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Traffic Volume Studies and Congestion Solutions of Urban Road in Junagadh City

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Abstract: ***Urbanization is a defining feature of modern civilization, with cities rapidly evolving into hubs of economic, social, and cultural activities. As the developing cities continue to grow in population, the efficient movement of people and goods becomes a critical challenge due to the increasing amount of vehicle. One of the central aspects influencing urban mobility is the traffic volume on road sections. As the population continues to grow, the volume density of traffic on roads also increases. This analytical paper aims to explore the problems faced by various road users, including vehicle users, pedestrians, and other users, due to the rise in traffic volume density. The study highlights the challenges associated with increased traffic, such as congestion, longer travel times, safety concerns, and environmental impacts. By understanding these issues, policymakers and transportation authorities can develop effective strategies to mitigate the negative consequences of increased traffic volume density.***

In this project, traffic on the urban road between two intersections at both ends of MG Road in Junagadh city is studied. Owing to the continuous growth of population, growth in number of vehicles and concentrated development of the city resulted into traffic congestion which calls for the demand of remedial measures especially in between the intersections which is not managed and control appropriately and thus resulting in decreased facilities to moving vehicles and pedestrian. Due to the lack of land, adding more lanes or constructing a grade separator to improving the traffic flow or increase capacity is not an easy task. However, efficient use of existing resources for the remedial measures which doesn't cost much could be a proper solution to overcome congestion issue

Keywords: Traffic congestion, Urban Road, Traffic volume studies, Congestion Solution, Population, Road Junction

I. INTRODUCTION

The essence of the importance of transportation is encapsulated in the statement that mobility is guiding civilization toward a more optimistic future. Presently, transportation stands out as one of the most pressing issues on a global scale. Each country addresses transportation challenges uniquely, tailoring solutions to its specific needs and capacities. When developing architectural plans, it is crucial to determine the loads exerted on the structure to calculate the necessary reinforcement for ensuring the secure functioning of the building. In transportation, volume plays a crucial role. Whether you're planning, designing, or operating a transportation system, knowing the volume is essential. Volume refers to the number of vehicles passing a particular part of a road. However, expressing this as a simple count per unit time becomes problematic when dealing with diverse vehicle types with different characteristics. To address this, traffic volume is often measured in terms of Passenger Car Units (PCU) per hour, where different vehicles are converted into equivalent passenger cars.

Handling traffic with various vehicle types interacting on the road can be quite complicated. Moreover, traffic volume is not constant; it changes over time. To keep the transportation system running smoothly, it's crucial to continuously calculate and monitor the volume. If this data is not consistently available, the transportation system could face challenges, potentially causing difficulties for the country's economy.

II. PROBLEM STATEMENT

The population of Junagadh city is 4.39 lakh as per the 2023 updated data. The population has grown from 3.19 lakh in 2011 to 4.39 lakh by the year 2023. Due to urbanization, vehicular ownership is growing very rapidly in Junagadh city. In Junagadh city scenario of vehicular growth is presented in table below.

Also due to poor public transportation system more use of private vehicles by people. There are various factors which creates congestion on the road like, mixed vehicle types, road condition, insufficient road capacity, weather condition, inefficient traffic management, inadequate public transportation, Lack of Alternative Modes of Transportation etc.

The problem of traffic congestion is one of the most significant in modern city. So, it is necessary to take steps to reduce the problem of congestion and to provide effective solutions.

A. Scope of study

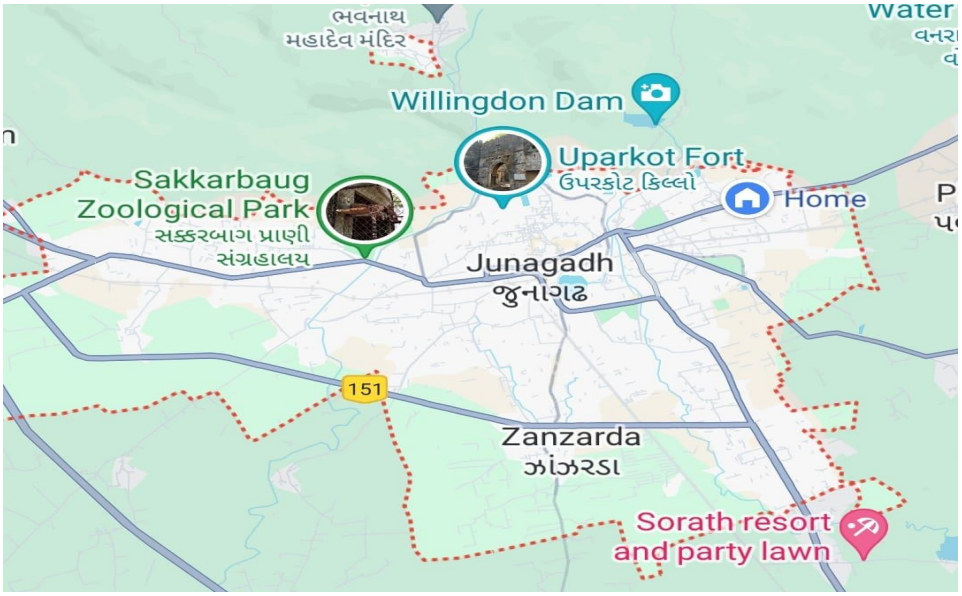
The aspects of vehicular flows include their volume, types, and the distribution of traffic over time and directions. The volume of traffic, or magnitude, is determined by how many vehicles are present. Vehicles are categorized based on their size and capacity. On a two-way road, we count the vehicles moving in each direction separately to understand the proportion. Analysing the time and directional split helps identify patterns like tidal flow.The distribution of vehicles in the traffic flow. The proportion of vehicles reveals whether public or private transportation is more prevalent in the traffic system. It also reflects the preferences of road usersChanges in the flow of traffic on various approaches at a junction or different segments of a road network system.Variations in vehicular flows across hourly, daily, yearly, and seasonal intervals. Understanding these fluctuations is essential for determining expansion factors for future planning. By utilizing these expansion factors, the Annual Average Daily Traffic (AADT) can be calculated based on a short count.

B. Objective of study

To conduct a thorough study of traffic volume patterns on a selected urban road section..Quantifying the traffic volume on the chosen road section..Analyzing congestion patterns and identifying bottlenecks.To identify the key factors contributing to congestion in the chosen road section..Proposing contextually relevant congestion mitigation strategies.To propose effective and practical solutions for mitigating congestion and improving traffic flow.

