COMPARATIVE ANALYSIS OF ADVANCED AND FIXED TIME TRAFFIC CONTROL SYSTEMS IN INCREASING TRAFFIC PERFORMANCE

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Abstract
The potential benefit of Advanced Traffic Control Systems (ATCS) to ease traffic congestion in large cities around the world is well known. However, the application of the systems in large cities in developing countries is noteworthy because of specific local conditions commonly occur in the large cities. The aim of this paper is to analyze the comparison of advanced traffic control systems and fixed time traffic control systems performance in a large city in a developing country. A large road network in Bandung, Indonesia was used as a case study. GETRAM (The Generic Environment for Traffic Analysis and Modeling) was conducted to evaluate the performance of the systems. The results of evaluation found that the application of ATCS was better than Fixed Time traffic control system at intersections with 5 legs, closed to adjacent intersections, and at intersections lied in CBD.

Keywords:
Advanced Traffic Control Systems, developing country, Fixed Time Traffic Control Systems, specific local condition.

INTRODUCTION

The potential benefit of Advanced Traffic Control Systems (ATCS) to ease traffic congestion in large cities around the world is well known. However, the application of the system in large cities in developing countries is noteworthy because of specific geometric and traffic conditions characterised in the cities.

In general, the specific conditions arises from many causes such as rapid population growth, high annual population growth, high annual vehicle growth (Morichi, 2005), limited land area, and diminishing financing for road infrastructure. In more detail, the local geometric conditions include low road network densities, irregular pattern of road network, various distances among intersections, various numbers of leg intersections, and narrow land widths. Whereas the specific traffic conditions are poor lane discipline (many types of vehicle use the same lane), parking activity near intersections, road capacity is not fully utilised because of on-street parking and street vendor activity on sidewalks forcing pedestrians to use the street, and bus and other public transport vehicles frequently stop anywhere along the street.

The aim of this paper is to analyse the comparison of advanced traffic control systems and fixed time traffic control systems in large city in a developing country in increasing traffic performance. The performance measurement analyses are based on differences in performance measurements under the same traffic conditions.

A large road network area in Bandung, Indonesia was used as a case study. SCATS (Sydney Coordinated Adaptive Traffic Control Systems) is the system currently running in Bandung. It was implemented in this large city in June 1997 as a pilot project (AWA Plessey, 1996a, 1996b). The performance as the result of implementing adaptive signal control SCATS was compared with that under Fixed Time control (Abdel-Rahim & Taylor, 2000; Eyler, 1997). The comparison analyses were carried out during morning peak (7:00 – 8:00am), off peak (10:00-11:00am), and afternoon peak (4:30-5:30pm) periods. The experiments using GETRAM (The Generic Environment for Traffic Analysis and Modelling) were conducted to evaluate both systems during peak and off peak periods.

Advanced Traffic Control Systems SCATS

SCATS (Sydney Coordinated Adaptive Traffic System) which was the subject of evaluation in this research is one applications of Advanced Traffic Management Systems (ATMS). SCATS was developed by New South Wales Department of Main Roads Australia and has gained popularity not only in Australia but also in Asia, and more recently in North America (PATH, ITS, 2005).

SCATS is a dynamic control system that can accommodate changing conditions using real time input from a number of different sources such as road detectors at the stop line, video cameras (CCTV), and pedestrian push buttons. This system updates intersection cycle length, stage split, and co-ordination with adjacent intersections within a road network to meet the variation in demand and improve traffic flow (US DOT, 2005).

METHOD

Data Collection

The field data collection was carried out in the Bandung road network including road and intersection geometric data, traffic demand data, and traffic control data. SCATS currently controls 117 signalised intersections out of 135 intersections in Bandung. Because of changes to the direction of traffic the 27 signalised intersections connected to SCATS is under flashing yellow signal (Sutandi, 2006). All signalised intersection under SCATS was divided into two regions, the Bandung North Region and the Bandung South Region.

Data collection from the 90 signalised intersections in the North Region and the South Region connected to SCATS during peak and off peak periods is used in this paper. It was repeated every 15 minutes, including throughput data of each loop detector at each intersection, plus queue length data from a number of critical intersections with CCTV (Sutandi, 2007); there were 4 up to 14 loop detectors at each signalised intersection for vehicle detection. Travel time data was collected from a number of streams in the North and the South Regions using the Floating Car technique. The other field data required for developing the Bandung microscopic traffic simulation models are traffic control data, including green time, amber time, all red time, cycle time, traffic directions, phases at each intersection, and possible turning movements for each lane.

