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Analysis of Parking Facility in an Urban City Using Geospatial Technology: A Case Study Mahanagar Underground Parking Lucknow

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Abstract: ***The increase in population in urban areas is affecting urban travel demand in the city. Due to the city's central business area, there is temporary on-street parking which affects the traffic flow, so construction of Underground parking was done. After the construction of Underground parking, people are parking their vehicles on the street near the intersection. The free flow of traffic between two or more points is not possible if there is traffic congestion in the path, especially narrowing of road width due to illegal parking, improper management of stoppage points, or slow speed of traffic movement. Lack of maintenance and proper management may lead to traffic congestion and the non-availability of proper parking facilities for public vehicles. Unauthorized on-street parking is affecting the traffic flow on major as well as minor roads. Proper management of parking facilities should be taken care of so that problems like delays in parking due to inappropriate entry and exit points, more carbon emission from vehicles, the unclear orientation of parking lots, time wasted in search of parking, etc. can be solved.***

Keywords: Parking facility, Traffic Flow, Parameters of parking, Unauthorized on-street parking, traffic congestion.

I. INTRODUCTION

These days the population is increasing day by day which causes an increase in urban travel demand. There is a rapid increase in the number of private vehicles as well as transit vehicles. The Central Business Areas of an urban city are the major attraction portion for traffic congestion. Availability of employment due to commercial and business areas generate traffic congestion. The cause of traffic congestion at a Central Business District is due to Unauthorized on-street parking, as people come from various other areas for work and park their vehicles on the street. People who use transit vehicles prefer that vehicles should drop near their workplace. Unplanned stoppage points and on-street parking created as per the public conveyance cause the bottleneck and congestion at the major as well as the minor intersection. This study includes the case study of Mahanagar Underground Parking, Gole Market, Lucknow, Uttar Pradesh, India. Mahanagar Gole Market is one of the central business districts of Lucknow city. On every Wednesday there is a market which is known as Buddh Bazar where people come for the shopping and there is total traffic jam due to street vendors. In this study, all day's traffic congestion is analyzed except on Wednesday. The main intersection which is affected due to on-street parking is Classic Chauraha and Gole Market.

II. OBJECTIVE

The main objective of this study is to find:

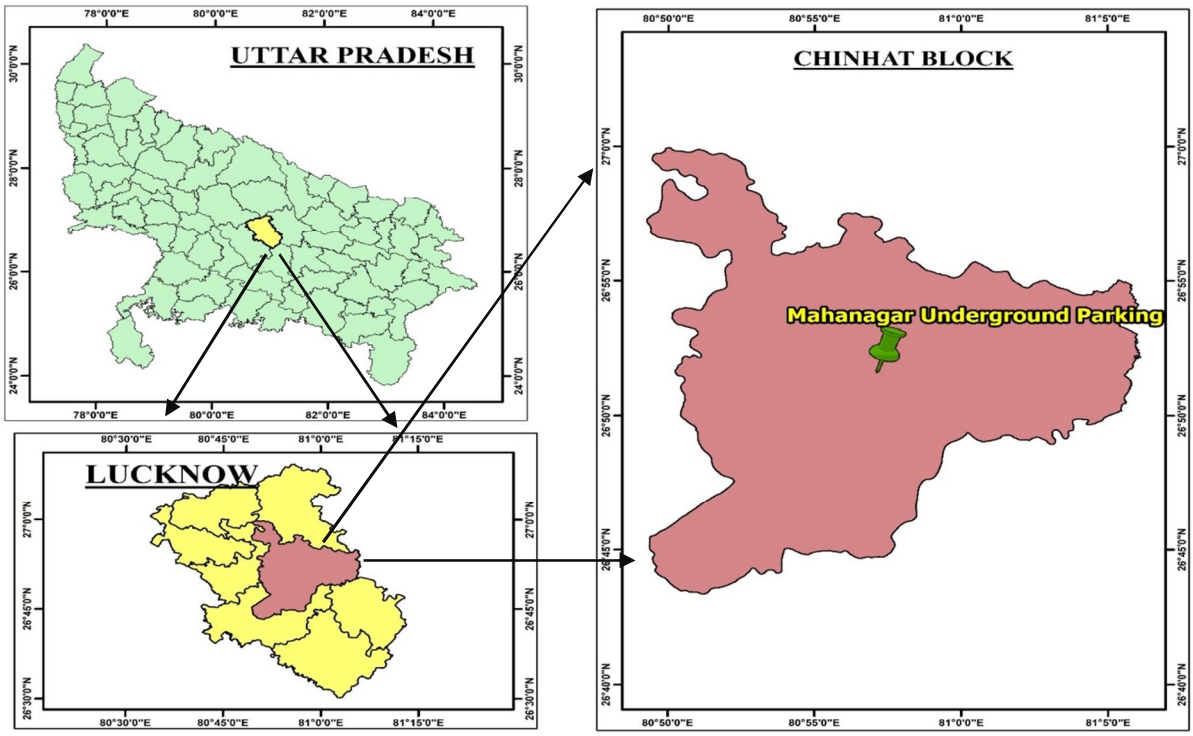
1) The impact of illegal and temporary parking of vehicles around the rotary.
2) Accessibility of public transport network at the intersection.

