

Analysis of Non-Conventional Roundabout Performance in Mixed Traffic Conditions

Guneet Saini, Shahrukh, Sunil Sharma

I. INTRODUCTION

Abstract—Traffic congestion is the most critical issue faced by those in the transportation profession today. Over the past few years, roundabouts have been recognized as a measure to promote efficiency at intersections globally. In developing countries like India, this type of intersection still faces a lot of issues, such as bottleneck situations, long queues and increased waiting times, due to increasing traffic which in turn affect the performance of the entire urban network. This research is a case study of a non-conventional roundabout, in terms of geometric design, in a small town in India. These types of roundabouts should be analyzed for their functionality in mixed traffic conditions, prevalent in many developing countries. Microscopic traffic simulation is an effective tool to analyze traffic conditions and estimate various measures of operational performance of intersections such as capacity, vehicle delay, queue length and Level of Service (LOS) of urban roadway network. This study involves analysis of an unsymmetrical non-circular 6-legged roundabout known as “Kala Aam Chauraha” in a small town Bulandshahr in Uttar Pradesh, India using VISSIM simulation package which is the most widely used software for microscopic traffic simulation. For coding in VISSIM, data are collected from the site during morning and evening peak hours of a weekday and then analyzed for base model building. The model is calibrated on driving behavior and vehicle parameters and an optimal set of calibrated parameters is obtained followed by validation of the model to obtain the base model which can replicate the real field conditions. This calibrated and validated model is then used to analyze the prevailing operational traffic performance of the roundabout which is then compared with a proposed alternative to improve efficiency of roundabout network and to accommodate pedestrians in the geometry. The study results show that the alternative proposed is an advantage over the present roundabout as it considerably reduces congestion, vehicle delay and queue length and hence, successfully improves roundabout performance without compromising on pedestrian safety. The study proposes similar designs for modification of existing non-conventional roundabouts experiencing excessive delays and queues in order to improve their efficiency especially in the case of developing countries. From this study, it can be concluded that there is a need to improve the current geometry of such roundabouts to ensure better traffic performance and safety of drivers and pedestrians negotiating the intersection and hence this proposal may be considered as a best fit.

Keywords—Operational performance, roundabout, simulation, VISSIM, traffic.

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WITH rapid urbanization and ensuing growth in number of vehicles, urban roads are getting excessively congested. Sustainable transportation has become a new buzz. One such area that is gaining acceptance of city planners and traffic engineers is roundabouts; although some drivers face problems in proper negotiation of this intersection type. The suffering areas are not just limited to large cities but also include small towns. In developing countries, government funds need to be used judiciously for implementation of an alternate design or replacement with a new design in the urban network. This entails the application of leading technology in planning, design and operation of urban networks to ease the congestion and reduce delays and conflicts. Traffic phenomenon is nonlinear and complex based on the interaction of different types of vehicles which are influenced by the driver's psychological behavior. Because of this, simulation models are gaining importance. In recent years, various techniques of traffic simulation have been used to assess roundabout performance. Simulation is a useful technique which is taking over the experimentation on physical system by experimentation on its explicit computer illustration.

Unsignalized intersections have very high crash rates due to large number of conflict points. Over the years, there have been many reformations in the design of a safe intersection. Initially the traffic was solely controlled by a policeman, then the rotaries were introduced which were then modified to present day roundabouts but still, at some roundabout intersections in India when there is high traffic flow, a policeman has to control it which is a result of design failure.

The glory of traffic circles after its introduction turned into criticism as the traffic volumes increased. This situation was faced globally by many countries experiencing gridlock conditions during high traffic volumes [1]. The concept of modern roundabout was established in United Kingdom to address problems related to traffic circles. The imposition of rule where circulating traffic had to yield to the entering traffic in 1966 resulted in better operational performance as there were no longer gridlocks at circular intersections [2], and improved safety due to significant drop in number and severity of crashes [1].

Though roundabouts are considered as a solution to safety concerns at intersections, a lot needs to be done to deal with the problems related to increasing travel demands. As presented in the NCHRP 2007 report [3], single-lane roundabouts are better in context of safety as compared to multi-lane roundabouts; but to satisfy the increasing travel

demands, multi-lane roundabouts are the preferred choice. To deal with challenges related to navigating multilane roundabouts, pavement markings, signs and other devices for traffic control play an important role guiding vehicles to maintain their travel lanes [4]-[6]. The operational performance of roundabouts is governed by one or more indices known as Measures of Effectiveness (MoE) [7]. The indices generally taken into account are: capacity, queue length and delay. LOS is the quality measure of intersection efficiency.

The maximum flow rate per hour at which traffic is expected to cross a point or a section of roadway during a particular time period under prevailing conditions is defined as capacity [8]. It is dependent on the following as observed in international literature [9]-[14]:

- Roundabout configuration by number of approach links and in circular roadway
- The geometric design at an acceptable level of detail
- The driver behavior in context of critical time gap T_c and follow up time gap T_f .