III. STUDY AREA DETAILS

Junagadh District is one of the 33 districts in the State of Gujarat, India. Positioned in the western part of Gujarat within the region known as Saurashtra, Junagadh was historically one of several princely states in the Saurashtra region before India gained independence in 1947.The total area of Junagadh city spans 160 square kilometres, spanning from : 21°31′19.9″N to 70°27′28.4″E with a population density of 2000 individuals per square kilometer.As of the 2011 census, Junagadh municipality had a population of 319,462. Over the span of a decade from 2001 to 2011, the population of Junagadh district experienced a growth of 9.87 percent.



Junagadh City Map

PARTICULARS		UNIT	PERSONS		MALE		FEMALE	
POPULATION	YEAR		2001	2011	2001	2011	2001	2011
GUJARAT		NO	5,06,71,017	6,04,39,692	26385577	31491260	24285440	28948432
JUNAGADH		NO	1388498	1525605	713175	784330	675323	741275

The population of Junagadh city is 3.19 lakh as per the 2011 census data. The population has grown from 2.23 lakh in 2001 to 4.39 lakh by the year 2023.

IV. DATA COLLECTION

The purpose of this survey is to comprehend the traffic dynamics, including average daily traffic, traffic composition, peak hour traffic, and directional split at specific survey locations. This survey is undertaken for various types of highway projects to gain insights into the diversity of vehicles passing through.

There is variety of vehicles are in the existence in urban areas of India. There is major two types of transport vehicles visible on Indian roads which are

1) Motorized Vehicles

These are the vehicles which runs with any mechanical arrangement inside the vehicle. There may be patrol, diesel or any other type of electric engines which provides the power to the vehicle to move from one place to another one.

Motorized transport includes vehicles like:

- 2 wheelers scooters and mopeds
- 3 wheelers rickshaws and other 3ws
- 4 wheelers cars
- Light commercial vehicles
- High commercial vehicles
- Buses

2) Non-Motorized Vehicles

These types of vehicles are normally hand drawn type of vehicles or pulled or pushed by any animals like camels, bullocks, etc. or driven by user but not containing external power for movement like bicycles.

A. Data Collection Method

Before going for the actual work, we have conducted a reconnaissance survey on the previous day of actual work. We decided to do Direct survey of Manual Counting Method with the help of 'Traffic Volume Count Mobile Application'. We visited the section of study and divided two groups at both ends of the road and four groups at selected junctions in between both ends of the road. We have conducted the survey of peak hours for the four days (24-Feb-2024 to 27-Feb-2024) including Saturday, Sunday, Monday and Tuesday of the week for better understanding of the volume of vehicles.

Then we took the average of the collected 4 days data in 15 min spans to find out the actual vehicle compositions of different vehicle types to define equivalent PCU factors.

B. Passenger Car Unit

A Passenger Car Unit (PCU) is a standard measure used in transportation engineering to represent the traffic flow and capacity of a road network. It serves as a way to express the varying effects of different types of vehicles on traffic congestion. The PCU is typically defined as an equivalent unit of passenger car size and traffic flow characteristics.

In simpler terms, it allows for the standardization of diverse vehicles based on their impact on traffic. For instance, a larger or slower-moving vehicle may be assigned a higher PCU value than a smaller or faster-moving passenger car. This unit simplifies the analysis and planning of road systems by treating all vehicles in terms of their equivalent impact on traffic flow, helping in the evaluation of road capacities and congestion levels.

Table I. Traffic Data at Kalva Chowk section

AVERAGE									AVERAGE								
Kalva chowk to Azad chowk (IN)									Kalva Chowk to Azad chowk (OUT)								
MG ROAD	VEHICLES							TOTAL	MG ROAD	VEHICLES							TOTAL
TIME		2W	3W	CAR	BICYCLE	LCV	Bus	VEHICLE	TIME		2W	3W	CAR	CYCLE	LCV	Bus	VEHICLE
9:00-9:15	AM	250	65	9	2	0	0	325	9:00-9:15	AM	187	72	9	4	0	0	271
9:15-9:30		215	73	11	6	2	1	307	9:15-9:30		207	77	11	7	2	0	302
9:30-9:45		253	72	8	4	0	1	338	9:30-9:45		224	74	8	2	0	1	308
9:45 - 10:00		272	54	15	3	1	0	344	9:45 - 10:00		247	68	15	1	1	1	331
10:00-10:15		290	76	13	10	0	1	390	10:00-10:15		203	105	12	1	2	1	322
10:15-10:30		313	88	15	1	1	1	417	10:15-10:30		211	82	16	3	1	1	314
10:30-10:45		267	87	17	3	0	1	375	10:30-10:45		262	108	13	5	1	1	389
10:45-11:00		299	90	19	4	1	0	413	10:45-11:00		261	114	19	1	1	0	394
11:00-11:15		298	82	9	5	2	1	395	11:00-11:15		254	107	13	0	2	1	376
11:15-11-30		309	77	18	7	0	0	411	11:15-11-30		322	98	13	7	1	0	439
11-30-11-45		342	89	17	3	1	1	452	11-30-11-45		276	104	12	2	3	1	397
11:45-12:00	PM	324	96	16	6	0	1	442	11:45-12:00	PM	326	82	18	2	0	1	429
12:00-12:15		329	80	16	7	2	1	433	12:00-12:15		320	108	17	1	1	0	447
12:15-12:30		263	44	11	4	0	1	323	12:15-12:30		347	82	9	7	2	1	447
12:30-12:45		372	75	15	6	0	1	469	12:30-12:45		340	91	13	0	0	1	445
12:45-1:00		228	45	17	3	4	1	298	12:45-1:00		283	84	8	1	5	1	381
4:00-4:15		171	52	15	6	1	1	245	4:00-4:15		116	63	34	4	0	1	217
4:15-4:30		198	64	13	5	0	0	280	4:15-4:30		177	79	30	2	0	1	288
4:30-4:45		211	83	17	2	1	1	314	4:30-4:45		180	78	15	15	3	1	290
4:45-5:00		213	74	19	3	0	1	310	4:45-5:00		189	89	14	1	1	1	293
5:00-5:15		232	80	20	2	2	1	336	5:00-5:15		243	79	16	2	0	1	341
5:15-5:30		211	68	17	3	0	0	298	5:15-5:30		216	70	19	2	1	1	308
5:30-5:45		231	73	21	6	1	1	332	5:30-5:45		223	96	22	3	3	1	348
5:45-6:00		271	92	11	7	0	1	382	5:45-6:00		271	92	13	15	1	1	392
6:00-6:15		286	86	20	7	1	1	400	6:00-6:15		301	95	23	8	2	1	428
6:15-6:30		290	66	10	10	0	1	376	6:15-6:30		244	91	12	3	1	1	351
6:30-6:45		337	76	10	6	1	1	431	6:30-6:45		275	72	10	9	0	1	367
6:45-7:00		285	51	18	6	1	0	360	6:45-7:00		297	53	14	5	0	0	369
7:00-7:15		356	81	16	3	0	1	457	7:00-7:15		290	83	14	3	1	0	390
7:15-7:30		314	92	10	9	2	1	427	7:15-7:30		287	98	19	4	1	1	409
7:30-7:45		312	98	19	5	1	0	435	7:30-7:45		292	92	12	8	2	1	406
7:45-8:00		295	93	17	5	0	0	410	7:45-8:00		274	95	14	2	0	1	385
TOTAL		8834	2418	477	154	20	20	11922	TOTAL		8140	2779	483	122	29	19	11571
PERCENTAGE		74.10%	20.28%	4.00%	1.29%	0.16%	0.17%		PERCENTAGE		70.35%	24.02%	4.17%	1.05%	0.25%	0.16%	