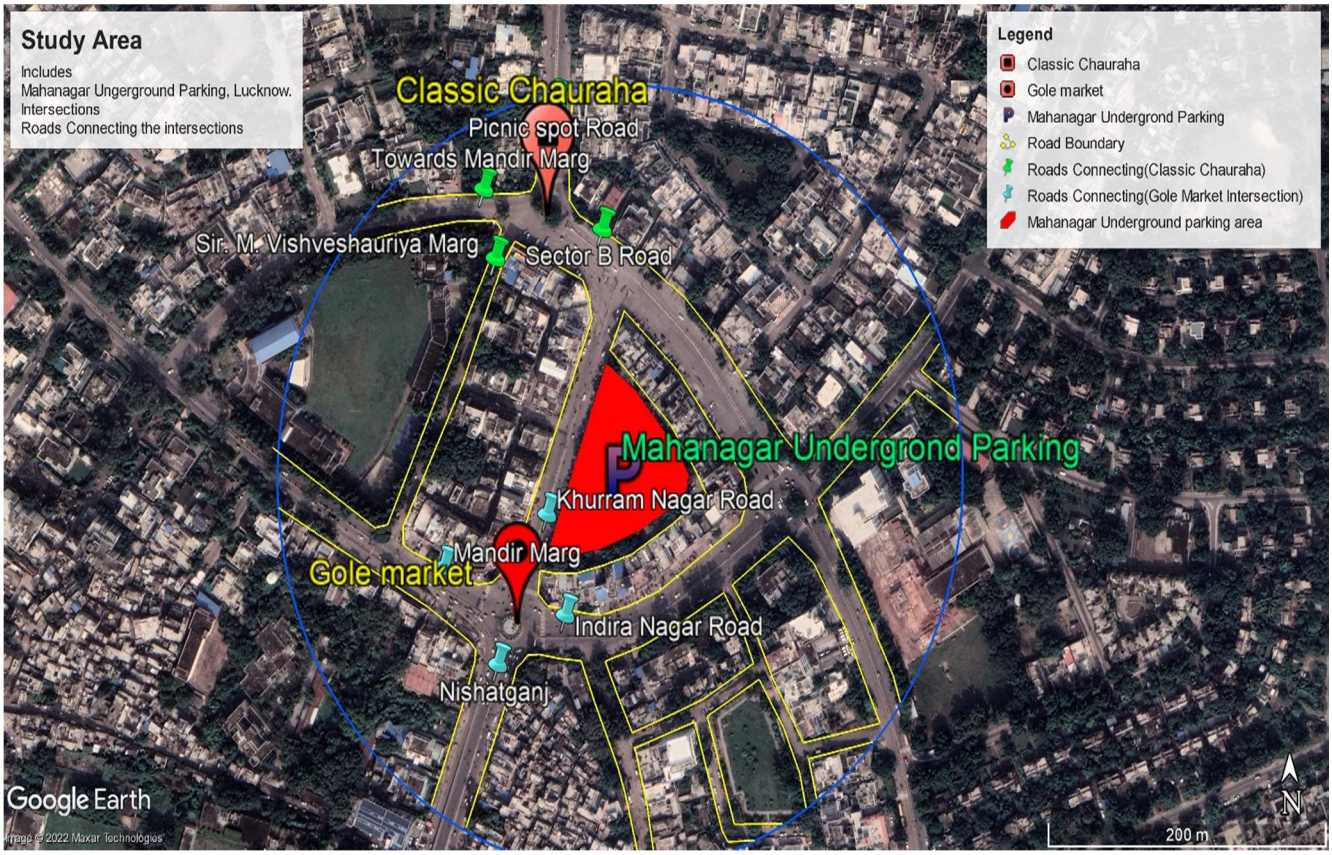
III. STUDY AREA

Study area is Mahanagar Underground Parking, Gole Market, Lucknow, Uttar Pradesh, India (Latitude:26.8740135°N, Longitude:80.9584746°E). Major commercial and business areas are around the Mahanagar underground parking. Private vehicles (i.e. two-wheelers and four-wheelers) and transit vehicles(i.e. Auto and E-Rickshaw) are being parked near the commercial area's entry points. The intersection near the underground parking which is affected due to this unauthorized on-street parking are:

1) Gole Market Intersection
2) Classic Chauraha

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UTTAR PRADESH
LUCKNOW
CHINHAT BLOCK
Mahanagar Underground Parking


Study Area
Includes
Mahanagar Ungerground Parking, Lucknow.
Intersections
Roads Connecting the intersections
Legend
Classic Chauraha
Gole market
Mahanagar Undergrond Parking
Road Boundary
Roads Connecting(Classic Chauraha)
Roads Connecting(Gole Market Intersection)
Mahanagar Underground parking area
Classic Chauraha
Picnic spot Road
Towards Mandir Marg
Sir. M. Vishveshauriya Marg
Sector B Road
Mahanagar Undergrond Parking
Khurram Nagar Road
Mandir Marg
Gole market
Indira Nagar Road
Nishatganj
Google Earth
200 m
N

The major roads considered in this study are listed below with their connecting rotaries:

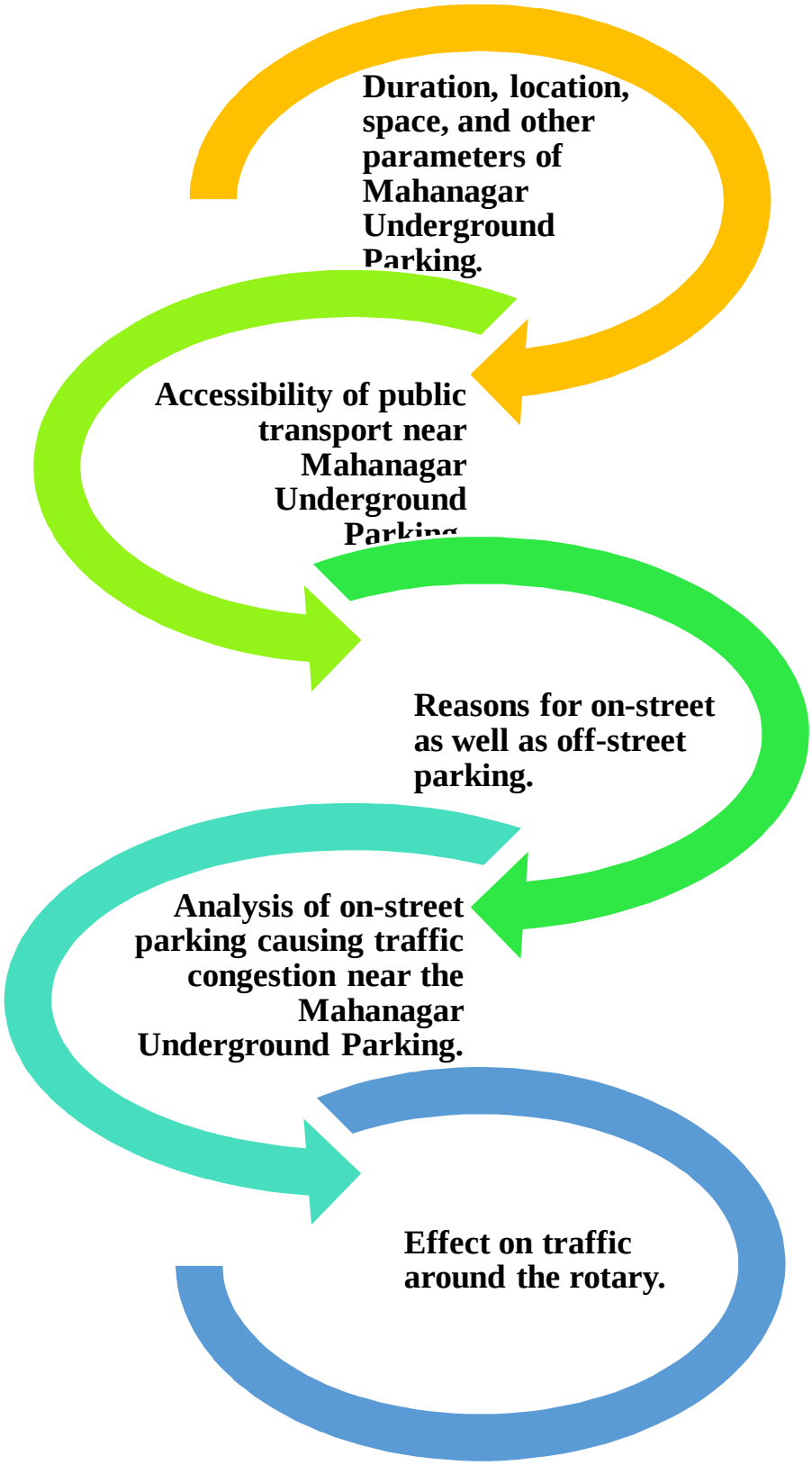
Location	Road name	Lane	Number of Lanes
Gole Market	Mandir Marg	towards	3
		away	2
	Khurram Nagar	towards	3
		away	3
	Indira Nagar	towards	3
		away	4
	Nishatganj	towards	3
		away	2
Classic Chauraha	Towards Mandir Marg	towards	2
		away	2
	Picnic spot Road	towards	2
		away	2
	Sector B Road	towards	5
		away	3
	Sir. M. Vishveshauriya Marg	towards	1
		away	1

