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Calibration of VISSIM for an Urban Corridor under Heterogeneous Traffic Conditions

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Abstract

The replication of heterogeneous traffic conditions in simulation tools is a challenging task due to involvement of various vehicle classes and their associated driving behaviours. Despite considerable efforts have been made in literature, further attention is still needed due to the complexity of heterogeneous traffic mixes, particularly for urban corridors with closely spaced intersections. In the present study, a systematic calibration procedure for VISSIM has been proposed by considering the vehicle-class specific driver behaviour parameters. The proposed procedure involved four key steps including; identification of sensitive parameters via sensitivity analysis, generation of random samples by using Latin Hypercube Design (LHD), development of regression model based on LHD samples and VISSIM output, and the use of regression model in Microsoft Excel Solver program to determine candidate parameter set producing measure of effectiveness (MOE) values closer to field values. After calibration, the model validation was also conducted which was done by assessing the statistical similarity between field and simulation data sets via paired t-test. The study concluded that the vehicles in heterogeneous traffic conditions tend to adopt smaller longitudinal and lateral gaps during standing and driving conditions. The proposed methodology can help the practitioners in developing simulation models for similar traffic conditions.

Keywords: Traffic simulations, calibration, heterogeneous traffic, driver behaviour, sensitivity analysis.

1. Introduction

Heterogeneous traffic conditions refer to a mix of various vehicle classes having diverse static and dynamic characteristics (Kanagaraj, Srinivasan and Sivanandan, 2010). Additionally, such traffic conditions involve improper lane marking, unpredictable driving behaviour by two-wheelers (2Ws) and three-wheelers (3Ws) and disorganized movement of a varied mix of vehicle types (Siddharth and Ramadurai, 2013). The replication of such traffic conditions in analytical models is difficult which necessitate the use of simulation models. However, the application of simulation models needs

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certain adjustments to reflect the intended traffic, driving behaviour and geometric conditions. This process of adjusting model parameters to replicate the actual field conditions is termed as calibration (Akbar *et al.*, 2018; Bhattacharyya, Maitra and Boltze, 2020). Though, numerous calibration methodologies have been presented in literature, a greater proportion of them is centred on homogeneous traffic conditions. In contrast, very limited studies are available that address the apparent characteristics of non-lane based heterogeneous traffic conditions.

The earliest calibration efforts involved several steps that consequently required a lot of time (Park and Schneeberger, 2003; Lownes and Machemehl, 2006). Later, in order to offer reliable output, detailed requirements and guidelines pertaining to calibration of simulation models were proposed (Dowling, Skabardonis and Alexiadis, 2004; Park and Qi, 2005). In parallel to general calibration guidelines, few attempts have been made to address specific characteristics of heterogeneous traffic conditions. Mathew and Radhakrishnan (2010) addressed the issue of side-by-side stacking of vehicles across the width of road at a signalized intersection in India. The study calibrated VISSIM for three signalized junctions in India by using stopped delay as MOE. Later, this procedure was modified by Manjunatha et al. (2013) who proposed two stop lines at a junction; one for two-wheelers and other for all other vehicle types. In the same year, Siddharth and Ramadurai (2013) also presented a calibration procedure which involved the calibration of two junctions by comparing the field and simulated traffic flows. Some other studies calculated the parameter values based on homogeneous conditions and then modified these values for heterogenous mix by employing weighted average method (Mehar, Chandra and Velmurugan, 2014; Suresh and Rajbongshi, 2016).

Recent studies have provided detailed step-by-step calibration procedure for heterogeneous traffic conditions (Maheshwary et al., 2017, 2020; Bhattacharyya et al., 2020). Though, these studies incorporated the few aspects of heterogeneous traffic, efforts to effectively calibrate the highly heterogeneous traffic conditions are not over yet. Also, there has been a lack of significant efforts in calibrating urban corridors with closely-spaced junctions. Given the presence of specific vehicle classes and geometric characteristics, there is a clear need for an appropriate calibration procedure. Therefore, this study proposes a step-based calibration procedure that attempts to accurately reflect the non-lane based heterogeneous traffic conditions of an urban corridor with three closely-spaced junctions.

