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Study of Lane Changing Operations for Varying Traffic Conditions on a Multi-Lane Highway: A Developing Country Perspective (Paper – 0915)

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Introduction

Traffic conditions and lane changing instances are closely related. Poor traffic conditions may cause more frequent lane changes from a road user, which may further impact the level of service (LOS).

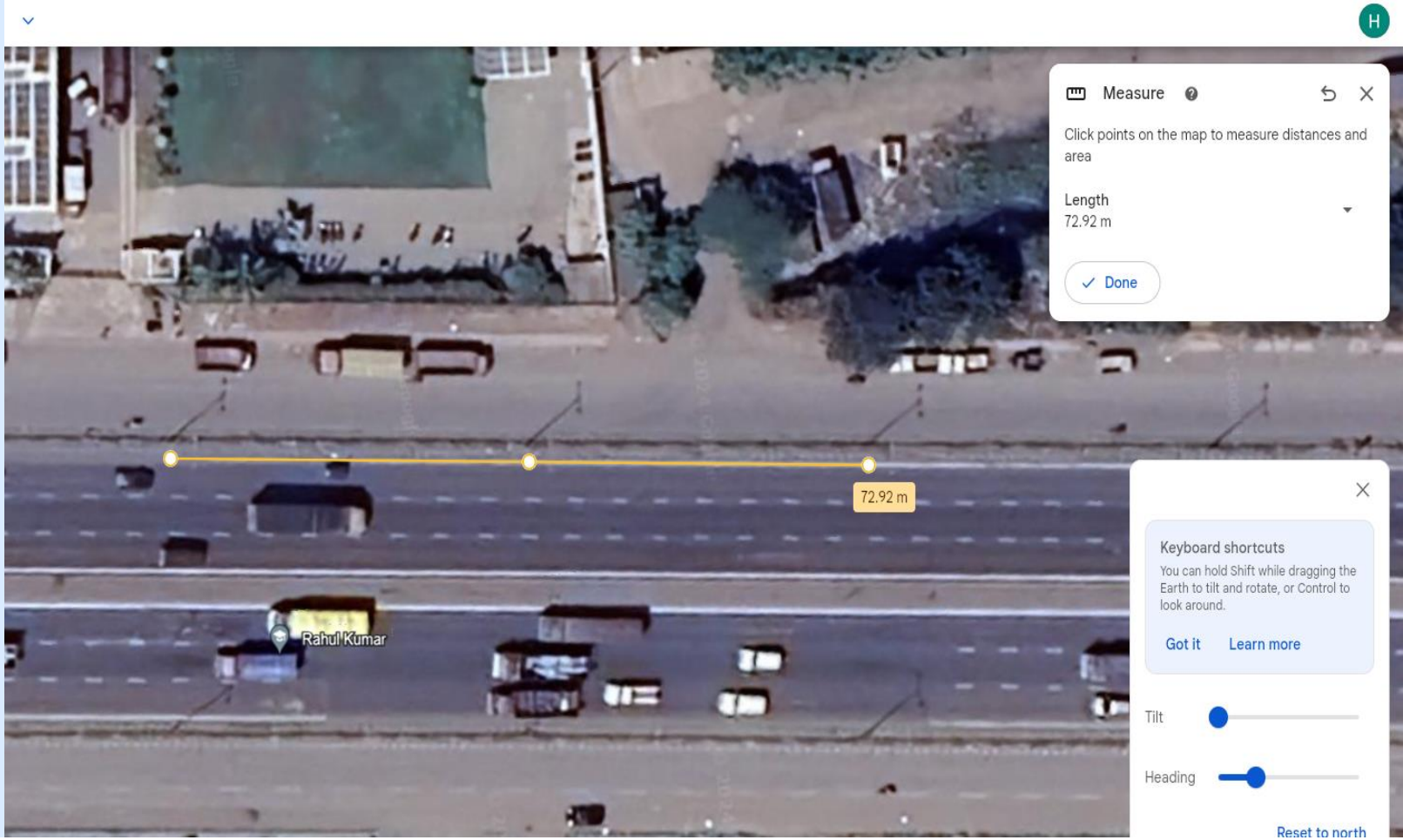
Lane changing models are therefore an important component in road network designs, safety analysis and traffic management.

Every region in India is likely to have a vast diversity in the type of driving styles, vehicular compositions and design considerations, which further necessitates a more granular and microscopic studies into traffic flows.

This study hopes to provide a clearer picture for the same with the context of Indian multi-lane highway infrastructure.

