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Civic Centre Junction Re-Designing

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Abstract
Traffic congestion is one of the major factors that causes various problems to the road users, these problems are commonly faced by developing countries around the world like India. Traffic Jam is a growing problem in cities, mainly at junctions during peak hours which causes major issues to the emergency services by delaying their service time and increases fuel consumption. Present study mainly focuses on the assessment of traffic jam at the Civic Centre junction, Nalasopara West, Mumbai, Maharashtra as the study area. The performance of the junctions will be analysed by using PTV VISSIM as a tool for further understanding of the junction. Along with the problems that are caused due to the local conditions will be analysed by site visits & trying to understand other issues that are existing (Pedestrian behaviour, Driving behaviour, Parking lots etc). All these design parameters will be used in PTV VISSIM to analysis the junction. A new design of the Civic Centre junction will be proposed considering all these parameters for a better free flow movement of traffic, minimizing traffic congestion, and increasing the safety of the road users to a better extend.
Index Terms- Design Parameters, PTV VISSIM, Road Safety, Traffic Congestion

1. Introduction

Traffic congestion is one of the major issues faced by the road users, commonly in developing countries like India. Traffic congestion is a situation in which excess of vehicles in a particular patch of the road is experience at a particular time resulting in slow traffic low, higher fuel consumption, lengthier travel time, excessive vehicle queueing, poor road safety and also affect the emergency services (ambulance, fire truck, etc.).
In the period of 2022-2023, a sum total of 64,876 new vehicles were registered by the Mumbai Central RTO, which is over 13,000 higher than 2021-2022 record [Source: THE FREE PRESS JOURNAL].
In Vasai – Virar region which includes the study area of this paper, Nalasopara West Civic Center Junction a population increase of 19,56,00 is predicted for the next 2 decades i.e., 2021-2041 by the VASAI – VIRAR CITY MUNICIPAL CORPORATION. Thus, such drastic growth in population will result in increase in demand for road vehicles and also will lead to various developments resulting in more rise in road traffic.
Junctions are reviewed as the major point as it connects 2 or more roads, acting as a medium of diversion for traffic to divert in different areas. Junctions connects major and minor roads i.e., highways, arterial streets, sub-arterial streets, and collector streets. A junction maybe signalized, roundabout or at-grade intersection depending upon the traffic volume and on-site conditions.
Civic Centre Junction, located in Nalasopara west, Mumbai, Maharashtra, serves as a mean to connect Nalasopara West to Nalasopara West-Nalasopara East flyover, NH 65 (Delhi – Chennai), Nalasopara Bus Depot, VVMT Bus Depot (Vasai Virar Municipal Transport). A major development has been seen in the Nalasopara West areas leading to increase in vehicles on roads, increase in need for parking spaces, pedestrian movement on roads has also increased. Since the major hospital are in the town region of Mumbai, this junction act as a crucial point as it connects the Nalasopara West to the Nalasopara Phata of the NH48 highway which link to the major parts of Mumbai.
Traffic study was performed on Civic Centre junction to study the existing capacity of the road and also the local problems were figured out to check whether the existing design of the junction is

efficient enough or not for the traffic and pedestrian characteristics, this includes the driving behavior, geometric design of the junction, pedestrian flow. If the existing layout of the junction is failing and causing traffic congestion a new layout undertaking all these parameters will be analyzed and proposed.

2. Problem Statement

The current flow of the traffic is not systematic nor safe, especially for the pedestrian present in the network. It is been observed that the vehicles tend to take a turn before the roundabout instead of going around the roundabout resulting in disrupted traffic flow.
This behavior is because of the smaller diameter of the roundabout and improper centralization of the roundabout. This is leading to traffic congestion at the junction which not only affects the travel time but also leads to higher fuel consumption and compromised safety of road users.
Also, the signages are not properly maintained which leads to indiscipline traffic behavior.
This project aims to provide a new improvised design of this junction considering all these aspects to minimize the traffic congestion to utmost extend and provide a safer and free flow for the traffic.

3. Objectives

The objectives for following study are as follows: -

3.1 To check out the existing junction section stability and its serviceability.
3.2 To provide a proper flow for the pedestrian.
3.3 To provide a proper flow for the vehicle users.
3.4 To increase safety for that particular area.
3.5 Reduce accidents and save lives.
3.6 To prevent congestion or to minimize the congestion.
3.7 To make easily accessible road to emergency services.

