

The evaluation of traffic characteristic analyzed by vissim (case study: underpass construction at Metro Pondok Indah Road)

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Abstract. Government of DKI Jakarta build road infrastructure such as fly over and/or underpass to reduce congestion and delay at the main junctions. One of that is underpass construction at Metro Pondok Indah Road. The impact of this project during construction is make the road narrowing (bottleneck) and cause longer travel time of vehicle and decreased average speed. This research tries to simulate this situation using Vissim as a modeling traffic tool and then compared with actual conditions. Some calibrations of driving behavior parameters have been done using GEH formula to adjust the parameter to the acceptance level at value less than 5.0, so it can conclude that simulation using Vissim can represent actual condition during traffic congestion and normal condition especially in Jakarta traffic. These adjusted parameters may represent the actual traffic condition in Jakarta.

Keywords: calibration, GEH formula, congestion, Vissim

1. Introduction

Transportation is needed by people to travel and moving objects from one place to another. This situation causes people depend on transportation to fulfil their life necessities and support their daily activities. To improve access in transportation sector, government of DKI Jakarta intensively building various projects on road transport. One of government projects is underpass at Metro Pondok Indah Road. Metro Pondok Indah Road is the access road to Ciputat area and Cilandak Town Square Mall (Citos) which has heavy traffic flow. In the implementation of this project, it was found that the construction used two lanes of three available. This condition affecting travel time and speed of vehicle that causes delay on the main road. The delay can develop long queuing and be worsen by blocking another junction. This condition can be predicted by appropriate traffic flow simulation model before the implementation of the project and take solution of what to do before everything become worse. In this research, Vissim version 9 for Student was used to simulate traffic flow. Vissim is one of transportation simulation software that can simulate traffic flow with different driver behaviors. Vissim can also display visual output in 3D and make user easier to describing the simulation result. However, Vissim version 9 for Student is a limited version that can only simulate the traffic up to 10 minutes.

There are 168 traffic condition parameters in Vissim which have default value that can be changing to meet the represent traffic conditions. Saputra & Pratama (2016) suggested seven parameters are meet



the heterogenous traffic condition in Indonesia that will be described in the next chapter. These parameters have been calibrated and validated using trial and error method.

2. Methodology

This research used several parameters such as vehicle volume, vehicle speed, travel time and road geometry. Speed, volume, and travel time are collected using video cameras located on pedestrian bridges. The video camera recorded all traffic flows for a given period. Road geometry data was collected by roller to measure the length and width of the location. In this study, vehicles were classified into three categories according to Road Capacity Manual of Indonesia (also known as MKJI 1997), such as light vehicles (LV), heavy vehicles (HV), and motorcycles (MC). The volume, speed and road geometry data are used for input parameters in the Vissim program and the outputs are travel time and vehicle speed and then comparing the result with the primary data using trial and error method.

3. Results and Discussion

3.1. Driving Behavior

According to Irawan & Putri, 2015, driving behavior is an individual attitude that different between one person to the other that influenced by interaction with other factor such as vehicle distance, acceleration, deceleration, and other traffic regulations. Saputra & Pratama, 2016 said that there are seven driving behavior parameters that appropriate with Indonesia traffic condition such as (i) standstill distance in front of obstacle is a parameter in meter that measure the safe distance to stop behind other vehicle, (ii) additive factor security is an additional parameter to stop distance with default value of 0.45 to 2, (iii) multiplicative factor security is a multiplier factor to stop distance with default value of 1 to 3, (iv) lane change rule is parameter that reflect the rule, (v) overtake at same line is parameter that the vehicle can do overtaking within the line, (vi) desired lateral position is parameter that reflect the vehicle can be at right or left position within the line, and (vii) lateral minimum distance is a distance to the right or left vehicle with default value of 0.2 to 1 meter.