IV. DATA AND SOFTWARE USED

Data used for the study- Parking Parameters (source Lucknow Development Authority (LDA) and Nagar Nigam).
Software used- Google Earth Pro, Google Maps, and ArcGIS.

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V. FLOW OF STUDY



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VI. METHODOLOGY

A. Duration, location, space, and other parameters of Mahanagar Underground Parking.

For the study required data is collected from Lucknow Development Authority (LDA) and Nagar Nigam, Lucknow.

Parameters required	
Location of the parking area	S-40, Gole Market, Mahanagar, Lucknow, Uttar Pradesh 226006, India
Type of parking	Underground Parking
Space of parking	300 spaces
Multilevel parking (number of floors)	3(100 spaces each)
Purpose of parking	Commercial purpose
Parking Layout	Parallel
Area of parking	5600m²
Vehicles parked day-night(monthly pass)	120 (4 wheelers)
	35 (2 wheelers)
Cost of a monthly pass for day parking	Rs.400 (4-wheelers)
	Rs.400 (2-wheelers)
Vehicles parked on daily token	40-50 vehicles per day(4-wheelers)
	8-10 vehicles per day(2-wheelers)
Provisions for restriction of on-street parking	Crane (about 15-20 vehicles are finned for illegal parking per day)
Problem	Parking of 2-wheelers (150-200 vehicles) around the Mahanagar Underground Parking
	On-street parking near Classic Chauraha

B. Accessibility of Public transport near Mahanagar Underground Parking.

The public transport available near the Mahanagar Underground Parking is Auto, E-Rickshaw and Buses. Stoppage points are marked on the map below and the description of stoppage points is given below in the table.



Stoppage Points of Auto And E-Rickshaw

Number	Type of vehicle	Pickup Point	Destination
1	Auto and E-Rickshaw	Classic Chauraha	To Khurram Nagar
2	Auto and E-Rickshaw	Classic Chauraha	To Kapoorthala Chauraha
3	Auto and E-Rickshaw	Gole Market	To Khurram Nagar
4	Auto and E-Rickshaw	Gole Market	To Kapoorthala Chauraha
10	Auto and E-Rickshaw	Mandir Marg	To Kapoorthala Chauraha

Bus stops

Number	Stoppages	Bus Available	Frequency
5	Bus stop (Gole Market)	301 Scooter India	Every 10 min
6	Bus stop (Gole Market)	103 Samarpan Hospital	Every 10 min
		402 Integral University	Every 12 min
		502 Kamta High Court	Every 12 min
		105 B.B.D. University	Every 12 min
		301 Engineering College Chowraha	Every 10 min
		104 Ramswaroop College	Every 17 min
7	Bus stop (Wireless Chauraha)	401 Integral University	Every 15 min
8	Bus stop (Classic Chauraha)	401 Integral University	Every 15 min
		402 Integral University	Every 12 min
9	Bus stop (Classic Chauraha)	402 Rajnikhand Terminal	Every 12 min
		401 Kashi Ram Yojana	Every 15 min

C. Reasons for on-street as well as off-street parking.

The main cause of on-street parking near the intersections (Gole Market Chauraha and Classic Chauraha) is the commercial and business places. Unauthorized on-street parking is around 10 to 15 minutes per vehicle. On-street parking of 4-wheelers is less as compared to 2-wheelers due to enforcement of parking laws by the traffic police i.e. towing of vehicles (cars only). The survey was done to check the number of 4-wheelers and 2-wheelers is parked in peak hours on the street.

