Analysis of Signalized Intersection Performance using IHCM 1997 method and PTV VSTRO Software

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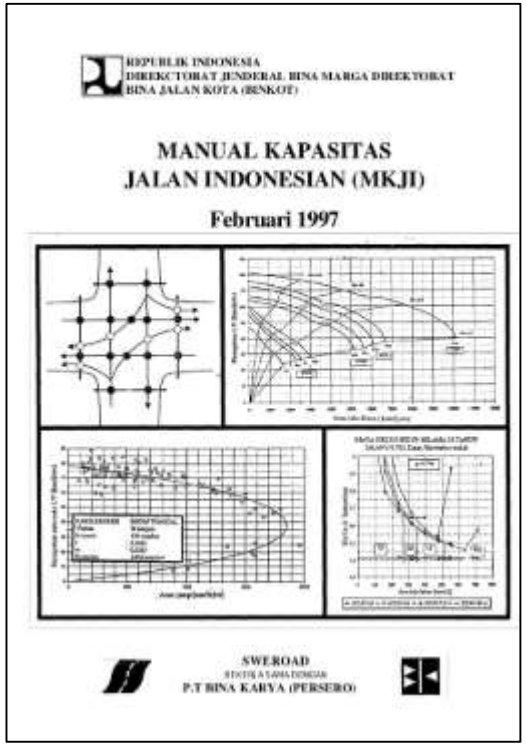
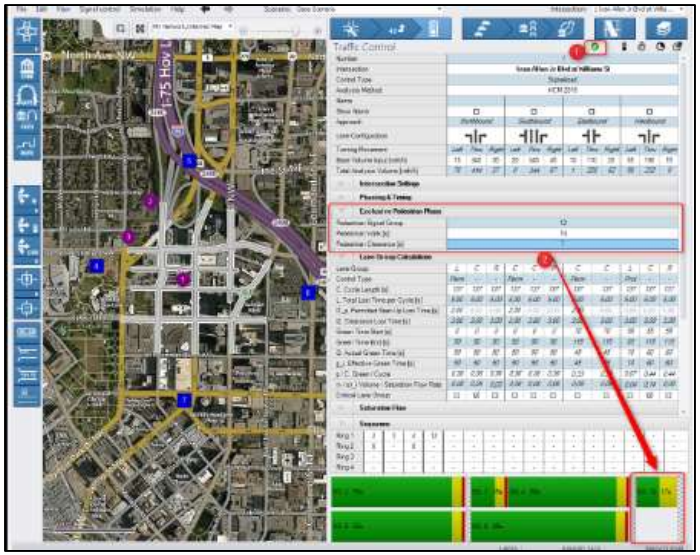
INTRODUCTION

Junctions are critical elements in a highway transport system as they are the locus points where delay, accidents and emissions tend to be concentrated. Knowing the signalized intersection performance requires traffic modelling.

The standard traffic modelling in Indonesia is the Indonesian Highway Capacity Manual (IHCM) 1997 method



PTV Vistro software



OBJECTIVE

This study is conducted to determine the differences between IHCM 1997 and PTV Vistro models results, with field data using default and calibrated values of traffic parameters.

Furthermore, it carried out the comparison of analytical results between PTV Vistro software using HCM 2010 approach with the IHCM 1997 method for analysis of signalized intersection.

RESEARCH METHOD

Location of Research

The objects of the research are Signalised Intersections located along the Brigjend Slamet Riyadi road in Surakarta City.

Stages of research:

- Data collection of traffic volume, composition and turning proportions, vehicle speed, geometry, signal timing, and traffic measures of performance (i.e. vehicle queue length), population, land use, and transportation system in Surakarta City.
- Data analysis and signalized intersection performance calculation. Signalized intersections performance calculation is divided into 3 scenarios:
  1. base model, use default values,
  2. calibration 1 model, change the value of base saturation flow,
  3. calibration 2 model, change the value of base saturation flow and PCU for motorcycle.
- Comparison of signalized intersection performance results between models and field data. Signalized intersection performance result of the IHCM 1997 method and PV Vistro software scenario that produces vehicle queue length closest to the field data are compared in terms of degree of saturation, vehicle queue length, vehicle delay and LOS intersection.
- Discussion and Conclusion.