4. Methodology

4.1 Data Collection

- Traffic Volume Survey

A traffic volume survey is a survey in which the number of vehicles and pedestrians along a road, path or a junction are noted down for the designing purpose or to find out the level of service for that particular road.
Traffic volume survey can be done by either complete automatically (installation of electronic devices), semi - automatically (recording the video and counting later by referring the video) or manually (counts are noted down visually at site on real time by observer).
For this particular study, the adopted method was manual traffic volume survey, where the data was collected manually my observers on site.
The data was collected according to peak hour that was observed, that is from 6.00 pm to 8.00 pm.
The survey was performed for 4 days which includes two weekdays and two weekend days, the day of survey are Monday, Wednesday, Saturday and Sunday.
The peak hour registered was 6.45pm to 7.45pm on Sunday carrying a vehicular volume of 4710 nos. and pedestrian volume of 1808.

Table I Traffic Volume At Peak Hour

PEAK HOUR 6.45PM - 7.45PM								SUNDAY	
VEH/HR	AUTO	2-WHEELER	CAR	CARRIER	BUS	TRUCK	CYCLE	MEN	WOMEN
STATION RD	631	221	14	11	0	0	19	198	165
BRIDGE	145	826	108	46	11	15	18	36	22
DEPOT	194	556	64	26	21	6	22	302	364
ZUDIO	689	625	248	59	43	39	35	355	332
STREET	0	12	2	0	0	0	4	20	14
SUM	1659	2240	436	142	75	60	98	911	897
	4710							1808	

- Study Of Geometric Design

Geometric design is an important factor in designing a road or a junction, as it contains major factors that will be affecting the design directly or indirectly later with time. It includes factors such as entry width, exit width, diameter of the roundabout, lane width, obstacles in the junction etc.

Accordingly, a study was performed to get the information of actual parameters of the junction, where the entry width, exit width, diameter of the roundabout, obstacles in the junctions, lane width were noted down to later use this information for designing of junction on Auto-CAD and PTV VISSIM.

- Origin Destination (OD) Survey

This survey gives the travel pattern of vehicles along a particular road network, it spots where the most vehicles are originated in the network and also where they finish their journey showing us how often the vehicles take that path.

Along with traffic volume survey, origin-destination survey was also performed to understand the flow of traffic direction, according to the data the most travelled direction varied according to the types of vehicles, for cars it was Zudio – Flyover and Flyover – Zudio, for Auto it was Zudio – Station Road and Station Road – Zudio, for bus it was Zudio – Depot.

Overall, the most travelled path involved roads Zudio and Flyover.

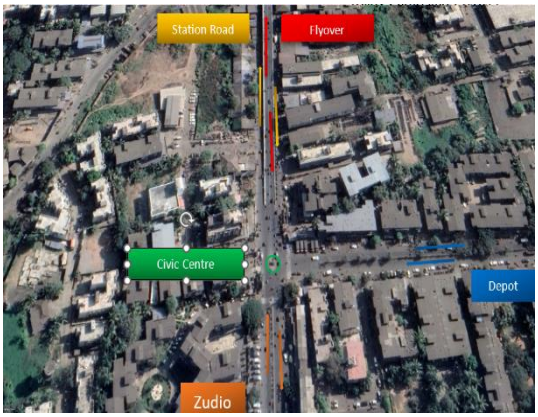

Figure 1 Junction Overview

- Behavior Analysis

It is an important factor to get the actual scenario of the junction performance, since the drivers use the path or drive in a way which is more conventional to them. So, a junction should be design including this parameter too, for better performance and to minimize traffic congestion.

In this study the driving behavior was analysis, and it was seen that since the diameter of the roundabout is smaller and it's also placed at an inconvenient distance, drivers tend to take the turn directly instead of going all around the roundabout which leads disrupted traffic flow causing congestion.

Figure 2 Bus Driving Pattern

Figure 3 Driving Pattern

- On-Site Factors
  The on-site factors for this junction were observed, to make suggestion in the new design to improvise the junction.
  Factors like illegal parking, parking allotted for light commercial vehicles, obstacle in the junction, improper signage placement, problematic auto stand location and no footpath were observed so that they can be tackled with in the new design to improve the junction workability.

