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ROAD ACCIDENT SEVERITY ANALYSIS FOR HYDERABAD CITY

S. Ghanshyam Singh[1], T. Saikrishna Bharadwaj[2], Mohammad Ibrahim [3], Arumulla Raju[4]

[1]Assistant Professor of Civil Engineering,CMR Institute of Technology, Hyderabad, Telangana, (India)
[2]PG Student, Dept. of Civil Engineering, Mallareddy Institute of Technology and Science, Hyderabad, Telangana, (India)
[3,4] PG Student, Dept. of Civil Engineering, University College of Engineering Osmania University, Hyderabad, Telangana, (India)

ABSTRACT

Understanding the underlying relationship between the crash injury severity and factors such as driver's characteristics, vehicle type and roadway conditions are very important for improving traffic safety. Many transportation agencies use accident frequencies, and statistical models of accident frequencies, as a basis for prioritizing highway safety improvements. However, the use of accident severities in safety programming has often been limited to the vocational assessment of accident fatalities, with little or no emphasis being placed on the full severity distribution of accidents (property damage only, possible injury) which is needed to fully assess the benefits of competing safety-improvement projects.

In the thesis we demonstrate a modeling approach that can be used to better understand the injury-severity distributions of accidents on highway segments, and the effect that traffic characteristics. The approach we use allows for the possibility that estimated model parameters can vary randomly across road segments to account for unobserved effects potentially relating to roadway characteristics, environmental factors, and driver behavior. Using severity data for Hyderabad city, a mixed logit model is estimated.

Estimation findings indicate that volume-related variables, while roadway characteristics such as the number of horizontal curves, number of grade breaks per km and pavement friction are best modeled for severity as fixed parameters. It was observed that rear end and swipe is significant for non-fatal accidents. Our results show that the mixed logit model has considerable promise as a methodological tool in accident analysis.

I. INTRODUCTION

India is undergoing major economic and demographic transition coupled with increasing urbanization and motorization. Among the top ten causes of mortality in the country, Road Traffic Accident was the tenth cause two decades back, but with the increasing urban expanse and lifestyle changes, it is projected that road traffic accidents will occupy the fifth position in the list of major killers and third position among causes of disease burden in 2020.In India, 11% of deaths due to non communicable diseases are due to injuries and 78% of injury

deaths are due to road traffic accidents. It is the leading cause of mortality for young adults of less than 45 years and a major burden of disease across all age groups.

Many metropolitan cities, including Hyderabad, India increase number of road accidents is imposing considerable social and economic burdens on the victims, and various direct and indirect costs. Road accidents are essentially caused by improper interactions between vehicles, and other road users or roadway features. The situation that leads to improper interactions could be the result of the complex interplay of a number of factors such as pavement characteristics, geometric features, traffic characteristics, road users, behavior, vehicle design, driver's characteristics and environmental aspects. Thus, the whole system of accident occurrence is a complex phenomenon.

1.1 Need for the study

In India, the traffic is highly heterogeneous in nature, ranging from pedestrians, animal drawn carts, cycle rickshaw, handcarts, to motorized vehicles, like motor cycles, three wheelers, motor cars, buses, trucks, multi axle as well as over sized vehicles. Analysis of traffic data indicated that drivers fault is responsible for a majority of the accidents and fatalities; where as human factor is a major contributor to the accidents As per recorded data in year 2011, about 49254 accidents have occurred and 17325 persons were killed in Andhra Pradesh state. In Hyderabad, approximately 9000 no of accidents occurred in the year 2011. On average, more than 2300 people are killed and about 6854 injured in traffic accidents annually. Hyderabad fatality rate has consistently been within the highest range in the nation in the last decade(sixth rank).

1.2 Objective of study

a. Identify and quantify the main contributing factors to the severity of road accidents in Hyderabad including human and roadway and environmental factors.
b. Identify policies and countermeasures to the major safety factor problems in Hyderabad.
c. Estimate the safety benefit of implementing proposed policies and countermeasures.

