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Issues and concerns of microscopic calibration process at different network levels: Case study of Pacific Motorway

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Abstract

Calibration process in micro-simulation is an extremely complicated phenomenon. The difficulties are more prevalent if the process encompasses fitting aggregate and disaggregate parameters e.g. travel time and headway. The current practice in calibration is more at aggregate level, for example travel time comparison. Such practices are popular to assess network performance. Though these applications are significant there is another stream of micro-simulated calibration, at disaggregate level. This study will focus on such micro-calibration exercise- key to better comprehend motorway traffic risk level, management of variable speed limit (VSL) and ramp metering (RM) techniques. Selected section of Pacific Motorway in Brisbane will be used as a case study. The discussion will primarily incorporate the critical issues encountered during parameter adjustment exercise (e.g. vehicular, driving behaviour) with reference to key traffic performance indicators like speed, lane distribution and headway; at specific motorway points. The endeavour is to highlight the utility and implications of such disaggregate level simulation for improved traffic prediction studies. The aspects of calibrating for points in comparison to that for whole of the network will also be briefly addressed to examine the critical issues such as the suitability of local calibration at global scale. The paper will be of interest to transport professionals in Australia/New Zealand where micro-simulation in particular at point level, is still comparatively a less explored territory in motorway management.

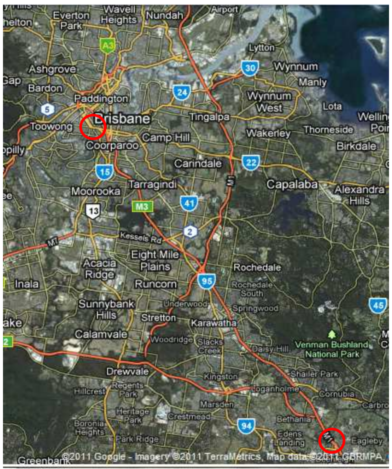
1. Introduction

Microscopic traffic simulation is a popular tool in traffic engineering and transport planning, primarily due to its strength in analysing vehicular and driving behaviour as well their replication under variable traffic scenarios to comprehend the implication of traffic management measures on network operational performance, traffic risk level. However, the effectiveness of a traffic simulator in evaluating traffic management strategies lies in its ability to accurately replicate actual traffic conditions; which thereby requires proper calibration of its parameters rather than using default values (Hourdakis et al. 2003). But this calibration process in micro-simulation is an extremely complicated phenomenon. The difficulties are more prevalent if the process encompasses fitting aggregate and disaggregate parameters e.g. travel time and headway respectively. The current practice in calibration is more at aggregate level, for example travel time comparison. Such practices are popular to assess network performance. Though these applications are significant there is another stream of micro-simulated calibration, at disaggregate level. This study will focus on such micro-calibration exercise- key to better comprehend motorway risk level, management of variable speed limit (VSL) and ramp metering (RM) techniques, using Aimsun platform. Selected section of Pacific Motorway in Brisbane will be used as a case study. The discussion will primarily incorporate the critical issues encountered during parameter adjustment exercise (e.g. vehicular, driving behaviour) with reference to key traffic performance indicators like speed, lane distribution and headway; at specific motorway points. The endeavour is to highlight the utility and implications of such disaggregate level simulation for improved traffic prediction studies. The aspects of calibrating for points in comparison to that for whole of the network will also be briefly addressed to examine the critical issues such as the suitability of local calibration at global scale. The paper will be of interest to transport professionals in Australia/New Zealand where micro-simulation in particular at point level, is still comparatively a less explored territory in motorway management.

2. Modelling platform and case corridor

The preferred modelling platform used in this project is AIMSUN 6.1.3 and case study corridor is Pacific Motorway, selected section (see Figure 1).

Figure 1: Pacific Motorway (M1 & M3) (Brisbane CBD – Logan River



The Pacific Motorway connects between Brisbane, Queensland and Tweed Heads, the New South Wales-Queensland border. It is 100 km in length with Brisbane Central Business District-Eight Mile Plains being allocated as M3 and Eight Mile Plains- Tweed Heads as M1 (Department of Transport and Main Roads 2011).The assigned case section starts at northern part of this motorway at Coronation Drive, Milton between Coronation Drive-Riverside Expressway merge (northbound) and finishes at Pacific Motorway-Logan River crossing (Figure 2, 3). The case network finally built in Aimsun constitutes 97 mainline links and 68 on/off ramps. This was used for network calibration.

Figure2: Coronation Drive-Riverside Expressway merge (northbound boundary)

Figure 3: Pacific Motorway-Logan River crossing (southbound boundary)

See Section 5 for the comparative concerns addressed during the network calibration process, based on the point adjustments. In addition, it should be noted the design sites for disaggregate level calibration, as per data availability were Pacific motorway north of Gateway Motorway Merge and south of Vulture St Overpass. Data in both sites include south and north bound traffic and for each lane separately (Figure 4, 5).

Figure4: Pacific Motorway (South of Vulture Street)

Figure 5: Pacific Motorway (North of Gateway Motorway in and off ramps)

See Section 4 on the issues and concerns encountered during such point level calibration process.

