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Safety Analysis and Level of Service (LOS) Evaluation for At-Grade Intersections along the Metro Rail Corridors in Smart City Pune

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Abstract: ***Infrastructure development is key for economic growth of a country. However, poorly planned and deficiently designed infrastructure facilities becomes hazardous to the public. This leads to frequent fatalities in densely crowded cities like Pune. To minimizing fatalities by improving existing infrastructure facilities is game changer to overcome this problem. In India and around the globe many crowded cities are transforming with Metro rail networks to make urbanites life easy. In this study we have analyzed safety measures and evaluated Level of Service (LOS) for At-Grade intersections, along metro rail corridors in Pune city. This study gives good to fare idea about current safety situation of At-Grade junction based on various parameters viz. Junction Design, Pedestrian Facilities, Public Transport Facilities, Impact of Metro Infrastructure etc. The data used in this study is mostly open sourced data from Mappls RealView 360, Google Street View and site inventory. This study can be used for wide scale implementation for crowded cities, which may helpful in multimodal infrastructure development.***
Keywords: Level of Service, LOS, Safety Analysis, At-Grade Intersection, Metro Impact, Junction Design.

I. INTRODUCTION

The economic development of a country is measured based on its road transport infrastructure. Here, I want to mention our honourable Road Transport Minister Shri. Nitin Gadkari. He often says the famously quoted words of US President John F Kennedy: "American roads are not good because America is rich, but America is rich because American roads are good." These words speak volumes about the significance of road infrastructure. India is fast growing and fifth largest economy in the world. Such growth will come from industrial and service sector. Most of the economic activities in these fields take place in urban areas. The state of our cities is key to India's economic growth. Further Indian cities are crowded with 35% of its total population. Across the world it has been experience that as economies grow, rapid urbanization takes this projection to over 70% before it begins to stabilize. As Such, the statistical projection studies says that, 90 Crore by 2050. As against ~50 Crore in 2021.

II. AIM OF THE STUDY

By considering rapid urban developments, urban areas must not only meet the transport needs of the current population but also to be adequate for future urbanites yet to join. In this context, the study of the existing road infrastructure becomes crucial by considering future population and vehicular growth. One of the prime concern on Indian roads is fatalities and injuries caused by traffic accidents. The road accident rates per million population have been increasing from the past three decades. As per NCRB data, 1.15 lakh people lost their lives in road accidents in 2007 which raised to 1.35 lakh in 2010 and 40 lakhs during the year 2012.

This clearly shows that, the road accident problem in urban areas cannot be solved without improving existing road infrastructure facilities. Which gives an importance to Level of Service evaluation and safety analysis of At-Grade intersections. This study method can be further used for larger scale in both urban and rural areas, for better management & upgradation of At-Grade intersections, for achieving better road safety.

III. LITERATURE REVIEW

Many researchers have worked on safety related topics, I haves studied (Bhatt Bhasker Vijaykumar et al.,2011) on Evolution of mechanism for road safety audit of urban roads, as case study conducted for Surat. 2 roads of Surat city were studied for various stages to check the safety for users on such roads. A rigorous accident analysis is carried out in the study with available data and compiled statistics from different police stations. Road safety audit was carried on two different stretches with different stages and situations, in first case the road which is under up-gradation scheme and conceptual design stage is accomplished.

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In second case the road under audit was opened to traffic one year prior to the study. The audit was performed on the road segment and issues regarding safety for road users were identified and all issues were addressed with possible recommendations and suggestions.

In one of the research, (El-Said Mahmoud Zahran et al., 2019) on reducing Road Traffic Accidents (RTA) and their socioeconomic costs is an increasingly important priority in many countries. In recent years, many authors have proposed various approaches to analyses historical RTA data using Geographic Information System (GIS) tools, so that locations with high instances or risk of RTA. i.e., RTA hotspots or blackspots – could be identified and ranked. This could then enable limited road engineering resources to be priorities for remediating more critical RTA hotspots and therefore reducing RTA rates. This paper presents the development of a new validation methods to evaluate the application of four different hotspot analysis methods in ESRI ArcGIS 10.2 to identify and rank RTA hotspots using historical RTA data on a section of a road in Brunei Darussalam as a case study.

During accident data analysis one of the important step is to get a spatial data for further use in future geometric improvements. I found a research (Nilesh Deshpande et al.,2011) on the concern, regarding road safety in a developing country like India, further amplifies in absence of proper framework to analyse the accident related data using modern tools & techniques, especially in semi-urban or rural setting. The model derived in this paper tries to utilize the data available through old records, by extracting factual & relevant information. This model analyses the data based on various parameters such as location of accident, severity, date and time of accident and some demographic parameters like population, educational institutions etc. Different methods of statistical & spatial analysis, such as Kernel density estimation and spatial autocorrelation, are being compared so as to determine the most appropriate way to analyse the acquired data. Geographical Information System (GIS) is being used as a tool for statistical analysis. The analytical process determines the statistically significant areas, which require urgent attention corresponding to the relevant parameters. Suggested areas are to be further investigated and recommendations can be made accordingly. The study was conducted for Pilani town & surrounding areas. With appropriate modifications, this system can be further applied over larger geographical extents, for better management & analysis of accident related data, for achieving better road safety.

