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VIRTUAL TRAFFIC SIMULATION TECHNIQUES USING VISSIM

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ABSTRACT

It has been noted that many adaptive traffic control algorithms which work well in more homogeneous traffic environments have suboptimal performance in more heterogeneous traffic conditions that are not based on lanes. Most of the time, the underperformance attributed to inaccurate demand forecasting, suboptimal solutions, and lengthy computations times. In addition, using discharge headway methods for demand estimation has further added to the errors in the estimation demand. In response to these challenges, this study presents an Adaptive Traffic Control algorithm based on queue length demand estimation to improve effectiveness with respect to traffic composition, roadway geometry and roadside friction. The proposed algorithm was tested in VISSIM 6.0 and was benchmarked against existing vehicle actuated algorithm. Two case studies were run, evaluating metrics such as average stopped delay, control delay, average queue length and peak hour discharge, in order to evaluate the developed algorithm. The performances of the adaptive traffic control algorithm are shown to improve substantially against these assessment criteria.

KEYWORDS: Homogeneous traffic, Heterogeneous traffic, Headway, stopped delay, Queue length, Peak hour discharge, Traffic control algorithms

I. INTRODUCTION

The growing sophistication of issues linked to urban traffic and intersections has stimulated traffic engineers towards adopting microscopic traffic simulation models such as PTV VISSIM, which model driver and vehicle interactions within lower roadway systems down to their minutest details. Such models allow motorized macroscopic and microscopic simulation of different management techniques without practical evaluation interruptions. Intersections, particularly T-junctions such as the one in Guntur, are some of the most critical points of conflict and congestion and are exacerbated by poor signalization, no accommodation of pedestrians, and channelization. Traffic signals designed and

controlled using the Webster method can, in combination with systematic design, control the flow of conflicts and improve safety and reduction flows. Design factors of a signal include control cycle length, green time, amber and clearance intervals, give smooth and efficient traffic movement, thus are elements critical in design.

The framework of PTV VISSIM is composed of four constituents: Infrastructure, Traffic, Control, and Output. The infrastructure contains the framework, road network, and signalized intersections which include roads, signals and their respective detectors to replicate; traffic vehicle definitions and their flow behaviour are included under traffic; control encompasses signal logic and regulations for intersection management; output is provision of graphical and numeric computation results for evaluation and analysis. VISSIM allows both signals.

II. LITERATURE REVIEW

VISSIM is one of the most popular and studied microscopic traffic simulation software globally used by transportation experts. The literature describes its ability to accurately replicate real traffic systems by emulating the operation of each vehicle on the road, as well as modelling driver behaviour due to various interactions on the roadway and control devices. Many researchers have confirmed that VISSIM accurately reproduces highly complicated traffic patterns, including heterogeneous traffic, frequently observed in developing nations. Its application in benchmarking traffic performance metrics such as delay, queue length, travel duration, and level of service has been exhaustively documented in transport engineering literature.

VISSIM's simulation of delays at bus stops, priority lanes, and boarding and alighting aids better planning in the systems. In addition, more complex vehicle movements like crosswalk clear-out times, waiting times, and their influence on vehicle movement can be calculated which aids in transport planning.

There are numerous studies that have utilized PTV VISSIM in the analysis of traffic dynamics, delay, queue length, and safety indexes under different traffic configurations, such as intersections, roundabouts, and ramps, and comparison with other simulators. For example, the study by Shaaban and Kim (2015) entailed a comparison of VISSIM with Sim Traffic and observed that both simulators gave the same results under different traffic conditions but that VISSIM was higher during congested traffic. Chitturi et al. (2013) integrated an autonomous traffic control system (ACUTA) with VISSIM and observed that the system performed well in the scenario of low traffic volume. Malim et al. (2019) used VISSIM in signal timing optimization at a very congested intersection in Shah Alam, and mean delays reduced. In addition, Gallelli and Vaiana (2008) tested the effect of simulation parameters such as minimum gap and headway on roundabout performance, thus emphasizing the critical role played by parameter calibration in the improvement of simulation accuracy. Moreover, Saleem et al. (2014) suggested the use of microsimulation in the evaluation of traffic safety through conflict analysis compared to the use of crash data alone.

