

# PERFORMANCE ANALYSIS OF A ROUNABOUT USING SIDRA INTERSECTION SOFTWARE

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**Abstract:** Because the ascension of population in developing cities increases the traffic volume. As the traffic volume increases the congestion of the traffic at the intersections also increases. Hyderabad is additionally one amongst the developing cities in Telangana. Modern roundabouts are used successfully throughout the world as a junction control device. Hyderabad also has its share of roundabouts. There are three legs; four legs; five legs and 6 legs roundabouts in Hyderabad; however little attention has been paid to the planning and capacity evaluation of the roundabouts. This study ends up in measure the performance analysis of a roundabout by using SIDRA intersection software. we've got just analyzed performance measure of a 4-legged roundabout intersection named as YMCA CIRCLE at Narayanaguda, Hyderabad and concluded that the Roundabout is found at the center of the city's business center, the roundabout is vulnerable to high traffic volume during peak and off-peak hours and also the level of service at the approach legs range from C to F, therefore there's a necessary of redesigning the roundabout or to supply suitable alternative.

**Key Words:** Roundabouts, SIDRA intersection, performance model analysis, empirical gap – acceptance method

## I. INTRODUCTION

Roundabouts are widely employed in Europe, Australia, and recently have received more acceptances within the us and other countries. Roundabouts work than traffic signals at intersections with low to medium traffic volumes. They reduce the delay, better handle intersections with high volumes of left turns, reduce fatal and injury accidents, reduce the speeds of approaching vehicles to the intersection, have lower maintenance costs, and supply a chance for landscaping inside the central island. Hyderabad Metropolitan Development Authority (HMDA) is that the sixth largest city in India, with a population of seven.1 million within the year 2014. town is one amongst the fastest growing metropolitan cities with a decadal rate of 32%. The urban agglomeration of Hyderabad meet a district of 650sq. km which comprises Hyderabad, and twelve other municipal entities surrounding it. The Hyderabad city is experiencing the rigorous changes in its infrastructure which is because of rapid urbanization, service-oriented activities and industrial development. town also exhibits that vehicular growth isn't in proportionate with the available road geometry. Most of the urban roads in HMDA area are static in behaviour during peak hours. this can be resulting in traffic jam and in-turn to endless transportation gridlocks which encompasses a direct impact on economy. Increasing in congestion levels which end up in reducing the common journey speeds at signalized intersection and roundabouts within the Hyderabad city. Delay at roundabouts, which is because of the absences of lane-based traffic system at roundabouts. this can be also result in increased threat to safety of road users. Indiscipline parking by the vehicle owners in any respect of CBD areas within the city. Poor existing geometric design of roundabouts which is insufficient to accommodate the present traffic volume. Variation in carriage widths creating turbulence in traffic flow. Now days, it's common to work out traffic jam at junctions in Hyderabad at peak hours within the morning and afternoon. the matter worsens especially at roundabout junctions, since it's more passionate about driver behaviour and balanced traffic flow between the approaches. This problem will continue, and it should worsen within the future because of the ascension of population and vehicle numbers in Hyderabad. Poor road planning and sub-standard geometric conditions of roundabouts have a major effect on roundabout capacity and traffic jam. Therefore, it's vital to judge the capacity performance of roundabouts for a stronger traffic flow.

## II. SOFTWARE DESCRIPTION

SIDRA INTERSECTION includes a full implementation of the roundabout capacity models described in HCM 6 (Highway Capacity Manual Edition 6, TRB 2016) and in HCM 2010 (TRB 2010a). SIDRA INTERSECTION offers powerful extensions to those models to boost roundabout design capabilities. The roundabout capacity model is that the only analysis method within the Highway Capacity Manual which uses lane-by-lane analysis, and intrinsically it's best implemented by SIDRA INTERSECTION which has been employing a lane-based model for all sorts of intersection since the 1980s, and now extended to a lane-based network model. The Highway Capacity Manual acknowledges the necessity to use alternative models visible of varied shortcomings of the HCM. Major extensions to the capacity and performance estimation method when the HCM 6 and HCM 2010 roundabout capacity models are utilized in SIDRA INTERSECTION 8.