The paper has been structured in four sections. Section 1 focuses on introduction to the research problem and the study objective. Section 2 details the proposed procedure, whereas, section 3 discussed the application of proposed procedure to a real-world site. Finally, the conclusions of the study are summarized in section 4.

2. Proposed Methodology

The proposed calibration procedure involves four main steps including; pre-calibration, model development and initial parameter adjustments, calibration and validation. The phases of methodology have been shown in Figure 1.

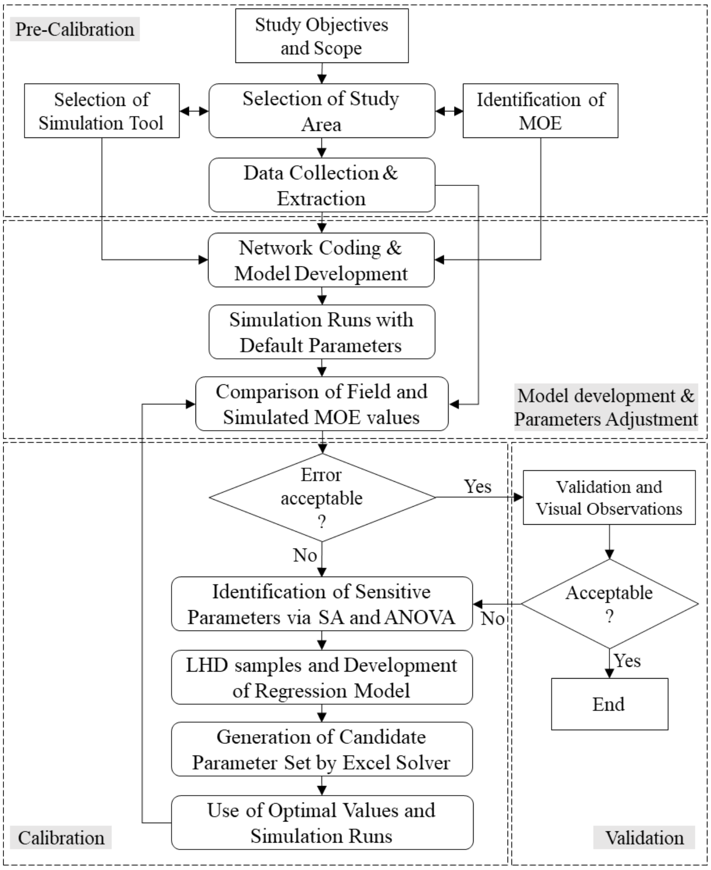

Figure 1: Proposed methodology.

2.1 Pre-calibration

This is the first step which involves the conceptualization and planning for the study. The phase involves the selection of suitable study site, identification of adequate MOE and the collection and extraction of required data sets.

The VISSIM tool has been most frequently adopted to model heterogeneous traffic conditions due to availability of enormous parameters and the flexibility of modeling any geometric, vehicular and control characteristics. Various studies have adopted this tool for calibration of heterogeneous traffic conditions (Manjunatha, Vortisch and Mathew, 2013; Bhattacharyya, Maitra and Boltze, 2020). Hence, these applications endorse the capabilities of VISSIM in reflecting the heterogenous traffic characteristics.

2.2 Model Development and Initial Parameter Adjustments

This step refers to the input of collected data for the development of simulation model. The field data on geometric, control, traffic volume and speeds are used in VISSIM to develop a site-representative simulation model.

For heterogenous traffic, some adjustments related to the behaviour of 2Ws and 3Ws are made as per field observations. Adjustment of parameters to reflect the gradual lane change in a queue, seepage of 2Ws by using the inter-vehicular spaces, diamond queueing by 2Ws and no adherence to lane discipline are done in this step. After adjusting the field observations, the model is run with default driving behavior parameters and the simulation output is compared with the field data. If the difference between field and model output is not within allowed thresholds, then model is considered for calibration.

