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A STUDY OF PEDESTRIAN SIGNALS IN THAILAND

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ABSTRACT

This study focuses on observing the pedestrian signal at two midblock crossings and three intersection crossings located in Bangkok, Thailand. The data has been collected for traffic phases and pedestrian phases. All are pedestrian two-way crossings. Each crossing width is measured. The minimum green interval are computed using the crossing width information. These are compared with the actual green interval for all crossings. The study finds that actual green interval are not enough. The warning remaining time for pedestrians to cross is not enough that pedestrians needs to run to get through causing unsafe conditions. Pedestrians also do not understand the pedestrians' rule of law that they should stop when warning of pedestrian signal showing as flashing. The minimum pedestrians' green interval should be considered with pedestrians' startup lost time and crossing width.

Disciplinary: Civil Engineering (Traffic Engineering).

1. INTRODUCTION

Accident data from the Thailand Accident Research Center, Asian Institute of Technology reports the statistics of highways accidents for 2013-2017, found that the characteristics of high-impact collisions include 'car and pedestrian accidents', which are classified as accidents with the highest severity index due to having an average of 55 deaths per 100 accidents. The cause of pedestrian accidents is no safe crossing point. Also, drivers do not respect traffic laws as they do not stop their car for people to crossing the road, making pedestrians more vulnerable to accidents.

Pedestrians traffic lights are regarded as one of the important equipment for people crossing the road. Pedestrians on the crossroads are another factor that is overlooked in the intersection design. Although equipment has been introduced to increase safety and reduce the risk for pedestrians

However, the current junction design of various departments such as the Department of

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Highways, Department of Rural Roads and various local agencies, mainly focusing on resolving vehicle traffic jams Affecting the safety of people crossing the road and vehicle users For the traffic to be effective This research is a study to make traffic signal management efficient and safe for both drivers and people crossing.

1.1 DETERMINING CROSSWALK TIME-SPACE

The design of the traffic light for pedestrians is based on the Highway Capacity Manual 2010. The green time for intersections or crossings must consider the green interval. For the timing of the traffic signal intended for pedestrians. Since the length of the signal at these strokes has a direct impact on pedestrian crossing success rates. If the length of the signal in this stroke is too short, pedestrians to have not enough time to cross the road. Which increases the likelihood of an accident on the crosswalk higher, but if the signal at this time is too long Will affect vehicles on the intersection, wasting more time traveling through the intersection than is necessary Therefore, the green time for pedestrians must be designed with regard to the main factors such as the number of pedestrians, the walking speed of pedestrians, the length of the crosswalk, Width of a crosswalk and Start-up time of pedestrians. Pedestrian signal criteria can be calculated from equation one and equation two as follows.

$$t = \mathrm{SLT} + \frac{L}{S} + 0.81\frac{N}{W} \qquad W > 3m \tag{1}$$

$$t = SLT + \frac{L}{S} + 0.27N \qquad W \leq 3m \tag{2}$$

Where

- t = time for crossing (seconds)
- L = length of the crossing (meters)
- S = Pedestrian walking speed (meters / seconds)
- N = number of people crossing for that time period (person)
- W = width of the crossing (meters)
- SLT = Startup lost time (seconds) (normally 3.2 seconds).

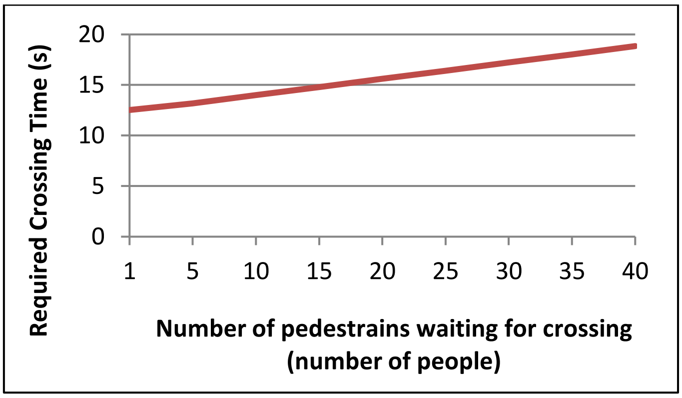


Figure 1: Required Green interval signal at a given number of crossing pedestrains for 5m width and 11m crossing length, with walking speed 1.2m/s.