Calibration is used for adjusting driver behavior parameter according to actual conditions. Reference for obtaining calibration values on driver behavior is validation of vehicle volume by GEH formula. Fieldman, O (2012) said the GEH is used to represents goodness-of-fit a model. It takes into account both the absolute difference and the percentage difference between the model and the observed flows. For traffic modelling work in the "baseline" scenario, a GEH of less than 5.0 is considered a good match between the modelled and observed hourly volumes (flows of longer or shorter durations should be converted to hourly equivalents to use these thresholds). If the GEH is greater than 10.0, there is a high probability that there is a problem with either the travel demand model or the data (this could be something as simple as a data entry error, or as complicated as a serious model calibration problem).

$$GEH = \sqrt{\frac{(q_{simulated} - q_{observed})^2}{0.5 \times (q_{simulated} + q_{observed})}} \quad (1)$$

where:

Q observed = volume observed
Q simulated = volume simulated

Conclusions from results of *Geoffrey E. Havers* formula

GEH < 5,0	Accepted
5,0 ≤ GEH ≤ 10,0	Warning: data error or bad model
GEH > 10,0	Rejected

This research is divided into two conditions, there are normal and congestion condition. In congestion conditions indicates that the vehicle volume level increases.

3.2. Road Geometric

The road geometric at Metro Pondok Indah Road and Duta Niaga Raya Road that have been used for input on Vissim Program.

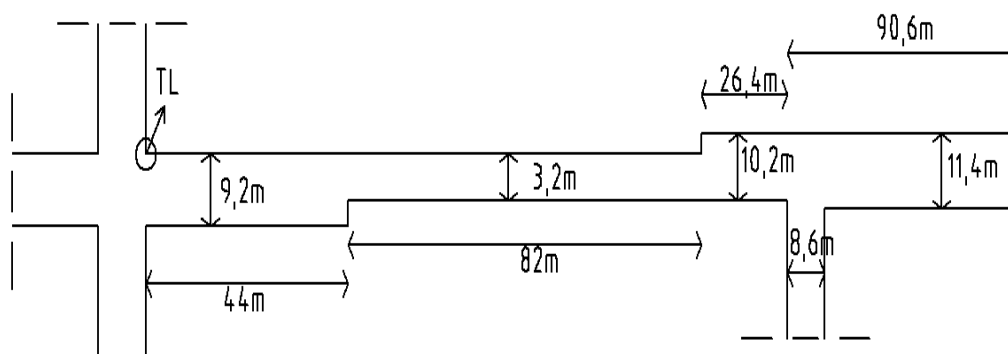


Figure 1. Road Geometric

3.3. Calibration and Validation at Normal Conditions

Table 1. Calibration at Normal Condition

No of Trial and Error	Parameter	Value of Parameter	
		Before	After
1	Default	No change	No change
2	Desired position at free flow	Middle of lane	Any
	Lane change rule	Show Lane Rule	Free Lane Selection
	Overtake on same lane: On left and on right	off	on
3	Distance standing in meter (stop)	1 Meter	0,35 Meter
	Distance driving in meter (50 kph)	1 Meter	0,5 Meter
	Average standstill distance	2 Meter	1 Meter
4	Additive part of safety distance	2	1
	Multiplicative part of safety distance	3	1,5
5	Distance standing in meter (stop)	0.35 Meter	0.2 Meter

	Distance driving in meter (50 kph)	0.5 Meter	0.4 Meter
	Average standstill distance	1 Meter	0,5 Meter
6	Additive part of safety distance	1	0.5
	Multiplicative part of safety distance	1.5	0.5
7	Distance standing in meter (stop)	0.2 Meter	0.15 Meter
	Distance driving in meter (50 kph)	0.4 Meter	0.3 Meter

Table 1 shows the difference value of each trial with difference random sheet until value of GEH test can be accepted. Result of GEH test are shown on Table 2.

Table 2. Validation Volume at Normal Condition

Trial and Error	Volume	GEH	Volume	GEH	Result
	Jl. Metro Pondok Indah		Jl. Duta Niaga Raya		
1 (Default)	197	14	48	6,2	Rejected
2	274	9,2	61	4,5	Rejected
3	323	6,4	75	2,8	Rejected
4	366	4,1	83	2	Accepted
5	381	3,3	91	1,1	Accepted
6	429	1	96	0,6	Accepted
7	447	0,09	100	0,2	Accepted

Table 2 shows that at fourth until seventh trial and error can be accepted by GEH test. We used the parameter used but value of GEH test that used is at seventh trial and error.

