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RESEARCH ARTICLE

CALIBRATION AND VALIDATION OF VISSIM MODEL OF AN INTERSECTION WITH MODIFIED DRIVING BEHAVIOR PARAMETERS.

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Abstract

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Microscopic simulation models have been widely used in both transportation operations and management analysis because simulation is safer, less expensive and faster than field implementation and testing. The usefulness of these models in making design and traffic control decisions will mainly depend on their accuracy and reliability. This paper describes the detail procedure for the calibration and validation of a microscopic model of highly congested intersection Mirpur-10 in Dhaka. Legs of this intersection is composed of both motorized vehicles (Bus, Passenger car etc.) and non-motorized vehicles (Rickshaws, Bicycles). Most cases, drivers are rarely concern about the lane based traffic operation. Addressing this phenomena, a micro-simulation VISSIM model with modified driving behavior parameters helps to create a virtual environment representing the traffic scenario, optimize the problems and visualize the outputs that is important to face the challenges of transportation system at present and future.

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Introduction:-

Advances in computational technology along with the increased complexity of roadway design and management have created an environment in which microscopic simulation models have become useful tools for transportation engineers. Microscopic simulations can be utilized in several different transportation areas. They can be used to evaluate alternate timing plans and geometric changes before implementing the design in the field. They are also appealing in the estimation of certain quantities that are not easily estimated or observed from the field. Microscopic simulation models contain numerous independent parameters to describe traffic control operation, traffic flow characteristics, and drivers' behavior. These models contain default values for each variable, but they also allow users to input a range of values for the parameters. Changes to these parameters during calibration should be based on field measured or observed conditions and should be justified and defensible by the user.

Dhaka is a large and densely populated metropolitan area which has one of the most diverse road transportation systems in the world. This system consists of both motorized vehicles (viz. bus, mini-bus, car, cng, baby taxi, motorcycle etc.) and non-motorized vehicles (viz. rickshaw, rickshaw van, bicycle etc.) modes. This mixed flow of vehicles leads to many problems, like conflicts at intersections, when number of non-motorized vehicle increases which adversely affects the speed and flow of other vehicles. Another feature of this traffic is the absence of lane marking and lane discipline. The lane widths are also not constant. Analytical modeling of such traffic is in nascent

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stage. Micro-simulation is favored to study and model heterogeneous traffic (Mathew et al., 2010). It is a useful tool to effectively analyze and evaluate proposed improvements and alternatives. For example, an intersection can be simulated for different signal timing plans and its effect found before implementing it. VISSIM which is used in this study is a microscopic, behavior-based multi-purpose traffic simulation to analyze and optimize traffic flows (VISSIM 5.30 User manual). VISSIM is better in terms of ease of use and does not require cumbersome coding (Park et al., 2002)

VISSIM has the ability to model the interaction between the various modes of transit with automobile traffic, ability to generate vehicles randomly and flexibility in modeling complex geometries (Moen et al., 2000). The components or parameters of simulation model requiring calibration include traffic control operations, traffic flow characteristics, and drivers' behavior. Model Validation tests the accuracy of the model by comparing traffic flow data generated by the model with that collected from the field.

Test Site and Simulation Model: -

Study Area: -

The study area is the intersection of Mirpur-10 roundabout, located in Dhaka metropolitan area. The study area includes four link roads connected with various infrastructures, cantonment and shopping mall. Dhaka cantonment, Mirpur DOHS is located in north direction, Sher-e-Bangla National Stadium in on west, Mirpur-13, 14 residential areas are on east and lots of government offices, hospital, institutes are located in the south direction which makes it one of the busiest intersection in Dhaka. Figure 1. Shows Mirpur-10 intersection.

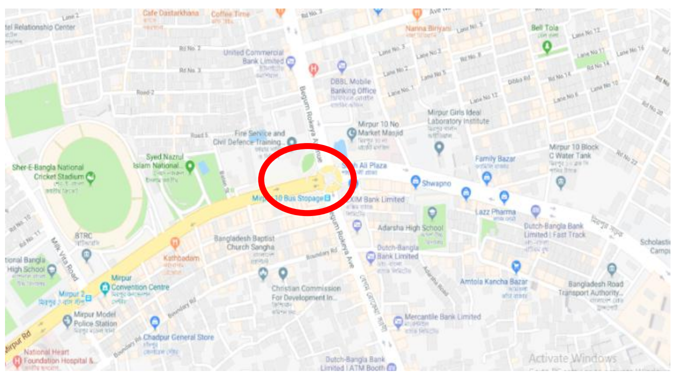


Figure 1:- Mirpur-10 Intersection

Simulation Model – VISSIM: -

The simulation model used in this research was VISSIM, version 5.30. VISSIM is a microscopic, time step, and behavior based simulation model. VISSIM uses the psychophysical driver behavior model developed by Wiedemann. In VISSIM this behavior is called Wiedemann 99. Proposed procedures are as follows:

Determination of Measures of Effectiveness: -

In this step one has to determine a performance measure, identify uncontrollable input parameters and controllable input parameters. Uncontrollable input parameters may include existing geometry, traffic counts, current signal timing plans, etc. Controllable input parameters in the simulation program may include lane changing distances, waiting times before diffusion, minimum headways, minimum and maximum look ahead distances, etc.