Important Places	Number of 4-wheelers	Number of 2-wheelers
Restaurants	6 to 7	8 to 10
Banks	4 to 5	8 to 10
Around Mahanagar Underground Parking	5 to 6	95 to 100
Jewelry shops	4 to 5	8 to 10
Cakes and Bakery shops	1 to 2	5 to 6
Electronics stores	1 to 2	5 to 6
General stores	2 to 3	8 to 10
Police station	2 to 3	5 to 6
Post office	4 to 5	7 to 8
Schools (Morning and afternoon)	10 to 12	30 to 40
Hospitals	10 to 12	20 to 30
Gym and salons	3 to 4	8 to 10
Banks	5 to 6	8 to 10
Service centers	4 to 5	7 to 8

Some of the permanent employees, business owners, and commercial area park their vehicles in the Mahanagar Underground parking area provided. The monthly pass is made and they park their vehicles accordingly.

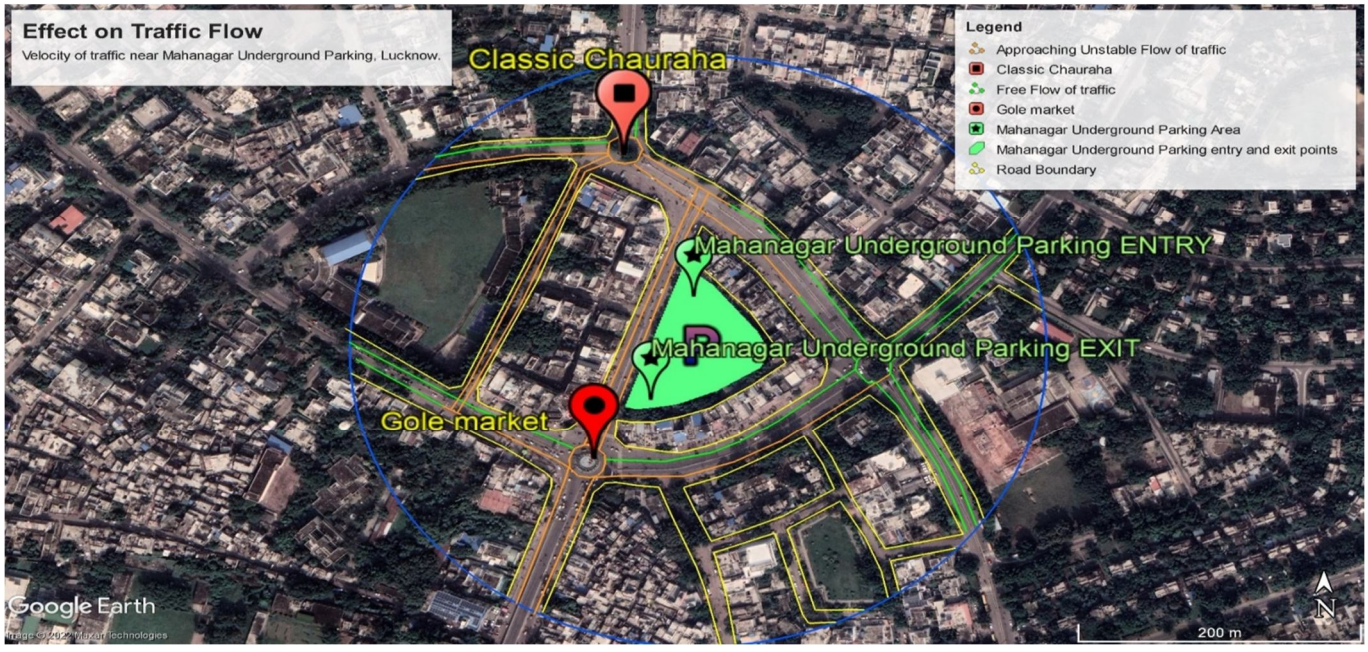
D. Analysis of on-street parking causing traffic congestion near the Mahanagar Underground Parking.

The narrowing of the road's width near the intersection causes the slow movement of traffic and causes congestion at the peak periods (i.e., between 4 pm to 8 pm according to IST). In the map below, the places with on-street parking are marked, affecting the flow of traffic.



E. Effect on Traffic Around the Rotary.

The map below is of Friday (one of the working days). The average velocity of traffic is shown in the map near the intersection as well as the roads connected to it. Due to unauthorized on-street parking the, width, of the road is narrowed down and there is a restriction in the smooth flow of traffic.