3. The case calibration process: conceptual framework and key constituents

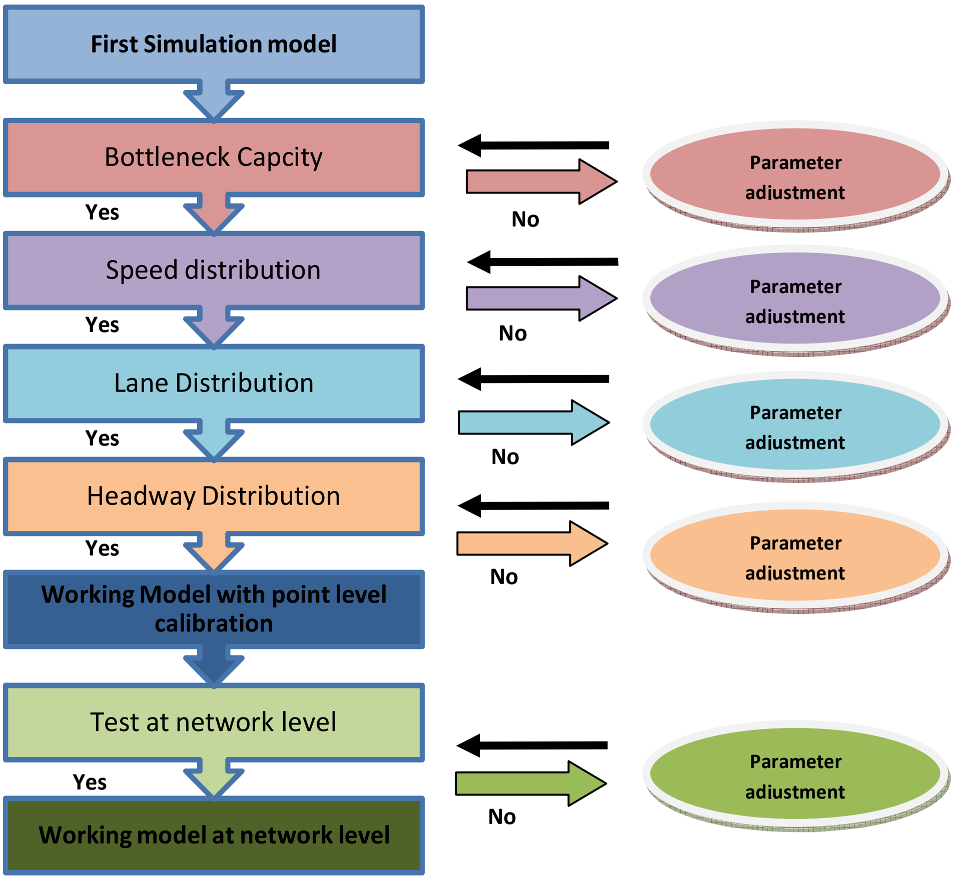
3.1 The approach

Once the case corridor network was set up for simulation, the calibration of the same was conducted first at disaggregate level to tune up the selected parameters. The real dataset *Metro Count Traffic Executive data for individual vehicles* has been used for the analysis, sourced from Department of Transport and Main Roads (DTMR). The temporal length of the traffic data are for consecutive 9 days (18 July 2009- 27 July 2009) and their average value is used as input for Vulture street calibration. The calibrated parameters at Vulture street point were then validated at Gateway point. For validation, field data were collected for Gateway point from same source, for same 9 days, averaged and the calibrated parameters of vulture street point were applied to test their ability to replicate observed traffic measures and distribution pattern for Gateway site. The final parameters were tested and refined as required to suit and replicate network level performance measures. A total of five replications were used in the simulation process.

The calibration strategy for this project is characterized by two key features at point level, i) use of consecutive sub tasks to make the simulation model closer to the real traffic situation and ii) use of stop criteria for each sub-tasks to ensure that they are tuned optimally. A set of parameters were used for each sub-tasks. At network level the parameters were adjusted simultaneously based on the result of performance indicators. The calibration process is presented in Figure 6.

This is to note that for each sub-tasks at point level, a set of model parameters were reviewed and adjusted so that the best value ranges were acknowledged For a following sub-task, some of the parameters tuned previously were re-tuned to ensure the best value range for those parameters were acknowledged under new sub-tasks and new parameters were also calibrated simultaneously. These practices ensured that all parameters were properly adjusted for each given sub-task.

Figure 6: Calibration process



3.2. Input data

Based on the network built, the geometric structure of the assigned sections were cross-checked. The data used as input for the model included mean vehicle length of 4.65 m, mean vehicle width of 1.75m (Austroads 2007); section lengths (m) and speed limit (km/hr) as per DTMR database. The traffic composition used for the model was car only.

3.3. The performance measures and turning parameters

Calibrating capacity, speed distribution, lane utilization and headway distribution often enable the simulated model to reflect the observed traffic condition for a motorway at disaggregate level (Pham and Chung 2005). Therefore at point level calibration for the study site, the performance measures selected included *speed, headway and lane utility*. Data availability was also crucial in such measure selection process. The distribution patterns for the selected measures were then generated and used for comprehension of the traffic characteristics of the case points, thereby developing strategies including threshold for tuning of each parameter. But calibration is a continuous process of adjustments of influence parameters which according to Dowling et al. (2004) can turn out to be a never –ending circular process. Therefore stop criteria for each of the tuning parameters were set based on the threshold value assigned to the performance measures, extracted from distribution and field data source. See Section 4 for details on the issues and concerns while performing such adjustment process. The tuned parameters from disaggregate level were later applied to measure the performance trends they produce for whole of the network and parameters went through subsequent adjustments as required. The measurable traffic variables used for comparing the behavior of the simulated network to that of the actual model were volume, speed and occupancy (all 3 at network level**)** as is often suggested for this level calibration **(**Hourdakis et al. 2003). This was to reduce the disparity in output result of the performance trends, between real scenario and simulated scenario. See Section 5 for details on the rationale and aspects of such disparity between aggregate and disaggregate calibration phenomenon.

The model parameters, during the whole process, that had been adjusted included reaction time (sec.), simulation step (sec.), maximum desired speed (km/hr), speed acceptance, maximum acceleration (m/s2), percent overtake, percent recover, distance zone 1 (sec.), distance zone 2 (sec.), look ahead distance (m), normal deceleration (m/s2) and car following model. These parameters were selected based on their direct effect on selected sub-tasks and in accordance with calibration objectives. Table 1 shows the parameters adjusted according to their category.

Table 1: Model parameters calibrated during the whole process

Parameter Groups	Parameter
Global Parameters	Reaction Time
	Simulation step
	Different Car Following versions
	Percent overtake
	Percent recover
	Look ahead distance
	Distance zone 1
	Distance zone 2
Vehicles Parameters	Maximum desired speed
	Maximum acceleration
	Speed acceptance
	Acceleration rate
	Normal deceleration
	Sensitivity factor

The detail on parameters that were tuned to achieve a threshold for the selected performance indicators were elaborated in Section 4 and 5. This should be noted that the parameter tuning were considered optimum when at disaggregate data level, they were able to reflect maximum proximity to the target values (stop criteria) of the performance measures and distribution similarity between observed and simulation data; at aggregate data level, enabling simultaneous representation of reasonably accepted error values.