Subsequent research emphasizes the integration capability of VISSIM with different platforms and sophisticated models. Tianzi et al. (2013) compared SIDRA and VISSIM and noted that VISSIM gave more precise results, whereas SIDRA was easier to use. Zhandong et al. (2016) employed VISSIM to calculate the thresholds of queuing for off-ramps and identified effective traffic control measures based on traffic conditions. Zhou and Huang (2013) employed surrogate safety models within VISSIM to

demonstrate the potential benefits of speed reduction for enhancing intersection safety, reliability and precision of traffic modeling and thus the significance of VISSIM as an effective decision-support tool in transportation planning.

There are many simulation software's for traffic engineers these days and while comparing them they all give data which can be utilised for the traffic safety mostly on an intersection, ramp and roundabouts.

Finally, this software helps in to design intelligent transportation systems

This software is just like structure analysing & designing software like STAAD .pro, ETABS these analyses load on a building whereas this software analyses the traffic parameters like speed delay, traffic density

III. METHODOLOGY

PTV VISSIM methodology is based on developing a microscopic, detailed simulation of traffic flow with the help of real-world data and behaviour-based models. The procedure starts with defining the objectives of the simulation, followed by the collection of data on road geometry, traffic volumes, and vehicle behaviour. Road geometry is represented by the application of links, connectors, and nodes, and traffic demand is included through vehicle entry points and routing. Signal control in the form of fixed-time and actuated signals is included to simulate real traffic conditions. The model is validated and calibrated using field data to achieve accuracy. Traffic scenarios are simulated, and the outputs in the form of travel times, delays, and queue lengths are analysed to aid decision-making and enhance traffic management strategies.

A. Data collection

The compilation of vehicle data forms a vital element of transport schemes, facilitating traffic analysis, infrastructure planning, and road safety. Consistent and correct traffic information allows transport authorities to regulate traffic flow, reduce congestion,

and formulate effective transport policies. Planners can make informed decisions on the basis of information while optimizing road networks in urban and rural areas and enhancing the quality of transport networks in general.

A number of technologies are used to collect traffic data. Inductive loop detectors placed inside roads detect vehicles and offer traffic volume, speed, and vehicle type data. Radar and lidar detectors detect vehicle speed and spacing and provide detailed data on traffic flow. CCTV cameras monitor traffic, and vehicle counts and congestion are collected through image processing. Vehicle GPS data—collected by navigation systems and mobile applications—is used to offer up-to-date data on traffic speed, travel time, and traffic flow through urban networks.

Other than technological methods, there is still manual counting of traffic in certain areas, such as where there is no higher-end equipment available or for specific short-term studies. Human counters gather the quantity of and kinds of vehicles at one point during an interval of time, which is useful data for low-resource locations. As there are more time- and labour-intensive, though not as efficient as automated methods, manual methods available, they are also useful complements to higher-end, technology-based information gathering systems utilized in traffic control

B. Traffic Data Collection:

The Traffic data is measured manually by this we got some traffic volume which was essential to the analyse the traffic delay and traffic congestion. Vehicle data collection involves gathering data on vehicle movements, speeds, and traffic patterns to inform traffic management decisions. This data is collected through various methods, including traffic cameras, sensors, and GPS tracking, and is used to analyse traffic flow, optimize traffic signal timing, and evaluate the effectiveness

Sr. no.	Time A.M/P.M	North	South	East	West
1	8:00 A.M	115	126	121	99
2	8:15 A.M	126	132	123	107
3	8:30 A.M	125	134	127	110
4	8:45 A.M	132	130	135	111
5	9:00 A.M	164	148	146	123
6	9:15 A.M	145	140	139	134
7	9:30 A.M	110	116	128	129
8	9:45 A.M	106	86	71	94
9	10:00 A.M	91	72	78	71
10	10:15 A.M	83	67	64	54

Table 1: data collection of the intersection

	VEHICLES				
	Bike's	AUTO Rickshaw's	Car's	Ambulances	Buses
NORTH ROAD	332	363	70	2	42
SOUTH ROAD	430	249	64	2	67
EAST ROAD	385	314	70	1	22
WEST ROAD	407	220	54	4	15