Scenarios	IHCM 1997 Method	PTV Vistro Software
Base Model (BM)	PCU of Motorcycle = 0.2 S0 = approach width x 600	PCU of Motorcycle = 0.2 S0 = Default
Calibration 1 Model (C1M)	PCU of Motorcycle = 0.2 S0 = approach width x 775	PCU of Motorcycle = 0.2 S0 = lane width x 775
Calibration 2 Model (C2M)	PCU of Motorcycle = 0.15 S0 = approach width x 775	PCU of Motorcycle = 0.15 S0 = lane width x 775

RESULTS AND DISCUSSION

Comparison of the IHCM1997 method and field data

Morning peak hour

Intersection	Approach	Degree of Saturation			Vehicle Queue Length (meter)				%
		BM	C1M	C2M	BM	C1M	C2M	Field Data (FD)	(BM-FD)
Purwosari	North	0.82	0.64	0.54	94	79	67	32	193%
	West	1.06	0.82	0.73	333	121	102	76	341%
Gendengan	West	1.05	0.81	0.74	254	115	101	96	166%
	South	1.21	0.93	0.83	551	157	121	100	451%
	North	0.90	0.70	0.53	133	104	77	70	91%
Sriwedari	West	0.87	0.68	0.61	84	69	60	60	41%
	South	0.44	0.34	0.29	38	37	33	41	8%
Ngapeman	West	1.04	0.80	0.75	201	93	84	45	347%
	North	0.74	0.57	0.51	90	78	67	91	1%
Pasar Pon	West	0.62	0.48	0.43	53	50	43	42	26%
	South	0.51	0.40	0.35	62	59	51	32	95%
Nonongan	West	0.82	0.64	0.57	121	107	93	72	68%
	North	0.31	0.24	0.31	28	27	24	37	25%
	South	0.40	0.31	0.26	46	46	39	55	15%

Afternoon peak hour

Intersection	Approach	Degree of Saturation			Vehicle Queue Length (meter)				%
		BM	C1M	C2M	BM	C1M	C2M	Field Data (FD)	(BM-FD)
Purwosari	North	0.93	0.72	0.64	132	95	83	45	193%
	West	0.69	0.54	0.48	86	77	68	77	11%
Gendengan	West	0.79	0.60	0.55	104	93	83	98	5%
	South	1.10	0.85	0.76	327	130	109	82	298%
	North	0.67	0.52	0.39	96	88	70	28	241%
Sriwedari	West	0.66	0.51	0.47	68	60	53	50	36%
	South	0.56	0.44	0.39	47	45	41	39	23%
Ngapeman	West	0.96	0.74	0.67	133	100	87	47	183%
	North	1.04	0.80	0.72	291	133	112	97	200%
Pasar Pon	West	0.50	0.38	0.34	45	42	37	48	6%
	South	0.57	0.44	0.38	68	64	56	30	126%
Nonongan	West	0.74	0.57	0.51	106	96	83	73	45%
	North	0.28	0.22	0.18	25	24	22	32	23%
	South	0.38	0.30	0.26	46	45	40	38	22%

Comparison of the PTV Vistro software and field data

Morning peak hour

Intersection	Approach	Degree of Saturation			Vehicle Queue Length (meter)				%
		BM	C1M	C2M	BM	C1M	C2M	Field Data (FD)	(BM-FD)
Purwosari	North	0.79	0.64	0.55	86	75	63	32	170%
	West	1.26	0.89	0.79	979	168	136	76	1,197%
Gendengan	West	1.25	0.92	0.83	748	188	157	96	682%
	South	1.06	1.04	0.92	293	263	145	100	193%
	North	0.86	0.71	0.53	122	101	75	70	74%
Sriwedari	West	0.86	0.63	0.51	95	63	53	60	58%
	South	0.56	0.46	0.35	39	35	28	41	5%
Ngapeman	West	0.77	0.54	0.51	121	98	92	45	169%
	North	0.55	0.55	0.48	74	74	65	91	19%
Pasar Pon	West	0.67	0.47	0.41	72	63	58	42	71%
	South	0.67	0.47	0.38	80	69	56	32	149%
Nonongan	West	0.98	0.69	0.50	197	133	104	72	173%
	North	0.22	0.18	0.15	25	24	19	37	33%
	South	0.95	0.67	0.57	103	73	63	55	88%

Afternoon peak hour

Intersection	Approach	Degree of Saturation			Vehicle Queue Length (meter)				%
		BM	C1M	C2M	BM	C1M	C2M	Field Data (FD)	(BM-FD)
Purwosari	North	0.90	0.74	0.66	121	93	80	45	169%
	West	0.84	0.59	0.53	132	103	91	77	71%
Gendengan	West	0.92	0.67	0.62	177	139	125	98	79%
	South	1.00	0.98	0.87	196	180	125	82	138%
	North	0.65	0.53	0.40	93	86	66	28	230%
Sriwedari	West	0.77	0.54	0.49	89	69	62	50	79%
	South	0.64	0.52	0.47	56	49	43	39	44%
Ngapeman	West	0.92	0.64	0.58	185	130	114	47	294%
	North	0.75	0.75	0.96	122	122	105	97	26%
Pasar Pon	West	0.58	0.45	0.39	69	62	54	48	44%
	South	0.64	0.40	0.35	69	61	52	30	129%
Nonongan	West	0.96	0.67	0.60	176	129	112	73	142%
	North	0.19	0.15	0.13	20	20	16	32	37%
	South	0.82	0.60	0.52	79	69	61	38	108%

The results shows that vehicle queue length value produced by the C2M are the closest among other scenarios to the field data. The t test results show Sig values > 0.025, meaning that the difference between the C2M results with the field data is not significant in the morning and afternoon peak hour conditions, apart from afternoon PTV Vistro model.