2.3 Calibration

Calibration refers to adjusting the model parameters to match the simulation output with the real-world. The calibration procedure involves following three sub-steps to be followed to meet the calibration targets.

2.3.1 Identification of sensitive parameters

The sensitive parameters are identified by considering two steps. In first step, relevant literature is reviewed to identify the most frequently adopted parameters for similar traffic conditions. The second step refers to application of SA for the identification of most sensitive parameters pertaining to current site and traffic conditions. While conducting SA, the impact of modifying a single parameter from its default value is observed on the MOE, while all other parameters are maintained at their default values. The change in MOE value in comparison to change in default values of the parameters is evaluated. if the change in default parameter value significantly affects the MOE, the parameter is considered sensitive (Al-Ahmadi *et al.*, 2019).

2.3.2 Experimental design and regression model

After identification of sensitive parameters in previous step, this step is conducted to identify the range of their values in relation to this study. The range of values for the most sensitive parameters is determined and the possible combinations of the parameter sets are computed. For heterogeneous traffic mix, varying characteristics of the vehicle classes endorse the use of separate values of parameters for each vehicular class (Manjunatha, Vortisch and Mathew, 2013; Akbar *et al.*, 2018; Maheshwary *et al.*, 2020). Hence, considering separate parameter sets for each vehicle class would result in unattainable number of possible parameter combinations. Due to constraints of time and computational effort, it would be impractical to analyze all these combinations; however, adequate sampling procedure is employed to minimize the effort yet covering entire sample space for each parameter. The LHD is the most widely adopted technique for the generation of representative samples for such combinations. This technique is used to reduce the number of combinations into a reasonable level, while still reasonably covering the entire parameter surface. Based on LHD, adequate number of parameter sets are obtained and each of the combinations is run by using different seed numbers. The simulation output obtained based on the LHD parameter sets is used in Statistical Package for the Social Sciences (SPSS) to develop a regression model by considering the MOE as dependent variable and the calibration parameters as dependent variables.

2.3.3 Generation of candidate parameter sets

Based on the regression model developed in previous step, the candidate parameter sets having appropriate values are obtained by using Microsoft Excel Solver (MES) program. The value of MOE obtained from field is set as target value in regression model and MES is run to obtain the combination of parameter sets producing the closest match to field values. Multiple combinations are obtained from MES program and the values are fed in simulation program to obtain the desired simulation output. The simulations are observed for any unrealistic behaviour by vehicles and the parameter set producing the most realistic simulations coupled with MOE value closest to the field MOE is selected as final calibration parameter set. This parameter set is expected to meet the set calibration targets.

2.4 Validation

This step is performed to check the validity of calibration procedure against a new data set. The new data set is obtained from the same or from a site having similar geometric, operational and control characteristics. The data from the same site can be obtained at different time of the day and can be used to validate the model. The new MOE values must be obtained based on new data set. The visual checks of the simulations are also important to observe the similarities between field and simulated conditions.

3. Application of Proposed Methodology

3.1 Pre-Calibration

For the application of proposed calibration methodology, a 1.4 km section of an urban corridor having three signalized intersections was selected as shown in Figure 2. The land-use around each junction is mainly commercial. Akbar Chowk (J1) is a 4-leg junction, whereas, Mochipura Morr (J2) and Honda Morr (J3) are 3-leg junctions.

