Significant reduction of cycle length via a two-stage crossing system

1. Background and goals

The cycle lengths[1] of signals at large intersections in Japan are much longer than those in Europe. This can irritate pedestrians, who must wait a long time for crossing signals to change at intersections. In addition to intersection traffic demand, the amount of time that pedestrians require to cross intersections has a large effect on determining cycle lengths. One method to reduce cycle lengths currently attracting attention is the introduction of two-stage crossings, where a central island in the middle of a crosswalk is established and pedestrian crossing signals allow crossing independently to either side of the island (Fig. 1, 2).

In this project, we performed a pilot survey for reducing cycle lengths through the introduction of two-stage crossings. We first accumulated research through on-site investigations and simulation analysis. Based on this, and with the support of road and traffic administrators, we installed two-stage crossings at the Kasumigaseki 2-chome intersection in downtown Tokyo, Japan.

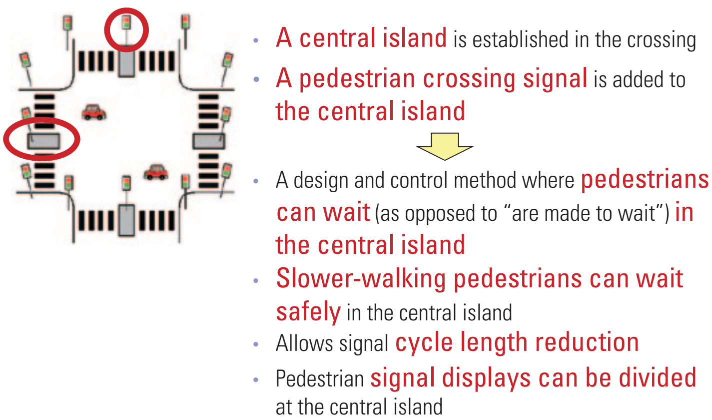

Figure 1. What is a two-stage crossing?

Figure 2. Two-stage crossings and signal display division

Project Leader: Hitoshi Ieda
Professor, Graduate School of Engineering, The University of Tokyo / National Graduate Institute for Policy Studies

(1) Signal cycle length: The time for the light on a traffic signal to cycle through green, yellow, red, and back to green. At large intersections in Japan, the signal cycle length is normally from 120 to 150 seconds.

2. Research content

In this project we (1) planned and implemented a public relations strategy, (2) performed a pilot survey and investigation, and (3) verified the effects of the experiment.

2-1. Planning and implementation of a public relations strategy

At first glance it might seem that two-stage crossings are even more inconvenient for pedestrians because the central island increases the number of times they must wait for signals, among other reasons. We therefore performed various strategic public relations activities so that users would better understand the intent of two-stage crossings.

Specifically, we created the “Easy Crossing Project KASUMIGASEKI” campaign (Fig. 3), and (1) installed explanatory panels in the Kasumigaseki subway station (Fig. 4), (2) distributed leaflets to government agencies, public offices, and pedestrians in the area, (3) created a website for answering questions and collecting opinions, and (4) advertised to the mailing lists of various organizations.

Easy Crossing Project
KASUMIGASEKI

Figure 3. The public relations logo

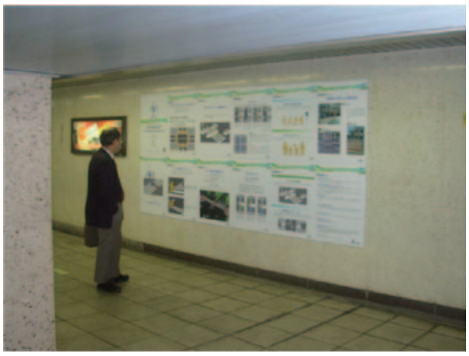

Figure 4. Explanatory panels were displayed at three locations in the station

2-2. Implementation of the pilot survey and investigation

The pilot survey was performed starting on 13 January 2009 from 10:00 to 15:00 on weekdays for one month. To ensure complete safety, we stationed a traffic guide in the central island who helped guide pedestrians (Fig. 5).

We began the experiment using a cycle length of 75 seconds (approximately one-half the normal time of 140 seconds), but as it became apparent that this caused pedestrians crossing in the counterclockwise (CCW) direction to rush, we extended the cycle length to 100 seconds from 9 February. Note that for the duration of the experiment, the cycle lengths at surrounding intersections were set to 150 seconds.

We conducted the following two investigations to measure the effects of the experiment:

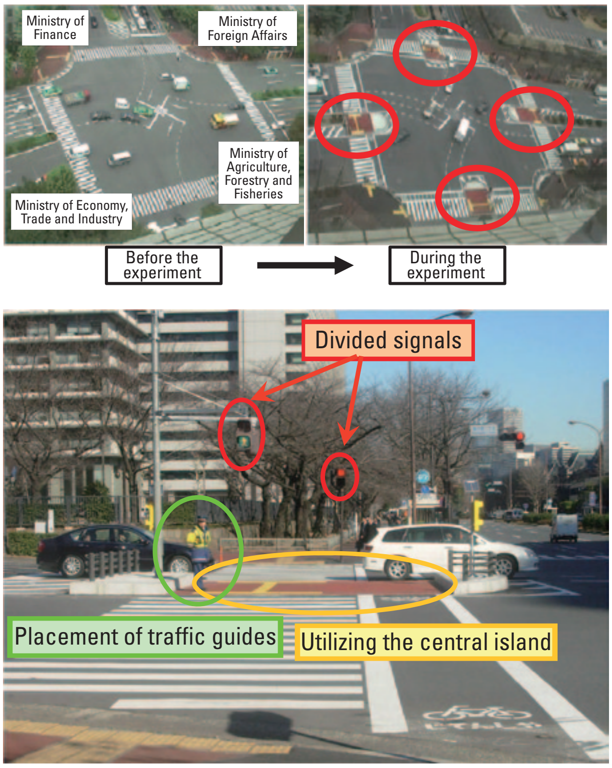

Figure 5. The pilot survey

(1) Video survey: We videotaped the crossing, and from this we measured factors such as pedestrian wait times, walking speed, how much pedestrians ignored signals, and situations when pedestrians and automobiles came into conflict.