## III. LITERATURE REVIEW

**H. S. Al-Mandhari** (2014) This paper evaluates the performance of a multi-lane four legged modern roundabout operating in Muscat using SIDRA model. The performance measures include Degree of Saturation (DOS), average delay, and queue lengths. The geometric and traffic data were used for model preparation. Gap acceptance parameters, critical gap and follow up headway, were used for calibration of SIDRA model. The results from the analysis showed that currently the roundabout is experiencing delays up to 610 seconds per vehicle with DOS 1.67 during peak hour. Further, sensitivity analysis for general and roundabout parameters was performed, amongst lane width, cruise speed, inscribed diameter, entry radius and entry angle showed that inscribed diameter is most important factor affecting delay and DOS. Up gradation of roundabout to completely signalized junction was found because the suitable solution which is able to serve for future years with LOS C for design year having DOS of 0.9 with average control delay of 51.9 seconds per vehicle. **Prakash Ranjitkar** (2014) hold up has significant social, economic and environmental costs related to it.

Efficiency of intersections contributes significantly towards the efficiency of whole urban road networks as they're the most bottlenecks within the system. This paper presents a comparative analysis of the operational efficiency of priority controlled, roundabout and signalised intersections under a spread of traffic conditions with different volume and turning ratios using SIDRA software. We used three measures to represent the operational efficiency namely: intersection capacity, average delay and total emissions. The analysis revealed strengths and weaknesses of every intersection types under a spread of demand and traffic conditions. At low traffic demand, priority-controlled intersections outperformed the opposite two types of intersection control. At moderate traffic demand, roundabout performed the most effective while at high traffic demand, signalised intersections performed the most effective. **Russell et al.** (2005) compared the operational performance of 11 intersections in 5 cities before and after their conversions to modern roundabouts. The study followed the identical methodology because the earlier study by **Mandavilli et al.** (2004). The SIDRA software was accustomed provide measures of effectiveness so on compare the intersection types. The MOEs chosen for this study are the 95th percentile queue length, degree of saturation, average intersection delay, maximum approach delay, proportion of vehicles stopped, and maximum proportion of vehicles stopped. before the SIDRA analysis, statistical tests were performed to determine if the before and after traffic volumes were statistically similar. **Al-Omari et al.** (2004) developed a model for estimating roundabout delay as a function of traffic and geometric factors. a complete of twenty hours of field traffic and geometric data were collected from fourteen roundabouts located throughout Jordan. Data were collected on sunny days from locations with good pavement conditions and through times when there have been no policemen within the area. it absolutely was unattainable to gather data during congested conditions because traffic police control roundabouts at these times. Circulating volume, entry volume, and entry delay were measured during peak and non-peak periods using video cameras.

#### IV. OBJECTIVES OF STUDY

The objective of this paper is to review the performance and capacity at selected roundabout intersection.

- To assess the present performance of the intersection from traffic flow efficiency and safety perspectives by considering all road users.
- To analyze the queue lengths, vehicular delay, degree of saturation, Co2 emission, travel speed and level of service using SIDRA INTERSECTION software on selected roundabout.

#### V. SCOPE OF THE STUDY

This research will concentrate on roundabout located at YMCA circle Narayanaguda in Hyderabad city. The analysis using empirical gap – acceptance method using SIDRA INTERSECTION software will provide a stronger platform to grasp the movement of traffic vehicles additionally as pedestrian movement. Queue length and vehicle delay will be calculated at the respective roundabout. Depending upon the queue length and vehicular delay, LOS is additionally calculated for the given traffic parameters. Therefore, the result of this research will provide a stronger understanding of the traffic flow at YMCA circle Narayanaguda. The results obtained have a awfully usage potential in Hyderabad city and in urban areas of comparable traffic characteristics.

#### VI. RESEARCH METHODOLOGY

For the present study a 4-legged roundabout intersection named as YMCA CIRCLE at Narayanaguda Hyderabad as shown in Figure 1 is identified for the study:.



Figure 1 4-Legged Roundabout Intersection

The research methodology for the current study is carried out in 2 Phases as shown in Figure 2.

**Phase I** – Filed survey was conducted at intersection to find out Traffic volume, lane widths. Data was collected in two phases, manually and through Government officials **Phase II** – Analysis of the collected data is done using SIDRA INTERSECTION. Network models were created as per the existing design and parameters like Queue length, Vehicular delay and LOS was found out.