The tables below show the cause of traffic congestion on different time duration and provided facilities near the intersection:

Intersection	Road's name	Lane	Time	Bus	4-wheelers	2-wheelers	Vendors	Auto and E-Rickshaw
Gole Market Intersection	Mandir Marg	towards	8-10	N	N	N	N	Y
			10-12	N	Y	Y	N	Y
			12-14	N	Y	Y	N	Y
			14-16	N	Y	Y	N	Y
			16-18	N	Y	Y	N	Y
			18-20	N	Y	Y	N	Y
			20-22	N	Y	Y	N	Y
		away	8-10	N	N	N	N	Y
			10-12	N	Y	Y	N	Y
			12-14	N	Y	Y	N	Y
			14-16	N	Y	Y	N	Y
			16-18	N	Y	Y	N	Y
			18-20	N	Y	Y	N	Y
			20-22	N	Y	Y	N	Y
	Khurram Nagar Road	towards	8-10	N	N	N	Y	Y
			10-12	N	N	Y	Y	Y
			12-14	N	N	Y	Y	Y
			14-16	N	Y	Y	Y	Y
			16-18	N	Y	Y	Y	Y
			18-20	N	Y	Y	Y	Y
			20-22	N	Y	Y	Y	Y
		away	8-10	Y	N	N	Y	Y
			10-12	Y	Y	Y	Y	Y
			12-14	Y	Y	Y	Y	Y
			14-16	Y	Y	Y	Y	Y
			16-18	Y	Y	Y	Y	Y
			18-20	Y	Y	Y	Y	Y
			20-22	Y	Y	Y	Y	Y
	Indira Nagar Road	towards	8-10	N	N	N	N	Y
			10-12	N	N	Y	N	Y
			12-14	N	N	Y	N	Y
			14-16	N	N	Y	N	Y
			16-18	N	N	Y	N	Y
			18-20	N	N	Y	N	Y
			20-22	N	N	Y	N	Y
		away	8-10	Y	N	N	N	Y
			10-12	Y	Y	Y	N	Y
			12-14	Y	Y	Y	N	Y
			14-16	Y	Y	Y	N	Y
			16-18	Y	Y	Y	N	Y
			18-20	Y	Y	Y	N	Y
			20-22	Y	Y	Y	N	Y
	Nishatganj	towards	8-10	Y	N	Y	N	Y
			10-12	Y	N	Y	N	Y
			12-14	Y	N	Y	N	Y
			14-16	Y	N	Y	N	Y
			16-18	Y	N	Y	N	Y
			18-20	Y	N	Y	N	Y
			20-22	Y	N	Y	N	Y
		away	8-10	N	N	Y	Y	Y
			10-12	N	N	Y	Y	Y
			12-14	N	N	Y	Y	Y
			14-16	N	N	Y	Y	Y
			16-18	N	N	Y	Y	Y
			18-20	N	N	Y	Y	Y

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			20-22	N	N	N	Y	Y
Classic Chauraha	Towards Mandir Marg	towards	8-10	N	N	N	N	N
			10-12	N	N	N	N	N
			12-14	N	N	N	N	N
			14-16	N	N	N	N	N
			16-18	N	N	N	N	N
			18-20	N	N	N	N	N
			20-22	N	N	N	N	N
		away	8-10	N	Y	Y	N	N
			10-12	N	Y	Y	N	N
			12-14	N	Y	Y	N	N
			14-16	N	Y	Y	Y	N
			16-18	N	Y	Y	Y	N
			18-20	N	Y	Y	Y	N
			20-22	N	Y	Y	N	N
	Picnic spot Road	towards	8-10	N	N	N	N	Y
			10-12	N	N	N	N	Y
			12-14	N	N	N	N	Y
			14-16	N	Y	Y	N	Y
			16-18	N	Y	Y	N	Y
			18-20	N	Y	Y	N	Y
			20-22	N	N	N	N	Y
		away	8-10	N	N	N	N	Y
			10-12	N	N	N	N	Y
			12-14	N	Y	Y	N	Y
			14-16	N	Y	Y	N	Y
			16-18	N	Y	Y	N	Y
			18-20	N	Y	Y	N	Y
			20-22	N	Y	Y	N	Y
	Sector B Road	towards	8-10	Y	N	N	N	Y
			10-12	Y	N	N	N	Y
			12-14	Y	Y	Y	N	Y
			14-16	Y	Y	Y	Y	Y
			16-18	Y	Y	Y	Y	Y
			18-20	Y	Y	Y	Y	Y
			20-22	Y	N	N	Y	Y
		away	8-10	Y	N	N	N	Y
			10-12	Y	N	N	N	Y
			12-14	Y	N	Y	N	Y
			14-16	Y	N	Y	N	Y
			16-18	Y	N	Y	Y	Y
			18-20	Y	N	Y	Y	Y
			20-22	Y	N	Y	Y	Y
	Sir. M. Vishveshauriya Marg	towards	8-10	N	N	N	N	Y
			10-12	N	N	N	N	Y
			12-14	N	N	N	N	Y
			14-16	N	N	N	N	Y
			16-18	N	N	Y	N	Y
			18-20	N	N	Y	N	Y
			20-22	N	N	N	N	Y
		away	8-10	N	Y	N	Y	Y
			10-12	N	Y	Y	Y	Y
			12-14	N	Y	Y	Y	Y
			14-16	N	Y	Y	Y	Y
			16-18	N	Y	Y	Y	Y
			18-20	N	Y	Y	Y	Y
			20-22	N	Y	Y	Y	Y

