This article has been accepted for publication in a future issue of this journal but has not been fully edited. Content may change prior to final publication. Citation information: DOI 10.21608/sej.2022.157149.1020, Sohag Engineering Journal (SEJ)

Available online at https://sej.journals.ekb.eg/

FACULTY OF ENGINEERING – SOHAG UNIVERSITY

Sohag Engineering Journal (SEJ), VOL. x, NO. x, MONTH xxxx

Calibration and Validation of Microsimulation Models for Estimating Control Delay at Signalized Intersections in Upper Egypt, Sohag city as case study

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Abstract

Macroscopic traffic analysis software (SIDRA) and microscopic simulation package (VISSIM) are used in this paper to get the theoretical delay time. The paper presents a calibration process for the models developed in Sohag government using VISSIM software, since microscopic simulation models are becoming increasingly important tools in modeling transport systems. Traffic simulation models sometimes provide significant advantages over traditional planning or analytical models, such as SIDRA. Other common reasons for the popularity of simulation models include their attractive animations; their stochastic variability for the capture of real-world traffic conditions; and their capabilities to model complex roadway geometries, such as combined systems of urban streets and freeways. After calibration, validation work using field data from a signalized intersection in Sohag Governorate, Egypt, was conducted and proved the model validity to represent real systems. The simulation model was applied to evaluate the impact of lane width and traffic volume parameters on vehicular delays. The impact of each parameter was assessed and analyzed. It was found that there is a direct proportion between the control delay and the traffic volume parameter and inversely with the lane width parameter. Additionally, the problem of traffic jam at any intersection begins to occur when the traffic volume at 900 veh /h and above at different lane widths, especially at 9 ft resulting in higher delays.

Keywords: Microsimulation; Signalized Intersections; Calibration; Validation; Traffic volume; Lane width.

1. INTRODUCTION

As known, intersection delay which is composed of deceleration, stopped, and acceleration delays, is the major contributing factor to arterial delays and is generally defined as the excess time consumed in a transportation facility compared to that of a reference value. More specifically, it is the difference between the time it would take to traverse a road section under ideal conditions and the actual travel time [1-4].

The delay may be occurred from poor pavement conditions, which is treated by using many modern technologies such as the use of polymers, nanotechnology, and waste materials in the paving industry [5-26]. Also, the presence of many intersections on the road causes many delays. Measuring delay is important for designing and operating traffic control systems. As a performance measure, delay plays a critical role in evaluating levels of service at signalized and unsignalized intersections [27]. To estimate control delay or trace individual vehicle trajectories, there are two methods. Firstly, the delay time can be measured in the field, since researchers have experimented with a variety of devices and procedures including ground-based time-lapse photography [28], aerial time-lapse photography [29], video [30], path tracing [31, 32]. and test car with GPS [33, 34]. But all these techniques tend to be very laborious compared with the second method, theoretical measurements or traffic simulation models. The simulation models are becoming increasingly important tools in modeling transport systems. The main reason is that simulation is faster, safer, and less expensive than field implementation and testing [25]. The simulation models representing the traffic system are typically grouped as either microscopic or macroscopic simulation models. Microscopic models model traffic as individual vehicles and simulate their trajectories as they traverse on the road. Macroscopic models model the overall vehicle flow and simulate the state

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of the traffic stream [36]. At present, a lot of simulation software such as VISSIM, SIDRA, SYNCHRO, AIMSUN, SIMTRAFFIC, and CORSIM can be applied to evaluate the signalized intersections. In this paper, two simulation software are used to estimate the theoretical delay time; macroscopic traffic analysis software (SIDRA) and microscopic simulation package (VISSIM). However, the simulation model needs to be calibrated to the local conditions before its application. Calibration addresses the variability in driver and vehicle behavior, and to a certain extent, the effect of geometry [37].

Thus, the aim of this study is to estimate the control delay theoretically and to develop an efficient methodology for the calibration of a microsimulation model. The salient aspects of this methodology include procedure for representing traffic, identification of sensitive parameters, heuristically setting the parameter ranges, and calibrating them by minimizing the error between the simulated and field delays. The intersection models are then validated with another data set from the same studied intersection. A brief review of the past studies that estimated the delay time theoretically at isolated signalized intersections is presented first.