4. Critical issues during disaggregate level calibration

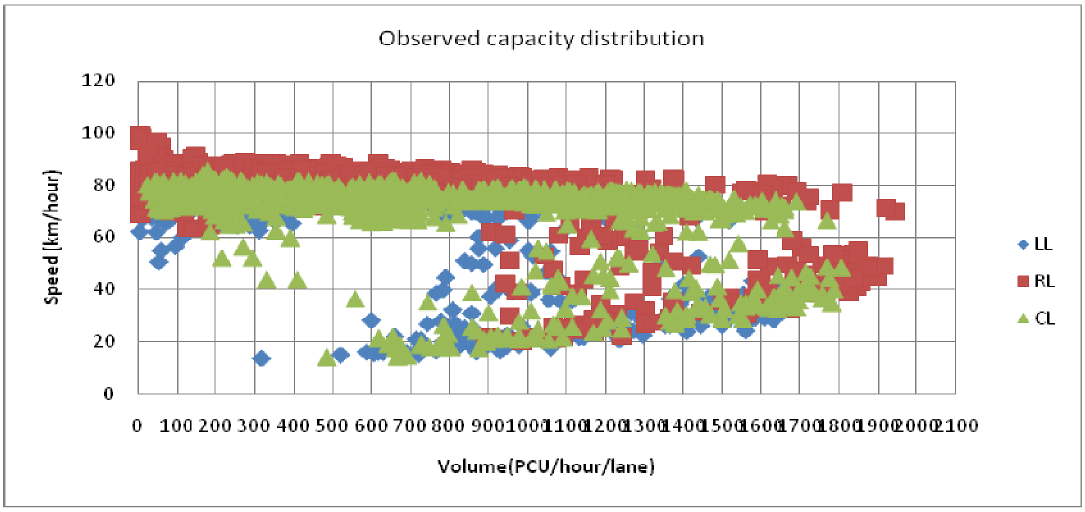
Based on the approach briefed in Section 3, the calibration of the case sites as specified in Section 2, Figure 4, 5 were conducted. The critical issues encountered during the calibration process are discussed below with reference to the performance measure for which the calibration was conducted.

4.1 Capacity calibration

Replication of correct traffic flow was crucial for any traffic performance and distribution analysis. Therefore, calibration of parameters to generate appropriate flow ranges was the first step in the calibration of this study, to ensure that other sub-tasks were adjusted based on a real platform. The capacity calibration and for that matter, all other calibration task to be performed were based on traffic flow at 10 minutes aggregate intervals. For artificial calibration of lane capacity particularly at bottleneck situation, the most effective parameters as regarded were reaction time and simulation step. Usually, from observation and previous studies it was also found that capacity of leftmost lane in a motorway was always the worse effected. The calibration therefore focused on this lane for the sub-task.

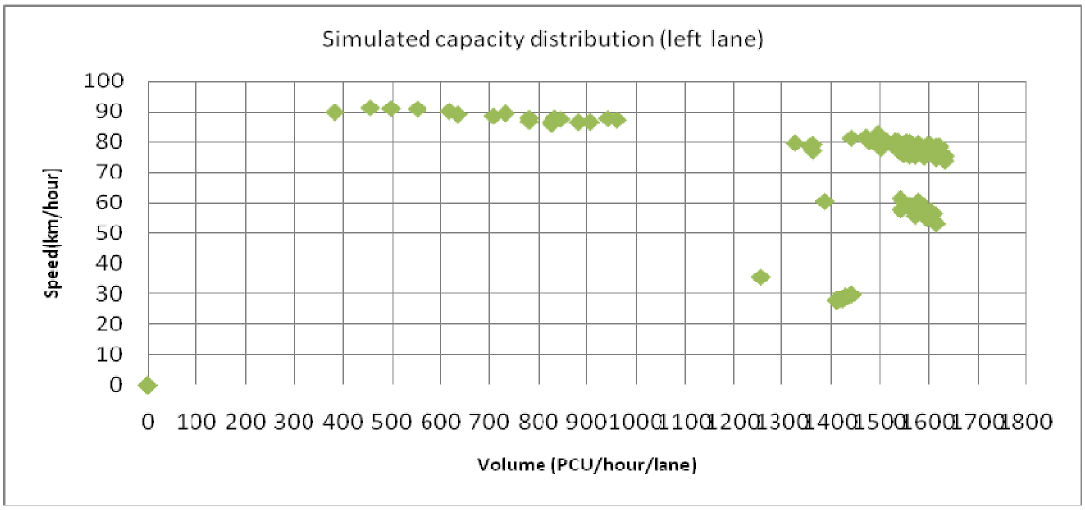
Figure 7 shows observed speed-flow diagram at the Vulture street location. The maximum flow/capacity of left lane is about 1650 vehicle per hour (vph) and this is the target capacity value to achieve through calibration as a base to properly replicate the traffic behaviour.

Figure 7: Speed-flow relationship with observed data



A combination of reaction time 1.2 second and simulation step 0.6 second were found to achieve the capacity of 1650 vph (Figure 8). It is noteworthy that in Aimsun, reaction time has to be a multiple of simulation step.

Figure 8- Simulated and calibrated best fit speed-flow diagram



Based on the calibration and validation, the first critical issue in this whole process was found to be selection of correct parameters for tuning capacity which were selected based on experience, recommended set of parameters for the purpose from Aimsun manual and previous literature such as Pham and Chung (2005). Even though this task used and achieved desired target threshold with two parameters, a set of other parameters such as minimum distance between vehicles, maximum speed difference could have been added into trial and error process if the said pair of parameters were unable to achieve desired result. In addition, as observed from Figure 7, another critical problem encountered included the necessity to create the bend of the speed in simulation when the capacity began to saturate due to congestion, to replicate a real distribution in the simulation. To calculate the lane capacity by simulation model we needed a bottleneck to create another wing of the speed-volume diagram which occurred in the traffic jams. Increase of volume in the model could not have achieved that. An artificial bottleneck therefore had to be created in this regard which was eventually generated by reducing downstream speed limit.