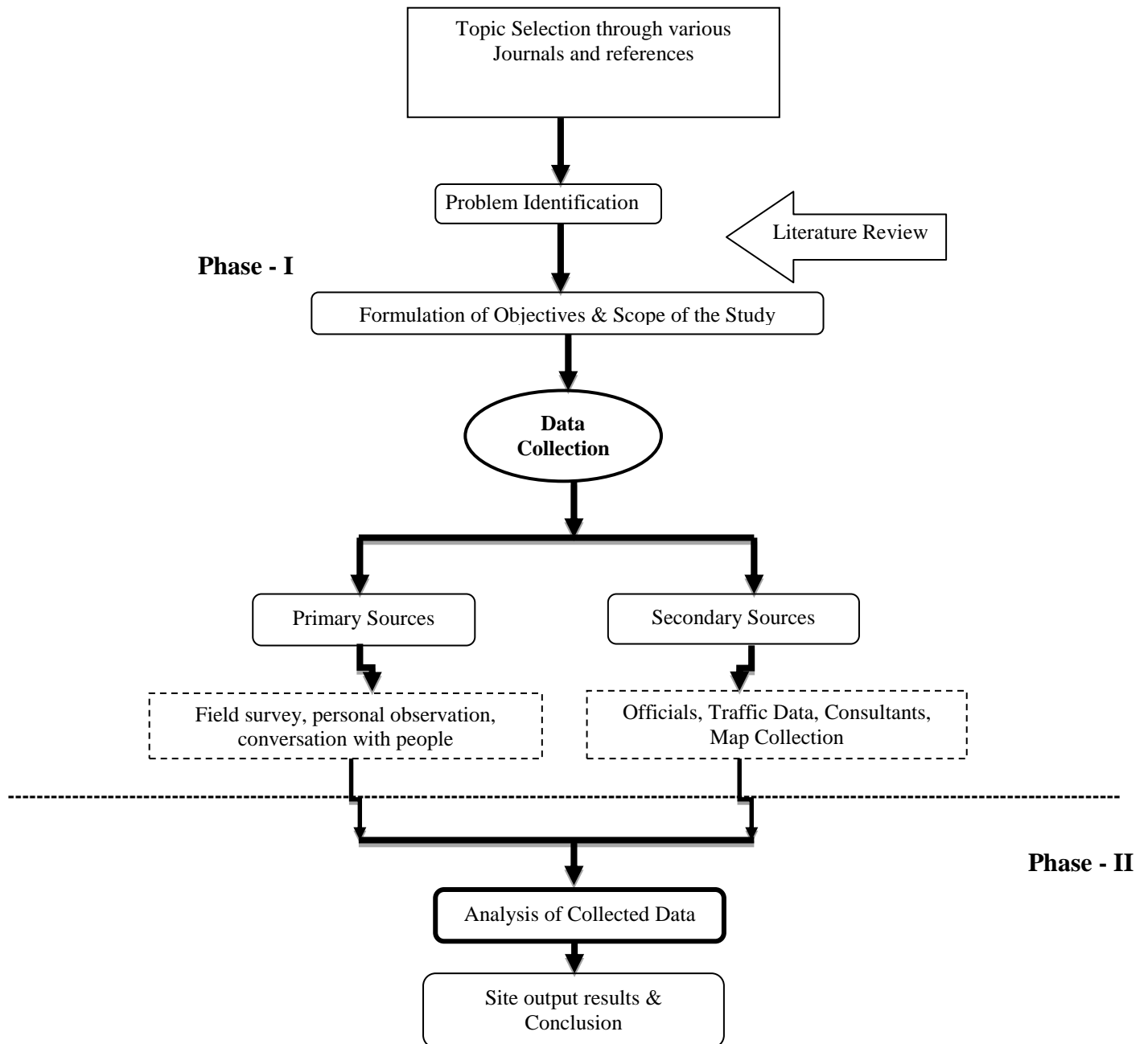


Figure 2 Research flow chart

**Phase – I Data Collection**

Geometric data collection of YMCA CIRCLE (Narayanaguda) is shown in Table 1.

**Table 1 Geometric characteristics of roundabout**

Roundabout name	Island diameter (m)	Direction	Entry width (m)	Circulating width (m)
YMCA CIRCLE (Narayanaguda)	17	Barkathpura road	9.5	11.3
		kacheguda signal	11.2	11
		king koti road	9.5	11.2
		Narayanguda road	12	11.6

Traffic data collection of YMCA CIRCLE (Narayanaguda) is shown in Table 2.