IV. RESEARCH METHODOLOGY

Steps followed to carry out this study are listed below:

1) Analysed two Metro Rail Corridors covering major parts of the city, which are passing through densely populated areas and heavy traffic routes.
2) Total 5 At-Grade intersections (renamed as J1, J2, J3, J4 & J5) are considered for this study based on intersection type, Landuse, Metro infrastructure impact and accident statistics etc.; Junction J1, J2 and J3 are from metro corridor-I and J4 & J5 are from corridor-II.
3) The checklist are prepared for At-Grade intersections based on IRC standards, and by following the guidelines from the 'Manual for Safer Road Design' developed for MoRTH
4) Below steps should be followed to evaluate the Level of Service (LOS) for At-Grade intersersections using checklists prepared in the point no. 3 are explained below:

In first step, marking (1 Mark for OK, 0 for NOT OK) should be entered in the checklist as shown in Fig -1 for all the subsections. Subtotal and total marks should be counted for each facility.

				Junction ==>	J1		J2		J3		J4		J5	
				Location (Lat /Long) ==>	18.62973, 73.80247		18.62605, 73.80561		18.58518, 73.83330		18.50688, 73.80280		18.52255, 73.85315	
				Junction Local Name ==>	Finolex Chowk		Ambedkar Chowk		Bhai Kotwal Chowk		Vanaz CNG chowk		PMC Chowk	
Step: I		Safety Audit Parameters for At-Grade Intersections (Give 1 mark for each parameter)			'1' Mark for OK '0' for NOT OK									
					1	0	1	0	1	0	1	0	1	0
	1	Junction Design Checks	Item											
	A	Lane width (Assuming lane marking are provided)	3.5 m per lane/as per IRC Standards		1		1		1		1		1	
	B	Two way road carriageway	Divided with median / lane marking		1		1		1		1		1	
	C	Minimum height-median	100- 150 mm		1		1		1			0		0
	D	Stop lines & Yield Lines	Not <2m and not >3 m from the edge of the junction		1		1		1		1		1	

Fig -1: Marking Sample Format

In second step, total marks for each facility should be calculated under '1' column and this value should be entered under marks obtained (b) column for each intersection as shown in TABLE I.

TABLE I
MARKS OBTAINED FOR EACH INTERSECTION

Sr. No.	Component/ Facility	Total Marks (a)	Marks Obtained (b)				
			J1	J2	J3	J4	J5
1	Junction Design Checks	12	10	10	8	7	8
2	Pedestrian friendly	19	16	14	11	13	10
3	Bicycle friendly	2	1	1	1	1	1
4	Public Transport	1	1	1	1	1	1
5	Parking	1	0.5	0.5	0.5	0	0.5
6	Metro Infra Impact	5	4	3	3	2	2
	Total	40					

In third step : Percentage achieved should be calculated for all the facilities for each intersection and filled in the TABLE II format.

TABLE II
PERCENTAGE (%) ACHIEVED FOR EACH INTERSECTION

Sr. No.	Component/ Facility	% Achieved c= (b/a)x100				
		J1	J2	J3	J4	J5
1	Junction Design Checks	83	83	67	58	67
2	Pedestrian friendly	84	74	58	68	53
3	Bicycle friendly	50	50	50	50	50
4	Public Transport	100	100	100	100	100
5	Parking	50	50	50	40	50
6	Metro Infra Impact	80	60	60	40	40

In fourth step : Based on Percentage achieved (c) in TABLE II, Level of Service is summarised in the TABLE III,
LOS range is given below :
LOS A More than 80%
LOS B Between 80% - 70%
LOS C Between 70% - 60%
LOS D Between 60% - 50%
LOS E Between 50% - 40%
LOS F Less than 40%

TABLE III
LEVEL OF SERVICE FOR INTERSECTIONS

Sr. No.	Component/ Facility	Level of Service (LOS) (d)				
		J1	J2	J3	J4	J5
1	Junction Design Checks	LOS A	LOS A	LOS C	LOS D	LOS C
2	Pedestrian friendly	LOS A	LOS B	LOS D	LOS C	LOS D
3	Bicycle friendly	LOS E	LOS E	LOS E	LOS E	LOS E
4	Public Transport	LOS A	LOS A	LOS A	LOS A	LOS A
5	Parking	LOS E	LOS E	LOS E	LOS F	LOS E
6	Metro Infra Impact	LOS B	LOS D	LOS D	LOS F	LOS F

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V. CONCLUSIONS

The study concludes that, in India there is no significant policy by government to no road accidents in urban areas. Currently In Indian cities, Infrastructure developement is in full swing. The newly developed infrastructure and existing facilities should undergo safety analysis to safegaurd the urbanites.