II. LITERATURE REVIEW

a) Timothy R. NeumanC. Glennon (TRR 923) have developed linear regression equation for the analysis for highway curves. They have found that the accident rate increases as the degree of curvature increases and decreases as the length of the curve shoulder width, and road width increases.

b) Kadiyali.L.R etal., (1984) developed an accident model based on population and motor vehicle by using regression technique. The collected accident data for 20 years (1960-1980), population and number of motor vehicles India. Based on the past trend a regression equation is developed based on number of deaths per 10,000 vehicles (D) and number of motor vehicles per 1000 population (V) and is follows

i. $D=91.5147V^{-0.2475}$

Where, D= number of deaths per 10000 vehicles

V= number of vehicles per 1000 population.

Assuming that the lane width, shoulder width and shoulder type have significant affect on safety.

c) Charles V. Zegeer and John A. Deacon (1992) developed a model. The research quantifies the effect of lane width, shoulder width and shoulder type on highway crash experience. The model, which is applicable to two-lane, rural highways is as follows:

$AR = 4.1501\ (0.8907)^{L}\ (0.9562)^{S}\ (1.0026)^{LS}\ (0.9403)^{P}\ (1.0040)^{LP}$ Where,

AR = number of Run-off-Road and Opposite Direction accidents per million vehicle miles

L = lane width in feet

S = shoulder width in feet (including stabilized and unstabilized components)

P = width in feet of stabilized component of shoulder ($0 \leq P \leq S$).

d) Matthew G. Karlaftis and Ioannis Golias (2002) have developed a relationship between rural road geometric characteristics, accident rates and their prediction, using a rigorous non-parametric statistical methodology known as hierarchical tree-based regression.

e) Srinivas Rao and Madhu (2005) laid emphasis on accident studies conducted national highway-5 from Anakapalli to Vishakhapatnam stretch of nearly 40km. From their studies they found that most of the accident on this stretch was due to the inadequate sign boards to guide the road user to perceive the situation and act upon it.

f) Dahee Hong etal (2005) have developed a regression modal for two lane and is given by

i. $Y=0.174+1.164*X1+0.835X2$ Where,

Y: Number of Accident (accident/km), X1: Number of Intersections (unit/km)

X2: Number of Pedestrian Traffic Signals (unit/km).for this the R square value is 0.746.

g) Archana (2008) submitted her desertion work by conducting studies at kerala and showed the percentage of vehicles vs. number of years, number of years vs number of accidents and timely variation of accidents.

h) Kishore Babu (2009) conducted studies on NH7 from nizamabab to Mahbubnagar. From his studies he forum that more number of accidents occur near village. Due to the inadequate signs and markings. Numbers of accidents occur near minor road junctions.