Table II. Traffic Data at Azad Chowk section

AVERAGE								
Azad chowk to Kalva chowk(IN)								
MG ROAD		VEHICLES						TOTAL
TIME		2W	3W	CAR	BICYCLE	LCV	Bus	VEHICLE
9:00-9:15	AM	198	81	12	2	0	0	293
9:15-9:30		217	73	9	6	2	0	306
9:30-9:45		224	93	14	4	0	1	336
9:45 - 10:00		241	73	11	1	1	1	327
10:00-10:15		234	91	14	5	2	1	346
10:15-10:30		234	67	11	2	1	1	315
10:30-10:45		288	83	9	8	1	1	389
10:45-11:00		229	91	14	4	1	0	339
11:00-11:15		288	68	9	1	2	0	368
11:15-11-30		270	81	18	3	1	1	374
11-30-11-45		217	82	9	3	3	1	313
11:45-12:00	PM	285	51	11	1	0	1	348
12:00-12:15		271	80	10	0	1	0	362
12:15-12:30		257	58	3	7	2	1	327
12:30-12:45		258	68	12	2	0	1	340
12:45-1:00		256	73	4	0	5	1	338
4:00-4:15		211	59	12	0	0	1	283
4:15-4:30		251	84	12	1	0	0	348
4:30-4:45		280	75	13	7	3	1	377
4:45-5:00		268	67	16	1	1	1	352
5:00-5:15		271	89	5	11	0	1	376
5:15-5:30		302	75	14	3	1	1	394
5:30-5:45		289	70	7	2	3	1	371
5:45-6:00		350	81	17	2	1	1	451
6:00-6:15		305	77	12	2	2	1	397
6:15-6:30		342	90	9	9	1	1	451
6:30-6:45		353	63	12	4	0	1	432
6:45-7:00		377	82	9	8	0	0	476
7:00-7:15		355	84	10	8	1	1	457
7:15-7:30		391	84	6	2	1	1	483
7:30-7:45		392	86	14	5	2	0	499
7:45-8:00		385	92	9	3	0	1	490
TOTAL		9087	2469	342	107	30	19	12053
PERCENTAGE		75.39%	20.48%	2.84%	0.88%	0.25%	0.16%	

AVERAGE								
Azad chowk to Kalva chowk (OUT)								
MG ROAD		VEHICLES						TOTAL
TIME		2W	3W	CAR	BICYCLE	LCV	Bus	VEHICLE
9:00-9:15	AM	175	61	9	5	5	0	272
9:15-9:30		198	53	6	1	5	1	269
9:30-9:45		234	70	12	2	2	0	330
9:45 - 10:00		218	54	11	0	8	1	296
10:00-10:15		237	74	11	10	7	0	351
10:15-10:30		204	60	7	5	4	1	289
10:30-10:45		240	79	15	2	3	1	359
10:45-11:00		83	37	5	1	2	0	143
11:00-11:15		209	71	8	7	2	1	313
11:15-11-30		184	54	9	5	0	0	258
11-30-11-45		213	62	9	1	1	0	293
11:45-12:00	PM	246	62	14	6	1	1	327
12:00-12:15		191	46	8	5	2	1	248
12:15-12:30		251	59	7	6	1	1	317
12:30-12:45		216	61	9	1	1	1	294
12:45-1:00		217	46	11	4	3	2	273
4:00-4:15		159	47	13	7	0	1	230
4:15-4:30		220	66	11	3	1	0	310
4:30-4:45		168	61	10	6	2	1	263
4:45-5:00		159	68	12	3	0	1	270
5:00-5:15		180	70	9	8	3	1	293
5:15-5:30		222	60	21	3	1	0	309
5:30-5:45		260	78	16	6	0	1	369
5:45-6:00		225	63	13	7	2	2	316
6:00-6:15		227	74	10	2	0	1	329
6:15-6:30		191	62	9	4	1	1	280
6:30-6:45		281	61	9	2	0	1	343
6:45-7:00		255	56	15	5	0	1	320
7:00-7:15		260	61	12	0	0	1	331
7:15-7:30		269	52	10	0	0	1	317
7:30-7:45		282	50	8	0	0	0	320
7:45-8:00		290	37	14	0	0	0	306
TOTAL		6959	1911	338	108	51	20	9387
PERCENTAGE		74.14%	20.36%	3.60%	1.15%	0.55%	0.21%	

Table III Traffic data at Junction No.1

Location: Vanzari chowk Junction

	Vanzari Chowk Junction No 1						
MG ROAD	IN/OUT (PCU)						
TIME	2W	3W	CAR	BICYCLE	LCV	Bus	TOTAL
9 to 10	131	17	9	2	1	0	159
10 to 11	413	26	13	8	1	0	459
11 to 12	626	34	8	4	2	0	673
12 to 1	695	34	9	11	6	0	754
4 to 5	454	27	11	7	2	0	500
5 to 6	531	24	12	11	3	0	580
6 to 7	644	21	19	8	3	0	694
7 to 8	615	30	18	4	1	0	667
TOTAL	4107	211	96	54	17	0	4486

Table IV Traffic data at Junction No.2

Location: KBC Street Junction

	Junction No 2 KBC Street						
MG ROAD	IN/OUT (PCU)						
TIME	2W	3W	CAR	BICYCLE	LCV	Bus	TOTAL
9 to 10	115	12	6	0	0	0	133
10 to 11	364	18	8	5	1	0	394
11 to 12	538	28	6	2	1	0	576
12 to 1	610	33	6	10	4	0	663
4 to 5	387	22	6	5	1	0	421
5 to 6	457	21	8	8	2	0	497
6 to 7	585	17	16	5	2	0	624
7 to 8	545	23	14	3	1	0	584
TOTAL	3599	175	69	38	11	0	3890