2. LITERATURE REVIEW

Although, there are several models for estimating vehicle delay theoretically at signalized intersections, it seems that the exploration on the method for estimating the delay is still continuously conducted. This is may be due to the consideration of various variables which could affect the delays [38]. Examples of these studies as follows:

Mousa [39] developed a microscopic stochastic simulation model to emulate the traffic movement at signalized intersections and estimated vehicular delays including the acceleration/deceleration delay. For validation purposes, validation work made with field data at an isolated intersection in Muscat City having posted speed 60 km/h and a shorter cycle length 80 s. Dion et al. [40] compared vehicle delays predicted by the INTEGRATION microscopic traffic simulation software and a number of analytical delay models. This study performed on a one lane approach to a pre-timed signalized intersection approach with a 60 s cycle length and a 30 s effective green interval for traffic conditions ranging from undersaturation to oversaturation. Darma et al. [41] determined a set of variables that affect control delay at signalized intersections by using SIDRA and Transyt-7F software. This was done by developing the basic test junction. The basic test junction is the intersection with basic layout and parameters. SIDRA analysis indicated that controller type, cycle time, ideal saturation flow, intergreen time, number of phasings, number of lane and left turn on red (LTOR) are significant variables affecting the control delay at signalized intersection. For TRANSYT-7F analysis results, it is only cycle time, intergreen time, number of phasings, number of lane, and left turn on red (LTOR) that significantly affect the control delay at signalized intersection. Hereth et al. [42] estimated average stopped delay for a given signalized intersection approach by using digitized still images created by the animation feature of CORSIM traffic simulation software. These images were analyzed to calibrate the computer algorithms based on the three methods (gap, gap-hybrid, and motion). The performance of the three methods varies depending on the quality of image, camera angle, and calibrated parameter values used for each method. Akgungor and Bullen [43] developed a new methodology for estimating the delay parameter (k) and proposed an analytical delay model for signalized intersections that considers the variation in traffic flow. The TRAF-NETSIM (TRAFfic NETwork SIMulation) microscopic simulation model was used in the calibration and verification of the new delay model for oversaturated conditions. Park and Li [44] proposed a generalized model incorporating three stochastic input variables in the HCM delay equation and analyzed the delay variability explicitly considering variations in key input variables. These variables include traffic volume, effective green time, and saturation flow rate. Murat et al. [45] investigated relationship of cyclic vehicle queue and vehicular delay considering different signal timings and phase sequencing and the MuLReD (Multiple Linear Regression Analysis based Delay Estimation) model is developed, since the coefficient of determination R^2 is obtained as 0.95.

3. ESTIMATION OF THEORETICAL DELAY TIME

To estimate the theoretical delay time, SIDRA and VISSIM software are used. SIDRA intersection 5.0 and VISSIM 5.3 were the versions used in this study. VISSIM is considered one of the widely used microsimulation software and can simulate traffic operation in various scenes. SIDRA is specially applied to simulate intersections including general intersections and roundabouts. It was proved that macroscopic simulations such as SIDRA can be used for unsaturated conditions whereas microsimulation such as VISSIM needs to be used for oversaturated conditions or unusual road geometry features [46]. However, both of them can analyze the effects caused by different traffic control strategy at signalized intersections and provide supporting decision basis to relieve the congestion of urban traffic network [47].

The accuracy of a traffic simulation model is mainly dependent on the quality of the vehicle modeling, e.g., the methodology of moving vehicles through the network. In contrast to less complex models using constant speeds and deterministic car following logic, VISSIM uses the psycho-physical driver behavior model developed by Wiedemann [48]. The basic concept of this model is that the driver of a faster moving vehicle starts to decelerate as he reaches his individual perception threshold to a slower moving vehicle. Since he cannot exactly determine the speed of that vehicle, his speed will fall below that vehicle's speed until he starts to slightly accelerate again after reaching another perception threshold [49]. This results in an iterative process of acceleration and deceleration [50]. VISSIM implements two variants of this model, the so called Wiedemann-74 and Wiedemann-99 models. The models differ in the way they define the thresholds or action-points where the driver changes his driving behavior and in the amount of stochasticity in the driver model [51].

The traffic, geometric and signal data, which were collected from the field survey from the studied intersection, were used as inputs to the software to obtain the control delay, and then the outputs have been compared with the field-measured delays as will be clarified in the later sections.