**Table 2 Details of Traffic Volume at YMCA CIRCLE (Narayanaguda), Hyderabad.**

Leg Direction	Heavy Vehicle	Light Motor Vehicle	Motor Cycle	Total Vehicles	Traffic Volume (PCU/h)
Barkathpura road (S)	14	280	466	760	534
kacheguda signal (W)	22	320	601	943	654
king koti road (N)	24	250	491	765	541
Narayanguda road (E)	22	310	589	921	638

**Phase – II Analysis of roundabout by SIDRA intersection**

**Basic Assumptions:** The following input data were assumed for a better prediction and analysis:

- **Movement classes** – only Standard movement classes were assumed in the SIDRA intersection movement class entry, which are: Light Vehicles, Heavy Vehicles
- **Roundabout Capacity Model** – SIDRA Standard capacity model was selected for roundabout analysis.
- **Roundabout Level of Service (LOS) Method** – SIDRA Roundabout LOS was selected for roundabout level of service analysis.
- **Environmental Factor** - Environmental factor of 1.0 was selected.
- **Volume Factors:** Peak Flow Factor – A peak flow factor of 92% was considered for all movement classes. Growth Rate – A growth rate of 2% per year was selected for all movement classes.
- **Gap acceptance Data** – A minimum departure of 2.5 vehicle per minute was taken for gap acceptance.
- **Movement Path Data** – Approach and Exit cruise speed for all movement classes was taken as 30km/hr.
- **Analysis** – the analysis was performed based on the level of service target considering the worst lane for a design life of 10 years.
- **LOS** – The site level of service target was set to LOS D, for the peak hour demand.
- **Vehicle Operating Cost:** Pump fuel Price = 75Rs/L, Fuel Resource cost factor = 0.5, Ratio of running cost to fuel cost = 0.30
- **Vehicle Time Cost:** Average income = 44 rupees/hr, Time value factor = 0.6
- **Site inputs:** Intersection, Movement Definitions, Lane Geometry, Lane movements, Roundabouts, Pedestrians, Volumes, Gap acceptance, Vehicle movement data, Parameter settings

The intersection data, movement class input, lane configuration, lane input, roundabout and pedestrian movement data, etc are presented in Figure 3-14 below:

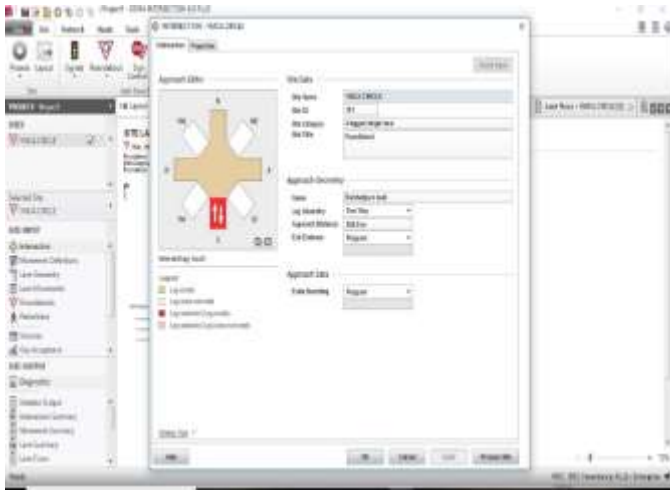


Figure 3 Intersection data input

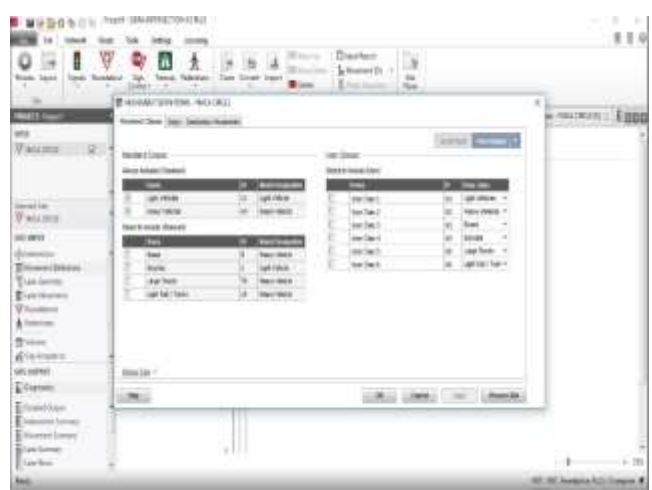


Figure 4 Movement classes input

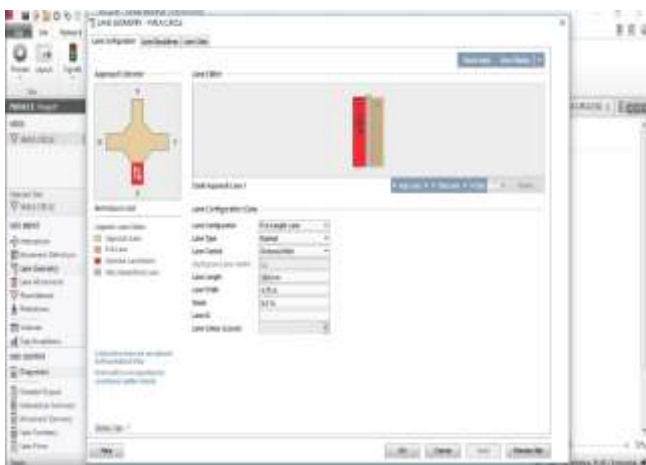


Figure 5 Lane configuration input



Figure 6 Lane movements input



Figure 7 Roundabout data input

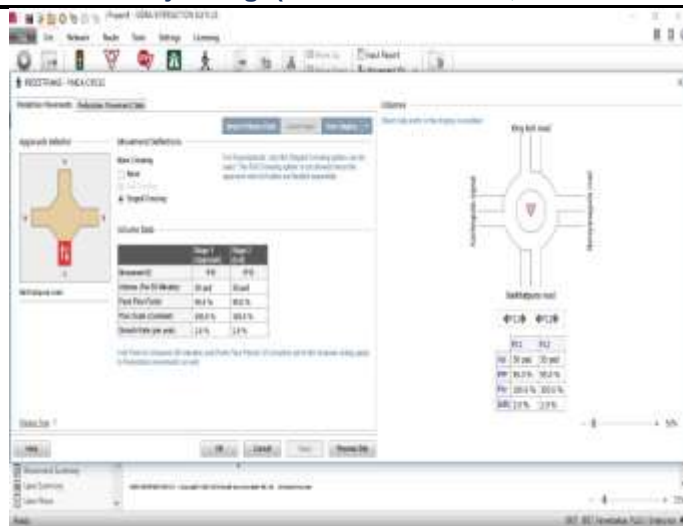


Figure 8 Pedestrian movement input

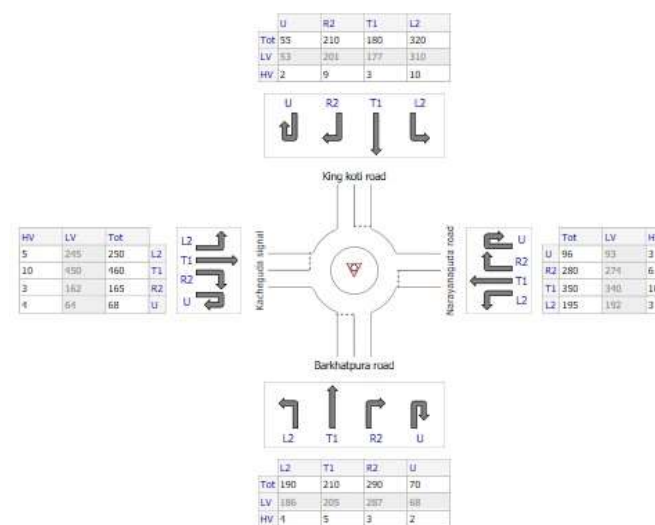


Figure 9 vehicle volume input

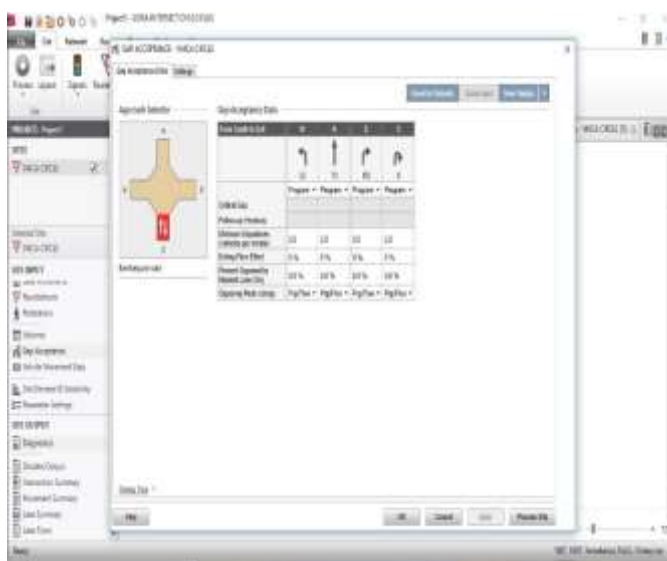


Figure 10 Gap acceptance parameter data

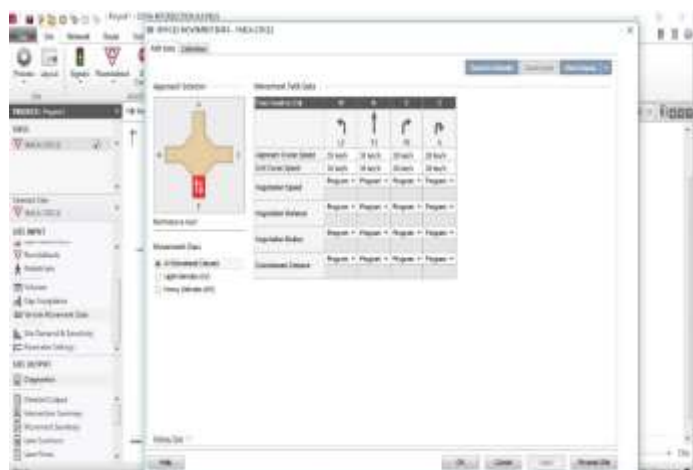


Figure 11 Vehicle movement data input

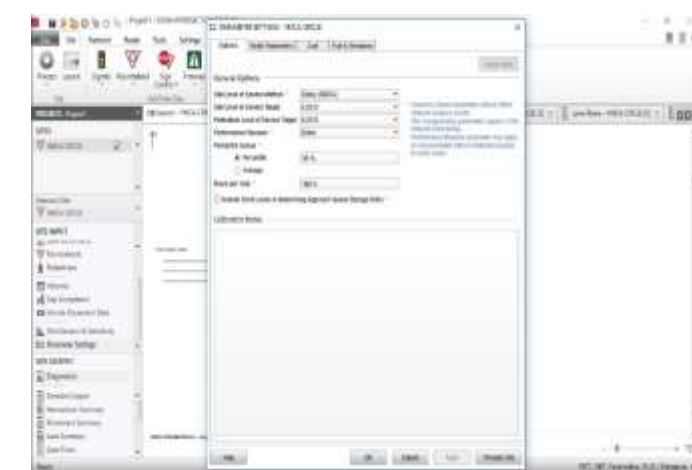


Figure 12 Parameter setting option input data

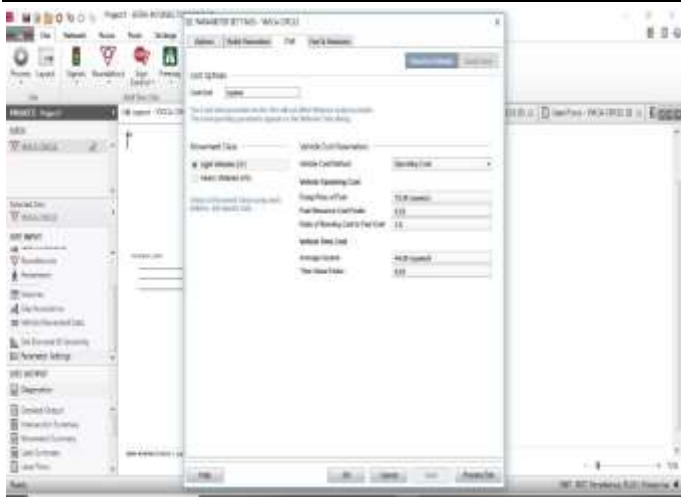


Figure 13 Cost data input

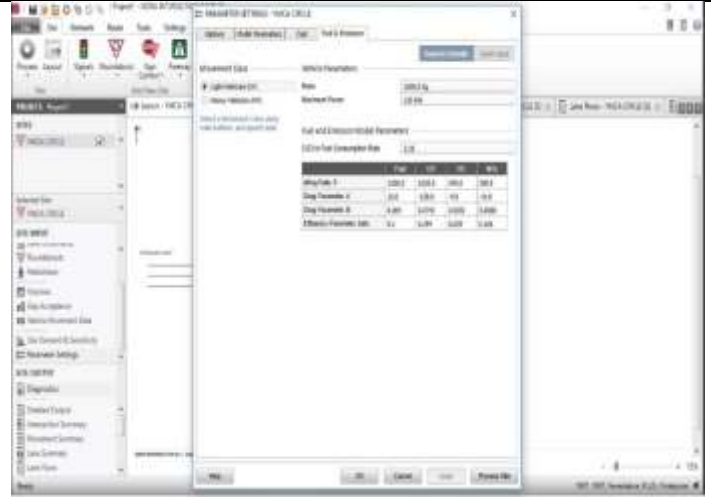


Figure 14 Fuel and emission data input

**VII. SITE OUTPUT RESULTS**

The result showing the delay, degree of saturation, average queue, LoS, travel speed, Co2 emission, performance of vehicle movement and land use, etc. are presented in Table 3- 8 as below:

**Table 3 Delay in seconds for all movement classes**

	Approaches				Intersection
	South	East	North	West	