Table V. Traffic data at Junction No.3

Location: Junction no.3

	Junction No 3 (Mangnath Road Street)						
MG ROAD	IN/OUT (PCU)						
TIME	2W	3W	CAR	BICYCLE	LCV	Bus	TOTAL

9 to 10	107	0	0	9	0	0	116
10 to 11	148	0	0	6	0	0	154
11 to 12	205	0	0	6	0	0	212
12 to 1	266	0	0	3	0	0	269
4 to 5	208	0	0	8	0	0	216
5 to 6	157	0	0	8	0	0	165
6 to 7	244	0	0	12	0	0	256
7 to 8	261	0	0	14	0	0	274
TOTAL	1595	0	0	66	0	0	1661

Table VI. Traffic data at Junction No.4

Location: Junction no.4

	Junction No 4 (Headquarters Street)						
MG ROAD	IN/OUT (PCU)						
TIME	2W	3W	CAR	BICYCLE	LCV	Bus	TOTAL
9 to 10	94	0	0	9	0	0	103
10 to 11	117	0	0	4	0	0	121
11 to 12	168	0	0	5	0	0	173
12 to 1	242	0	0	1	0	0	243
4 to 5	172	0	0	6	0	0	177
5 to 6	118	0	0	6	0	0	125
6 to 7	238	0	0	12	0	0	250
7 to 8	218	0	0	10	0	0	227
TOTAL	1366	0	0	52	0	0	1418

V. ANALYSIS

A. *Vehicle Composition*

Vehicle Composition					
Kalva Chowk to Azad chowk					
IN/OUT					
2W	3W	CAR	BICYCLE	LCV	Bus
72.23%	22.15%	4.08%	1.17%	0.21%	0.16%

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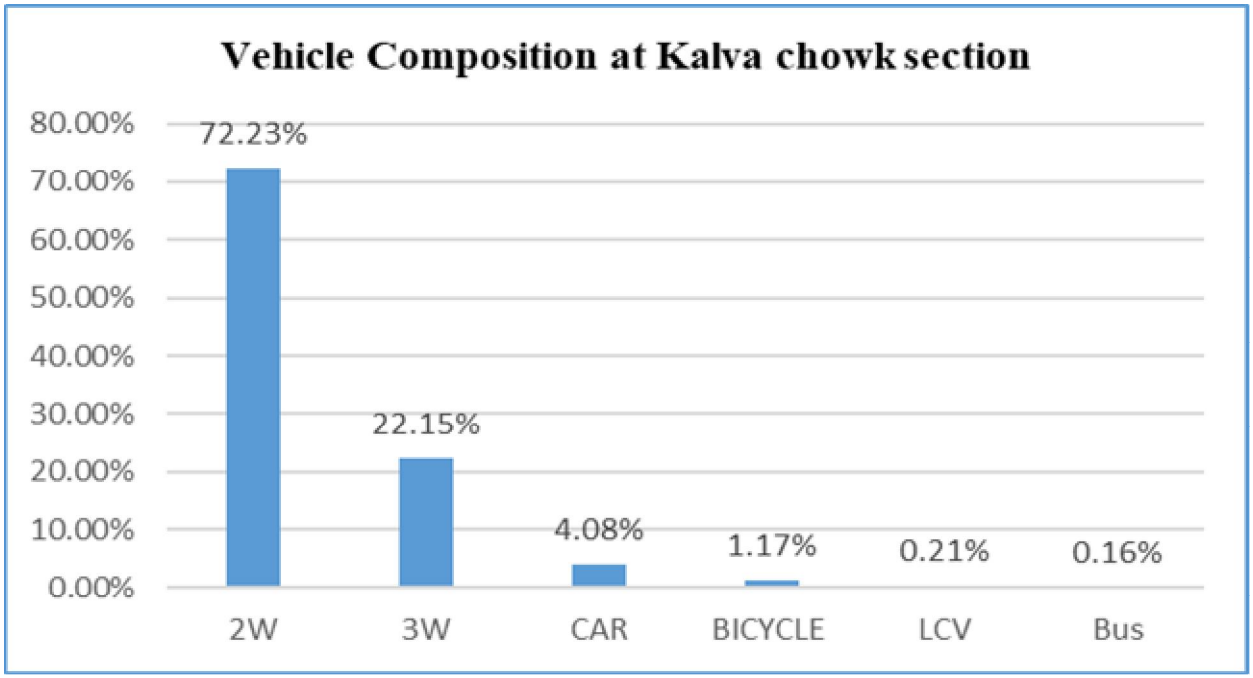
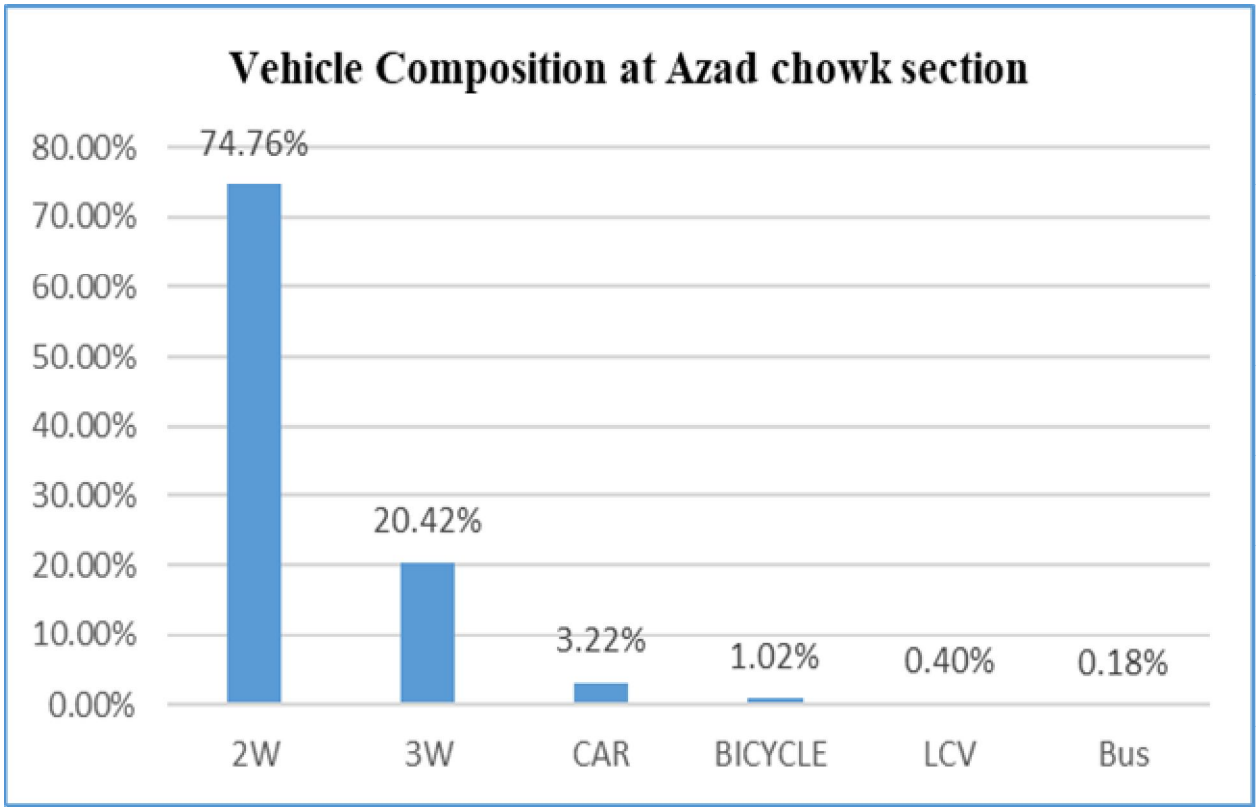