Two data sets were collected for use in this research. The first data set was used to develop and calibrate the models and the second data set was used for validation. The throughput data from each loop detector at each signalised intersection, in addition to queue length data from a number of signalised intersections with CCTV surveillance, travel time data of selected streams, and also the traffic control data, are believed to make up one of the largest sets of "real world" data available for the development, calibration, and validation of microscopic traffic simulation models (Sutandi, 2006).

GETRAM

Bandung microscopic traffic simulation models have been developed, calibrated, and validated using GETRAM (The Generic Environment for Traffic Analysis and Modeling), during peak and off peak periods. GETRAM which consists of TEDI as a traffic editor and AIMSUN (Advanced Interactive Microscopic Simulator for Urban and Non Urban Networks) as a microscopic traffic simulator (TSS, 2004a, TSS, 2004b) was used as a tool to evaluate the performance of both traffic control systems.

Based on the results of a number of statistical analyses including Paired T-test, Two Sample T-test, Regression Analysis, Analysis of Variance, and Correlation Tests (Mason, Robert L. et al., 2003, Montgomery, Douglas C., and Runger, George C., 2003, Ott, R. Lyman, and Longnecker, Michael, 2001), it was found that all of the calibrated and validated models reproduced traffic conditions with an acceptable degree of confidence. Therefore, the models were clearly accepted as significant valid replication of the real conditions (Sutandi and Dia, 2005a, 2005b). The validated models were then used to evaluate the performance of both systems.

Running the Bandung Validated Models Under SCATS Traffic Control System

Using the Bandung validated microscopic traffic simulation models, the results of traffic performance evaluation of the road network under SCATS during peak and off peak periods can be obtained for the whole network. Traffic performance measures used in this study are traffic flow (veh/h) and queue length (veh) at the intersections, and density (veh/km), speed (km/h), travel time (h:mm:ss), delay time (h:mm:ss), stop time (h:mm:ss), and number of stops per km (veh) in the streams.

Running the Bandung Validated Models Under Fixed Time Traffic Control System

The validated models in the Bandung North and the South Regions during peak and off peak periods were also run under the Fixed Time control. In large cities in Indonesia, include Bandung, the Fixed Time system at signalised intersections is based on the Indonesian Highway Capacity Manual (IHCM) – 1997 (Indonesian Highway Capacity Manual, 1997). In this manual, the methodology for analysing the signalised intersections is derived from the real geometric and traffic conditions in large cities in Indonesia.

RESULTS AND DISCUSSION

The results of comparative evaluation of the traffic performance measures differences (%) between running the validated models under SCATS and under Fixed Time traffic control system are presented in Tables 1 to 3 below.

Based on the results shown in these tables, the following observations are made:

1. Results of running the validated models under both systems for the 90 signalized intersections in Bandung indicated a variety of changes in throughputs and queue lengths at intersections and also in densities, speeds, travel times, delay times, stop times, and number of stops in streams. These results showed that the advanced traffic control system SCATS did not always produce better results than the Fixed Time control.

2. In Table 1, it can be seen that throughput under SCATS in the North Region was found to decrease by 12.00% during the morning peak period, to increase by 4.61% during the off peak period, and to increase by 4.35% during the afternoon peak period. On average, there is a decrease of 1.01% in throughput and an increase of 16.10% in maximum queue length. These results indicated that on average, the North Region road network performance under SCATS traffic control system was worse, but not significantly so, than that under Fixed Time control. This occurs especially during the morning peak period where, based on existing conditions, the traffic tends to be very congested. Whereas in South Region, throughput decreased 1.06% during the morning peak period, decreased 7.09% during the off peak period, and increased 2.74% during afternoon peak period. On average, there was a decrease of 1.80% in throughput and an increase of 17.11% in maximum queue length. These results indicated that on average, the South Region road network performance under SCATS traffic control system was also worse, but not significantly so, than that under Fixed Time control.

