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Application of the Automatic Signal Control Systems during the Construction of MRT Brown Line Train in Bangkok

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Abstract

The construction of the city line train (MRT Brown Line) in Bangkok causes critical urban traffic congestion on Thailand Highway #351 (Kaset-Nawamin). The purpose of this research was to make an efficiency comparison between the Adaptive Signal Control (ASC) and the Fixed-Time Control (FxTC) at five intersections on Thailand Highway #351 (Kaset-Nawamin). The study result indicates that in similar daily average traffic volume, the ASC can improve the traffic flow condition, resulting in shorter working times of the traffic police officers. Compare to FxTC, ASC reduces vehicle travel time in the working days and holidays.

Discipline: Civil Engineering (Traffic Engineering).

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1 Introduction

This study explores the manpower problems of traffic police officers and the development of an automatic traffic light control system on Thailand Highway#351 (Kaset-Nawamin) for flexibility in performing duties of traffic police officers. Because Highway#351 connects between Intercity

Motorway#9 and Phaholyothin Road. It is an important route because it connects to and from the city with a distance of 12.328 kilometers.

There are 5 major intersections that affect traffic and in the future there will also be a brown line electric train project that will occur on Highway#351 along with both sides of the line. It is a residence for a large group of people. This resulted in heavy traffic on this highway throughout the day.

There are many electric train construction projects, namely the Pink Line on Highway#304 (Ram Inthra) and the Green Line extension. This makes road users avoid Highway#1 (Phaholyothin) and use Highway#351 as a bypass to enter the city. As a result, traffic on Highway 351 is currently critical.

It was found that the control of traffic lights on Highway# 351of the five main intersections is under the responsibility of Khok Kram Police Station. There is only one shift per day for continue 16 working hours which do not have enough police officers to serve the people because statistics of accidents and statistics of violations of traffic laws are many, especially when parking in a no roadside parking. and violation of traffic lights in which the incident requires a fast mobile police unit to help in the event of an accident and enforce the law in case of violators found.

2 Literature Review

Prasertvasu and Raksunthorn (2016) studied enhancement of the smart vehicle actuation control traffic light system using Video Image Processing vehicle detection on large intersections for Samut Songkhram Province of Thailand. It was found that the travel delay and the length of waiting at the intersection can be reduced. both during peak hours and off peak hours

The Bureau of Traffic Safety, Department of Highways of Thailand studied the efficiency of the Adaptive Traffic Signal Control system that uses Video Image Processing vehicle detection systems on northern intersections and the Pa Kham intersection, Lampang province, was found to be able to reduce the delay. in travel and the length of the retreat at the intersection, both during rush hour and off rush hour

The Bangkok Metropolitan Administration (BMA), in collaboration with JICA (Japan International Cooperation Agency) and Electric Industries Ltd., has installed an interoperable traffic light system on Rama VI Road by installing a GPS clock and setting the time of the traffic light in each signal loop to be all equal so that the main road (Rama 6) will receive a continuous green light signal

On secondary roads, video image processing and vehicle detection are used. The evaluation of the efficiency of the system is found to reduce travel delays by an average of 7.49 percent during the day and 19.91 percent at night and reduce fuel consumption by 288 liters per day.

A study in the United States (Federal Highway Administration (FHWA)) used a timed autonomous signaling system which will adjust the format according to the current traffic conditions. The operation of the signaling system uses current traffic data to evaluate and improve the signal pattern every few minutes throughout the day, which can reduce travel time by 10-50%

compared to the fixed time signaling system and can also help reduce expenses in travel costs for businesses by up to 10 percent per year.

A study in Australia (Department of Infrastructure, Transport, Regional Development and Communication) has studied and developed the SCATS signaling system, which works to collect traffic data on the entire number of vehicles. The traffic density in each direction then sends the data to the Traffic Management Center, which has a computer to calculate the traffic signal and send the information back to set the signal time in that intersection.

A comparative study found that the SCATS signaling system reduced travel time by 21%, fuel consumption by 12% and reduced accidents, compared to a fixed-time signal system.

3 Method

This study analyzes traffics at five intersections on the Highway #351 (Kaset-Nawamin) in Bangkok, including Lat Pla Khao intersection (Int#1), Sena intersection (Int#2), Sukonthasawat intersection (Int#3), intersection under the expressway (Int#4), and water park intersection (Int#5).

These intersections normally install fixed-time control (FxTC) systems. After having done the data collection, FxTC is replaced with the Adaptive Signal Control (ASC) system. ASC data collection is made on similar traffic volumes. To compare the efficiency of the ASC and FxTC traffic light control system, data collection is divided into 3 types: (1) physical data collection of intersection (2) the working time for police officers to perform their duties (3) data collection of traffic volumes on each intersection. This uses indicators such as travel time, travel time passing intersection and working time of the police officers.