Vehicle Composition					
Azad chowk to Kalva Chowk					
IN/OUT					
2W	3W	CAR	BICYCLE	LCV	Bus
74.76%	20.42%	3.22%	1.02%	0.40%	0.18%



PCU value for different types of vehicles are mentioned in IRC: 106-1990 page no. 10.
Based on the composition of vehicles, we took following PCU factors to find hourly flow of vehicles.

Equivalent PCU Factors

Car	1.0
Bicycle	0.4
Motorcycle	0.75
3-Wheeler	2.0
LCV	1.4
Bus or Truck	2.2

B. Hourly Share of Vehicles

Table VII. Hourly Share at Kalva Chowk section

Hourly Share of the Vehicles						
	Kalva Chowk to Azad chowk					
MG ROAD	IN/OUT					
TIME	2W	3W	CAR	BICYCLE	LCV	Bus
9 to 10	1791	554	83	27	5	4
10 to 11	2105	749	124	26	6	5
11 to 12	2450	733	116	30	7	5
12 to 1	2482	610	105	27	13	6
4 to 5	1454	581	155	37	4	5
5 to 6	1898	650	139	38	6	6
6 to 7	2314	589	117	53	4	5
7 to 8	2123	639	104	33	5	4
TOTAL	16618	5104	943	270	48	39

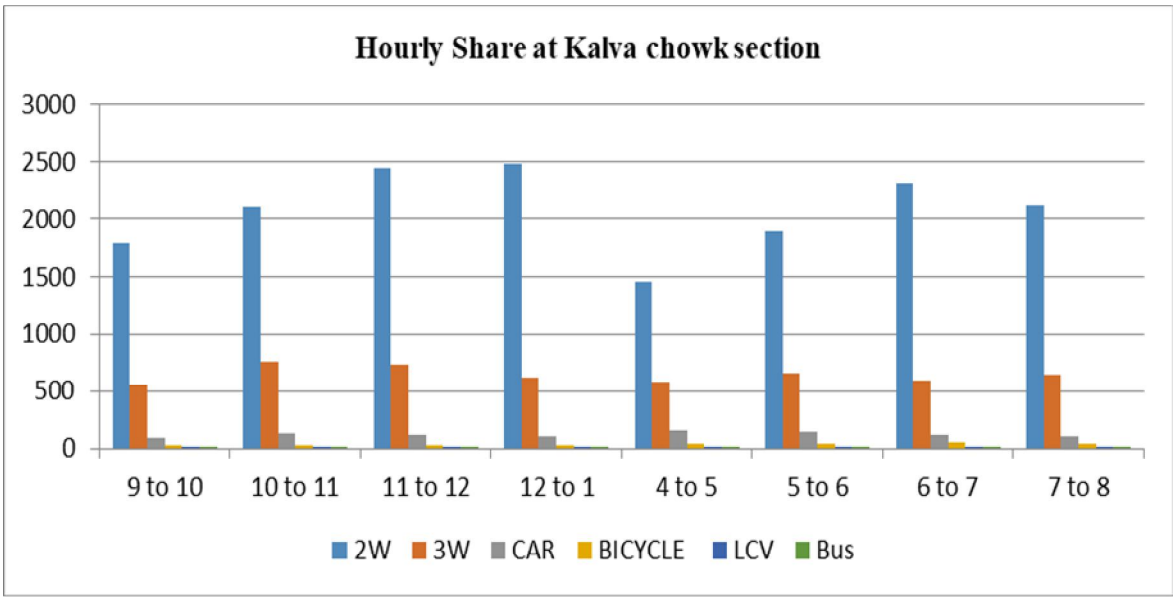
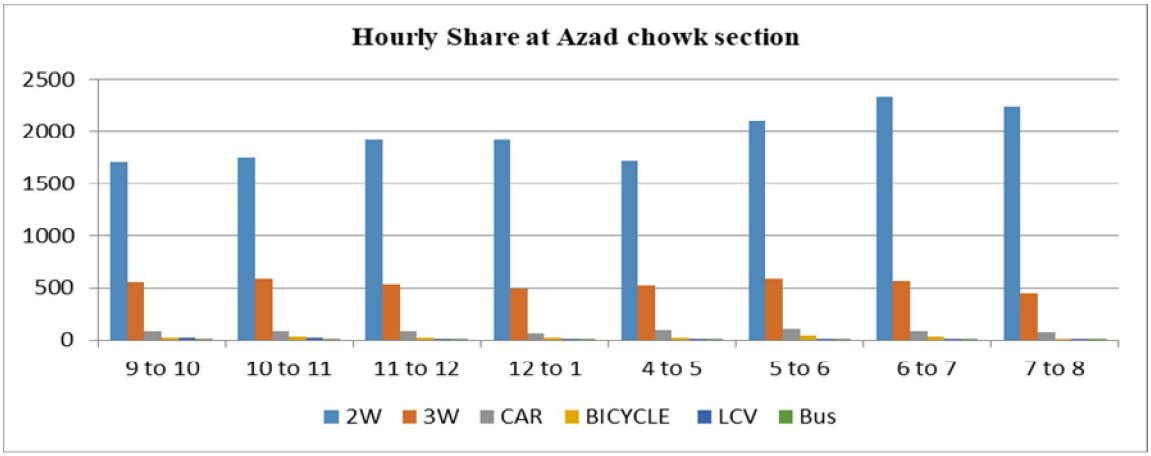
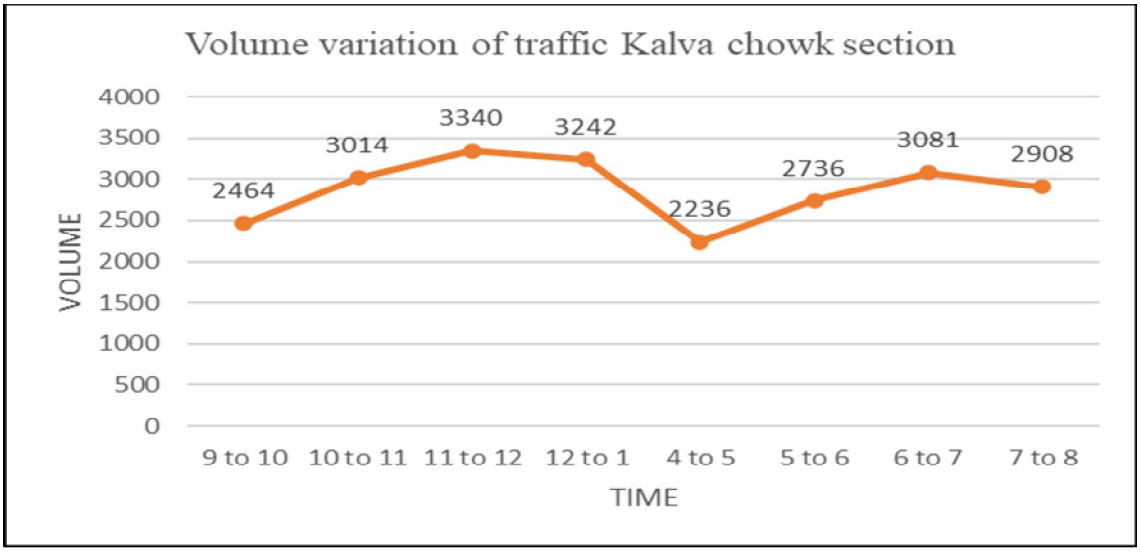