Figure 4 Light commercial vehicle parking within 10 meters from the junction

Figure 5 Improper Signage Causing Obstruction

4.2 Designing And Analysis Of Existing Layout Of Junction

- After collecting all the data mentioned above, a layout of the existing design of junction was prepared on AUTO-CAD.

PTV VISSIM					
QUEUECOUNTEREVALUATION: SIMRUN	ROAD	TIMEINT (SEC)	QLEN (METER)	QLENMAX (METER)	QSTOPS (NOS.)
AVG	ZUDIO	0-3600	113.37	233.07	737
AVG	BRIDGE	0-3600	18.11	58.63	146
AVG	DEPOT	0-3600	17.36	55.93	92
AVG	STATION	0-3600	0.94	27.28	2
AVG	STREET	0-3600	0	0	0

Table II Queue Analysis for Existing Layout

For analyzing the junction performance with the actual scenario PTV VISSIM was used to study the junction. All the parameters including behavior pattern of drivers was included while designing the junction to get the actual performance of the junction.

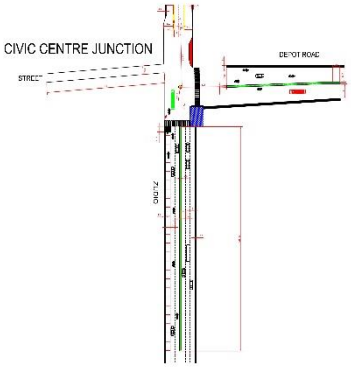

Figure 6 Existing Layout

- Results from the simulation run of an hour were obtained, maximum queue length of around 220 meters was observed on Zudio road during site visits and the simulation results obtained were matching the real time scenario for all the roads, hence all the results were noted down considering them valid.

Table III Travel Time for Existing Layout

PTV VISSIM						
VEHICLE TRAVELTIMEMEASUREMENTEVALUATION :SIMRUN	TIMEINT SEC	LINK	VEHS(ALL) NOS.	TRAVEL TIME (ALL) SEC	DISTANCE TRAVEL (ALL) METER	SPEED (KM/HR)
AVG	0-3600	ZUDIO-BRIDGE	55	111.81	250.01	8
AVG	0-3600	ZUDIO-STATION	32	107.22	240.01	8
AVG	0-3600	ZUDIO-DEPOT	30	114.8	201.42	6
AVG	0-3600	BRIDGE-ZUDIO	106	51.96	200.02	14
AVG	0-3600	STATION-ZUDIO	76	41.09	200.01	18
AVG	0-3600	BRIDGE-DEPOT	21	41.54	150.12	13
AVG	0-3600	STATION-DEPOT	13	14.42	140.14	35
AVG	0-3600	DEPOT-BRIDGE	29	51.14	204.13	14
AVG	0-3600	DEPOT-ZUDIO	47	116.73	200.15	6

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PTV VISSIM								
DELAY MEASUREMENTEVALUATION :SIMRUN	TIMEINT SEC	LINK	STOPDELAY (ALL) SEC	STOPS (ALL) NOS.	VEHDELAY (ALL) SEC	VEHS (ALL) NOS.	PERSDELAY (ALL) SEC	PERS (ALL) NOS.
AVG	0-3600	ZUDIO	49.04	4.5	85.64	117	82.15	339
AVG	0-3600	BRIDGE	9.47	3.8	33.15	126	33.29	187
AVG	0-3600	STATION	3.1	1.1	14.28	89	15.33	171
AVG	0-3600	DEPOT	49.31	3.96	70.29	76	70.33	184
MAX	0-3600	ZUDIO	135.73	6.16	173.7	162	147.21	573
MAX	0-3600	BRIDGE	22.07	6.66	58.98	165	61.71	245
MAX	0-3600	STATION	5.19	1.62	19.03	104	19.74	199
MAX	0-3600	DEPOT	84.03	6.67	118.55	112	165.5	255

Table IV Delay Measurement for Existing Layout

- From the data acquired above by PTV VISSIM simulation, it was observed that the queuing leads to about 230 meters on zudio road which is crucial for our design because it is the road that connects Nalasopara West to the highway and any emergency services like ambulance which might needs to go to the town part of Mumbai via that highway in urgency, a delay or a traffic congestion of such extent can be fatal during an emergency.
- Also, after computing the travel time the average speed was 13.4 km/hr for a parameter of around 100 meter around the junction.
- Average delay experienced per vehicle was 49.04 seconds on zudio road and maximum upto 135.73 seconds.
- Average delay experienced by all the pedestrian in network was 50 seconds.