4.2 Speed calibration

In order to simulate speed distribution, three parameters were tuned. They included-maximum desire speed, speed acceptance and acceleration rate. The calibration was first done for Vulture street site and then tested on Gateway site. Field estimated mean, deviation, minimum, maximum values for maximum desired speed in km/hour (95.4, 8.8, 50, 157) and speed acceptance rate (0.95, 0.1, 0.8, 1.4), model default acceleration rate in m/sec2 (3) were put as input into the model for simulation. This set together with other combinations of parameters totalling 10 parameter sets were applied before realizing final tuned values.

To make decision about each parameter setting results, *in disaggregate data level*, average and deviation of speed distribution (estimated to be 77 kph, 8 kph respectively based on results of observed data) were the most effective practiced criteria and therefore been used. *In aggregate data level,* Root Mean Square error (RMSE) percentage was the chosen statistical test as recommended by Barcelo and Casas (2005), Hourdakis et al. (2003). Lowest RMSE with closest disaggregate match was considered as selection benchmark for desired parameter set. This is to note that the tuning commenced with reaction time fixed at 1.2 second and simulation step fixed at 0.6 second based on capacity calibration. The best results for vulture street was found with mean, deviation, minimum, maximum tuned values for maximum desired speed in km/hour (110, 10, 50, 157) and speed acceptance rate (1, 0.12, 0.7, 1.5), acceleration rate in m/sec2 (2.8). The combination was also found to be best satisfactory with reference to RMSP, the selected indicator for aggregate data validation. The resultant values with these parameters for Vulture Street is presented in Table 2.Even when applied to the Gateway site the results from the tuned parameters were quite acceptable on this site(Table 2) validating the appropriateness of the tuned parameters .

Table 2: Comparison of calibration results at two case points compared to target value

Type	Target	Vulture site	Target	Gateway site
Average (km/hour)	77	76.89	95	86.84
Deviation (km/hour)	8	9.14	8	11.47
Minimum (km/hour)	10	55.38	50	56.12
Maximum (km/hour)	150	109.29	157	127.77
RMSP (%)		3.75		6.01

The speed distribution similarity of simulation with actual condition is depicted in Figure 9 and 10 for Vulture street site as example demonstration of the calibration validity.

Figure 9: Speed distribution in Vulture Street based on observed data

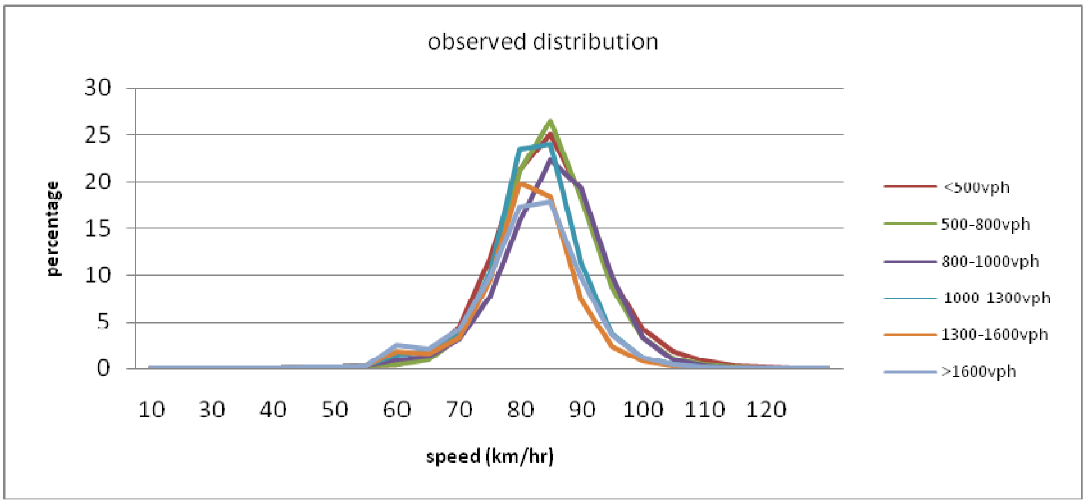
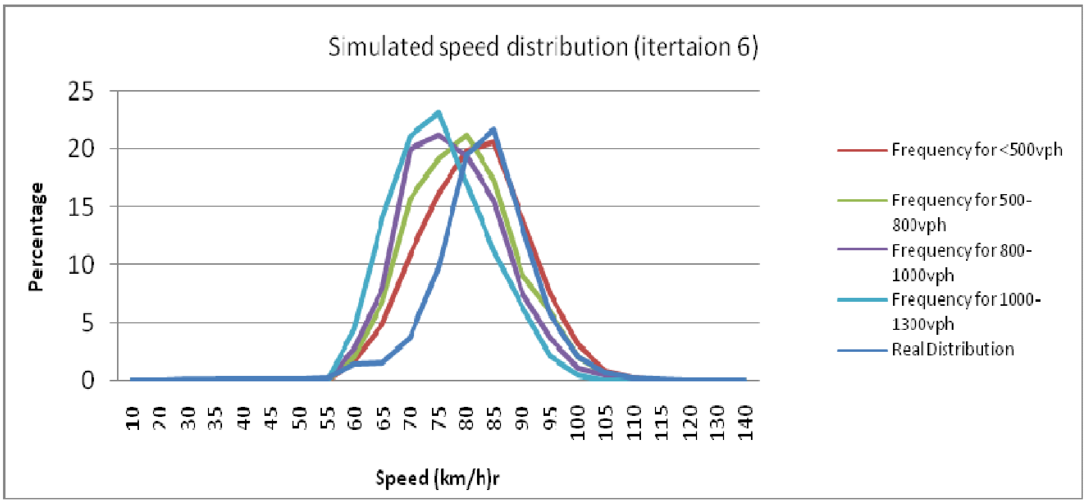


Figure 10: Speed distribution in Vulture Street based on simulated data



Similar distribution pattern were also found for Gateway site as well compared to observed ones. These also indicated the validation capability of the chosen parameters in replication of the actual speed state.