Data Collection: -

Once the measures of effectiveness have been identified, the next step in the calibration and validation process is data collection from the field. Performance measures and uncontrollable input parameters should be collected from the field.

VISSIM Network Model Coding: -

As described before simulation via VISSIM starts with the introduction of network coding. It should be done by creating links, connecting them, inputting vehicles composition, creating route decision, setting signal controls, data collection points and configuration.

Identification of Calibration Parameters: -

All calibration parameters within the microscopic simulation model must be identified. Examples of the controllable calibration parameters are lane change distance, desired speed, and minimum headway distances in the simulation model. Acceptable ranges for each of the calibration parameter should be determined.

Evaluation of Parameter Sets: -

In this step multiple runs will be conducted to verify whether the parameter sets identified in the previous step generate statistically significant results. For each parameter set, a distribution of performance measure will be developed and compared with the field measure.

Collection of New Data Set for Validation: -

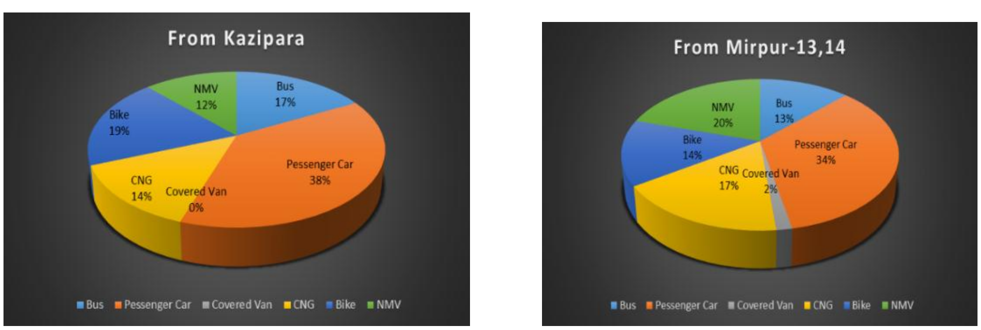
In order to perform validation of the microscopic simulation model a new set of field data under untried conditions should be collected. One way of collecting validation data would be collecting data for different time periods or conditions.

Implementation of the Proposed Procedures: -

Data Collection: -

Data of heterogeneous traffic flow such as traffic volume, vehicles composition, speed, and signal timing of the chosen road along with geometric data are collected. The vehicle flow input is given in start of leg near first foot over bridge and the outflow is found by placing 4K digital camera at selected 4 locations at peak time 9.00AM-11.00AM and 5.00PM-7.00PM. The research area is manually signalized intersection. It is intersected by two roads of two-way two lanes. East-west direction road and north-south direction road both are assumed major road. The width of each lane is not fixed but average 3.25m. Two hours of data in the morning peak and evening peak are collected. Figure 2. And Figure 3. show data collection and vehicles composition respectively.