Table 2: data collection of the intersection with respect to vehicle count

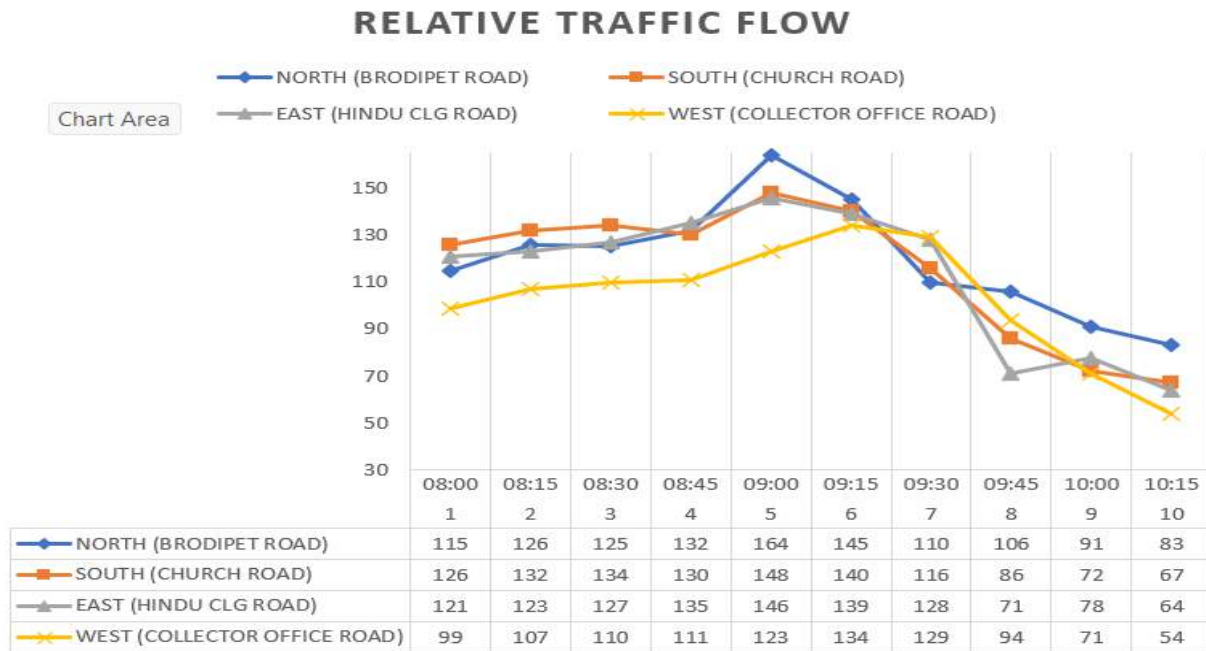


Fig 1: graph of relative traffic flow

C. Steps for Replicating Model in VISSIM

STEP 1: Creating Links and Connectors

The first step in PTV VISSIM, after defining the study area, is to create links and connectors, which are the backbone of the simulation model. This step is crucial because links represent the road segments

STEP 2: Removal of conflict points

As we simulate the model the collision points will be shown so atfirst we have to remove the collision points to get accurate output.

STEP 3: Reduced speed areas

As vehicles will turn on the intersection so speed should be less, so for that case provide reduce speed area and use this option from the Network objects bar on left of VISSIM and then the select area where vehicle speed has to be reduced.

STEP 4: Vehicle Input

This step determines how vehicles enter and move through the road network, influencing the overall traffic patterns and helping to assess the performance of the transportation system. The vehicle input is essential for realistic simulations and for getting accurate analysis.

STEP 5: Vehicle Routing

After vehicle input routing of vehicle is also important. It is also done from the option bar vehicle routing. how traffic flows through a transportation network. It determines the paths that vehicles follow as they travel from their origin to their destination, influence the traffic distribution, congestion patterns, and system performance

STEP 6: Vehicle Modelling

After vehicle routing vehicle Modelling can be enhanced by incorporating SketchUp to create custom 3D models of vehicles and then importing them into the simulation for more realistic and visually accurate representations. This process involves designing vehicle models in SketchUp, a widely-used 3D Modelling software.

STEP 7: Signal group Designing

A signal group refers to a set of traffic movements controlled by the same signal phase. Properly designing signal groups is essential for accurate representation of traffic control at intersections, and it ensures the simulation of realistic traffic flow and operational performance under various conditions. The process of signal group design in PTV VISSIM allows for the definition of how different traffic movements are coordinated at signalized intersections, influencing the efficiency of the network.

STEP 8: Calibration

This ensures the accuracy and reliability of the simulation results by aligning the model's behaviour with real-world traffic conditions. It involves adjusting various parameters and inputs within the simulation to better reflect actual traffic patterns, driver behaviour, and network dynamics.

STEP 9: Simulation

The simulation step in PTV VISSIM is a fundamental part of the Modelling process that involves running the traffic simulation to analyse and evaluate the behaviour of vehicles, pedestrians, and other elements within a transportation network.