Delay is the consequence of time lost during the travel through a roundabout. In the context of traffic engineering, the queuing theory describes delay (w_s) as a result of following rates [15]:

- Queue waiting time (w_c): It is time taken by vehicle from the point of joining the queue till the time it reaches the yielding line
- Service time (T_s): It is time between the points of vehicle reaching the yielding line till entrance in the circulatory roadway to undergo required maneuver.

Hence,

$$w_s = w_c + T_s$$

Although the total delay is also attributed by the geometric delay caused by the time taken to accelerate and decelerate the vehicle, it is sufficient to analyze the system delay (w_s) to evaluate the efficiency of circulation.

Queue length is the number of vehicles waiting behind the vehicle which is currently maneuvering the roundabout. The vehicles queued is an essential measure of effectiveness because:

- It acts as a traffic flow quality index at the roundabout
- It is essential for design and validation of geometric layout of roundabout
- Its estimation helps to prevent traffic jam at intersection entry

Traffic Simulation is an effective tool to assess the performance of traffic networks and helps in designing new alternatives. The traffic simulation packages include building a virtual roadway network and observing the impact of different traffic demand levels on various control techniques prior to field implementation. There are multiple microsimulation software packages that are used for roundabouts such as VISSIM, ARCADY, RODEL, SIDRA, KREISEL and GIRABASE. VISSIM is one of the most widely used simulation software for modelling roundabouts.

As proved by Trueblood, VISSIM can effectively simulate driver's behavior [16]. The most significant input parameters are carefully analyzed for choice of variables for different scenarios [17].

This case study aims to assess the existing performance of a non-conventional roundabout using VISSIM software and propose countermeasures based on capacity, queue and delay measures.

II. SITE SELECTION, DATA COLLECTION AND ANALYSIS

A. Study Site Description

The site selected for this study, Kala Aam Chauraha, is a six-legged unsymmetrical roundabout exhibiting high traffic volume during peak hours. The roundabout experiences unbalanced flows, high congestion, long queues and poor traffic circulation due to missing roundabout geometry, unorganized hawkers and vehicular parking at the roundabout location. Therefore, the site serves as an appropriate case study for performance analysis of a roundabout using VISSIM software.

The study site, as shown in Fig. 1, is located in an old town of Bulandshahr in Uttar Pradesh, India, which is regionally connected to major cities like Delhi, Noida, Ghaziabad, Aligarh, Kolkata etc. via national and state highways. The study roundabout has historical significance and the surrounding area is a mixed-use development. The roads intersecting at the roundabout are:

- DM Road (ROW- 14 m, 2-way divided road)
- Savana Road (ROW- 24 m 2-way divided road)
- Hospital Road (ROW- 21 m, 2-way divided road)
- Preet Vihar Road (ROW- 16-20m, 2-way divided road)
- Delhi Road (ROW – 20-24 m, 2-way divided road)
- Police Line Road (ROW – 10 m, undivided road)

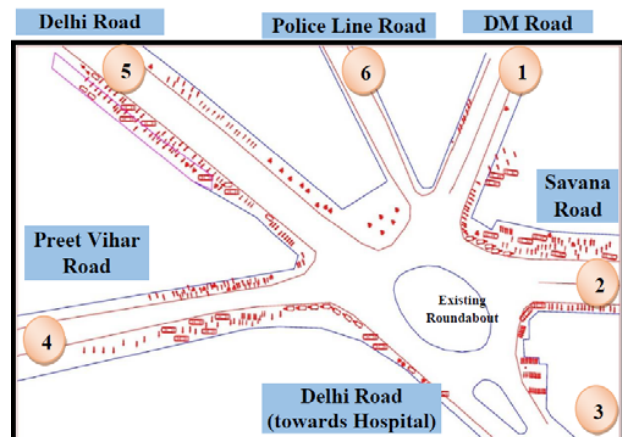


Fig. 1 Layout of Kala Aam Chauraha, Bulandshahr

B. Traffic Pattern Analysis

The traffic flow and delay observation at site using Google Maps for an entire week is done to analyze the traffic patterns during different time and days of week. The general pattern observed at the location is as shown in Fig. 3.



Fig. 2 An aerial view of Kala Aam Chauraha

C. Data Collection and Methodology

Data collection is a significant part of the study in order to

accurately model the roundabout in VISSIM software. The objective of the data collection exercise in this study is to determine the classified traffic flow at each approach to the roundabout, turning movements, speed profile, acceleration and deceleration of each vehicle class. In order to attain accuracy in modelling the field traffic operation at the study site in VISSIM, errors are avoided by taking appropriate measures. Prior to conducting the main survey, pilot survey is done at the location. During this survey, rough estimation of flow counts, training of enumerators and marking camera locations has been done. The final data collection survey details at study site are given in Table I.