3. The results presented in Table 1 are also aimed at demonstrating how the traffic control systems performance is influenced by the geometric and traffic conditions of the large city. The results are as follows:

   - SCATS traffic control at intersections with 5 legs has the largest benefit with an increase in throughput of around 6.89% in the North Region and 18.58% in the South Region. These results indicated that, because of geometric condition and the complexity of phase control at intersections with 5 legs, they need traffic control by an adaptive system more than intersections with 4 or 3 legs do.
   - Intersections with CCTV decreased in throughput around 5.61% in the North Region but increased around 5.72% in the South Region. Based on the existing conditions, this could occur because intersections under CCTV surveillance in North Region are those with usually over saturated traffic conditions ($v/c \geq 1$), so the presence of the adaptive traffic control system could not help to improve traffic performance. On the other hand, traffic condition at intersections under CCTV surveillance in the South Region are not as congested as those in the North Region, therefore the application of the advanced system can improve the traffic performance through increase in throughput .
   - Performance of SCATS in CBD was found to increase around 0.72% in throughput in the North Region and to decrease around 1.51% in the South Region. Whereas in residential areas, throughput was found to decrease by 3.46% in the North Region and to decrease by 10.86% in the South Region. The result indicated that better performance of adaptive traffic control system in CBD in the North Region did not apply to the South Region, which was indeed worse.
   - Based on the distance between adjacent intersections, it was found there was an increase in throughput at intersections with close distance to adjacent intersections (100 to 200 m), but a decrease in throughput at intersections with a greater distance to adjacent intersections (> 400 m). This occurred in both regions. The results indicated that the performance of SCATS was better at intersections that were closer to adjacent intersections, but the performance of Fixed Time control was better at intersections with farther distance to adjacent intersections.
   - Throughput was found to increase by less than 2% on roads with high v/c ratio and on roads with low levels of side friction in the North Region. The condition was worse in the South Region. The results indicated that performance of SCATS in increasing throughput was not significantly better.
   - In general, increases in queue lengths always occur at intersections in the North Region as well as in the South Region based on the

classification of intersections. The results indicated that on average performance of SCATS, in terms of queue length as a performance measures, was worse than those of Fixed Time control.

Table 1. Flow and queue length differences between SCATS and Fixed Time traffic control systems in Bandung road network based on classification