Location

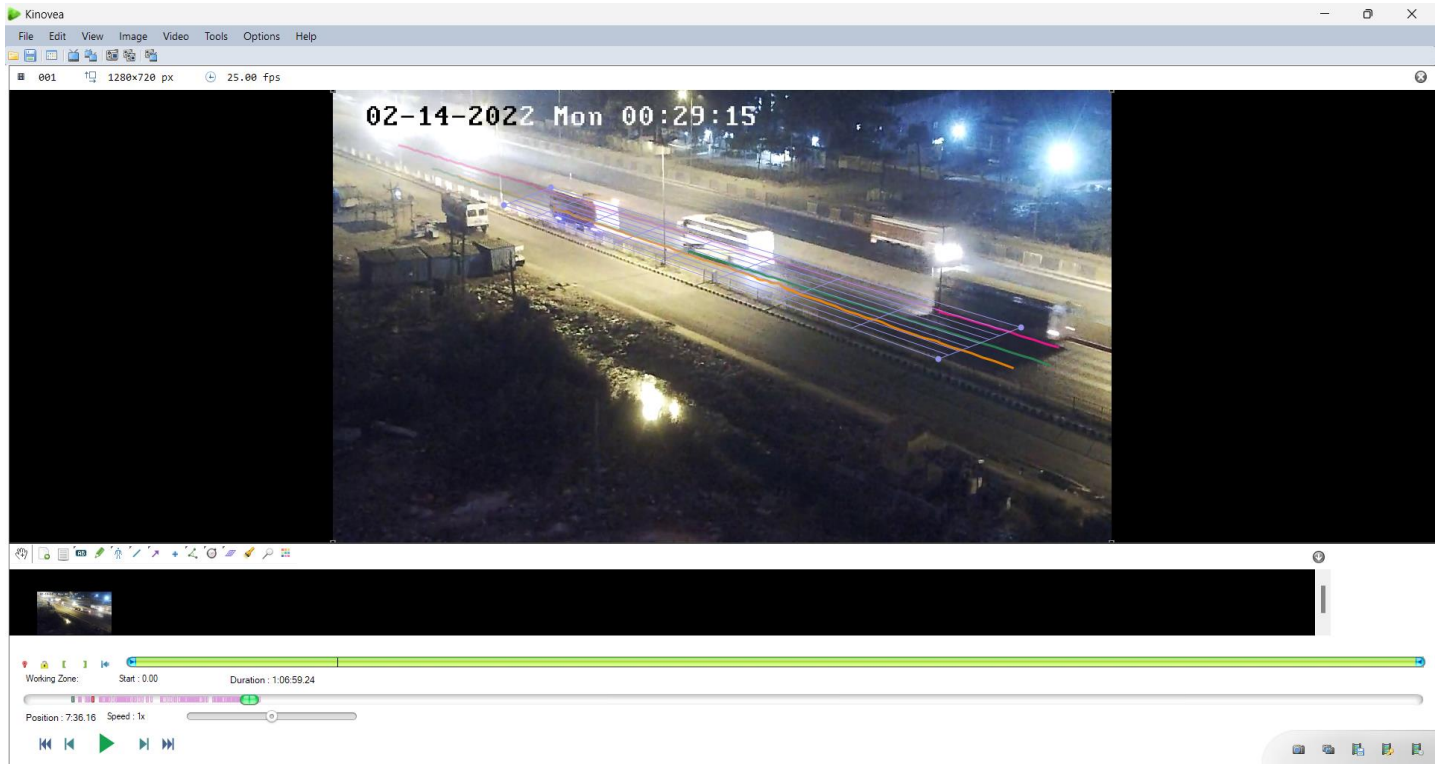
- Location: 21°21'7.71"N, 72°57'34.26"E
- 100 m, 6 lane segment of the Golden Quadrilateral Highway, NH 48, located in Pipodara, Gujarat
- Light posts used as reference for extracting distances)
- 5 Hour traffic footage from roadside pole mounted camera.



Data Extraction

Vehicle trajectory data of instantaneous longitudinal and lateral positions was extracted from the video footage using Kinovea, an open-source software for tracing object movements from video footage.