3.4. Calibration and Validation at Congested Conditions

Calibration and validation at congested condition was done eight-time trial and error with difference random sheet.

Table 3. Calibration at Congested Condition

No of Trial and Error	Parameter	Value of Parameter	
		Before	After
1	Default	No change	No change
2	Desired position at free flow	Middle of lane	Any
	Lane change rule	Show Lane Rule	Free Lane Selection

	Overtake on same lane: on left and on right	off	on
3	Distance standing in meter	1 Meter	0.5 Meter
	Distance driving in meter	1 Meter	0.5 Meter
	Average standstill distance	2 Meter	1 Meter
4	Additive part of safety distance	2	1
	Multiplicative part of safety distance	3	2
5	Distance standing in meter	0.5 Meter	0.2 Meter
	Distance driving in meter	0.5 Meter	0.4 Meter
	Average standstill distance	1 Meter	0.5 Meter
6	Additive part of safety distance	1	0.5
	Multiplicative part of safety distance	2	1
7	Distance standing in meter	0.2 Meter	0.05
	Distance driving in meter	0.4 Meter	0.3
	Average standstill distance	0.5 Meter	0.05
8	Additive part of safety distance	0.5	0.1
	Multiplicative part of safety distance	1	0.5

Table 4. Validation Volume at Congested Condition

Trial and Error	Volume		Volume		Result
	Jl. Metro Pondok Indah	GEH	Jl. Duta Niaga Raya	GEH	
1 (Default)	201	15,9	85	8,8	Rejected
2	276	11,37	96	7,7	Rejected
3	312	9,3	112	6,2	Rejected
4	348	7,3	126	4,9	Rejected
5	373	6	132	4,4	Rejected
6	411	4,1	147	3,1	Accepted
7	435	3	154	2,6	Accepted
8	501	0,04	186	0,1	Accepted

3.5. Vehicle Travel Time at Normal Conditions

The distance from point A to B is 161 meters and distance from point C to D is 147 meters. Measurement of travel time can be seen in the following scheme.

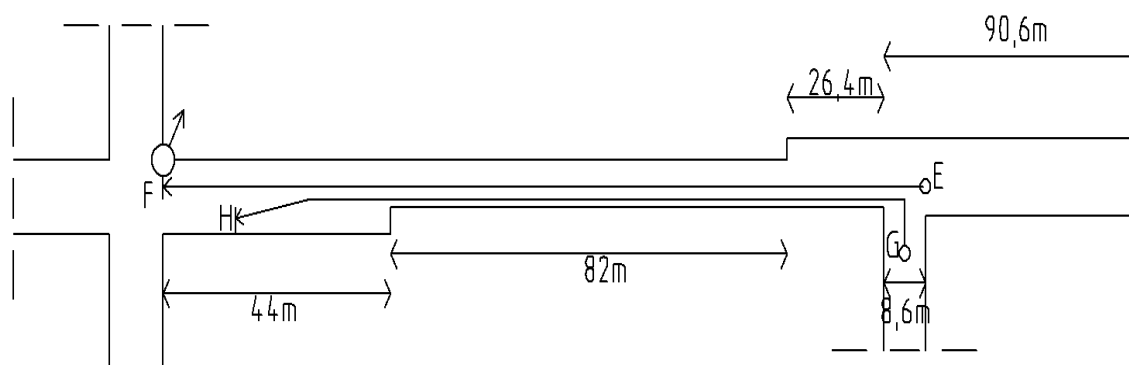


Figure 2. Vehicle Travel Time Scheme at Normal Condition

Repetition of random seed was done at five times on this model. The average output of vehicle time travel such as motorcycle, cars, buses and trucks will compare with actual results. Table 5 below shows the results of average travel time modeling by using Vissim and average actual travel time result.