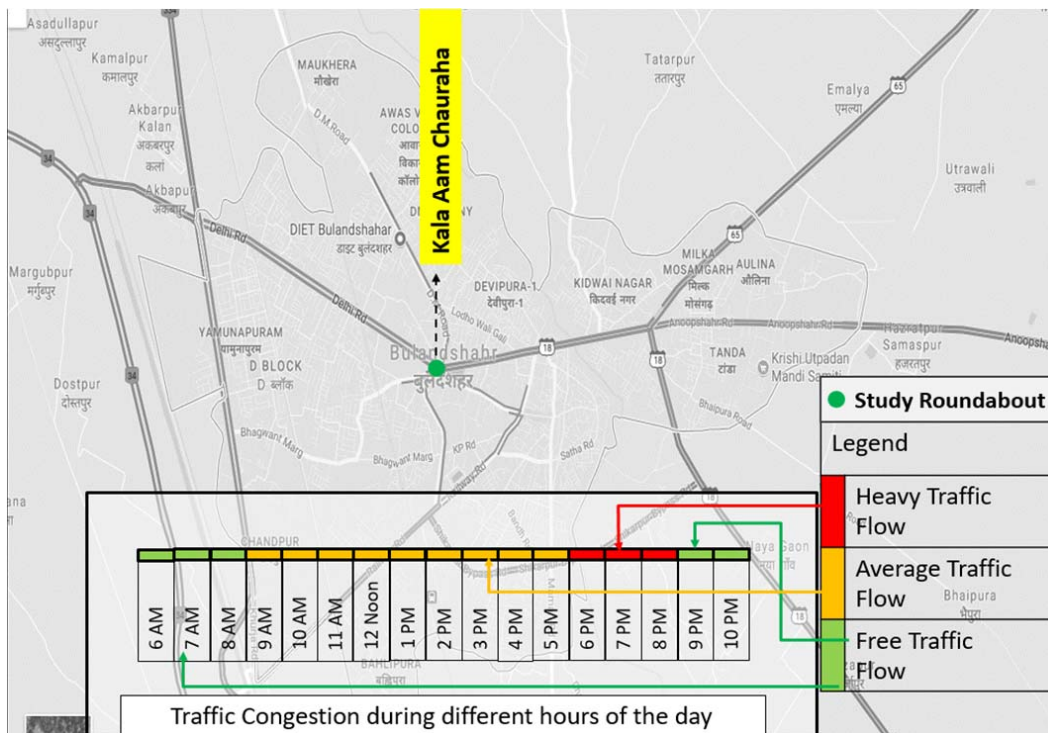


Fig. 3 Traffic Pattern Analysis of Kala Aam Chauraha

TABLE I
DATA COLLECTION DETAILS

Survey Duration	1 day
Time of survey	Morning Peak Hour (9am-11am) Evening Peak Hour (6pm to 8pm)
Survey Methodology	Video Recordings
Volunteers Required	4 (only for spot speed survey)
Extraction of data	By playing video tapes in lab
Time intervals	5 minutes

Here one video-camera was placed above the building of Police Station adjacent to one turning of roundabout giving a clear view point. Other cameras were installed to record the weaving and left turning traffic at the roundabout itself. Spot Speed Study for each vehicle type using speed guns has been done at each leg (entry and exit) of Kala Aam Chauraha, both

away and at entry of roundabout, to draw the “desired speed distribution” curve and “reduced speed distribution” curve, respectively.

The study used video recording technique for collection of entry traffic volume, exit traffic volume for each approach and some turning movements which require little effort and the rest were estimated using Gaussian Elimination Method.

Data obtained from video recording were used as an input to a model, based on Gaussian elimination approach proposed in [22], to obtain turning movements at roundabout. Since one leg of the roundabout has very less traffic flow, hence it can be ignored for simplification considering the roundabout as five-legged. The assumptions involved in the mathematical approach are as follows:

1. Continuous traffic flow i.e. parking or stopping at the

roundabout is neglected. $\sum E_i = \sum L_i$ (E_i = Entry traffic from leg i ; L_i = Exit traffic from leg i and T_{ij} = traffic moving from leg i to leg j)

2. U-Turns are neglected. Accordingly, $T_{ii} = 0$
3. Homogeneous traffic conditions exist i.e. same composition of traffic from all approaches

Fig. 4 shows the sketch of a 5-legged roundabout with all the turning movements from and to different legs. The data in this figure relates to all the known and missing turning movements at the site. This process required entry flow counts from each leg (E_i), exit flow counts for legs 2, 3, 4 and 5 (L_i) and weaving flow between leg 1 and 2 (W_{12}). For solving the equations, ten other redundant individual counts which could be obtained easily from site, are used e.g., left turns from one leg to adjacent leg ($T_{12}, T_{23}, T_{34}, T_{45}, T_{51}$) and next to left turns which required some extra effort ($T_{13}, T_{24}, T_{35}, T_{41}, T_{52}$).