IHCM 1997

Time	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Morning Peak Hour	8.19286	19.50741	5.21358	-3.07039	19.45610	1.571	13	0.140
Afternoon Peak Hour	1.13643E1	19.95328	5.33274	-0.15639	22.88496	2.131	13	0.053

PTV Vistro

Time	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Morning Peak Hour	1.89786E1	28.75954	7.68631	2.37331	35.58383	2.469	13	0.028
Afternoon Peak Hour	2.30429E1	20.66758	5.52364	11.10975	34.97596	4.172	13	0.001

Comparison of IHCM1997 method and PTV Vistro software

Intersection	Approach	Degree of Saturation		Vehicle Queue Length (meter)			Vehicle Delay (sec/pcu) LOS	
		IHCM 1997	PTV Vistro	IHCM 1997	PTV Vistro	Field Data	IHCM 1997	PTV Vistro
Purwosari	North	0.54	0.55	67	63	32	23.54 C	26.17 D
	West	0.73	0.79	102	136	76		
Gendengan	West	0.74	0.83	101	157	96	35.63 D	49.6 E
	South	0.83	0.92	121	145	100		
	North	0.53	0.53	77	75	70		
Sriwedari	West	0.61	0.51	60	53	60	13.81 B	10.88 B
	South	0.29	0.35	33	28	41		
Ngapeman	West	0.75	0.51	84	92	45	24.9 C	20.35 C
	North	0.51	0.48	67	65	91		
Pasar Pon	West	0.43	0.41	43	58	42	14.41 B	15.55 C
	South	0.35	0.38	51	56	32		
Nonongan	West	0.57	0.50	93	104	72	23.89 C	36.47 D
	North	0.31	0.15	24	19	37		
	South	0.26	0.57	39	63	55		

Intersection	Approach	Degree of Saturation		Vehicle Queue Length (meter)			Vehicle Delay (sec/pcu) LOS	
		IHCM 1997	PTV Vistro	IHCM 1997	PTV Vistro	Field Data	IHCM 1997	PTV Vistro
Purwosari	North	0.64	0.66	83	80	45	21.46 C	21.21 C
	West	0.48	0.53	68	91	77		
Gendengan	West	0.55	0.62	83	125	98	35.45 D	42.65 E
	South	0.76	0.87	109	125	82		
	North	0.39	0.40	70	66	28		
Sriwedari	West	0.47	0.49	53	62	50	12.64 B	10.25 B
	South	0.39	0.47	41	43	39		
Ngapeman	West	0.67	0.58	87	114	47	25.22 D	26.74 D
	North	0.72	0.96	112	105	97		
Pasar Pon	West	0.34	0.39	37	54	48	16.57 C	15.61 C
	South	0.38	0.35	56	52	30		
Nonongan	West	0.51	0.60	83	112	73	28.29 D	32.87 D
	North	0.18	0.13	22	16	32		
	South	0.26	0.52	40	61	38		

In general, the IHCM 1997 method produces vehicle queue length closer to field data than the PTV Vistro software.

The IHCM 1997 method tends to produce lower degree of saturation than the PTV Vistro software.

The analysis signalised intersection performance using the IHCM 1997 method and PTV Vistro software show differences in results due to some reasons as follows:

- The basic saturation flow parameter used in the calibration and validation processes using the IHCM 1997 method formula. This might not suit the PTV Vistro software approach. This is because the analysis of traffic movement of the IHCM 1997 method is based on the width of the approach, while PTV Vistro software is based on the width of the lane.
- The adjustment factor used in saturation flow calculation between IHCM 1997 method and PTV Vistro software is different.
- The signal timing calculation between the IHCM 1997 method and PTV Vistro software is different.

CONCLUSION

- The vehicle queue length output of base model IHCM 1997 and PTV Vistro software is different to that of the vehicle queue length based on field data.
- It is necessary to calibrate and validate the model. T test results show that there is no significant difference between model results and field data, apart from the PTV Vistro software model for afternoon peak hour.
- The IHCM 1997 method tends to produce lower degree of saturation, vehicle delay and LOS than PTV Vistro software.
- The IHCM 1997 method for the current condition often yields an analysis result that is less appropriate to the conditions in the field. Therefore, this manual is updated to adapt to the latest traffic developments of the Indonesia Highway Capacity Guideline (IHCG) 2014. However, there is still a need for improvement due to the relatively significant difference of the IHCG 2014 method output with the field data.

THANK YOU