III. METHODOLOGY

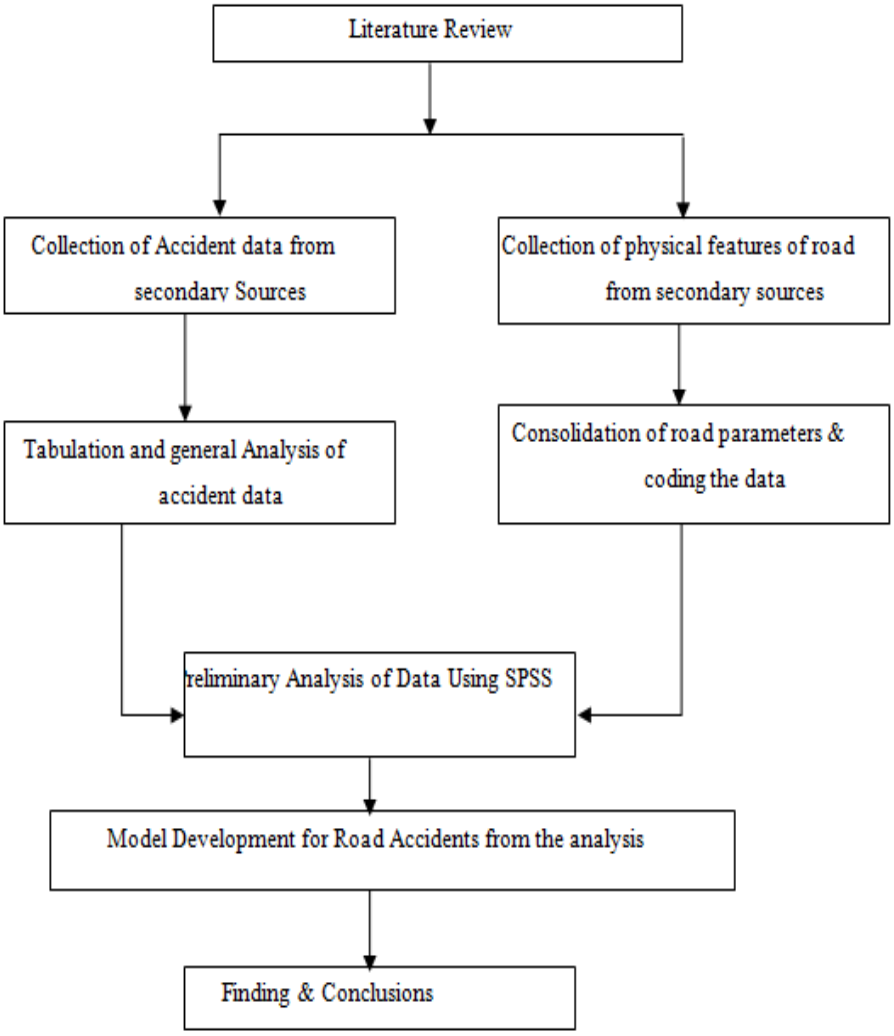

Figure 1 Methodology Adopted for the Study

IV. DATA COLLECTION

4.1 Study Area Description

The accident data was collected by Hyderabad city from the records kept by the state police department for five year period and also from Accident Deaths and Suicides in India 2011, published by the National Crime Records Bureau, Ministry of Home Affairs, Government of India, and New Delhi. Further accident data for north, east, west, south and central zones were collected for five year period from the respective police department of all zones. The accident data details collected include time, number of vehicles involved, severity, hourly & pedestrian involvement etc. The zonal description and the police station limits are obtained thorough of TS police. The population details are also collected. Figure …. Shows study area and its zone limits

Figure 2 Police Zones Limits of Hyderabad city

4.2 Accident data

It was assumed that knowledge of the circumstances and severity of accidents would be essential in their modeling since the causes of, and countermeasures to help prevent, different accident types may be very different. For example, causes and countermeasures for a slight pedestrian accident would certainly be different to a major head-on vehicle accident. The following data were therefore identified and proposed for collection from files at individual police stations.

1. Zone and Place
2. Time of day of collision and Day, Month and year
3. Overall accident severity (classified as that of the Fatal, Non Fatal & Serious)
4. Number and types of vehicles involved and Number, severity (fatal, non fatal & serious)
5. Vehicle type in which (or by which) the casualty was injured
6. Collision pattern: vehicle man oeuvres prior to crash: text and diagram. This is especially important for junction accidents. Sketches were to be encouraged and collected separately if the appropriate movements could not be entered into a spreadsheet as compass directions for example. Collision type (e.g. head on, rear-end, swipe etc.)

4.3 Road environment inventory/survey data

The nature of the road environment is known to have a major influence on the occurrence of accidents. The starting point for the collection of road feature data was to produce lists of various parameters which had been found to have a significant influence on road safety from existing research. These studies have been summarized in the literature review in Appendix A. Although a large number of variables can be collected during a physical survey of the road and it is desirable to measure as many variables as possible, this must be balanced against what is practical and feasible given time and budgetary constraints. From the significant variables highlighted in the literature review, a consideration of how variables are collated, the following data were identified for collection: -

1. Road reference and Carriageway surface condition

2. Median type, presence of gaps in the median and the nature (type, width, condition) of the shoulder.
3. Number of lanes and their widths and Whether or not curves are super-elevated
4. The presence of a slick surface and quality of a footpath
5. The presence , quality of road signs and road markings
6. The degree of side friction imposed by pedestrians, shop fronts, parked vehicles, bus stops on passing traffic and The nature of the off-road environment (embankment or flat; rural or urban; residential or industrial; drains, barriers or kerbs; etc)

4.4 Accident Data Collection from Secondary Sources

In India, police men are responsible for recording road accidents. The accident data was collected from concern police stations. Data consisting details of accidents for five zones of Hyderabad city from year 2001 to 2011are collected. Accident details includes date, day of occurrence, time of accident, type of area, nature of accident, vehicles involved, classification of accident, number of deaths, number of injured, type of maneuver, responsibility of driver, cause of accident etc. Table 1 indicates the road accident data for Hyderabad City.

