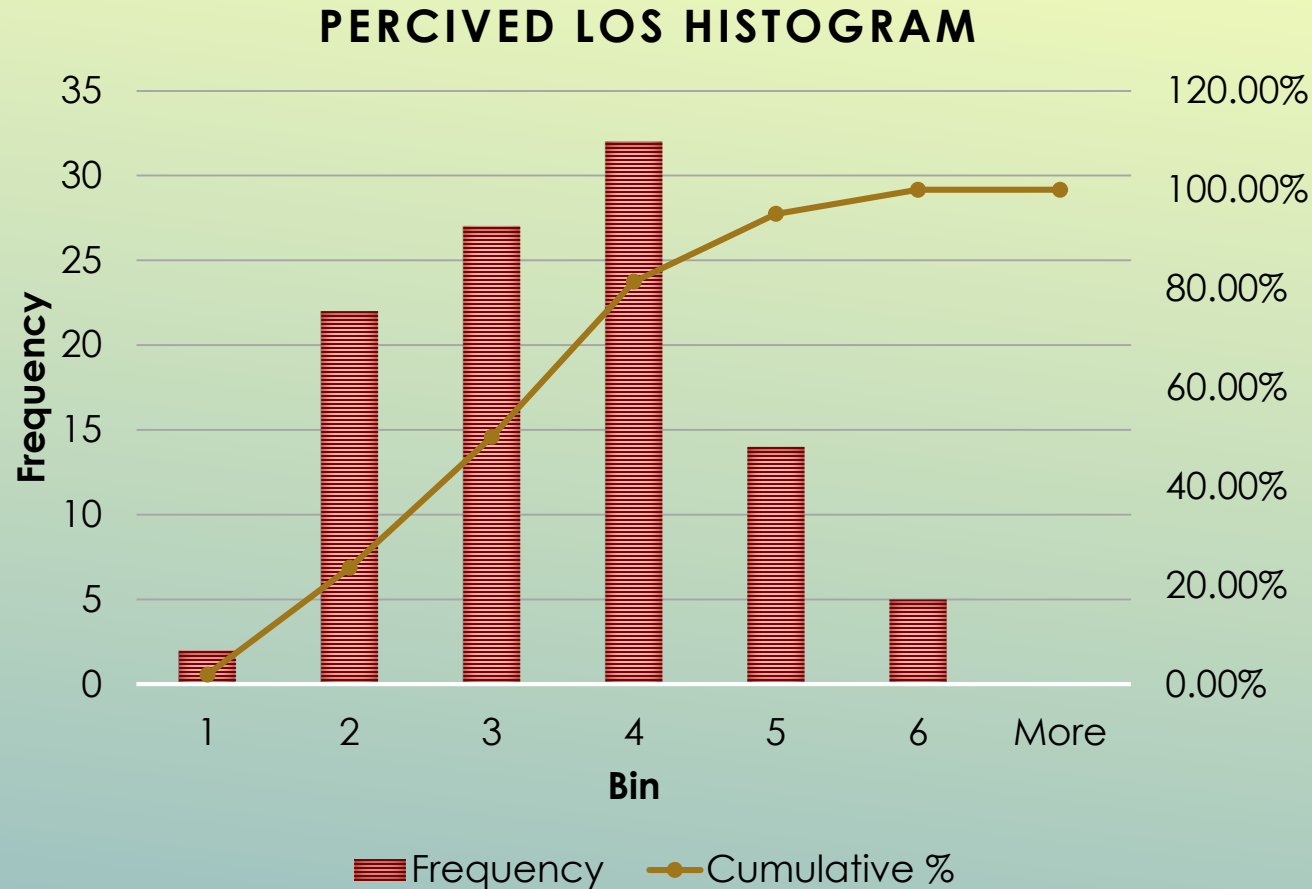**PERCIVED LOS HISTOGRAM**

Fig 3:Frequency distribution of predictor variable

➢ Ordered Logit model is preferred over the normally distributed data.

➢ The Ordered logit model uses cumulative frequency of each order/class for modelling.

➢ The predictor is observed having a central peak and bell shaped distribution.