Figure 2:-Data Collection using 4K camera



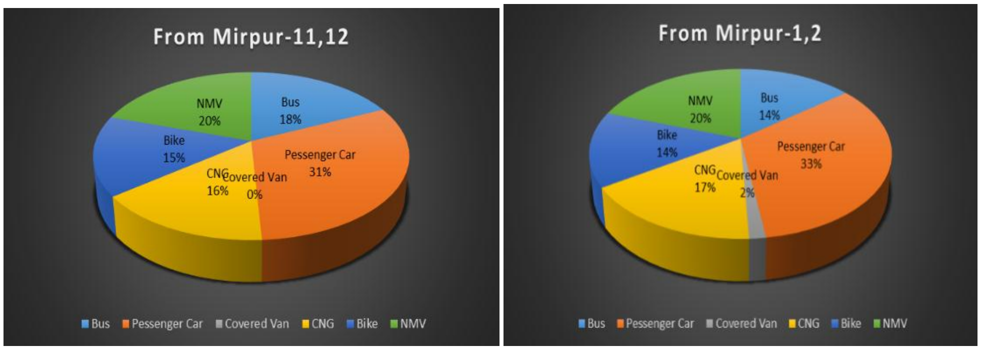


Figure 3:-Vehicles Composition

Building VISSIM Model: -

Detailed network geometry is coded through VISSIM graphical user interface (GUI).To make model representative of the real field, both MV (bus, truck, car etc.) and NMV (rickshaws, bi cycle etc.) are defined. There is no enforcement of lane discipline which results non-lane based traffic situation in the study area. Though it is quite difficult to model non-lane based flow but modifying different parameter values (driving behavior, lateral distance etc.) in VISSIM with sophisticated programming, it is possible to build the intersection model. After coding the model, the base model is run with Wiedemenn 74 car following driver behavior model. Signal timings obtained from field are also input. After creation of the model, the vehicle composition input for various legs are given according to the collected data. This is followed by specifying the various routes Leg1, Leg2, Leg3 etc. through which vehicles travel. Local vehicles are modelled in 3D Studio-Max first and then converted into VISSIM recognizable vehicle element by V3DM. Figure 4. represents the microscopic simulation VISSIM model of Mirpur-10 intersection.

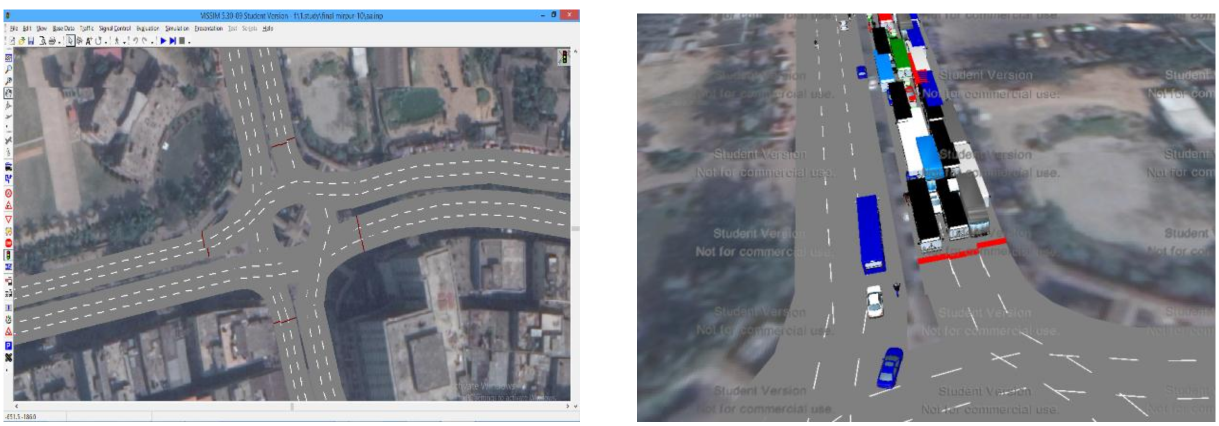


Figure 4:-VISSIM model Coding

Model calibration: -

Calibration is the process in which various parameters of the simulation model are adjusted till the model accurately represents field conditions. VISSIM has a COM interface which can be used to calibrate VISSIM externally through a code. Algorithm, a random search and optimization technique is used to generate random sets for parameters within specified bounds and the calibration code is run till it finds the least mean absolute percentage error value between the actual and simulated measure (Siddharth et al., 2013). **Figure5shows the difference of number of . .scharged vehicles between actual field and calibrated modeldi**

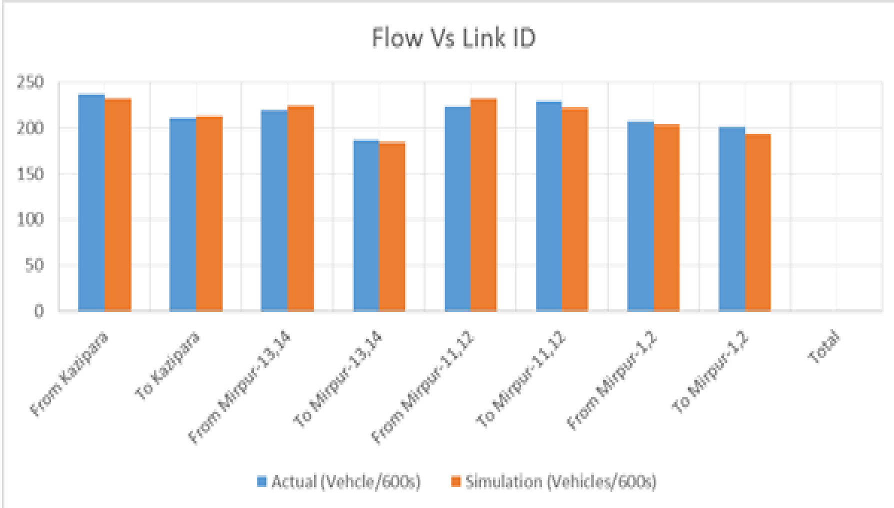


Figure 5:-The Difference of number of discharged vehicles between actual field and calibrated model

Modified Driving Behavior: -

VISSIM has several parameters that can be changed during calibration. But all the parameters in VISSIM may not affect the output of the model in a significant way. Sensitivity analysis is used to find the parameters which have a significant effect on the model. Different values from calibrated VISSIM model are given in Table 1.