Delay (Control)	327.5	27.6	171.2	133.1	157.9
LOS	F	C	F	F	F

**Table 4 Degree of saturation**

	Approaches				Intersection
	South	East	North	West	
Degree of Saturation	1.69	0.98	1.32	1.25	1.69

**Table 5 Average queue distance**

	Approaches				Intersection
	South	East	North	West	
Queue Distance (Aver)	357	72	233	233	357

**Table 6 Lane Level of Service**

	Approaches				Intersection
	South	East	North	West	
LOS	F	C	F	F	F

**Table 7 Travel Speed**

	Approaches				Intersection
	South	East	North	West	
Travel Speed	8.3	41.8	15.8	19.0	15.9

**Table 8 Total CO2 Emission**

	Approaches				Intersection
	South	East	North	West	
CO2 (Total)	435.7	254.3	330.3	365.2	1385.5

**Table 9 Movement Performances – Vehicle**

<b>Movement Performance - Vehicles</b>
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Mov ID	Turn	Demand Flows		Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		Total	HV				Vehicles	Distance				
		veh/h	%	v/c	sec		veh	m				km/h
South: Barkhatpura road												
1	L2	207	2.1	1.685	326.3	LOS F	124.8	887.1	1.00	6.37	9.06	8.2
2	T1	228	2.4	1.685	325.9	LOS F	124.8	887.1	1.00	6.37	9.06	8.2
3	R2	315	1.0	1.685	328.8	LOS F	124.8	887.1	1.00	6.37	9.06	8.3
3u	U	76	2.9	1.685	329.7	LOS F	124.8	887.1	1.00	6.37	9.06	8.4