no.	classification	flow difference (%)				queue length difference (%)							
		morning peak	off peak	afternoon peak	average	morning peak		off peak		afternoon peak		average	
						mean	max	mean	max	mean	max	mean	max
	North Region												
1	all (48) intersections	-12.00	4.61	4.35	-1.01	40.05	26.60	7.29	13.03	162.07	8.66	69.80	16.10
2	number of leg intersections:												
	3 leg intersections	-8.96	3.35	11.45	1.94	248.85	36.43	84.86	14.64	104.11	19.15	145.94	23.41
	4 leg intersections	-12.06	6.43	-0.40	-2.01	85.48	36.22	123.25	36.26	161.99	34.71	123.57	35.73
	5 leg intersections	0.90	0.55	19.22	6.89	60.35	49.14	138.25	52.88	-1.99	22.63	65.54	41.55
3	the existence of CCTV:												
	without CCTV	-10.03	5.47	4.92	0.12	147.83	37.72	113.89	29.08	140.27	28.52	133.99	31.77
	with CCTV	-16.33	-0.55	0.05	-5.61	59.26	23.60	56.04	32.54	50.58	31.35	55.29	29.16
4	Location:												
	CBD	-8.76	2.63	8.29	0.72	136.84	29.07	98.53	25.01	87.90	19.74	107.76	24.61
	Residential Area	-16.00	13.39	-7.76	-3.46	160.65	62.97	149.77	43.69	291.95	58.81	200.79	55.15
5	the distance to the closest int:												
	100 m - 200 m	-6.91	8.49	7.85	3.14	36.14	22.48	77.75	45.30	39.05	33.80	50.98	33.86
	200 m - 300 m	-21.50	4.59	5.56	-3.78	341.08	66.73	191.32	38.15	104.31	17.03	212.24	40.64
	300 m - 400 m	-0.77	4.67	14.36	6.09	12.58	3.78	11.66	5.45	33.17	7.67	19.13	5.63
	> 400 m	-7.93	4.59	-1.73	-1.69	90.79	35.00	107.54	29.01	235.29	45.63	144.54	36.55
6	v/c of the road												
	high v/c	-8.35	5.52	6.52	1.23	99.15	30.60	40.75	16.94	124.37	23.83	88.09	23.79
	low v/c	-18.30	3.46	-2.63	-5.82	99.15	30.60	40.75	16.94	124.37	23.83	88.09	23.79
7	level of side friction												
	high level of side friction	-11.59	2.87	3.95	-1.59	154.12	34.35	115.84	32.14	109.05	25.73	126.34	30.74
	low level of side friction	-9.26	7.31	5.27	1.11	130.46	39.32	104.71	26.45	160.27	31.65	131.81	32.47
	South Region												
1	all (42) intersections	-1.06	-7.09	2.74	-1.80	3.01	12.57	41.42	29.30	-6.13	9.45	12.77	17.11
2	number of leg intersections:												
	3 leg intersections	-2.98	-6.44	-4.13	-4.52	65.31	27.05	57.21	24.44	60.48	27.34	61.00	26.28
	4 leg intersections	-1.11	-8.40	1.96	-2.52	83.53	35.92	180.78	57.95	70.14	28.58	111.48	40.81
	5 leg intersections	11.14	-2.73	47.33	18.58	-12.19	5.09	231.61	89.32	-28.05	-1.91	63.79	30.83
3	the existence of CCTV:												
	without CCTV	-1.72	-8.90	-0.63	-3.75	74.45	29.56	157.60	49.35	71.30	30.01	101.11	36.31
	with CCTV	2.12	-1.86	16.91	5.72	97.80	57.07	163.55	70.08	33.97	13.25	98.44	46.80
4	Location:												
	CBD	-1.37	-5.56	2.41	-1.51	84.90	36.83	118.35	42.96	70.23	29.73	91.16	36.51
	Residential Area	0.69	-30.08	-3.18	-10.86	10.15	1.81	539.37	141.15	25.45	7.47	191.66	50.14
5	the distance to the closest int:												
	100 m - 200 m	1.67	-2.82	19.18	6.01	146.43	71.02	179.61	76.61	-4.15	-9.95	107.30	45.89
	200 m - 300 m	2.07	-4.32	9.40	2.38	73.23	29.40	136.15	55.33	45.48	41.99	84.96	42.24
	300 m - 400 m	-3.07	-14.17	-4.95	-7.40	87.84	30.70	255.11	77.67	99.60	28.37	147.52	45.58
	> 400 m	-2.14	-6.17	-1.74	-3.35	50.44	26.08	84.44	22.60	70.78	31.55	68.56	26.74
6	v/c of the road:												
	high v/c	0.83	-4.84	6.32	0.77	74.56	32.47	96.12	35.60	54.51	18.42	75.06	28.83
	low v/c	-3.37	-11.26	-3.01	-5.88	81.32	34.62	227.01	70.70	78.56	37.73	128.97	47.68
7	level of side friction:												
	high level of side friction	-1.91	-6.00	-0.92	-2.94	69.98	30.35	97.00	36.15	69.56	33.14	78.84	33.22
	low level of side friction	0.48	-12.13	8.12	-1.18	95.19	40.51	295.54	88.35	57.95	15.28	149.56	48.05

4. On average, based on the road hierarchy of the streams, the application of SCATS traffic control system in the North Region produced the following results (Table 2):
   - An increase in density was found on primary arterial roads (6.52%), secondary arterial roads (2.87%), primary collector roads (13.36%), secondary collector roads (17.19%) and a decrease on local roads (9.67%).
   - A variety of values (increases and decreases) was found in speed and number of stops on each road hierarchy.
   - There was an increase in travel time found on primary arterial roads (3.15%), secondary arterial roads (1.19%), primary collector roads (17.04%), secondary collector roads (32.25%) and a decrease on local roads (8.62%).
   - There were increases in delays and stop times at a variety of levels on all road hierarchies.

All of the above results indicated that the performance of adaptive traffic control system was found to be better than Fixed Time on local roads than those in streams with very congested traffic, such as arterial roads and collector roads. However, the increase of the system performance is not significant because the decrease in density and travel time were less than 10 percent.

5. Based on road hierarchy of the streams, the application of SCATS traffic control system in the South Region shows the following results (Table 3):
   - There was an increase in density, delay time and stop time found at a variety of values at every road hierarchy.
   - There was an increase in travel time found on primary arterial roads (15.87%), secondary arterial roads (19.78%), primary collector roads (7.20%), secondary collector roads (45.43%) and a decrease on local roads (0.28%).
   - There was a variety of values (increases and decreases) found in speed and number of stops on each road hierarchy.

   Similarly to the conditions in the North Region, the performance of the adaptive traffic control system in this region was found better than Fixed Time control on local roads than that in the streams with higher road hierarchy. However, the increase in system performance is not significant, because the decrease in travel time was only 0.28%.