Table 5. Average Travel Time of Actual and Modeling at Normal Condition

Average of Vehicle Travel Time Actual (s)					Average of Vehicle Travel Time Modeling (s)			
Destination	Motorcycle	Car	Bus	Truck	Motorcycle	Car	Bus	Truck
E-F	64	131	117	111	68	128	103	109
G-H	56				57			

As the average travel time field result, the shortest travel time is the vehicle with destination to Citos (G-H). This is because vehicle to the Citos (G-H) is not affected by traffic lights and is the final road of Metro Pondok Indah Road. The next step is validation process, to determine whether the model is correct and match with the actual conditions. Result of validation are shown on Table 6.

Table 6. Difference of Vehicle Travel Time Actual and Modeling

Destination	Motorcycle	Car	Bus	Truck
E-F	-6%	2%	12%	2%
G-H	-2%			

According to Collins & Margison, 2009, if the difference in actual vehicle travel time and modeling is less than 15% it means acceptable and reflects the field conditions. As a result, this modeling in the normal condition can be accepted because the value is 12%.

3.6. Vehicle Travel Time at Congested Conditions

Distance from point E to F is 161 meters and distance from point G to H is 147 meters. Measurement of travel time can be seen in the following scheme.

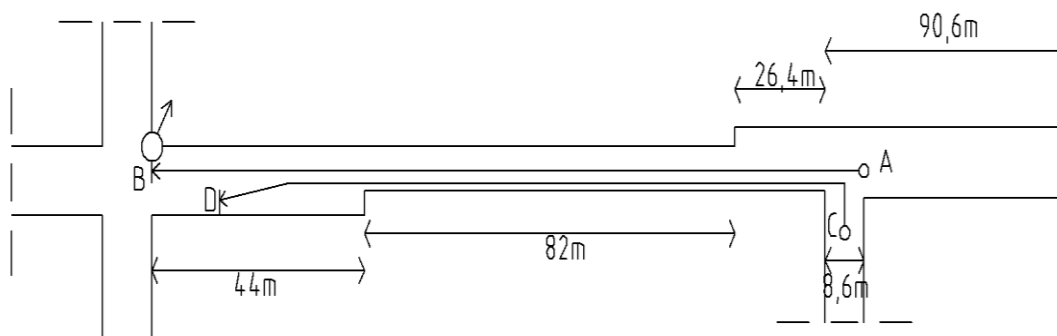


Figure 3. Vehicle Travel Time Scheme at Congested Condition

Based on observations, condition of vehicle volume on traffic flow at Metro Pondok Indah Road has increased. It has an effects on vehicle travel time.

Table 7. Average Travel Time of Actual and Modeling at Congested Condition

Average of Vehicle Travel Time Actual (s)					Average of Vehicle Travel Time Modeling (s)			
Destination	Motorcycle	Car	Bus	Truck	Motorcycle	Car	Bus	Truck
A-B	157	187	176		158	186	178	
C-D	101				105			

Validation result at congested condition are shown on table 8, where the biggest difference value is 4 %. As Collins & Margison, 2009 said if the difference in actual vehicle travel time and modeling is under 15 % then the modelling is acceptable.

Table 8. Difference of Vehicle Travel Time Actual and Modeling at Congested Condition

Destination	Motorcycle	Car	Bus	Truck
A-B	-1%	1%	3%	2%
C-D	-4%			

3.7. Journey Speed at Normal Condition

Traffic characteristics consist of several parameters, they are speed, volume and density. Speed is divided into six types of speed. One of them is journey speed.