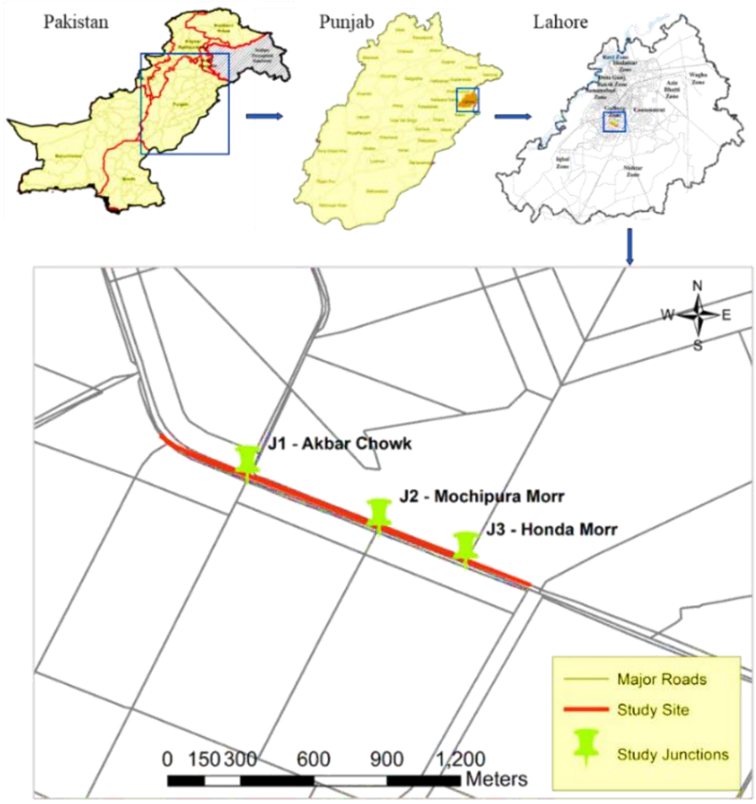

Figure 2: Location of selected study site.

Data was collected by using videography technique coupled with manual observations and measurements. Later, the videos were played multiple times to extract data on traffic volume, turning proportions, desired speed distributions and vehicle compositions. The details on vehicle composition are given in Table 1. It is evident that 2Ws constitute nearly half of the total traffic volume.

Table 1: Vehicle composition at three junctions.

Junction	*Motorcycle*	*Rickshaw*	*Car*	*Wagon*	*Bus*	*Truck*
J1	49.2%	17.4%	27.3%	2.4%	0.3%	3.5%
J2	49.1%	19.2%	25.5%	2.7%	0.1%	3.5%
J3	48.9%	19.3%	25.5%	3.3%	0.2%	2.8%

Travel time along Eastbound (EB) direction of corridor and traffic volume at 10 key locations were used as MOEs as endorsed by various guidelines (Oregon Department of Transportation, 2011; WSDOT, 2014) and used by many studies in literature for similar geometric conditions (Park and Schneeberger, 2003; Maheshwary *et al.*, 2017; Al-Ahmadi *et al.*, 2019). The data on travel time was collected by using floating car method in which a vehicle was driven along the study corridor at the average speed of the vehicles on the roadway.

3.2 Model Development and Initial Parameter Adjustments

The VISSIM software was employed to develop base model representing the site conditions. The geometric characteristics were recorded and coded in the software. The lane widths, their configurations and location of stop-line at each approach of the three junctions were placed as per field conditions. The links and connectors were joined to develop the base network. After development of base network, vehicle routes, input volumes and vehicle compositions were defined. Some features associated with heterogeneous traffic such as the maneuvering of smaller vehicles by using the inter-vehicular spaces at junctions and lane change behavior by all vehicular classes were also adjusted in this step.

3.2.1 Manoeuvring of Smaller Vehicles

The heterogeneous traffic mix contains the smaller vehicles such as 2Ws which utilize the inter-vehicular spaces of queued vehicles and can advance to the front of queues. This seepage of smaller vehicles was simulated in VISSIM by reducing the values for lateral clearances at 0 km/h and at 50 km/h for all vehicles. The studies in literature considered smaller than default values especially for 2Ws and 3Ws (Manjunatha, Vortisch and Mathew, 2013; Arkatkar *et al.*, 2016). The values of lateral distances were adjusted for each vehicle type based on the values adopted in literature for similar vehicle characteristics.

3.2.2 Lane Change Behaviour

In heterogeneous traffic conditions, the vehicles utilize any position across the road width during the stopping as well as driving condition. To reflect such behaviour, VISSIM offers an option to define the desired position of the vehicles at free flow. By default, this option was set to “middle of lane” in VISSIM which was changed to “any” for all vehicular classes. It means the vehicles can hold any lateral positions across the road width. Also, the smaller vehicles were allowed to overtake other vehicles from both left and right sides when approaching a queue. Due to smaller lateral distances, vehicles in simulations were not considering the presence of vehicles in adjacent lanes which was causing side-swipe conflicts. This issue was resolved by checking an option of "observe adjacent lanes" in VISSIM.