Based on calibration and validation experience of speed distribution, one key learning/ issue of concern revealed was the uncertainty in section of tuning parameters for simulation purpose. Among the chosen parameters, maximum desired speed did not cause too much difference in speed distribution as advised in few literature such as Pham and Chung (2005). The cause could be the speed limit in the location was lower than desired speed. More over in Car Following model minimum of these two speeds was used; which in this location was the speed limit. Rather, change in speed acceptance was found to be much more effective than maximum desired speed. The same thing of maximum desired speed was also true for acceleration rate as well for replicating distribution. The important learning from such finding was that the combination parameters or their influence can vary depending on the simulation platform used or the local distribution character of traffic. In addition, the distributions of the simulations were found to be more dispersed compared to observed condition indicating the degree of uncertainty associated with the simulation process, which is extremely difficult to eliminate due to constant changing unpredictable behaviour of the drivers.

4.3 Lane utility calibration

The parameters primarily used for lane utility calibration was percent overtake and percent recover. The other parameters that were associated with the preliminary testing also included look ahead distance, distance zone 1, distance zone 2. But these were found to have negligible or no impact on the lane changing phenomenon for the case site and therefore they were kept with default value at final calibration results. The calibration was first done for Vulture street site (3 lane corridor) and then tested on Gateway site (2 lane corridor).

The fundamental principle adopted in the adjustment process based on ideal vehicle behaviour, field observation (Figure 13) and literature (Al Kaisy et al 1999; Pham and Chung 2005) was that vehicle should use the normal lanes (left lane or middle lane in this instance) with their desired speed. The overtaking lane is used when driver would like to overtake their front vehicle and then will come back to normal lane to continue with their desired speed. The traffic flow of overtaking lane should therefore be low under free flow condition and increases as the flow increases. The key inputs were the calibrated parameters from capacity (reaction time, simulation step) and speed measures (maximum desired speed, speed acceptance rate, speed acceleration).

The simulation results of the lane utility calibration at Vulture site in comparison to the observed values are presented in Figure 11, 12 as example of distribution validity. The final adjusted values were found to be percentage overtake (98%), percentage recover (99%), distance zone 1(20 meter), distance zone 2 (3 meter), look ahead distance (200 meter).

Figure 11: Observed lane distribution at Vulture Street

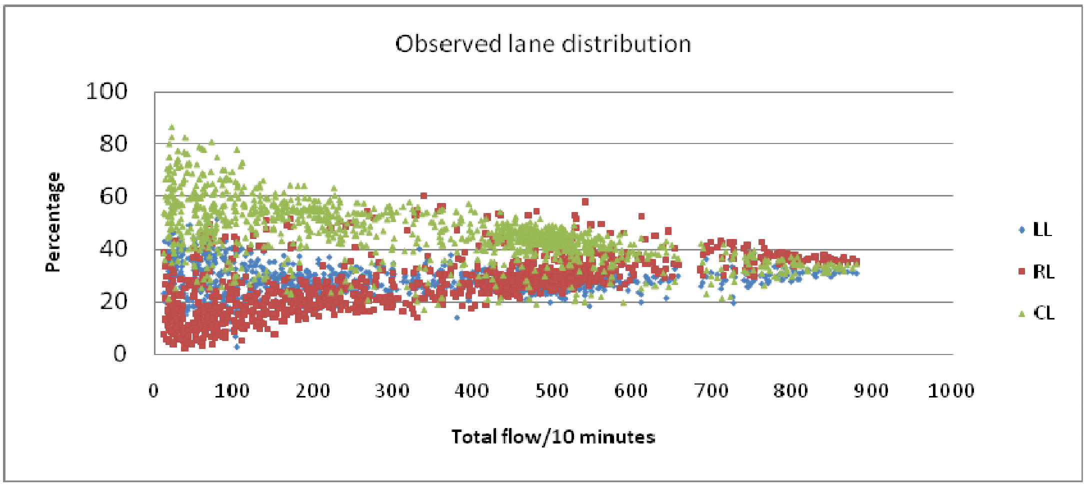
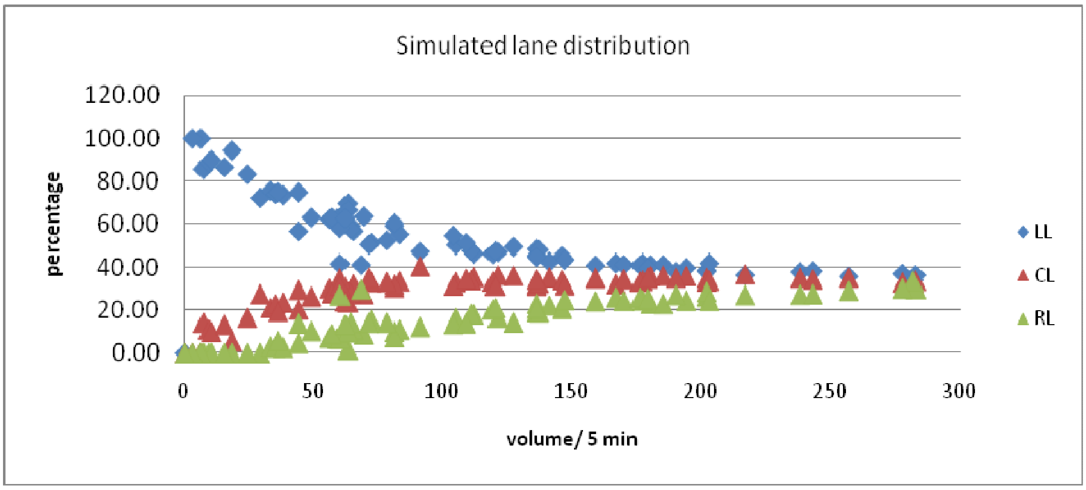


Figure 12: Simulated lane distribution with best adjusted parameters at Vulture Street



The findings of calibration at Vulture Street indicated that left lane is attracting more traffic than centre lane, differing from the observed distribution. No sets of parameter combinations have been able to generate a distribution that have centre lane with higher volume than left lane. This is primarily attributable to the fact that lane distribution in Aimsun assigns higher volume to leftmost lane, then centre lane and then the fast lane which is right lane. So it does not match with observed distributions, in case of a 3 lane scenario as above. To reinforce the argument and check driving behaviour, we examined another 3 lane motorway in Switzerland (see Karkowski and Chung 2007 for details). The cross-check also shows similar results, i.e. 3 lane motorways have similar driving behaviour of generating more volume for centre lanes than left lanes.