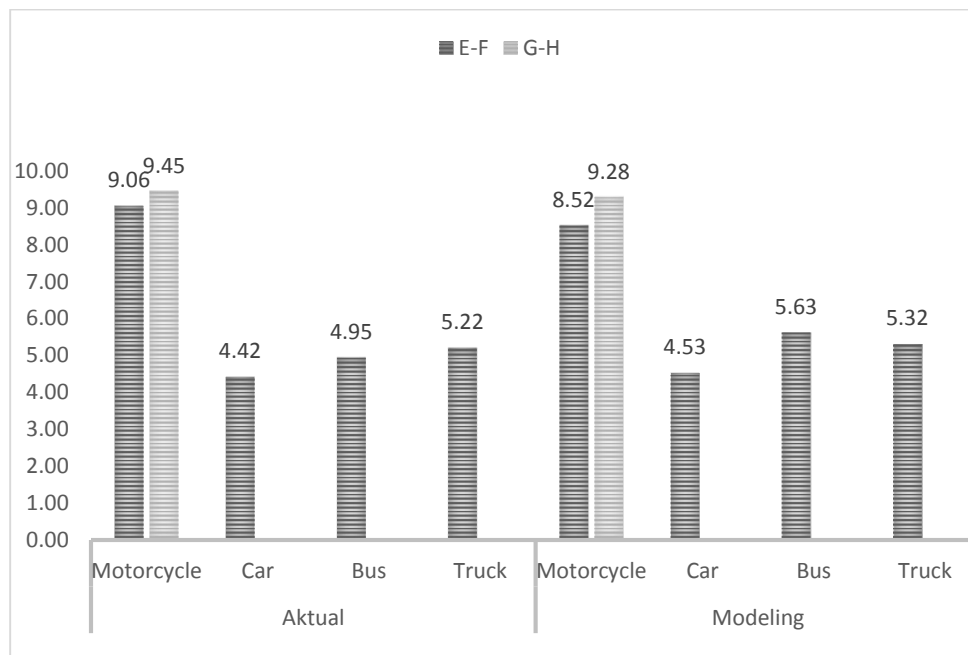


Figure 4. Journey Speed Between Actual and Modeling at Normal Condition

Figure 4 shows that journey speed between actual and modeling is not much different and journey speed still reflects reality in the field.

3.8. Journey Speed at Congested Condition

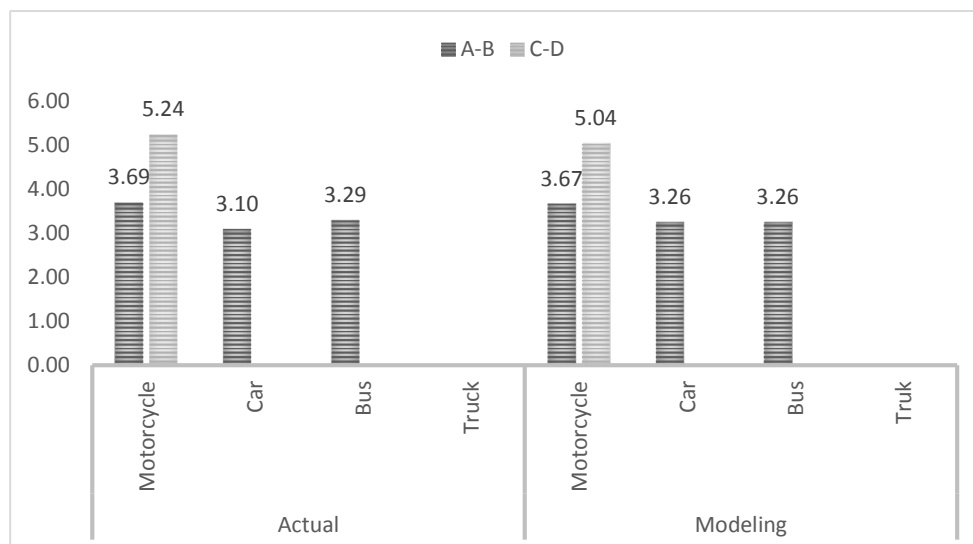


Figure 5. Journey Speed Between Actual and Modeling at Congestion Condition

In Figure 5 the highest journey speed at the actual condition and modeling is found on the motorcycle towards to Citos (C-D).

4. Conclusion

The driver behavior parameters are obtained by trial and error determined by GEH valid value. At the normal condition, distance standing in meter value is 0.15 m, distance driving in meter 0.3 m, average

standstill distance equal to 0.5 m, additive part of safety distance equal to 0.5 and multiplicative part of safety distance equal to 0.5. In the congested condition, the distance standing in meter value is 0.05 m, distance driving in meter 0.3 m, average standstill distance equal to 0.05 m, additive part of safety distance equal to 0.5 and multiplicative part of safety distance equal to 1.