Approach		826	1.8	1.685	327.5	LOS F	124.8	887.1	1.00	6.37	9.06	8.3
East: Narayanaguda road												
4	L2	205	1.5	0.977	25.5	LOS C	25.1	179.4	1.00	1.54	2.35	41.2
5	T1	368	2.9	0.977	25.7	LOS C	25.1	179.4	1.00	1.54	2.35	42.0
6	R2	295	2.1	0.977	29.9	LOS C	25.1	179.4	1.00	1.54	2.35	41.9
6u	U	101	3.1	0.977	32.1	LOS C	25.1	179.4	1.00	1.54	2.35	42.4
Approach		969	2.4	0.977	27.6	LOS C	25.1	179.4	1.00	1.54	2.35	41.8
North: King koti road												
7	L2	337	3.1	1.323	169.4	LOS F	80.6	579.0	1.00	3.38	7.14	15.8
8	T1	189	1.7	1.323	169.6	LOS F	80.6	579.0	1.00	3.38	7.14	15.9
9	R2	221	4.3	1.323	174.1	LOS F	80.6	579.0	1.00	3.38	7.14	15.8
9u	U	58	3.6	1.323	176.1	LOS F	80.6	579.0	1.00	3.38	7.14	15.9
Approach		805	3.1	1.323	171.2	LOS F	80.6	579.0	1.00	3.38	7.14	15.8
West: Kacheguda signal												
10	L2	263	2.0	1.251	131.8	LOS F	81.2	579.6	1.00	3.49	7.29	18.9
11	T1	484	2.2	1.251	132.0	LOS F	81.2	579.6	1.00	3.49	7.29	19.0
12	R2	174	1.8	1.251	136.3	LOS F	81.2	579.6	1.00	3.49	7.29	19.0
12u	U	72	5.9	1.251	138.5	LOS F	81.2	579.6	1.00	3.49	7.29	19.1
Approach		993	2.3	1.251	133.1	LOS F	81.2	579.6	1.00	3.49	7.29	19.0
All Vehicles		3593	2.4	1.685	157.9	LOS F	124.8	887.1	1.00	3.60	6.33	15.9