1.2 PEDESTRIAN SIGNAL PHASES

Pedestrian signal according to the Manual on Uniform Traffic Control Devices for Streets and Highways 2009 that the range of Phase pedestrian signal has 3 phases. The first phase signal is red time. The second phase signal is green time and the thrid phase signal is Is a flashing red time.

2. LITERATURE REVIEW

Zhang et al. (2018) investigated pedestrian phase pattern in a traffic light scheduling problem for signalized network, by presenting a traffic signal scheduling strategy for a pedestrian-vehicle mixed-flow network with consideration of the pedestrian two-way crossing phase (TWC) and the exclusive pedestrian phase (EPP) in the urban traffic system.

Alhajyaseen (2010) studied current signal control strategies tending to ignore the pedestrian delays that may be imposed by reducing traffic delays. This is reasonable for motorways and rural roads where vehicular traffic is dominant over pedestrian traffic.

Gårder (1989) carried out a traffic conflicts technique. Most pedestrian accidents in built-up areas occur at intersections. Even after signalization the number of accidents involving pedestrians often remains high. This paper describes how the traffic conflicts techniques has been used to examine the risk to pedestrians at 120 intersections.

Ma (2014) discussed established quantitative criteria for selecting pedestrian phase patterns between the exclusive pedestrian phase (EPP) and the normal two-way crossing (TWC) with both safety and efficiency factors traded-off in an economic evaluation framework.

Kattan et al. (2009) studied the City of Calgary, Alberta, Canada, with an implementation of a pilot test of the pedestrian scramble operation (or the Barnes dance) at two intersections in the downtown area. Pedestrian scramble is an exclusive pedestrian signal phase in which traffic in all four directions is stopped and pedestrians are allowed to make diagonal as well as lateral crossings. The purpose of this study is to evaluate the pilot project at one intersection to determine the effect of this new operation on pedestrian safety.

Noland (2007) analysed simple hypothetical network using the VISSIM micro-simulation model to study the effects of signal cycle timings on delay and travel time costs for both vehicles and pedestrians in various pedestrian phasing scenarios.

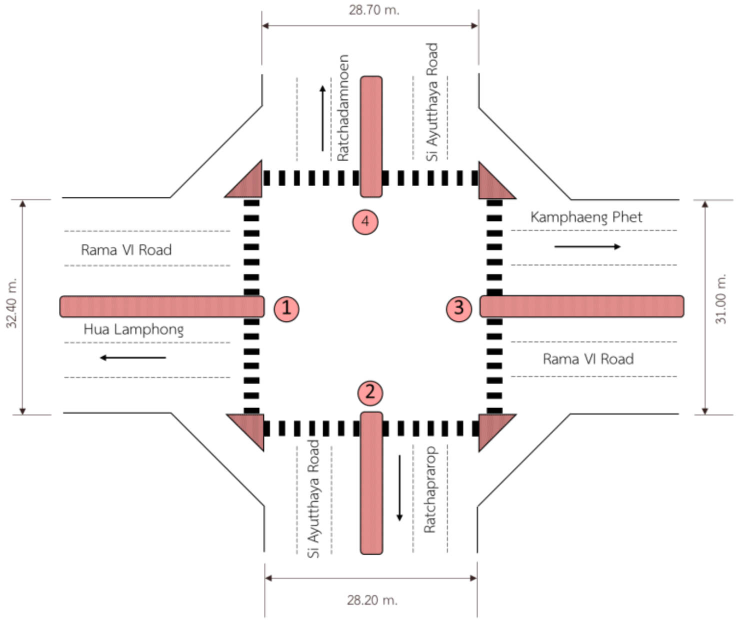
All the works have been done and reported so far involved with of pedestrian safety. This research investigates green interval and pedestrian signal phases for all crossings.