Based on the adjustment values, the tuned parameters were tested on Gateway and satisfactory similarity between observed and simulated distribution were found. Such results indicated satisfactory similarity for the 2 lane condition, i.e. the traffic flow of overtaking lane is observed to be low under free flow condition and increases as the flow increases. This denoted the suitability of the adjusted parameters. However, it can be derived from such analysis that in Aimsun or for that matter other simulation tools with similar principles, the lane distribution cannot be perfectly calibrated to replicate 3 lane motorway condition if the center lane tends to have higher volume than left most lane throughout which contradict to the general lane changing principle. Short et al (2004) has rightly stated that lane changing is a notoriously difficult and complex behavioural process to model.

In addition, another significant criticality that was identified during the lane utility calibration was the inability to generate the total demand beyond 3600 PCU per hour compared to observed values of >4000 PCU, applicable to both case sites. This was particularly attributable to the reaction time (1.2) as adjusted previously, too slow to generate the observed flow levels but could not be refined as otherwise that would tamper the other adjustments, capacity in particular.

4.4 Headway calibration

Following suit to speed and lane distribution, the headway distribution of Vulture Street has been conducted first and then the adjusted parameters are validated on Gateway site. **T**he calibration commenced with previous tuned parameter of capacity, speed and lane utility as background environment. Five parameters that have been tuned here was reaction time, simulation step, Car-Following Model, normal deceleration and sensitivity factor. The tuning started with already tuned values of 1.2 second for reaction time, 0.6 second for simulation step and the model given default values for the parameter set Car-Following Model (Version 6.0,default), normal deceleration (4 m/sec2), sensitivity factor (1). These combinations together with 11 other parameter set were used as calibration input.

In order to judge the parameter setting results, *in disaggregate data level*, average and deviation of headway distribution (estimated to be 4.94 sec, 12.1 sec respectively based on results of observed data) were the most effective criteria and therefore been used. *In aggregate data level,* Root Mean Square error (RMSE) percentage (Hourdakis et al. 2003; Barcelo and Casas 2005) and correlation coefficient (Barcelo and Casas 2005) was the chosen statistical test. This should be noted that for aggregate data, the lowest combination of RMSE and correlation value coupled with best fit disaggregate outputs would be the optimum level for settling the calibration. The best results for vulture street was found with values of 1.2 second, 0.6 second, Version 6.0 default, 2.5 m/sec^2, 1 for parameters reaction time, simulation step, car following model, normal deceleration, sensitivity factor respectively. The combination was also found to be best satisfactory with reference to RMSP and correlation coefficient, the selected indicators for aggregate data validation. The resultant values with these parameters for Vulture Street is presented in Table 3. Even when applied to the Gateway site, the tuned values of Vulture street site provided quite acceptable results at this site as well (Table 3) **validating** the suitability of the calibration values.

Table 3: Validation result of different parameter combinations

	Set type	Target	Vulture site	Target	Gateway site
disaggregate	Average	4.94	8.330	4.01	4.22
	dev	12.07	40.42	7.51	4.75
	C1	85%	80.00	76.68%	70.26
	C2	2-3.5	1.8_3.5	2-3.5	2-3.5
	C3	0.2-0.5	0.500	0.2-0.5	0.2-0.5
	C4	15%	14.00	14%	22%
	RMSP (%)	-	10.10		12.84
aggregate	correlation coefficient	-	0.989		0.96

Note:

C1: The percentage of vehicle in simulation having headway smaller than of equal to 6 seconds should be within that percentage in reality (85% for vulture, 77% for gateway) plus/minus 10%. This is applied to all flow ranges.

C2: The headway value interval that the most number of vehicles have should be from 2-3.5 seconds.

C3: The lowest headway should be 0.2-0.5 seconds

C4: The percentage of vehicles having headways belonging to one headway interval should not be greater than 15% (vulture), 14% (Gateway).

The comparative headway distribution of simulation with actual condition for Vulture street is depicted in Figure 13, 14 as example demonstration of calibration validity.