Fig 2: command ribbon of software

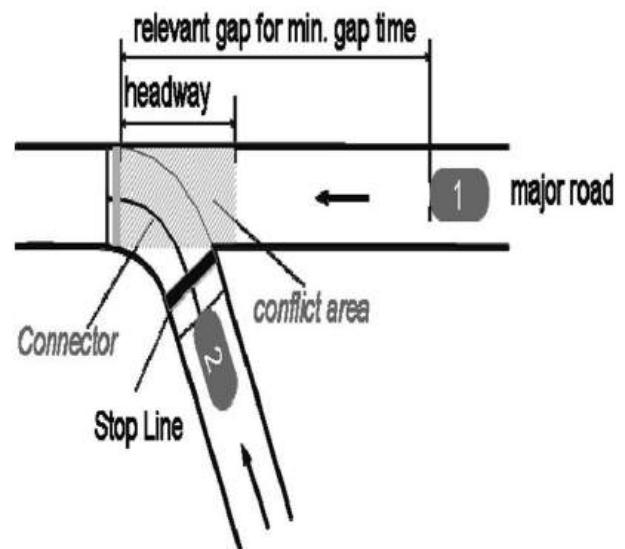


Fig 3: priority rule concept



Fig 4: represents the combined network with links and connectors of the intersection.



Fig 5: represents the conflict points of the intersection.



Fig 6: represents the vehicle routing which was assigned to the intersection



Fig 7: represents the signal phase of the intersection



Fig 8: represents the simulation of the intersection.

IV. RESULTS AND DISCUSSION

Traffic congestion analysis is a crucial element in evaluating the performance of road networks, identifying trouble locations, and prescribing remedial interventions. Basic traffic measures such as traffic density, delay, speed, and volume give's a description of traffic flow and congestion. These measurements are employed in the identification of specific road segments that require enhancement to enhance efficiency and reduce delays.

A. Traffic Density(vehicles / kilometre):

Traffic density, in the form of vehicles per kilometre, is a significant measure of road congestion. A mean of 39.05 vehicles per kilometre represents moderate congestion on road sections. Traffic is moving, but stream is interrupted and periodic delays result due to the volume of vehicles. The minimum of 8.83 vehicles per kilometre is representative of road sections with light traffic, wherein conditions would normally allow free flow. there are some sections with very high traffic density, with 130.65 vehicles per kilometre.

These high-density sections are usually found near intersections, bridges, or where the road is narrowed. These are the areas that are likely to have high congestion, causing delays as vehicles are compelled to slow down or even come to a standstill. These bottlenecks need urgent measures, which may include enhanced lane management, provision of extra lanes, or establishment of alternative routes to enable a more balanced flow of traffic on the network.

Sim Run	Time Int	LinkEval Segment	Density (All)	Delay (All)	Speed (All)	Volume
17	0-3600	1:WEST (RAMESH HOSPITAL) - 90-100	44.556/km	71.08%	40.465km/h	570.36/h
17	0-3600	4:EAST (HINDU CLG) - 90-100	58.818/km	74.37%	39.324km/h	450.021/h
17	0-3600	5:SOUTH (CHURCH) – 90-100	60.650/km	70.89%	34.330km/h	687.864/h
17	0-3600	7:NORTH (BRODIPET) - 90-100	130.650/km	79.89%	24.4330km/h	667.849/h

Table 3: result of link segment evaluation of the intersection

B. Traffic Delay (seconds per vehicle)

Traffic delay in seconds per vehicle highlights the time spent by vehicles in stops due to congestion or inefficient traffic control. The average overall delay was computed at 41.50 seconds per vehicle, reflecting average waiting times during peak traffic periods. The individualized segments of the road were either zero or had negligible delays, with a

minimum of 0.92 seconds, reflecting free flowing traffic. Some sections had high delays, with a maximum of 181.67 seconds, typically due to inefficient traffic signal control or heavy congestion.

C. Traffic Speed (kilometres per hour)

Traffic speed is another important parameter, providing information about the level of fluency in traffic along a road. The average traffic speed is 34.41 km per hour, showing a blend of free traffic and congestion. This speed is the characteristic of urban roads, where traffic conditions are affected by factors such as intersections controlled by signals and walking paths.