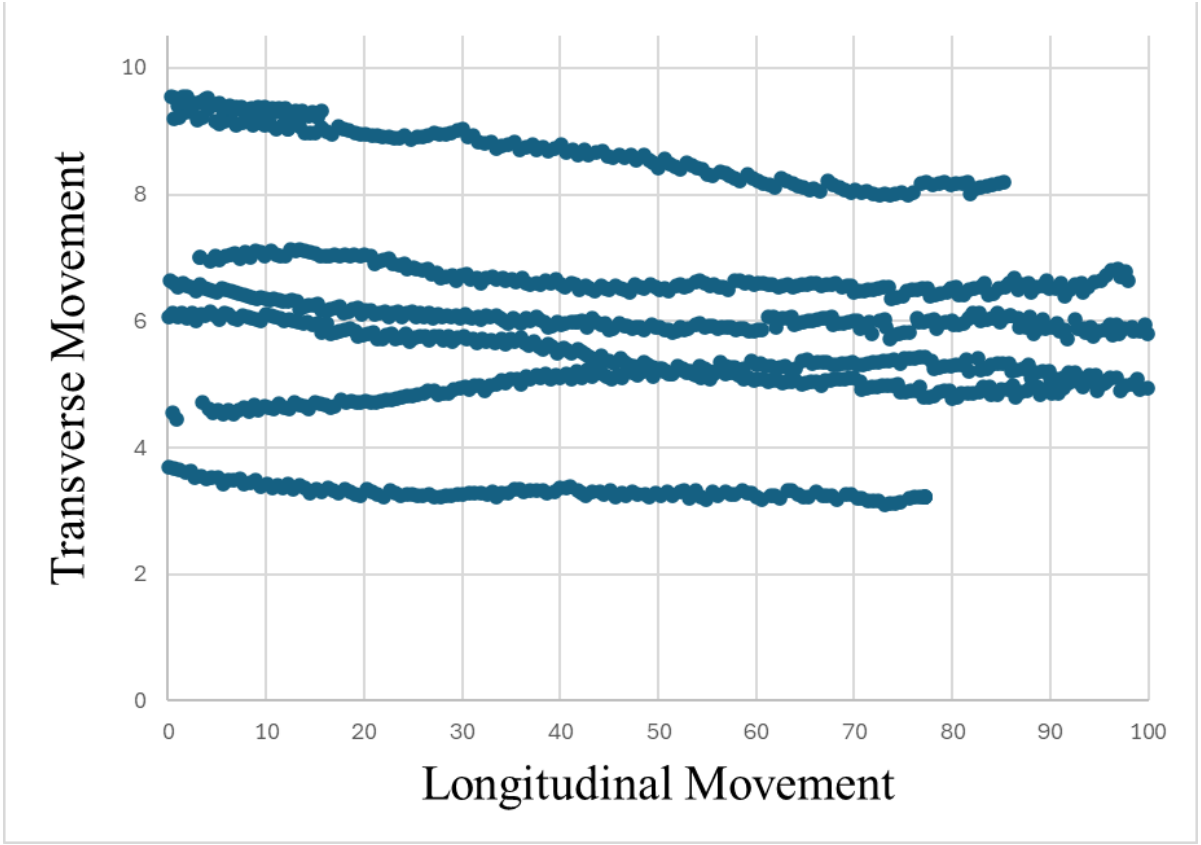
Category wise vehicle composition and lane changing instances for a total of 5 hours were recorded and the data was sectioned into sixty 5-minute intervals.



Data Extraction

	A	B	C	D	E
1		Coords (x,y:m; t:time)			
2	Vehicle	x	y	t	Speed
3	HV001	7.01	3.25	0.04	
8	HV001	7.03	5.84	0.24	49.5
9	HV001	7.06	6.43	0.28	53.1
10	HV001	7.08	6.82	0.32	35.1
11	HV001	6.99	7.34	0.36	46.8
12	HV001	7.1	7.87	0.4	47.7
13	HV001	7	8.4	0.44	47.7
14	HV001	7.11	8.93	0.48	47.7
15	HV001	7.09	9.39	0.52	41.4
16	HV001	7.04	9.89	0.56	45
17	HV001	7.11	10.49	0.6	54

Category wise individual instantaneous vehicle trajectory data.



Traced trajectories of multiple vehicles through the study section.

Data Analysis

Operating Speed (Km/h)	Capacity (PCU/h/direction) for Six Lane Divided Highway Segments
70	5500
80	5930
90	6360
100	6790

Base Capacity Values for varying Operating Speed
(Table 3.6 Indo-HCM 2017)

LOS	Volume/Capacity
A	0.00 - 0.20
B	0.21 - 0.30
C	0.31 - 0.50
D	0.51 - 0.70
E	0.71 - 1.00
F	> 1.00

LOS Thresholds for 6 Lane Highway
(Table 3.9 Indo-HCM 2017)

Vehicle Categories (Lane Changes)						PCU - 5min (Volume)						Total Volume (Hourly)	V/C	LOS	Lane Changes
HCV	Trailer	Small Car	Big Car	LCV	Bus	HCV	Trailer	Small Car	Big Car	LCV	Bus				
1	1	7		2		280	43	11	0	10.2	20.4	3894.84	0.657	D	11
6	1	4		1		185	77.4	20	0	10.2	25.5	3817.20	0.644	D	12
3		6				130	94.6	18	4.5	44.2	20.4	3740.40	0.631	D	9