4. METHODOLOGY

The methodology proposed to address the characteristics of the existing traffic at the studied intersection includes representation of vehicles, geometry and traffic data followed by identification of calibration parameters by multi parameter sensitivity analysis, setting their ranges heuristically and determining the parameter values by an optimization model which minimizes the simulation error. First, to make sure the need for calibration, the model is to be simulated with the default settings (pre calibration) and the delay values are to be obtained. These values are compared with field values; if the error is insignificant (which is generally unlikely), then the model with default settings can be adopted without any further calibration. If the error is significant, the calibration steps are to be followed. Mathew and Radhakrishnan [52] reported that although the specific parameters vary from model to model, they can broadly be grouped into parameters for vehicle-to vehicle interaction (car following), overtaking and/or lane changing, and driver behavior at signals. To ascertain the influence of a parameter on the delay values, a sensitivity analysis is to be conducted. The sensitivity of a parameter is generally assessed by incrementing its value by small units and the effect on the output is recorded; but this procedure demands a large number of simulations runs.

To reduce the number of iterations, a two-stage process is proposed in this study. First, the sensitive parameters are identified by changing each parameter value by a definite amount while keeping all other parameters at their default values. The simulated delay is then compared with the delay obtained using default parameters. Thus, if changing the default values of a parameter significantly affects the delay value, then that parameter is considered as an influencing parameter and is selected for calibration. This step is necessary to reduce the computation time by calibrating only the influencing parameters. Second, the ranges of the sensitive parameters are fixed in an iterative process that will be discussed below.

4.1. Vehicle Representation

Simulation models typically come with a set of standard types of vehicles such as car, bus, truck, and motorcycle. Therefore, the first step in the simulation is to accurately define the static and dynamic characteristics of every vehicle type in terms of length, width, acceleration and deceleration, and speed ranges.

4.2. Geometric Representation

The next step is to represent the intersection accurately. This achieved by defining the number of approaches, width of each approach, and turning space, the space occupied by each turning movement in the intersection. Also, the representation includes the signal control system. The system comprises the cycle time, green time, and red time for each movement group, amber time, and phase sequence.

4.3. Traffic Representation

This part involves identifying the local characteristics of the traffic and the elements of networks so that the traffic in the simulation behaves similar to the one in the reality. One can observe different additional movements in terms of lane changes, smaller vehicles seeping through, etc. Manjunatha et al. [51] reported that the available parameters in the simulation model may not be sufficient to replicate certain special movements by the vehicles in traffic, but depending on the flexibility of network modeling, one can try to bring the behavior in the simulation as close as possible to reality.

4.4. Identification of Sensitive Parameters

Based on VISSIM documentation, the parameters that can affect delay are identified as longitudinal movement parameters, lateral movement parameters, lane changing parameters, behavior at amber, and car-following parameters. The longitudinal movement is controlled by the number of observed vehicles and the look-ahead distance (minimum and maximum) and temporary lack of attention (duration and probability). Among the lateral movement parameters are the lateral clearances (minimum and at 50 km/h). The lane-changing parameters consist of acceptable headways, deceleration rates and distance required for deceleration, and the waiting time for diffusion (i.e., if the vehicle is not able to change lane within this time, it is simply removed from the network). There are two conditions for the behavior at amber: one decision and continuous check. There are three parameters (α, β_1 and β_2) for the one decision condition. The common driving behavior parameters selected for this study were those for the behavior at amber, lateral clearance, waiting time for diffusion, and look-ahead distance. Parameters of both car-following models [48] were considered in this paper.

The Wiedemann 74 model has three car-following parameters. These are ax_average, the average standstill distance; bx_add and bx_mult; and the additive and multiplicative factors respectively of safety distance [48]. The Wiedemann 99 model has 10 car-following parameters, namely CC0 to CC9, where CC0 is the average standstill distance between cars, CC1 is the desired time headway, CC2 is the variation in the following distance deliberately left by drivers, CC3 is the threshold for entering the following mode, CC4 and CC5 are the sensitivity parameters, CC6 and CC7 are the parameters that define the oscillation of vehicular speeds during following, CC8 is the standstill acceleration, and CC9 is acceleration at 80 km/h speed [49].

5. CASE STUDY

In order to demonstrate the feasibility of the proposed methodology, a case study is conducted using data from three-legged fixed-time signalized intersection in Sohag Governorate, Egypt, having significant turning movements. VISSIM, a universal car-following based microsimulation tool, is used for the case study [49]. For simulation purposes, the model was applied to simulate the through traffic movement at this intersection which has a cycle length of 85 s, displaying 36, 4, and 45 s for the green, yellow and red indications respectively. Stopped delays as well as acceleration and deceleration delays were measured at that intersection using the test car method with GPS which is based on second-by-second vehicle speed profiles obtained from the GPS device to identify these components. Additional details of the data collection method and measurements were presented in the study of Hashim et al. [21].