6. The performance of SCATS was found to be better but not significantly so on local roads in the North Region as well as in the South Region. In addition, there was a variety of values (increases and decreases) in density, speed, travel time, delay time, stop time and number of stops during off peak period and afternoon peak period as the results of the application of SCATS.

Table 2 Traffic performances difference in Bandung North Region

no.	Stream	density difference (%)	speed difference (%)	travel time difference (%)	delay time difference (%)	stop time difference (%)	no of stops difference (%)
	Primary Arterial Road						
1	Jend. A. Yani E to W	-10.12	5.01	-22.03	-22.88	-23.02	25.87
2	Jend. A. Yani W to E	-13.20	3.86	-17.46	-39.30	-42.40	-21.64
3	KH. Mustofa E to W	6.96	-0.48	5.70	50.34	77.16	9.85
4	KH. Mustofa W to E	7.39	-0.32	1.50	14.83	23.94	-3.33
5	Pasteur E to W	7.44	9.27	10.75	15.77	18.29	-11.46
6	Pasteur W to E	28.06	-8.66	52.72	132.63	178.19	13.13
7	Surapati E to W	-19.82	2.83	-26.20	-33.54	-34.70	-26.54
8	Surapati W to E	45.46	-3.32	20.22	130.37	196.12	77.22
	avg=	6.52	1.02	3.15	31.03	49.20	7.89
	Secondary Arterial Road						
1	Laswi N to S	2.66	-0.39	0.00	0.00	0.00	0.00
2	Laswi S to N	3.08	-4.78	2.37	3.52	3.19	12.92
	avg=	2.87	-2.59	1.19	1.76	1.59	6.46
	Primary Collector Road						
1	Pasirkaliki N to S	-0.36	-0.96	21.23	45.79	55.79	-3.62
2	Pasirkaliki S to N	27.09	-4.37	12.85	28.79	33.82	-5.83
	avg=	13.36	-2.67	17.04	37.29	44.81	-4.73
	Secondary Collector Road						
1	A.R. Saleh E to W	-9.80	0.50	-0.55	-22.62	0.00	0.00
2	A.R. Saleh W to E	-9.36	7.19	-9.44	-35.44	-39.32	-31.17
3	Cihampelas	138.97	-15.32	280.14	538.75	590.30	166.37
4	Garuda N to S	-12.06	0.64	-0.59	-3.50	0.00	12.22
5	Garuda S to N	0.15	0.02	0.00	0.00	0.00	0.00
6	H. Juanda N to S	37.61	-6.68	32.31	100.13	124.90	50.70
7	H. Juanda S to N	16.43	-3.35	17.12	48.16	60.45	-1.04
8	Pajajaran E to W	-17.38	8.98	-6.59	-14.15	-10.63	-13.16
9	Pajajaran W to E	17.78	-4.35	15.05	28.22	27.65	-0.12
10	R.E. MartadinATA E to W	13.27	-3.37	17.51	53.44	76.75	7.58
11	R.E. MartadinATA W to E	13.45	-1.98	9.76	27.72	36.48	7.04
	avg=	17.19	-1.61	32.25	65.52	78.78	18.04
	Local Road						
1	Cipaganti	-10.75	6.77	-6.36	12.75	45.81	-7.60
2	Diponegoro E to W	-37.16	39.35	-58.01	-62.11	-63.89	-5.25
3	Diponegoro W to E	-44.98	9.21	-17.02	-58.48	-63.84	-63.43
4	Merdeka	-12.96	0.26	-2.54	37.86	103.14	-27.23
5	WR. Supratman E to W	5.69	0.69	-0.42	-3.24	4.32	-12.54
6	WR. Supratman W to E	42.11	-8.03	32.62	100.72	117.63	36.97
	avg=	-9.67	8.04	-8.62	4.58	23.86	-13.18