4.3 Designing And Analysis Of Existing Layout Of Junction For A Predicted Scenario Of After A Decade

- The similar analysis was performed on the same layout and same parameters were used for a after decade scenario.

Table V Queue Analysis For Existing Layout After A Decade

PTV VISSIM					
QUEUECOUNTEREVALUATION: SIMRUN	TIMEINT (SEC)	ROAD	QLEN METER	QLENMAX METER	QSTOPS NOS.
AVG	0-3600	ZUDIO	232	415.56	1587
AVG	0-3600	BRIDGE	125	200.7	371
AVG	0-3600	STATION	35.5	90.08	259
AVG	0-3600	DEPOT	58.3	88.95	413
AVG	0-3600	STREET	0.28	21.67	0

- The growth rate of 6.5 % per year was used for the prediction of traffic growth. {Source: - Comprehensive Mobility Plan For Greater Mumbai.}
- The growth was later used for a decade growth by formula $A = P(1 + r) \wedge n$ {Source: - IRC 037:2019}
- The population growth of 50% rise was taken into account for a after decade scenario {Source: - Action Plan For Control Of Air Pollution In Non-Attainment Cities Of Maharashtra, Vasai – Virar Municipal Corporation.}
- It was observed that if the layout of the junction is kept the same over time, the traffic congestion will be a more severe issue over this particular reason.
- The queuing was almost increased to twice its length in the present scenario.
- The average speed dropped down from 13.5 km/hr to 6.89 km/hr for 100-meter parameter around the junction.
- Average delay experienced by the vehicles went up resulting in increase in travel time as well as fuel consumption.

Table VI Travel Time For Existing Layout After A Decade

PTV VISSIM						
VEHICLE TRAVELTIME MEASUREMENTEVALUATION :SIMRUN	TIMEINT SEC	LINK	VEHS(ALL) NOS.	TRAVEL TIME (ALL) SEC	DISTANCE TRAVEL (ALL) METER	SPEED (KM/HR)
AVG	0-3600	ZUDIO-BRIDGE	93	102.99	250.01	9
AVG	0-3600	ZUDIO-STATION	52	97.69	240.02	9
AVG	0-3600	ZUDIO-DEPOT	36	71.23	201.45	10
AVG	0-3600	BRIDGE-ZUDIO	92	151.61	200	5
AVG	0-3600	STATION-ZUDIO	144	112.62	200	6
AVG	0-3600	BRIDGE-DEPOT	13	138	150	4
AVG	0-3600	STATION-DEPOT	21	63.32	140	8
AVG	0-3600	DEPOT-BRIDGE	47	109.84	203.85	7
AVG	0-3600	DEPOT-ZUDIO	47	161.39	200.04	4

Table VII Delay Measurement For Existing Layout After A Decade

PTV VISSIM								
DELAY MEASUREMENTEVALUATION :SIMRUN	TIMEINT SEC	LINK	STOPDELAY (ALL) SEC	STOPS (ALL) NOS.	VEHDELAY (ALL) SEC	VEHS (ALL) NOS.	PERSDELAY (ALL) SEC	PERS (ALL) NOS.
AVG	0-3600	ZUDIO	31.01	3.81	68.25	181	82.26	597
AVG	0-3600	BRIDGE	62.87	14.69	133	104	138	156
AVG	0-3600	STATION	22.66	7.38	83.08	165	85.58	309
AVG	0-3600	DEPOT	77.56	6.89	113.98	94	102.68	210
MAX	0-3600	ZUDIO	44.68	4.48	82.23	193	99.9	618

MAX	0-3600	BRIDGE	68.75	17.77	148.82	111	152.89	164
MAX	0-3600	STATION	24.1	7.7	85.53	177	87.95	333
MAX	0-3600	DEPOT	80.27	6.92	118.79	102	106.83	223

4.4 Design Of New Layout For Civic Centre Junction

- With the same traffic volume count and same parameter used for existing layout, a new design is proposed with some suggestions.
- New design layout was prepared on AUTO-CAD, by referring IRC.GOV.IN. SP.041.1994 for design of triangular islands in the junction.