6. SOFTWARE OUTPUTS

The simulation interface in SIDRA and VISSIM is shown in Figures 1 and 2 respectively. After using all data collected from the studied intersection as inputs to the software, the next step was to process these data to get the outputs.

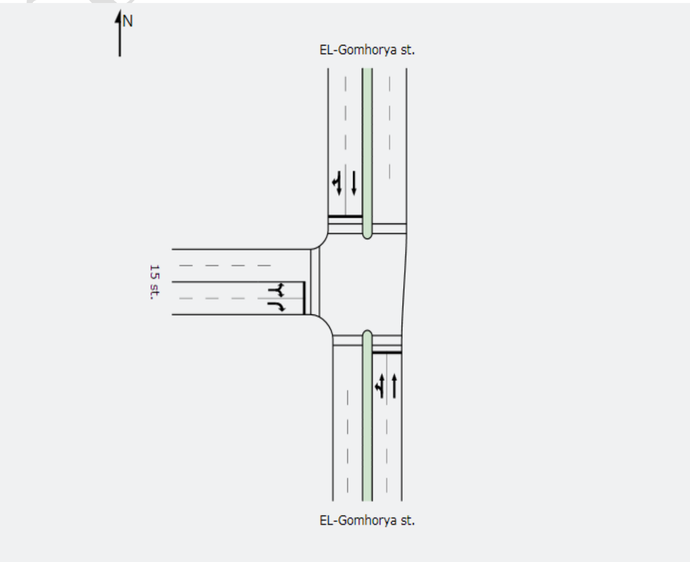

Fig. 1: Simulation Interface in SIDRA Software.

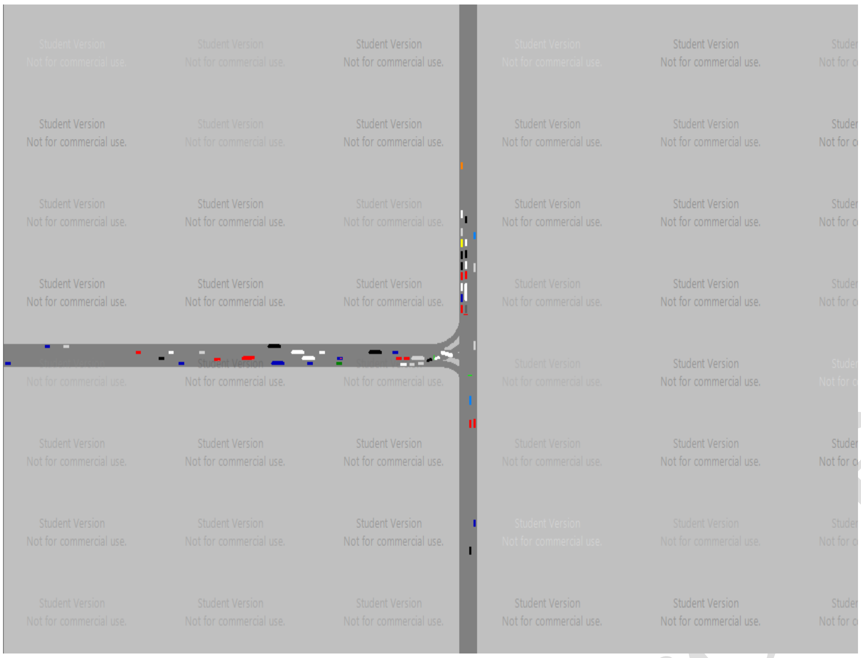

Fig. 2: Simulation Interface in VISSIM Software.

Tables 1 and 2 indicate a comparison between the observed and predicted delays obtained from the two kinds of software with default settings at peak (7.00 a.m. to 8.00 a.m.) and off peak (6.00 a.m. to 7.00 a.m.) hours respectively. In these tables, "absolute error" is used as the evaluation criterion, which is the level of accuracy of the estimates and can be calculated by the difference between the observed and predicted delays. If the variation of simulation results is within 15% of the field-measured delay, it is considered acceptable according to Dowling et al. [37].