3.2.3 Simulation Runs and Output Comparison

After inputting the field data and adjusting initial parameters, the base model was run for simulations. Guide manuals have suggested to use a minimum of 10 simulations runs to record the simulation output (Oregon Department of Transportation, 2011; VDOT, 2020). Whereas, another manual suggested that the output must be reported on the basis of a minimum of 11 simulation runs (WSDOT, 2014). Based on these suggestions, the study adopted 11 simulation runs with different random seed numbers and the output was recorded. The average value of travel time for 11 runs was then reported and compared with the field values.

The simulations produced an average travel time value of 402 sec in comparison to the 255 sec from field. Table 2 provides the travel times for field and VISSIM along with the percentage difference between field and VISSIM values. The percentage differences of 57.65% was higher than the calibration threshold of ±30% for arterials as recommended by Virginia Department of Transportation (VDOT, 2020). Also, the difference between field and VISSIM traffic volume was obtained by computing Geoffrey E. Havers (GEH) statistics (Table 3). According to WSDOT, the GEH value must be less than 5 for at least 85% of the roadway segments (WSDOT, 2014). The comparison between field and VISSIM traffic volume showed that GEH statistics criteria was not met.

Table 2: Percentage difference between field and VISSIM MOE values.

Direction	*From*	*To*	*Average Travel Time (sec)*		*% Difference*
			Field	*VISSIM*	
EB	J1	J3	255	402	57.65%

Table 3: Percentage difference and GEH statistics for field and VISSIM traffic volume.

Junction	*Approach*	*Traffic Volume (veh/ hr.)*		*GEH Statistics*
		Field	*VISSIM*	
J1	NB	1404	1405	0.04
	SB	1386	1391	0.13
	EB	2514	2261	5.18
	WB	2382	2272	2.27
J2	NB	1081	988	2.90
	EB	2339	2011	7.03
	WB	2356	2114	5.11
J3	SB	1794	1784	0.24
	EB	2303	2194	2.31
	WB	2233	1783	10.04

The higher differences between field and VISSIM outputs as shown in Table 2 and Table 3 endorse the need of detailed calibration of driving behaviour parameters.

3.3 Calibration

Calibration is considered as most important step in application of simulation models. This step has been further divided into 3 sub-steps.

3.3.1 Identification of Sensitive Parameters

Previously, the selection of sensitive parameters was conducted by review of previous literature followed by the application of SA to further refine the most sensitive parameters for considered traffic conditions (Siddharth and Ramadurai, 2013; Arkatkar *et al.*, 2016; Bhattacharyya, Maitra and Boltze, 2020). A similar strategy was adopted in this study and the studies pertaining to heterogeneous traffic conditions were reviewed and their identified calibration parameters were summarized to find the most relevant parameters for such traffic conditions. It was found that nine (9) parameters including four (4) general car-following, three (3) car-following and two (2) lane change parameter were most frequently adopted by the calibration studies considering similar traffic conditions. The most frequently adopted parameters are given in Table 4.

Table 4: Most frequently adopted Parameters in Literature.

No.	*Aspect*	*Parameter*
P1	General Car-Following	Minimum look ahead distance (m)
P2		Minimum look back distance (m)
P3		Maximum look ahead distance (m)
P4		Maximum look back distance (m)
P5	Car-Following	Average standstill distance (m)
P6		Additive part of safety distance
P7		Multiplicative part of safety distance
P8	Lane Change	Minimum Clearance - Front/ Rear (m)
P9		Safety Distance Reduction Factor

The effect of the parameters, identified from the previous literature, was assessed for the current traffic conditions by employing SA. The change in MOE value in comparison to change in default values of parameters was observed. Furthermore, Analysis of Variance (ANOVA) test was employed to check the significance of calibration parameters at 95% confidence interval.