Figure 13: Headway distribution with observed data

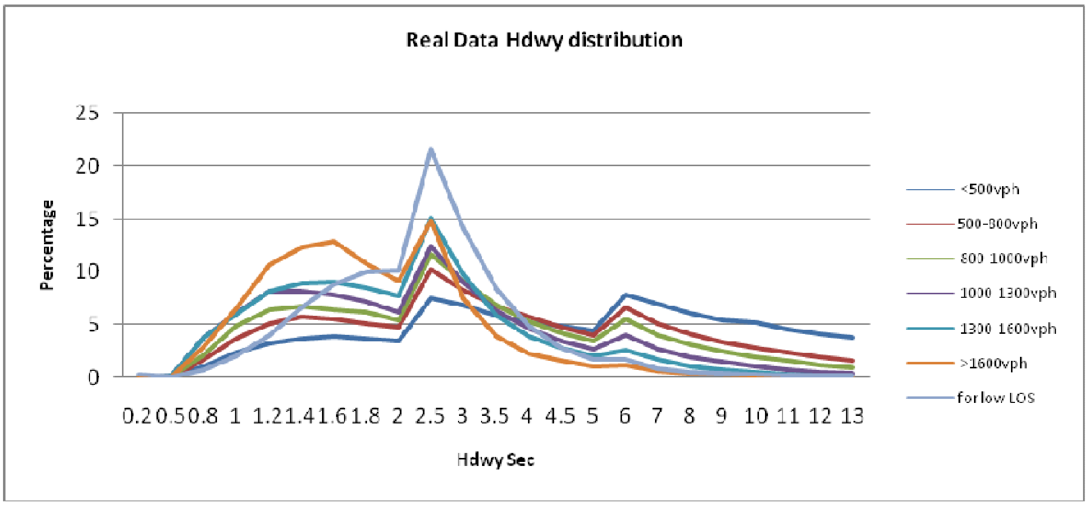
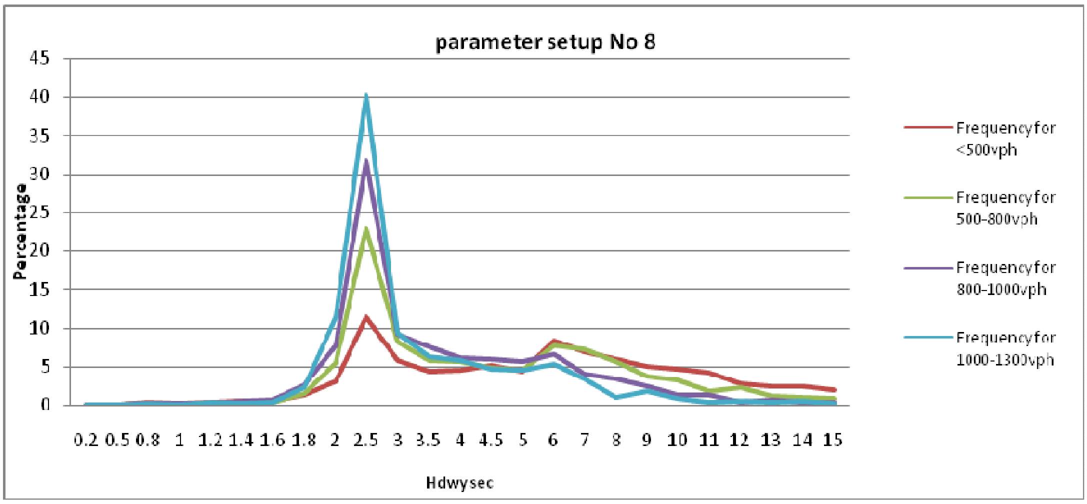


Figure 14: Headway distribution with simulated data



The critical learning from this distribution analysis was that the simulations in both instances were unable to replicate the small headways of the observed data. This was primarily attributable to the fact that in simulation very small headways such as up to 1.6 sec remain absent/ negligible proportion in both cases, irrespective of accuracy of the calibration task. Such phenomenon occurs as in simulated environment, traffic behave to a minimum threshold discipline level which means inability to generate enough congestion that can lead to such small headways. However, the ability to replicate high headway values does indicate the validity of the calibration parameters in replicating those cases at reality.

The point calibration with reference to different performance measures revealed the fact that though such micro-calibration enables to replicate a large number of driving and vehicular behaviours and as such relative risk level and performance for motorway management, there are certain issues that still remain uncertain. For instance, inability to replicate lane changing pattern or very small headways or greater dispersion in speed distribution, which might impact the precision of traffic performance prediction.

5. Comparative concerns of calibration: Point versus network

The parameters at point level such calibrated and validated were then applied at network wide performance analysis for the selected case network of Pacific Motorway (Figure 2, 3). However, a number of key issues/concerns that were encountered during the transition of the calibrated local (point) level parameters to replicate global simulation were depicted below.

5.1 The scene

The selected scenario for global testing was a regular business day at Pacific Motorway with major educational institutions running, having good weather (no rain) and no incident reported (as sourced from TMR incident data). Public Transport Data Service (PTDS) was the base source of the loaded network and the simulation duration was for 17 hours (3am to 8pm).

5.2 Adjustment of local calibration to match global application

5.2.1. Correction to the distribution of traffic

The locally calibrated parameters were applied to the loaded network. The distribution of all predefined performance measures (volume, speed, occupancy) over the mentioned period were generated and compared to the observed distribution for the same. Volume distribution was chosen as the performance measure of this discussion due to space limitation. The comparative distribution showed that the simulation (Figure 16) was not producing similar volume trend (limited to mostly 1000 PCU and in few places up to 1500 PCU) in PM period (after 1pm) as compared with observed data (dominant share of 1500 to 2500 PCU at similar locations) (Figure 15). However, the AM period was quite similar (Figure 16).

More specifically, the simulation with local calibration was incapable to replicate the bottlenecks and higher level traffic flows as was found at observed distribution. For instance, the bottleneck condition created at city in PM peak (4pm-6pm) for outbound traffic was absent at that location in the simulation, so was at the downstream of Gateway Motorway in AM peak (7am-9am). These trends clearly indicated the necessity of adjustments to the locally tuned parameters and it was revealed that refining reaction time and simulation step were the key influence in this regard. Their adjustment (shifting reaction time to 0.9 second and simulation step to 0.45 second) greatly improved the overall flow rate of the network, enabling better capacity and flow distribution pattern with reference to the observed model (Figure 17). Moreover, the volume trend for PM period was much better replicated in this stage. The bottlenecks were also possible to be mostly replicated with such modifications.

Figure 15: Observed volume contour

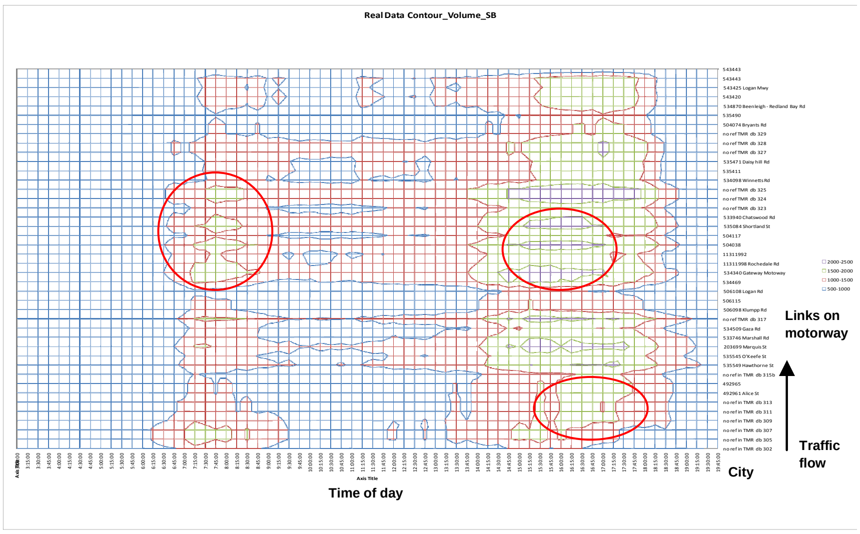


Figure 16: Simulated volume contour (with local calibration)