Table 1 Road Accident Data for Hyderabad City

Year	Population (P)	Vehicles (N)	Fatalities (F)	Injuries (I)	Total Accidents (C)
2001	3829753	930841	720	1950	2670
2002	4251025	995999	805	2515	3320
2003	4718639	1070700	902	2918	3820
2004	5284875	1151002	989	3481	4470
2005	5813834	1243082	1020	3950	4970
2006	6453356	1345015	1295	4295	5590
2007	7163225	1459341	1540	4700	6240
2008	7951180	1600120	1790	5076	6866
2009	8915692	1634600	1937	5523	7780
2010	9021481	1742834	2189	6289	7998
2011	10056160	1792139	2371	6854	8962

V. RESULTS & ANALYSIS

5.1 Accident Data Analysis for Hyderabad City

5.1.1 Yearly Variation of Accidents During 2009 to 2011

Total numbers of accidents registered in various zones of Hyderabad city police station wise are represented in Table 5.1. The total distance covered is 650sq.kilometers. A total 6649 accidents were recorded during 2009 to 2011, in these 85 were fatal accidents and 6537 were non-fatal accidents. More number of accidents occurred in west zone of police station region than remaining police station regions. The police station wise distributions of accidents are presented in table 2.

Table2: Police station wise accidents occurred

Police Station Limits Zone wise	2009		2010		2011		Total
	F	NF	F	NF	F	NF	
Central Zone	5	39	6	568	6	534	1114
North Zone	6	118	6	446	19	511	1106
East Zone	3	49	6	558	6	474	1096
West Zone	3	73	8	745	6	779	1614
South Zone	1	29	1	326	2	339	698
Hyderabad Total	**18**	**308**	**27**	**2643**	**39**	**2637**	**5672**

5.1.3 Nature of Accident Occurred

The rear end collision and head on collision are more due to misjudgment of speeds between following and opposing vehicles, as show in Table 3 and presented graphically in Figure: 3

Table 3: Nature of accidents occurred

NATURE OF ACCIDENT	NO.OF ACCIDENTS
Head on collision	852
Rear end collision	542
Swipe collision	107

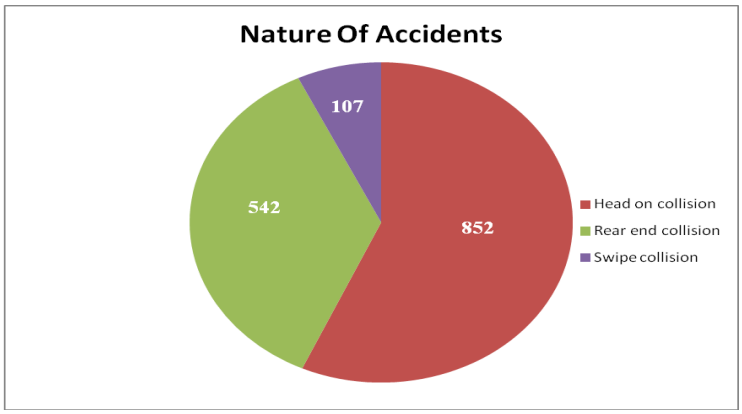

Figure 3 Composition of Nature of Accidents

5.1.4 Time Wise Distribution of Accidents

The time of occurrence of accidents is categorized into hourly blocks indicating that the accidents are distributed throughout the day. It is seen that the accidents occurred during day and night are in equal proportion. From Table 4 it is observed that accidents are occurring during 19:00 to 20:00 and 16:00 to 17:00 hours and presented graphically in Figure 4

Table 4: Time wise distribution of accidents

HOUR OF THE DAY	NO OF ACCIDENTS	HOUR OF THE DAY	NO OF ACCIDENTS
0:00- 1:00	27	12:00-13:00	84
01:00 - 2:00	65	13:00-14:00	98
2:00- 3:00	57	14:00-15:00	79
3:00-4:00	71	15:00-16:00	96
04:00 - 5:00	62	16:00-17:00	**127**
5:00-6:00	70	17:00-18:00	120
6:00-7:00	92	18:00-19:00	107
7:00-8:00	71	19:00-20:00	**137**
8:00-9:00	87	20:00-21:00	108
9:00-10:00	88	21:00-22:00	72
10:00-11:00	100	22:00:00-23:00	74
11:00-12:00	81	23:00-24:00	75