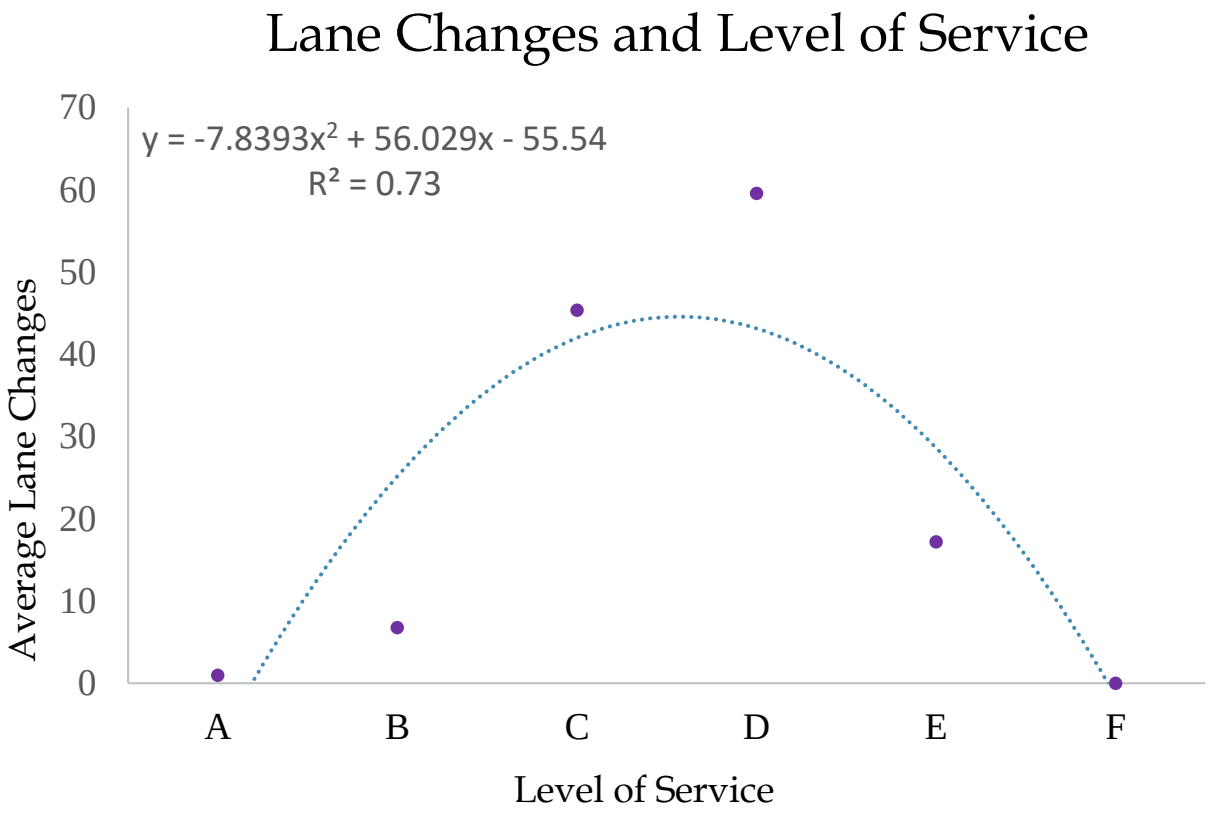
Sample from data set for category wise lane changes, PCU Volumes and corresponding LOS.

Result

Average lane changes over five-hour period for each level of service

LOS	Lane Changes	
	Total	Average
A	5	1
B	34	6.8
C	227	45.4
D	298	59.6
E	86	17.2
F*	0	0

* - LOS F was not observed during the study



Polynomial distribution of lane changes.

Result

A regression analysis of the data with vehicle composition classified by vehicle types against the occurrence of lance changes produced the following equation:

$$\text{Lane Change} = 0.01109\ \text{T.H.V.} - 0.0230\ \text{HCV} - 0.051\ \text{Trailer} + 0.1212\ \text{SC} + 0.1149\ \text{BC} + 0.111\ \text{LCV} - 0.146\ \text{Bus}$$

$$(R^2 = 93.78\%)$$

Where,

T.H.V. =	Total hourly volume
HCV =	Proportion of heavy commercial vehicles
Trailer =	Proportion of trucks with trailers
SC =	Proportion of small cars
BC =	Proportion of big cars
LCV =	Proportion of light commercial vehicles
Bus =	Proportion of busses

Conclusion

- The distribution of lane change instances follows a polynomial distribution from LOS A to E with an R^2 of 0.73
- LOS A with free flow conditions experiences the least number of lane changes with worsening LOS, the lane changes occur more frequently, peaking at LOS D and beginning to fall again from LOS E.
- It is observed that higher proportions of HCVs, Trailers and Busses might cause a reduction in the number of lane changes while a higher proportion of cars might result in an increase in the number of lane changes.
- Small cars and big cars combined perform the highest number of lane changes.
- This can be explained by the differences in relative speeds within the various vehicle classes.

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Thank You