It was observed that only three (3) parameters of Wiedemann 74 car-following model including; average standstill distance (P5), additive part of safety distance (P6) and multiplicative part of safety distance (P7) showed significant effect on MOE with the change in their values. The remaining six (6) parameters showed minimal effect on output. The three (3) most sensitive parameters were selected for the next phase of calibration.

3.3.2 Experimental Design and Regression Model

Since the heterogeneous traffic conditions represent vehicle-class dependent driving behaviour, separate parameter values were identified for each vehicle class. From the literature, it was observed that smaller values of driving behaviour parameters were adopted for traffic streams having 2Ws and 3Ws (Vinet and Zhedanov, 2011; Akbar *et al.*, 2018; Chepuri *et al.*, 2018). Similarly, separate parameter sets were identified for experimental design of following four vehicle categories;

1. Two-wheelers (motorcycles);
2. Three-wheelers (rickshaws);
3. Cars (including wagons); and
4. Heavy vehicles (including buses and trucks).

Based on abovementioned vehicle classes and sensitive parameters, a total of 12 parameters (4 (vehicle classes) × 3 (sensitive parameters)) were identified. Therefore, these 12 parameters were considered for the development of random samples in MATLAB by employing LHD technique.

A code was developed and run in MATLAB by considering the 12 parameters and their value ranges. Based on the code, 200 parameter combinations were produced and each parameter combination was run in VISSIM with different seed numbers. The output of 200 samples was then used to develop linear regression model by considering the MOE as dependent variable and calibration parameters as independent variables. The linear regression model was developed by using the simulation output of LHD samples in SPSS package. The significance of each of the twelve parameters was checked and their effect on the travel time was evaluated based on ANOVA test. The test showed that ten out of twelve parameters showed p-value lower than the 0.05 at 95% confidence interval. Therefore, the regression model was developed by considering only 10 significant parameters. The equation (1) provides the linear regression model that was developed by considering the average travel time as dependent variable and the ten calibration parameters as independent variables. This regression model was then used in the next step for generation of candidate parameter sets.

$$TT_{EB}=35.09+36.19P_1+31.91P_2+14.63P_3+26.80P_4+14.41P_5+9.27P_6+41.05P_7+27.09P_8 + 16.47P_9+5.97P_{10} \quad (1)$$

3.3.3 Generation of Candidate Parameter Sets

The regression model produced in previous step was used in Microsoft Excel Solver (MES) Program to generate the candidate parameter sets providing a close match between field and model MOE. For example, the travel time was set as a target value in the linear regression model and Solver was run to obtain combination of parameters producing the travel time value. The values of parameters were adjusted by the Solver to produce the desired output. A total of ten combinations of parameters were generated for evaluation of calibration process. For each of the obtained parameter sets, simulation runs with different random seed numbers were conducted and the output on average time was obtained. The animations for each parameter set were observed and any parameter set producing unrealistic driving behaviour were eliminated. The values of the selected parameter set and calibrated values of each parameter are given in Table 5.

Table 5: Selected parameter set and calibrated values.

No.	*Vehicle category*	*Parameters*	*Default Values*	*Calibrated Value*
P1	2W- Motorcycle	Average standstill distance -2W	2.0	0.68
P2		Additive part of safety distance-2W	2.0	0.90
P3		Multiplicative part of safety distance-2W	3.0	0.73
P4	3W-Rickshaw	Average standstill distance -3W	2.0	0.82
P5		Additive part of safety distance-3W	2.0	0.97
P6		Multiplicative part of safety distance-3W	3.0	1.06
P7	Car	Average standstill distance -Car	2.0	1.05
P8		Additive part of safety distance-Car	2.0	1.16
P9		Multiplicative part of safety distance-Car	3.0	1.23
P10	Heavy Vehicles (HVs)	Average standstill distance -HV	2.0	1.64

Based on the calibrated parameters, simulations were run and output was obtained to compare the average travel time and traffic volume at defined locations. Table 6 and Table 7 show the comparison between field and simulation output with calibrated parameter values. The calibrated parameter set produced the percentage difference of 7.83% between field and VISSIM travel time as shown in Table 6. It was found that the calibration procedure produced the acceptable values of travel time (difference between field and simulation output within ±30%).