Hence, the missing ten flows could be obtained from Gaussian Elimination Method by forming matrix and solving. The required matrix for the study is:

$$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} T_{14} \\ T_{15} \\ T_{21} \\ T_{25} \\ T_{31} \\ T_{32} \\ T_{42} \\ T_{43} \\ T_{53} \\ T_{54} \end{bmatrix} = \begin{bmatrix} E_1 - T_{12} - T_{13} \\ E_2 - T_{23} - T_{24} \\ E_3 - T_{34} - T_{35} \\ E_4 - T_{45} - T_{41} \\ E_5 - T_{51} - T_{52} \\ L_2 - T_{12} - T_{52} \\ L_3 - T_{13} - T_{23} \\ L_4 - T_{24} - T_{34} \\ L_5 - T_{35} - T_{45} \\ W_{12} - T_{12} - T_{13} - T_{52} \end{bmatrix}$$

The missing flows obtained by solving above matrix are as shown in Table II.

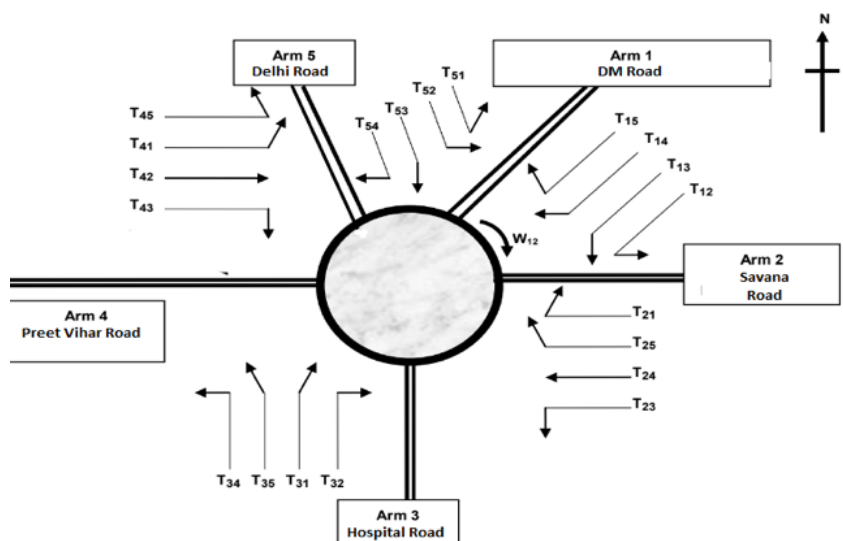


Fig. 4 Sketch of 5-legged roundabout showing all turning movements

TABLE II
MISSING TURNING MOVEMENTS

Morning Peak Hour	Evening Peak Hour		
T14	935	T14	947
T25	306	T25	218
T31	556	T31	603
T42	347	T42	34
T53	833	T53	799
T15	677	T15	808
T21	787	T21	876
T32	439	T32	615
T43	131	T43	378
T54	123	T54	7

The data collected of spot speed at site are used to obtain speed distribution profile of different types of vehicles at each leg of the roundabout. The desired speed distribution curve for different modes has been obtained and used for base model development.

III. SIMULATION METHODOLOGY

The study has been carried out in steps including developing a microsimulation model, calibration and validation of model and then running simulations. The model development methodology has been explained in Fig. 5 using a flow chart.

The existing data used as an input in modelling include entry traffic volumes, turning movements, modal share of vehicles at each approach, desired and reduced speed profiles, acceleration/deceleration data, calibration and validation data (traffic volume per 5 minutes count interval, weaving speeds).

A base model is built in VISSIM software with all the input data that represent real traffic conditions at the site. Simulation on the base model developed is first run with default parameters and errors are identified. Then, the model is calibrated and validated to represent accurately the real traffic scenario at site. The errors are minimized to meet the validation targets and if the model does not meet the validation targets, it is again calibrated after making certain

adjustments. This step is repeated until an accurate model is obtained which precisely represents prevailing site conditions.

To obtain optimal parameters, a heuristic approach is applied for error-checking. In the process of calibration, simulations on the model are done with pre-selected parameters and Mean Absolute Percentage Error (MAPE) is checked between the simulated outputs and field outputs. If the MAPE value is very high, then the pre-selected parameters are adjusted in such a manner that the error keeps on minimizing. The parameters which influence the MAPE value are identified first and then value of one parameter is varied keeping the others fixed and simulations are run with the adjustments. The step is repeated until MAPE keeps on minimizing and hence, the parameter values with minimum MAPE values are selected as calibrated parameters. For this study, the selected parameters for calibration are: ax (average stand still distance), bx_add (additive part of safety distance) and bx_mult (multiplicative part of safety distance).