Some road sections have a minimum speed of 6.33 km per hour, showing a significant decrease, perhaps due to extreme congestion or obstruction in strategic placeson the other hand, the roads that support a maximum speed of 60 km per hour shows smoother traffic with less disturbance. These parts are improving management activities, with improved traffic control systems and adequate road capabilities to support the dominant traffic volume.

D. Traffic Volume (vehicles per hour)

Traffic volume, is the number of vehicles per hour, reading the number of vehicles passing a point on the road. The average traffic volume for all road segments is 461.92 vehicles per hour, representing the average traffic conditions.

Other segments have recorded lower volumes, with a minimum calculation of 26.99 vehicles per hourThese segments might be less used, either due to a route preference or because of lower demand during certain times of the day.

Areas with high traffic, up to 826.08 vehicles per hour, can be blocked, especially during peak hours. These areas require upgrading infrastructure to meet traffic flow and provide free flow.

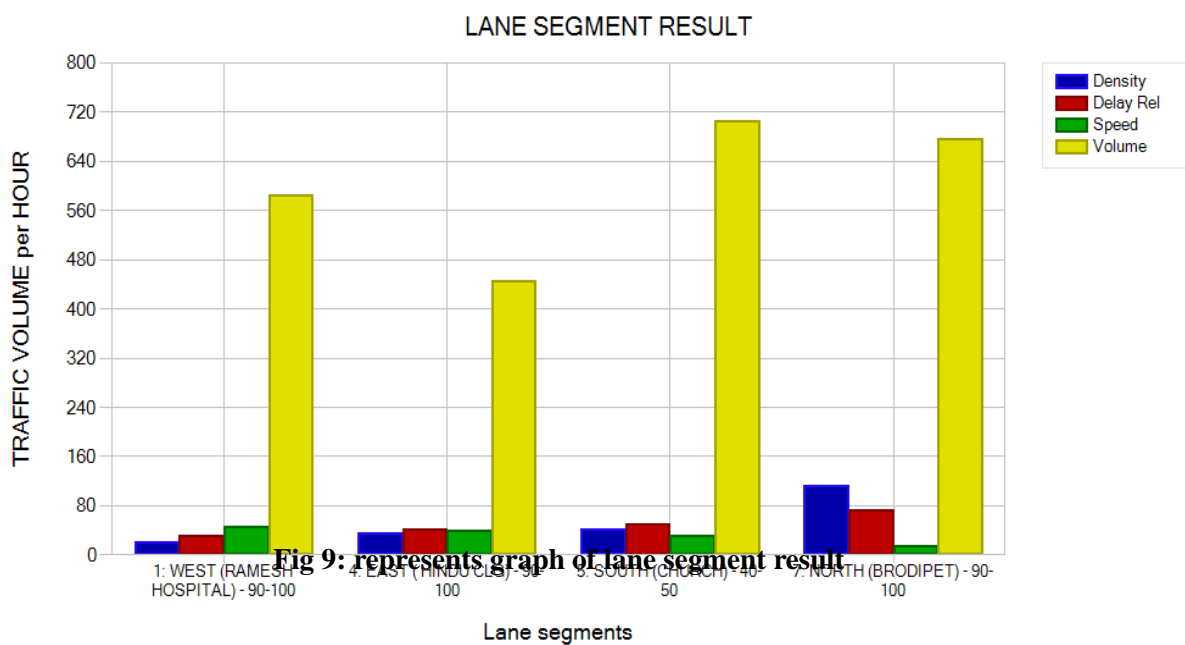


Fig 9: represents graph of lane segment result

V. CONCLUSION

The PTV VISSIM simulation got valuable results in terms of the operational status of the studied traffic network. It showed serious problems during rush hours, particularly when there was severe congestion and delay at some major intersections. The outcomes reveal that the current infrastructure, such as heavy signal timing and insufficient road capacity, cannot accommodate growing traffic volume. These weaknesses point towards an immediate need for strategic interventions and improvements aimed at optimizing traffic flow and removing delays.

Among the key outcomes of the simulation is the identification of congestion hotspots. These are specific road segments with heavy traffic and long delays and are therefore carrying traffic at or over capacity. These hotspots have a major impact on overall network performance. To counter them, targeted interventions in the form of increasing the lane capacity, controlling signal timing, and constructing diverging routes can be implemented in an effort to reduce the overload on these saturated segments.