Table 6: Comparison between field and VISSIM travel time based on calibrated values.

Direction	From	To	Average Travel Time (sec)		% Difference
			Field	VISSIM	
EB	J1	J3	255	275	7.83%

The GEH statistics values from field and VISSIM traffic volume based on calibrated parameters are given in Table 7. It can be observed that GEH statistics is less than the recommended value of 5 for all the considered locations. The acceptable values of percentage differences for average travel time and GEH statistic < 5 for traffic volume endorse the effectiveness of proposed calibration procedure for heterogeneous traffic conditions. The next step involved the validation of proposed procedure.

Table 7: Percentage difference and GEH statistics for field and VISSIM traffic volume.

Junction	*Approach*	*Traffic Volume (Veh/ hr)*		*% Difference*	*GEH Statistics*
		Field	*VISSIM*		
J1	NB	1404	1406	0.2%	0.06
	SB	1386	1392	0.4%	0.16
	EB	2514	2492	-0.9%	0.45
	WB	2382	2336	-1.9%	0.94
J2	NB	1081	1074	-5.4%	1.80
	EB	2339	2356	0.7%	0.36
	WB	2356	2339	-0.7%	0.34
J3	SB	1794	1784	-0.6%	0.24
	EB	2303	2297	-0.3%	0.13
	WB	2233	2220	-0.6%	0.28

3.4 Validation

A different data set from the same site was used to validate the model. This data set was collected for relatively low volume conditions (off-peak conditions). The traffic volume was used in calibrated model and the simulations output on average travel time was compared with the field data. The model produced a percentage difference of 8.25% between the field travel time and simulated travel time along westbound (WB) direction. In addition to travel time along WB, the visual observations of queue length data were also assessed and it was found that the model showed the successful application of the proposed calibration procedure. The output of validation procedure is given in Table 8.

Table 8: Percentage difference between field and VISSIM MOE values.

Direction	*From*	*To*	*Average Travel Time (sec)*		*% Difference*
			Field	*VISSIM*	
WB	J3	J1	194	210	8.25%

3.5 Statistical Analysis

The paired t-test was conducted in order to compare the data obtained from the VISSIM with the corresponding data obtained from field. The statistical test is used to compare the means of two populations and to test the null hypothesis that the difference between the mean of the two populations is zero. For this study, the two populations under considerations were the data obtained from the field and the output from VISSIM. The traffic volume at different locations along corridor and travel time was used for comparing field and VISSIM output by employing t-test. The test was conducted by using Statistical Package for the Social Sciences (SPSS).

Table 9 shows that test statistics of 0.71 for travel time and 1.82 for traffic volume fall within acceptance regions of the t-distribution. This indicates that the null hypothesis "H_0" (stating that there is no statistical difference between field and VISSIM output) is not rejected. Also, the p-value > 0.05 which implies that there is not sufficient statistical evidence to show the difference between the field data and simulation output. The values of 0.998 and 0.999 for correlation coefficients were obtained for travel time and traffic volume, respectively. A value closer to 1 shows that the points fall near the straight line. To represent this fact, the traffic volume from field was plotted against VISSIM output and a linear function; y = x was superimposed on the plots. Figure 3 shows that the plotted points fall in close proximity of the function which endorses the similarity between field and VISSIM outputs for traffic volume (a) and travel time (b).

Table 9: Paired t-test details for traffic volume.