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RESULTS OF ORDERED LOGIT MODEL

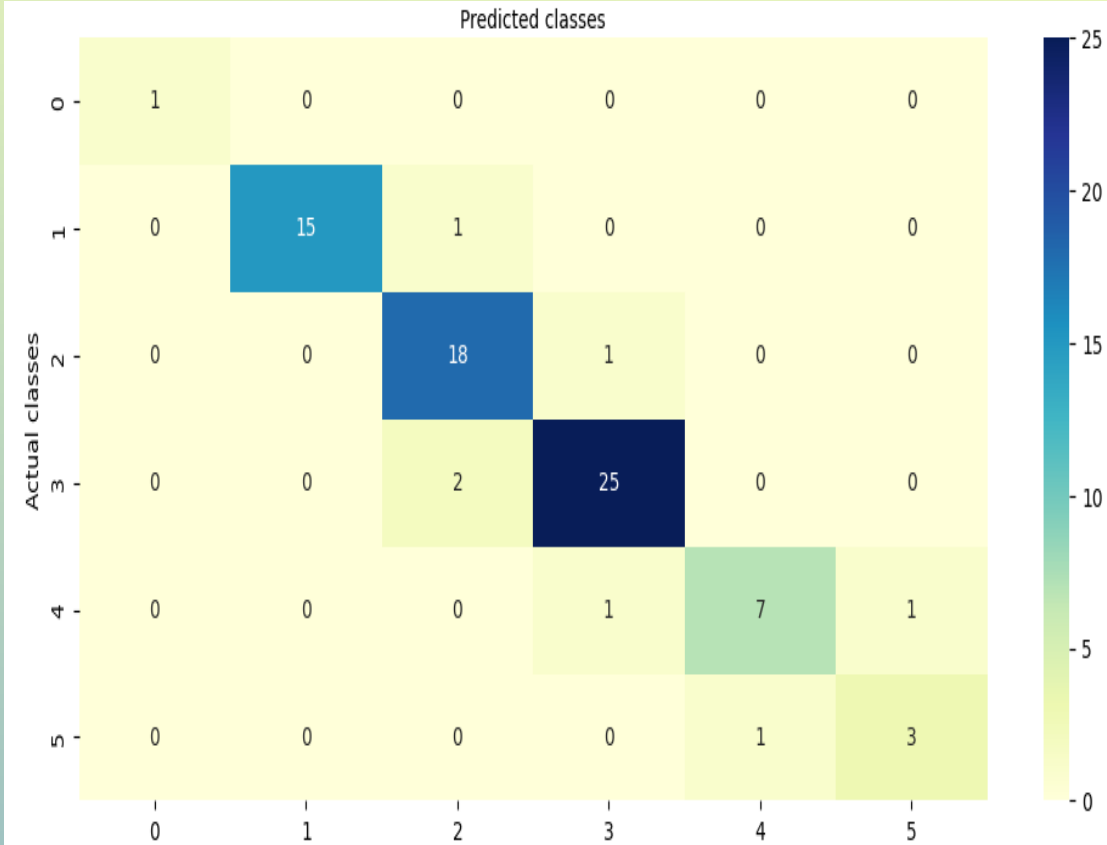| Attribute names	Beta	Standard error	p-value	Lower bound 95%	Upper bound 95%
PCI	11.146	2.374	<0.000	6.493	15.799
EW	0.702	0.162	<0.000	0.384	1.019
CD	-0.027	0.006	<0.000	-0.041	-0.014
OSP	-0.043	0.012	<0.000	-0.068	-0.017
VC	-12.630	2.863	<0.000	-18.243	-7.018
Ancillary parameters	Beta		p-value		
μ_1	-9.70		<0.001		
μ_2	3.14		<0.015		
μ_3	11.20		<0.000		
μ_4	22.73		<0.000		
μ_5	29.85		<0.000		