A method to analyse safety measures and evaluating Level of Service (LOS) of At-Grade intersections gives a good iterpreatetion about existing condition of the road infrastructure facilities and impact of metro corridors on it. This study helps to understand the exisiting situation and gives overall idea about At-Grade intersection functionality based on LOS, to concerned stakeholders. Level of Services (LOS) of At-Grade intersections can be evaluated at any stage of the project based on requirements.

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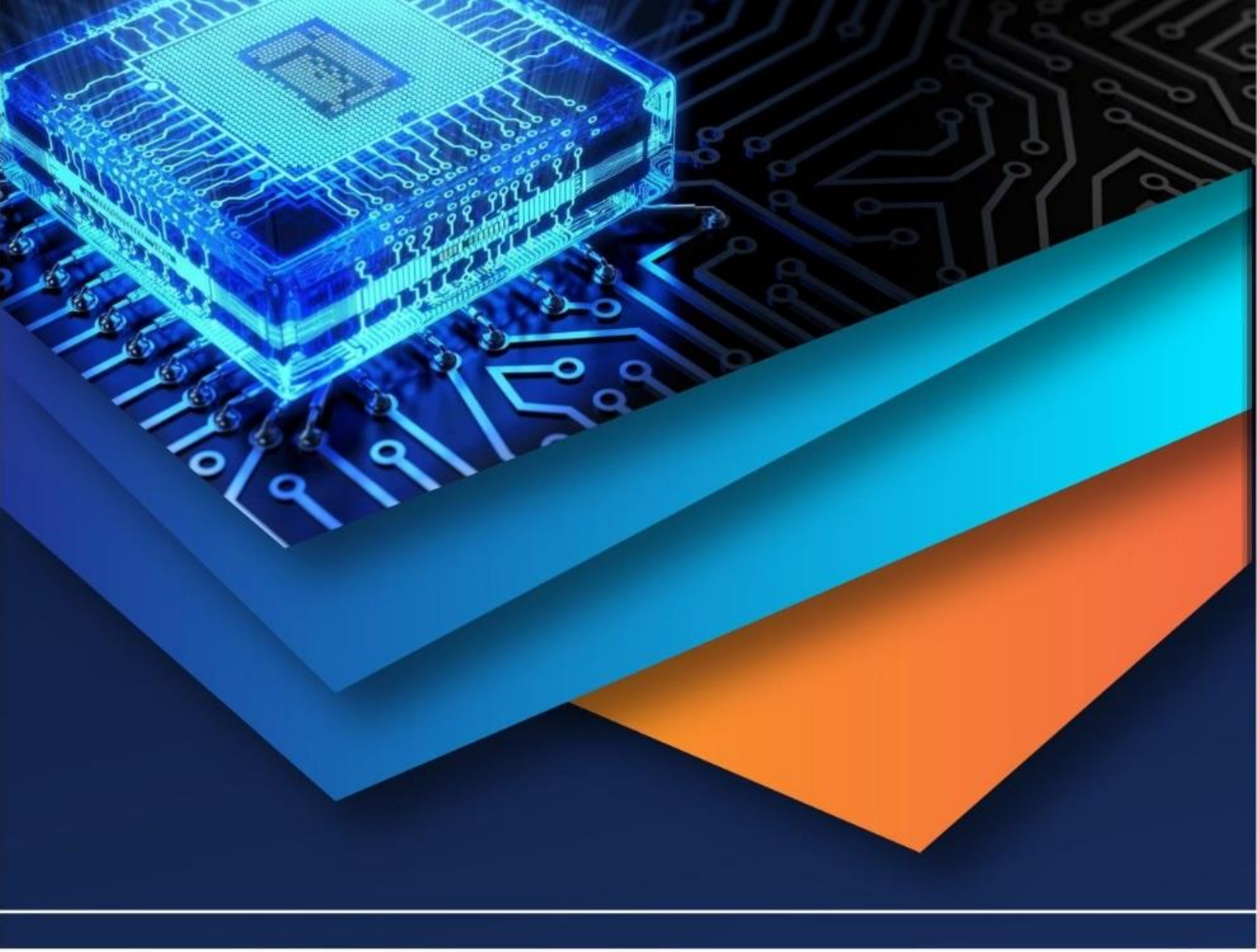

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