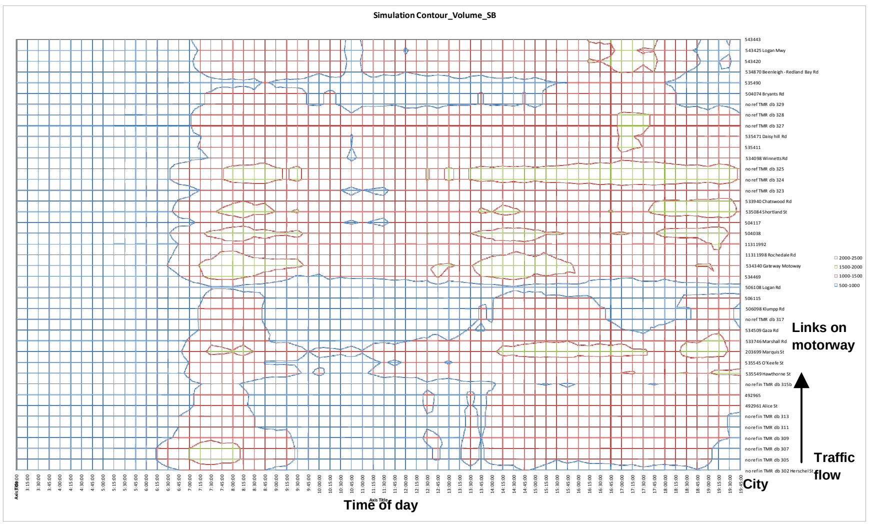
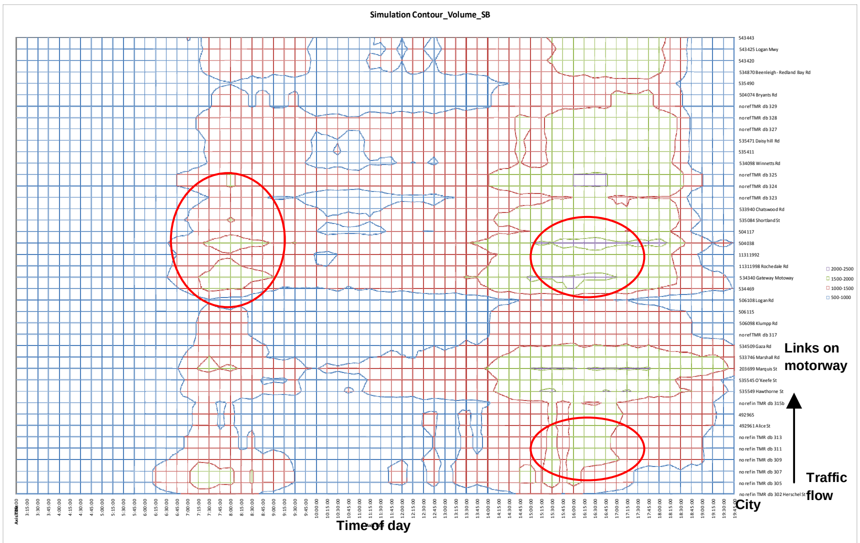


Figure 17: Simulated volume contour (after adjustment)



5.2.2. Fine-tuning the vehicular behaviour

In addition to the aforementioned adjustment requirement, the simulation test with local calibration also demonstrated another key concern while applied to global scale. That is the inconsistent behaviour of vehicular traffic in lane changing protocol, commonly known as weaving. A number of locations on mainline particularly those approaching an exit were encountering with sudden weaving activity such as shift from fast lane (right most/middle lane) to the exit lane (left most lane) in case of three/four lane mainline. This was found to be primarily attributable to the setting of the lane changing parameter, distance zone 1 and distance zone 2 which were calibrated as 20 second and 3 second respectively at point level, but proved inappropriate at global application. This is to note that in Aimsun distance zone 1 indicates the minimum distance from next turning where vehicles need to get closer to the correct side of the road from which turn is allowed (middle lane in a three lane motorway) corresponding to discretionary lane changing protocol (DLC) and distance zone 2 indicates the minimum distance at which vehicles are forced to move to turning lane (left lane) corresponding to mandatory lane changing (MLC) protocol (Gipps 1986, Hidas 2002, Aimsun 2009).Therefore, such settings were creating weaving at network level, for instance in sections with link speed and section lengths that were not allowing enough distance for vehicles to safely move to turning lane The values therefore required to be adjusted locally to suit to the section distances and speed limits when equipped with exit lane and where such weaving was observed. In this sequence, the distance zone 1 and 2 were set at different combinations such as 10 second, 2second; 60 second, 30 second etc to smooth the lane changing, thereby minimizing/eliminating weaving.

The above two issues clearly depicted the problem that modellers often encounter while fixing the locally calibrated parameters to global settings, the accuracy of which is crucial in micro-simulation process to successfully replicate observed traffic and driving behaviour, thereby increasing likelihood of success in predictive management decisions for motorways.

6. Conclusions

Calibration of a micro-simulation traffic model is extremely difficult due to its dependency on the simulator used and the group of parameters offered by the simulator for producing specific performance measure. The model used in this calibration process, Aimsun 6.1.3 also had its own sets of parameters, offered for each task. The calibration process had been hierarchical and administered within those confinement and guidelines. The key issues determined relevant to the calibration process, problems and their results at both point and network l(Section 4 and 5) level showed that calibration enables micro-simulation to explain vehicular and driving behaviour to a substantial extent. But there still exist considerable constraints in micro-simulated prediction, attributable to the inherent limitation of the simulation tool; the availability and quality of available observed data; the changing dynamics of the traffic condition and driver behaviour that poses certain degree of uncertainty in calibration. These issues and concerns of micro-calibration should be kept in consideration while making prediction for any future traffic behaviour analysis for motorway management.

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