TABLE 1: COMPARISON OF SIMULATED AND OBSERVED DELAYS FOR STUDIED INTERSECTION AT PEAK HOUR (DEFAULT VALUES FOR PARAMETERS)

Model Used	Observed Delay (s)	Simulated Delay (s) (VISSIM)	Simulated Delay (s) (SIDRA)	Absolute Error (s)
SIDRA	37.11	-	47.3	10.19
W74	37.11	25.37	-	11.74
W99	37.11	29.43	-	7.68

TABLE 2: COMPARISON OF SIMULATED AND OBSERVED DELAYS FOR STUDIED INTERSECTION AT OFF-PEAK HOUR (DEFAULT VALUES FOR PARAMETERS)

Model Used	Observed Delay (s)	Simulated Delay (s) (VISSIM)	Simulated Delay (s) (SIDRA)	Absolute Error (s)
SIDRA	19.58	-	22.3	2.72
W74	19.58	8.29	-	11.29
W99	19.58	10.38	-	9.2

As in Tables 1 and 2, it is observed from the results obtained from both software that the developed model at peak hour needed parameter calibration for local traffic conditions, since the absolute error is not within acceptable limits. But, at off peak hour for SIDRA software, the absolute error is acceptable (i.e., SIDRA can be used to estimate the control delay directly at off peak hour without parameter calibration). The findings and conclusions based on the uncalibrated or inappropriately calibrated models could be misleading and even erroneous. Thus, proper calibration is a crucial step in simulation applications [47]. Table 3 gives the step-by-step procedures for using the traffic models (SIDRA and VISSIM) to estimate the average control delay.

TABLE 3: PROCEDURES TO DETERMINE THE AVERAGE DELAY USING THE TWO TRAFFIC MODELS

Procedures	Inputs	SIDRA	VISSIM
Step 1. Coding and Inputs	Geometric Data	Links Number of Lanes Lane Type Lane width and Length Basic Saturation Flow Speed Limit	Scaling Links Lanes Connectors Edit Speed Distribution
	Traffic Data	Volume of each Lane Percentage of HV and PHF	Volume of each Link Volume of each route Percentage of each HV and the speed of each type of autos
	Signal Timing	Cycle length Signal Phasing	Edit the signal control Set of placements of each signal head
Step 2. Model Calibration			Observe animation screen to get the average delay in VISSIM
Step 3. Model run and Outputs analysis		The results can be obtained directly after the coding	Set up multiple runs Get the average delay after processing the simulation outputs

7. CALIBRATION OF DELAY MODEL

A sensitivity analysis is conducted on the parameters to identify the critical ones. Simulations are performed with different random seeds to reduce the effect of stochasticity. Delay is obtained by simulation and the error is then computed. All the three car-following parameters of the Wiedemann 74 model are used for calibration. Eight car-following parameters CC0 to CC7 from the Wiedemann 99 model are selected based on the sensitivity analysis for calibration. The remaining car-following parameters and some of the other parameters are not sensitive and hence excluded. Otherwise, even though a parameter may be sensitive, a variation in the values led to unrealistic situations such as ignoring other vehicles, signal, etc. Some of the parameters which did not give significant change in delays are discarded during the process. Thus, four parameters of the Wiedemann 99 model, CC0 to CC3, are used for calibration.

7.1. Range Setting for Parameters

Each parameter needs a lower and upper bound the value can take so that the optimization model needs to search in lesser space which makes the procedure computationally efficient. Such a range is necessary to ensure realistic performance of the simulation model [53]. Simulation is performed with a parameter value above the default value for one parameter, keeping all other parameters at their respective default values. An increase in the parameter value is not needed to necessarily increase the delay. Therefore, if a parameter has a positive effect on delay, then that value is increased until the delay reaches the prespecified upper bound; this value is set as the upper limit for the parameter.

In a similar manner, the value of this parameter is reduced in steps, until the delay reaches the lower limit. On the other hand, if the parameter has negative influence on the delay, then an opposite procedure is adopted to get the lower and upper limits. This iterative process is continued and the range for each selected parameter is established. While doing this, care should be taken to see that the parameter limits do not result in unrealistic behavior. During this process, if the search is able to yield delay values within the precision set, then calibration of the parameters can be considered completed [54-55].

7.2. Calibration Process

Optimum values of parameters are found out by minimizing the absolute error that was obtained from calibrated and observed delays. The optimized parameters using the Wiedemann 74 model and the resulting absolute error values are shown in Table 4. The optimized parameters using the Wiedemann 99 model and the resulting absolute error values are shown in Table 5. It can be noticed that the absolute errors for calibration of the intersection model are less than 1 s. These values are within acceptable limits (15 %).