Table 10 Lane Use and Performance

Lane Use and Performance													
	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total	HV						Veh	Dist				
	veh/h	%	veh/h	v/c	%	sec		m		m	%	%	
South: Barkhatpura road													
Lane 1 d	826	1.8	490	1.685	100	327.5	LOS F	124.8	887.1	Full	500	0.0	25.9
Approach	826	1.8		1.685		327.5	LOS F	124.8	887.1				
East: Narayanaguda road													
Lane 1 d	969	2.4	992	0.977	100	27.6	LOS C	25.1	179.4	Full	500	0.0	0.0
Approach	969	2.4		0.977		27.6	LOS C	25.1	179.4				
North: King koti road													
Lane 1 d	805	3.1	609	1.323	100	171.2	LOS F	80.6	579.0	Full	500	0.0	9.5
Approach	805	3.1		1.323		171.2	LOS F	80.6	579.0				
West: Kacheguda signal													
Lane 1 d	993	2.3	793	1.251	100	133.1	LOS F	81.2	579.6	Full	500	0.0	9.5
Approach	993	2.3		1.251		133.1	LOS F	81.2	579.6				
Intersection	3593	2.4		1.685		157.9	LOS F	124.8	887.1				

## CONCLUSIONS

YMCA CIRCLE (Narayanaguda) performance analysis results indicate the foremost of the legs of roundabouts are in serious problems or over saturation. Supported observed actual field conditions it's common to determine that at peak hours, there's an oversized queue formation. Because the study uncovered the important issues are identified with deficiency of number of entry lanes, number of circulatory lanes, high traffic flow and unbalanced traffic on the approaches of the roundabout. The level of service at the approach legs range from C to F LOS. The North, South and West legs are in critical condition; which suggests that the lanes don't seem to be capable sustain the traffic volume that are imposed on them.

### Future scope of study

After studying the peak hour data collection for the roundabout that has high and unbalanced traffic flow, a replacement with other intersection type or redesign of roundabout is recommended. Since the analysis relies on traffic volume data which was collected for a brief period of your time with a manually performed count, the results may not fully reflect the particular condition on the sphere, therefore further study is prescribed with more data accumulation with a more robust equipment and data collection technique so on refine the result and to be used of roundabout traffic services improvement.

## REFERENCES

- [1] H. S. Al-Mandhari (2014) “*Performance Evaluation of Al Jame’ Roundabout Using SIDRA*” International Scholarly and Scientific Research & Innovation 8.
- [2] Prakash Ranjitkar (2014) “*Evaluating Operational Performance of Intersections Using SIDRA*”, The Open Transportation Journal.
- [3] Dr. Gandhi G. sofia (2012) “*Development of delay models for roundabouts*”, Journal of engineering and development vol 6.
- [4] Rahmi Akçelik (2011) “*Roundabout Metering Signals: Capacity, Performance and Timing*”, Elsevier Ltd.
- [5] Russell et al (2005) “*Operational performance of intersections*”, Independent thesis.
- [6] Al-Omari et al (2004) “*Model for estimating roundabout delay*”, Independent thesis.
- [7] Abishai Polus (2005) “*Evaluation of Roundabouts versus Signalized and Unsignalized Intersections in Delaware*”, Independent thesis.