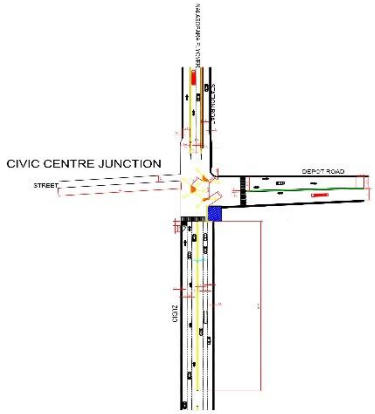

Figure 7 New Layout Of Civic Centre Junction

- For the above shown layout, the data was entered in PTV VISSIM and the stimulation was run again for an hour giving the following results.

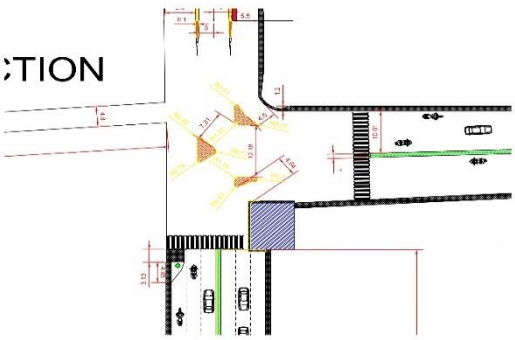

Figure 8 New Layout Detailed View

- New layout simulation run resulted in lesser queue formation and less delay in vehicles, the main targeted road link of zudio to bridge was improved to a great extent.
- From 230 meter of queue the queuing went down to 27.77 meters for zudio road in the new layout that was designed.
- Station road experienced the same queue length due to its lane width; meanwhile other roads were tackled and the congestion was reduced to a great extent by the new layout.
- Average speed went up to 22.53 km/hr parameter of the junction.
- Average delay was also reduced to a great extent.

Table VIII Queue Analysis For New Layout

PTV VISSIM					
QUEUECOUNTEREVALUATION: SIMRUN	ROAD	TIMEINT SEC	QLEN METER	QLENMAX METER	QSTOPS NOS.
AVG	ZUDIO	0-3600	0.42	27.77	2
AVG	BRIDGE	0-3600	6.63	39.25	107
AVG	DEPOT	0-3600	1.15	21.73	10
AVG	STATION	0-3600	7.18	27.99	68
AVG	STREET	0-3600	0	0	0

PTV VISSIM						
VEHICLETRAVELTIME MEASUREMENTEVALUATION :SIMRUN	TIMEINT SEC	LINK	VEHS (ALL) NOS.	TRAVEL TIME (ALL) SEC	DISTANCE TRAVEL (ALL) METER	SPEED (KM/HR)
AVG	0-3600	ZUDIO-BRIDGE	60	28.96	249.13	31
AVG	0-3600	ZUDIO-STATION	33	28.45	239.16	30
AVG	0-3600	ZUDIO-DEPOT	30	30.22	198.51	24
AVG	0-3600	BRIDGE-ZUDIO	132	46.01	199	16
AVG	0-3600	STATION-ZUDIO	89	68.22	199.11	11
AVG	0-3600	BRIDGE-DEPOT	33	35.21	146.18	15
AVG	0-3600	STATION-DEPOT	11	25.78	135.24	19
AVG	0-3600	DEPOT-BRIDGE	45	23.64	200.46	31
AVG	0-3600	DEPOT-ZUDIO	75	25.94	198.29	28

Table IX Travel Time For New Layout

Table X Delay Measurement For New Layout

PTV VISSIM								
DELAY MEASUREMENT EVALUATION :SIMRUN	TIMEINT SEC	LINK	STOP DELAY (ALL) SEC	STOPS (ALL) NOS.	VEH DELAY (ALL) SEC	VEHS (ALL) NOS.	PERS DELAY (ALL) SEC	PERS (ALL) NOS.
AVG	0-3600	ZUDIO	0.19	0.1	2.81	123	2.08	293
AVG	0-3600	BRIDGE	8.36	2.41	27.25	165	27.4	246
AVG	0-3600	STATION	13.84	3.68	40.92	100	43.53	192
AVG	0-3600	DEPOT	0.78	0.2	4.3	120	3.36	274

MAX	0-3600	ZUDIO	0.19	0.1	2.81	123	2.08	293
MAX	0-3600	BRIDGE	8.36	2.41	27.25	165	27.4	246
MAX	0-3600	STATION	13.84	3.68	40.92	100	43.53	192
MAX	0-3600	DEPOT	0.78	0.2	4.3	120	3.36	274