TABLE 4: CALIBRATED PARAMETERS FOR THE INTERSECTION MODEL UNDER STUDY (WIEDEMANN 74 PARAMETERS)

Parameter	Calibrated Values	Default Values
ax_average	1.84	2.00
bx_add	1.05	2.00
bx_mult	7.96	3.00
Control Delay (s/veh) (field)	37.11	-
Control Delay (s/veh) (VISSIM)	37.42	-
Absolute Error	0.31	-

TABLE 5: CALIBRATED PARAMETERS FOR THE INTERSECTION MODEL UNDER STUDY (WIEDEMANN 99 PARAMETERS)

Parameter	Calibrated Values	Default Values
CC0	2	1.50
CC1	1.99	0.90
CC2	7.86	4.00
CC3	-7.11	-8.00
Control Delay (s/veh) (field)	37.11	-
Control Delay (s/veh) (VISSIM)	37.90	-
Absolute Error	0.79	-

8. VALIDATION OF MODEL

A new data set corresponding to different traffic and, preferably, geometric conditions should be used for validating the simulation model. The absolute error between delay from the calibrated model and field delay is computed. The model can be confidently used if this error is within certain limits. Thus, the model is validated using the calibrated parameters and traffic data from the same intersection from a different time period. The results of validation process are shown in Table 6 which indicates the errors are less than 15%.

Based on these results, it could be drawn that the model proposed in this paper is valid for estimating the average control delay at signalized intersections in Egypt that have similar characteristics of the area under study.

TABLE 6: RESULTS OF VALIDATION BASED ON CALIBRATION WITH DATA FROM THE SAME INTERSECTION USING THE WIEDEMANN 74 (W74) AND WIEDEMANN 99 (W99) MODELS

Model Used	Observed Delay (s)	Simulated Delay (s) (VISSIM)	Absolute Error (s)
W74	19.58	17.43	2.15
W99	19.58	16.62	2.96

9. DIFFERENT SCENARIOS FOR THE AVERAGE DELAY TIME

Several parameters were used in the calibration process. These parameters include traffic volume and lane width, that are considered from several parameters have the greatest effect on the simulated control delay. Field measurements with utmost care and accuracy are necessary to define these parameters in VISSIM, as a little variation in these can result in a varied output in simulation. Thus, the following part indicates different scenarios for lane widths and traffic volumes to identify their influence on the simulated delay time.

9.1. Traffic Volume

Traffic volume is defined as the number of vehicles passing a point on a highway, or a given lane or direction of a highway, during a specified time interval. The unit of measurement for volume is simply "vehicles," although it is often expressed as "vehicles per day" or "vehicles per hour". Capacity and other traffic analyses focus on the peak hour of traffic volume because it represents the most critical period for operations and capacity requirements. However, the volumes at peak hours are not constant from day to day and from season to season [56]. The peak hour volumes represent about 7-10% for urban roads and 12-15% for rural roads from average daily traffic according to MUTCD [57]. Acceptable ranges considered in this paper for traffic volumes were determined to be about 500 to 1200 veh/h. Tables 7 and 8 and Figures 3 and 4 clarify the average delays obtained from the simulation process using the Wiedemann 74 and 99 models respectively that are corresponding to traffic volume variations. Also, these tables contain the LOS values which are based on the simulated delay. These values are identified according to HCM (2010) [58]. There are six LOS are defined for each type of facility that has analysis procedures available. Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Poor LOS (E and F) can be solved by increased capacity such as additional lanes or overcoming bottlenecks, and in the case of transit, more buses or trains.

9.2. Lane Width

Travel lanes provide the space that moving vehicles occupy during normal operations. The standard width of a travel lane is 12 ft (metric standard is 3.6 m), although narrower lanes are permitted when necessary. The minimum recommended lane width is 9 ft (2.7 m). Lanes wider than 12 ft are sometimes provided on curves to account for the off-tracking of the rear wheels of large trucks. Narrow lanes will have a negative impact on the capacity of the roadway and on traffic operations. In general, 9 ft and 10 ft lanes should be avoided wherever possible. Lanes with 9 ft are acceptable only on low-volume, low-speed rural or residential roadways, and 10 ft lanes are acceptable only on low-speed facilities [57]. Tables 7 and 8 and Figures 3 and 4 also clarify the average delays obtained from the simulation process using the Wiedemann 74 and 99 models respectively that are corresponding to lane width variations.