3. MODELING STUDY AREA

This study collect data from five two midblock crosswalks and three intersection crosswalks located in Bangkok. These three intersection crosswalks are (1) Crosswalks on the Sri Ayutthaya intersection (2) Crosswalks on Arun Amarin intersection (3) Crosswalks on Suan Miskawan intersection. The two midblock crosswalks are (4) Midblock crosswalk in front of the Din Daeng District office, Mitmaitri Road and (5) Midblock crosswalk beside the Bangkok City Hall M. The physical characteristics of the five crossing are shown as follows.

3.1 SRI AYUTTHAYA INTERSECTION

In the area of Sri Ayutthya Road intersecting with Rama VI Road, having four legs, six traffic lanes. The crosswalk widths are 32.40, 31.00, 28.20 and 28.70 meters as show in Figure 2 (a). Traffic signal phase of the Sri Ayutthaya intersection as shown in Table 1 and Figure 2 (b). Comparative table of the shortest green interval and the current green interval used in the Sri Ayutthaya intersection as shown in Table 2.



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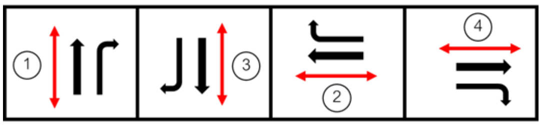


(b)

Figure 2: Physical and traffic signal phase of the Sri Ayutthaya intersection.

Table 1: Traffic signal phase of the Sri Ayutthaya intersection (in seconds).

Time period	Phase 1	Phase 2	Phase 3	Phase 4	Signal cycle time
6:00-20:00	55	45	35	40	175
20:00-23:00	40	40	25	25	130
23:00-6:00	35	35	35	35	140

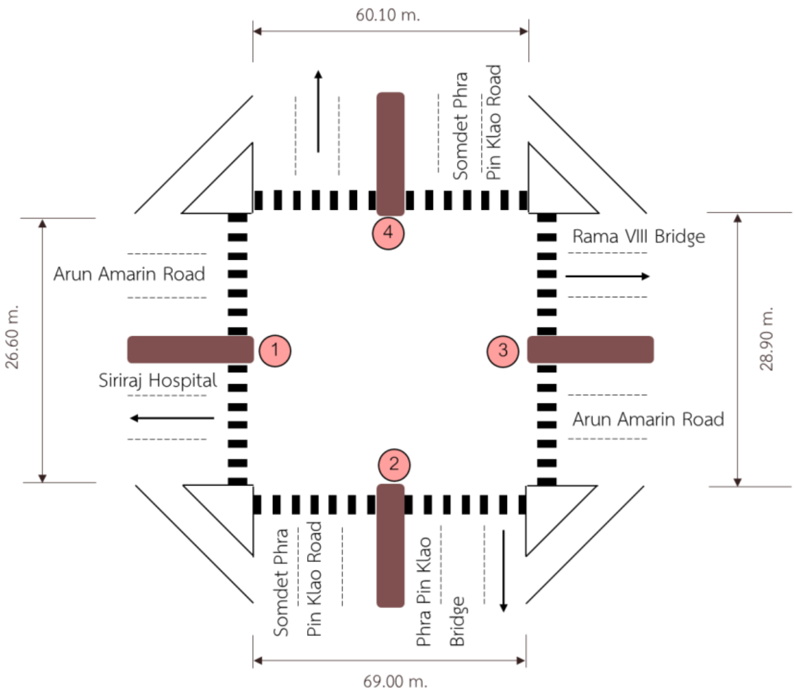
Table 2: Comparative table of the shortest green interval and the current green interval used in the Sri Ayutthaya intersection.

Time period	Phase	Length of crosswalk (meters)	The minimum green interval (seconds)	Current green interval (seconds)	Different time (seconds)
6:00-20:00	Phase 1	32.4	30	55	25
	Phase 2	31	29	45	16
	Phase 3	28.2	27	35	8
	Phase 4	28.7	27	40	13
20:00-23:00	Phase 1	32.4	30	40	10
	Phase 2	31	29	40	11
	Phase 3	28.2	27	25	-2
	Phase 4	28.7	27	25	-2
23:00-6:00	Phase 1	32.4	30	35	5
	Phase 2	31	29	35	6
	Phase 3	28.2	27	35	8
	Phase 4	28.7	27	35	8

3.2 ARUN AMARIN INTERSECTION

In the area of Arun Amarin Road intersecting with Somdet Phra Pinklao Road, having four legs, six traffic lanes. The crosswalk are 26.60, 69.00, 28.90 and 60.10 meters as show in Figure 3 (a). Traffic signal phase of the Arun Amarin intersection as shown in Table 3 and Figure 3 (b). Comparative table of the shortest green interval and the current green interval used in the Arun

Amarin intersection as shown in Table 4.