4.5 Design Of New Layout For Civic Centre Junction After A Decade Scenario

- Similarly, the new layout was analyzed with data computed for after a decade scenario to check whether the layout keeps performing in a better condition.
- It was observed by the simulation run results that the new design was able to performed well even after a rise in traffic volume and pedestrian count.
- The main focus of this study, Zudio road experienced a maximum queue length of 38.75 meter when compared to existing layout which causes a queue length of around 230 meter in the present date, the new layout was a great success
- Traffic coming from the flyover experienced the same queuing for after a decade scenario since the lane width of the flyover for one way traffic is 3 meters.
- Hence it was clearly observed in the results obtained through the stimulation that the new proposed layout of the design is far better than the existing layout.

Table XI Queue Analysis for New Layout After A Decade Scenario

PTV VISSIM					
QUEUECOUNTEREVALUATION: SIMRUN	TIMEINT SEC	ROAD	QLEN METER	QLENMAX METER	QSTOPS NOS.
AVG	0-3600	ZUDIO	2.01	38.75	10
AVG	0-3600	BRIDGE	111.03	199.19	557
AVG	0-3600	STATION	81.7	167.32	274
AVG	0-3600	DEPOT	2.29	41.52	11
AVG	0-3600	STREET	0.28	21.67	0

Table XII Travel Time For New Layout After A Decade Scenario

PTV VISSIM								
DELAY MEASUREMENTEVALUATION :SIMRUN	TIMEINT SEC	LINK	STOPDELAY (ALL) SEC	STOPS (ALL) NOS.	VEHDELAY (ALL) SEC	VEHS (ALL) NOS.	PERSDELAY (ALL) SEC	PERS (ALL) NOS.
AVG	0-3600	ZUDIO	0.38	0.27	9.89	158	10.95	497
AVG	0-3600	BRIDGE	28.18	7.28	77.68	190	78.79	283
AVG	0-3600	STATION	49.85	9.98	112.59	115	119.48	218
AVG	0-3600	DEPOT	5.34	0.77	14.23	216	24.24	461
MAX	0-3600	ZUDIO	0.97	0.52	10.94	159	11.7	498
MAX	0-3600	BRIDGE	33.7	7.54	85.63	193	86.92	287
MAX	0-3600	STATION	66.16	10.52	120.42	118	127.74	225
MAX	0-3600	DEPOT	5.83	0.81	15.27	220	28.59	468

PTV VISSIM						
VEHICLETRAVELTIME MEASUREMENTEVALUATION :SIMRUN	TIMEINT SEC	LINK	VEHS(ALL) NOS.	TRAVEL TIME (ALL) SEC	DISTANCE TRAVEL (ALL) METER	SPEED (KM/HR)
AVG	0-3600	ZUDIO-BRIDGE	77	38.17	249.13	23
AVG	0-3600	ZUDIO-STATION	44	31.09	239.16	28
AVG	0-3600	ZUDIO-DEPOT	37	36.59	198.51	20
AVG	0-3600	BRIDGE-ZUDIO	154	96.9	199	7
AVG	0-3600	STATION-ZUDIO	102	144.62	199.11	5
AVG	0-3600	BRIDGE-DEPOT	36	83.37	146.18	6
AVG	0-3600	STATION-DEPOT	13	57.73	135.24	8
AVG	0-3600	DEPOT-BRIDGE	88	43.83	200.37	16
AVG	0-3600	DEPOT-ZUDIO	128	28.83	198.29	25

Table XIII Delay Analysis for New Layout After A Decade Scenario

5. Suggestions

- Relocating of light commercial vehicle parking 100 meter away from the entry point of junction on Zudio road.
- Relocating of Auto stand which was inside the junction to depot road.
- Providing of median with chevron marking at the start of the flyover, to align the traffic going out and coming in the junction.

6. Conclusion

As seen in the results if the current design is kept the same it will go on increasing the traffic congestion resulting in more travel time and more fuel consumption over time.
While the new layout that is designed is tackling with the problem more efficiently and will be more beneficial to emergency service during an emergency.
Hence it is proposed to implement this new design for the Civic Centre Junction along with suggestion that are mentioned above for a better traffic flow and road safety.

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