Measure	*Mean of the Differences*	*Standard Deviation of the Differences*	*Pearson Correlation Coefficient*	*Critical value of t-distribution (two-tailed), alpha = 0.05*	*Test Statistics (t value)*	*p-value (Two-tailed)*
Travel time	1.5	7.35	0.998	-2.20, 2.20	0.71	0.495
Traffic volume	18.3	31.64	0.999	-2.26, 2.26	1.82	0.10

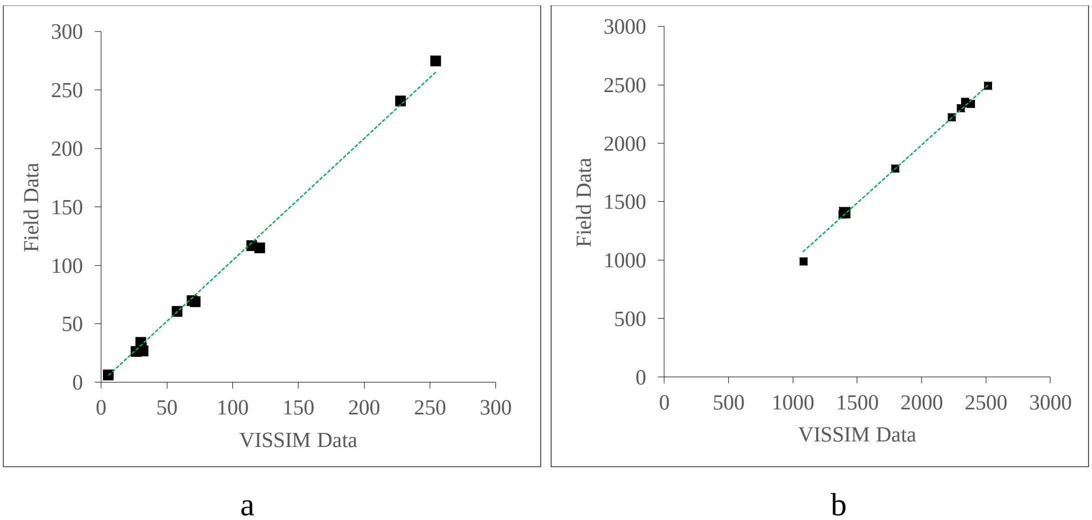

Figure 3: Plot between field data and VISSIM output with superimposed y = x function; (a) travel time, (b) traffic volume.

4. Conclusions

This paper has presented a 4-steps calibration procedure of VISSIM simulation model for non-lane based heterogeneous traffic conditions. The proposed procedure was applied to a 1.4 km section of an urban arterial having three closely-spaced signalized junctions. Data collected through videography and manual observations was fed into VISSIM to develop base model. The initial runs with default parameter settings showed percentage difference of 57.65% between field and simulation output, which endorsed the need of detailed calibration. The calibration step consists of three sub-steps; review of literature and subsequent application of SA for identification of sensitive parameters, generation of random samples by employing LHD technique in MATLAB and consequent development of regression model, and determination of calibrated parameters by applying MES program. The calibrated parameter values produced a percentage difference of 7.83% between field and model travel time. In addition to the average travel time, the field values of hourly traffic volume at various points were also compared with the simulation output and it was found that the differences fall within acceptable thresholds. The validation step was also conducted by using different data set which also yielded satisfactory results. In addition, paired t-test was also conducted to confirm the statistical similarity between field and simulation output.

The proposed methodology provided insights on adjusting specific characteristics of non-lane based heterogeneous traffic. The behavior of utilizing inter-vehicular spaces in a queue by 2Ws was reflected by adjusting the lateral distances and longitudinal speeds. In addition to the satisfying quantitative measures, the qualitative observations of queue formation also produced the satisfactory results. The final parameter set revealed that the smallest values for standstill distance and safety distances were realized for 2Ws followed by 3W, cars and HVs. The proposed methodology is useful for traffic practitioners dealing with heterogeneous traffic operations in developing countries. The study concluded that the vehicles in heterogeneous traffic conditions tend to adopt smaller longitudinal and lateral gaps during standing and driving conditions in comparison to default values of model.

Although, the results produced in this study are case-specific, the proposed calibration methodology can be effective for similar traffic conditions especially where driving behaviour is highly vehicle-class dependent. Similar researches for various geometric and traffic characteristics of developing countries should be conducted in order to establish a guideline that provides the optimal values of driving behaviour parameter sets involving different vehicle classes and traffic scenarios. Such findings will help practitioners to get the desired impact of any proposed course of action without consuming time on calibrating local conditions and in turn will improve the reliability of simulation output.

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