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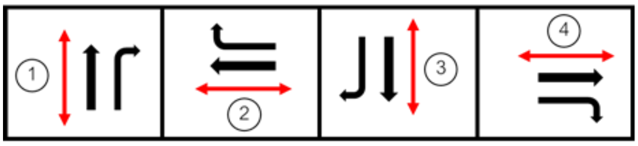

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Figure 3: Physical and traffic signal phase of Arun Amarin intersection.

Table 3: Traffic signal phase of Arun Amarin intersection (in seconds).

Time period	Phase 1	Phase 2	Phase 3	Phase 4	Signal cycle time
6:00-22:00	25	20	40	25	110
22:00-6:00	20	15	25	20	80

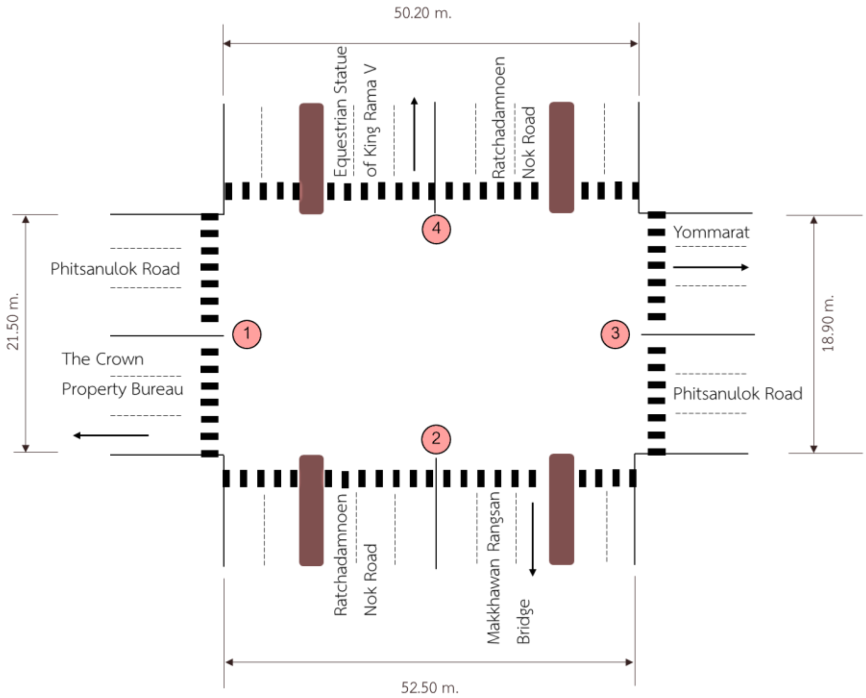
Table 4: Comparative table of the shortest green interval and the current green interval used in the Arun Amarin intersection.

Time period	Phase	Length of crosswalk (meters)	The minimum green interval (seconds)	Current green interval (seconds)	Different time (seconds)
6:00-22:00	Phase 1	26.6	26	25	-1
	Phase 2	69	61	20	-41
	Phase 3	28.9	28	40	12
	Phase 4	60.1	54	25	-29
22:00-6:00	Phase 1	26.6	26	20	-6
	Phase 2	69	61	15	-46
	Phase 3	28.9	28	25	-3
	Phase 4	60.1	54	20	-34

3.3 SUAN MISKAWAN INTERSECTION

In the area of Ratchadamnoen Nok Road, intersecting with Phitsanulok Road, having four legs, six and ten traffic lanes. The crosswalk are 21.50, 52.50, 18.90 and 50.20 meters as show in Figure 4 (a). Traffic signal phase of the Suan Miskawan intersection as shown in Table 5 and Figure 4 (b). Comparative table of the shortest green interval and the current green interval used in the Suan

Miskawan intersection as shown in Table 6.