3.1 Route Traffic Volume

The FxTC traffic volume data on Saturday 9 to Monday 11 March 2021 will be used to study the fixed-time traffic control system. This study has recorded ASC data from Saturday 23 October 2021 to Monday 25 October 2021. The estimated average daily traffic for the intersection is 130,000-172,000 vehicles per day. The intersection with highest traffic volume per day is at Int#1 and the intersection with the lowest traffic volume per day is at Int#2. According to data recording, it was found that Monday had the highest average traffic compared to other days, and the traffic is lowest on Sunday.

3.2 Improvement of the Signaling System

To improve the signaling system at the intersection, All intersections are equipped with Adaptive Signal Control (ASC), which operates the lights according to traffic flow. It will calculate the amount of traffic in every direction. The system has the ability to calculate the continuity of the signal based on the minimum green signal and will extend the duration of the green signal.

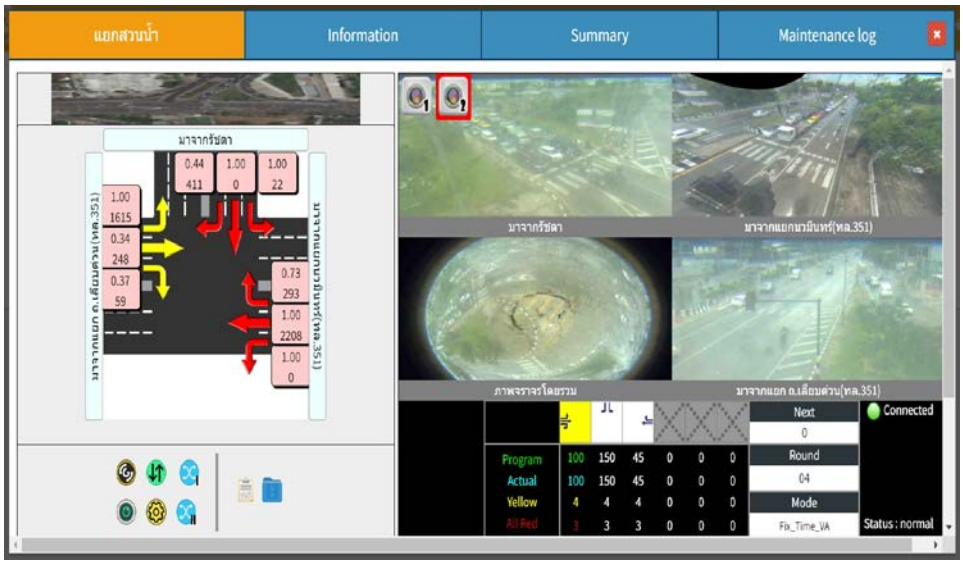

Figure 1: The picture shows the operation of the ASC system.

4 Result and Discussion

4.1 Working Times of Traffic Police Officers

The study has collected data and statistics on the work time of traffic police officers who control light signals. The time for police officers to perform their duties in the ASC traffic light system compared to the FxTC was shorter up to 5 hours a day on weekdays and Sundays.

On Saturday, the automatic traffic light control system cannot reduce the time spent performing duties of the traffic police.

Table 1: Working time of the traffic police officers.

Type of the traffic light signal control system	Date	Police Working Time		Number of Hours change
		Period	Number of hours	
FxTC	Saturday 9 March 2021	10.45 – 21.00	9 Hours 15 Mins	45 Mins more
ASC	Saturday 23 October 2021	11.00 – 21.00	10 Hours	
FxTC	Sunday 9 March 2021	09.45 – 11.00 15.00 – 20.45	7 Hours	5 Hours less
ASC	Sunday 24 October 2021	13.00 – 14.00 19.00 – 20.00	2 Hours	
FxTC	Monday 9 March 2021	06.00 – 11.45 13.15 – 20.00.	13 Hours 15 Mins	5 Hours less
ASC	Monday 25 October 2021	06.00 – 10.00 15.45 – 20.00	8 Hours 15 Mins	

4.2 Travel Time

This study compares the efficiency in terms of travel time of vehicles on Highway#351. The statistics of travel time is obtained from the vehicle travel time measurement systems (FxTC and ASC) on Saturday (holiday) and Monday (working day), and are compared between FxTC and ASC for INT#1 to INT#5.