Difference vehicle travel time actual and modeling in normal condition at A-B are: motorcycle is 1%, car 1%, bus 3% and truck 2% while at C-D motorcycle has 4%. In congested condition, difference of actual and modeling at E-F for motorcycle is 6%, car 2%, bus 12% and truck 2% while at G-H motorcycle has 2 %.

In congested condition, journey speed riding who crossed the road in this research ranged from 3 km/h to 5 km/h and journey speed of riding on normal condition ranged from 4 km/h to 9 km/hour.

5. References

- [1] Abdi, A., Mobasheri, & Alavi, M. P. (2012). The Evaluation of Lane-Changing Behavior in Urban Traffic Stream with Fuzzy Clustering Method. *Research Journal of Applied Sciences, Engineering and Technology*, 22.
- [2] Chisty, J. C., & Lall, B. K. (2005). *Dasar-Dasar Rekayasa Transportasi*. Jakarta: Erlangga.
- [3] Collins, & Margison. (2009). Paramics Microsimulation Modelling Manual. *Roads and Traffic Authority*.
- [4] Daniel, L., & Mathew, J. (1975). Traffic Flow Theory. *Transportation Research Board*, 165.
- [5] Feldman, O. (2012, October). *The Geh Measure And Quality Of The Highway Assignment Models*. Taken from <https://www.researchgate.net/>:
https://www.researchgate.net/publication/263140653_The_Geh_Measure_And_Quality_Of_The_Highway_Assignment_Models
- [6] Gladys, F. (2009). Traffic Management and Transport Demand Management. *The World Bank Distance Learning Course in Urban Planning pp*, 1-18.
- [7] Hoobs, F. D. (1995). *Perencanaan dan Teknik Lalu Lintas*. Gadjah Mada University Press.
- [8] Indrajaya, Y. (2002). Pengaruh Penyempitan Jalan Terhadap Karakter Lalu Lintas (Studi Kasus pada Ruas Jalan Kota Demak-Kudus km 5). *Tesis Program Magister Teknik Sipil*.
- [9] Irawan, M. Z., & Putri, N. H. (2015). Kalibrasi Vissim Untuk Mikrosimulasi Arus Lalu Lintas Tercampur Pada Simpang Bersinyal (Studi Kasus: Simpang Tugu, Yogyakarta). *Jurnal Penelitian Transportasi Multimoda*, 97-106.
- [10] Krajzewicz, D., Herkorn, G., & Rossel, C. (2002). Simulation Of Urban Mobility. *Open Source Traffic Simulation*.
- [11] *Manual Kapasitas Jalan Indonesia*. (1997). Jakarta: Departemen Pekerjaan Umum, Direktorat Jendral Bina Marga.
- [12] Morlok. (1991). *Pengantar Teknik dan Perencanaan Transportasi*. Jakarta: Erlangga.
- [13] Morlok, E. K. (2008). *Pengantar Teknik dan Perencanaan Transportasi*. Jakarta: Erlangga.
- [14] PTV, V. (2016). *PTV VISSIM 9 USER MANUAL*. Karlsruhe: PTV GROUP.
- [15] Saputra, & Pratama, F. (2016). . Analisis dan Optimasi Kinerja Simpang Bersinyal Di Jl. Gunung Bawakaraeng – Jl.Jend.Sudirman Berbasis Micro –Simulasi.

- [16] Sugiarto, & Limanoond, T. (2013). Impact of On-street Parking on Urban Arterial Performance: A Quantitative Study on Travel Speed and Capacity Deterioration. *Aceh International Journal of Science and Technology*, 63-69.
- [17] Wiedemann, R. (1974). *Simulation des Straßenverkehrsflusses In Schriftenreihe des Instituts für Verkehrswesen der Universität Karlsruhe*. Germany.
- [18] Zhang, C., & Et all. (2016). Micro-Simulation Of Desired Speed For Temporary Work Zone With A New Calibration Method. *Traffic & Transportation*, 49-61.