Table 1:-Different values from calibrated VISSIM model

Parameter	***Calibrated Value***	***Default value***
	Car Following	
Standstill Distance(m)	*0.5*	1.5
Headway Time(s)	1.2	0.9
	Lane Changing	
Overtake reduced speed area	Allowed	Not Allowed
	Lateral	
Desired Position at Free Flow	Any	Middle of Lane
Observed vehicles on next lanes(s)	Allowed	Not Allowed
Consider next turning direction	Allowed	Not Allowed
	Minimum Lateral Distance(m)	
Distance at 0Km/h	0.6	1
Distance at 50Km/h	0.8	1
	Overtake on Same Lane	
On Left	Allowed	Not Allowed
On Right	Allowed	Not Allowed

Model Validation: -

The calibrated models are then evaluated with a new set of data under untried conditions, including the input volumes, traffic composition, and other required data. This study adopts the Geoffrey E. Heaver (GEH) statistic to compare field traffic volumes with those obtained from simulation data. As a general guideline for model validation, GEH values less than 5 indicate good fit (UK highway agency). Several simulations run with different parameter for confirmation. Table 2. shows that GEH value of the microscopic model is 2.863 which indicates a well calibrated model and represents the field traffic condition with remarkable accuracy. Figure 6. also shows the least variation between actual flow and validated flow.

Table 2:-GEH Values of different legs of the intersections

Segment	Actual (Vehicles/600s)	Simulation (Vehicles/600s)	Actual-Simulation difference(vec/hr)	% Difference	GEH
From Kazipara	237	232	30	2.1097	0.3264
To Kazipara	210	213	-3	-1.4285	0.2062
From Mirpur-	220	224	-24	-1.8181	0.2684
To Mirpur-	187	184	18	1.6042	0.2202
From Mirpur-	223	232	12	-4.0352	0.5966
To Mirpur-	229	222	42	3.0567	0.4661
From Mirpur-	207	204	18	1.4492	0.2092
To Mirpur-1,2	201	193	48	3.98	0.5699
Total				4.93	2.863

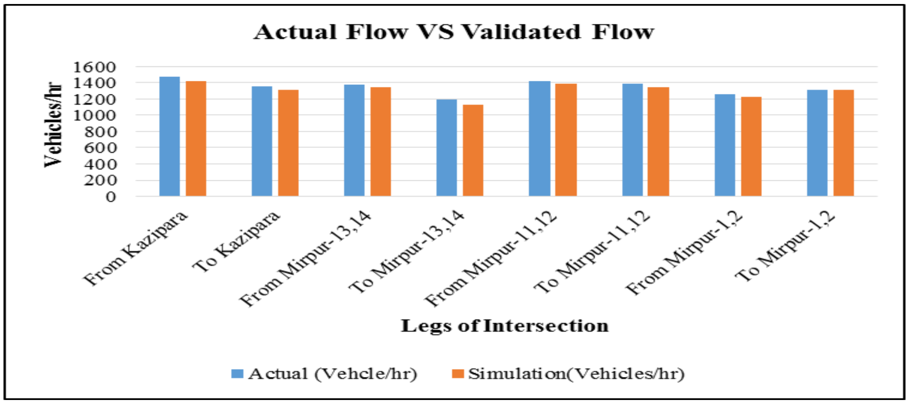


Figure 6:-The Difference of number of discharged vehicles between actual field and VISSIM model

Concluding Remarks: -

This paper proposed a procedure for microscopic simulation model calibration and validation. The proposed procedure appears to be effective in the calibration and validation for VISSIM for signalized intersections. Two important issues were encountered during the implementation of calibration and validation procedure. The first issue dealt with statistical testing when claiming the calibrated model was equal to the field data. The second issue was the importance of visualization in the calibrations process. The study only utilized a single day of data collection and two measures of performance. It is recommended to collect multiple days of field data, if possible, in order to consider variability of field data. A range of flows and geometries would give more general conclusions. It is also recommended to utilize other performance measures such as number of stops, delays, fuel consumptions, or emissions to see if they produce different variability.

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