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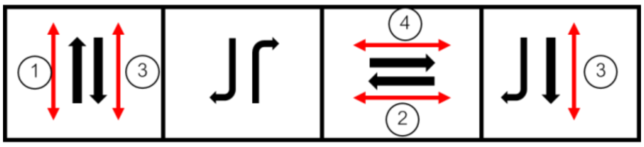

(b)

Figure 4: Physical and traffic signal phase of the Suan Miskawan intersection.

Table 5: Traffic signal phase of the Suan Miskawan intersection (in seconds).

Time period	Phase 1	Phase 2	Phase 3	Phase 4	Signal cycle time
6:00-22:00	50	35	40	15	140
22:00-6:00	30	20	20	10	80

Table 6: Comparative table of the shortest green interval and the current green interval used in the Suan Miskawan intersection.

Time period	Phase	Length of crosswalk (meters)	The minimum green interval (seconds)	Current green interval (seconds)	Different time (seconds)
6:00-22:00	Phase 1	21.5	21	50	29
	Phase 2	50.2	45	35	-10
	Phase 3	52.5	47	40	-7
	Phase 4	18.9	19	15	-4
22:00-6:00	Phase 1	21.5	21	30	9
	Phase 2	50.2	45	20	-25
	Phase 3	52.5	47	20	-27
	Phase 4	18.9	19	10	-9

3.4 MIDBLOCK CROSSWALK IN FRONT OF DIN DAENG DISTRICT OFFICE, MITMAITRI ROAD

Midblock crosswalks in front of Din Daeng District Office Located on Mitmaitri Road Located on the same side as the Thai-Japanese stadium, Din Daeng, having 4 traffic lanes in 2 directions, 2 traffic lanes in opposite directions. The midblock crosswalk are 11 meters as show in Figure 5.

Comparative table of the shortest green interval and the current green interval used in the Suan Miskawan intersection as shown in Table 7.

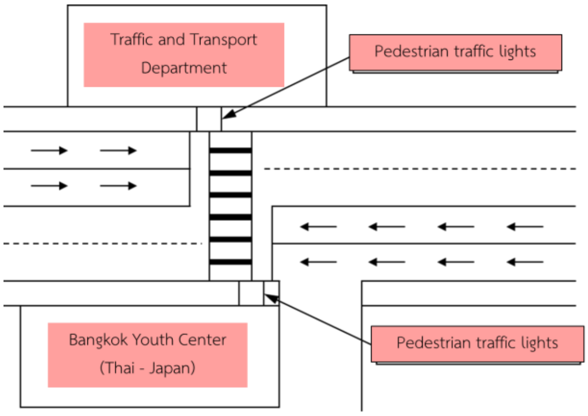

Figure 5: Physical characteristics of midblock crosswalks in front of the Din Daeng District office.

Table 7: Comparative table of the shortest green interval and the current green interval used at midblock crosswalks on Mitmaitri Road.

Area	Length of crosswalk (meters)	The minimum green interval (seconds)	Current green interval (seconds)	Different time (seconds)
Mitmaitri Road Crosswalk	11	13	10	-3

3.5 MIDBLOCK CROSSWALK BESIDE BANGKOK CITY HALL DINSO ROAD

Midblock crosswalk beside bangkok city hall located on pencil road, having 4 traffic lanes in 2 directions, 2 traffic lanes in opposite directions. The midblock crosswalk 11 meters. as show in Figure 6. Comparative table of the shortest green interval and the current green interval used in the Suan Miskawan intersection as shown in Table 8.

Table 8: Comparative table of the shortest green interval and the current green interval used at midblock crosswalks beside Bangkok City Hall.