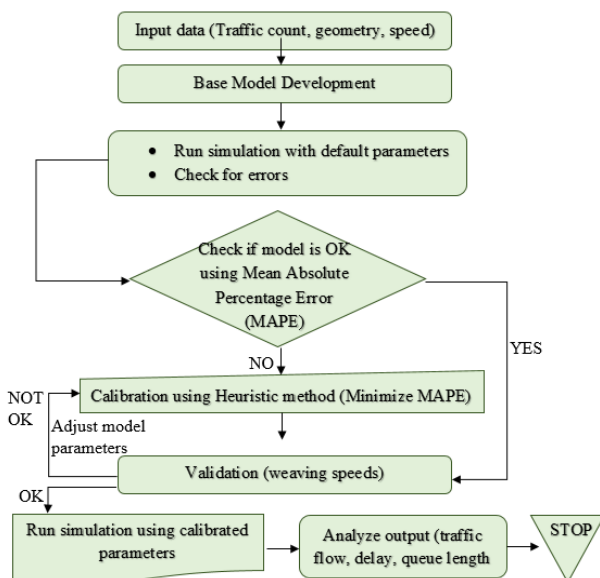


Fig. 5 Methodology for VISSIM simulation

A. Model Development in VISSIM

Developing a base model in VISSIM includes several components to accurately reproduce the current network such as:

- Links and Connectors

These are the main tools to build a road network of intersection. A satellite imagery of the study site with suitable scale is added in background and the network is constructed using links to build the roads and connectors to link two roads taking into account the curvature of roads, number of lanes, lane width and driving behavior, as shown in Fig. 6.

- Vehicle Inputs and Routing Decisions

After the network is developed, vehicle inputs are given at each entry link based on the data collected. 3-D models of different types of vehicle such as car, bus, truck, auto etc. have

been coded in the base model by modifying the configurations of existing models in the software based on field conditions. Routing decisions are coded based on the flow proportions and direction of travel from single origin to multiple destinations, as shown in Fig. 7.

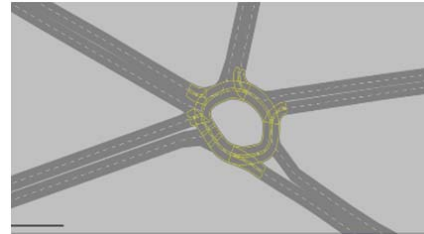


Fig. 6 Coding of study network using links and connectors

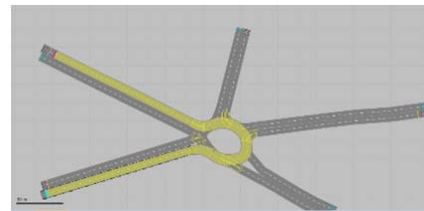


Fig. 7 Routing input at Kala Aam Chauraha base model

- Reduced Speed Areas

These zones force the driver in the network to slow their speed from its desired speed to the speed observed on field when the vehicle is entering the roundabout. This element acts as a control tool at roundabout entry and curvature.

- Priority Rules and Conflict Areas

To assign the yield control at the intersection, conflict areas and priority rules are the tools used. Conflict areas can clearly define priorities for a particular direction by giving Right of Way (ROW) to one direction and give-way to other. However, priority rules consist of a stop line at roundabout entry and conflict markers associated with it giving clear priorities.

- Speed Distribution and Acceleration/Deceleration Data

The speed profiles obtained from field data analysis for each vehicle class are coded in VISSIM under base data section. Separate curves are developed for desired speed zones and reduced speed zones. The maximum and desired acceleration and deceleration data for various modes are used according to Indian traffic scenario.

B. Model Calibration

Previous studies show that calibration is an important step in VISSIM to reciprocate the field conditions [18]-[21]. There are several parameters which can be calibrated in VISSIM but those parameters are selected which significantly affect the model output. In this study, car-following parameters are selected for calibration as explained below:

Wiedemann 74 model parameters are:

- ax_avg: average standstill distance which defines the average desired distance between stopped cars
- $bx = (bx_add + bx_mult * z) * \sqrt{v}$

bx is the desired safety distance with an additive (bx_add) and multiplicative part (bx_mult); v is the vehicle speed in m/s, z lies between 0 and 1 with a mean of 0.5 and standard deviation of 0.15

VISSIM parameters are calibrated using several trials in order to minimize error. MAPE value is obtained between default set of three parameters i.e. average stand still distance (ax_avg), additive part of safety distance (bx_add), and multiplicative part of safety distance (bx_mult) and field traffic flow data to check if the model closely reciprocates the roundabout. MAPE is minimized using a heuristic approach by modifying the set of mentioned parameters accordingly. The MAPE values obtained for the study roundabout are as shown in Table III and calibrated parameters obtained are as mentioned in Table IV.