(2) Questionnaire survey: we conducted a questionnaire survey to determine pedestrian psychology at crossings and degree of acceptance of the new crossing method.

2-3. Verification of the effect

(1) Results of the video survey

Video analysis of pedestrian behavior yielded the following results (Table 1). Note that in the analysis we weighted the spacing between arrival times of individual pedestrians, and calculated each index as a normalized uniform arrival distribution with constant density.

Table 1. Analysis results (comparison with a 140-second cycle length)

Measurement item	Two-stage crossing (75 seconds)	Two-stage crossing (100 seconds)
(1) Average pedestrian wait time	CW: 53% decrease CCW: 18% decrease	CW: 54% decrease CCW: 6% decrease
(2) Average walking speed	CW: 6% increase CCW: 26% increase	CW: 3% increase CCW: 9% increase
(3) Pedestrians in crossing after signal changes to red	CW: 3% decrease CCW: 61% increase	CW: 8% decrease CCW: 30% increase
(3)' 95th percentile walking time after signal changes to red	CW: 67% decrease CCW: 20% increase	CW: 74% decrease CCW: 12% decrease
(4) Pedestrians in central waiting island	CW: 0% CCW: 34%	CW: 0% CCW: 28%

(a) Changes in pedestrian wait times

We found that average pedestrian wait times decreased in all scenarios. Specifically, with a cycle length of 75 seconds (C75) the wait time for pedestrians crossing in the clockwise direction (CW) was decreased by 53% and that for pedestrians crossing in the CCW direction was decreased by 18%. With a cycle length of 100 seconds (C100), the CW decrease was 54% and the CCW decrease was 6%.

(b) Changes in walking speed

We next examined average pedestrian walking speed and found that with C75 there was a 6% CW increase and a particularly high 26% CCW increase. With C100, there was a significantly smaller increase in walking speed in both directions of just 3% CW and 9% CCW.

(c) Changes in the ratio of pedestrians remaining in the crosswalk and in pedestrian walking time after signal change

We also compared the ratio of pedestrians remaining in the crosswalk when the signal became red, and found that while there was a 3% CW decrease with C75, there was a very large 61% CCW increase. The CCW increase was lowered to 30% with C100. This is still not a low number, but when we compare 95th percentile values of walking time after signal change for pedestrians remaining in the crosswalk, we found that although with C75 there was a 20% CCW increase, with C100 there was a 12% CCW decrease. This indicates that with C100 pedestrians are clearing out of the crosswalk faster than with C75. When we interviewed the traffic guides regarding this, they reported that many

CCW-walking pedestrians ignored signals when the cycle length was 75 seconds, but that this was not a problem at 100 seconds.

(2) Questionnaire survey results

Responses to the questions “Were you able to cross with less waiting time than at other intersections?” and “Were you able to cross without hurrying?” showed trends similar to those found as a result of video analysis. Responses to the question “Do you think that crosswalks with a central waiting island and separate crossing signals like those used in this experiment should be applied to various other intersections?” were around 70% positive for pedestrians crossing in each direction, indicating a high level of pedestrian acceptance of two-stage crossings. However, slightly less than 40% of respondents reported difficulty understanding how to cross the two-stage crossings, indicating that this is a problem that must be addressed.

3. Conclusions

Results of the analysis of the pilot survey performed in this project indicate that cycle length reduction via two-stage crossings is an extremely effective measure for reducing automobile and pedestrian wait times and irritation. Considering that nearly 70% of pedestrians had positive feelings toward this experiment, we believe that there is a high probability that the introduction of two-stage crossings in Japan will be accepted to reduce cycle times. We note, however, that negative opinions related to pedestrian confusion were expressed regarding the new crossings. Some pedestrians would try to cross them in the usual manner, not noticing the change in signals.

In the future, it will be necessary to accumulate experience at a variety of intersections to discover methods by which two-stage crossings can be better understood, such as by changing crossing structure, adjusting the position and size of signals, changing how remaining time and wait times are displayed, or providing road lighting and voice guidance.

4. Future outlook

Since the implementation of this project, both road and traffic administrators have gained an understanding of the effectiveness of two-stage crossings, and the implementation of these systems will be considered at some locations. However, the true effect of cycle length reduction via the introduction of two-stage crossings will only be seen after the verification of network effects through their introduction at multiple locations. It will therefore be essential in the future to select locations where this method can be applied as a network, and to perform trial implementation in those areas. As we head toward the Tokyo Olympic Games in 2020, we must ensure that road intersections in Japan do not pose an international embarrassment, and that we continue to make changes for their increasingly comfortable use by both pedestrians and automobiles.