From these Tables and Figures, it was found that the control delay increases, as the lane width decreases and the traffic volume increases meaning that there is an inverse proportion with the lane width and a direct proportion with the traffic volume. Generally, the most important observations that can be discerned upon examining these Tables and Figures:

- Increasing the traffic volumes from 500 to 800 veh /h on the studied direction at different lane widths does not affect the significant impact on the control delay for both models. The range of delay values is from 15.24 s to 40.39 s for W99 model and from 14.1 s to 35.7 s for W74 model resulting in LOS values from B to D.

- At 900 veh/h traffic volume, the control delay starts to be affected by increasing the volumes with lane width variations for both models. As seen in the Figures, at 9 ft lane width, the difference in delay value between the cases at 800 and 900 veh/h traffic volumes is equivalent to the one that is in the case between 500 and 800 veh/h. This indicates that the traffic congestion problem at signalized intersections actually occurs starting from this volume especially with the lowest lane width. The range of delay values are from 42.79 s to 61.4 s for W99 model and from 37.65 s to 57.75 s for W74 model resulting in bad LOS from D to E.
- The traffic volumes from 900 to 1200 veh/h with all lane width variations significantly affect the control delay and the simulated delays in this case are higher than those in other cases resulting in the worst LOS values from E to F. This means a volume of traffic generates demand for space greater than the available road capacity; this point is commonly termed saturation. These conditions result in traffic problems at the intersection, in addition the sheer weight of traffic leads to defects in the road surface which needs a lot of repair costs.

TABLE 7: CONTROL DELAYS CORRESPONDING TO TRAFFIC VOLUME AND LANE WIDTH VARIATIONS AT PEAK HOUR (WIEDEMANN 74 MODEL)

Traffic Volume (veh/h)	Lane Width (ft)	Control Delay (s/veh)	LOS
500	9	16.80	B
	10	15.55	B
	11	14.30	B
	12	14.10	B
600	9	26.91	C
	10	26.85	C
	11	25.77	C
	12	25.32	C
700	9	31.35	C
	10	29.90	C
	11	29.75	C
	12	29.50	C
800	9	35.72	D
	10	33.28	C
	11	33.02	C
	12	32.10	C
900	9	57.75	E
	10	47.65	D
	11	40.50	D
	12	37.65	D
1000	9	73.10	E
	10	68.40	E
	11	65.87	E
	12	57.80	E
1100	9	85.33	F
	10	81.10	F
	11	73.05	E
	12	63.45	E

1200	9	98.60	F
	10	96.10	F
	11	89.65	F
	12	81.80	F

Table 8: Control Delays Corresponding to Traffic Volume and Lane Width Variations at Peak Hour (Wiedemann 99 model)

Traffic Volume (veh/h)	Lane Width (ft)	Control Delay (s/veh)	LOS
500	9	19.25	B
	10	16.60	B
	11	15.35	B
	12	15.24	B
600	9	29.60	C
	10	27.21	C
	11	27.15	C
	12	26.75	C
700	9	35.70	D
	10	34.73	C
	11	33.25	C
	12	33.00	C
800	9	40.39	D
	10	38.05	D
	11	35.74	D
	12	34.98	C
900	9	61.40	E
	10	53.02	D
	11	49.22	D
	12	42.79	D
1000	9	88.10	F
	10	79.20	E
	11	78.65	E
	12	71.01	E
1100	9	100.3	F
	10	93.40	F
	11	91.00	F
	12	89.10	F
1200	9	111.35	F
	10	108.95	F
	11	108.83	F
	12	105.46	F