Table 3 Traffic performances difference in Bandung South Region

no.	Stream	Bandung South Region density difference (%)	speed difference (%)	travel time difference (%)	delay time difference (%)	stop time difference (%)	no of stops difference (%)
	Primary Arterial Road						
1	Asia Afrika	-17.28	1.80	-9.87	40.40	81.59	-13.35
2	Jend. A Yani E to W	51.27	-31.39	67.07	158.60	236.58	37.59
3	Jend.Sudirman E to W	5.23	1.63	5.27	20.76	34.72	-1.42
4	Jend.Sudirman W to E	3.68	-0.24	1.01	3.30	6.26	-17.96
	avg=	10.72	-7.05	15.87	55.77	89.79	1.21
	Secondary Arterial Road						
1	BKR E to W	6.79	2.07	4.48	12.32	18.17	-9.32
2	BKR W to E	4.70	2.30	0.44	1.54	6.18	-18.19
3	Jamika N to S	12.78	-3.95	33.94	74.72	89.66	11.93
4	Jamika S to N	19.68	-4.63	14.97	48.08	64.23	35.12
5	Laswi N to S	-0.71	1.07	5.25	15.75	21.51	-5.51
6	Laswi S to N	16.72	-1.66	17.72	70.24	91.30	45.29
7	PETA E to W	29.32	-14.18	29.89	117.50	136.08	17.76
8	PETA W to E	4.42	-0.22	15.06	81.15	100.95	6.02
9	PP 45 N to S	17.81	-1.85	2.70	6.31	8.46	8.90
10	PP 45 S to N	32.43	-14.15	73.34	89.98	91.36	15.92
	avg=	14.39	-3.52	19.78	51.76	62.79	10.79
	Primary Collector Road						
1	Kopo N to S	4.44	-0.36	10.75	59.53	80.60	13.69
2	Kopo S to N	0.00	0.00	0.00	2.22	0.00	-8.93
3	Pasirkoja E to W	7.48	-1.43	23.87	98.33	122.86	10.76
4	Pasirkoja W to E	-2.72	2.22	-5.82	-46.83	-67.04	-53.24
	avg=	2.30	0.10	7.20	28.31	34.11	-9.43
	Secondary Collector Road						
1	Buah Batu N to S	21.23	-0.32	15.28	36.00	40.01	11.85
2	Buah Batu S to N	-11.18	1.04	-10.01	-22.95	-29.43	0.00
3	Jend.G Subroto	-12.36	-0.28	-10.11	-6.55	-3.76	-1.42
4	Jend.G Subroto	22.12	1.62	-24.39	-37.95	-41.33	-15.60
5	Kebonjati	-17.51	0.05	8.33	48.42	65.62	-6.86
6	Lembong	7.51	0.89	9.74	48.37	91.17	-8.04
7	M Ramdan E to W	-13.77	-0.15	11.63	44.02	59.52	1.71
8	M. Ramdan W to E	-12.24	2.58	-4.05	-14.58	-14.76	-22.23
9	M. Toha	91.47	-8.98	74.85	276.20	367.69	19.65
10	Pungkur E to W	294.36	-27.41	262.74	374.71	408.29	13.64
11	Pungkur W to E	16.48	-36.80	78.26	83.22	84.70	-14.37
12	Rajawali Timur	0.42	0.08	0.00	0.00	0.00	0.00
13	Suniaraja	173.40	-46.26	164.49	346.75	507.35	340.12
14	Veteran	13.76	-6.49	8.64	40.84	83.76	5.05
	avg=	41.88	-9.16	45.43	93.73	124.20	25.09
	Local Road						
1	A. Anyar	12.54	-6.43	18.23	189.29	347.62	87.90
2	Gardujati N to S	41.24	-7.01	34.17	106.03	152.27	18.24
3	Gardujati S to N	24.26	-5.17	28.05	91.20	135.69	13.62
4	Karapitan	-58.53	22.78	-65.23	-80.18	-82.34	-51.22
5	Otista	13.83	-2.87	22.46	143.52	224.23	34.47
6	Talaga Bodas E to W	-52.31	14.77	-50.52	-59.23	-60.41	-44.23
7	Talaga Bodas W to E	37.37	-2.49	10.91	29.17	40.75	-17.00
	avg=	2.63	1.94	-0.28	59.97	108.26	5.97

The above results indicated that the performance of SCATS in large city in a developing country was not significantly better than those of Fixed Time traffic control instead it was worse during high traffic congestion.

CONCLUSIONS

The application of the systems in large cities in developing countries is noteworthy because of specific local conditions commonly occur in the large cities.

In general, the results showed that advanced traffic control systems performance varied substantially according to specific local conditions which were found to have an influence on traffic performance. The evaluation found that the application of ATCS was better than Fixed Time traffic control system at intersections with 5 legs, closed to adjacent intersections, and at intersections lied in CBD.

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