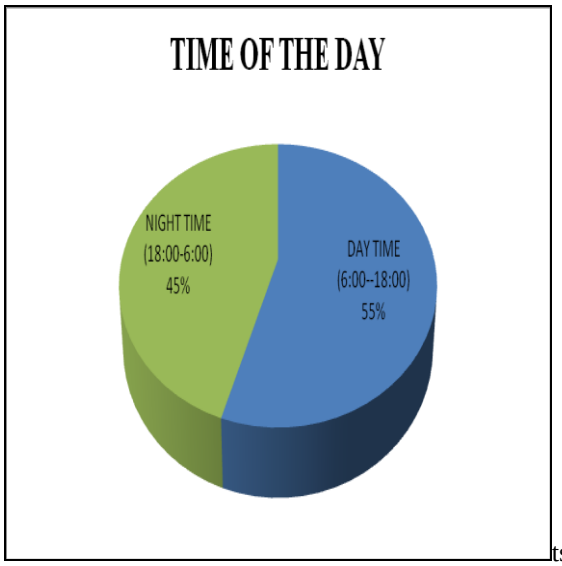

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Figure 4 Time wise distribution of accident

5.2 Analysis of Road Accidents Using SPSS

5.2.1 Analysis for type of collision

The logistic Regression is used for development of models based on severity which is given by

$$y = \frac{e^{\beta_0 + \beta_1 x_1}}{1 + e^{\beta_0 + \beta_1 x_1}}$$

Where y = Dependent Variable

x = Odd against even Fatal and Non Fatal

a) Head on collision:-

Odd ratio is determined where n11, n12, n21 & n22 are……..

$n_{11} = 2$; $n_{12} = 101$; $n_{21} = 85$; $n_{22} = 5395$

Odds ratio = $n_{11} \times n_{22} = 2 \times 5395 = 10.790 = 1.256$

$= n_{12} \times n_{21} = 85 \times 101 \quad 8585$

Odds ratio = exp (β_1) where exp (β_1) = 1.256

$\beta_1 = \log (1.256) = 0.09928$

Confidence Interval = Exp $\{\beta_1\}$ $\pm Z_1 - \delta$ x SE (β_1)

SE $(\beta_1) = \sqrt{\frac{1}{n_{11}} + \frac{1}{n_{12}} + \frac{1}{n_{21}} + \frac{1}{n_{22}}}$

$= \sqrt{\frac{1}{2} + \frac{1}{101} + \frac{1}{85} + \frac{1}{5395}} = 0.7223$

Confidence Interval = exp $\{\beta_1\} \pm Z_1 - \delta$ x SE (β_1)

= exp {(0.0928) ± (1.96) x (0.7223)}

= exp {(0.09928) ± (1.415708)}

= exp {1.514, -1.3166428}

= (4.549366, 0.268091215)

The Odds Ratio between Head on accident and Severity of the accident is computed and found to be 1.256 which indicates that the Odds against even is around 100 percent Severity. We have also computed the Confidence internal of Severity of accident and found that the interval is (4.54, 0.268) indicating that the confidence interval values is skewed towards right side the normal curve.

b) Rear end collision type:-

$n_{11} = 81$; $n_{1\,2} = 5357$; $n_{21} = 6$; $n_{22} = 139$

Odds ratio = n_{11} x n_{22} = 81 x139 = 0.35012

= n_{12} x n_{21}= 5357 x6

Odds ratio = exp (β_1) where exp $(\beta_1) = 0.35012$

β_1 = log (0.35012) = - 0.455

Confidence Interval = Exp $\{\beta_1\}$ $\pm Z_1 - \delta$ x SE (β_1)

SE $(\beta_1) = \sqrt{\frac{1}{n_{11}} + \frac{1}{n_{12}} + \frac{1}{n_{21}} + \frac{1}{n_{22}}}$

$= \sqrt{\frac{1}{81} + \frac{1}{5357} + \frac{1}{6} + \frac{1}{139}} = 0.43$

Confidence Interval =exp $\{\beta_1\} \pm Z_1 - \delta$ x SE (β_1)