Table VIII. Hourly Share at Azad Chowk section

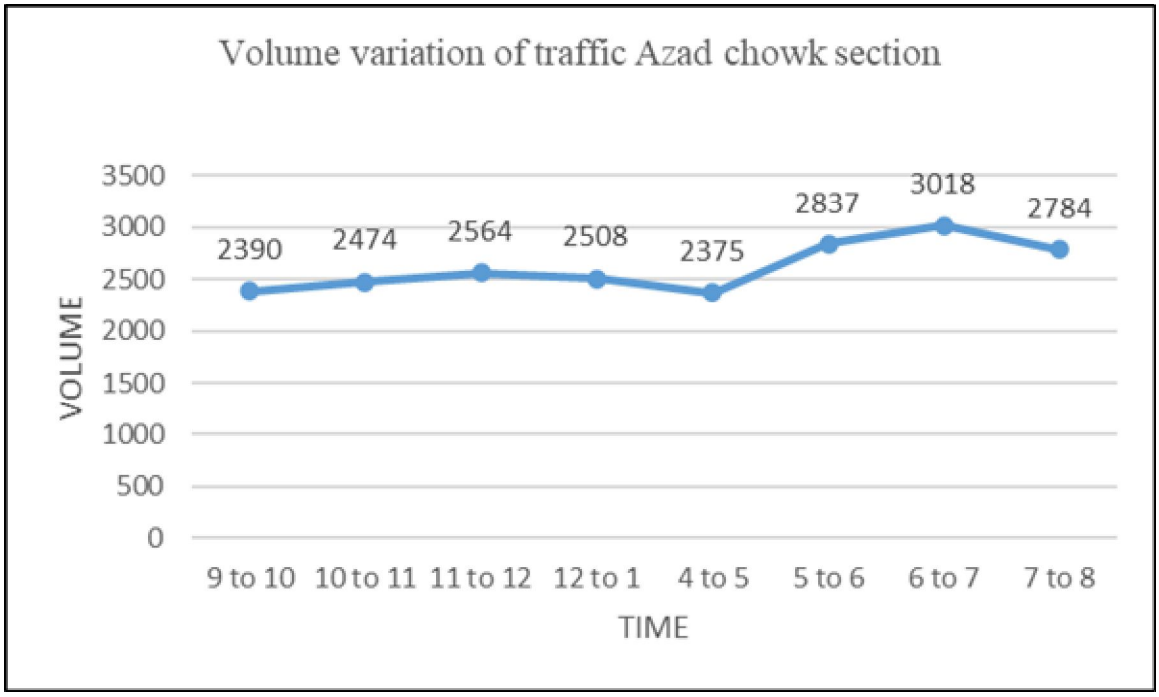
Hourly Share of the Vehicles						
	Azad chowk to Kalva Chowk					
MG ROAD	IN/OUT					
TIME	2W	3W	CAR	BICYCLE	LCV	Bus
9 to 10	1705	557	84	19	21	5
10 to 11	1750	581	86	34	20	5
11 to 12	1911	531	86	25	8	5
12 to 1	1915	490	63	23	13	6
4 to 5	1715	527	97	26	5	5
5 to 6	2099	585	100	39	9	6
6 to 7	2330	564	84	34	3	5
7 to 8	2237	454	74	14	3	3
TOTAL	15661	4288	672	212	81	38