TABLE III
ERROR IN CALIBRATION PARAMETERS AND OBTAINED MAPE VALUES

Trial No.	ax_avg	bx_add	bx_mult	Min Error %	Max Error %	MAPE
Default	2	2	3	40.70	55.27	47.99
1	1	1	1	1	13.39	4.57
2	1	1	3	1.11	18.78	6.75
3	1	1	2	0.55	34.53	12.15
4	1	2	1	1.25	17.13	4.91
5	0.5	1	1	0.13	14.38	5.93
6	0.5	0.5	1	0.138	22.27	6.85
7	0.25	0.50	0.50	0.83	24.86	7.82
8	0.25	1	1	0.14	15.35	5.37
9	0.75	1	1	0.41	12.15	4.18
10	1	0.75	1	0.26	17.26	7.57
11	0.75	0.75	0.75	0	21.16	5.42
12	0.5	0.5	0.5	0	18.92	6.31

TABLE IV
CALIBRATED PARAMETERS

Description	ax_avg	bx_add	bx_mult
Default Parameters	2	2	3
Calibrated Parameters_ Kala Aam Chauraha	0.75	1	1

C. Model Validation

Validation of the calibrated model is done to confirm if the model can successfully measure any performance indices. In this study, validation is done using circulating speeds that were collected between approach 1 and approach 2 during each peak hour data collection and compared with speeds obtained from running simulations with the calibrated model. The obtained MAPE in the validation process is given in Tables V and VI for each peak period.

IV. EXISTING AND ALTERNATE SCENARIOS

The existing and proposed scenarios have been prepared in VISSIM and analyzed to enhance efficiency of the roundabout performance. The existing scenario includes an unsymmetrical roundabout with poor traffic circulation. The proposed scenario is improving the geometry of central island to convert it into a modern roundabout increasing efficiency and safety. It also includes median for dividing roads, slowing traffic

down and establishing a yield control over entry traffic by proper diversion.

TABLE V
VALIDATION OF STUDY ROUNDABOUT FOR MORNING PEAK HOUR

Interval (seconds)	Circulating Speeds from VISSIM	Observed Circulating Speeds	Absolute Error (%)
0-300	20	19	5.26
300-600	16	18	11.11
600-900	16	17	5.88
900-1200	16	17	5.88
1200-1500	17	18	5.56
1500-1800	14	16	12.5
1800-2100	17	18	5.56
2100-2400	18	18	0
2400-2700	15	17	11.76
2700-3000	19	20	5
3000-3300	17	19	10.53
3300-3600	18	20	10
MAPE			7.42

TABLE VI
VALIDATION OF STUDY ROUNDABOUT FOR EVENING PEAK HOUR

Interval (seconds)	Circulating Speeds from VISSIM	Observed Circulating Speeds	Absolute Error (%)
0-300	22	20	10
300-600	19	20	5
600-900	20	19	5.26
900-1200	18	19	5.26
1200-1500	18	18	0
1500-1800	19	20	5
1800-2100	19	19	0
2100-2400	17	18	5.55
2400-2700	19	19	0
2700-3000	20	19	5.26
3000-3300	20	20	0
3300-3600	20	18	11.11
MAPE			4.37

The MoE of the proposed alternative would be capacity, queue length and vehicle delay at each approach to the roundabout. The success would be indicated by vehicle delay and queue length reduction. This will determine the acceptance or rejection of the proposal.

A. Alternate Scenario

Based on the data collection survey observation, the central island is an unplanned rotary because of which there was queue accumulation and increased delay at the intersection. The proposal is to improve the roundabout geometry by developing an elliptical roundabout of major axis 50 meters and minor axis of 25 meters. The geometry, as presented in Fig. 8, is motivated to reduce the vehicle speeds due to high pedestrian activity around the intersection. The splitter islands at all approaches are designed to divide the entering and exiting traffic and provide smooth channelization at entry to the roundabout ensuring yield control.