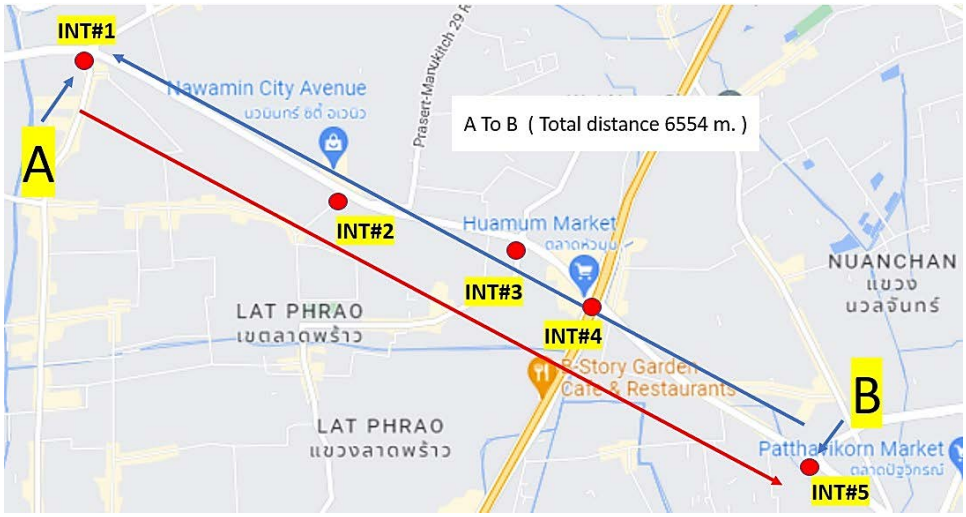

Figure : Studied intersections on Highway#351 (Courtesy of Google Maps).
(Available from https://www.google.com/maps/@13.8348229,100.6311244,13.61z).

From the collected data of the travel time measurement system. It was found that ASC traffic lights can help vehicles increase their average speeds from 1.70 to 7.60 kilometers per hour. And an automated traffic signal system can help vehicles speed up to 8 kilometers per hour at night when traffic is not heavy. In the daytime in the inbound direction, vehicles can speed up to 10 kilometers per hour, and has a slight decrease in speed in the outward direction by about 1.80 kilometers per hour.

Table 2: Data on speed increase after light control system improvements on Saturday.

Period	Speed of traffic flow (km/h)					
	INT#1 To INT#5			INT#5 To INT#1		
	FxTC	ASC	Change	FxTC	ASC	Change
Daytime (10:00-15:45)	31.6	29.6	-2.0	33.1	39.9	+6.8
Nighttime (20:00-24:00)	38.3	42.1	+3.8	39.5	47.5	+8.0
Average	35.9	37.6	+1.7	37.2	44.8	+7.6

Table 3: Data of increased speed after improving the signal control system on weekdays.

Period	Speed of traffic flow (km/h)					
	INT#1 To INT#5			INT#5 To INT#1		
	FxTC	ASC	change	FxTC	ASC	change
Daytime (10:00-15:45)	25.4	24.6	-0.8	25.5	32.5	+7.0
Nighttime (20:00-24:00)	39.3	42.6	+3.3	45.6	50.3	+4.7
Average	34.2	36.1	+1.9	38.3	43.8	+5.5

4.3 Travel Time through the Intersections of Vehicles on Secondary Roads

On weekdays, the automatic traffic light system has been found to reduce the time of vehicles passing through the intersection throughout the three time periods, including during the morning rush hour (07.45-8.45 a.m.), and during the daytime (12.00 - 13.00 hrs.).) and during evening rush hours (4:00 PM - 5:00 PM), there may be some points that the pre-improved light system has a faster travel distance than the post-improved light system, but there is only a slight difference.

On Saturday, the automatic traffic light system was found to reduce the time of vehicles passing through intersections in two time periods: during the daytime (12.00-13.00) and during the evening rush (14.00 - 17.00). During the morning rush hour (07.45-08.45) the fixed-time traffic control system can do better because the main traffic in the morning is vehicles coming from Ratchada Road heading to the road intersection. along expressway Ramintra-At Narong

According to the study, the travel distance showed that the automatic traffic signal system can help vehicles to increase average speed by an average of 1.70 to 7.60 kilometers per hour and reduce travel time on secondary roads throughout the whole Day, which corresponds to the literature that has been presented both in Thailand and abroad.

Travel time through intersections of vehicles on secondary roads is reduced throughout the day on weekdays (weekdays), during daytime and Saturday evening rush hour (holiday)

5 Conclusion

In the study, the Adaptive Signal Control (ASC) system is compared with a fixed-time FxTC traffic signal control system at five intersection on Highway#351 in Bangkok, Thailand, with average daily traffic between 92000 cars per day and 160000 cars per day. From this study, travel time was found that ASC can help vehicles increase their average speed. Working time for police officers in an ASC traffic light control system is reduced compared to a FxTC signal control system, both on weekdays (working days) and on Sundays (holidays) by 5hours per day.

6 Availability of Data and Material

All information has been included.

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