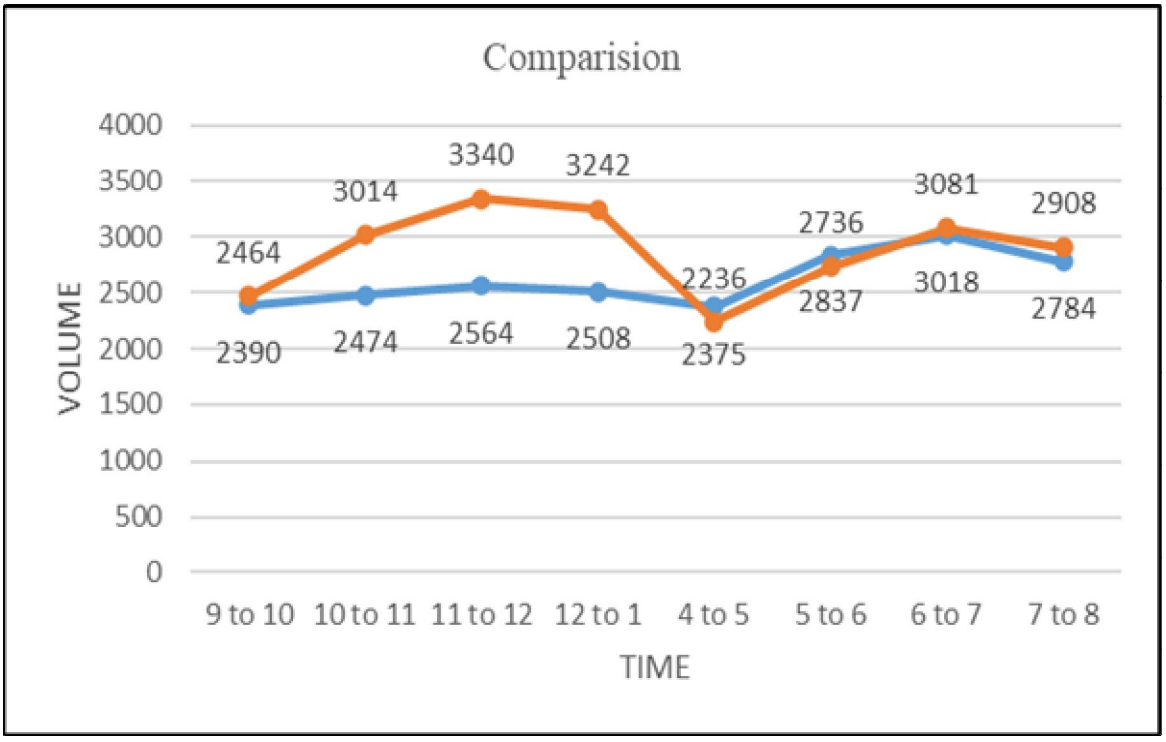
C. Volume Variation of Vehicles



Volume Variation of Vehicles at Kalva chowk section



Volume Variation of Vehicles at Azad chowk section



Comparison of Volume Variation

D. Peak Hour Factor and Hourly Flow

$$\text{Peak Hour Factor} = \frac{\text{Volume in PCU During Peak Hour}}{4 \times \text{Highest Volume in PCU during 15 min interval of Peak Hour}}$$

1) At Kalva chowk section :

	Volume	
	VEHICLE	PCU
PEAK 15 MIN	880	903

PEAK 1 HOUR	3449	3532.7
PEAK HOUR FACTOR		0.98

2) At Azad chowk section :

	Volume	
	VEHICLE	PCU
PEAK 15 MIN	819	804.9

PEAK 1 HOUR	3202	3160.6
PEAK HOUR FACTOR		0.98

Here, 0.98 means that 98% of time the road is occupied in that time span of 1 hour at both the sections.

E. Design service capacity of carriageway

Here, the selected road section is 2-Lane (Two Way) so, take design service volume for this road 1500 from IRC : 106-1990 page no. 11.

1) At Kalva chowk section:

Volume	3532.7
Capacity from IRC	1500
V/C	2.36

2) At Azad chowk section:

Volume	3160.6
Capacity from IRC	1500
V/C	2.11

As per IRC 106-1990 guidelines, the ratio of vehicle volume to capacity is taken as 0.70 times the maximum capacity which is taken as 'Design Service Volume'.

Here, at both the section the ratio of volume/capacity are 2.36 and 2.11 at Kalva chowk section and Azad chowk section respectively, which is much bigger than the design service volume.

VI. CONCLUSION AND RECOMMENDATIONS

A. Conclusions

1) Discussion on vehicle composition:

From the data, we can see that most vehicles in the area are motorcycles and three-wheelers, with cars making up a smaller portion. This distribution indicates a heavy reliance on two-wheelers and three-wheelers for commuting between Kalva Chowk and Azad Chowk. Buses, though fewer in number, are usually municipal buses or police vehicle.

This suggests a need for better public transportation, including more buses and improved maintenance. Overall, the data highlights the importance of upgrading the transportation system to better serve the community's needs.

In conclusion, while the dominance of light vehicles reflects the proximity of the location to high-income residential areas, also there is no presence of public transportation buses underscores modification in the transportation system. Therefore, strategic interventions aimed at bolstering public transportation services and modernizing existing fleets are warranted to enhance the efficiency and quality of the traffic system.

2) Discussion on survey data of Four junction:

a) Junction No 1 (Vanzari Chowk Junction):

- This junction shows varying levels of traffic throughout the day, with peaks during the 11 AM to 12 PM and 6 to 7 PM time slots.
- The total number of vehicles recorded is 4,486.

b) Junction No 2 (KBC Junction):

- Similar to Junction No 1, this junction experiences peaks during the 11 AM to 12 PM and 6 to 7 PM time slots.
- The total number of vehicles recorded is 3,890.

c) Junction No 3 (Mangnath Road Street):

- This junction exhibits lower traffic volumes compared to Junctions No 1 and 2, with peaks during the 6 to 7 PM time slot.
- The total number of vehicles recorded is 1,661.

d) Junction No 4 (Headquarters Street):

- Junction No 4 also shows lower traffic volumes, with peaks during the 6 to 7 PM time slot.
- The total number of vehicles recorded is 1,418.

Based on the comparison, Junction No 1 (Vanzari Chowk Junction) has the highest total number of vehicles recorded, indicating potentially higher levels of traffic and congestion. Junction No 2 (KBC Junction) follows closely behind in terms of total vehicle count. Therefore, Junction No 1 is more likely to create more trouble for the main road due to the higher volume of traffic it experiences.

3) Discussion on hourly share of vehicles:

Based on the survey, we can observe that the data is collected between 9 AM to 8 PM, the highest numbers of vehicles observed are during the 6 to 7 PM time slot, followed closely by the 7 to 8 PM time slot. Two-wheelers dominate the traffic throughout the day, with their numbers peaking during the evening rush hours.

The data highlights the importance of understanding the hourly distribution of vehicles to effectively manage traffic flow and plan transportation infrastructure. It suggests that measures may be needed to address peak traffic periods, particularly during the evening rush hours, to ensure smoother and more efficient travel between the two locations.

Overall, the data underscores the need for strategic planning and management of transportation resources to alleviate congestion and improve commuting experiences for residents and commuters in the area.

4) Discussion on volume variation of traffic

a) Kalva chowk section:

- This direction experiences varying levels of traffic throughout the day, with peaks during the 11 AM to 12 PM and 6 to 7 PM time slots.
- The total number of vehicles recorded in this direction is 23,021.

b) Azad chowk section:

- This direction also shows fluctuations in traffic volume, with peaks during the 11 AM to 12 PM and 6 to 7 PM time slots.
- The total number of vehicles recorded in this direction is 20,951.

Comparing the total volume of traffic between the two directions, Kalva Chowk section has a higher total number of vehicles recorded (23,021) compared to Azad Chowk section (20,951). Therefore, Kalva Chowk to Azad Chowk direction potentially experiences higher levels of traffic and congestion, indicating it may create more trouble for the main road compared to the Azad Chowk section.