In comparison to the congested segments, the simulation also highlighted sections that are marked by free flow of traffic and minimal delays. These effective sections have outstanding performance given the existing conditions, maintaining optimal speeds and showing minimal congestion. Sustaining the working performance of these segments is vital as their conditions can serve as models to improve other, less effective, parts of the network. Distributing the qualities of these effective road segments to other segments of the network can stimulate a more even and efficient traffic network. A notable finding was another set of irregularities in the traffic flow through the network. Speed variations and delays indicate that traffic movement is being obstructed by some outside factors as well as design-related factors. The interference is commonly caused by inappropriate signal coordination, intersection geometry-based complexities, and abrupt changes in road width or configuration. All these issues should be resolved in order to create more smooth and consistent traffic flows as well as improved overall driving conditions.

The simulation also identified key indicators of congestion—places that are marked by a concentration of high traffic levels and drastically low speeds. These places are points of total traffic breakdown if not addressed. There is a need to give high priority to interventions at these places since their upgrade will yield direct dividends, e.g., reduced travel times and cleaner air. These places should therefore be the focus of priority traffic management interventions to prevent further decline.

Finally, the research confirms the increasing demand for intelligent traffic management as cities grow and encounter increasing numbers of vehicles. PTV VISSIM becomes a tool in such a scenario, allowing for the creation of optimized traffic control strategies, optimizing the efficiency of the entire transportation system, and providing sustainable urban development. Congestion reduction and its associated environmental and economic burdens will trust's primarily on such sophisticated simulation tools.

VI. REFERENCES

- [1] Shaaban, K., & Kim, I. (2015). Comparison of Sim Traffic and VISSIM microscopic traffic simulation tools in modelling roundabouts. *Procedia Computer Science*, 52, 43-50.
2. Li, Z., Chitturi, M. V., Zheng, D., Bill, A. R., & Noyce, D. A. (2013). Modelling reservation-based autonomous intersection control in VISSIM. *Transportation research record*, 2381(1), 81-90.
3. Malim, M. R., Halim, F. A., & Abd Rahman, S. S. (2019). Optimizing traffic flow at a signalized intersection using simulation. *Malaysian journal of computing*, 4(2), 261-269.
4. Gallelli, V., & Vaiana, R. (2008). Roundabout intersections: evaluation of geometric and behavioural features with VISSIM. In *Proceedings of TRB National Roundabout Conference*. Kansas City, Missouri, USA.
5. Saleem, T., Persaud, B., Shalaby, A., & Ariza, A. (2014). Can microsimulation be used to estimate intersection safety? Case studies using VISSIM and Paramics. *Transportation research record*, 2432(1), 142-148.
6. Tianzi, C., Shaochen, J., & Hongxu, Y. (2013). Comparative study of VISSIM and SIDRA on signalized intersection. *Procedia-Social and Behavioral Sciences*, 96, 2004-2010.
7. Zhou, H., & Huang, F. (2013). Development of traffic safety evaluation method based on simulated conflicts at signalized intersections. *Procedia-Social and Behavioral Sciences*, 96, 881-885.
8. Zhandong, Z., Shaohui, C., Yanquan, Y., Aixiu, H., & Xinyi, Z. (2016). VISSIM simulation-based expressway exit control modes research. *Procedia engineering*, 137, 738-746.
9. Fellendorf, M., & Vortisch, P. (2001, January). Validation of the microscopic traffic flow model VISSIM in different real-world situations. In *80th Annual Meeting of the Transportation Research Board*, Washington, DC. 51
10. ownes, N. E., & Machemehl, R. B. (2006, December). VISSIM: a multiparameter sensitivity analysis. In *Proceedings of the 2006 Winter Simulation Conference* (pp. 1406-1413). IEEE
11. Bloomberg, L., & Dale, J. (2000). Comparison of VISSIM and CORSIM traffic simulation models on a congested network. *Transportation Research Record*, 1727(1), 52-60.
12. Zhou, S. E., Li, K., Sun, J., & Han, P. (2010). Calibration and validation procedure for intersection safety simulation using SSAM and VISSIM. In *ICCTP 2010: Integrated Transportation Systems: Green, Intelligent, Reliable* (pp. 603-615).
13. Istiqomah, N., & Qidun, M. B. (2018, November). Traffic simulation in an intersection by using integrated Vissim-MATLAB. In *2018 International Conference on Sustainable Energy Engineering and Application (ICSEEA)* (pp. 122-127). IEEE.
14. Congress, I. R. (1994). Guidelines for the Design of at grade intersections in rural and urban areas. IRC SP, 41-1994.