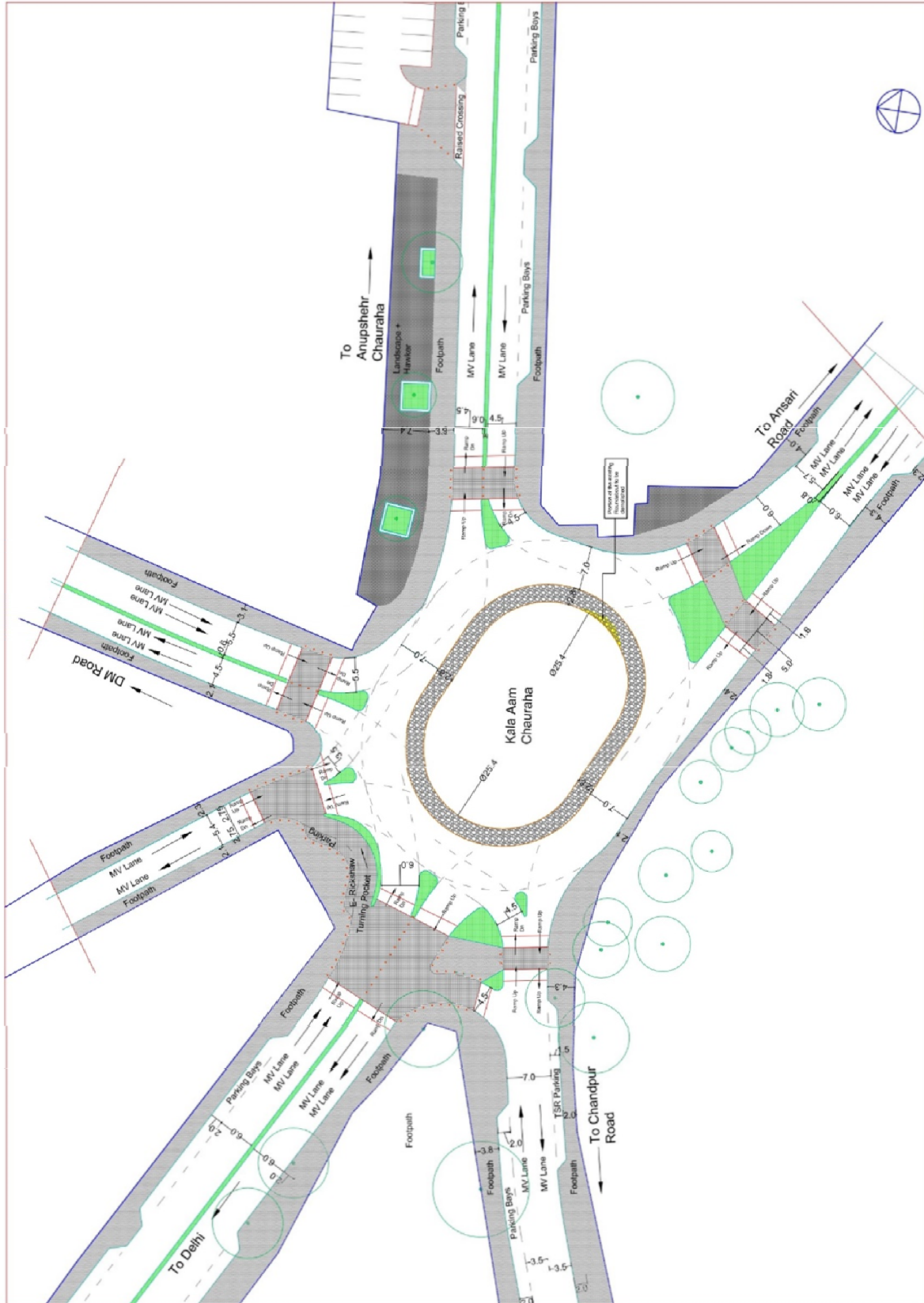


Fig. 8 Proposed Alternative for Kala Aam Chauraha

V.RESULTS AND ANALYSIS

Using the microsimulation platform, VISSIM, two scenarios are tested for the study intersection in this research. The primary MoE used to assess the operational performance of roundabout are queue length, average delay and capacity. The final conclusions are based on the simulation results of assessment of the proposal and its comparison with current traffic performance based on various MOE.

A. Simulation Results for Existing Traffic Conditions

For the analysis of the prevailing traffic scenario at the roundabout, morning and evening peak hour traffic flows are used. The results are compared for an interval of 5-minutes during each peak period. Three simulation runs are performed for the scenario and an average was used to compare. The results are divided into three parts: network results; link results and node area results.

- Network Results: As per simulation results, average vehicle delay of 26 seconds during morning peak and 27 seconds during evening peak has been observed. According to HCM criteria, roundabout is performing at LOS D in the existing scenario.
- Link Results: The average approach speed at each road for both peak periods is approximately 25 km/h for existing traffic flow conditions. Average vehicle speed at the circulatory roadway is approximately 18 km/h during both peak hours.
- Node area results: As observed from VISSIM results, average queue length and vehicle delay at Road 1 and Road 2 during both peak hours are approximately 6 m and 25 seconds, respectively. Road 3 and Road 4 experience an average queue length and average vehicle delay of approximately 18 m and 27 seconds, respectively during both peak periods. Road 5 experiences highest average delay length i.e. approximately 35 seconds for morning peak hour and 45 seconds for evening peak and highest average queue length, i.e. approximately 34 m during both peak hours.

It has been concluded that the current traffic at the intersection experiences heavy queue lengths and delays and hence, even a small increase in the number of vehicles in the near future will negatively affect the intersection performance leading to grid-lock conditions.

B. Simulation Results for Alternative Proposal

- Network Result Comparison: The proposal tested yields a reduction in total network delay by 6 seconds in morning peak hour accounting for 22% reduction and 8 seconds in evening peak hour accounting for 31% reduction. The results also show a significant reduction in average number of stops by 24%. The comparison is as shown in Figs. 9 and 10.
- Link Result Comparison: The comparison of link results show that the average speed at each link is negligibly affected with the proposed scenario. The entry density of vehicles at each link is reduced by a very small percentage.