ROTARY NAME	ROAD NAME	LANE	TRAFFIC SIGNAL (WITH TIMING)	TEMPORARY AND PERMANENT PARKING	TRAFFIC POLICE	SIGNAGES	ALARMING SYSTEM
Gole Market Intersection	Mandir Marg	towards	YES (R-1min 55sec, G-25sec)	YES	YES	YES	YES
		away	NO	YES	YES	YES	YES
	Khurram Nagar	towards	YES (R-1min 55sec, G-25sec)	YES	YES	YES	YES
		away	NO	YES	YES	YES	YES
	Indira Nagar	towards	YES (R-1min 55sec, G-25sec)	YES	YES	YES	YES
		away	NO	YES	YES	YES	YES
	Nishatganj	towards	YES (R-1min 55sec, G-25sec)	YES	YES	YES	YES
		away	NO	YES	NO	YES	YES
Classic Chauraha	Towards Mandir Marg	towards	NO	YES	NO	YES	NO
		away	NO	YES	NO	YES	NO
	Picnic spot Road	towards	NO	YES	NO	YES	NO
		away	NO	YES	NO	YES	NO
	Sector B Road	towards	NO	YES	NO	YES	NO
		away	NO	YES	NO	YES	NO
	Sir. M. Vishveshauriya Marg	towards	NO	YES	NO	YES	NO
		away	NO	YES	NO	YES	NO

VII. RESULTS & CONCLUSION

A. Result

The outcome of this study is-

1) There is sufficient space in Mahanagar Underground Parking.
2) Accessibility of public transport near the Mahanagar Underground Parking is good.
3) On-street parking and street vendors are affecting the width of the road
4) The width of the road is affected during peak hours of the day.

Time	Common Problem	Exception	Cause

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8 to 10	• Bus, Auto, and E-Rickshaw Stoppage.	• Nishatganj • Mandir Marg	• Tea shop vendor • Restaurant
10 to 12	• Bus, Auto and E-Rickshaw Stoppage • Business hours. • Office hours for nearby post office, police station, and other important places.	• There is variation in on-street parking as it is the time when most of the shops are opening	• Only the employees and owners of the shops reach the market and park their vehicles in the provided parking place.
12 to 14	• Bus, Auto and E-Rickshaw Stoppage • Business hours. • Office hours for nearby post office, police station, and other important places.	• This is the time of lunch for the employees.	• Vendors start opening their shops.
14 to 16	• Bus, Auto and E-Rickshaw Stoppage • Business hours. • Peak hours for marketing. • Office hours for nearby post office, police station, and other important places.	• Vendors	• Increase in customers at the vendors.
16 to 18	• Bus, Auto and E-Rickshaw Stoppage • Business hours. • Peak hours for marketing. • Office hours for nearby post office, police station, and other important places.	• Traffic from Nishatganj overbridge and Picnic spot road affect the intersection.	• Traffic from other congested areas comes towards the intersection.
18 to 20	• Bus, Auto and E-Rickshaw Stoppage • Business hours. • Closing hours for the nearby post office, and other important places. • Peak hours for marketing.	• Traffic from Nishatganj overbridge and Picnic spot road affect the intersection.	• Traffic from other congested areas comes towards the intersection.
20 to 22	• Bus, Auto and E-Rickshaw Stoppage • Closing of the market and offices.		• Shutting down of the market.