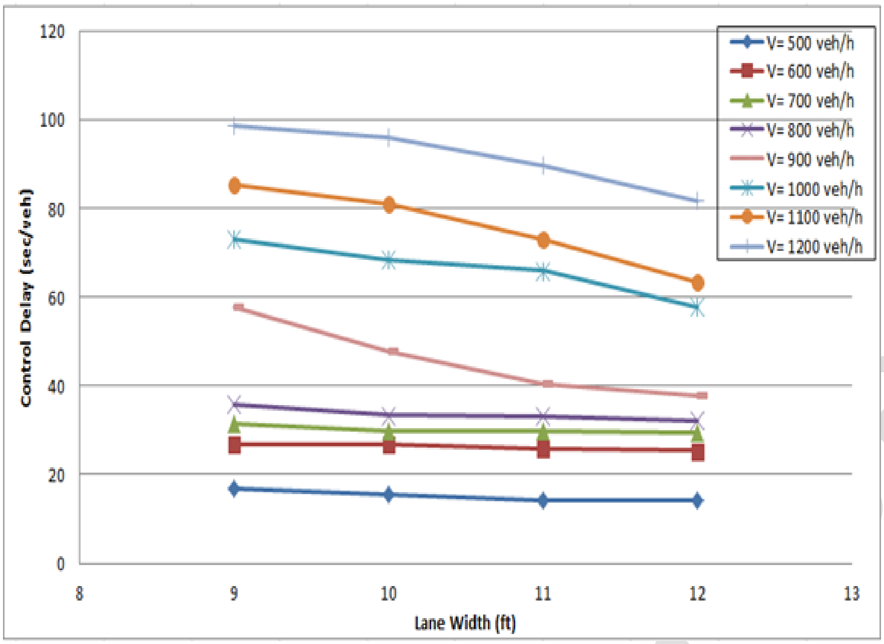

Fig. 3: Variation of Simulation Output with Change in Traffic Volumes and Lane Width at Peak Hour (Wiedemann 74 model).

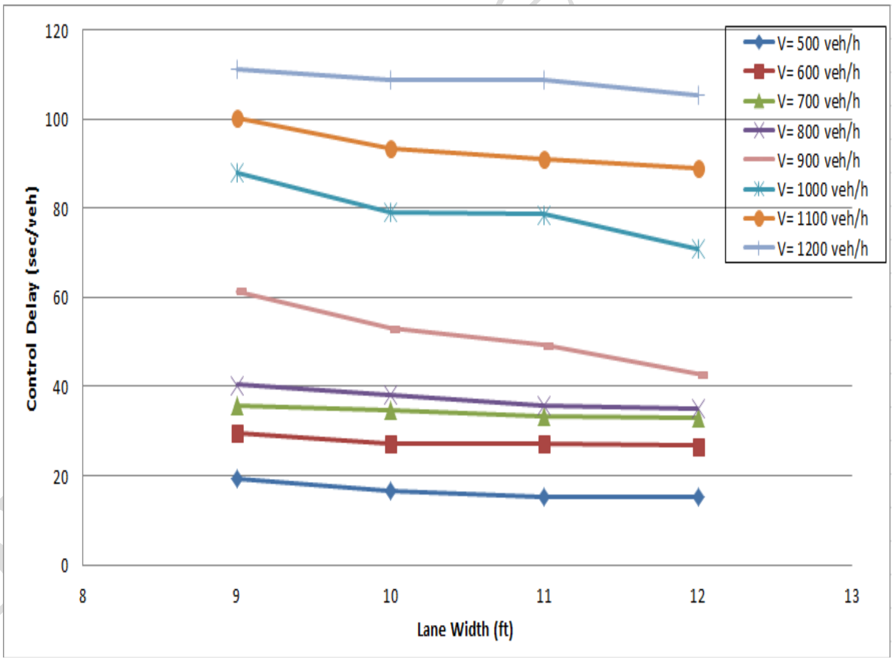

Fig. 4: Variation of Simulation Output with Change in Traffic Volumes and Lane Width at Peak Hour (Wiedemann 99 model).

10. CONCLUSION

This paper is to estimate the simulation-based (VISSIM) and analytical-based (SIDRA) methods for determining the average control delay. The collected traffic, geometric and signal data were used as inputs to the software and "absolute error" is used as the evaluation criterion which is the level of accuracy of the estimates. This criterion can be calculated by the difference between the observed and predicted delays. After that, software outputs with default settings have been compared with the field values and it was found that the simulation model at peak hour needed parameter calibration for local traffic conditions, since the absolute error is not within acceptable limits. VISSIM implements two variants of models, the so called Wiedemann

74 and Wiedemann 99 models. The calibration was conducted on the studied direction using both models. This process was followed by the validation of the simulation model with data from different time period. This validation resulted in the validity of using this model in estimating the average control delay at signalized intersections in Egypt that have similar characteristics of the area under study.

There are several parameters including traffic volume and lane width parameters have a great effect on the resulted control delay from the simulation process. A little variation in these can result in a varied output in simulation. Consequently, different scenarios for lane widths and traffic volumes were introduced to identify their influence on the delay time simulated. Acceptable ranges for traffic volumes were determined to be about 700 to 1200 veh/h. For lane width parameter, the range was from 9 ft to 12 ft (2.7 m to 3.6 m). From simulation outputs, it was clarified that there is a direct proportion between the control delay and the traffic volume parameter and inversely with the lane width parameter. In addition, it could be observed, the problem of traffic jam at any intersection approach begins to occur when the traffic volume at 900 veh /h and above at different lane widths, especially at 9 ft resulting in higher delays which in turn, lead to the worst LOS values

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