5) Discussion on hourly flow of vehicles:

a) Kalva chowk section:

- This direction experiences varying levels of traffic throughout the day, with peaks during the morning and evening rush hours.
- The total hourly flow of vehicles varies between 595.9 PCU and 903.0 PCU.
- The peak hour for this section is 11:15 AM to 12:15 PM.
- The total volume of vehicles recorded in this direction is 24,393.

b) Azad chowk section:

- TShis direction also shows fluctuations in traffic volume, with peaks during the morning and evening rush hours.
- The total hourly flow of vehicles varies between 520.9 PCU and 870.1 PCU.
- The peak hour for this section is 7:00 PM to 8:00 PM.
- The total volume of vehicles recorded in this direction is 21,758.8.

6) Discussion on design service capacity of road section:

Both sections are experiencing traffic volumes exceeding their capacity as per IRC standards. As per IRC 106-1990 guidelines, the ratio of vehicle volume to capacity is taken as 0.70 times the maximum capacity. It indicates the degree of congestion, with higher values suggesting more severe congestion.

The V/C ratio of both section is much higher at Kalva Chowk (2.36) and Azad Chowk (2.11), indicating potentially higher levels of congestion at throughout the section.

B. Recommendations

1) Periodic Review of Design Standards: It's crucial for transportation authorities to regularly reassess and update design standards to match evolving traffic dynamics, urban population growth, and development patterns.

2) Parking Facility: We observed that there is a need for better parking facility alongside the road due to the lack of parking space besides carriageway.

3) Expansion of Carriageway: Considering the evident correlation between carriageway capacity and road width, exploring options to widen carriageways where possible is prudent. This could involve repurposing space from non-essential areas, lane reallocation, or innovative solutions like road widening projects.

4) Integration of Sustainable Transportation: Alongside expanding road capacity, emphasis should be on promoting sustainable transportation modes such as public transit, cycling infrastructure, and pedestrian-friendly designs. This holistic approach not only eases congestion but also addresses environmental concerns and enhances urban quality of life.

5) Technology Integration: Leveraging advancements in traffic management technologies, like intelligent transportation systems (ITS), can optimize traffic flow, enhance safety, and maximize the utilization of existing road infrastructure. Real-time traffic monitoring, signal synchronization and adaptive control systems can significantly enhance urban road network efficiency.

6) Community Engagement: Engaging local communities and stakeholders in the planning process is vital for garnering support for road design initiatives. Collaboration with residents, businesses, and advocacy groups ensures that urban road designs align with community needs and aspirations.

Implementing these recommendations can help urban areas develop resilient road networks that cater to current and future transportation demands while promoting sustainability, safety, and accessibility for all road users.

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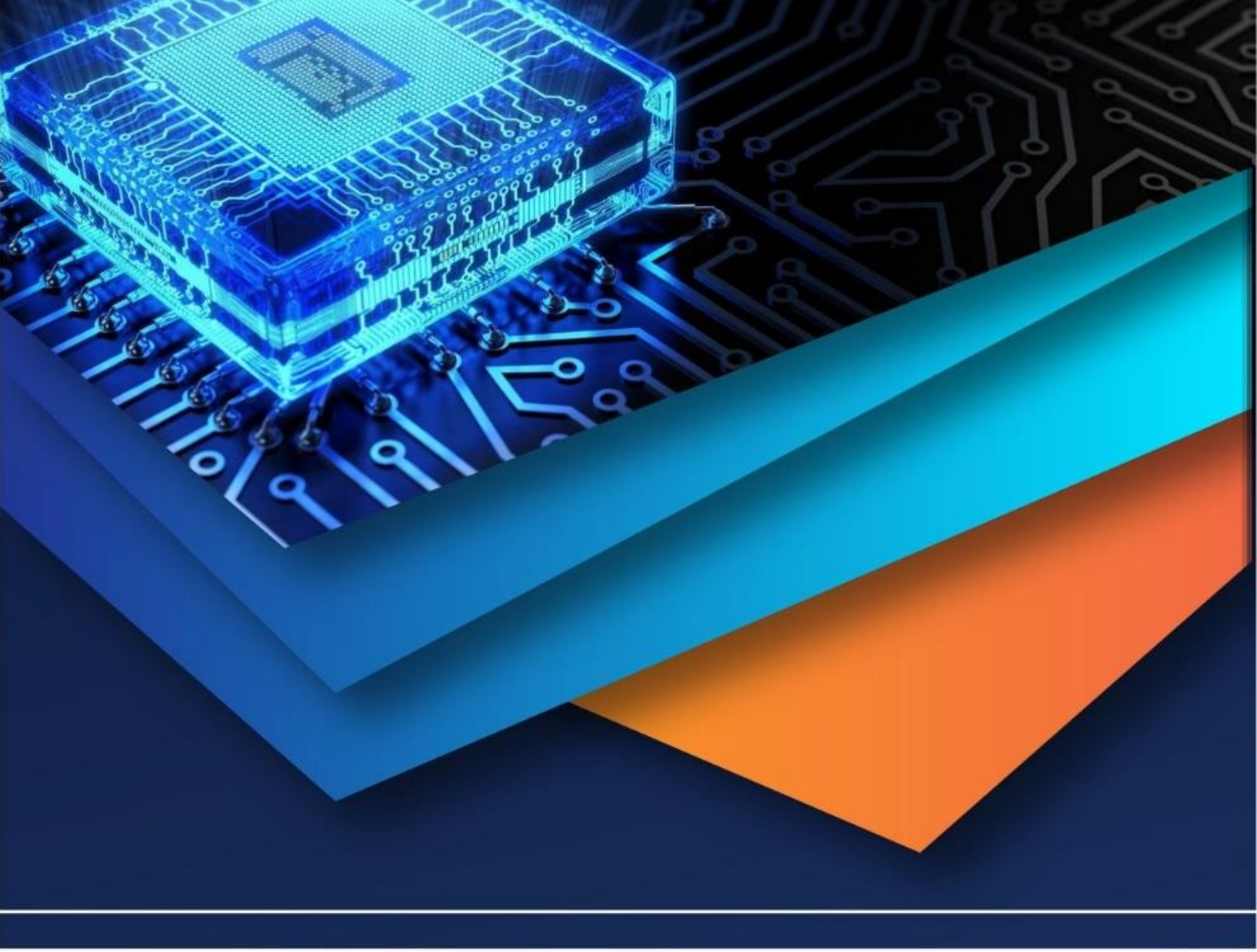

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