- Node Area Result Comparison: The results observed in VISSIM show an average decrease in vehicle delay and queue length at Road 1 by 25% and 33%, respectively. Road 2 experiences a decrease in average delay and queue length by 35% and 69%, respectively, whereas Road 3 experiences 75% decrease in queue length and 58% decrease in control delay. The reduction in average queue length at Road 4 is 60% and at Road 5 is 70%, whereas reduction in average vehicle delay at Road 4 is 50% and at Road 5 is 30%.

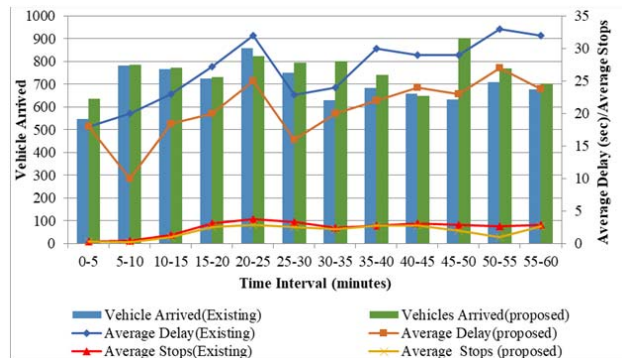


Fig. 9 Network Comparison: Alternative Scenario vs Existing Scenario (Morning Peak Hour)

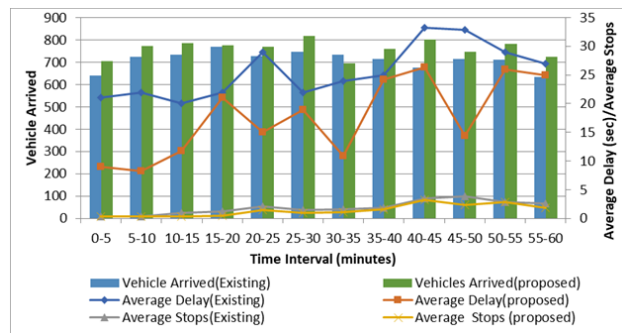


Fig. 10 Network Comparison: Alternative Scenario vs Existing Scenario (Evening Peak Hour)

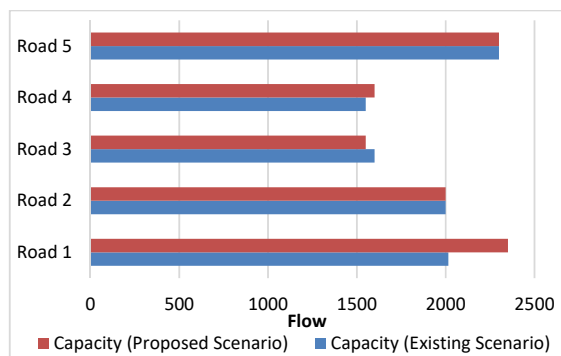


Fig. 11 Capacity Comparison: Proposed Alternative vs. Base Model

- Flow-Density Curve: The capacity of the roundabout is compared with the help of flow-density curves obtained

from link results in VISSIM. The capacity comparison of the alternative proposed with the base model is shown in Fig. 11.

VI. CONCLUSION

In this case study, VISSIM modelling of the Kala Aam Chauraha in Bulandshahr city of Uttar Pradesh, India was done to evaluate and visualize the existing performance of roundabout and test proposed alternatives to ease the traffic operation at the site. For this motive, data collection survey at all the approaches to the roundabout is carried out (neglecting a minor approach) giving due consideration to turning movements and vehicle type. The geometric configuration of the road network has been coded in VISSIM software along with traffic flow, turning movements, speed profile, and vehicle configurations. The base model developed was simulated with default parameters, errors are checked and then configuration of the model parameters is done using MAPE. The calibrated model is validated for reciprocation of real conditions. Calibration is an important step in simulation and in this study a heuristic approach has been followed to calibrate parameters by altering them in multiple simulation runs.

The main aim of this project is to propose an alternative to reduce congestion, delay and queue length at the intersection, that allow vehicles to safely negotiate the intersection. The MOE used in the study are capacity, average queue length and vehicle delay. The research involved identifying the inefficiencies in the geometry of study intersection and developing a proposal to improve traffic performance. The proposal involves improvement in the geometry of central island so as to convert it into a modern roundabout and enable proper circulation of traffic, splitter islands for dividing the opposite direction traffic and divert the entry traffic at each approach to enable yielding of entry traffic to the circulating traffic and safe pedestrian infrastructure.

The results show a considerable reduction in average vehicle delay and queue length for both morning and evening peak hours in the whole network and at each approach. Hence, this proposal is considered to significantly improve the roundabout performance by reducing vehicle delay and queue length.

This research only focused on the improvement of vehicular traffic operation without considering the effect of pedestrians at the intersection with the limitation of time and human resources, so the proposed scenario is also restricted. In further research, scope may be widened to include other alternatives such as pedestrians in the network. Also, other calibration methods may be used such as using VISSIM COM interface or Genetic Algorithm approach for better representation of traffic conditions and hence yielding better results.

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