= exp {(-0.455) ± (1.96) x (0.43)}

= exp { (0.09928) ± (0.8428)}

= exp {0.3878, -1.2978}

= (1.473, 0.2789)

From the above analysis of Rear end Severity it is observed that accidents are very less in occurrence with an Odds Ratio (-0.455). This is observed in during 2009-2011. Also with respect to Confidence Interval (CI) the distribution is not much skewed.

c) Swipe end collision type

$n_{11} = 4$; $n_{1\,2} = 38$; $n_{21} = 83$; $n_{22} = 5458$

odds ratio = n_{11} x n_{22} = 4 x 5458 = 6.92

$= n_{12}$ x $n_{21} = 38 \times 83$

Odds ratio = exp (β_1) where exp (β_1) = 6.92

β_1 = log (6.92) = 0.840

Confidence Interval = Exp {β_1} ± $Z_1 - \delta$ x SE (β_1)

$$SE(\beta_1) = \sqrt{\frac{1}{n_{11}} + \frac{1}{n_{12}} + \frac{1}{n_{21}} + \frac{1}{n_{22}}}$$

$$= \sqrt{\frac{1}{4} + \frac{1}{38} + \frac{1}{83} + \frac{1}{5458}} = 0.537$$

Confidence Interval = exp {β_1} ± $Z_1 - \delta$ x SE (β_1)

= exp {(0.840) ± (1.96) x (0.537)}

= exp { (0.840) ± (1.052)}

= exp {1.892, -0.212}

= (6.632, 0.8089)

From the above calculations it is observed that the Severity of Swipe end accidents is assumed 84 percent during 2009-2011 indicating there are good amount of Swipe end accidents taken place. With respect to the Confidence Interval (CI) the Swipe end accidents are skewed towards right side of the normal curve.A Cross Tabulation between Severity of accident and the type of collision is shown in table 5 and its chi-square test results are shown in table 6

Table 5 Cross tabulation between Severity & Types of Collision

			Severity		Total
			Fatal	non fatal	
Head on	yes	Count	2	101	103
		Expected Count	1.6	101.4	103
	no	Count	85	5395	5480
		Expected Count	85.4	5394.6	5480
Total		Count	87	5496	5583
		Expected Count	87.0	5496.0	5583

			Severity		Total
			fatal	non fatal	
Rear end	yes	Count	81	5357	5438
		Expected Count	84.7	5353.3	5438
	no	Count	6	139	145
		Expected Count	2.3	142.7	145
Total		Count	87	5496	5583
		Expected Count	87.0	5496.0	5583

			Severity		Total
			fatal	non fatal	
Swipe	yes	Count	4	38	42
		Expected Count	.7	41.3	42
	no	Count	83	5458	5541
		Expected Count	86.3	5454.7	5541
Total		Count	87	5496	5583
		Expected Count	87.0	5496.0	5583

Table 6 Pearson Chi-Square Tests Results for severity & type of collision

Type of Collision	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Head on Severity	.101[a]	1	.751	Not significant	
Rear end on Severity	6.458[a]	1	.11	Significant	
Swipe on Severity	17.504[a]	1	.000	Significant	

VI. CONCLUSIONS

The following conclusions can be drawn based on the present data

- It is observed that among all categories of vehicles, buses comprised the single highest number of involvement in accidents. This suggests that some more studies should be undertaken in the future to investigate the possible causes of involvement of buses in accidents in order to find appropriate remedial measures. This would in turn help to improve the overall road safety situation in Hyderabad City
- More number of accidents is occurred in central zone compare to the other four zones.
- Heavy vehicles and were major cause of accidents.
- Inadequate shoulder width forcing the heavy vehicles to come on to the carriage way there by conflicting with the traffic.
- More number of non fatal accidents are occurred in the city because of reduction in the journey speed.
- Most of accidents occurred during day time.
- More number of accidents occurred due to the driver's fault
- Highest numbers of accidents have occurred Arterial roads.
- Swipe & Rear end accidents are more significant for non fatal accidents occurrence in the city.
- Swipe end, Rear end and Head on collision is evaluated using the logistic regression. Odds against Fatal to Non Fatal were evaluated and found those rear end swipes are significant for non fatal accidents.

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