Area	Length of crosswalk (meters)	The minimum green interval (seconds)	Current green interval (seconds)	Different time (seconds)
Bangkok City hall crosswalk	11	13	15	2

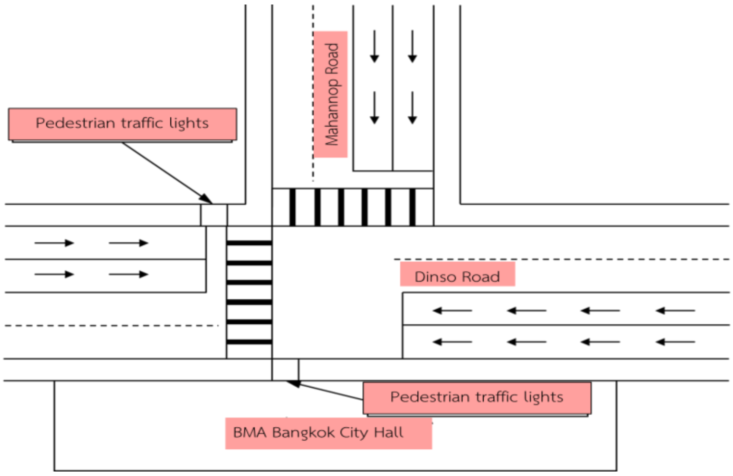

Figure 6: Physical characteristics of the crossing on the side of Bangkok City Hall.

4. ANALYSIS AND RESULTS

4.1 GREEN INTERVAL FOR PEDESTRIANS

From data collection and survey which can be divided into 2 areas which are the road signalized for both at intersection and at midblock crosswalks in Thailand. The green interval for pedestrians depends on the length of the crossing at a speed of 1.2 meters per second. Considering the green interval of the pedestrians signal in Bangkok areas, it is found that the green interval enabled for each crossing is sufficient for only those who are in the first row awaiting at the crossing as can be shown from Table 2, 4, 6, 7 and 8. There is not enough green interval to safely cross the road for pedestrian crossing. Which may increase the chances of accidents on the crosswalk.

Pedestrian signals at intersection, the green interval for pedestrians of all surveyed points is a fixed time control. The green interval is not enough for pedestrians to be able to crossing successfully as can be shown from Tables 2, 4 and 6. The changing of traffic signal phase does not consider pedestrians on the crosswalk when the traffic signal is controlled by a traffic police.

Pedestrian signals at midblock crosswalks, The green interval for pedestrians at the crosswalk being surveyed is an inappropriate and insufficient to safely crosswalk the road. The green interval activated is sufficient for the person crossing the street in the first row, that people crossing the street must immediately walk when receiving a walking green signal as can be shown from Tables 7 and 8.

4.2 PEDESTRIAN SIGNAL PHASES

Pedestrian signal phases at intersection crosswalk is to turn on the pedestrian signal for 3 phases. In the first phase, the green signal for pedestrians (Image of a green pedestrian). The second phase is the green signal flashing three times for pedestrians. (Flashing green pedestrian image) and the third phase is the red signal for pedestrians (Red pedestrian image). Found that the second phase is not adequate for pedestrians to cross the road safely. Therefore, it can be concluded that the timing of the signal on the intersection is incorrect and inappropriate.

Pedestrian signal phases at midblock crosswalk will turn on the pedestrian signal for 3 phases. When you press the button, the first phase will stop waiting for the pedestrian signal, (red walking figure) with a countdown number until zero. The second phase is a green signal for pedestrians (green pedestrian image) with a countdown number until zero and the third phase stops the pedestrian signal (the image of the red pedestrian and there are no countdown numbers). However, the second phase is to give pedestrian signal that pedestrians have to decide for themselves from the remaining time.In which the decision is based on the standard of guessing resulting in incorrect decisions or intentionally violating the power signal Which allowing pedestrians to make their own decisions may increase the likelihood of accidents. Therefore, it can be concluded that the opening of the timing signal using the countdown timer on the crossing is incorrect and inappropriate.

5. CONCLUSION

Based on data collected, the pedestrian signals are only installed on some signalized intersections which meet one of the pedestrian signal criteria. However, pedestrian phases at most intersections and midblock crosswalks are not adequate for pedestrians to cross the road safely.

The green interval for both at intersection and at midblock crosswalks must consider the number of pedestrians, the speed of pedestrians, the length of the crossing, width of the crossing and startup lost time of pedestrians. Providing pedestrian signal for midblock, crosswalk should add warning signal phase or may change to use the countdown in the warning signal phase instead.

6. DATA AVIALABILITY

Relevant information is available by contacting the corresponding author.

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