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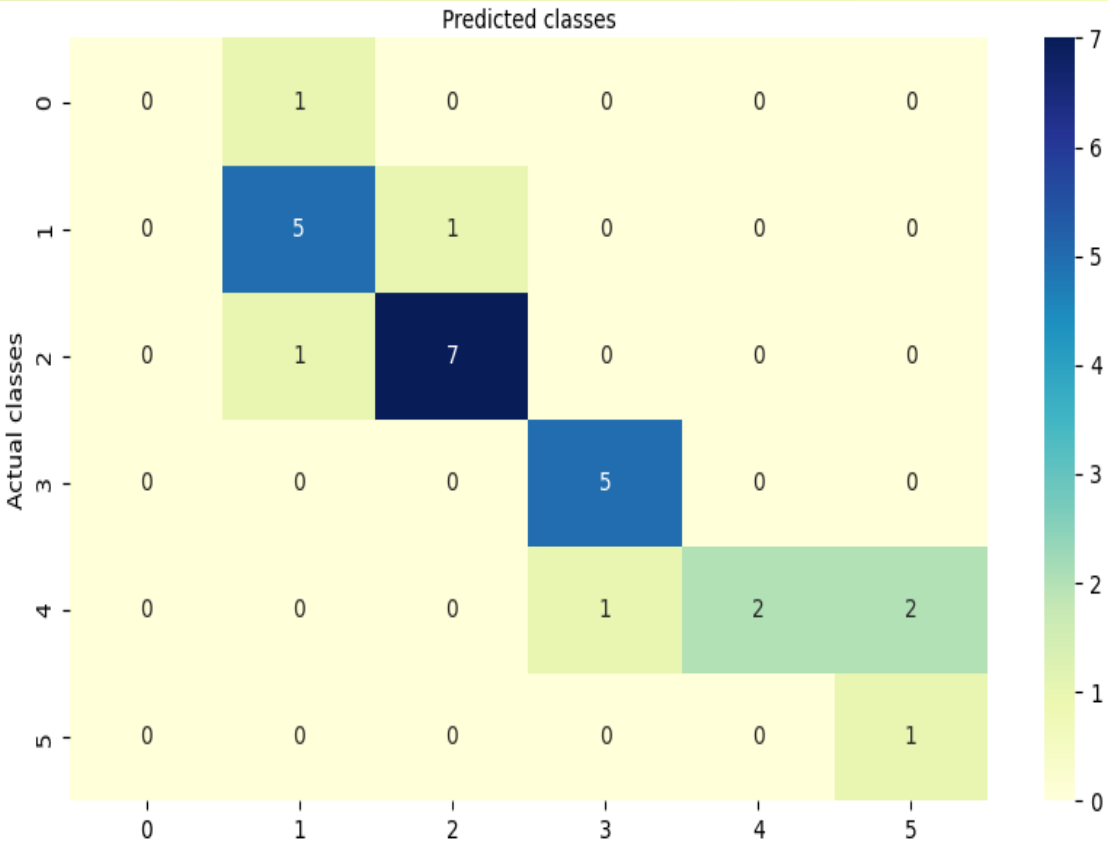Fig 4: Heatmap for Predicted vs. Observed classes of training data

Fig 4: Heatmap for Predicted vs. Observed classes of testing data

ACCURACY OF MODEL FITTING

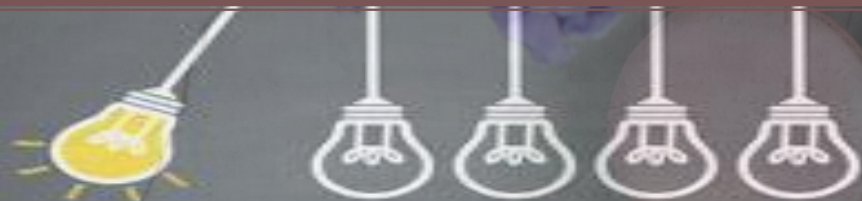| Classes	Precision train	Recall train	Precision test	Recall test
1	100	100	NA	0
2	100	93.750	71.428	83.333
3	85.714	94.736	87.5	77.777
4	92.592	92.592	71.428	100
5	87.500	77.777	100	40
6	75	75	33.333	100
Goodness of fit				
Pseudo R^2	Train precision	Train recall	Train accuracy	Test precision	Test recall	Test accuracy
0.847	0.901	0.889	0.907	0.727	0.668	0.740

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SUMMARY AND CONCLUSIONS

➢ Truck drivers face difficulties different from other modes of vehicles due to its large size and operational characteristics.

➢ It was found that trucks drivers' satisfaction is sensitive towards Pavement condition Index, Effective width, Control delay, On-street parking volume and Volume to Capacity ratio using correlation analysis.

➢ The Truck-Level of service is found to be different than that of the current manual followed

➢ The Ordered Logit model is found to be accurate and good fit for the Truck-LOS modelling.

➢ The training $R^2_{nagelkerke}$ 0.847 and accuracy is in acceptable range.

➢ The accuracy, precision and recall also shows a good value for both training and testing.

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▪ *Ko, B. (2007). Identification of preferred performance measures for the assessment of truck level of service (Vol. 68, No. 06).*

▪ *Beura, S. K., Srivastava, A., & Bhuyan, P. K. (2021). Unsignalized Intersection Level of Service: A Bicyclist's Perspective. International journal of intelligent transportation systems research, 19(2), 405-416.*

▪ *Othayoth, D., Rao, K. V. K., & Bhavathrathan, B. K. (2020). Perceived level of service at signalized intersections under heterogeneous traffic conditions. Transportmetrica A: Transport Science, 16(3), 1294–1309. https://doi.org/10.1080/23249935.2020.1737270*

ANY QUESTIONS?

Thank You

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