5) Traffic flow is affected due to unauthorized on-street parking.
6) Approaching unstable traffic flow is mostly on the lanes connecting Gole Market Chauraha and Classic Chauraha.
7) Sir. M. Vishveshauriya Marg is occupied with Auto, E-Rickshaw, and Tempo Unauthorized Parking.

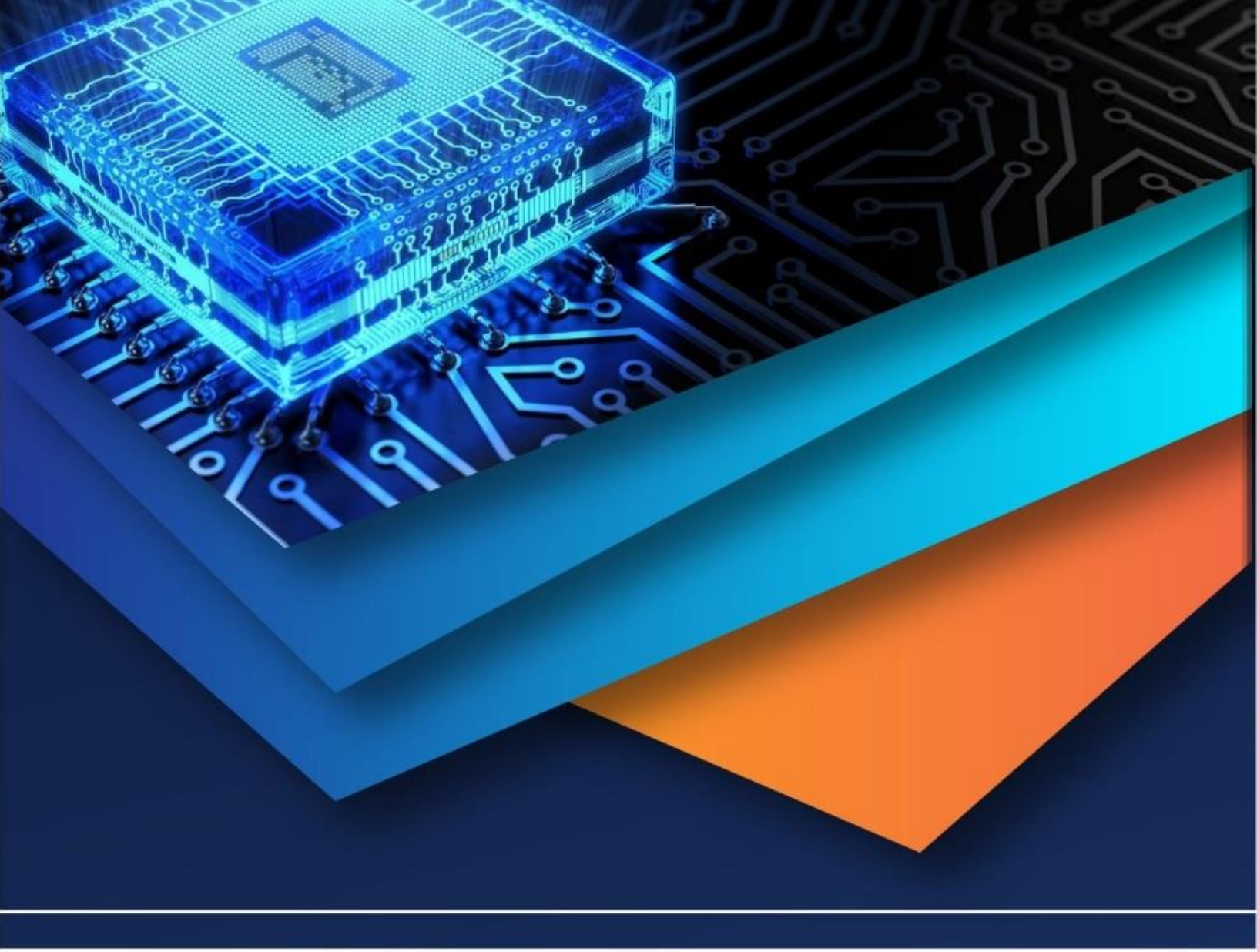
VIII. CONCLUSION

The study concludes the following points-

1) There should be proper site suitability for the entry and exit of Mahanagar Underground Parking.
2) Strict provisions should be made for two-wheelers on-street parking.
3) Leftover spaces in Mahanagar Underground Parking can be used as stoppage points for Auto and E-Rickshaw.
4) Provisions for street vendors should be made.

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